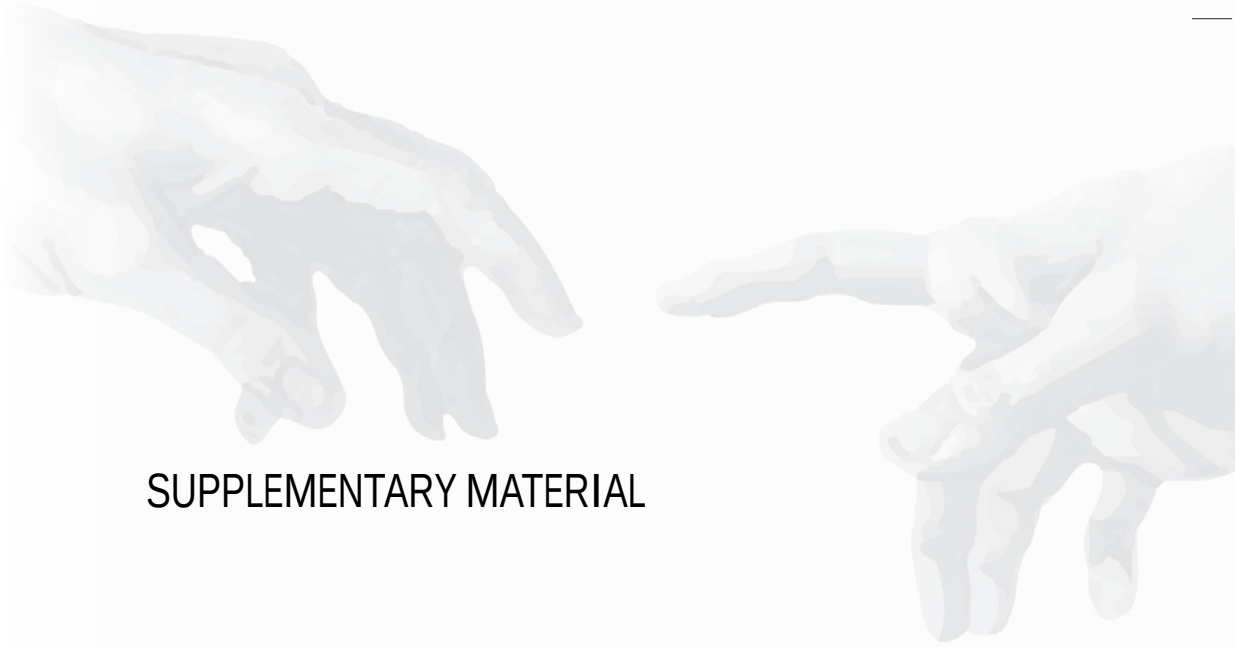

SUPPLEMENTARY MATERIAL

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Appendix A

THE COSMIC MODEL OF ARISTOTLE

All bodies move according to their nature.

— Paraphrase of Aristotle, *On the Heavens.*

According to Aristotle, there are "only these two simple motions: the circular and the straight." The former applies to the heavens and the latter to the Earth.

The Heavens

The simple motion of the Moon, Sun, planets, and stars is circular. Everything in the heavens is made up of a fifth element: aether.

Within the Sublunary Sphere

The sublunary sphere is everything below the Moon and its circular orbit. This region includes Earth at the center of the universe. All simple motion in this region is straight.[1]

All things within the sublunary sphere are made of the four elements: earth, water, air, and fire. In various combinations, these elements make up all earthly matter.[2]

The motions of earth and water are naturally downward toward the center of the Earth. The motions of air and fire are naturally upward away from the center of the Earth.[3]

Aristotle's Nested Crystalline Spheres

Aristotle writes that "the motion of heaven [is] continuous and regular and eternal."[4] He gives us a caveat:

> *This applies only to the first heaven and the first movement; for the lower spheres exhibit a composition of several movements into one.*[5]

If I interpret Aristotle correctly, the "first heaven" refers to the stars, which are contained on a single sphere. The "lower spheres" carry the planets, Sun, and Moon, respectively. They exhibit *compound motion*, thus requiring several interlocked spheres to produce that motion.

How does Aristotle justify this? "Nature makes matters equal and establishes a certain order," he writes, "giving the single motion [the stars] many bodies and to the single body [a planet, the Sun, or Moon] many motions."[6] One can almost feel the master struggling to explain here.

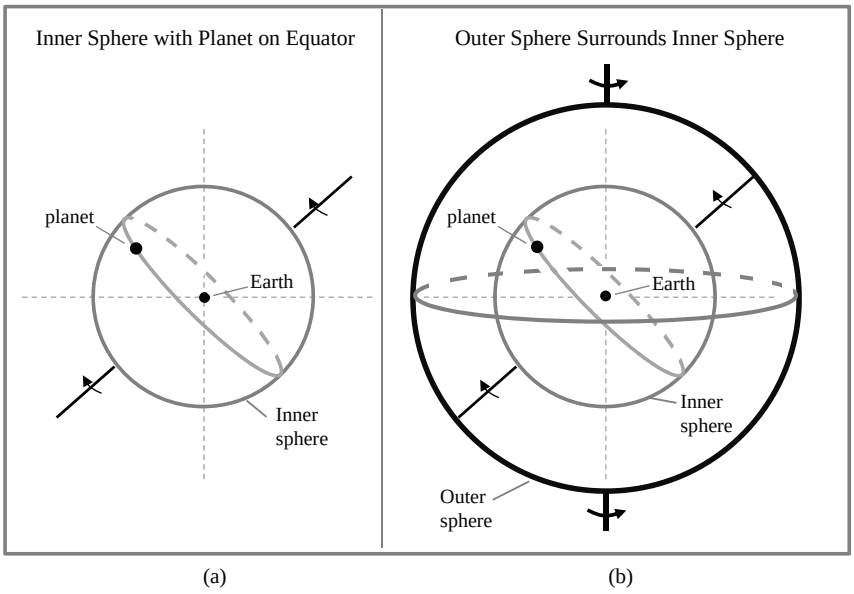


Figure A .1. Aristotle's Two Concentric Spheres Model.

The Planets and Interlocking Spheres

Aristotle's model for planetary motion uses a series of interlocking spheres. For simplicity, let's first look at a two-sphere model. Earth is at rest at the center of the inner sphere (Fig. A.1(a)). This inner sphere rotates at a constant speed on a *tilted* axis.

The inner sphere is placed inside and concentric with an outer sphere (Fig. A.1(b)). Concentric means both spheres have the same center, in this case the Earth. The outer sphere rotates in the *opposite* direction at constant speed on a *straight up-and-down* axis.

Note in the figure that the axis of the inner sphere is attached to the outer sphere. Thus, when the outer sphere rotates, the inner sphere rotates as well. But, because the inner and outer spheres rotate on different axes and in opposite directions, the inner sphere precesses like a rotating top. As a result, the planet attached to the inner sphere makes a kind of figure eight pattern, as seen from Earth. This is shown in Fig. A.2.

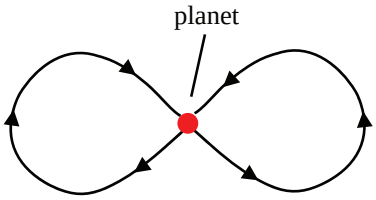


Figure A.2. Figure Eight Motion. The rotation of two nested spheres about different axes produces a so-called Hippopede motion for the planet attached to the inner sphere.

Do you see it? Imagine you are hanging onto a certain point on the surface of a great hollow ball. When it rotates, you go around with it. Now an even larger hollow ball is placed over the first one. The two poles of the inner ball are bolted to the outer one. The outer one is made to rotate in the opposite direction along a different axis.

You are the planet in Aristotle's model. You find yourself tossing to and fro from the double-rotation of the two balls.

Let us now add a third outermost ball or sphere (not shown in the figure). I know this is convoluted, but we are almost done. The third outermost sphere contains the outer and inner sphere within it. And like them, it too is centered on the Earth. (Remember, for Aristotle, the Earth is the center of the universe.)

We now have three spheres. The first sphere, the innermost, is the smallest. The second, the so-called outer sphere, is larger. The third sphere, the so-called outermost, is larger still.

Again, the axes of the first and smallest sphere are attached to the second and larger sphere. And the axes of this sphere are attached to the third and largest sphere. When the third and largest sphere rotates, it affects the motion of the other two.

The rotation of the third and largest sphere makes the figure eight pattern of the *planet* attached to the surface of the first sphere "smear across the sky," again as seen from Earth. Thus the planet undergoes a kind of pseudo retrograde motion. This is shown in Figure A.3.[7]

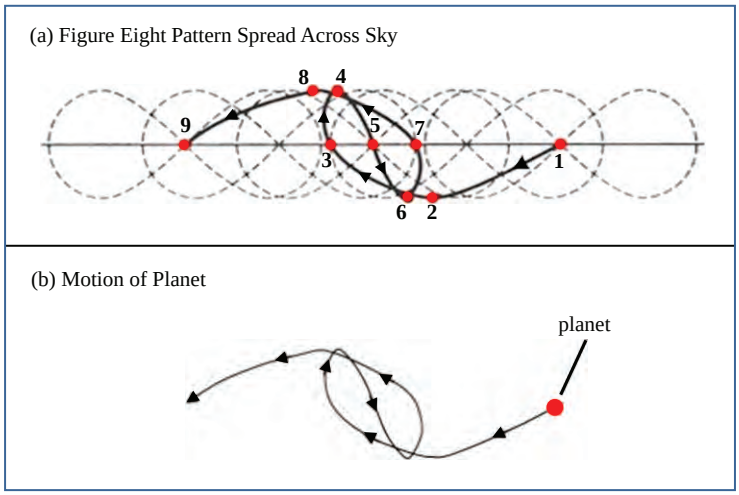


Figure A.3. Pseudo-retrograde Pattern Produced by Addition of a Third (Outermost) Sphere. (a) Hippopede pattern spread across sky as seen from Earth. (b) Resultant motion of planet attached to surface of inner sphere is roughly retrograde. Figures by Craig Sean McConnell, Associate Professor of Liberal Studies at California State University, Fullerton.

Appendix B

THREE KEYS TO THE SCIENTIFIC REVOLUTION

The Base Ten Counting System

Ancient India: Birthplace of Hinduism, Buddhism, and Jainism. Home of magnificent art, glorious architecture, and mystical literature. Land of karma, dharma, and reincarnation. Source of ground-breaking discoveries in science and mathematics.

It is said that here the base-10 numerical system was born.[1] The truth is historians do not know exactly where this history-making concept originated.[2] What is certain is that by the seventh century (600s) AD, a "base 10 numeral system with nine symbols was being used in India." The nine symbols represented the numerals one though nine. There was no zero* yet.[3]

The first sign that Indian numerals were moving west is from "Severus Sebokht, a Nestorian bishop who lived in Keneshra on the Euphrates River," according to O'Conner & Robertson.[4]

In 662 AD, Sebokht, wrote:

> *I will omit all discussion of the science of the Indians. . . of their subtle discoveries in astronomy, discoveries that are more ingenious than those of the Greeks and the Babylonians, and of their valuable methods of calculation which surpass description. I wish only to say that this computation is done by means of nine signs.*

Note the *nine signs*. The system still lacked a zero digit.[5]

It was not until the late 800s that we find Muslim mathematicians using a base-10 numerical system** with the *zero digit*. It seems "mathematicians in India took the same step at essentially the same time. The two groups apparently derived" their systems independently.[6] Thus the name: "Hindu-Arabic numerals."

---

*The Mayans of Central America and their neighbors "had independently developed the concept of zero by at least as early as 36 BC." Their counting system used "only three symbols: zero, represented as a shell shape; one, a dot; and five, a bar." Source: "Mayan Mathematics" storyofmathematics.com. https://www.storyofmathematics.com/mayan.html. Retrieved Feb 28, 2021.

**This is a *base-10 system* because there are ten and only ten symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. Numbers from ten and above require two combinations of these ten symbols; e.g., 37. Until one hundred and above, which require three combinations of these ten symbols; e.g., 721. Until one thousand and above, which require four combinations of the ten symbols; e.g., 2502. Etc. In more formal mathematical language, numbers are represented in powers of ten. One is 1×10^0. Ten is 1×10^1. One hundred is 1×10^2. Etc.

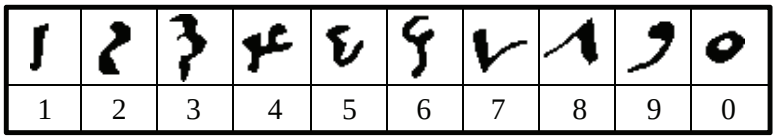


Figure B.1. Numerals from Islamic Astronomer and Mathematician Abu Sa'id al-Sijzi's Treatise of 969 AD. Modern number symbols shown below Arabic ones. Note the similarity of symbols for one, two, three, four, six, nine, and zero.[9]

"Calculation with the Indian symbols had become fairly widespread in the Arabic world" by the beginning of the eleventh century.[7] An example is shown in Figure B.1.

Another major breakthrough occurred in the early twelfth century (1100's). "Arab mathematicians in North Africa extended this numeral system to include *decimals*."[8]

To Europe and Beyond

The *Codex Vigilanus* — copied by a monk in Islamic Spain in 976 — represents the "first surviving example" of Hindu-Arabic numerals in Europe. Still, it wasn't until the twelfth century (1100s) that the counting system made inroads into Christian Europe. This was facilitated by translations of works in Arabic of mathematicians al-Khwārizmī, al-Kindī, and others into Latin.[10]

Italian mathematician Leonardo Bonacci of Pisa (1170–1250) had lived in North Africa. Also known as Fibonacci, he further spread Hindu-Arabic numerals among European mathematicians. In the beginning of his famous book *Liber Abaci* (Book of Calculation) of 1202 AD, he wrote[11]:

> *There are nine figures of the Indians: 1 2 3 4 5 6 7 8 9. With these nine figures and the symbol 0, which in Arabic is called zephirum, any number can be written . . .*

Acceptance of the new counting system was slow in Europe. Suspicion of "Muslim mathematics" was one factor.[12]

The invention of the printing press in c. 1440 changed everything. It accelerated the acceptance of the Hindu-Arabic numeral system as nothing before had — particularly in mathematics and science. European "trade, printed books, and colonialism helped popularize the adoption of Arabic numerals around the world."[13]

We tend to take the ease of use of the Hindu-Arabic counting system for granted. Consider long division. The speed of light is some 670,616,629 miles per hour. In Roman numerals that is $\overline{\overline{\text{DCLXX}}}\,|\overline{\text{VI}}|\,\overline{\text{XVI}}$ DCXXIX miles per hour. (I looked it up.) To convert that to kilometers per second, please divide by MMCCXXXVII. Good luck![14]

The adoption of the base-ten counting system, along with paper and the printing press would be key to the Scientific Revolution in the West.

The Paper-Making Process

The history is a bit muddy. Tradition says the invention of paper occurred around 105 AD in Luoyang, China. Here Ts'ai Lun or Cai Lun was a court eunuch and/or director of the Imperial Workshops. Lun cut some plant fibers and boiled them in water. He cast the resulting pulp in a mold and pressed it flat. He then dried it in sheets on screens or wooden frames. The paper-making process was born. (See Figure B-2.)[15]

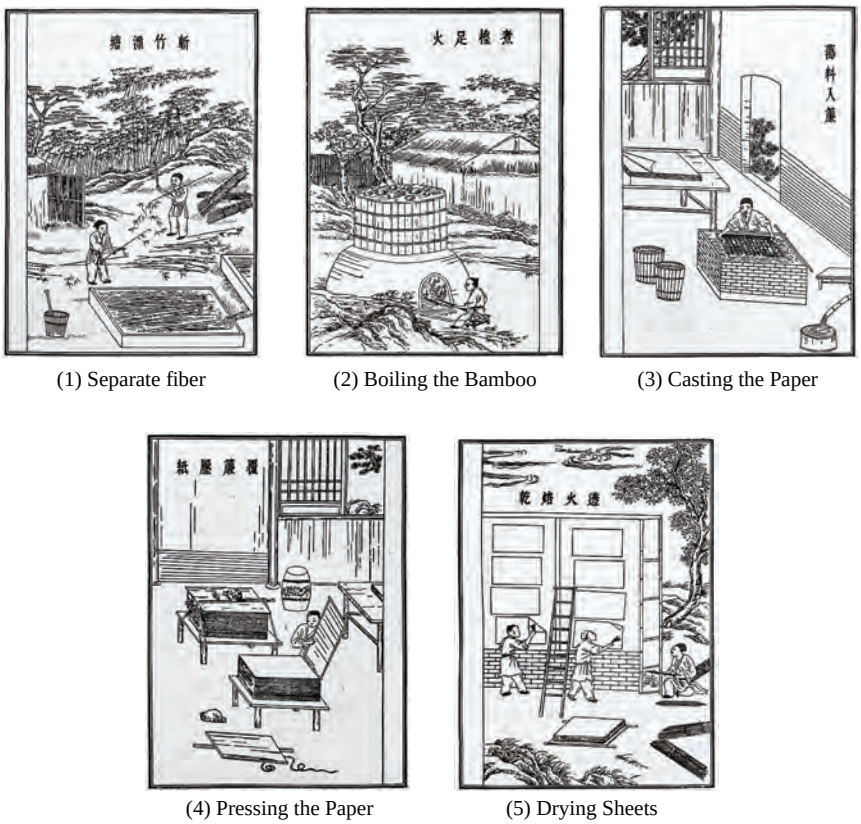
Not so fast. Recent archeological evidence "unearthed in the ancient Silk Road cities of Dunhuang and Khotan" in Western China and in Tibet suggests paper "was being made in China as early as c. 200 BC."[16] This from history teacher, writer and self-professed nerd Dr. Kallie Szczepanski. It seems that Ts'ai Lun improved an already existing process. His approach is said to have shortened production time by several months.[18]

Whatever its history, the Chinese paper making process would reverberate around the world.

Writing on paper replaced heavier and more expensive writing mediums such as "bark, silk, wood, leather, and bamboo sticks." Lightweight and inexpensive, "rolled into scrolls or folded in to booklets," paper would become ubiquitous in China.[19]

It would be used for hats, fans, umbrellas, packaging, and money. Artisans combined paper with varnish to produce exquisite "lacquer ware, storage vessels, and furniture." Its most important role was in the recording of the written word. This included calendars, funeral and wedding guides, educational material, dictionaries, almanacs, official records, documents on agriculture and farming practices, the first printed newspaper in 740 AD — and books.[20]

By the Tang dynasty beginning in the seventh to ninth centuries, "thousands of books, religious and secular, were produced," New York Times art critic Holland Carter tells us. They would play a "huge role in



(1) Separate fiber (2) Boiling the Bamboo (3) Casting the Paper

(4) Pressing the Paper (5) Drying Sheets

Figure B.2. The Ancient Chinese Paper Making Process. *Cai Lun woodcuts.*[17]

the cultural advancement of China and the World in terms of literature and literacy."[21]

Like silk, China tried to keep its paper-making process a secret. Nonetheless, paper-making technology would find its way to Korea in the 500's, Japan in 610, and Tibet and India in the mid-600s AD.[22]

To the Islamic World

Paper-making made its way west to the Islamic Empire in the eighth century (or perhaps earlier.) It appears that the Battle of Talas in Central Asia was pivotal. In 751 AD, Tang Dynasty forces faced an alliance of Arabs of the Abbasid Caliphate, the Tibetan Empire, and Uighurs. The story goes that

after the alliance's victory, Arabs took a group of Chinese paper makers prisoner.[23]

By 793, Muslims had set up a paper mill in Baghdad. Paper-making soon found its way to "Persia, Syria and North Africa." Egypt replaced its difficult to make papyrus with paper in the early 900s.[24]

Paper would be key to the Golden Age of Islam in the 8th to 12th centuries and its advances in science and mathematics. It would become the medium for books in "physics, chemistry, astronomy, optics, biology, agriculture, medicine, geometry, trigonometry, algebra, engineering, and more."[25]

By 1120, Moors had set up a paper mill in Valencia, Spain. The process soon spread to Italy and Germany.[26] Another invention would make the use of paper ubiquitous throughout Europe.[27]

The Printing Press

China had invented block printing on paper using hand-carved wood panels in 868 AD. This was replaced by moveable type printing in the eleventh century (1000s). In the 1440s, goldsmith Johannes Gutenberg invented a European version of movable type printing in Mainz, Germany.[28]

Paper was now of enormous importance. Together with the Gutenberg printing press, it would allow "the mass production of books and pamphlets" in Europe for the first time in history.[29] As discussed in Chapter 18, this would be a major factor in the spread of the Scientific Revolution (1543–1687) — and the Protestant Reformation,

It was not until the 16th and 17th centuries AD (or perhaps somewhat earlier) that Western cosmological ideas reached China. They were introduced by Jesuit missionaries who translated western astronomical and mathematical books into Chinese. These books were printed on paper.[30]

Appendix C

THE CANNONBALL AND THE MOON — SOME CALCULATIONS

The mathematical details for Newton's orbiting cannonball and the Moon are given below. They are based on lectures by Michael Fowler, Professor of Physics at the University of Virginia.[1]

Cannonball Orbiting Earth

The cannonball orbiting the Earth travels at a horizontal velocity of 8000 meters per second. It drops towards Earth 5 meters in that same second, due to Earth's gravity. Due to its curvature, Earth's surface falls away from a horizontal line at a rate, R_E of about:

R_E = 5 meters/ 8000 meters.

This means that in one second:

- The orbiting cannonball travels 8000 meters and falls **5 meters** towards Earth.
- Over that same 8000-meter distance, Earth's surface drops off **5 meters**.

Thus the cannonball never strikes the surface of the Earth. (8000 meters a second, or some 18,000 miles per hour is about the speed at which satellites in low Earth orbit travel today.)

Isaac Newton had proposed (as did Robert Hooke) that an object orbiting the Earth is both moving tangentially with respect to the Earth and falling towards the Earth. It is the combination of these two motions which gives the object (in this case the orbiting cannonball) its net motion.

Moon Orbiting Earth

The Moon is also in orbit around the Earth. It too possesses two motions 1) straight line motion tangential to the Earth, and 2) accelerating motion (falling) towards the Earth. The combination of these two motions results in its net motion around the Earth.

In other words, the Moon is constantly falling towards the Earth, but its motion tangential to the Earth is so great that it orbits the Earth rather than plunging into it. (See Figure C.1).[2]

From the size of the Moon's orbit and the time it takes to complete one revolution, Newton estimated that the Moon travels in its orbit around the Earth at a speed of about 1 km per second. From this, Newton also

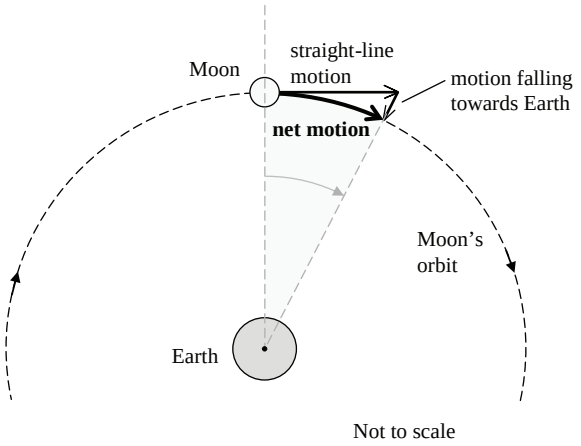


Figure C.1. The Moon Continually Falls Towards Earth as it Orbits. The Moon's net orbital motion is a result of two components, (1) straight-line motion tangential to the Earth and (2) acceleration (fall) towards Earth due to Earth's gravity. Note: The net motion of an orbiting body is termed gravitational acceleration.[3] Recall that acceleration is a change in speed and/or a change in direction. In this case, the Moon is continually changing direction as it orbits the Earth. (Note that the Moon's orbit is actually slightly elliptical. Its rotation speed also varies. Earth and Moon revolve around a common center of gravity slightly displaced from Earth's center.)[4]

determined that the Moon is falling towards the Earth at a rate of about **1.37 mm per second**.

Now, as noted, the orbiting cannonball falls towards the surface of the Earth at a rate of **5 meters per second**. Why is the orbiting Moon falling so much more slowly towards the Earth than the orbiting cannonball?

Because the Moon is so much farther away. This confirms that gravity weakens as distance becomes greater.

Comparing Cannonball and Moon Orbiting Earth

Newton guessed that the rate of the Moon and cannonball's fall depends on their respective distances from the *center of the Earth*.[5] He compared the two rates of fall to determine how much gravity weakens with distance. Newton calculated that:

- The orbiting Moon is some **60** times further away from the *center* of the Earth than the orbiting cannonball.

- The orbiting Moon falls towards the Earth a factor of **3600** times slower than the orbiting cannonball. This means that the *force* of Earth's gravity is 3600 weaker at the Moon.

Now 60 times 60 (or 60 squared) equals 3600. This confirms that gravity weakens as the *square* of the distance!

Calculation Details

The ratio of the *rate of fall* close to the Earth's surface to the orbiting Moon's rate of fall is:

Fall ratio = 5 meters per second/1.37 mm per second
= 5000 mm per second/1.37 mm per second
= about **3600**

The ratio of the *distance* from the center of the Earth to the Moon and the center of the Earth to the orbiting cannonball close to the surface of the Earth is about:

Distance ratio = 384,000 km / 6,350 km
= about **60**

Historical Note

As mentioned in Chapter 24, Newton made his first attempt at this calculation in the 1660's. It missed the mark. The "data available to him at the time was not accurate enough," Christie tell us. Instead of a fall ratio of 3600, he derived a value of over 4000.[6]

Appendix D

NEWTON BEYOND SCIENCE

There was much more to Isaac Newton's life than what is revealed in the *Principia* and his other scientific publications. His life outside the world of physics encompassed alchemy, personal feuds, politics, civil service, and more. None was more important to the Great One than his religious investigations.

Secret Writings

Of the trinity to reason
Leads to license or to treason

— Adam of St. Victor, 12th century.[1]

We now know that Isaac Newton's primary passion was religion. His private papers on the subject — released by Cambridge University in 1888 — were greater in size than all his scientific writings combined.[2] With his obsessive work ethic and exacting rational approach, the great one had attained a mastery of the Old and New Testaments matched by few theologians.

Over endless hours, Newton tried to ferret out the precise meaning and timing of obscure Hebrew Bible prophesies, and to determine the exact date for the second coming. Oddly, in all his investigations of the Old Testament, it seems he never recognized its flat-earth cosmology.[3]

Anti-Catholic to the core, Newton attacked the papacy, the invocation of saints, and the veneration of the Virgin Mary.[4] His primary objection was the Christian Doctrine of the Trinity — which he saw as heresy and a challenge to monotheism itself.

Recall that according to the Trinity, Jesus the Son of God is equal in substance and nature to God the Father. Newton saw this as a violation of God's First Commandment: *Thou shalt have no other gods before me.* Like the Arians of the fourth century, Newton argued that Jesus, though divine, was a "lesser and therefore subservient being."[5]

He blamed the Roman Catholic church for the "blasphemy" of the Trinity. He argued that it had "manipulated Emperors Constantine and Theodius to introduce the false doctrine of the Trinity into Scriptures." This was later adopted in error by the Church of England.

Newton kept his heretical belief a closely guarded secret, sharing it only with his most trusted friends, e.g., John Locke. If revealed to the public, it would threaten his professorship and status in English society. Denial of the trinity remained against the law in Britain until 1813.[6]

Newton's rejection of the Trinity is why he refused to take the oath to the Church of England when appointed a fellow at Cambridge in 1667. It is why he refused appointment as Master of Trinity College in 1700, as it required taking holy orders in the Church. And it is why the great scientist refused the Last Rites on his deathbed in 1727.[7]

Newton's friend and successor to the Lucasian chair, William Whiston had come out publicly against the Trinity in 1708. He was charged with promoting doctrines contrary to the established creed of the Church of England. Whiston refused to disavow his beliefs. He was summarily stripped of his professorship and banned from the University. At least they no longer burned you at the stake.

Newton said nothing in defense of his friend.

The Calculus Wars

Among his enemies, Isaac Newton counted the great German mathematician Gottfried Leibniz. Why? Because he had dared to invent calculus around the same time as Newton.

The two scholars and their supporters engaged in ugly fights over precedence. In 1712, Leibniz appealed to the Royal Society of London to settle the disagreement. As president, Isaac Newton surreptitiously wrote its "Report of Findings," in which he declared himself as first inventor.[8]

Second inventors have no rights.

— Isaac Newton.[9]

Today we know from private papers and historical records that both geniuses developed calculus *independently*. Leibniz made the discovery in 1674 and published in 1684. Newton developed it in 1664–1666 but withheld publication until 1704. It is the notation of Leibniz which is commonly taught and used in calculus today.[10]

Calculus would go on to become arguably the "most important branch of mathematics." Its use in science and engineering would become ubiquitous. We see its use today in physics, astronomy, cosmology, chemistry, biology, climate science, computer science, medical science, and much more.[11] Calculus is also found outside of science in such diverse fields as economics, finance, statistics, and actuarial work, to name a few.[12]

We conclude with a brief highlight on the Great One's effort in a science other than physics.

Unification

Newton performed extensive experiments in *alchemy*.* Among other things, he hoped this would lead to a theory which would unite the microscopic world of chemistry with the macroscopic world of gravity. This attempt to find a single scientific paradigm for both worlds — in the modern case, quantum mechanics and general relativity — continues to elude physicists to this day.

* "Alchemy included much that we now label applied and industrial chemistry," Thony Christie argues, ". . . alchemy of the seventeenth century [was] not so much a pseudo-science as a proto-science." Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XV," thonyc.wordpress.com.

Appendix E

GEOLOGY AND EVOLUTION

Given enough time and enough accumulated changes, natural selection can create entirely new species . . . [It]is what turned dinosaurs into birds, amphibious mammals into whales, and the common ancestor of apes and humans into the people, chimps and gorillas we know today.

— Science writers Ker Than and Ashley P. Taylor.[1]

Modern geological developments have explained and resolved a number of key issues regarding Darwinian evolution. They include the age of the Earth, tectonic plates, the fossil record, mass extinctions, and the current geological age — the Anthropocene. A brief overview follows:

The Age of the Earth

It was thought in Darwin's day that the Earth was some 100 million years old. This was seen as insufficient time for slow, gradual evolution to have produced all known extinct and existing species.[2]

Radioactive dating of primeval rocks and mineral grains since have established a value for the age of the Earth at some 4.5 billion years. The earliest life forms yet found on our planet date to some 3.4 to perhaps 4 billion years old. "Molecular clock" and other biological analyses confirm that this is sufficient time for evolution by natural selection to produce the organisms we see today.[3]

Tectonic Plates

The movement of tectonic plates extending deep into the Earth was discovered in the 1960s. This was the root cause of many geological changes which Darwin had come across on his *Beagle* trip — likely including the earthquakes he experienced in Chili.[4]

According to plate tectonics theory, these rigid plates — massive slabs of Earth's crust and uppermost mantle — are typically about 60 miles (100 km) thick.[5] Our continents rest on these tectonic plates, which in turn move on a "moldable, partially molten layer called the asthenosphere," write Stanford geo-archaeologist Tjeerd H. van Andel and Brendan Murphy, Professor of Geology at St. Francis Xavier University, Nova Scotia. "[The moving plates] converge, diverge, or slip past one another along their boundaries."[6]

There are "seven very large continental-and ocean-sized plates, six or seven medium-sized regional plates, and several small ones," Van Andel and Murphy tell us. They move ever so slowly "relative to each other, typically at rates of 5 to 10 cm (2 to 4 inches) per year," — causing entire continents to drift across the globe over time. (See Fig. E.1.)[7]

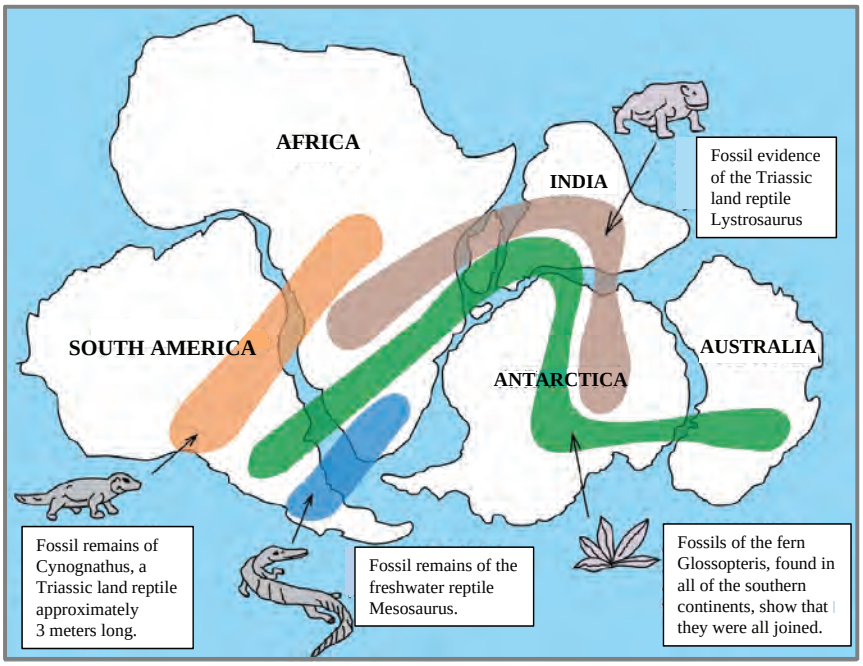


Figure E.1. Gondwana — part of Supercontinent Pangaea. Centered on the equator, Pangaea began to form some 335 million years ago and broke apart some 175 million years ago. It was surrounded by superocean *Panthalassa.* Other supercontinents "have formed and broken up over the course of the Earth's lifespan. These include Pannotia, which allegedly formed about 600 million years ago, and Rodinia, which existed more than a billion years ago. "Present-day plate motions are bringing continents together again."[8]

The movement of tectonic plates is chiefly responsible for mountain formation, earthquakes,* and volcanoes. Riding on these plates, continents experience gradual changes in climate as they move across the globe. This movement of continents at times connects and at other times isolates countless life-forms. Plate tectonics and resultant continental drift are key drivers of "long-term climate change, the composition of Earth's atmosphere and oceans" — and evolution.[9]

* "Earthquakes happen when plate margins (edges) move past, or bump into each other." Source: "Highest Elevation: Mount Everest," extremescience.com. Retrieved Mar 22, 2020. http://www.extremescience.com/everest.htm.

Continental drift explains in part why Darwin found such different animals in Australia and South America than in Europe. In the "continuing breakup of the continents that began some 200 million years ago, Australia and South America were isolated from other continents," vertebrate paleontologist Michael Novacek writes. "Marsupial mammals thrived and diversified in both Australia (kangaroos and koalas) and South America (opossum), while placental mammals took over similar roles on the other continents."[10]

The Fossil Record

"We as yet have found only an exceedingly small fraction of the species buried in the crust of the earth," Darwin wrote in his *Essay* of 1844. Over the nearly 180 years since, paleontologists working on all seven continents have filled in the fossil record to a remarkable degree. Their findings provide overwhelming evidence of the evolution of species through natural selection.[11]

The discovery in 1994 of the fossil remains of *Ambulocetus natans* is one of countless examples. (See Fig. E.2) The "name literally means 'swimming-walking whale,' writes Ker Than. "Its forelimbs had fingers and small hooves but its hind feet were enormous given its size. It was clearly adapted for swimming, but it was also capable of moving clumsily on land, much like a seal. When it swam, the ancient creature moved like an otter, pushing back with its hind feet and undulating its spine and tail."[12]

Mass Extinctions

Global catastrophes have had a major effect on species destruction and the subsequent evolution of new species. Geological examinations coupled with

Figure E.2. Ambulocetus natans. "Walking whale that swims." Existed about 49 million years ago. Note the five digits on hands and feet, like us.

fossil finds across the planet confirm five big mass extinctions with some 75 to 96% off all species lost. The first four events occurred:

(1) at the end of the Ordovician period 444 million years ago;
(2) in the late Devonian 375 million years ago;
(3) at the end of the Permian 251 million years ago; and
(4) at the end of the Triassic 200 million years ago.

Suspected causes range from climate change, disruptive new life forms, and cataclysmic volcanic eruptions.[13]

The fifth and most recent mass extinction occurred at the end of the Cretaceous period some 66 million years ago. A six to nine mile (ten to 15 kilometers) wide Asteroid or Comet struck the Yucatán Peninsula in Mexico. The impact formed the Chicxulub crater, estimated to be some 93 miles (150 km) wide and 12 miles (20 km) deep.[14]

Scientists have reconstructed the likely aftermath: A "cloud of hot dust, ash, and steam and excavated material broiled the Earth's surface." This was followed by wildfires, colossal shockwaves, global earthquakes, and volcanic eruptions. The resultant mass of debris filled the atmosphere and blocked the Sun for decades. This disrupted the food chain and starved most survivors.[15]

This cataclysmic event wiped out an estimated 75% to 80% of all species on our planet, including all non-avian dinosaurs. Some ancient mammal species, mostly tiny shrew-like animals, managed to survive. Their "numbers and diversity exploded" in the now nearly unoccupied lands. They are the progenitors of all mammals on Earth today, including we humans.[16]

The Anthropocene — A number of scientists argue that we are now undergoing a sixth great species mass extinction — this one caused by us.[17] It is dubbed the Anthropocene Epoch or "Age of Man."[18]

We have met the enemy, and they are us

— Pogo[19]

Our species has had a profound deleterious effect on Earth's surface, oceans, atmosphere, and ecosystems. Since the days of Sumer some 5000 years ago, an estimated "83% of wild mammals, 80% of marine mammals, 50% of plants and 15% of fish have vanished worldwide.[20]

More recently, we have seen an exponential growth in human population — from some 1.6 billion in 1900 to 7.8 billion in 2020.[21] The result: *human-induced* extinction of other species is "currently running 100 to 1000 times faster than" extinctions from natural causes. This according to Earth science professor Will Steffen of the Australian National University.[22]

Human behaviors which have eliminated and continue to threaten the future existence of other species include fossil fuel burning and subsequent global warming. This has led to ocean acidification, sea-level rise, more frequent and more devastating wild fires, heavier rainfall events, more intense heat waves, more severe droughts, and more intense storms. Added to this are industrial farming practices, pesticide use, plastic pollution, deforestation, overfishing, overhunting, habitat destruction, soil erosion, meat consumption, spread of infectious diseases, and "rain forest converted to oil palm plantations."[23]

If we continue on this path, an estimated "75% of species will become extinct within the next few centuries," not to mention major increases in human deaths, mass migrations, and property destruction.[24]

Appendix F

QUANTUM UNCERTAINTY EXAMPLES

Uncertainty lies at the very heart of quantum theory. It tells us that nature at the microscopic level is inherently random.

Photon and Window

You can see out the windows in your home or office. This is because the window glass transmits visible light. At night with inside lights on, you can also see a reflection of the interior of the room. This is because the window glass also reflects some of the light.

Consider a window which transmits 95 percent of light of a certain frequency and reflects 5 percent. (We ignore absorption, scatter, and back-reflection of light for simplicity.) If we send a beam of this light containing billions of photons towards the window, it will transmit 95% of the photons and reflect 5%.

What if we send a *single* photon. Will it transmit through the window? Will it reflect?

We don't know. No one knows. "Mother nature" doesn't know. According to Quantum Mechanics, all we can say is that the photon has a 95% *probability* of being transmitted and a 5% *probability* of being reflected. What it actually does is an unpredictable random quantum event. (See Figure F.1(a).)

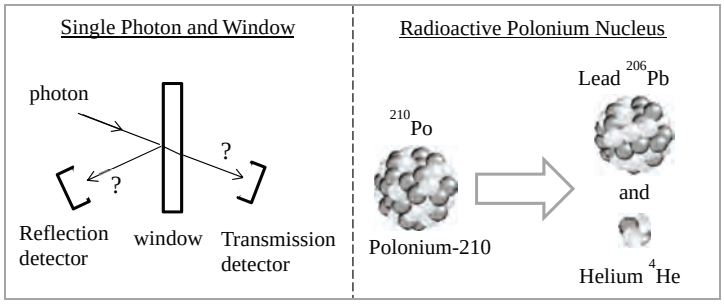


Figure F.1. Two Random Quantum Events — Light Transmission/ Reflection and Radioactivity. (a) A window transmits 95% of a light beam and reflects 5%. Will a single photon be transmitted or reflected? No one knows. It is random. (b) The nuclei of a pellet of Polonuim-210 decay into Lead and Helium with a half-life of 138.376 days. When will a single nucleus decay? No one knows. It too is random. (The nucleus of polonium-210 contains 84 protons and 126 neutrons. It decays into ^{206}Pb and 4He. Note that ^{206}Pb has 82 protons and 124 neutrons, and ^{4}He has 2 protons and 2 neutrons. Thus proton and neutron counts are conserved.)

Polonium-210 Decay

Similarly, let us consider the element polonium-210, discovered by Polish physicist Marie Curie and her husband Pierre in 1898. It is radioactive. That means it is unstable. Its nucleus spontaneously decays or breaks apart into a lead and helium nucleus.[1] (Please see Figure F.1(b).)

To understand this, we need to consider its "half-life." The so-called half-life of a particle is the time it takes for half the particles to transform (decay) into other particles. Polonium-210 has a half-life of 138 days.[2]

Imagine we have **1000** freshly created Polonium-210 nuclei in our laboratory. After 138 days, only about **500** would still exist. The rest would be lead and helium nuclei. If we wait another 138 days, there will only be about **250** Polonium-210 nuclei left, and so on. In other words, the population of Polonium-210 nuclei is cut in half every 138 days.

We can predict the *probability* of decay for a large number of polonium-210 nuclei to great accuracy. (More precisely, they have a half-life of 138.376 ± 0.002 days.)[3]

What about a *single* polonium-210 nucleus? When will it decay or break apart into a lead and a helium nucleus? Again, nobody knows. For a single nucleus, the process is random, unpredictable. All we can know is the *statistical* prediction that half of a large number of nuclei will decay in 138.376 days.

The same is true for all quantum events. We cannot know what an individual particle or constituent will do. This includes all radioactive decay, diffraction, the double-slit experiment, ferromagnetism, solid/liquid/gas phase transitions, superconductivity, superfluidity, lasers, Bose-Einstein condensates, and quantum tunneling.[4]

The notion of determinism ala Laplace is dead. Experiments and tests verify that there is an inherent uncertainty in nature itself — one which no measurement can overcome. No one knows why.

Quantum Mechanics and Evolution

As we learned, mutation is the primary driver of evolutionary variation in all living organisms. Again, exposure to ultraviolet light, chemical carcinogens, natural radiation in rocks or soil, drugs, viruses, or muons in the atmosphere can cause one or more DNA base molecules to transform into another.

These are *quantum events*. So are DNA copying errors. They are all as unpredictable as whether a single photon reflects or transmits through a window, or exactly when a single polonium-210 nucleus decays into lead and helium.

"The fact that mutation and variation are inherently unpredictable means that the course of evolution is, too," writes Kenneth R. Miller in *Finding Darwin's God*. "Evolutionary history can turn on . . . the quantum state of a single subatomic particle."[5]

Though he was one of its founders, Albert Einstein famously had great difficulty accepting the randomness in nature espoused by quantum mechanics. In the fifth Solvay Conference in 1927, he argued over this issue with Niels Bohr:

"God does not play dice," Einstein said.

"Stop telling God what to do," Bohr is said to have answered.[6]

ENDNOTES

Introduction

1 Weinberg, Steven. *To Explain the World: The Discovery of Modern Science* (New York: HarperCollins, 2015) p. xii.
2 ibid, p. 47.

Chapter 1

1 Cummings, poetry-archive.com. Poem edited by me.
2 Bertman, p. 143; Hallo & Simson, p. 28.
3 Kramer, *The Sumerians.* p. 235; Potok p. 15. Sumerian is an "agglutinative tongue with a complex vocabulary and sophisticated grammar." It is neither Semitic or Indo-European. Sumerian is a so-called language isolate, as "no language on earth today is related to it." Sources: Gelb, brittanica.com.; Michalowski, pp. 19–59. As cited in en:wikipedia.
4 Kramer, *Sumerian Mythology*, sacred-texts.com.
5 Carter, sjsu.edu.; "A Brief Introduction to Sumerian History," sumerian-shakespeare.com. Scholars have attempted to determine the origins of Sumerians from historical, linguistic, racial, cultural, and archeological information. A review of the continued difficulty in determining their roots is given in: So³tysiak, Arkadiusz. "Physical anthropology and the 'Sumerian problem,'" Studies in Historical Anthropology, vol. 4:2004[2006], pp. 145–158. http://www.antropologia.uw.edu.pl/SHA/sha-04-07.pdf.
6 Meeker, mm-gold.azureedge.net
7 Ibid.
8 "Sumerians," tokenrock.com.
9 "Sumerian History," crystalinks.com.; "Ancient Mesopotamia," histiasi-glo20.org; Mark, "Sumer," worldhistory.org; Potok, pp. 12–15; Kramer, *The Sumerians*, pp. 159, 162, 163; "A Brief Introduction to Sumerian History," sumerianshakespeare.com.
10 Kramer, *The Sumerians*, pp. 109, 10; "Sumerians," tokenrock.com.

11 Kramer, *Sumerian Mythology*, sacred-texts.com.
12 Potok, p. 10; Kramer, *Cradle of Civilization*, p. 33.
13 "Ancient Mesopotamia," histiasiglo20.org.; Kramer, *Sumerian Mythology*, sacred-texts.com.; Kramer, *Cradle of Civilization*, p. 163. Why wedge-shaped? In part because it was difficult to draw "curves and lines in clay." Source: Kielmas, theclassroom.com.
14 Kramer, *The Sumerians*, p. 35.
15 Ibid, pp. 36, 230.
16 Kramer, *Cradle of Civilization*; Kramer, *Sumerian Mythology*, sacred-texts.com. note 31.; Kramer, *The Sumerians*, p. 100; "Sumerians," tokenrock.com.
17 Kramer, *The Sumerians*, pp. 23, 24, 31, 35, 67.
18 Ibid, p. 263.
19 Ibid, pp. 208, 17
20 Ibid, pp. 23, 24, 31, 35, 67.
21 Ibid, p. 21.
22 Kramer, *Cradle of Civilization*, p. 17.
23 Russell, John Malcolm. *From Nineveh to New York: The Strange Story of the Assyrian Reliefs in the Metropolitan Museum & the Hidden Masterpiece at Canford School*, (New Haven, CT: Yale University Press, 1997); Mieroop, Marc van de. (1997). *The Ancient Mesopotamian City*. (Oxford: Oxford University Press, 1997) p. 95; Kramer, p. 20.
24 This new language was Sumerian. Unlike Semitic languages, its vowels were not variable. For consonants there was "not so much distinction between hard and soft palatals and dentals." A palatal is pronounced by pressing the tongue against the palate, such as *y* in the English word *yes*. A dental is pronounced with the tongue pressed against upper teeth like *th* in the English word *this*. Source: Kramer, *The Sumerians*, p. 20.
25 Kramer, *The Sumerians*, p. 20.
26 Ibid, *The Sumerians*, p. 21. Oppert noted that the Sumerian language has "close affinities with Turkish, Finnish, and Hungarian."
27 Kramer, *The Sumerians*, pp. 26–28; Helstad, sjsu.edu. The Jendet Nasr mound was discovered in the ruins of a town between Baghdad and Kish in 1926. Additional excavations were conducted under the direction of British archaeologist Roger Matthews in 1988 and 1989. Here we see typical Sumerian artifacts — bronze tools, cylinder seals, cuneiform tablets, and more. Source: Matthews, Roger. (1992), "Defining the Style of the Period: Jemdet Nasr 1926–28," Iraq, **54**: 1–34, JSTOR 4200350, pp. ix, 1–3.
28 Helstad, sjsu.edu.
29 Kramer, *The Sumerians*, p. 132.
30 The Sumerian language "is still not fully understood" to this day. "Many nuances are provisionally lost to us" Source: Thompson, westnet.com.au.

31 Kramer, *Cradle of Civilization*. pp. 7, 165.
32 Potok, p. 13. More than their writings, archeological and geological records have provided scholars with an understanding of the early Sumerian history. Source: Mark, "Sumer" worldhistory.org.
33 Plate IX. Enlil Separates Heaven and Earth. (Tablet 13877 in Nippur collection at University Museum.); Kramer, *Sumerian Mythology*, sacred-texts.com.
34 Meeker, mm-gold.azureedge.net; Kramer, *Sumerian Mythology*, sacred-texts.com.
35 Mark, "The Mesopotamian Pantheon," worldhistory.org.
36 Mark, "Sumer" worldhistory.org.
37 Kramer, *Sumerian Mythology*, sacred-texts.com.
38 Black, ancient-origins.net.
39 Kramer, *Sumerian Mythology*, sacred-texts.com.; Kramer, *The Sumerians.* p. 119.
40 "Sumerian History" crystalinks.com.
41 Meeker, mm-gold.azureedge.net.
42 Kramer, *Sumerian Mythology*, sacred-texts.com; Meeken; realhistoryww.
43 Kramer, *Sumerian Mythology*, sacred-texts.com.; "Nanna" worldhistory.org.
44 Ibid.
45 Meeker, mm-gold.azureedge.net.
46 Kramer, *The Sumerians*, p. 154. Other gods reside here — banished for immoral acts. Even *Enlil*, king of the gods, was sent to *Kur* by the high gods for the rape of his "future consort, the young grain goddess *Ninlil*." It appears that in Sumerian culture, no one was above the law — at least theoretically. Sources: Kramer, *Cradle of Civilization*, p. 102; "Enlil," newworldencyclopdia.org.
47 "Ancient Man and his First Civilizations: Sumer," realhistoryww.com.
48 Kramer, *Cradle of Civilization*, p. 102. Law and order are enforced by demons or *galla* — inhuman creatures who "eat no food, drink no water." They serve as the police of Kur.
49 Potok, p. 17.
50 Kramer, *The Sumerians*, p. 245.
51 At the top of the Sumerian pantheon were the four creation gods — heaven-god *An*, earth-goddess *Ki* (later called *Ninhursag*), water-god *Enki*, and air-god *Enlil*. They were followed by the astral deities: moon-god *Nanna*; *Utu* the Sun god, and *Inanna*, goddess of Venus — "the great lady of the horizon and zenith of the heavens." These seven deities decreed the fates. Below the seven were the fifty "great gods," the *Anunnaki*, children of heaven-god *An*. They were followed by a plethora of gods and goddesses. While the "major gods and most lesser gods chose to come down to the Earth," the primeval gods and 300 lesser gods called the *Igigi* remained in the Heavens. Sources: "Ancient Man and his First Civilizations: Sumer," realhistoryww.com.;

Thompson, westnet.com.au.; Kramer, *The Sumerians*, pp. 3, 115,118, 124, 125, 210, 231.

52 "Ancient Man and his First Civilizations: Sumer," realhistoryww.com.

53 Geerts, bibliotecapleyades.net

54 Jastrow, Morris (1911). "Eabani". In Chisholm, Hugh. *Encyclopædia Britannica*. 8 (11th ed.). Cambridge University Press. pp. 788–789.

55 Kramer, *The Sumerians*, p. 54; Geerts, bibliotecapleyades.net.

56 Kramer, *The Sumerians*, p. 117.; "Mesopotamian Gods," factsanddetails.com.

57 Potok, p. 17; Mark, "The Mesopotamian Pantheon" worldhistory.org.

58 Kramer, *The Sumerians*, p. 130.

59 Ibid.

60 Ibid, p. 112.

61 Mark, "The Mesopotamian Pantheon" worldhistory.org.; Kramer, *Cradle of Civilization*, pp. 99, 102; "Ancient Man and his First Civilizations: Sumer," realhistoryww.com.; Kramer, *The Sumerians*, pp. 112, 160. "The *me's* were originally collected by *Enlil* and then handed over to the guardianship of *Enki*." Source: Kramer, *The Sumerians*, p. 122.

62 "Ancient Mesopotamia: History of Civilization," timemaps.com.; newswithviews; Kramer, *Sumerian Mythology*, sacred-texts.com.

63 "Mesopotamian Gods," factsanddetails.com.

64 "The Sumerians and Mesopotamia," khanacademy.org.; "Sumerian History" crystalinks.com.; "Ancient Mesopotamia: The Sumer." ducksters.com.; galegroup.

65 Ibid.

66 "The Sumerians and Mesopotamia," khanacademy.org; "Sumerian History," crystalinks.com.; "Ancient Mesopotamia: The Sumer." ducksters.com.

67 Kramer, *The Sumerians*, p. 173.

68 "The Sumerians and Mesopotamia," khanacademy.org.; "The Ziggurat." odysseyadventures.ca.

69 "The Ziggurat." odysseyadventures.ca.

70 "Ziggurat," brittanica.com; "The Sumerians and Mesopotamia," khanacademy.org.

71 Hall, M. D. *A Study of Sumerian Moon God Nanna/Suen*. Ph.D thesis, University of Pennsylvania, 1985, p. 227. As cited in en:wikipedia.

72 Nolan, fathis.com.

73 Kramer, *The Sumerians*, p.137; "Sumerian History," crystalinks.com.

74 Kielmas, theclassroom.com. To reduce water damage, Sumerian builders placed baked mud bricks set in bitumen, a natural tar, on the outer walls and tops of ziggurat platforms. To further mitigate erosion through dampness,

they placed holes through the exterior to allow evaporation of water from its core. They also built drains into the platforms to carry away winter rains. Sources: "The Sumerians and Mesopotamia," khanacademy.org.; "Mesopotamian Temples, Ziggurats, and Architecture," factsanddetails.com.

Chapter 2

1. Zantonavitch, rebirthofreason.com.
2. Kramer, *The Sumerians*, p. 73.
3. Ibid, pp. 141-2.
4. Kramer, *The Sumerians*, p. 74.
5. Kramer, *Cradle of Civilization*, p. 35, 74.; "Sumer," worldhistory.org.
6. Horn, newwithviews.com.
7. "Nippur," unesco.org.
8. Skotzko, clark.edu.
9. Kramer, *Cradle of Civilization.* pp. 35-6; Kramer, *The Sumerians*, pp. 43–56, 72, 89; Somevill, pp. 25–29; "A Brief Introduction to Sumerian History." sumerianshakespeare.com.
10. Kramer, *The Sumerians* p. 43,53, 59; "A Brief Introduction to Sumerian History." sumerianshakespeare.com.
11. Van De Mieroop, p. 43. The so-called "short chronology" is used here.
12. https://www.pinterest.it/pin/860680178764975982/?autologin=true.
13. "The Armies of Sumer and Akkad, 3500 to 2200 BC." sumer2sargon.wordpress.com.; "Sumerians," tokenrock.com.
14. Kramer, *Cradle of Civilization*; "Sumerian Military," crystalinks.com.; "The Armies of Sumer and Akkad, 3500 to 2200 BC," sumer2sargon.wordpress.com. Bronze produced by smelting cooper and tin proved to be a revolutionary military technology for the Sumerians. Unlike earlier stone and copper, these bronze weapons were more easily shaped, stronger, and sharper — and did not tend to shatter, chip or crack.
15. Kramer, *Cradle of Civilization*, p. 36.
16. Ibid, p. 40.
17. King, L. W. *Chronicles concerning early Babylonian kings* (London, UK: Luzac, 1907) pp.3ff; 87–96. As cited in en:wikipedia.
18. Time-Life, p. 37; Kramer, *Cradle of Civilization* p. 59; Van De Mieroop, p. 64.
19. Mark, "Sargon of Akkad," worldhistory.org.
20. Mark, "Sargon of Akkad," worldhistory.org.; Kramer, *The Sumerians*, p. 62.
21. Samuel Noah Kramer, as cited in Mark, "Sargon of Akkad," worldhistory.org.

22. "Sumerian Civilization." newworldencyclopedia.org. Over the centuries, poor drainage and high-evaporation rates in this hot arid climate led to the build-up of dissolved salts in the soil.
23. Van De Mieroop, p. 67; Kramer, *Cradle of Civilization*, p. 39.
24. Mark, "Ur-Nammu," worldhistory.org.
25. Ibid.
26. Ibid.
27. "Some scholars contest the traditional view of a resurgent 'Sumerian Renaissance.'" Source: Thompson, westnet.com.
28. Kramer, *The Sumerians*, p. 142.
29. Ibid, p. 288.
30. Jacobsen, britannica.com. Babylonians, as well as Elamites, Akkadians, and Assyrians continued the Sumerian ziggurat tradition — making them taller and more tower-like. The main temple of Babylon, the *Etemananki*, was said to rise some 300 feet (90 meters) above the ground. The city at the time was "a melting pot of people. Many different languages were spoken." Perhaps this is the source of the Tower of Babel story in the Hebrew Bible. (Babylonian temple height given in writings of Ancient Greek historian Herodotus.)
31. "A Brief Introduction to Sumerian History." sumerianshakespeare.com.

    "Most of our present knowledge of Sumerian is derived from texts in an era in which Sumerian as a spoken language was already extinct." Source: Thompson, westnet.com.
32. "Egypt profile — Timeline," bbc.com; "Timeline of Egyptian History and Culture," cemml.colostate.edu.; "Indus civilization," britannica.com.; Lee, jstor.org.
33. Ibid.
34. "Egyptian Civilization," dio.org.
35. Kramer, *The Sumerians*, p. 183.
36. Kramer, *Cradle of Civilization*, pp. 108, 158, 159.
37. Kramer. *History Begins at Sumer.*
38. "Sumerian/Babylonian Mathematics," storyofmathematics.com.; "Sumerian Mathematics and Economics." crystalinks.com.

    The Sumerians developed "several different number systems, including a mixed radix (base) system with alternating base 10 and base 6." Source: "Sumerian Civilization." newworldencyclopedia.org.
39. Mark, "Sumer," worldhistory.org.; "Ancient Sumer," scribd.com. The Sumerians produced the first mathematical tables, the earliest decimal notation (different from the modern version), and quadratic equations. Sumerians were the first to record how to determine the area of a triangle and the

volume of a cube; the earliest to establish standard units of measurement for length, area, and capacity. Much of this was passed on to the modern era via the Greeks and Arabic scholars.

40. "Sumerian Astrology," historicalastrology.com.; "A Brief Introduction to Ancient Sumer: Technology."sumerianshakespeare.com. It is not clear how much the Sumerians did on astronomy. The tablets unearthed to date are vague. It seems they did name some stars and some constellations. They likely observed the "heliacal (near Sun) rising of particular stars, and knew Venus was both the morning and evening star." A comprehensive review of Sumerian astronomy is given in Thompson, westnet.com.
41. I cannot longer find David Darcey's blog on Sumer on the internet. If you have this reference, please let me know.

Chapter 3

1. McClellan, answersingenesis.org.
2. Pagan Egypt also flirted with a kind of monotheism. Amenhotep IV (later Akhenaten) worshipped Aten, the disk of the sun as the only god, ca. 1353–1336 B.C. The Hymn to Aten, most likely written by Akhenaten, reads in part: "O living Aten, beginner of life ... O sole god, like whom there is no other! Thou didst create the world according to the desire ... "Any connection between Aten and Hebrew monotheism is, according to Chaim Potok, unlikely. Source: Potok, p. 76.
3. Though inconclusive, archaeological investigations "suggest there was no complete destruction of Jericho or most of the other cities cited in the book of Joshua at the presumed time of Israel's incursion." Source: Bandstra, p. 208.
4. Finkelstein & Silberman, p. 312.
5. Mark, "Canaan." worldhistory.org.
6. Finkelstein & Silberman, p. 318; "Best-selling Book." guinnessworldrecords.com.
7. Stewart, kyphilom.com.
8. Potok, p. 131.
9. Coogan, pbs.org.
10. Hirsch, jewishencyclopedia.com.
11. Kramer, *The Sumerians*, pp. 91, 286.
12. Ibid, p. 37. From the Sumerian poem "The Curse of Agade."
13. Kramer, *Cradle of Civilization*, p. 100–102.
14. Mark. "Ur-Nammu" worldhistory.org.
15. Another example: The Book of Ezekiel in the Bible tells of Hebrew women in Jerusalem weeping for the death of *Tammuz* — the Hebrew name for the

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Sumerian shepherd-god *Dumuzi*. (Ezek 8:14-15). The fourth month of the Hebrew calendar still bears the name *Tammuz*. Source: Kramer, *History Begins at Sumer*, p. 45.

16. There are two Creation stories in Genesis. In the first, "Creation takes six days and Man and woman are created last." (Gen 1:1-2:3.) In the second, "Creation takes one day, man is created first," then plants and animals, and woman last. (Gen 2:4-25.) Source: "The Two Biblical Stories of Creation," leighb.com.
17. Crawford, smithsonianmag.com.
18. Kramer, *The Sumerians*, p. 148.
19. Kramer, *Cradle of Civilization*, pp. 104, 115; Smitha, fsmitha.com.; Tharoor, Ishaan. "Before *Noah*: Myths of the Flood Are Far Older Than the Bible" time.com Apr 1, 2014. https://time.com/44631/noah-christians-flood-aronofsky/. Retrieved Jun 24, 2021.

    As Tharoor points out, a number of ancient cultures have "legends of watery cataclysm and salvation." They include Vedic lore of India, Egypt, the Aztecs, and even Scandinavia.
20. Other similarities include the Tower of Babel story and its confusion of tongues. (Gen 11:1–9.) Scholars suggest it has precursors in Mesopotamia and may refer to the ancient 300-foot (90-meter) high ziggurat *Etemenanki* in ancient Babylon.The city at the time was "a melting pot of people. Many different languages were spoken." Source: Kramer, *Cradle of Civilization*, p. 104; "The Sumerian Legacy." bandoline.no.
21. Kramer, *The Sumerians*, p. 296.
22. Ibid, p. 291. Kramer tell us that the Akkadian language in particular was the common language of literature "all over Palestine and its environs in the second millennium BC."
23. Shermer, michaelshermer.com. This from Old Testament scholar Ellen van Wolde. See: Alleyne, Richard. "God is not the Creator, claims academic" telegraph.co.uk. Oct 8, 2009. http://www.telegraph.co.uk/news/religion/6274502/God-is-not-the-Creator-claims-academic.html. Retrieved Feb 12, 2017.
24. Ibid, p. 292.
25. McDermott, pp. 25-27.
26. Freedman.
27. Potok, pp. 37–8; DiMattei, contradictionsinthebible.com.; "El," newworldencyclopedia.org.
28. Hebrew Bible scholar and linguistics expert Jeff A. Benner tells us that the literal meaning of *Ēl Shaddāi* is "mighty teat." He writes: Just as the goat provides nourishment to its kids through the milk, God nourishes his children

b4592_Endnotes.indd 524 01-Sep-22 9:47:58 AM

through his milk and provides all the necessities of life." Source: Benner, Jeff. A. "The Meaning of El Shaddai" ancient-hebrew.org, https://www.ancient-hebrew.org/studies-words/meaning-of-el-shaddai.htm. Retrieved July 26, 2021.

29. Gilad, Elon. "We Shouldn't Take God's Name in Vain. But What Is It?" haaretz.com. Oct 10, 2018. https://www.haaretz.com/archaeology/.premium.MAGAZINE-we-shouldn-t-take-god-s-name-in-vain-but-what-is-it-1.6546806. Retrieved Jun 24, 2021. As to the meaning of *YHWY*, "not all scholars accept this etymology."
30. "El," newworldencyclopedia.org.
31. Biblical scholar Michael Coogan points out that historically the god *El* was from the north and *YHWH* from the south. Source: Coogan, pbs.org.
32. "El," newworldencyclopedia.org; DiMattei, contradictionsinthebible.com. For a comprehensive treatment of the subject, see: F. M. Cross, *Canaanite Myth and Hebrew Epic: Essays in the History of the Religion of Israel* (Harvard University Press 1973.) http://contradictionsinthebible.com/are-yahweh-and-el-the-same-god/.
33. Finkelstein & Silberman, pp. 33–43.
34. Potok, p. 29, 35; Genesis 11:27; Mark, "Amorite" worldhistory.org.; Dever, p. 98 and fn 2.
35. Finkelstein & Silberman, pp. 57–64; Meyers, Carol. pbs.org.
36. Ibid.
37. "The Bible's Buried Secrets: An archeological detective story traces the origins of the Hebrew Bible." NOVA pbs.org. https://www.pbs.org/wgbh/nova/video/the-bibles-buried-secrets/ Retrieved Aug 1, 2019.
38. Finkelstein & Silberman, pp. 72–92.
39. Ibid, p. 97–120. Archeologist William Dever writes that "most of the large Canaanite towns that were supposedly destroyed by invading Israelites were either not destroyed at all or destroyed by Philistines and other 'Sea People.'" Source: Dever, wgbh.com.
40. Dever, wgbh.com.; Finkelstein & Silberman, p. 97–120.
41. Sparks, pp. 96-97.
42. Redmount, Carol A (2001) [1998]. "Bitter lives: Israel in and out of Egypt." In Coogan, pp. 71–72, 97.
43. Finkelstein & Silberman, pp. 97–120; Dever, wgbh.com.
44. Finkelstein & Silberman, pp. 97–120.
45. Ibid, p. 129.
46. McKenzie, nytimes.com.; Dever, wgbh.com.
47. Finkelstein & Silberman, pp. 123–142.
48. Finkelstein & Silberman, p. 132.; Dever, wgbh.com. Also see Mississippi State University finding: "Discovery of official clay seals support existence

of biblical kings David and Solomon, archaeologists say." sciencedaily.com. https://www.sciencedaily.com/releases/2014/12/141216100433.htm.

49. "Ten Lost Tribes of Israel," britannica.com.
50. "Kingdom of Israel." newworldencyclopedia.org.; Stern, Philip, history.net.
51. Finkelstein & Silberman, pp. 153–159; "Kingdom of Israel." newworldencyclopedia.org.
52. "Samaria," livius.org.; "City of Samaria," biblegateway.com.
53. Barnett, sheknows.com.
54. "The Army that Built the New Assyrian Empire," searchinginhistory.blogspot.com.
55. Finkelstein & Silberman, pp. 217, 220.
56. Potok, pp. 172,178; Finkelstein & Silberman, pp. 199, 217. Scholars debate whether it was "Shalmaneser V or his son Saigon II who conducted the final overthrow of the city of Samaria."
57. Potok, p. 172.

    As of this writing, fewer than 800 Samaritans still exist. They call themselves *Bene-Yisrael* and *Shamerim* in Hebrew; or "Children of Israel" and the "Observant Ones" respectively. They say they are the true practitioners of the worship of *YHWH* as handed down from Abraham and Moses. Unlike modern Judaism, they are led by priests and practice animal sacrifices in their veneration of the Hebrew God. Some reside in the village of Kiryat Luza on holy Mount Gerizim near Nablus in the West Bank. Others live in the city of Holon south of Tel Aviv in Israel. Sources: "Samaritan" britannica.com.; Potok, p. 172.; Lieber, tabletmag.com.
58. Finkelstein & Silberman, p. 194.
59. Ibid, p. 317.
60. Stern, Philip. historynet.com.
61. Ibid.
62. Finkelstein & Silberman, pp. 252, 259.
63. Stern, Philip. historynet.com.
64. Ibid. An earlier Bible passage may be closer to the truth: "Thus sayeth the Lord ... Behold I will put a spirit in him (Sennacherib), and he should hear rumour and shall return to his own land." (2 Kgs 19:6-7).

Chapter 4

1. Finkelstein & Silberman, p. 247.
2. Ibid, pp. 248, 271.
3. Ibid, p. 248.
4. Ibid, p. 255.

5. Hirsch, jewishencyclopedia.com.
6. Finkelstein & Silberman, p. 264.
7. Ibid, p. 259.
8. Ibid, pp. 260, 277.
9. Ibid, pp. 275–80.
10. Finkelstein & Silberman, p. 276; Berman, Ch 2. Finkelstein & Silberman point out that, in the 7th century, literacy was widespread in Judah for the first time. So there was a "popular audience for such works."
11. Finkelstein & Silberman, pp. 183–4.
12. Ibid, pp. 287, 288, 492.
13. Mark, "Ashurbanipal," worldhistory.org.
14. "Babylonia and the Conquest of Judah," churchofjesuschrist.org.; Potok, p. 197.
15. Bullock, p. 340.
16. Finkelstein & Silberman, p. 294.
17. Dever tells us "we don't have a lot of direct archeological evidence (for the fall of Jerusalem) because we have never been able to excavate large areas of (the city). The Temple Mount has never been excavated and never will be." Source: Dever, pbs.org.
18. Potok, pp. 195–197; Schniedewind, pbs.org.
19. Dever, pbs.org.
20. Enns, wp.biologos.org.
21. Stewart, kyphilom.com. Enns, wp.biologos.org.; Schniedewind, pbs.org.
22. "The Iranian Impact on Judaism," uidaho.edu. Excerpted from Gier, Nicholas F. *Theology Bluebook*, Ch.12. (University of Idaho, 1994 — 3rd ed.) http://www.webpages.uidaho.edu/ngier/309/zorojud.htm.

    Nicholas Gier, Professor Emeritus in Philosophy at the University of Idaho argues that for "the generation in (Persian) exile and 400 years following, (the Judeans) lived under strong Persian dominion and influence." Thus a number of biblical ideas and beliefs derive from the religion of Persia at the time; Zoroastrianism.

    Its supreme God *Ahura Mazda* gave "humans free will so they could choose between good and evil." The first to "speak unequivocally in terms of *individual* moral responsibility was Ezekiel, a Bible prophet of the Babylonian exile." (My italics.)

    "Late Bible books like Daniel developed their angelology" from the Persian religion. The concept of "heaven and a fiery hell" also comes in part from Zoroastrianism. Its "*Angra Mainyu*, the Evil One ... is the prototype for late Jewish and Christian ideas of Satan."

However, Gier points out, Zoroastrianism in not the source of Hebrew monotheism. By the time of the Judean exile, "Zoroaster's strict monotheism had been compromised by polytheistic practices."

23. Finkelstein & Silberman, p. 307.
24. Schniedewind, pbs.org.
25. Fried, bibleoddyssey.org.
26. Davies, p. 219.
27. Potok, p. 209.
28. Schniedewind, pbs.org.
29. Finkelstein & Silberman, p. 299.
30. Ibid, p. 320.
31. Ibid, p. 320.
32. Dever, pbs.org. Dever writes that "in 1970's, Israeli archeologists digging in Kunillet Ajoud in the Sinai found in the little desert fort of the same period *YHWH* and *Asherah* all over the place in Hebrew inscriptions."
33. Stern, Ephraim, baslibrary.org.
34. Potok, p. 69.
35. Kramer, *Cradle of Civilization*, p. 168.
36. Potok, pp. 102–3.
37. Berman, pp. 41, 46.
38. Potok, p. 97.
39. Berman, pp. 53, 78.
40. Ibid pp. 68, 94.
41. Berman p. 102; Finkelstein & Silberman, p. 285.

Chapter 5

1. As cited in "Plato: Quotes," goodreads.com. https://www.goodreads.com/author/quotes/879.Plato?page=1.
2. "The Greeks: Crucible of Civilization." pbs.org.
3. Pannekoek, pp. 96, 105.
4. "The Greeks: Crucible of Civilization." pbs.org.
5. Pannekoek, p. 96.
6. Crowe, p. 21. The ancient Greeks "based their astronomical models on geometry rather than algebra and so needed other calculation aids. They developed trigonometry for this work based on chords of a circle. The first chord tables are attributed to Hipparkhos (c. 190–c. 120 BCE) but they did not survive." Source: Christie, Thony. "Mathematical aids for Early Modern astronomers." thonyc.wordpress.com.

7. "Thales of Miletus" livius.org; Weinberg, Steven. pp. 3–4. Weinberg writes that Thales alleged solar eclipse prediction is unlikely, as it would have been "visible in only a limited geographic area."
8. "Pythagorean model of the Universe," spark.iop.org; Ratner, doi.org.
9. Pannekoek, p. 99.; "Thales," mathopenref.com.; Mark, "Anaximander." worldhistory.org.
10. Pannekeok, p. 100.; "Classical Astronomy." atnf.csiro.au.
11. O'Conner & Robertson, E.F. "Heraclides of Pontus," groups.dcs.st-and.ac.uk.
12. Casson, pp. 11–13.
13. "The Origins of Geometry," ms.uky.edu.; Seidenberg, doi.org.
14. Giusti, php.math.unifi.it.
15. DeYoung, link.springer.com.
16. "A Brief History of Geometry," jwilson.coe.uga.edu. "Aristotle, on the other hand, believed that mathematics was the invention of Egyptian priests with the time and leisure to speculate on abstract things. There is controversy among modern historians of mathematics about the extent of Thales's discoveries." Source: "Classical Greek Geometry — 1," math10.com.
17. "A Brief History of Geometry," jwilson.coe.uga.edu.; "Classical Greek Geometry — 1," math10.com.
18. Casson, p. 145.; Shuttleworth, "Egyptian Mathematics," explorable.com. According to Shuttleworth, papyruses and hieroglyphics also show "that the Egyptians used a decimal system of numbers. Although it was not positional like our modern system, which meant that they did not need a symbol for zero, much like the Roman system of numbers."

    "Egyptian mathematicians understood a little algebra and were capable of solving linear equations, and could solve simple quadratic equations by using a series of guesses to find the closest answer, a brute force method that was used for many centuries afterwards."
19. Casson, p. 49.
20. "Egypt profile — Timeline," bbc.com.
21. Brier, thegreatcoursesdaily.com.: Smithfield, thevintagenews.com. Smithfield writes: "The Great Pyramid of Giza was once covered in highly polished white limestone, before it was removed to build mosques and fortresses"
22. Brier, thegreatcoursesdaily.com.
23. Smithfield, thevintagenews.com.; Löhner, cheops-pyramid.ch. The Tura quarries were some 15 km (9 miles) from Giza.
24. Smithfield, thevintagenews.com.
25. Casson, pp. 130, 134; Wilson, gresham.ac.uk.

26. Wilson, gresham.ac.uk.; Brier, thegreatcoursesdaily.com."; Calvert, khanacademy.org.
27. Wilson, gresham.ac.uk.; Casson, p. 136.; Calvert, khanacademy.org. Calver writes: "Above the King's Chamber are five stress-relieving chambers of massive granite blocks topped with immense cantilevered blocks forming a pent roof to distribute the weight of the mountain of masonry above it. The king's sarcophagus, also carved from red granite, sits empty at the exact central axis of the pyramid."
28. Casson, p. 131.
29. Egdall, pp. 207, 8.
30. Translation by Rex Warner. As cited in Bowra, p. 100.
31. Bond, forbes.com.
32. "Greco-Persian Wars: 492–449 BC"
33. Thorley, p. 74. According to Thorley, the number of those who could vote "varied between 30,000 and 50,000 out of a total population of around 250,000 to 300,000."
34. "Socrates," worldhistory.org.
35. Weinberg, Steven. p. 10; "Top 10 Greatest Philosophers in History," listserve.com.; Meinwald, britannica.com.

    "Among others who wrote about Socrates or mentioned him in their works were Xenophon (399–350 BC), a friend of Socrates; Aristophanes (450–388 BC), a playwright who satirized Socrates in *The Clouds*; Aristotle (384–322 BC), a pupil of Socrates; Plutarch (46–119 AD), a Greek biographer and historian who mentions Socrates often in *Parallel Lives*; and Greek author Diogenes Laërtius (180–240 AD), who wrote *Lives and Opinions of the Eminent Philosophers: Life of Socrates*." Source: "Socrates (469–399)," cummingsstudyguides.net.
36. "Socrates," worldhistory.org.; Plato, Symposium.
37. "Socrates," ancientgreece.com.; Bowra, p. 137.
38. Cummings, Michael J., cummingsstudyguides.net; Brun, Jean. *Socrate* (Paris: *Presses universitaires de France*, 6th ed., 1978) pp. 39–40; Ober, aeon.co.
39. "Socrates Presents His Defense," cummingsstudyguides.net.
40. In Plato, *Apology*, 31d. https://thereitis.org/socrates-2-3-apology/.
41. "Why Socrates Died: Dispelling the Myths," timeshighereducation.com.; Plato, *Alcibiades* 1 ; Plat. Alc. 1 103a http://www.perseus.tufts.edu/hopper/text?doc=Perseus%3Atext%3A1999.01.0176&redirect=true.
42. "Why Socrates Died: Dispelling the Myths," timeshighereducation.com. In addition, Socrates argued that it is "not majority opinion but knowledge and

competence which yields correct policy — traits possessed only by the few." Source: Plato. *Gorgias* 503c–d, 515d–517c,

43. Mark, "Socrates," worldhistory.org.; Ober, aeon.co.
44. Herman, p. 3.
45. As cited in Bowra, p. 138.
46. "Socrates Presents His Defense," cummingsstudyguide.net.
47. Ober, aeon.co.
48. "The Suicide of Socrates, 399 BC," eyewitnesstohistory.com.
49. Plato, *Apology*. 36a–b theritis.org.; Laërtius, 2.41 and 2.42. See Rhodes, p. 729.
50. Donn, greece.mrdonn.org.; Laërtius, 2.42.
51. Filonik, core.ac.uk.
52. Plato. *Crito*.
53. Ober, aeon.co.
54. Plato. *Phaedo*, 67e-68a. As cited in "Introduction to Western Philosophy: Selections from The *Phaedo* by Plato" hawaii.edu., p. 8.
55. Plato. *Phaedo*. 115b, 84d.
56. Plato. *Phaedo*. As cited in Herman, p. 5.
57. Plato. *Phaedo*. 76b3. For the soul, Socrates used the word *psyche*, or "breath." Source: Herman, p. 15.
58. Plato. *Phaedo*. 79, 80b.
59. Plato. *Phaedo*. 80b. ". . . if at the time of its release the soul is tainted and impure, because it has always associated with the body and cared for it and loved it, and has been so beguiled by the body and its passions and pleasures that nothing seems real to it but those physical things which can be touched and seen and eaten and drunk and used for sexual enjoyment, and if it is accustomed to hate and fear and avoid what is invisible and hidden from our eyes, but intelligible and comprehensible by philosophy — if the soul is in this state, do you think that it will escape independent and uncontaminated? That would be quite impossible . . . the soul which is tainted by its presence is weighed down and dragged back into the visible world, through fear, as they say, of Hades or the invisible, and hovers about tombs and graveyards. The shadowy apparitions which have actually been seen there are the ghosts of those souls which have not got clear away, but still retain, some portion of the visible, which is why they can be seen."
60. Plato. *Phaedo*. 84c.
61. Other schools founded by followers of Socrates include the Cynic, Stoic, and Cyreniac schools. The Cynics promoted a virtuous life in concert with nature, while living with only the bare necessities. Stoics believed the path to

happiness is acceptance of "that which we have been given in life." They called for "self-control and fortitude" in order to "overcome destructive emotions." Cyreniacs were hedonists who claimed the "only intrinsic good is pleasure." (My kind of philosophy.) Sources: Russell Bertrand. *A History of Western Philosophy*, (New York: Touchstone, 1905) p. 254; "Cynicism" The Basics of Philosophy, philosophybasics.com. 2021. http://www.philosophybasics.com/movements_cynicism.html.; Annas, Julia. *The Morality of Happiness* (Oxford, UK: Oxford University Press, 1995) p. 229.

62. Mark, "Socrates," worldhistory.org.; Plato quote from *Phaedo*, 118.
63. Weinberg, Steven. p. 10; "Top 10 Greatest Philosophers in History," listserve.com.; Meinwald, britannica.com.
64. Pannekoek, p. 101.
65. "The Platonic Solids," geom.uiuc.edu.
66. Cohen, washington.edu.; Lindgren, galileo.phys.virginia.edu.
67. Plato, *Timaeus* 28a. As cited in Lindgren, galileo.phys.virginia.edu.
68. Kraut, plato.stanford.edu.
69. Plato, *Timaeus* 38d and 39d. As cited in Cohen, washington.edu.

    According to Plato, the purpose of the celestial objects was to mark the passage of time. The Sun and stars marked day and night, the Moon the month, and the Sun the year. The wandering planets "stood guard over the numbers of time . . ." Source: Kraut, plato.stanford.edu.
70. Lindgren, galileo.phys.virginia.edu; Cohen, washington.edu.
71. Cohen, washington.edu.
72. Pannekoek, pp. 101–102.
73. Plato, *Timaeus*, prefactory remarks. As cited in Kraut, plato.stanford.edu.
74. Bowra, p. 140.
75. Plato, *Laws*, Book 10. As cited in Weinberg, Steven. p. 47.
76. Weinberg, Steven. p. 47; Bowra, p. 124.
77. Trelawny-Cassity, .iep.utm.edu.; "Eudoxus of Cnidus," math.tamu.edu.; Shields, plato.stanford.edu.; McLeish, p. 5.
78. Laërtius, *Lives* III. 46–47.
79. "First cause," britannica.com.
80. Plato adopted uniform circular motion from Empedocles (c. 494–c. 434 BCE). Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XXVIII ."
81. Van der Waerden, articles.adsabs.harvard.edu.
82. "Classical Astronomy," atnf.csiro.au.
83. Crowe, p. 1. Today, in the Northern hemisphere, stars appear to revolve around Polaris. Due to the precession of Earth's rotation axis, in 3000 BC, the north pole star was Thuban aka Alpha Draconis. In some 13,000 years it will be Vega. Source: Why is Polaris the North Star, gsfc.nasa.gov.

84. Weinberg, Steven. p. 77.
85. The Aristotelean Universe Emerges," homework.uoregon.edu.
86. Lindgren, galileo.phys.virginia.edu.
87. Heath.
88. Lindgren, galileo.phys.virginia.edu.
89. According to Sosigenes, who heard it from Eudeaus. Source: Simpicius in De caelo ii, 12 (292 b 10) p. 488. 20–24. Neinb. As cited in Heath, p. 140.
90. Lindgren, galileo.phys.virginia.edu.
91. First attributed to Simplicius of Cilicia. See Plutarch's "On the Face in the Orb of the Moon," hence see also (in Greek) Plutarch, De faciae quae in orbe lunae apparet, 923a (or in English) at the Perseus Project. As cited in en:wikipedia.
92. Rorabacher, Darold. Attachment to email of Sept. 16, 2020: Review of Draft Chapters 3, 4, 5, and 6.
93. Shields, plato.stanford.edu.; McLeish, p. 5; Weinberg, Steven. p. 22.

Chapter 6

1. Weinberg, Steven. p. 23.; Aristotle Quote "... *there is a science"* from Aristotle, *Metaphysics.* As cited in "Famous Quotations: Famous Philosophy Quotes" spaceandmotion.com. https://www.spaceandmotion.com/Famous-Quotations-Philosophers-Quotes.htm.
2. Bowra, p. 141.
3. Shields, plato.stanford.edu.; Weinberg, Steven. p. 22. Weinberg points out that "the works of Aristotle that survived appear chiefly to be notes from his lectures at the Lyceum," the school he founded after leaving the Academy.
4. Shields, plato.stanford.edu. "There are scholarly disputes about the number of works he produced and also about the authenticity of some of the works coming down to us under his name."
5. Alighieri, Durante degli, aka Dante. As cited in Bowra, p. 142.
6. "The Aristotelean Universe Emerges," homework.uoregon.edu.
7. Aristotle. *On the Heavens.* Aristotle also includes an extensive discussion of the nature of "weight and lightness."
8. Weinberg, Steven. p. 23; Zeyl & Sattler, plato.stanford.edu.; Cummings, Michael. cummingsstudyguides.net.
9. Weinberg, Steven. p. 25.
10. "The Aristotelean Universe Emerges," homework.uoregon.edu.
11. "Plato's Homework Problem," astronomynotes.com.
12. Aristotle. *On the Heavens*, p. 6.
13. Ibid, p. 33.

14. Ibid, p. 34.
15. Ibid, p. 41.
16. Ibid, p. 42.
17. Ibid, p. 71.; Wudka, phyun5.ucr.edu.; Weinberg, Steven. p. 78.
18. Aristotle. *On the Heavens*, p. 71.
19. Ibid, p. 83.; "All About Astronomy," pbs.org.
20. "Geocentric, Heliocentric & Ptolemaic Models of the Universe," study.com.
21. Aristotle. *On the Heavens.*, p. 74.
22. Ibid, p. 74.
23. Ibid, p. 88.
24. Ibid, p. 89.
25. Weinberg, Steven. p. 65. Simanek, lockhaven.edu.
26. Weinberg, Steven. p. 65; Aristotle. *On the Heavens*, p. 83.
27. Aristotle. *On the Heavens*, pp. 85, 88.

    Aristotle also addressed what he called "one of the strangest problems" — planetary motion. "Since the stars undergo but a single motion (they all wheel together around the earth)," he wrote, "the simplicities of the planetary motions ought to be proportional to their *proximity* to the Heaven (my italics)." In other words, the motions of planets closer to the stars (like Jupiter and Saturn) should be simpler than those further away (like Mercury and Venus). "We see, however, something else," he continues, "namely that the motions of the Sun and Moon are simpler than those of some of the planets that are closer to the Heaven."

    Aristotle offers a solution grounded in the "goodness" of nature. He suggests the stars and planets ought to be regarded as living beings "possessed of goods and of action for the sake of those good." He compares these celestial objects to animals. "And just as among terrestrial animals there is not a strict proportion of the simplicity of action to the nobility of good, so among the stars and planets." Source: Baumer, academic.csuohio.edu.
28. Aristotle. *On the Heavens.*, p. 64.
29. Ibid, p. 8.
30. Ibid, pp. 11, 24.
31. "The Aristotelean Universe Emerges," homework.uoregon.edu.; "Plato's Homework Problem" astronomynotes.com; Meeker, mm-gold.azureedge.net,
32. English astronomer Edmund Halley was the first to determine the "proper motion" of stars with respect to each other in 1718, based on the aberration of starlight.
33. For an excellent animation of Aristotle's model, see: "Homocentric Spheres: What Eudoxus and Aristotle Thought About Planetary Motion." https://facultystaff.richmond.edu/~ebunn/homocentric/.

34. "Eudoxus of Cnidus," math.tamu.edu.
35. "Pythagorean model of the Universe," spark.iop.org.
36. Aristotle. *On the Heavens*, p. 61.
37. Hannam, p. 37.
38. *History of Astronomy: An Encyclopedia,* p. 34.

    Along with the Sun and Moon, the motions of the classical planets Mercury, Venus, Mars, Saturn, and Jupiter are confined to a region astronomers call the Zodiac, which extends some 8 degrees on either side of the ecliptic. Source: Crowe, p. 11.
39. As cited in Weinberg, Steven. p. 26.
40. Shakespeare, William. *Julius Caesar* (II, ii, 30–31).
41. Weinberg, Steven. p. 97.
42. Aristotle. *Metaphysics*, Book XII, Part 8. As cited in Mcclung, themcclungs.net.
43. Crowe, pp. 22–24.
44. Ibid, p. 23.
45. Crowe, p. 24.
46. Weinberg, Steven. p. 81.
47. "Viewing the Planets," astro.cornell.edu.
48. Popovic, 1stmuse.com; Griffith, britannica.com.
49. Tridimas, kie.vse.cz.; "The Final End of Athenian Democracy," pbs.org.

Chapter 7

1. As cited in Brann, Eva. "Beauty Bare," Dec. 1, 2009. philoxtetes.org. http://philoctetes.org/news/Beauty_Bare#:~:text=The%20title%20comes%20from%20a,malice%2C%20you%20have%20to%20smirk.
2. Wasson, wordlhistory.org; Martin & Blackwell, p. 2; "Greek Mythology: Heracles," greekmyythology.com.
3. Martin & Blackwell, pp. 2, 29, 35; Popovic,1stmuse.com.
4. Wasson, wordlhistory.org.; Griffith, britannica.com.
5. Mishkov, documentarytube.com.
6. Martin & Blackwell, pp. 85–95, 166.
7. Ibid, p. 74.; "Alexander the Great," bbc.co.uk.; *The Cambridge History of Greek and Roman Warfare,* p. 396.
8. Turchin, Hall and Adams, jwsr.pitt.edu.

    Alexander faced the Persian army of king Darius II in two epic battles: Issus in northern Syria in 333 and Gaugamela in northern Mesopotamia in 331 BC. In both instances, Alexander out-maneuvered and out-fought an army two to three times the size of his forces.

Famously, Alexander placed his vaunted infantry in a wedge formation armed with 18 to 20-foot-long pikes and short swords for close combat. The Macedonian phalanx, as it was called, attacked Darius's center at an oblique angle — augmented by mobile light infantry and archers. Mounted on the right of his infantry, Alexander personally led lightning cavalry attacks on the flank. The Persian king fled the battle field on both occasions — the first time leaving his mother, wife, and daughter behind.

As the new king of Asia, the young Macedonian king showed a wisdom beyond his years. He treated the royal family of Darius with great respect and kindness, fostering admiration from Persian troops and populace alike. Sources: Wasson. "The Army of Alexander the Great," wordlhistory.org.; "Alexander the Great and the Hellenistic World," timemaps.com.

9. "Alexander's Self-Deification," livius.org; Martin & Blackwell, p. 159.
10. "Alexander the Great and the Hellenistic World," timemaps.com.; Popovic, 1stmuse.com. Historians disagree on the date of Alexander's death.
11. "Alexander's Self-Deification," livius.org.; Martin & Blackwell, p. 2.
12. Wasson, "Alexander the Great as God," wordlhistory.org.
13. The number of casualties during Alexander's war of conquest: "It's hard to say as most primary sources present vastly different numbers; scholars predict the number to be in or around 200,000 killed and doesn't include Alexander's troops (which were comprised of Greek, Persian, Indian and other ethnic troops). The largest number of deaths were recorded during the Battle of Gaugamela — anywhere from 50,000–90,000." Source: Chase, Greg,"Quora,"quora.comhttps://www.quora.com/What-is-the-death-toll-of-the-Alexander-the-Greats-campaigns.
14. Roisman & Worthington, p. 186; Green, pp. 56–59; Waterman, McDowell, and Hopkins, umich.edu.; "History of Greece: Hellenistic," ancient-greece.org.
15. Atsma, thoi.com.
16. "Alexander the Great and the Hellenistic World," timemaps.com.

    The term "Hellenization" was coined by 19th century German historian Johann Gustav Droysen (1808–1884).
17. Green, pp. 56–59.
18. Pingree, D. "History of Mathematical Astronomy in India". *Dictionary of Scientific Biography.* (1978) *15.* pp. 533, 554f.
19. Even, weebly.com.; Boardman, jstor.org.; Martin & Blackwell, p. 151.
20. Boardman, jstor.org.; Cambon, Pierre; Jarrige, Jean-François. "Afghanistan, les trésors retrouvés: Collections du Musée national de Kaboul." [Afghanistan, the treasures found: collections of the Kabul national museum] *(in French).* Réunion des musées nationaux, 2006. p. 269. https://library.soas.ac.uk/Record/715924/Description.; Pingree, D. (1978).

21. Green, pp. 29–34; Martin & Blackwell, p. 168; "History of Greece: Hellenistic," ancient-greece.org.; "Alexander the Great and the Hellenistic World." timemaps.com.
22. Among these were Alexandria at the mouth of the Tigris, Alexandria by the Caucasus, and Alexandria Eschate ("The Furthest") in modern Tajikistan. He also founded Alexandria Arachosia and Alexandria of the Aryans, now modern Kandahar and Herat in Afghanistan, respectively. In addition, he established two cities in the Punjab: Alexandria Nikaia (Victory) commemorating his defeat of Indian King Poros and Alexandria Bucephalus honoring his beloved horse. Sources: Popovic, 1stmuse.com.; Arrian, p. 111.
23. Werner, britannica.com.
24. Mark, "Alexandria, Egypt." worldhistory.org.
25. Ibid; Mason, moyak.com.
26. Mason, moyak.com.
27. Rowlatt, Mackie, and Reimer, britannica.com.; Krystek, unmuseum.org.
28. Rowlatt, Mackie, and Reimer, britannica.com.; Lowe, jstor.org.
29. "Timeline of Egyptian History and Culture," cemml.colostate.edu.
30. Martin & Blackwell, pp. 20, 87, 145.
31. Mason, moyak.com.; Rowlatt, Mackie, and Reimer, britannica.com.; Martin & Blackwell, p.169.
32. Rowlatt, Mackie, and Reimer, britannica.com.; Dunn, touregypt.net; Mason, moyak.com.
33. Mason, moyak.com.; Timeline of Egyptian History and Culture," cemml. colostate.edu.
34. Martin & Blackwell, p.169.
35. Dunn, touregypt.net.
36. Norton, pitt.edu.

    Pythagoras is likely the author of most of Euclid's book I. His book II is "probably a Pythagorean adaptation of Babylonian algebra to Greek geometric methods." Hippocrates of Chios is considered author of book III. It is generally accepted that Eudoxus is author of Euclid's books V and XII (epsilonics). Book "VII is an anonymous Pythagorean textbook of number theory." Archytas is the author of book VIII ("closely related to musical theory"), and Theaetetus author of books X (classifications of irrationalities) and XIII (regular bodies). Other Pythagorean or Athenian mathematicians are likely the sources of Books IV, VI, XI, and XII. Sources: Freudenthal, Hans. Book Review of *Science Awakening* by B. L. van der Waerden. (New York: Oxford Univ. Press, 1961) https://www.ams.org/journals/bull/1962-68-06/S0002-9904-1962-10833-7/S0002-9904-1962-10833-7.pdf. Retrieved July 26, 2021.; Ball, Walter William Rouse. *A Short Account*

of the History of Mathematics (4th ed.). (New York: Dover, 1908) p. 38. As cited in en:wikipedia.

37. Aristarchus primarily used observation of Earth's shadow on the Moon and the Moon's coverage of the Sun's disk during a solar eclipse. He calculated that (1) "the distance from the Earth to the Sun is 19 to 20 times larger than the Earth to the Moon, (2) the diameter of the Sun is between 19 and 20 times larger than the diameter of the Moon, (3) the diameter of the Earth is between 108/43 and 40/19 times larger than the diameter of the Moon, and (4) the distance from the Earth to the Moon is between 30 and 45/2 times larger than the diameter of the Moon." Source: Weinberg, Steven. p. 68.
38. Aristarchus' proposal that the Earth goes around the Sun is found in statements by Archimedes and Plutarch, who indicated it was the great size of the Sun relative to the Earth. Unfortunately ... the original writings of Aristarchus were "lost in the destruction of the great Library of Alexandria in 415 AD." Sources: Weinberg, Steven. p. 70; "Classical Astronomy." atnf.csiro.au.; Van der Waerden, articles.adsabs.harvard.edu.
39. Riebeek, earthobservatory.nasa.gov.
40. "The Aristotelean Universe Emerges" University of Oregon, homework. uoregon.edu.
41. Evans, brittanica.com.
42. The "actual polar circumference of Earth is just a bit over 40 thousand km (about 24,860 miles)." At the time of Eratosthenes, there was no universal standard for the unit of length, the *stadion*. Source: Russell, windows2universe.org.
43. O'Conner & Robertson, groups.dcs.st-and.ac.uk; Jones, britannica.com. See these references for details on how Hipparchus arrived at his outstanding astronomical calculations and conclusions.
44. Ibid. The system Hipparchus developed for star magnitudes is similar to the one used today.
45. Jones, britannica.com.
46. Ibid.
47. Ibid. Hipparchus determined the precession to be 45 to 46 arc-seconds per year, remarkably close to the modern value of 50.26 arc-seconds per year. (An arc-second is one 60^{th} of an arc-minute, which in turn is one 60^{th} of a degree.)
48. Ibid.
49. Crawford, Amy. smithsonianmag.com.
50. Rowlatt, Mackie, and Reimer, britannica.com.
51. The war machines of the Roman legions army included mobile catapults, huge two-man crossbows, and onagers that could "lob a 60-pound missile a half a mile." Source: Hadas and Eds. p. 95.

52. Sørensen, britannica.com.
53. Hadas and Eds. pp. 122–118; Gibbons quote as cited in Haggard, Howard W. *From Medicine Man to Doctor: The Story of the Science of Healing* (New York: Dover, 2004) p. 182; Wasson, "Pax Romana." wordlhistory.org.
54. Written toward the end of the first century B.C. As cited in Morris, nytimes.com.
55. Hadas and Eds., pp. 11, 22.
56. Ibid, pp. 81–82.; Argyrid, eu.greekreporter.com.
57. Erskine, jstor.org.; Weinberg, Steven. p. 88.
58. Crowe, pp. 29, 38.

Chapter 8

1. This epigram appears "in some manuscripts of the *Algamest*. Attribution to Ptolemy is plausible, but not certain," Steven Weinberg tells us. It is "from the Greek Anthology, verses compiled in the Byzantine Empire around 900 AD. This translation is from Heath, Thomas L. *Greek Astronomy* (Mineola, NY: Dover, 1991), p. ivii." Sources: "Ptolemys Exposition of Mathematical astronomy," astronomyclub.xyz.; Weinberg, Steven. p. 347, endnote 19.
2. Weinberg, Steven. p. 100; Jones, "Ptolemy: Egyptian astronomer, mathematician, and geographer," britannica.com.
3. "Almagest," britannica.com. Ptolemy also did pioneering work in optics, including "measurements which verified the equal-angles rule of Euclid and Hero . . . (and) applied this to reflection by curved mirrors . . . Ptolemy also studied refraction."
4. Grasshoff, G. *The history of Ptolemy's star catalogue* (New York: Springer, 1990). As cited in O'Conner & Robertson, "Claudius Ptolemy," https://mathshistory.st-andrews.ac.uk.
5. Weinberg, Steven. p. 88.
6. Ibid, pp. 72, 88; Jones, "Ptolemy: Egyptian astronomer, mathematician, and geographer," britannica.org."
7. Ptolemy, *Algamest*, Book I, 1. (Preface). As cited in Crowe, pp. 50, 51, 52.
8. Ibid, p. 62.
9. Milton, John (1608–1674). *Paradise Lost* (1667). As cited in Crowe, p. 186.
10. Van der Waerden, articles.adsabs.harvard.edu. Van der Waerden tells us a "primitive epicycle theory" is said to have been invented by the Pythagoreans. "It was quite good for the Sun, Mercury, and Venus, but not for the outer planets."
11. Weinberg, David. astronomy.ohio-state.edu.

12. Ibid.
13. "Ancient Greek Astronomy," phas.ubc.ca.

    Steven Weinberg writes: "Ptolemy's work is "strikingly modern in its methods. Mathematical models are proposed for planetary motions containing various free numerical parameters, which are then found by constraining the predictions of the models to agree with observations . . . Nothing in the apparent motions of planets tells us how far away they are. Hence, in the theory of Ptolemy, the apparent motion of any planet does not depend on the absolute sizes of the epicycle and deferment; it depends only on the *ratio* of their sizes." Source: Weinberg, Steven, pp. 88–89.
14. Crowe, p. 38.
15. Hanson, homepages.uc.edu.
16. A simulation of Ptolemy's epicycle model is given in "Ptolemy to the Rescue?" homework.uoregon.edu.
17. As attributed in Keller, John Esten. *Alfonso X, El Sabio* (1967) Preface. https://todayinsci.com/P/Ptolemy/Ptolemy-Quotations.htm.
18. "Classical Astronomy." atnf.csiro.au.; Weinberg, David. astronomy. ohioostate.edu.
19. Sort of like modern day Quantum Mechanics. See endnote 21.
20. "Plato's Homework Problem," astronomynotes.com.
21. The issue as to what is real and what is mathematical artifice plagues modern day quantum mechanics. The so-called "wave function" gives the statistical *probability* of how a subatomic particle will behave. It does so with extraordinary accuracy. Is the wave function real? Or is it just a computation device? Physicists continue to argue over this issue in numerous scientific papers.

Chapter 9

1. Shalem, biu.ac.il.; Magness, p. 50.
2. Magness, pp. 47–53; Conder, p. 24.; Zank, bu.edu.

    The principal Council of seventy-one members — the *Sanhedrim* — sat in Jerusalem. Men of all classes were eligible, "qualified by reputation for sagacity and knowledge of the Law. Smaller councils of twenty-four members sat in country towns." Source: Conder, p. 25.
3. Conder, p. 28.
4. Ibid, p. 55.
5. Fisk, westmont.edu.; "Nehemiah: Jewish Leader," britannica.com.; Magness, p. 52.
6. Shalem, biu.ac.il.

7. Magness, p. 66; Hooker, jewishvirtuallibrary.org.
8. First century AD Jewish historian Josephus wrote that Alexander had come to Jerusalem to pay his respects to *YHWH* and high priest Jaddua (Antiquities 11: 325-31). This story "was fabricated to show that even Alexander the Great acknowledged the omnipotence of the God of Israel," writes American archeologist and religious scholar Jodi Magness. Source: Magness, p. 67.
9. Potok, p. 211.
10. Laomedon of Mytilene had initial control of Judea under the province of Syria. Ptolemy 1 Soter of Egypt seized it from Laomedon in 320. Five years later, the Antigonids of Macedonia gained control. Ptolemy recaptured the province in 312. A year later it was again in the hands of the Antigonids. Ptolemy retook it from the Antigonids in 301 — this time for good. Sources: Hooker, jewishvirtuallibrary.org.; Siculus, Diodorus. *Bibliotheca*, xviii. 3; Photius, *Bibliotheca*, cod. 82, cod. 92 http://www.tertullian.org/fathers/photius_03bibliotheca.htm; Justin, *Epitome of Pompeius Trogus*, xiii. 4 http://www.forumromanum.org/literature/justin/english/trans13.html#4; Curtius Rufus, *Historiae Alexandri Magni*, x. 10. http://remacle.org/bloodwolf/historiens/quintecurce/dix.htm; Appian, *The Foreign Wars*, "The Syrian Wars", 52. http://www.perseus.tufts.edu/hopper/text?doc=App.+Syr.+9.52&redirect=true. As cited in en:wikipedia.
11. Fisk, westmont,edu.
12. Ibid.
13. Gottheil, "Josephus, Flavius," jewishencyclopedia.com.

    1 Maccabees was written in Hebrew by an unknown Jewish author in the late 2nd century BC. 2 Maccabees is a synopsis of a five-volume history written by Jason of Cyrene. It was written in Koine Greek between 150 and 120 BC. It was likely "directed towards the Jews of Alexandria to enlist solidarity for their Judean brethren in Jerusalem." Source: Branon, Marlon. "One of the People" Jerusalem Post, jpost.com. https://www.jpost.com/blogs/one-of-the-people/-436009.

    Scholars do not know why 1 and 2 Maccabees are not included in the Hebrew Bible. They are included in the Catholic and other versions of the New Testament. An interesting discussion in this issue can be found in: Turkienicz, Rachel. "Why the Maccabees Aren't in the Bible: The books that tell the Hanukkah tale didn't make it into the Hebrew Bible — but they are in the Catholic one." myjewishlearning.com. https://www.myjewishlearning.com/article/omitting-the-maccabees/. Retrieved Feb. 1, 2021.

    Gary William Poole, associate editor of *Encyclopædia Britannica*, writes on Josephus: Like "most ancient writers: his analyses are superficial, his chronology faulty, his facts exaggerated, his speeches contrived . . . Yet he

unites in his person the traditions of Judaism and Hellenism, provides a connecting link between the secular world of Rome and the religious heritage of the Bible . . . for his toadyism he well deserved the scorn heaped upon him by his countrymen . . . [Nonetheless] he remained true to his Pharisee beliefs and, being no martyr, did what he could for his people." Source: Pool, Gary William. "Flavius Josephus." Encyclopedia Britannica, britannica.com. Jan1, 2021. https://www.britannica.com/editor/Gary-William-Poole/2346.

14. Arrian & Roos.
15. "Seleucid empire," britannica.com.; Tanner, Paul, paultanner.org.
16. https://commons.wikimedia.org/wiki/File:Seleuco_I_Nicatore.JPG.
17. "Angelic Conflict," cgtruth.org.
18. Jona, ancientbattles.com.; Magness, p. 68.
19. Zank, bu.edu.
20. Conder, p. 13.
21. Smitha, "Hellenism and Jews." fsmitha.com.; Potok, pp. 240, 252; Gilan, haaretz.com.
22. Potok, p. 243.
23. Tanner, paultanner.org. The rival — a usurper named Heliodorus — in turn had killed the new king's brother, the son of Antiochus III, to gain the throne.
24. From the speech of December 8, 1941 by United States President Franklin Delano Roosevelt regarding the surprise attack on the U.S. naval base at Pearl Harbor, Hawaii by the naval and air forces of the Empire of Japan the day before: "A date which will live in infamy." Source: "A Date which Wil Live in Infamy: FDR Asks a Declaration of War" George Mason University, historymatters.gmu.edu http://historymatters.gmu.edu/d/5166/.
25. Volkmann, britannica.com; Tanner, paultanner.org.
26. Volkmann, britannica.com; Gilan, haaretz.com.; Shalem, biu.ac.il.; Potok, p. 246.
27. Bell, warfarehistorynetwork.com.

    Impoverished from his failed Egyptian expeditions, Antiochus then looted the sacred Temple. He absconded with its "golden candlestick, the altar of incense, the sacred vessels, and even the veils and crowns of the sanctuary." Sources: Shalem, biu.ac.il.; Potok, p. 246; Conder pp. 16–17.
28. Gilan, haaretz.com.; Potok, p. 246; Shalem, biu.ac.il.
29. Magness, p. 94.
30. Potok, p. 247; Barry, scribd.com.; Dąbrowa, ejournals.eu/electrum.; Tanner, paultanner.org.
31. Fisk, westmont.edu.
32. Potok, p. 247.
33. Ginzberg, "Antiochus IV., Epiphanes." jewishencyclopedia.com.; "Hellenism and Jews." fsmitha.com.; Conder, p. 81.

9"x6" b4592 Ethnic Roots

34. Conder, p. 81.
35. Bell, warfarehistorynetwork.com.; Potok, p. 247, Magness, p. 94; Conder, pp. 83–84.
36. Bell, warfarehistorynetwork.com.
37. This included a "company of Hasideans, mighty warriors of Israel, everyone who offered themselves for the law (of Torah)." (1 Macc 2:42.) Who were the Hasideans? Their name is *Chasidim* in Hebrew — from *chasid* which means "kind, pious." I find this association between "kind" *and* "pious" noteworthy. It connects belief in *YHWH* with compassion, a core value of ethical monotheism. Little is known of these "pious ones." They are mentioned three times in 1 and 2 Maccabees, and then only briefly. Some scholars propose it was this Puritan sect which led the earlier Jerusalem uprising, and were the main reason for Antiochus' ban of Judaism. Maccabees texts indicate that when the Hasideans joined with Mattathias, it turned the tide of the rebellion. Sources: "2623. Chasid," biblehub.com. http://biblehub.com/hebrew/2623.htm.; Henriques, getd.libs.uga.edu.
38. Gilad, haaretz.com.; Dąbrowa, ejournals.eu/electrum.; Condor, p. 87.
39. Bell, warfarehistorynetwork.com.
40. Conder, p. 85; "Avaran" Net Bible, net.bible.org (dictionary entry). https://net.bible.org/#!search/avaran.
41. Dąbrowa, ejournals.eu/electrum; Shalem, biu.ac.il.
42. Dąbrowa, ejournals.eu/electrum. *This is one version of the story. Scholars are not sure whether the mass insurrection sparked Antiochus's decree or the decree sparked the insurrection. Source: Shalem, biu.ac.il.
43. Josephus, *Antiquities*, Book XII, ch. 7; Bell, warfarehistorynetwork.com.
44. Bell, warfarehistorynetwork.com.; Joshua 10:12-13.
45. Kantor, p.83; Bell, warfarehistorynetwork.com.; Conder, pp. 90–92.

    Seleucid troops in these battles were mostly residual forces and mercenaries. The best of Antiochus's army was off fighting the Parthians in the east at the time. Source: JPS review of, www.amazon.com.
46. Bell, warfarehistorynetwork.com.
47. Conder, p. 92.
48. Ibid, p. 93.
49. Bell, warfarehistorynetwork.com.
50. Ibid; Conder, p. 95.
51. Bell, warfarehistorynetwork.com.
52. Conder, pp. 96–97; Bell, warfarehistorynetwork.com.
53. Ibid.
54. Conder, p. 98; Bell, warfarehistorynetwork.com. When Gorgias and the remnants of his forces arrived at the camp at Emmaus, it was in flames. The joined the Seleucid retreat to the Gezer fortress. Gezer was located on the

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northern edge of the Shephelah region, roughly midway between modern Jerusalem and Tel Aviv.

55. Bell, warfarehistorynetwork.com.; Conder, p. 100; Herman, Mark, "The Hammer of God: Part II. Yumpu.com. https://www.yumpu.com/en/document/view/24486991/the-hammer-of-god-part-ii-c3i-ops-center.
56. Bar Kochva, Bezalel. *The Seleucid Army: Organization and Tactics in the Great Campaigns* (Cambridge, UK: Cambridge University Press, 1976), JPS review of, www.amazon.com.
57. Gilad, haaretz.com.
58. Conder, pp. 101–104; Potok, p. 248.
59. In c. 163 BC, Judah received reports of Syrian forces assaulting Jewish civilians in Galilee to the north and Gilead across the Jordan river. He sent Simon with three thousand men to Galilee. Simon overpowered a small Syrian contingent, liberated Jewish prisoners, and returned with them to Jerusalem.

    Judah along with Jonathan led 8000 troops "through the Trans-Jordan desert to Gilead. They overwhelmed a series of "fortified Hellenic towns east of the Golan Heights." They then routed Seleucid and Idumean troop laying siege to the Dathema fortress. Turning northwest, Maccabean troops overpowered Syrian forces at the Hellenic city of Raphon and sacked the city.

    Judas led two other missions in the spring of 164 BC: (1) to Idumea in the Hebron Hills to the south against Arab harassment of border villages; and (2) to the highlands north of Heshbon, where he defeated the Amorites under Timotheus at the town of Jager 40 miles north of Jerusalem. Sources: Bell, warfarehistorynetwork.com.; Conder, p. 117.
60. Conder, p. 128.
61. Bell, warfarehistorynetwork.com.; Conder, p. 134.
62. 1 Macc 6.
63. Lev. 25:2–7; comp. Ex. 23:10, 11, 12; Lev. 26:34, 35.
64. Easton's Bible Dictionary (1897).
65. Conder, p. 140. According to 1 Maccabees, on his deathbed Antiochus IV appointed his friend Philip "ruler over all his kingdom." (1 Macc 6:14.) This set up the conflict between Philip and Lysias for power. Source: Gera, Dov. *Judaea and Mediterranean Politics, 219 to 161 B.C.E.* (Leiden, Neth: Brill's Series in Jewish Studies, Vol 8, 1998) pp. 255–6.
66. Gilad, haaretz.com.; Conder, p. 140.
67. Conder, p. 146; Bell, warfarehistorynetwork.com. Demetrius then appointed Alcimus, an avid Jewish Hellenizer, as High Priest in Jerusalem. The new Seleucid king sent an army under General Bacchides to Jerusalem to enforce his selection. Once installed in the Holy City, Alcimus had sixty of his critics executed. When Bacchides left, civil war broke out again — this time

between Hellenists and Chasidim. Judas came to their rescue, overcame the Hellenists, and forced Alcimus to flee back to Antioch. Sources: Smitha. "Hellenism and Jews." fsmitha.com.; "Bacchides," jewishvirtuallibrary.org.
68. Bell, warfarehistorynetwork.com; Conder, p. 146.
69. Conder, p. 150.
70. Conder, p. 157. 1 Macc 9.1.
71. Conder, p. 157.
72. Bell, warfarehistorynetwork.com; Conder, p. 158.
73. Conder, p. 126.

Chapter 10

1. "Daniel's Son of Man." livius,org.; Yale Course: "RLST 152" oyc.yale.edu.
2. Yale Course: Yale Course. "RLST 152" oyc.yale.edu.
3. Ehrman, "Heaven and Hell, Part One." ehrmanblog.org.
4. Smitha, "Hellenism and Jews," fsmitha.com.
5. Ehrman, "The First Apocalypse: The Book of Daniel." ehrmanblog.org.
6. "Son of Man," encyclopedia.com. "The phrase 'son of man' is a literal rendering of the Hebrew *ben 'ādām* (Aramaic, *bar 'ĕnāš;* Greek, υἱὸς ἀνθρώπου), an expression that more exactly means 'a man,' or 'a human individual' (see adam). It is not the common expression for man, but is used especially in poetic parallelism with more usual words for 'man' (e.g., Nm 23.19; Is 51.12;56.2; Ps 8.5)." This "one like a son of man" is "a celestial being rather than a mortal; the clouds of heaven 'on' or 'with' (Aramaic '*im*) which he comes are commonly the vehicle of *YHWH* and an element of divine theophanies."
7. Yale Course, oyc.yale.edu.
8. "Saoshyans" britannica.com.; "Yasht," xix. 89–93; Bundahis, xxx. 1–33.
9. Ehrman, "Heaven and Hell, Part One." ehrmanblog.org.

   In Zoroastrianism, "perfection will come with the establishment of the Good Kingdom (Avesta, "Vohu Khshathra"), the Wished-for Kingdom (Avesta, "Khshathra Vairya"), or the Kingdom of Desire (Avesta, "Khshathra Ishtōish") . . . the world will become regenerate (Avesta, "Ahūm Frashem Kar"; or "Frashōkereti"). A final battle between the powers of good and evil will take place. Ahriman and his hosts will be routed and good shall reign supreme ("Yasht," xix. 89–93; Bundahis, xxx. 1–33). The advent of the Messiah (Saoshyant) will be accompanied by the resurrection of the dead and the general judgment of the world, which thenceforth will be free from evil and free from harm. Source: Kaufmann; Jackson. jewishencyclopedia.com.

Earlier Hebrew prophets also envisioned "an utterly transformed cosmos, extending from the heights of heaven to the depths of She'ol." Isaiah termed it "new heavens and new earth," (Isa. 65:17-25, 66:22-24). Total peace would reign among all nations (Isa. 2:4; Mic. 4:3). Death itself would be "swallowed up forever" (Isa. 25:7-8). This apparently includes the "resurrection" of the righteous dead of the past (Isa. 26:19). If so, Isaiah 26:19 is the only reference to resurrection of the dead in Hebrew Bible outside of Daniel. Sources: Tabor, uncc, edu.; "Jewish Resurrection of the Dead, myjewishlearning.com.

10. Conder, p. 206.
11. Ehrman, "Heaven and Hell, Part One." ehrmanblog.org.
12. Jos. *The Jewish War*. II, 125.
13. "What is a Maccabee?" blog, solaceradio.com.; "The Onias Dynasty: The Maccabee Revolt." lost-history.com.; Than, nationalgeographic.com.
14. Wein, jewishhistory.org.; Smitha, "Hellenism and Jews," fsmitha.com.; "The Onias Dynasty: The Maccabee Revolt." lost-history.com.
15. Cohen, Marsha, scholar in Jewish history and culture. Review of author draft of *Cosmic Roots*, Dec. 26, 2020.; Potok, pp. 254–5; Conder, p. 190.
16. Conder, p. 203; Smitha, "Hellenism and Jews," fsmitha.com.; "The Onias Dynasty: The Maccabee Revolt." lost-history.com.; "The Four Sects of Judaism According to Josephus." yumpu.com.
17. "The Four Sects of Judaism According to Josephus." yumpu.com.
18. Jos. *The Jewish War*. II 8:8.2, 43, 8.6; "The Onias Dynasty, lost-history.com.; Than, nationalgeographic.com.; "Hasideans," biblegateway.com.
19. Dąbrowa, ejournals.eu; Potok, p. 249.
20. Conder, p. 85; Dąbrowa, ejournals.eu.
21. Smitha, "Hellenism and Jews." fsmitha.com.
22. Stegemann, p. 130; Potok, p. 256; Dąbrowa, ejournals.eu; Smitha, "Hellenism and Jews." fsmitha.com.; Ginzberg, jewishencyclopedia.com; Josephus. as cited in "The Onias Dynasty," lost-history.com.
23. "Seleucid empire," britannica.com. Appian, *Syriaca* VIII 49, Justin, *Historiarum Philippicarum T. Pompeii Trogi* XL 2.2.
24. "Julius Caesar and the Jews," jewishhistory.org.
25. Dąbrowa, ejournals.eu. Hyrcanus had made an alliance with Aretas, king of the Nabataean. Together they laid siege to Aristobulus in Jerusalem. Pompey then sent part of his army under M. Aemilius Scaurus to Palestine. (Jos. *BJ* 1.127; *AJ* 14.29–32) Aristobulus bribed Scaurus with 400 talents of silver for his support. The Roman quaestor accepted the money and ordered the siege of Jerusalem be stopped. Aristobulus then proceeded to attack the withdrawing troops, inflicting heavy casualties. (Jos. *BJ* 1.130; *AJ* 14.33) According

to Josephus, "Aristobulus, with a great army, made war with Aretas and Hyrcanus, and fought them at a place called Papyron, and beat them in the battle, and slew about six thousand of the enemy." (Jos. *Ant*. XIV 2.) Sources: Dąbrowa, ejournals.eu; "Marcus Aemilius Scaurus," theodora.com.

26. Dąbrowa, ejournals.eu; Wein, "The End of the Hasmoneans, the Rise of Rome." jewishhistory.org.
27. Wein, "The End of the Hasmoneans, the Rise of Rome." jewishhistory.org.
28. Smitha, "Hellenism and Jews." fsmitha.com.; Wein, "The End of the Hasmoneans, the Rise of Rome." jewishhistory.org.; Dąbrowa, ejournals.eu.
29. Alexander, the elder son of Aristobulus II, raised an army against Rome in 57 BC. Aristobulus II escaped from Rome a year later and, with his younger son Antigonus II, seized the Alexandrium fortress northeast of Jerusalem. Alexander again stirred up a revolt in 55 BC. Pitholaus also rose up in rebellion in Galilee. (Jos. *Ant*. XIV 5:2, 6:1, 6:3, 6:4, and 7:1)

    In 40 BC, Antigonus rebelled once again. At the time Rome was caught up in a civil war between Octavian and Marc Antony. With the help of the Parthians, Antigonus seized Jerusalem and declared himself King and High Priest. He managed to hold the Judean crown for three years. (Jos. *Ant*. XIV 12:1)

    The infamous Herod, son of Antipater and tetrarch of Galilee, fled to Rome. There he convinced the Roman Senate to elect him "king of the Jews." They sent him back to the Holy Land with legions under General Gauis Sosius to reconquer the land of the Jews in the name of Rome. Herod and Sosius crushed the forces of Antigonus in 37 BC. The last Judean king was beheaded in Antioch that same year. Source: Smallwood, Mary E. *The Jews under Roman Rule: From Pompey to Diocletian: A Study in Political Relations* (Atlanta, GA: SBL Press, 2104 (reprint edition).
30. Ginzberg, "Alexander II., of Judea." jewishencyclopedia.com. Wein, "Review of the Hasmonean Era," jewishhistory.org.; Armstrong, p. 126.
31. Jos. *BJ* I.34-69, *AJ* XIII ww8-300; Dąbrowa, ejournals.eu; Crown, pp. 32–33; Singer, Isidore. Eds. *The Jewish Encyclopedia: A Descriptive Record of the History*, Vol. 6, p. 516; The Onias Dynasty: The Maccabee Revolt," lost-history.com.

    Archeological and numismatic evidence indicates that Judean rulers had been particularly "ruthless toward captured cities in Idumea and Samaria." These cities were "completely or almost completely razed." In comparison, destruction in cities in Galilee, Transjordan, and the Mediterranean coast was "small to imperceptible." This shows the particular hatred by the Jews for Samarians and Idumeans. Source: Dąbrowa, ejournals.eu.
32. In Herod's "monumental reconstruction project, the Temple Compound was double its original area." Source: Reznick, Leibel. "The Riddle of the

Shushan Gate" jewishaction.com. https://jewishaction.com/jewish-world/history/riddle-shushan-gate/. Retrieved Feb 1, 2021.

33. Myers, pbs.org; Perowne, britannica.com.
34. Wray, p. 34.
35. Tabor, "What the Bible Says About Death Afterlife, and the Future," uncc.edu; Fredriksen, "Jews and the Roman Empire." pbs.org.; Myers, pbs.org.; Coogan, p. 357; Potok, p. 263; Perowne, britannica.com.

    In addition to the rebuilt Temple, Herod's building projects included a "magnificent fortified palace"; a vast amphitheater and harbor in Caesarea Maritima; "whole cities with Greco-Roman theatres and baths"; military fortifications, including the famed fortress at Masada; and a "massive 1,700-foot-high butte overlooking the Dead Sea." Sources: Tabor, "The Jewish World of Jesus: An Overview" uncc.edu.; Fredriksen, "Jews and the Roman Empire"; Myers, pbs.org.; Potok, p. 263.
36. The Hasmonean period (c. 150 to 67 BC) saw the generation of additional messianic literature beyond that of the Book of Daniel. Some called for independent rule of Judea by a messiah-king; others by a messiah-king and messiah-priest. Scholars see a number of these appeals for the restoration of the Davidic monarchy as veiled criticism of the legitimacy of Hasmonean kings, who were not of the line of David.

    Messianic texts included the "*Book of Jubilees*, *Testament of Levi* and the *Testament of Judah*, as preserved in the Greek book *Testaments of the Twelve Patriarchs*. While of Jewish origin, the collection contains an accumulation of many later additions, especially Christian, which obscure the original version."

    "The expectation for David's monarchy to be restored by a royal messiah is further reflected in at least over a dozen texts in the Dead Sea Scrolls, most of which are considered among the principal doctrinal documents of the Qumran community. Their number includes the *Damascus Document* (CD), the *Rule of Community* (1QS), and the *Rule of Congregation* (1QSa). The figure of the royal messiah is concealed under various designations: the "Prince" or the "Prince of the Congregation," the "Branch of David," the "Scepter" . . . The Qumran texts feature one more eschatological figure, a priestly messiah . . . the dating of respective documents and their subsequent redactions still remain the subject of scholarly dispute. Sources: Dąbrowa, ejournals.eu; Toy, jewishencylopedia.com.

Chapter 11

1. Lendering, "Judaea," livius.org.
2. "Judea (Roman Province." en.wikipedia.org.

3. Sheehan, p. 49.
4. Attridge, "John the Baptist," pbs.org.
5. "Behind the Name: John." https://www.behindthename.com/name/john.
6. White, L. Michael. "John the Baptist: John the Baptist and the Ritual of Baptism." pbs.org.
7. Jackson, christiancourier.com; "Nazirite," jewishvirtuallibrary.org.
8. Strugnell, britannica.com. According to Strugnell, "the discovery of the Dead Sea Scrolls drew attention to the numerous parallels between John's mission and that of the Essenes, with whom John may have received some of his religious training. Both were priestly in origin . . . But John neither belonged to nor intended to found any organized community, (and) he did not stress study of" Torah Law.
9. Earle, Ralph. *Word Meanings in the New Testament*. (Peabody, MA: Hendrickson, 2000) p. 30. As cited in Strugnell, britannica.com.
10. Sheehan, p. 49.
11. Strugnell, britannica.com.; Sheehan, p. 29.
12. Sheehan, pp. 52, 53.
13. Strugnell, britannica.com.; White, L. Michael. "John the Baptist, pbs.org.; Attridge, John the Baptist, pbs.org.; Sheehan, p. 49.
14. Recognitions, i. 60, ii. 8: *ib*. Homilies, ii. 23, Acts 2:41. As cited in Kohler, Kaufmann "John the Baptist" http://www.jewishencyclopedia.com/articles/8733-john-the-baptist.
15. Jackson, christiancourier.com.
16. "The Bible does not give the name of the daughter of Herodias. We know her as Salome from Josephus (Antiquities 18:5:4)." Source: Stevenson, John. Pastor and Bible Scholar, "Review of Cosmic Roots draft", email to author, Aug 23, 2020.
17. Strugnell, britannica.com.
18. Sheehan, p. 52.
19. Aslan, p. xxviii.
20. Sheehan, p. 6.
21. "Josephus on Jesus" en.wikipedia.org. I rarely reference Wikipedia directly, as anyone is allowed to edit it, whether competent or not. In this case, I feel it gives a comprehensive assessment of the mentions of Jesus in Josephus' works.
22. Fredriksen, "What Are the Gospels?: Religious Advertisements." pbs.org.; Will Jerom on Dydimos. J. Thomas. Review of Bart Ehrman book: *Misquoting Jesus*. August 22, 2008. https://www.amazon.com/Misquoting-Jesus-Story-Behind-Changed/dp/0060859512.

    "We don't have any of the original manuscripts from the New Testament," Dydimos writes. "the earliest complete versions we do have are hundreds of

years removed from the originals. There are thousands of discrepancies in the manuscripts that are available to us . . . Some of these errors were unintentionally made by inexperienced scribes who mis-copied the texts. Other changes were made by well-meaning scribes who 'corrected' the texts they thought were in error. Still other scribes changed words and added passages to further a specific doctrine or to combat teachings they viewed as heretical."

On the dating of the Gospels between 70-100 A.D. John Stevenson points out that "Acts is an obvious sequel to Luke and this would mean that Luke would have to be composed at an earlier date. Since Luke is thought by many to have segments where it quotes from both Matthew and Mark, this would push them also to an earlier composition. The problem grows in enormity when we have apostolic fathers quoting from the gospels just a few years later . . . this was before the era of . . . the printing press, so these works needed to have time to be hand copied and distributed around the ancient world so that they could be quoted." Source: Stevenson, John. "Review of Cosmic Roots draft", email to author, Aug 23, 2020.

23. As to Jesus being illiterate, some scholars disagree. See, for example: Keith, Chris. "Jesus and Literacy" bibleodyssey.org. 2019. https://www.bibleodyssey.org/en/tools/ask-a-scholar/jesus-and-literacy. Retrieved Jun 25, 2021.
24. Frontline video. "From Jesus to Christ: The First Christians" pbs.org. https://www.pbs.org/wgbh/pages/frontline/shows/religion/; Taylor, thegospelcoalition.org.; Tabor, "The Jewish World of Jesus: An Overview" uncc.edu.
25. Aslan, pp. xxxiii, 36.; Losch, *All the People in the Bible*.; "Did Jesus have any brothers, sisters, or siblings?" bibleinfo.com. https://www.bibleinfo.com/en/questions/did-jesus-have-any-brothers-andor-sisters. According to Scriptures, Jesus may have worked as a carpenter (Mark 6:3).
26. Hanks, Hardcastle, and Hodges, p. 146; Crossan, pbs.org. ". . . the gospels . . . say that Jesus was the one predicted by John. So one of the essential problems is the accuracy of that description of the relationship between the two. That is, John as the self-conscious and deliberate forerunner of Jesus. A number of contemporary secular scholars would see that to be a construct developed by the early church to help explain the relationship between the two. For the early church it would have been something of an embarrassment to say that Jesus, who was in their minds superior to John the Baptist, had been baptized by him, and thereby proclaimed some sort of subordination to him, some sort of disciple relationship to him...." Source: Attridge, "John the Baptist: Historical Problem with John the Baptist." pbs.org.
27. Ehrman, "Do Paul and Jesus Represent Different Religions?" ehrmanblog.org.

28. Potok, p. 168.
29. Josephus. *The Jewish War*, as cited in Aslan, p. 8.
30. Sheehan, p. 64.
31. Sheehan, pp. 37, 64. Torah Law consisted of forty-one laws in the Covenant Code, seventy-eight additional in Deuteronomy, plus myriad regulations on sacrifices, feasts, and sex in Leviticus. (Exodus 20:3-23:33; Deut. Ch. 12-26; Lev. Ch. 17-26.) There were also extensive interpretations and regulations of "oral law," as emphasized by the Pharisees.
32. The accounts of the life and death of Jesus would come to be called the Gospels or "Good News" in English; after the Greek *euangelion* or good message. Source: Woodhead, Linda. *Christianity: A Very Short Introduction.* (Oxford, UK: Oxford University Press, 2004) p. 16.
33. Aslan, p. 97.
34. Ibid, pp. 97-8
35. Ibid, pp. 97-8
36. Ehrman, "Jesus' Claim to be the Messiah," ehrmanblog.org.
37. "The Disciples," bbc.co.uk.; Aslan, pp. 97-8; Jacobson, classroom.synonym.com.
38. Sheehan, p. 78.
39. Ehrman, "The Jewish Messiah," ehrmanblog.org.
40. "Messianic Secret," oxfordbiblicalstudies.com.; "Messianic Secret, en.wikipedia.org. "The literary explanation theory has it that Mark made a conscious effort to identify Jesus with Odysseus, a Greek hero with whom Mark's gentile audience would certainly have been familiar. Odysseus, on his return home, has to disguise his identity to avoid his enemies, and in Mark the messianic secret could serve the same purpose for Jesus."
41. *Berian Study Bible*, Bible Hub, biblehub.com. https://biblehub.com/jeremiah/20-9.htm.
42. Aslan, p. 3.
43. Ibid, pp. 73-76.
44. Ibid, p. 74.
45. Ibid, p. 230.
46. Taylor, blogs.thegospelcoalition.org.
47. Aslan, p. 3; Fredriksen, Paula. "Arrest and Execution: Why Was Jesus Killed?" pbs.org.
48. Tabor, James, "The Jewish Roman World of Jesus" uncc.edu.
49. Josephus, p. 303. In "The Jewish War," Josephus gives us an eyewitness description of the Sanctuary: "The Sanctuary itself, the Holy temple, situated in the middle . . . seen from the front it was the same height and width, 150 feet each way . . . The first gate was 105 feet high (10 stories) and 37½ feet

wide, it had no doors, this revealing . . . the vast expanse of heaven. The face was covered with gold all over . . . The Sanctuary was two stories high . . ."

50. John 2:14; Aslan, p. 74. According to the Book of Exodus (Exodus. 30:13), every Jewish adult male (over 20) must give a half-shekel to the Temple annually. Money changers are needed at the Temple outer court, as no foreign money is allowed in paying this Temple tax. Source: "Who Killed Jesus of Nazareth? The Money Changers." easy2surf.com.
51. Some scholars suggest that Jesus confronted the money changers to purify the House of *YHWH* in preparation for the imminent coming of the Kingdom of God. Still others claim it was a symbolic act which signified the rejection of Judaism "in favor of the new religion he is about to introduce." The trouble with the latter notion is that it is anachronistic. As noted, Jesus himself never proposed a new religion. This came well after his death. Source: Cohen, "The Cleansing of the Temple: Religious and Political Act." pbs.org.
52. Ehrman, "The Memory of Jesus' Triumphal Entry," ehrmanblog.org.
53. Matthew 26:36–46
54. Ehrman, *How Jesus Became God*, p. 123; "Roman Crucifixion Methods Reveal the History of Crucifixion: Crucifixion in Antiquity," biblicalarcheology.org.
55. "Who killed Jesus of Nazareth?" easy2surf.com.; Meeks, "The Jesus Movement: Explaining 'King of the Jews'" Frontline, pbs.org.
56. Geggel, Laura. "Jesus Wasn't the Only Man to Be Crucified. Here's the History Behind This Brutal Practice." livescience.com. Apr 19, 2019. https://www.livescience.com/65283-crucifixion-history.html. Retrieved Jun 25, 2021.;" Roman Crucifixion Methods Reveal the History of Crucifixion: Crucifixion in Antiquity," biblicalarcheology.org.

    Flogging is a severe whipping which causes "severe pain, deep wounds and bleeding."
57. Rabbi and writer Martin Lockshin questions whether "Jews" actually turned Y'shua in to Roman authorities to be killed. See: Lockshin, Martin. "Who Killed Jesus: From the Gospels to Nostra Aetate, how Jews were accused of deicide." myjewishlearning.com. http://www.myjewishlearning.com/article/who-killed-jesus/.

    "It is probably the case that the plaque that was nailed to the cross is one of the few clear pieces of historical evidence that we have, writes L. Michael White. "Precisely because it reflects a legitimate charge upon which the Romans would have called for execution . . . The plaque which sarcastically names him as Jesus, the *king* of the Jews, suggests that the charge on which he was executed was one of political insurrection — a threat to Pax Romana." (My italics.) Source: White, "Arrest and Execution: Evidence of Crucifixion." pbs.org.

58. New International Bible. biblegateway.com. https://www.biblegateway.com/passage/?search=Matthew%2027%3A38&version=NIV. Other versions of the Christian Bible refer to the two others crucified as "thieves."
59. Aslan, p. 172. Many ancient cultures had practiced crucifixion. This included Phoenicians, Babylonians, Egyptians, Assyrians, Persians, Scythians, Greeks, Carthaginians, Seleucids, and the Hasmonean Alexander Jannaeus — but none to the extent of Rome. Source: Cáceres, Marco. "The Crucifixions" huffingtonpost.com. Sep 30, 2013. http://www.huffingtonpost.com/marco-caceres/the-crucifixions_b_3678113.html.
60. "The Dating of the Gospels," bc.edu.
61. "The Many Messiahs in Jerusalem," delancyplace.com.
62. Aslan, p. 174.
63. Ibid, p. 176. "Modern research on visions has shown that visions are almost always believed by the people which experience them." Source: Ehrman, "Did Some Disciples Not Believe in the Resurrection?" ehrmanblog.org.
64. As cited in Reno, R. R. "The Christian Passover" Review, The Wall Street Journal, April 15–16, 2017. Believed to be composed somewhere between the fifth and seventh centuries AD. Source: "Exultet" *The Catholic Encyclopedia,* catholic.com. https://www.catholic.com/encyclopedia/exultet.
65. Ehrman, "Jesus' Claim to Be the Messiah," ehrmanblog.org.
66. Aslan, p. 163. The first written story of a resurrection is attributed to the Sumerians: "*Inanna's* Descent into the Nether World" — where *Enki* revives *Inanna's* impaled corpse to life. Source: Kramer, *History Begins at Sumer.*
67. White, L. Michael. "The Jesus Movement," pbs.org.; "Sect of 'The Way,'" biblethingsinbibleways.wordpress.com.
68. Ehrman, "From Jewish Sect to Gentile Church," ehrmanblog.org.

    According to Christian tradition, the Apostles in particular paid a heavy price for their beliefs. Of the twelve, only one died a natural death. Others are said to have been crucified, flayed alive, sawn in pieces, slain with arrows, hung, or killed with a spear. Source: "Who were the 12 disciples?" bibleinfo.com.
69. Sheehan, p. 180: Aslan, pp. 136–7.
70. Long, readingacts.com.
71. Aslan, pp. 170, 263; Ehrman, "Do Paul and Jesus Represent Fundamentally Different Religions?" ehrmanblog.org.

    "Matthew 13:55-56 names Jesus' brothers James, Joseph, Simon, and Judas and sisters (plural), so He had at least six siblings. "James is always named first when Jesus' brothers are listed, which in his day likely meant that he was the eldest of the four." Source: Myers, Jeannie. "Who Was James, Jesus' Brother?" biblestudytools.com. https://www.biblestudytools.com/

bible-study/topical-studies/who-was-jesus-brother-james.html. Retrieved Nov 24, 2020.

72. Based on the Gospels, the exact length of Jesus's ministry is estimated to be from one to three-and-a-half years. I chose a two-year period as most likely, based on analysis given in: Burdette, Andrew. "The World Views from the Biblical Perspective." https://andrewburdettewrites.com/about/long-ministry-jesus/
73. White, "The Jesus Movement. The Resurrection," pbs.org.

Chapter 12

1. Aslan p. 54.
2. Aslan, p. 48. About 40 AD, half-mad Roman emperor Caligula declared himself a god and ordered a statue of himself be set up in the Jerusalem Temple. Herod Agrippa, then puppet king of Judaea, persuaded him to stay the order out of respect for the Jewish religion. Pious Jews realized the whims of a Roman emperor could desecrate the House of *YHWY* at any time. Their sense of powerlessness fed a growing revolutionary zeal. This from the writings of Philo. In Josephus' version, Caligula did not rescind the order, but Rome's Syrian Legate Publius Petronius delayed its implementation. Caligula's death ended the threat. Smallwood points out this is a "fairly-tale ending, chronologically incompatible with demonstrations in the early summer (since Gaius [Caligula] did not die till January 41)." Source: Josephus, *The Jewish War*, chapter 7, endnote 37, p. 429.
3. "Timeline of Paul's Ministry," christianityinview.com.; Aslan, p. 49.
4. Aslan, pp. 49-51.
5. Ibid, p. 51.
6. Biswas, C. R. *In Search of Brighter Sunshine: The Semitic Refugee Crisis: Past and Present.* (Chennai, India: Notion Press, 2016)
7. Aslan, pp. 51-52; "Sicarii" jewishvirtuallibrary.org.; Horsley, jstor.org.
8. Jos. *BJ* 2. 254-56.; As cited in Horsley. A parallel account is found in Josephus, *Antiquities* (20.164-165).
9. Aslan, p. 52; Horsley, jstor.org.; Roth, commentarymagazine.com.
10. Josephus, *The Jewish War*, Ch. 8, endnote 2, p. 431.
11. Potok, pp. 278-9.
12. Josephus, *The Jewish War*, p. 149.
13. Ibid, p. 152. Was this vile act by Florus a ruse? Josephus argues that Florus had intended to drive the Jews to war to "divert attention from his own crimes." If so, it worked. Source: Josephus, *The Jewish War*, p. 150.
14. "Ancient Jewish History: The Great Revolt," jewishvirtuallibrary.org.; "Jewish War (66-70)," livius.org.; McGoodwin, mcgoodwin.net.

15. "Jewish War (66–70)," livius.org; Jos. War 2.18.9; Goldberg, josephus.org.
16. Goldberg, josephus.org.
17. Ibid.
18. Gottheil & Krauss, "Gallus, Caius Cestius" jewishencyclopedia.com.; Goldberg, josephus.org.
19. Josephus, *The Jewish War*, p. 178.
20. Goldberg, josephus.org.; Lennartz, prezi.com.
21. Josephus. (War 2.20.1 556); Goldberg, josephus.org.
22. Tabor, "The Roman World of Jesus: An Overview," uncc.edu; McGoodwin, mcgoodwin.com.; "Timeline of the First Jewish-Roman War," Mansfield, gospelassembly.files.wordpress.com.
23. The Sicarii seized the "Herodian Fortress of Masada on a cliff overhanging the Dead Sea." They exterminated all the Roman troops there. In addition, Jews were slaughtered in Caesarea and killed in Syria. Anti-Jewish purges were conducted in "Scythopolis, Ascalon, Ptolemais, Tyre, etc." Jews also attack Jews. Sources: Roth, commentarymagazine.com.; McGoodwin, mcgoodwin.net.
24. Roth, commentarymagazine.com.
25. Josephus, *The Jewish War*, pp. 189, 194.
26. "Vespasian," jewishencyclopedia.com.
27. "Gamla – The Masada of the Golan," biblewalks.com.; Josephus, *The Jewish War*, p. 236.; "Chronology of the Jewish War, 66-74," livius.org.; Green, haaretz.com.
28. The story goes that three Roman soldiers from the 15th Legion managed to sneak into the city at dawn and seize the guard tower. Source: Green, haaretz.com.
29. Josephus, *The Jewish War*, pp. 242-243.
30. Tabor, "The Roman World of Jesus: An Overview," uncc.edu.
31. Josephus, *The Jewish War*, pp. 267-8.

    The Romans opened their "campaigning season of 68 AD" with an attack on Gadara, capital of Peraea, in the Spring. Source: Josephus, *The Jewish War*, Ch, 15, endnote 20, p. 443 (text p. 267).

    Vespasian then reconquered eastern areas, including Atipatris, the toparchy of Thamna, Lydda, Jamnia, Emmaus, the toparchy of Bethleptepha, and Idumaea. He also constructed camps in Jericho and Adida. "The encirclement of Jerusalem was complete." Source: Josephus, *The Jewish War*, p. 271, 3.
32. "Vespasian," jewishencyclopedia.com.
33. Josephus, *The Jewish War*, p. 259.
34. Josephus, *The Jewish War*, p. 273. "Vespasian had returned to Caesarea and was getting ready to march his entire force against Jerusalem itself, when he

received new that Nero had met a violent end." Nero committed suicide on June 9, 68 AD. It took about a month or so for the news to reach Vespasian in Palestine.

35. Tabor, "The Roman World of Jesus: An Overview," uncc.edu.
36. "Nero: Emperor," Encyclopedia Britannica, brittanica.com.
37. Ibid.
38. "The Lie of Nero," From Seutonius, C. *The Lives of the Twelve Caesars* (Loeb Classical Library, 1914) penelope.uchicago.edu. http://penelope.uchicago.edu/Thayer/e/roman/texts/suetonius/12caesars/nero*.html.
39. "Timeline of the First Jewish-Roman War," Mansfield, gospelassembly.files.wordpress.com.
40. Tiberius Alexander, governor of Egypt, "called on soldiers and civilians to swear allegiance to Vespasian. Since oaths of allegiance were taken only to the emperor," this was tantamount to declaring Vespasian as emperor. Source: Josephus, *The Jewish War*, p. 263 and Endnote 49, p. 446.
41. "Timeline of the First Jewish-Roman War," Mansfield, gospelassembly.files.wordpress.com.
42. Roth, commentarymagazine.com.
43. Ibid.
44. "Simon and his followers cut off part of the Roman rear-guard and seized the baggage train, which they brought back in triumph to Jerusalem." Source: Roth, commentarymagazine.com.
45. According to Josephus, Simon was born in "Gerasa, a large Hellenistic city in Transjordan — a city of mixed population." Some modern scholars argue he was from "the village of Jerash in the neighborhood of Hartuv (Press, Erez, 1 (1951[2]), 174, S.V. *Geresh*)." Others suggest "Kefar Jorish near Shechem. Since the word *giora* means proselyte in Aramaic, many scholars hold that his father was a convert to Judaism." Sources: "Simon Bar Giora," jewishvirtuallibrary.org.; Roth, commentarymagazine.com.
46. Roth, commentarymagazine.com.
47. Josephus, *The Jewish War*, pp. 275-6.
48. "Simon Bar Giora," jewishvirtuallibrary.org.
49. "The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
50. Roth, commentarymagazine.com.
51. Josephus, *The Jewish War*, pp. 288-9.
52. "Timeline of the First Jewish-Roman War," Mansfield, gospelassembly.files.wordpress.com.
53. Josephus, *The Jewish War*, p. 317.

54. Ibid, pp. 307, 295, 273.; Goldberg, "A War Chronology — Part 7: The Siege and Destruction of Jerusalem," josephus.org.; "The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
55. Aslan, p. 56.
56. The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
57. Josephus, *The Jewish War*, p. 309.
58. Potok, p. 285; "The Siege of Jerusalem — 70 AD." Invicta. you-tube.com.; Josephus, *The Jewish War*, pp. 310, 11.
59. Josephus, *The Jewish War*, pp. 274, 288, 332, 304.
60. Ibid, p. 312. Roth, commentarymagazine.com.
61. Roth, commentarymagazine.com.; "The Siege of Jerusalem — 70 AD." Invicta. you-tube.com. "The Siege of Jerusalem — 70 AD." Invicta. you-tube.com.
62. Josephus, *The Jewish War*, p. 309.
63. Ibid, p. 314; The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
64. "The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
65. Ibid; Josephus, *The Jewish War*, p. 314.
66. Josephus, *The Jewish War*, pp. 325-6.
67. Ibid, p. 338.
68. Ibid, p. 306. John had his men secretly excavate a tunnel under Roman siege ramps at the Antonia Fortress. They set the bitumen-coated wood supports alight. The tunnel collapsed and a chasm opened which engulfed the ramps and set the Roman siege engines on fire. With "heavy rain, men, and machinery weighing John's tunnel, the northern wall of the fortress collapsed. When the Romans rushed forward, they found John has constructed a second wall. Source: "The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
69. Ibid, p. 348.; Roth, commentarymagazine.com.
70. Ibid; The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
71. The wall was interspersed with thirteen forts. Source: Josephus, *The Jewish War*, p. 330.
72. "According to Jewish tradition, the year which ran from the autumn of 68 had been a sabbatical year. If correct, no replenishment was available during 69–70." The next harvest would have been April-May of 70. Titus arrived at the outskirts of the city at around that same time and began the siege in

mid-May. Sources: Josephus, *The Jewish War*, Ch. 17, endnote 4, p. 446; "Chronology of the Jewish War, 66–74" livius.org.

73. Josephus, *The Jewish War*, p. 315.
74. Ibid, pp. 341-2. Two days earlier, a handful of Roman volunteers had attempted to scramble over the wall. They were all killed.
75. Peters, historynet.com.
76. "The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
77. Josephus, *The Jewish War*, pp. 342-4.; Goldberg, "A War Chronology — Part 7: The Siege and Destruction of Jerusalem," josephus.org.
78. Josephus, *The Jewish War*, pp. 342-43, 355-6.; "The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
79. "The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1), youtube.com."
80. Ibid.
81. Ibid; Josephus, *The Jewish War*, p. 357.
82. Josephus, *The Jewish War*, p. 359.
83. Ibid, p. 367; Roth, commentarymagazine.com.; "The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
84. The Phasael tower remains to this day today as an Ottoman structure. It was constructed over earlier ruins as the "northeast tower of the present citadel" — popularly known as David's tower in Jerusalem's Old City. Built by Herod and named after his brother, it was Simon ben Giora's headquarters for much of the war. Source: Barat, Rami (ed.) "Jerusalem Between the Hasmoneans and Herod the Great." In Arav, Rami (ed.) *Cities through the Looking Glass: Essays on the History and Archeology of Biblical Urbanism*. (University Park, PA: Eisenbrauns, 2007) pp 122–4. As cited in en: wikipedia.

    In addition, much of "the southern part of the Temple enclosure was spared." (This includes the south wall of what Moslems call the *al-Ḥaram al-Šarīf*, 'the Noble Sanctuary.' Today, in the great plaza above is the al-Aqsa Mosque where Mohammed is said to have traveled in his dream trip before ascending to heaven; as well as the Dome of the Rock Mosque, believed by Muslims to be the location where Abraham's near sacrifice of his son was stayed by an angel of God (Allah).) Source: Josephus, *The Jewish War*, Ch. 22, endnote 2, p. 454.
85. Josephus, *The Jewish War*, p. 370.
86. Ibid.
87. Ibid, *The Jewish War*, p. 376.
88. Ibid.; "Simon Bar Giora" jewishvirtuallibrary.org.

89. Ibid. "John, starving to death with his brothers in the sewers . . . also gave himself up. [He] was sentenced to life-imprisonment." Source: Josephus, *The Jewish War*, p. 327.
90. "The Siege of Jerusalem (70 AD) — Romans at the Gates (Part1)," youtube.com.
91. McGoodwin, mcgoodwin.net.
92. Roth, commentarymagazine.com; Josephus, *The Jewish War*, p. 386. Josephus writes that "Simon was dragged to the usual spot in the Forum." Some scholars take this to mean he was hurled from the Tarpeian rock to his death.
93. Roth, commentarymagazine.com.; "Simon Bar Giora," jewishvirtuallibrary.org.
94. "The Siege of Jerusalem (70 AD) – Romans at the Gates (Part1)," youtube.com.
95. In a final insult, Rome ordered the "Temple tax" which had been paid by Jews throughout the empire for the upkeep of the Jerusalem Temple to now be collected for the maintenance of the Temple of Jupiter on the Capital in Rome. Josephus, *The Jewish War*, Ch. 23, Endnote 11, p. 457.
96. "Timeline of Christian History," christianityinview.com.; Aslan, pp. 211, 12.

Chapter 13

1. Barnstone, p. 447.
2. White, pp. 145–147; Wright, p. 404.; Aslan, p. 170.
3. Talmud Shabbat 31a. As cited in Rich, jewfaq.org.
4. "Disobedient members of synagogues were punished by some form of ostracism or by light flogging, which Paul himself later suffered at least five times (2 Corinthians 11:24)" Source: Sanders, britannica.com.
5. Maynard, whmaynard.blogspot.com.
6. Some suggest Saul went to Arabia to meditate on Mount Sinai. Source: Wright, N.T. "Paul, Arabia, and Elijah", "Paul in Arabia" Bulletin for Biblical Research 12.1 (2002) pp. 47–66.
7. Most scholars date the Book of Acts to c 80-90 AD, although evidence suggests it was still being substantially revised well into the 2nd century." Source: Perkins, pp. 250-253.

   "This is somewhat problematic," Stevenson points out, "since the book ends on something of a cliff-hanger with Paul awaiting his trial before Nero. Was he executed? Was he released, only to be re-arrested at a future time and then executed? The writer of the Book of Acts does not tell us and this is the problem with placing the composition of the book many years later." Source:

b4592 Cosmic Roots 9"x6"

Stevenson. John. "Review of Cosmic Roots draft," email to author, Aug 23, 2020.

8. Lazare, p. 63.
9. Tabor, "The Roman World of Jesus: An Overview," uncc.edu.
10. "Jesus and the Messianic Prophecies, ehrmanblog.org.
11. Tabor, "The Jewish Roman World of Jesus," uncc.edu
12. Ehrman response to Talmoore comment in Ehrman, "Do Paul and Jesus Represent Fundamentally Different Religions?" ehrmanblog.org.
13. Zanzig, p. 33. The earliest mention of the name Jesus is in Paul's 1 Thessalonians: "To the Church of the Thessalonians in God the Father and the Lord Jesus Christ." The letter was likely written in c. 50 AD. The first secular mention of Jesus is by Josephus in *Antiquities*, written c. 95 AD: "[The high priest Ananus] convened the judges of the Sanhedrin and brought before them a man named James, the brother of Jesus who was called the Christ . . ." (Jos. Ant. XX, 9.1). Jesus is mentioned again in Antiquities but "the text is generally considered inauthentic (Jos. *Ant.* XVIII,3.3)." Source: Sheehan, Ch. 1, note 23, pp. 242–3.

    Regarding Saul's name change to Paul: "The Book of Acts makes this transition from Saul to Paul," Stevenson writes, "when the Apostle has a meeting with a Roman Proconsul who has the same last name as Paul. This takes place in Acts 13:7-9 when he meets with Sergius Paulus. At least at that point, the name change might also have something of a political motivation." Source: Stevenson.
14. "The Way" is used widely in the Book of Acts. The term Christians is mentioned only three times in the New Testament (Acts 11:26, 26:28, 1Pe 4:16). Source: "Sect of 'The Way,'" 'The Nazarenes' & 'Christians': Names Given to the Early Church," biblethingsinbibleways.wordpress.com.
15. Ehrman response to godspell comment in Ehrman, "Paul's Own (and Only) Gospel" ehrmanblog.org.
16. Sanders, britannica.com.
17. Ibid.
18. Rich, jewfaq.org.; Sanders, britannica.com.
19. Rolheiser, ronrolheiser.com.
20. Ehrman, "The Death of the Messiah for Salvation." ehrmanblog.org.
21. Sanders, britannica.com.
22. Ibid.
23. Acts 8 tells of the conversion of an Ethiopian eunuch prior to the conversion of Cornelius. He was either a Jewish convert or proselyte, thus not a "Gentile." "The Ethiopian Eunuch," apologeticspress.org.
24. Long, readingacts.com.

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25. Wilkinson, jstor.org.
26. "From Jerusalem to Jericho," bibleresources.americanbible.org. .
27. Ibid.
28. Ehrman, "Did Luke Really Write the Gospel and the Book of Acts?" ehrmanblog.org.
29. Leuchter, thetorah.com.
30. Sundee Tucker Frazier, *Check all that apply; finding wholeness as a multiracial person*. (Westmont, Illinois: InterVarsity Press, 2002); "Summary and Analysis The Gospel of Luke" cliffsnotes.com.
31. 2 Corinthians 11:27; "Paul's Journeys" Loyola Press, loyolapress.com. https://www.loyolapress.com/catholic-resources/scripture-and-tradition/jesus-and-the-new-testament/saint-paul-and-the-epistles/pauls-journeys/.
32. Sanders, britannica.com.; Phil 4:11-12.; 2 Cor 11:27.
33. McGee, matthewmcgee.org.

    It is possible the Epistle of James could have been written before the Pauline epistles. There is "wide disagreement as to the date of [the James composition], though many scholars hold that it was probably post-apostolic and was likely penned at the turn of the 1st century." Source: "Letter of James. Encyclopedia Britannica, britannica.com. https://www.britannica.com/topic/The-Letter-of-James. Retrieved Nov 24, 2020.
34. Aune, p. 9 "While seven of the letters attributed to Paul are almost universally accepted as authentic (Romans, 1 and 2 Corinthians, Galatians, Philippians, 1 Thessalonians, Philemon), four are just as widely judged to be pseudepigraphical, i.e., written by unknown authors under Paul's name: Ephesians and the Pastorals (1 and 2 Timothy and Titus).
35. Cole, churchplanting.com.
36. Sanders, britannica.com.; Barnett, p. 200.
37. ". . . great as was the success of Barnabas and Paul in the heathen world, the authorities in Jerusalem insisted upon circumcision as the condition of admission of members into the church." This was so until, on the initiative of Peter and James, "it was agreed that acceptance of the Noachian Laws — namely [those regarding] avoidance of idolatry, fornication, and the eating of flesh cut from a living animal — should be demanded of the heathen" who wished to join the Church. Source: Kohler, Kaufmann et al. "New Testament: Spirit of Jewish Proselytism in Christianity," jewishencyclopedia.com.
38. Ehrman, "Do Paul and Jesus Represent Fundamentally Different Religions?" ehrmanblog.org. Ehrman writes: "Should a person follow the Jewish Law or not? Jesus thought the answer was yes—this was the core of his teaching. Paul thought the answer was no—doing so would not allow one to be saved

. . . [However] Paul certainly did not think that people should go about 'breaking' the law (committing adultery, or murder, or false witness, etc.).'"

39. Aslan, p. 193.
40. "Paul, St," Cross, F. L., ed. "The Oxford dictionary of the Christian church." (New York: Oxford University Press, 2005); Capes et al, p. 203; "Apostle Paul's Roman Citizenship," biblestudy.org.

    It may be that Paul was Roman citizen not because he was from Tarsus. "Expositor's Greek Testament says that St. Paul's citizenship of Tarsus did not make him a Roman citizen, otherwise his answer in Acts 21:39 would have been sufficient to have saved him from the present indignity. Tarsus was a *nurbs* libera, not a *colonia* or *municipium*, and the distinction made in Acts between the Roman and Tarsian citizenship of Paul is in itself an additional proof of the truthfulness of the narrative. How his father obtained the Roman citizenship we are not told. . . As early as the first century B.C. there were many thousands of Roman citizens living in Asia Minor." Source: Jireh, Godwin Goziem. In "Why was Paul born a Roman citizen?" quora.com. https://www.quora.com/Why-was-Paul-born-a-Roman-citizen.
41. Aslan, pp. 195–6.
42. Malik & Davinport, theconversation.com.; "Throwing Christians to the Lions: Fact and Legend," jaysromanhistory.com.; Allen, Charlotte "The Story Behind 'Paul the Apostle of Christ,'" House of Worship, The Wall Street Journal, April 13, 2018.
43. Tacitus. Annals, 15.44. As cited in Lendering, "Tacitus on the Christians, livius.org.; Ehrman, "Constantine and Christianity," ehrmanblog.org.
44. Ignatius of Antioch, "Letter to the Ephesians," Chap. XII, orderofstignatius.org.; Dionysius of Corinth, "Fragments from a Letter to the Roman Church," Chap III, earlychristianwritings.com.
45. Ehrman, "Paul and Jesus," ehrmanblog.org.
46. As noted, archaeological evidence tells us Jews continued to live in Jerusalem as well as other parts of the Holy Land. Source: Ehrman, Response in "Aslan's Zealot: Historical Mistakes," ehrmanblog.org.

    As to Jesus followers who had lived in Judaea, they had refused to fight for Jerusalem and "had fled to Pella and Transjordan. Mainstream Jews considered them traitors." This according to the Gospel of Luke. (Luk 21:20-24). We have no way of knowing the validity of this story. Source: "2000 Years of Christianity: What Happened," biblethingsinbibleways.wordpress.com.
47. Thomas Jefferson, a Deist, was a critic of Paul and his views. He wrote that Paul was the "first corruptor of the doctrines of Jesus." Source: *The Writings of Thomas Jefferson: Being his Autobiography, Correspondence, Reports, Messages, Addresses, and Other Writings, Official and Private*. Ed. H. A. Washington. Vol. VII. (Washington, DC: Taylor Maury, 1854).

Chapter 14

1. "Bible Verses About Growth," biblestudytools.com.
2. Allen, Charlotte "The Story Behind 'Paul the Apostle of Christ,'" House of Worship, The Wall Street Journal, April 13, 2018. Quotes in the text are those of Ms. Allen.

   "Acts 2 speaks of 3,000 being baptized in a single day and Acts 4:4 puts the number of Christian men in the early church at 5,000," Source: Stevenson, John. "Review of Cosmic Roots draft," email to author, Aug 23, 2020.
3. Ehrman. *The Triumph of Christianity,* p. 209.; Sherrard, pp. 15, 16.
4. Sherrard, p. 16.; "Christianity as a Mystery Cult," kenyon.edu.; Merkelbach, britannica.com.

   Pagan mystery religions featured secret initiations, a "mystical communion with their Deity, membership in a close-knit community, and a promise of immortality" — all similar to Christianity. There is "no clear direct influence of the mystery religions on early Christianity," writes scholar James Tabor, ". . . many non-Christians would have perceived Christians as members of an oriental Jewish mystery cult." Source: Tabor, The Roman World of Jesus: An Overview," uncc.edu.
5. Ehrman. *The Triumph of Christianity,* pp. 133-4. Ehrman points out that "early fourth century defender of the faith, Lactantius, also indicates that most Christians were uneducated and 'foolish'" (Divine Institutes,5.1-2).
6. Holy Bible, New International Version. (NIV) https://www.biblegateway.com/passage/?search=1+Corinthians+1%3A26-27&version=NIV.
7. Ehrman. *The Triumph of Christianity*, pp. 78, 83.
8. Pliny, *Letters*, transl. by William Melmoth, rev. by W.M.L. Hutchinson (Cambridge: Harvard Univ. Press, 1935), vol. II, X:96, cited in Habermas, *The Historical Jesus*, 199. As cited in Gleghorn, bethinking.org.
9. Ehrman. *The Triumph of Christianity*, p. 136.
10. Ibid, p. 107.
11. Ibid, p. 139-144.
12. "the better angels of our nature, and it worked." Source: Weigel, George. "The Easter Effect and How It Changed the World" Wall Street Journal. Mar 30, 2018.
13. Sherrard, p. 16.
14. Ehrman, *The Triumph of Christianity*, p. 111.
15. Ibid, p. 109.
16. Ibid, p. 117. Ehrman points out that ancient "Jews typically did welcome anyone who seriously wanted to consider adopting their worship and ways. We have records of pagans converting to become Jews." Yet "recent scholarship has persuasively shown that . . . ancient Judaism lacked a genuine missionary impulse."

17. Ibid.
18. Ibid, pp. 119, 176. Early "Christians did not convert others through organized missionary efforts," Ehrman tells us. In fact, "we have almost no record of any full-time evangelists after Paul, of missionaries or organized mission of any kind."
19. Patterson, books.google.com.
20. "Q & A About Jesus Before the Gospels, Part I," ehrmanblog.org.
21. Fredriksen, "What Are the Gospels?: Religious Advertisements." pbs.org.
22. Ehrman. *The Triumph of Christianity*, p. 76.; Patterson, books.google.com.; Kruger, ehrmanproject.com. See this for Kruger's arguments against Ehrman's views on the identity of Gospel authors.
23. "Some scholars have argued that from the time of Nero Christianity was illegal across the empire." This is doubtful, as "evidence for Nero's treatment of Christians comes from the second century and does not mention a law of any kind." Source: Moss, Ch.4, endnote 13, p. 280.
24. Kierspel, p. 5. As cited in Goldhagen, pp. 263-265.
25. It isn't just the Book of John. I found the Gospels of Mark, Matthew, and Luke — the so-called Synoptic Gospels — to be progressively more anti-Semitism.

    Post-second temple Pharisee leadership did not help the situation. In synagogues near the end of the first century, they read the following curse:

    For the apostates let there be no hope . . . Let the nozerim (Hebrew for Nazarene, i.e., Christian) and the minim (Hebrew for heretic) be destroyed in a moment . . . Blessed art thou, O Lord, who humblest the arrogant." — Recited in synagogues c. 90 AD

    This "effectively drove out 'Christian heretics,' that is Jews who believed in Christ from the synagogues." Source: "Bible things in Bible Ways, 2000 years of Christianity: what happened? biblethingsandbibleways.com.
26. "Who Killed Jesus of Nazareth? easy2surf.com.
27. Ibid.; Taylor, p. 8.
28. "Who Killed Jesus of Nazareth? easy2surf.com.
29. Embassy to Gaius 302. From translations Smallwood, E. Mary. Legatio ad Gaium (Leiden: E. J. Brill, 1961). As cited in Ehrman, *The Triumph of Christianity*, p. 163.
30. Tabor, "The Jewish World of Jesus: An Overview," uncc.edu.
31. Ibid, Aslan, p. 47.; Josephus, *Jewish Antiquities* 18.89.
32. Aslan, p. 47; Ehrman, *The Triumph of Christianity*, pp. 123, 162.
33. Ehrman, *The Triumph of Christianity*, p. 89.

34. Johansson, journals.sagepub.com. As historical scholar Tavis Bohlinger points out, in the Gospel of Mark, Jesus "doesn't know everything God the Father knows (Mk 13:32); he is occasionally unable to perform miracles (Mk 6:5); and his question to the rich man — 'Why do you call me good? No one is good except God alone' (Mk. 10:18)." Source: Bohlinger, academic.logos.com.
35. Aslan, xxvii; Duling, Dennis C. "The Gospel of Matthew". In Aune, pp. 298-9; Nolland, p. 18.
36. Weidmann, joshweidmann.com.
37. Ehrman. *The Triumph of Christianity*, pp. 84-5.
38. Among early Christians, there was great disagreement on the nature of the afterlife. Some held to the resurrection of the body on the Day of Judgement ala Jesus and the Book of Daniel. Others believed in the immortality of the soul. Still others believed in "astral immortality," i.e., "some people become stars or other heavenly bodies upon death." This idea "held wide currency in the Greco-Roman world." Sources: Moss. p. 209; Park, Joseph S. Conceptions of Afterlife in Jewish Inscriptions: With Special Reference to Pauline Literature ... (Tübingen, GE: Mohr Siebeck, 2000) p. 157.

    Regarding the Christian roots of the fires of Hell, Jesus refers to 'Gehenna' multiple times in the New Testament; e.g., Mt. 5:29-30; cf. 18:9; Mk. 9:43-47. "This is the valley of Hinnom, where garbage burned continually, and corpses were sometimes deposited." It is suggested that "he referred to it to illustrate his lessons on spiritual growth and the Earthly realm — the earthly body was meaningless and would be thrown on the garbage dump." Source: "Yeshua Before 30 CE: The Church's Development of the Hell Myth," 30ce.com.
39. "Yeshua Before 30 CE: The Church's Development of the Hell Myth," 30ce.com. Cicero quote as cited in this reference. "Socrates describes a quasi-mythical view of the cosmos where human beings currently live in hollows in the earth. After death, souls proceed to the lakes of Tartarus and Acheron for punishment. If their souls are purified by philosophy, they have the opportunity to ascend to the true earth above. Source: Moss, pp. 38–9.
40. Kirby, earlychristianwritings.com.
41. Tertullian. *Apology*: De Spetaculis, Trans. T. R. Glover. Loeb Classical Library 250 (Cambridge, MA: Harvard University Pres, 1931). As cited in Ehrman. *The Triumph of Christianity*, p. 154.
42. Ehrman. *The Triumph of Christianity*, p. 154.

43. Plato, *Phaedrus*. A cited in goodreads.com. https://www.goodreads.com/author/quotes/879.Plato?page=1.
44. Moss, p. 134. The question of precisely when Jesus followers began to "think of and call themselves Christians is a huge one." It depends, in part, on "the dating of the *Acts of the Apostles*." Source: Moss, Ch. 4, endnote 8, p. 279.
45. "The First Ten 10 Popes of the Catholic Church," ourladyspromise.org. Christian tradition holds Apostle Peter was the first pope. The three following popes of the first century are believed to have been Linius (67–76), Analetus or Cletus (76-88), and Clement (88–97).
46. Ehrman. *The Triumph of Christianity*, p. 128.
47. Cohen, Shaye I. D., "Legitimization Under Constantine," pbs.org.; Boyarin, p. 15.; Severance, christianity.com.
48. National Geographic "Gospels of Matthew, Mark, Luke, and John Written." nationalgeographic.com. http://www.nationalgeographic.com/lostgospel/timeline_04.htm; "Christian History Timeline," christianhistoryinstitute.org. An interesting scholarly discussion on the various other gospels is given in: "Emergence of the Four Gospel Canon" pbs.org. April, 1998. https://www.pbs.org/wgbh/pages/frontline/shows/religion/story/emergence.html. Retrieved Jan 19, 2021.
49. Wingren, britannica.com.

    "Fusing Christian terms with concepts from Greek Philosophy and Asian religion, Gnostics taught the world was evil and was governed by angelic powers, that God is distant to this world. Salvation, they said, could be attained only through special secret teachings that they who were Spiritual knew, being superior to regular Christians." Source: ""Bible things in Bible Ways, 2000 years of Christianity: what happened?" biblethingsandbibleways.com.

    According to James Tabor, "discoveries in modern times (the Mandaean literature, the Manichaean papyri, the Nag Hammadi texts) combined with the previously known Hermetic literature have convinced scholars that Gnosticism was pre-Christian and originated in the East. There is still no consensus, however, on whether its essential ideas were current at the time of the rise of early Christianity." Source: Tabor, James. "The Roman World of Jesus: An Overview," uncc.edu

    Some Platonic Gnostics saw the dual aspects of Jesus as human and divine as mirroring Plato's transient material world and the eternal realm of Forms. They also believed it was the Demiurge — Plato's divine craftsman — who wrote Torah Law in ignorance.
50. Grant, p. 6.

51. Vermebrand, Mordechai and Ruth, Betzalel S. "The People of Israel - the history of 4000 years - from the days of the Forefathers to the Peace Treaty," 1981, pg. 95). As cited in en.wikipedia; Schiffman, myjewishlearning.com.
52. Here in Alexandria lived the great Hellenist Jewish philosopher Philo in the first century AD. He wrote dozens of books which attempted to reconcile Jewish faith with Greek philosophy. Source: "Philo Judaeus" *Encyclopedia Britannica*, britannica.com. Mar. 14, 2021, https://www.britannica.com/biography/Philo-Judaeus; http://strangeside.com/philo-jewish-philosopher/.
53. Conder, p. 59.
54. Hooker, jewishvirtuallibrary.org.
55. Naffziger, bustedhalo.com.; "The Origin of the Septuagint," biblearchaeology.org.
56. Smitha, "Hellenism and Jews." fsmitha.com.
57. Bart Ehrman writes: "a lot of ancient people believed there were multiple layers to the heavens [like the Sumerians] — not just Aristotelians, but also middle Platonists, Jewish apocalypticists, Christian Gnostics, and so on — with the highest being reserved for God himself." Source: Ehrman, "The Invention of Heaven and Hell" ehrmanblog.org.
58. Simanek, lockhaven.edu. According to Schadewald, flat Earthers included "Theophilus of Antioch, Irenaeus, Tertullian, Methodius, Theodore of Mopsuestia, John Chrysostom, Cyril of Jerusalem, Ephraim Syrus, Athanasius of Alexandria, Diodorus of Tarsus, Epiphanius of Salamis, Hilary of Poitiers, and Severianus of Gabala." Source: Schadewald, Robert. 1999 (Oct. 24, 16:15). "Re: Wells speech at Burlington Edison High School," USENET post to talk.origins, Message-Id <3.0.1.32.19991024161523.01174958@gold.tc.umn.edu>.

    Followers of "eccentric English sectarian Lodowick Muggleton" reconstituted the idea of a flat earth in the 18th century. Some religious fundamentalists have since supported the notion. The Flat Earth Society, founded in 1956, proposes, amongst other things, that NASA's Apollo moon landings were a hoax. They're out there. Source: Science writer Robert J. Schadewald. As cited in "Flat Earth" by Donald E. Simanek; "On the Level?" *New York Times*. June 12, 1960. p. 2.

Chapter 15

1. The Roman Colosseum was built between 71 to 80 AD by emperors Vespasian and Titus. The massive oval amphitheater, the largest ever built in ancient times, is situated just east of the Forum. Its construction was funded

by plunder taken from the Jewish Temple during the fall of Jerusalem in 70 AD. It had four tiers of seats which could hold an estimated 50,000 people. In its prime, it held staged naval battles, animal hunts, death by beast, and gladiator contests. Source: Claridge et al., pp. 276–282.

2. Adams, Cecil. straight-dope.com.
3. Animals used in Roman amphitheaters included "rhinoceros, hippopotamuses, elephants, giraffes, aurochs (extinct species of large wild cattle), wisents (European bison), Barbary lions, panthers, leopards, bears, Caspian tigers, crocodiles, and ostriches." Source: Claridge, pp. 276–282.
4. "Were Christians really thrown to the lions?" straightdope.com; Aptowicz, livescience.com.
5. Hopkins & Beard, p. 103; Mueller, smithsonianmag.com.

   Most Christian executions were carried out at the Circus Maximus. Source: Brockman, Norbert C.). *Encyclopedia of Sacred Places [2 volumes]*. ABC-CLIO. September 13, 2011, p. 108.

   Other "criminals" were condemned to the beasts in the Colosseum, as well as other amphitheaters across the empire. They included those captured in war, army deserters, poisoners, counterfeiters, those convicted of committing political crimes, instigators of uprisings (executed by beast or crucified depending on social standing), and kidnappers of children for ransom. It was common for those condemned to the beasts to attempt suicide rather than face being eaten alive. Sources: *The Civil Law* sps11, 15; Aptowicz, livescience.com.
6. Moss, p. 129; Bigsby, Melinda. Review of Moss, Candida. *The Myth etc*. in Amazon.com; Malik, theconversation.com. Nov. 21, 2016.
7. Moss, p. 15. "Recent scholarship has shown" that over the first three centuries or so centuries of Christianity's existence, martyrdoms were "relatively rare." Christian theologian Origen of Alexandria (c. 184–c. 253), "one of the best-travelled" Christian scholars, wrote: "Only small number of people, easily counted have died for the Christian religion." Source: *Against Celsus* 8; trans. Henry Chadwick, Origen: *Contra Celsum* (Cambridge, UK: Cambridge University Press, 1953). As cited in Ehrman, *The Triumph of Christianity*, p. 157.
8. Moss, pp. 14,16. Beginning in the early seventeenth century, the Society of Bollandists and subsequent generations of Dutch, German, Italian, and French scholars spent the next three centuries studying a "sixty-eight volume collection of texts and commentary about the saints." They determined that "only a handful of stories were historically reliable. The rest had been thoroughly edited or simply made up." Source: Moss, pp. 16, 88.

9. "The myth of constant persecution largely stems from two works written in the early fourth century A.D., *On the Deaths of the Persecutors* by Lactantius, a Christian professor of Latin, and the *Church History* of Eusebius, bishop of Caesarea, now in modern-day Israel." Sources: Malik, theconversation.com.; Moss, p. 216.
10. Tacitus. Annals, 15.44. As cited in Lendering, livius.org.
11. "Religion: Public Display and Private Practice," "romansinfocus.com.
12. Moss, Candida. pp. 175, 180. As for the post-second Temple Jews, archeological evidence indicates that "although they did not participate in imperial processions," Jews did "accord the emperor certain honors — inscriptions dedicated to the well-being of the emperor, for instance." Source: Moss, Candida. Ch. 5, endnote 12, p. 286.
13. Moss, pp. 166, 174.
14. Jackson, Dean. Review of Candida Moss, *The Myth etc*. in Amazon.com. June 23, 2014.
15. Moss, pp. 144, 181–2.
16. Tertullian. *Apology*, Ch III. earlychristianwritings.com.
17. Dio, Epitome of Book LXVIII (68). uchicago.edu.
18. Ferguson, christianitytoday.com.
19. Pliny, georgetown.edu.
20. Ferguson, christianitytoday.com.; Pliny, georgetown.edu.; Moss, pp. 140–143.
21. Dio, Epitome of Book LXIX (69), uchicago.edu.; "Ancient Rome: The Fall of Rome," ducksters.com.
22. Frend, christianhistoryinstitute.org.; Ferguson, christianitytoday.com. "This order of Hadrian was attached by the Christian apologist Justin Martyr to the end of his *First Apology*, c. 155."
23. Salah, historum.com.
24. Ibid.
25. Ibid.
26. Ibid, Hartwell, hauburn.tripod.com. His source: Mitchell, S., 'Legio VII and the garrison of Augustan Galatia' CQ 26 (1976), pp. 298–308.
27. Salah, historum.com
28. Ibid.
29. Cassius Dio wrote that the Bar-Kokhba revolt was sparked by Hadrian's decision to remake Jerusalem into a pagan city with a temple to Jupiter constructed in the Holy City on the site of the Second Temple. Eusebius, on the other hand, claimed that this Hadrian's decision was the "result of the war rather than the cause." Source: Kerstein, worldhistory.org.

30. "Ancient Jewish History: The Bar-Kokhba Revolt," jewishvirtuallibrary.org.; Kerstein, worldhistory.org.
31. "Ancient Jewish History: The Bar-Kokhba Revolt," jewishvirtuallibrary.org.; Kerstein, worldhistory.org. In 1960's, several letters from Bar-Kokhba were found in a cave in the Judean desert (the "Cave of Letters") which it seems "houses refugees from the revolt." His name appears as Shimon Ben-Cosiba.
32. Spiro, aish.com.
33. Kerstein, worldhistory.org.
34. Ibid.
35. Ibid.
36. Mishnah Taanit 4:6; Dio, Epitome of Book LXIX (69), uchicago.edu.; Kerstein, worldhistory.org. According to Eusebius, Aelia Capitolina was "colonized by foreigners," though small communities of Jews continued to live in the region.
37. Herodian. *Roman History*, vi.7.10.
38. Dio, Epitome of Book LXXX (80), uchicago.edu.
39. Ehrman, *The Triumph of Christianity*. p. 17; Mark, "The Crisis of the Third Century," worldhistory.org.
40. Hekster, p. 31; Le Bohec, p. 196.
41. Ehrman, *The Triumph of Christianity*, p. 17.; Mark, "The Crisis of the Third Century," worldhistory.org.
42. As cited in Johnkansas. Review of Moss, *The Myth etc*., Amazon.com. Nov. 25, 2014
43. Moss, p. 145. The Decree of Decius is lost. There is "no reference to it outside of Christian literature." Scholars debate the exact date of the decree. Sources: Moss, p. 146 and Ch. 4, endnote 24, p. 281; Ehrman, *The Triumph of Christianity*, p. 202.
44. Moss, p. 147.
45. Frend, p. 319.
46. Moss, p. 148.; Ehrman, *The Triumph of Christianity*, p. 203. According to Moss, persecutions were particularly intense in the North Africa area. A number of Christian reneged to save their lives. When they later tried to rejoin Christian churches, there was significant "friction and tension in Carthage."
47. Moss, p. 151.
48. Moss, pp. 152, 258.
49. Regarding the martyrdom accounts of deaths from 257 to 259, the "content is of dubious origin." Moss, p. 153.

The Crisis of the Third Century threatened the survival of the Roman Empire. The Sassanids under King Shāpūr I routed emperor Valerian at the Battle of Edessa in 260. The Persians took Valerian captive — the first time in Rome's military history an emperor had been taken prisoner. That same year, Rome's western provinces of Gaul, Britannia, Germania, and (briefly) Hispania broke off to form the Gallic Empire. Seven year later, Queen Zenobia of Palmyra conquered Rome's eastern provinces of Syria Palaestina, Egypt, Arabia Petraea, and large parts of Asia Minor. What remained of the Roman Empire was confined to southern Europe, North Africa, and a part of Asia Minor. (See Fig. N15.1.) Sources: Kerrigan, britannica.com.; Aurelius Victor (c. 320–c. 390 33.8; Eutropius (Later half of fourth century) 9.9.1.

Figure N15.1. Break-up of Roman Empire around 271 AD.

Emperor Aurelian (270-275) reunited the Roman Empire. In a series of brilliant campaigns, he defeated the Vandals, the Visigoths, and Zenobia and her Palmyrene Empire. He then vanquished the Sassanids, and finally the forces of the remaining Gallic Empire at the battle of Battle of Châlons in late 274. Source: "Aurelian," britannica.com.

50. Nakamura, *jstor.org*.; Wasson, "Diocletian," wordlhistory.org.
51. Wasson, "Diocletian," wordlhistory.org.
52. Bissel, nytimes.com.; Sherrard, p. 16.

53. Ehrman, *The Triumph of Christianity*, p. 205. Diocletian may have been spurred on by "neo-Platonic philosopher Porphyry" and his "vitriolic polemic" in his book *Against the Christians*.
54. Eusebius wrote that "no buildings were destroyed at all." Source: Moss, p. 156. According to Moss, "the dating of the 'Great Persecution' depends a great deal on the evidence provided by later Christian writers. See Moss, Ch. 4, endnote 3, p. 278.
55. Ehrman, *The Triumph of Christianity*, p. 205.
56. Moss, p. 157.
57. The first edict also denied Christians "the right to either petition the courts or respond to legal actions brought against them," making them potential subjects for judicial torture Sources: Moss, pp. 155–157; Eusebius, *Historia Ecclesiastica* 8.6.10; Barnes, p. 24.
58. Moss, p. 158. "Curiously, the fourth edict is not discussed by Christian writers in Lactantius, or Eusebius *Church History*. Eusebius does mention it in *Martyrs of Palestine*. Source: Malik & Davenport, theconversation.com.
59. "Bible things in Bible Ways, 2000 years of Christianity: what happened?" biblethingsandbibleways.com.

Chapter 16

1. Eusebius of Caesarea. Book 1, Ch. 1 Preface.
2. Wasson, "Diocletian," wordlhistory.org.
3. Sherrard, p. 17.; Ehrman, *The Triumph of Christianity,* p. 21. A brief summary: In April of 307, Maxentius defeated Severus, who he later executed. Constantine moved up to emperor in the West with Maxentius as his vice-emperor. A year later, Galerius convinced Diocletian to name Maxentius as a usurper. Galerius then proclaimed his friend Licinius emperor of the West. Constantine refused demotion to vice-emperor. Galerius died in 311, as did Diocletian. A year later, Constantine defeated Maxentius at the Battle of Milvian Bridge. Maxentius drowned in the Tiber. Licinius in turn defeated Maximinus Daia in April of 313. Daia died that August. Constantine would be victorious over Licinius in 324 AD, as we shall see.
4. Drijvers, pp. 9, 15–17.
5. Ehrman, *The Triumph of Christianity*, pp. 217–18.; Barnes, pp. 73–74; Lenski, p. 60.; Odahl, pp. 72, 301.
6. Ehrman, *The Triumph of Christianity*, p. 23.; Ferguson, christianitytoday.com.
7. Ferguson, christianitytoday.com.
8. Ehrman, *The Triumph of Christianity*, p. 28.

9. "Constantine's heavenly vision before the battle of Milvian Bridge in 312 as found in *Lactantius Liber Mortibus Persecutorum XLIV*" earlychurchtexts.com. https://earlychurchtexts.com/public/lactantius_constantine_heavenly_vision.htm.
10. Ehrman, *The Triumph of Christianity*, pp. 25, 28.
11. Eusebius, *Life of Constantine*, 1:28. As cited in Ehrman, *The Triumph of Christianity*, pp. 26–7.
12. Ehrman, *The Triumph of Christianity*, p. 25.
13. Zosimus. *Historia Nova*. Translated by R.T. Ridley. (Canberra: Byzantina Australiensia, 1982) pp. 2.16.2–4.; Ehrman, *The Triumph of Christianity*, p. 21.

    Renowned eighteenth-century English historian Edward Gibbon argued against the miraculous cross in the sky story (chapter XX. P. 649, footnote 48). He points out that Eusebius tells the tale in his *Life of Constantine* but not in his *History*. The bishop wrote that the cross appeared some eleven years later in Constantine's campaign against Licinius. In addition, Gibbon notes, "Ecclesiastical writers of the 4th and 5th century were unaware of the story." Source: Sullivan, Terry. "The Church of the Empire versus the Christian church of North Africa: 312–430 AD" 2008. http://www.radical-christianpress.org/Pages/ConstantinesMiracle.aspx.; Gerberding R. and J.H. Moran Cruz. *Medieval Worlds*. (New York: Houghton Mifflin Company, 2004) p. 55; cf. Eusebius, *Life of Constantine*; Sherrard, p. 93. In 310 AD, an anonymous orator told of a recent vision where the sun god Apollo — Sol Invictus ("Unconquered Sun"), the official sun god of the later Roman Empire — appeared to Constantine. Some scholars suggest this vision some two years before the Battle of Milvian Bridge later came to be "remembered" by Constantine as a vision of Christ. Source: Ehrman, *The Triumph of Christianity*, p. 29.
14. Kipfing, persee.fr.
15. From Lactantius, *De Mort. Pers.* Ch. 34, 35. Opera, ed. O. F. Fritzsche, II, p. 273. (Bibl. Patt. Ecc. Lat. XI, Leipzig, 1844.) As cited in Halsall, Sourcebooks, fordham.edu.
16. Ehrman, *The Triumph of Christianity*, p. 245; Sherrard, p. 18: Malik & Davenport, theconversation.com.

    The only extant copies of the edict are "those posted by Licinius in the eastern part of the empire." Source: Nicol & Matthews, brittannica.com.
17. From Lactantius, *De Mort. Pers.*, Ch. 48. opera, ed. 0. F. Fritzsche, II, p 288 sq. (Bibl Patr. Ecc. Lat. XI). As cited in Halsall, sourcebooks.fordham.edu.

    The Edict of Milan was actually a letter written in Bithynia after the meeting in Milan between Licinius and Constantine. The former published the

letter and sent it to "provincial governors in the East." Source: Ehrman, *The Triumph of Christianity*, p. 219.

18. Drake, Harold A. *Constantine and the Bishops: The Politics of Intolerance* (Baltimore, MD: Johns Hopkins, 2002), p. 194. As cited in Ehrman. *The Triumph of Christianity*, p. 220.
19. *Lactantius, Venantius* (1871), "De Mortibus Persecutorum" [Of the Manner in Which the Persecutors Died: Chapters XLV–XLVIII], *The Works of Lactantius*, translated by William Fletcher. As cited in en:wikipedia.
20. DiMaio, roman-emperors.org.; Chisholm, p. 587.
21. Sherrard, pp. 18, 93; Gerberding, p. 55; Nicol & Matthews, brittannica.com.; Ehrman, *The Triumph of Christianity*, p. 35.; Ehrman, "Constantine and Christianity," ehrmanblog.org.
22. Ehrman, *The Triumph of Christianity*, pp. 14, 277.
23. Sherrard, p. 94.
24. Ehrman, *The Triumph of Christianity*, pp. 37, 227.
25. Constantine letter cited in Eusebius, *Life of Constantine* 1.64-72. As cited in Ehrman, *The Triumph of Christianity*, p. 226.
26. Ehrman, "The Controversies about Christ: Arius and Alexander," ehrmanblog.com.
27. Ehrman, *The Triumph of Christianity* book, p. 223. Ehrman on the Arian view: "In eternity past. God existed alone. He then, prior to the creation of the universe, begot a Son, a second divine being, who, since he was begotten of God, was secondary and subservient to him, as a son to a father." Alexander, on the other hand, argued that God the father and Christ, his co-equal the Son, had both existed for eternity past.
28. Schaff, Philip, earlychurch.org.uk; Schaff, David Schley, Section 120; "Who Killed Jesus of Nazareth? Easy2surf.com.
29. Despite Constantine's attempts at unity, Arianism continued to attract converts after the Council of Nicaea — including later emperors. Source: Ehrman, *The Triumph of Christianity*, p. 227.
30. "Universal Declaration of Human Rights: Christianity and its Persecution of Heretics," heretication.info.
31. Ehrman. *The Triumph of Christianity*, p. 269. Constantine's laws decreed that any Jew who attacked another Jew for converting to Christianity was to be burned to death; and to confiscate the property of any Christian who converted to Judaism. (Theodosian Code 16.8.1 and 16.8.8). Source: Ehrman, *The Triumph of Christianity*, pp. 269, 276.
32. "Who Killed Jesus of Nazareth?" easy2surf.com.; Constantine also forbade Jews from proselytizing and barred them from circumcising their slaves. They were not allowed in Jerusalem except on the anniversary of the destruction of Herod's Temple in 70 AD (*Tisha B'Av*). Source: Lazare, p. 72.

33. Nicol & Matthews, brittannica.com.

    "Ostensibly, gladiatorial games were prohibited by Constantine in AD 325 (*Theodosian Code*, XV.12) and the remaining schools closed by Honorius in AD 399. They continued, in one form or another, until AD 404, when Honorius finally abolished [them] altogether, prompted, says Theodoret (*Ecclesiastical History*, V.26), by the death of a monk, Telemachus, who had entered the arena, endeavoring to stop the fight, and was stoned to death by the indignant crowd." Source: "Essays on the History and Culture of Rome: The Roman Gladiator," penelope.uchicago.edu. https://penelope.uchicago.edu/~grout/encyclopaedia_romana/gladiators/gladiators.html. Retrieved Jun 28, 2021.
34. Ibid; *Inscriptiones Latinae Selectae*, archived from the original on 20 July 20, 2012, retrieved 5 February 2016; Carrié & Rousselle, L'Empire Romain, p. 659.
35. Brittain, biblehub.com.; Nicol & Matthews, brittannica.com.: Ehrman, *The Triumph of Christianity*, pp. 238, 9.
36. Ehrman, *The Triumph of Christianity*, p. 6.
37. For a counter-argument on Christian versus pagan charity, see Carrier, Richard. "Christians Did Not Invent Charity and Philanthropy." richardcarrier.info. May 24, 2017.
38. Sherrard, p. 18.
39. Nicol & Matthews, brittannica.com.; Wasson, "Constantinople," worldhistory.org.; Odahl, p. 180; Sherrard, p. 18.
40. Sherrard, pp. 31–2.
41. Ibid, p. 33.
42. Ibid, p. 37; Ehrman, *The Triumph of Christianity*, p. 229.
43. Sherrard, pp. 34, 96; Wasson, "Constantinople," wordlhistory.org.; Simons, nytimes.com.
44. Wasson, "Constantinople," wordlhistory.org.; Lendering, "Greek Byzantium," livius.org.
45. Nicol & Matthews, brittannica.com.; Wasson, "Constantinople," wordlhistory.org.; Odahl, p. 180; Sherrard, p. 18.
46. Cohen, "Legitimization Under Constantine: The Path to Victory," pbs.org.

    The Protestant reformation came too late. There was no more room for their denominations inside the Church of the Holy Sepulcher. Anglican Protestants believe the Tomb of Jesus to be in the Garden tomb outside the Old City near the Damascus gate.
47. "St. Helena," britannica.com.; Ehrman, *The Triumph of Christianity*, p. 232.
48. Lazare, p. 72; Cohen, "Legitimization Under Constantine: The Path to Victory," pbs.org.

49. Ehrman, *The Triumph of Christianity*, pp. 32–35, 76.
50. As cited in Ehrman, *The Triumph of Christianity*, p. 230.
51. Barnes. *Constantine and Eusebius* (Cambridge, MA: Harvard University Press, 1984). As cited in Albert Noyer, Amazon Review, April 11, 2000.
52. Ibid.
53. Ehrman, *The Triumph of Christianity*, pp. 246, 7.
54. Ibid, pp. 38, 135, 242; Sherrard, pp. 55–6.
55. "Universal Declaration of Human Rights: Christianity and its Persecution of Heretics," heretication.info.
56. Ehrman, "The Conversion of Constantine and Beyond." ehrmanblog.org.

    Hannam writes: "When Constantine made Christianity the official religion, the Roman Empire remained just as much of a military despotism as it ever was. It was not until Theodosius was reprimanded by Archbishop Ambrose that some of the Emperors' megalomaniac proclivities were to be at all circumscribed by Christianity and even then, not by much." Source: Hannam, James. "Did Early Christians Destroy Pagan Literature?" jameshannam.com. 2007. https://jameshannam.com/literature.htm. Retrieved Oct 15, 2020.
57. "Nicene Creed" britannica.com. "The Niceno-Constantinopolitan Creed has been the subject of scholarly dispute. Most likely it was issued by the Council of Constantinople, even though this fact was first explicitly stated at the Council of Chalcedon in 451. It was probably based on a baptismal creed already in existence, but it was an independent document and not an enlargement of the Creed of Nicaea."
58. Ehrman, *The Triumph of Christianity*, p. 270.
59. "Universal Declaration of Human Rights: Christianity and its Persecution of Heretics," heretication.info.
60. Ehrman, *The Triumph of Christianity*, p. 242.
61. "The Temple of Serapis in Alexandria," uchicago.edu.
62. Deakin, "Hypatia," britannica.com.; Deakin, "100 Women, "Hypatia," britannica.com.; O'Connor & Robertson, "Hypatia of Alexandria," st-andrews.ac.uk. The Eastern Roman emperor was now emperor Theodosius II (no relation to Theodosius I.
63. Christie, "The Copernican Revolution 101," thonyc.wordpress.com.
64. Ibid.
65. Hannam, jameshannam.com.
66. For an interesting and thoughtful discussion on the alleged early Christian suppression of pagan science, see: Lindberg, David C. "Science and the Early Christian Church." *Isis*, vol. 74, no. 4, 1983, pp. 509–530. *JSTOR*, www.jstor.org/stable/232210. Accessed 16 Mar. 2021.

67. Ehrman, *The Triumph of Christianity*, pp. 173, 251.
68. Ibid, p. 283.
69. Ibid, p. 253. Ehrman argues that, given the relentless rate of growth of Christianity, it would have come to dominate the Roman Empire even without Constantine's conversion.
70. Ehrman, "The Conversion of Constantine and Beyond," ehrmanblog.org.
71. Ibid,; Ehrman, *The Triumph of Christianity*, pp. 4, 5.
72. Ehrman, *The Triumph of Christianity*, p. 177.
73. Data as of 2015: Islam has some 1.8 billion followers. With their higher birth rates, Muslims are projected to outnumber Christians by 2035. Source: "The Changing Global Religious Landscape," www.pewforum.org.
74. "The Islamic Empire did not begin to appropriate Greek knowledge until the eighth century CE. Their first sources of Greek scientific and philosophical works were those that had been translated into Syriac by Nestorian Christians, within the Persian Empire. Their second, and major, source was Byzantium, the Eastern Empire, which was Christian. By the eighth century there began the first low level returns of Greek astronomical knowledge into Europe during the Carolingian Renaissance in the form of calendrical and computus studies." Source: Christie, "The Copernican Revolution 101" thonyc.wordpress.com.

Chapter 17

1. Weinberg, David, astronomy.ohioostate.edu. "Dark Ages" is a bit of a misnomer; however, as during this era of knights and castles stretching from approximately the 7th to the 14th century, significant advances in art, literature, science, and medicine were made. Source: en:wikipedia.
2. Sherrard, Introduction and pp. 12, 135, 138, 158. At its brief peak in the 6th century, the Byzantine empire extended from "Spain in the west to Mesopotamia in the east, the Black Sea and Danube in the north to the coastal fringes of the Mediterranean Africa in the south," including "virtually an entire Byzantine city in Venice." Source: Sherrard, pp. 22, 55.
3. Weinberg, Steven, p. 124.
4. Hannam, pp. 12-17.
5. Weinberg, Steven, pp. 49–50. The great theologian Augustine of Hippo confirmed this view in 426 AD: "I have rightly been displeased, too, with the praise with which I extolled Plato . . . or the Academic philosophers beyond what was proper for such irreligious men, especially those against whose great errors Christian teaching must be defended."

6. Crone, opendemocracy.net.; Steward, p. 15.; "Muhammad — Script," pbs.org.
7. Stewart, p. 14.
8. Lambert, p. 287.

   The Qur'ân originated with the first Caliph, Abu Bakr, who "ordered scribes to write down the story of Mohammad as told to them by his followers." Source: Nicolle, p. 61.

   "The Qur'an was a living text during the lifetime of Muhammad. Certain verses revealed to Muhammad were later repudiated by him as 'satanic' verses revealed not by Gabriel but by Satan. These verses were expunged from the text that so many had memorized." Source: "The Rise and Development of Islam," iun.edu.
9. Stewart, p. 33.; Patterson, Margot, p. 10.; Arberry, Arthur. *The Koran Interpreted* (London, ON: London, 1956); Nicolle, p. 22.
10. Saliba, alhewar.com.
11. "Comparison Table between Christianity, Islam and Judaism," christianityinview.com.
12. "The Story of Jesus and Mary in the Holy Quran," islamreligion.com.
13. "Muhammad — Script," pbs.org.

    A number of historians had regarded sixth century Arabia as an unsophisticated backwater outside the mainstream of neighboring civilizations. Recent archeological discoveries suggest that it was "a much more developed place than most Islamic scholars had ever expected," writes historian of Islam Patricia Crone. In addition, rather than biblical stories being an accidental "foreign borrowing by a trader [Muhammad] who did not really understand what they meant . . . the prophet was . . . a full participant in these [religious] debates." Source: Crone, opendemocracy.net.
14. Stewart, p. 14.
15. Baron, Salo B. *A Social and Religious History of the Jews*, 3 vols. (New York: Columbia University Press, 1937), 1, pp. 308T. As cited in Peters, Joan. "Medina, Islam's second holiest city, was originally a Jewish 'settlement'" eretzyisroel.org. 1984, http://www.eretzyisroel.org/~peters/medina.html.
16. Stewart, p. 13.
17. Ibid, p. 16.; "The Birth of Islam in Arabia," explorethemed.com.

    It is said that Muhammad was deeply disturbed by Mecca's materialistic culture dominated by businessmen, financiers, bankers, and merchants. He rued the neglect of traditional tribal values of caring for the poor, the widow, the orphan, the needy. Sources: Saliba, alhewar.com; Armstrong, pbs.org.

Muhammad's father Abdullah — a man of modest means — had died shortly before his birth. He lost his mother when he was six years old. An impoverished orphan, he was taken in and raised by his maternal uncle, Abu Talib, leader of the clan of Hāshim. Source: Stewart, p. 14.; "Muhammad — Script," pbs.org.

18. "The Birth of Islam in Arabia," explorethemed.com.; "Muhammad — Script," pbs.org.
19. Stewart, pp. 16-17. "Timeline of Islam," pbs.org.
20. Stewart, p. 17.; Holt *et al*, p. 39.

    Fighting in Yathrib had "mainly involved its Arab and Jewish inhabitants." A seventy-five member "delegation of the twelve important clans of Yathrib invited Muhammad as a neutral outsider to serve as the chief arbitrator for the entire community." Source: "Flight from Mecca to Medina," lumenlearning.com.
21. Timeline of Islam, pbs.org.; Stewart, p. 17.
22. Stewart, p. 18.
23. Rizvi, al.islam.org.; Sherrard, p. 17.
24. Stewart, p. 17.

    "Muhammad did order 10 people be killed, (Ibn Sa`d "Tabaqat, "Vol 2, page 168), including two polytheist singing girls that had sung satirical songs about him. Only some of these people were executed, others escaped." The remaining "idol-worshippers of Mecca were given a four-month grace period to stay and study Islam. If they were still not convinced of Islam's message, they were to be asked to leave the holy territory of Mecca. (See the Qur'an Surah at-Tawba, 9:3)" Sources: "The Birth of Islam in Arabia," explorethemed.com.; Rizvi, al.islam.org.
25. Stewart, p. 13.
26. Ibid, p. 19.; Google Translate.
27. Saliba, alhewar.com. Muslims believe that it was Abraham who built the *Ka'bah*, the holiest shrine in Islam.
28. Watt, p. 207.; Sinai, britannica.com.
29. Esposito, p. 17.
30. Watt, pp. 175, 177.
31. "The Birth of Islam in Arabia," explorethemed.com.
32. Stewart, pp. 18-19.
33. "The Birth of Islam in Arabia," explorethemed.com.; Stewart, pp. 18-19.; Watt, pp. 170-176. Patricia Crone and other modern scholars question the historicity of the *Banu Qurayza* story. Source: "The Siege of the Banu Qurayza" pfander.uk. https://www.pfander.uk/debate-topics/historical/siege-banu-qurayza/.

34. "The Birth of Islam in Arabia," explorethemed.com.; Sahih Muslim 19, 4366, Hitti, p. 61.
35. Nicolle, p. 85.
36. Stewart, p. 11.
37. Data as of 2015. Source: "The Changing Global Religious Landscape," www.pewforum.org. With their higher birth rates, Muslims are projected to outnumber Christians and become the largest religion on the planet by 2035
38. Kennedy, rps.macmillan.yale.edu; "Timeline: Islam in the Middle Ages," edu.gov.mb.ca. Western Mesopotamia (Iraq) had been under the Byzantine Empire, Eastern Mesopotamia, Persia (now Iran), and points east had been under the Sassanid Empire.
39. Stewart, p. 11.
40. Gardner & Kobtzeff, pp. 208–209.
41. Bowman, Robert M. Jr. "Joshua's Conquest: Was It Justified?" North American Mission Board. namb.net. Mar. 30, 2016. https://www.namb.net/apologetics-blog/joshua-s-conquest-was-it-justified/.; Nicol & Matthews, britannica.com.
42. With the disintegration of the Abbasid caliphate. Sources: Christie, "History of science on the Internet — the gift that keeps giving" thonyc.wordpress.com.; "The Abbasid Empire" *World Civilization*, lumenlearning.com. https://courses.lumenlearning.com/suny-hccc-worldcivilization/chapter/the-abbasid-empire/.
43. Hitti, Philip K. *History of the Arabs*, 8th ed. (London: MacMillan, 1964) p. 150; Karabell, Zachary. *Peace Be Upon You* (New York: Knopf, 2007) p. 27. As cited in Saliba, alhewar.com.
44. Lapidus, Ira M. *A History of Islamic Societies*. (London, UK: Cambridge University Press, 2014) pp. 61, 153.
45. Rizvi, al.islam.org.

    "The tribute or tax "was based on one's ability to pay. Women, children, old men, slaves, poor monks, and the mentally sick were exempt." Source: Saliba, alhewar.com.
46. According to the "conversion curves" of historian Richard Bulliet, roughly 10% of the non-Arab population converted to Islam in the Umayyad period (661-750). During the "more politically multicultural" Abbasid period (750–1258), this rose to roughly 40% by the mid-9th century and close to 100% by the 11th (with the exception of Egypt, Syria, and the Fertile Crescent which contained large Christian minorities during the Abbasid period.). Source: Siebers, Tobin., Ed. *Religion and the Authority of the Past* (Ann Arbor, MI: University of Michigan Press, 1993) pp. 113–115.

47. Islam Arrives in Indonesia," factsanddetails.com. Jun, 2015. http://factsanddetails.com/indonesia/History_and_Religion/sub6_1a/entry-3944.html.
48. "The Rise and Development of Islam," iun.edu.
49. Stewart, p. 12.; "Islam And The West," twf.org. For example, "Cordoba in the 10th century was by far the most civilized city of Europe . . . It is said that the 400,000 volumes in its ruler's library amounted to more books than all the libraries of the rest of Europe put together . . . Many of the traits on which modern Europe prides itself came from Muslim Spain. Diplomacy, free trade, open borders, the techniques of academic research, of anthropology, etiquette, fashion, various types of medicine, and hospitals, all came from this great city of cities."
50. Stewart, pp. 85, 121; Lunde, p. 96; Weinberg, David, astronomy.ohioostate.edu.

    This included the works of Indian astronomers Aryabhata, Varahamihira and Brahmagupta. Source: "The Structure of the Solar System," st-andrews.ac.uk.
51. Al-Khwārizmī also presented the "first systematic solution of linear and quadratic equations." Source: Lunde, pp. 96-97 and Gandz 1936 (as cited in en: wikipedia) and Nationmaster.com Encyclopedia — Geometry. www.statemaster.com/encyclopedia/Geometry.

    "Abū al-Wafāʾ, Muḥammad ibn Muḥammad ibn Yaḥyā ibn Ismāʿīl ibn al-ʿAbbās al-Būzjānī (940–998) was the first mathematician to use all six trigonometrical functions. Source: Christie, "It's all a question of angles," thonyc.wordpress.com.
52. Stewart, p. 121.
53. "Yale University Arabist Dimitri Gutas disputes the existence of the 'House of Wisdom'," Thony Christie tells us. "He posits in his 1998 book that "House of Wisdom" is a translation error from *Khizanat al-Hikma*, which he asserts simply means a storehouse . . . Gutas asserts that, without consistent naming conventions, a physical ruin, or corroborating texts, the phrase 'House of Wisdom' may just as well have been a metaphor for the larger Academic community in Baghdad rather than a physical academy specializing in translation work." This theory is debatable. Source: Christie, "History of science on the Internet — the gift that keeps giving," thonyc.wordpress.com.
54. Hannam, p. 21; Sardar, Marika. "Astronomy and Astrology in the Medieval Islamic World." In *Heilbrunn Timeline of Art History*. New York: The Metropolitan Museum of Art, 2000. https://www.metmuseum.org/toah/hd/astr/hd_astr.htm.

55. en: wikipedia. Persian Muslim Ibn Sina (980 to 1037), recognized as "one of the greatest minds of all time," who "wrote some 170 books on philosophy, medicine, mathematics, and astronomy," and "helped lay the foundations of experimental science." His five-book opus, *Canon of Medicine* "served as the guide to medical science in European universities. Jabir ibn Hayyan and other Islamic scholars lay the foundations for modern chemistry. Source: Stewart pp. 124-125.

    Khwarizmi, Islam's most outstanding mathematician, wrote the first "readily understandable" text on algebra in the 9th century. It serves as the principle mathematical textbook in Europe from the 12th to the 16th century. Alhazan, a 10th century Persian, founded the principles on which the modern science of optics is based. Source: en: wikipedia
56. "Islamic astronomy," Encyclopedia Historica. https://history.wikia.org/wiki/Islamic_astronomy.
57. "Cosmology in medieval Islam," en: wikipedia
58. Tbakhi, Abdelghan and Amir, Samir S. "Ibn Al-Haytham: Father of Modern Optics" Ann Saudi Med. 2007 Nov-Dec; 27(6): 464–467. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6074172/#:~:text=Gorini%20wrote%20the%20following%20on,of%20proof%20in%20the%20field. Retrieved Jul 14, 2020.
59. Duhem, Pierre. *To Save the Phenomena: An Essay on the Idea of Physical theory from Plato to Galileo*, (Chicago, IL: Univ. of Chicago Press, 1908) p. 28. As cited in en: wikipedia.; El-Bizri, Nader "In Defense of the Sovereignty of Philosophy: Al-Baghdadi's Critique of Ibn al-Haytham's Geometrisation of Place." *Arabic Sciences and Philosophy* 17 (2007): 57-80. As cited in "Ibn al-Haytham," newworldencylopedia.org.
60. Sayili, Aydin (1987), "Ibn Sīnā and Buridan on the Motion of the Projectile," *Annals of the New York Academy of Sciences* 500 (1): 477–482.; Kechichian, Joseph A. "Sparking the idea of a spinning Earth" gulfnews.com. May 15, 2014. https://gulfnews.com/lifestyle/sparking-the-idea-of-a-spinning-earth-1.1332856. Retrieved Jun 23, 2021.
61. Weinberg, Steven, pp. 119-120.
62. Ibid, pp. 121-123.
63. Riley-Smith, Jonathan. *The Oxford History of the Crusades* (New York: Oxford University Press, 1999). As cited in en: wikipedia.
64. en: wikipedia
65. *Crusades* in *The New Catholic Encyclopedia*, New York: McGraw-Hill Book Company, 1966, Vol. IV, p. 508. As cited in en: wikipedia.

Chapter 18

1. "20 Great Medieval Quotes," Medievelists.net. https://www.medievalists.net/2014/08/20-great-medieval-quotes/. Retrieved Aug 22, 2021.
2. "An Early History of Genghis Kahn," Footprints Tours Ltd, Programming & design by Green Kiwi Ltd http://www.greenkiwi.co.nz/footprints/mongolia/ghengis_history.htm.
3. Man, p. 68.
4. Ibid, pp. 59-67.
5. "Conceiving the idea of a Pony Express," Encyclopedia Britannica, britannica.com. https://www.britannica.com/topic/Pony-Express.
6. Pritchard, Maria. *Genocide: A History from Carthage to Darfur* (London: RW Press, 2013) p. 1958.
7. Dutch, uwgb.edu.
8. en: wikipedia.
9. Dutch, uwgb.edu. "Between the years 1300 and 1350, nine European embassies were sent to the Mongols. In turn, Mongol ambassadors came to Rome, Paris, Barcelona, Valencia, and London."
10. The Mongol Empire was 24.0 million sq km (9.27 million sq. mi) in size. The Roman Empire 5.0 million sq km (1.93 million sq mi). The Macedonian (Alexander the Great's) 5.2 million sq km (2.01 million sq mi). Source: en: wikipedia.
11. Lach, Donald F. *Asia in the Making of Europe, Vol. II*, (Chicago, IL: University of Chicago) pp. 380-398; Weinberg, Steven, p. 253.

    Marco Polo's fanciful book *The Description of the World* or *The Travels of Marco Polo* as it became known (c. 1300) became a best seller in Europe. Although most questioned the veracity of his travelogue, it "paved the way for the travels of thousands of Westerners (to the Orient) in the centuries to come. Source: "Marco Polo and His Travels," Silkroad Foundation, http://www.silk-road.com. http://www.silk-road.com/artl/marcopolo.shtml.
12. Hannam, p. 5.
13. Hale, John R. *Age of Exploration* (New York: TIME-LIFE, 1974) pp. 11–20. Some historians argue that Europeans invented the compass independently of China. Others point out that it existed in Mesoamerica before its discovery in China. Source: Carlson, John B. "Lodestone Compass: Chinese or Olmec Primacy? Multidisciplinary Analysis of an Olmec Hematite Artifact from San Lorenzo, Veracruz, Mexico", *Science*, New Series, Vol. 189, No. 4205 (5 September, 1975), pp. 753-760 (753). As cited in en: wikipedia.
14. Blake, Stephen P. "The observatory in Maragha." *Astronomy and Astrology in the Islamic World* (Edinburgh Univ. Press, 2016) p. 65. As cited in en: wikipedia.

15. Saliba. alhewar.com 1994b, pp. 245, 250, 256–257.) As cited in en: wikipedia.
16. Chambers Biographical Dictionary, page 3. As cited in en: wikipedia
17. Hannam, p. 71.
18. Ibid, p. 25-29.
19. Ibid, p. 5-6.
20. Ibid, p. 136.
21. Ibid, pp. 99-100.
22. Taylor & Adamson, p. 181; "John Carter Brown Library Exhibitions — Islamic encounters." Retrieved 30 October 2012; Sonneborn, Liz. *Averroes (Ibn Rushd): Muslim Scholar, Philosopher, and Physician of the Twelfth Century*. (New York: Rosen, 2006) p. 89.
23. Crowley, brittanica.com.
24. Hannam, p. 9.
25. Bacon, Roger. (trans. Tenney Lombard Davis), *Roger Bacon's Letter Concerning the Marvellous Power of Artifice and Nature and Concerning the Nullity of Magic* (Easton: Chemical Publishing Company, 1923), p. 26. As cited in Hannam, p. 146.
26. Weinberg, David, astronomy.ohioostate.edu. Aquinas wrote that reason could not explain everything, though it could prove the existence of God.
27. Smith, H. E, ucsd.edu.; Hannam, pp. 99-100; Weinberg, Steven, p. 27.
28. Christie, "Galileo, Foscarini, The Catholic Church, and heliocentricity *etc.* "thonyc.wordpress.com.
29. "The Universe of Aristotle and Ptolemy," cartage.org.lb. www.cartage.org.lb/en/themes/sciences/astronomy/TheUniverse/Thedevelopement/GalileoTheTelescope/TheUniverseofAristotleandPtolemy/TheUniverseofAristotleandPtolemy.htm.
30. Ibid.
31. Weinberg, Steven. p. 132-133. Buridan used his concept of impetus to (incorrectly) explain the circular motion of the planets. They are given their initial impetus by God, but kept in motion by impetus itself from then on.
32. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXVIII," thonyc.wordpress.com."
33. Hannam, pp. 184-5.; Weinberg, Steven, p. 135.
34. Hannam, p. 198.

    In the early 15th century, the First Viennese School of Mathematics "laid the foundations for the evolution of the modern astronomy," writes Thony Christie, ". . . Here Gmunden, Peuerbach and Regiomontanus modernized Ptolemaic astronomy, integrating the newly developing trigonometry and many Arabic developments into Peurbach's *Theoricae Novae Plaetarum*

(1473) and the Peuerbach & Regiomontanus *Epitoma in Almagestum Ptolemae* (1496), which became the new textbooks for astronomy for the next one hundred plus years and were also the books Copernicus used to learn his astronomy. Source: Christie, "Oh really, might as well pack up and go home then." thonyc.wordpress.com.

35. White, Matthew. "The Great Book of Horrible Things," http://www.bookof-horriblethings.com/ax01.htm.
36. Wheeler, web.cn.edu.
37. Ibid.
38. "Renaissance Interactive," Annenberg Learner, learner.org. http://www.learner.org/interactives/renaissance/middleages_sub.htm; Weinberg, Steven p. 140.
39. en: wikipedia
40. Roos, history.com.
41. Christie, "The emergence of modern astronomy – a complex mosaic: Part IV," thonyc.wordpress.com. "Less than twenty years after Gutenberg published his Bible," Christie writes, "Regiomontanus printed and published the first printed astronomy book Peuerbach's *Theoricae Novae Planetarum* (Nürnberg, 1473) followed by a handful of other astronomy/astrology books. Unfortunately, he died before he could publish their *Epytoma in almagesti Ptolemei*, which was first published by Ratdolt in Venice in 1496. Both titles became standard astronomy textbooks throughout Europe for more than one hundred years."
42. Weinberg, David, astronomy.ohioostate.edu.
43. Renaissance," encyclopedia.com.
44. "The Renaissance: Humanism," lumenlearning.com. The philosophy and science of ancient Greece and Rome were also glorified. Scholars "would discard almost the entire legacy of medieval (pre-Renaissance) philosophy." Despite this, works of a number of medieval natural philosophers were preserved and accessible, now that the printing press was around. Source: Hannam, pp. 195.
45. en: wikipedia
46. Weinberg, Steven, p. 28.

Chapter 19

1. The Holy Scriptures.
2. Duhem, Pierre. *To Save the Phenomena:An Essay on the Idea of Physical Theory from Plato to Galileo. Trans*. Edmund Dolan and Chaninah Maschler

(Chicago,IL: University of Chicago Press, 1969). As cited in Crowe, pp. 66-81. (Chapter Five).

3. Ibid. As cited in Crowe, p. 72.
4. Ibid. As cited in Crowe, pp. 70–71.
5. O'Connor & Robertson, "Nicolas Copernicus," st-andrews.ac.uk.
6. Picture source: http://frombork.art.pl/pl/His name was Mikolaj Kopernik Kepa, culture.pl.
7. Christie, "Nit-picking — Authors who should know better," thonyc.wordpress.com.; O'Neill, Tim. historyforatheists.com.
8. Christie, "Nit-picking — Authors who should know better," thonyc.wordpress.com.
9. O'Neill, Tim. historyforatheists.com.
10. "Nicolaus Copernicus (1473-1543)," phy.pmf.unizg.hr.; Kusukawa, hps.cam.ac.uk.; Christie, "The emergence of modern astronomy — a complex mosaic: Part III," thonyc.wordpress.com.
11. O'Connor & Robertson, "Nicolas Copernicus," st-andrews.ac.uk.
    Although none of Novara da Ferrara writings have survived he is said to have taken a critical attitude to Ptolemaic astronomy and might be the trigger that started Copernicus on his way. Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part III," thonyc.wordpress.com .
12. Sobel, p. 50.
13. O'Connor & Robertson, "Nicolas Copernicus," st-andrews.ac.uk.; Brody & Brody, p. 9.
14. Copernicus, *De revolutionibus*, Preface (Letter to His Holiness Pope Paul III.)
15. Christie, "The emergence of modern astronomy — a complex mosaic: Part III," thonyc.wordpress.com.

    Commentariolus contained Copernicus' seven axioms: 1. "There is no *one* center in the universe. 2) The Earth's center is not the center of the universe. 3) The center of the (solar system) is *very near* (but not at) the sun. 4) The distance from the Earth to the sun is imperceptible compared with the distance to the stars. 5) The *rotation of the Earth* accounts for the apparent daily rotation of the stars. 6) The apparent annual cycle of movements of the sun is caused by the Earth revolving round it. 7) The apparent retrograde motion of the planets is caused by the motion of the Earth from which one observes." (my italics). Source: O'Connor & Robertson, "Copernicus," st-andrews.ac.uk.

    It "today bears the *title Nicolai Copernici de hypothesibus motuum coelestium a se constitutis commentariolus* (roughly translated: *Nicolas Copernicus' short commentary on his hypothesis about the movement of the celestial bodies*) . . . three manuscripts are known to exist today. None of them, however,

in Copernicus's own handwriting. There is almost no direct evidence for the existence of this document in the sixteenth century and almost everything that we can say about its origin, its distribution and its impact is based on reasonable, speculative interpretation of indirect evidence." Source: Christie, Thony. "The emergence of modern astronomy — a complex mosaic: Part VI," thonyc.wordpress.com.

16. Copernicus, *Commentariolus*, themcclungs.net.
17. Weinberg, David. astronomy.ohioostate.edu.

    According to James Hannam, it appears that Copernicus's technical argument for the rotation of the Earth was lifted "straight out of the work of John Buridan." Source: Hannam, p. 275.
18. Aristarchus also proposed that the Earth rotates on its axis daily. Copernicus mentioned Aristarchus in his *De revolutionibus* manucript, but removed it from the printed version of 1543. No one knows why. Source: Christie, "Why scientists shouldn't write history of science," thonyc.wordpress.com.
19. Rabin, plato.stanford.edu; Christie, "The emergence of modern astronomy — a complex mosaic: Part V," thonyc.wordpress.com.
20. Rheticus, Georg. *Narratio Prima* (1540). As cited in Christie, "The emergence of modern astronomy — a complex mosaic: Part VII," thonyc.wordpress.com.
21. Rheticus, born Georg Joachim Iserin, was a Lutheran "from the home of Lutheran Protestantism, Wittenberg University, visiting a Catholic cathedral canon [Copernicus] in the middle of a deeply Catholic area." Thony Christie tells us. "The visit took place in the middle of the Reformation and the beginnings of the Counter Reformation . . . This courtesy across the religious divide amongst scholars during this period of European religious turmoil was actually very common." Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part VII," thonyc.wordpress.com.
22. Crowe, p. 85.; Christie, "The emergence of modern astronomy — a complex mosaic: Part VII," thonyc.wordpress.com.; Christie, "Nit-picking — Authors who should know better," thonyc.wordpress.com.

    Narratio Prima was published "in Danzig in 1540. with a second edition appearing in Basel in 1541."
23. "A third edition of the *Narratio Prima* was included in the second edition of *De revolutionibus* published by Heinric Petri in Basel in 1566. The fourth and a fifth editions were included in the first and second editions of Johannes Kepler's *Mysterium Cosmographicum* in 1597 and 1621. As such, more people probably learnt of Copernicus's heliocentric system from the *Narratio Prima* than any other source." Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part VII," thonyc.wordpress.com.

24. Crowe, p. 85.
25. Copernicus, Nicholas. *On the Revolutions*, p. XVI. As cited in Crowe, p. 100.
26. Christie, "The emergence of modern astronomy — a complex mosaic: Part X," thonyc.wordpress.com.; Christie, "The emergence of modern astronomy — a complex mosaic: Part XI," thonyc.wordpress.com.
27. Copernicus, *De revolutionibus*, Preface (Letter to His Holiness Pope Paul III.)
28. Weinberg, Steven. p. 85.
29. Copernicus, *De revolutionibus*, Book 1, Ch. 5.

    "The Pythagoreans, who were the first to consistently argue for a spherical earth, had already in the 6th century BCE, i.e. earlier than Aristarchus, claimed that the earth and the counter earth revolve around the sun." Source: Christie, "Why scientists shouldn't write history of science," thonyc.wordpress.com.
30. Weisstein, scienceworld.wolfram.com.
31. Knox, Dilwyn. "Copernicus's Doctrine of Gravity and the Natural Circular Motion of the Elements" Journal of the Warburg and Courtauld Institutes. Vol. 68 (2005), pp. 157–211. DilwynKnoxJWCI_68_Copernicus.pdf. file:///C:/Users/Owner/Downloads/DilwynKnoxJWCI_68_Copernicus.pdf.

    According to Knox, Copernicus' physics was influenced by modified Aristotelian physics; the thinking of Scholastics, such as on impetus; Oresme's work; classical philosophers such as Pliny and Cicero; and probably the Byzantine Suda of the 10th century.
32. Copernicus, *De revolutionibus*. Book 1, Chs. 4, 7; Knox, DilwynKnoxJWCI_68_Copernicus.pdf.

    "The natural motion of elements earth and water [according to Copernicus] are circular," writes Knox. Thus the diurnal rotation of the Earth, where air rotates with it.
33. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXXIX," thonyc.wordpress.com.
34. Copernicus, *De revolutionibus*, Book 1, Ch. 9.

    "The notion that gravity was implanted by divine providence to ensure the spherical cohesion of celestial bodies draws on Pliny's *Natural History* and Cicero's *De natura deorum*." Source: Knox, DilwynKnoxJWCI_68_Copernicus.pdf.
35. Knox, DilwynKnoxJWCI_68_Copernicus.pdf.
36. Copernicus, De revolutionibus. Book 1, Ch 6.

    Medieval scholars Jean Buridan (c.1300–c.1358/61), Nicole Oresme (c.1320-1325–1382), Pierre d'Ailly (1351–1420) and Nicholas of Cusa (1401–1464) all discussed the model of geocentrism with diurnal rotation.

Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part I," thonyc.wordpress.com.

37. This is called bounded elongation. "Mercury is always found within 28 degrees on either side of the Sun and Venus within 46 degrees. In Ptolemy's model, "the centers of the Mercury and Venus epicycles (were) always collinear with the Sun." Source: Crowe, pp. 15, 48.
38. Copernicus, *De revolutionibus*, Book 1, Ch 10. Martianus Capella's (fl.c. 410–420) "cosmos model with Mercury and Venus orbiting the Sun in an otherwise geocentric model was very popular in the Middle Ages. Source: Christie, Thony. "The emergence of modern astronomy — a complex mosaic: Part I," thonyc.wordpress.com.
39. Heckert, Paul. *Understanding Kepler's Laws*. Ch. 5.
40. Rabin, plato.stanford.edu.
41. In *De revolutionibus*, Copernicus wrote: "For [these outer planets] are always closet to the earth, as is well known, about the time of their evening rising, that is, when they are opposite the sun, with the earth between them and the sun. On the other hand, they are at their farthest from the earth at the time of their evening setting, when they become invisible in the vicinity of the sun, namely, when we have the sun between them and the earth. These facts are enough to show that their center belongs more to the sun, and is identical with the center around which Venus and Mercury likewise execute their revolutions." Source: Copernicus, *De revolutionibus*, Book 1, Ch 10.
42. Copernicus, *De revolutionibus*, Book 1, Ch 10. As cited in Gingerich, Owen. "The real Martin catastrophe and how Kepler fixed it" Sep 1, 2011. physicstoday.scitation.org, https://physicstoday.scitation.org/doi/10.1063/PT.3.1259
43. Weinberg, David. astronomy.ohio-state.edu.
44. Brody, pp. 11–12.
45. There are two types of retrograde motion; looping and S-shaped, depending on "where the planet is relative to the *nodes* of its orbit." A node is "the direction, as seen from the Sun, where the plane of the planet's orbit crosses the plane of our orbit." If the planet is near a node, an S-shape is produced. Otherwise, a loop is produced. Source: Seligman, seligman.com.
46. Seligman, seligman.com.
47. Sobel, p. 56.
48. Christie, "The emergence of modern astronomy — *a complex mosaic*: Part XXIII," thonyc.wordpress.com.
49. Swerdlow, N. "Copernicus, Nicolaus (1473–1543)", in *Encyclopedia of the scientific revolution from Copernicus to Newton*, ed. W. Applebaum (New York and London, 2000), 165. As cited in Ragep, adsabs.harvard.edu.

A number of Islamic documents have yet to be translated and studied. Still, science historian Noel Swerdlow and scholars J. l. E. Dryer, Edward

Kennedy, Otto Neugebauer, Otto Neugebauer, and George Saliba have uncovered striking similarities between the complex geometric models of Copernicus and those of Marāgha school astronomers. Source: Ragep, adsabs.harvard.edu.

50. Swerdlow, N. and O. Neugebauer, *Mathematical Astronomy in Copernicus's De revolutionibus*, 2 vols., (New York: Springer-Verlag, 1984) p. 47. As cited in Rabin, Notes to "Nicolaus Copernicus," plato.stanford.edu.
51. Saliba, p. 76.
52. Ibid, p. 25.

    Other Islamic influences on Copernicus:

    Eleventh century Islamic astronomer Abu Sa'id al-Sijzi (ca. 945–ca. 1020) had proposed that the Earth rotates on its axis. Source: Nasr, Seyyed Hossein. *An Introduction to Islamic Cosmological Doctrines*. (Albany, NY: SUNY Press. 1993) p. 135. Persian astronomer Naṣīr al-Dīn al-Ṭūsī (1201–1274) and Ottoman astronomer Ala al-Dīn Ali ibn Muhammed (1403–1474), aka Ali Qushji, also discussed the rotation of the Earth. Source: Goldstein, Bernard R. (1967). "The Arabic version of Ptolemy's planetary hypothesis". *Transactions of the American Philosophical Society* **57** (pt. 4): 6.
53. Teres, Dick. Lost Discoveries: *The Ancient Roots of Modern Science — from the Babylonians to the Maya* (New York: Simon & Schuster, 2003) p. 3.
54. Crowe, p. 83.
55. Ragep, adsabs.harvard.edu. Copernicus's sources were Regiomontanus' *Epitome* and Pico's *Disputationes*.
56. Huff, Toby E. *The Rise of Early Modern Science: Islam, China and the West.* (London, UK: Cambridge University Press, 2003) p. 58; Kirmani, M. Zaki; Singh, Nagendra Kr *Encyclopaedia of Islamic Science and Scientists*: A–H. Global Vision. (2005).

    Science historian Otto Neugebauer found a Greek manuscript which was brought to the Vatican after the fall of Constantinople to the Ottomans (Vatican Gr. 211). In it is a diagram of the Tusi couple. Source: Saliba, p. 29.

    "Urdi's lemma appears to have been the center of investigation" by Kepler's mentor, German astronomer Michael Maestlin "in his correspondence with Kepler." Source: A. Grafton, "Michael Maestlin's Account of Copernican Planetary Theory," Proceedings of the American Philosophical Society 117 (1973):523–5520. As cited in Saliba, pp. 29–30.
57. Weinberg, Steven. p. 117.

    Early traces of a heliocentric model are also found in several anonymous Vedic Sanskrit texts composed in ancient India before the 7th century BC. Source: en:wikipedia.

Aristarchus as well as Nicholas of Cusa in 1440 had similar theories about the Earth orbiting the Sun. Source: Weisstein, scienceworld.wolfram.com.

F. Jamil Ragep, History of Science Professor at McGill University, Canada points out that there is a "remarkable coincidence" between a passage in *De revolutionibus* (1.8) and one in Persian scientist Nasīr al-Dīn al-Tūsī's *Tadhkira* (II.1[6]), where "Copernicus follows Tūsī's objection to Ptolemy's 'proofs' of the Earth's immobility." Source: Ragep, adsabs.harvard.edu.

German Astronomer Johann Müller wrote a "book called the *Epitome* (published posthumously in 1496) which noted the weaknesses in Ptolemy's geocentric" theory. He was particularly critical of Ptolemy's epicycles. This too may have influenced Copernicus. Source: Brody & Brody, p. 8.

58. Recorde, Robert. *The Castle of Knowledge* (1556). As cited in Christie, "The emergence of modern astronomy — a complex mosaic: Part XII," thonyc.wordpress.com.
59. Copernicus, *De revolutionibus*, Book 1, Ch 8.
60. Ibid.
61. Van Helden, Al. "Tycho Brahe (1546–1601): The Galileo Project" galileo.rice.edu. 1995. http://galileo.rice.edu/sci/brahe.html.
62. Christie, "History of science on the Internet — the gift that keeps giving," thonyc.wordpress.com.
63. Christie, "The emergence of modern astronomy — a complex mosaic: Part X," thonyc.wordpress.com.
64. Christie, "The emergence of modern astronomy — a complex mosaic: Part V," thonyc.wordpress.com.
65. Copernicus, *De revolutionibus*. Foreword by Andreas Osiander
66. Christie, "The emergence of modern astronomy — a complex mosaic: Part IX," thonyc.wordpress.com.
67. Christie, "Acceptance, rejection and indifference to heliocentricity before 1610," thonyc.wordpress.com.; "Nicholas Copernicus and Johannes Kepler, Astronomers," allsaintsrussellville.org. http://allsaintsrussellville.org/?p=914. Retrieved Sept 30, 2020.

    Tolosani quote from an appendix to Tolosani's *On the Truth of Sacred Scripture* As cited in Christie, "Acceptance, rejection and indifference to heliocentricity before 1610," thonyc.wordpress.com.
68. "Ptolemy versus Copernicus," Osher Map Library oshermaps.org. https://oshermaps.org/special-map-exhibits/philosophy-religion-and-the-center-of-the-universe/ptolemy-vs-copernicus; Knox, DilwynKnoxJWCI_68_Copernicus.pdf.; Melanchthon "in the 1549 edition of his *Initia doctrinae physicae* and, more moderately, in the revised edition of 1550."

69. Christie, "Galileo, Foscarini, The Catholic Church, and heliocentricity etc.," thonyc.wordpress.com. For an account of Martin Luther's alleged rejection of Copernican heliocentricity, see Christie, "Acceptance, rejection and indifference to heliocentricity before 1610," thonyc.wordpress.com.
70. Ganss, newadvent.org.
71. Ibid.
72. Orta, nationalgeographic.com. Earlier Catholics had attempted to reform the Church. They included "John Wycliffe (c. 1320s–1384) in England, Jan Hus (c. 1372–1415) in Bohemia and Desiderus Erasmus (1466–1536)." In Martin Luther's time, there were reformers "Philipp Melanchthon (1497–1560), Thomas Müntzer (1489–1525), Huldrych Zwingli (1484–1531), Jean Calvin (1509–1564) and other minor figures." Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XXIV," thonyc.wordpress.com.
73. Luther, Martin. *Disputations on the Power of Indulgences*.(95 Theses) 1517. uncommon-travel-germany.com. https://www.uncommon-travel-germany.com/martin-luther-95-theses.html.
74. Orta, nationalgeographic.com. Punishment of Luther fell to the newly crowned Holy Roman Emperor and the "assembled German Estates "at the Diet of Worms in 1521. (Saxony was part of the empire.) Luther again refused to recant. The Emperor "placed Luther under the ban of the empire and ordered the destruction of his writings." By secret arrangement, he was spirited away to the Castle of Wartburg, near Eisenach for safe-keeping. Source: Ganss, newadvent.org.
75. George, christianhistoryinstitute.org.; Luther, Martin. *Lectures on Genesis*: Chapters 45–50, eds. Jaroslav Jan Pelikan, Hilton C. Oswald, and Helmut T. Lehmann, vol. 8 *Luther's Works*. (Saint Louis: Concordia Publishing House, 1999), 5:326. https://christianhistoryinstitute.org/magazine/article/dr-luthers-theology. The quote "the free, unearned, and unmerited favor of God" is from Pitts, Leonard, "I survived a fire in my home, but it could have been much worse." *Miami Herald*, March 24, 2019.

    Much of Luther's theology had been expressed in his "Disputation Against Scholastic Theology," written in 1517 before his famous letter on indulgences.Seelink:https://scholasticus.wordpress.com/2007/08/08/luthers-disputation-against-scholastic-theology/
76. Ganns, newadvent.org. Humanists, the "major intellectual movement of the Renaissance," emphasized the human realm and the study of classical Greek and Roman culture over the "barbarous middle ages." They saw the Protestant Reformation and its rejection of the Catholic Church as their ally. Source: Grendler, Paul. "Humanism" oxfordbibliographies.com. June 27, 2017.

http://www.oxfordbibliographies.com/view/document/obo-9780195399301/obo-9780195399301-0002.xml.; Ganns, newadvent.org.

77. Orta, nationalgeographic.com.; Metaxas, Eric. "The Real Story of the Reformation" House of Worship, Wall Street Journal, Nov. 3, 2017. By 1600, Scotland, England, Norway, Sweden, Denmark, and Netherlands would be Protestant countries. Catholic France, Hungary, Poland and Lithuania would have substantial minority Protestant populations. The Holy Roman Empire (Central Europe) would be a mix. Spain, the Papal States. the Kingdom of Naples, Spanish Netherlands, and Ireland would remain exclusively Catholic.
78. Ganns, newadvent.org.
79. Ganns, newadvent.org.; Martin, Marty. *Martin Luther*. (New York: Viking Penguin, 2004) p. 1; Hauger, Martin. Martin Luther and the Jews: How Protestant Churches in Germany Deal with the Reformer's Dark Side." Oct 24, 2017. https://doi.org/10.1177/0040573617721913.
80. Ganns, newadvent.org.
81. Sahgal, Neha. "500 years after the Reformation, 5 facts about Protestants around the world." pewresearch.org. Oct. 27, 2017.
    http://www.pewresearch.org/fact-tank/2017/10/27/500-years-after-the-reformation-5-facts-about-protestants-around-the-world/.
82. Pearcy, Nancy; Thaxton, Charles. The Soul of Science (Wheaton, IL: Crossway Books, 1994) p. 23. As cited in "The Reformation and Science: No Simple Answers, but Some Clear Foundations," evolutionnews.org.
83. "The Reformation and Science: No Simple Answers, but Some Clear Foundations," evolutionnews.org.
84. Wootton, David. "History: Science and Reformation" *Nature* Vol. 550, pp. 454–455, Oct. 26, 2017. As cited in "The Reformation and Science: No Simple Answers, but Some Clear Foundations," evolutionnews.org. See the latter for counter-arguments.
85. Metaxas, Eric. "The Real Story of the Reformation" House of Worship, Wall Street Journal, Nov. 3, 2017.
86. Catholic and Protestant scholars tend to agree that Christian belief in a rationale God was key to the Scientific Revolution. Yet ancient Jews held the same belief, but achieved no notable advances in science. As we have seen, it was the pagan Greeks with their multitude of gods who made extraordinary scientific breakthroughs. To them it was the rationality of mathematics, particularly geometry that drove their advances in natural philosophy. Again, the rediscovery of ancient Greek works along with Islamic advances is what sparked the renewal of science in Western Europe, and ultimately the Scientific Revolution. So, it seems, rationality, though not a guarantee of scientific advancement, does appear to play a part.

87. As cited in Brody & Brody, p. 13.
88. Crowe, p. 85.; Christie, "History of science on the Internet — the gift that keeps giving," thonyc.wordpress.com.
89. Christie, "The emergence of modern astronomy — a complex mosaic: Part VII," thonyc.wordpress.com.
90. Crowe, p. 85.
91. The Copernicus death-bed "legend was put in the world by Tiedemann Giese," Prince-Bishop of Warmia (Ermland) and mentor to Copernicus. Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part IX," thonyc.wordpress.com.

    The 1543 first edition of *De revolutionibus* was published in Nürnberg. A second unchanged edition was published in 1566 in Basel. "Each edition has been estimated to have been around five hundred copies. . . Owen Gingerich surveyed the marginalia in all the surviving copies and . . . nearly all the readers ignored the first, heliocentric cosmological Book, confining themselves to the mathematical models in the other five books. Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part X," thonyc.wordpress.com.
92. In addition to Earth's rotation on its axis and circular orbit around the Sun, Copernicus introduced an unnecessary third motion to offset a believed swiveling of Earth's axis. Source: Weinberg, Steven. pp. 151–153.
93. "Nicolaus Copernicus," phy.pmf.unizg.hr.
94. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXIII," thonyc.wordpress.com.; Crowe, pp. 98–99.

Chapter 20

1. Donne, John. (1571/2-1631). From "An Anatomie of the World, The First Anniversary" (1611). As cited in Crowe, p. 177.
2. Crowe, p. 142.
3. "Tycho Brahe Quotes and Sayings" inispiringquotes.us. https://www.inspiringquotes.us/quotes/aylI_ihLuUyYK Retrieved Jul 15, 2020.
4. Eggen, britannica.com.; Templeton, geek.com.; Van Helden, "The Galileo Project: Tycho Brahe (1546–1601)." galileo.rice.edu.
5. "Tycho Brahe Biography," thefamouspeople.com.
6. McKee, astronomy.com.; Redd, "Tycho Brahe Biography," space.com.; "Knutstrop Castle," spottinghisotry.com. https://www.spottinghistory.com/view/1600/knutstorp-castle/.
7. "Tycho Brahe Biography," thefamouspeople.com.

8. Christie, "The emergence of modern astronomy — a complex mosaic: Part XIV," thonyc.wordpress.com.

   Jørgen Brahe's "brother-in-law, Peder Oxe, was Steward of the Realm — the most powerful man in the kingdom" outside of the King.
9. "Tycho Brahe Biography," thefamouspeople.com.
10. Christianson, John Robert. *On Tycho's Island: Tycho Brahe, Science, and Culture in the Sixteenth Century* (Cambridge, UK: Cambridge University Press, 2002).
11. "Tycho Brahe Biography," thefamouspeople.com.; Christie, "The emergence of modern astronomy — a complex mosaic: Part XIV," thonyc.wordpress.com.
12. "Tycho Brahe Biography," thefamouspeople.com.
13. "Tycho Brahe," st-andrews.ac.uk.
14. "Tycho Brahe," cs.mcgill.ca.; "Tycho Brahe Biography," thefamouspeople.com.
15. Mosley, Adam. *Bearing the Heavens: Tycho Brahe and the Astronomical Community of the Late Sixteenth Century* (Cambridge, UK: Cambridge University Press, 2007) p. 83.
16. Weinberg, Steven. p. 159. The remnant of Tyco's supernova was discovered by radio astronomers in 1952.
17. "Tycho Brahe Biography," thefamouspeople.com.; Tian, Wenwu; Leahy, Denis A. "Tycho SN 1572: A Naked Ia Supernova Remnant without Associated Ambient Molecular Cloud". *Astrophysical Journal Letters*. ***729***(2): L15, (December 26, 2010).
18. "Tycho Supernova," en.wikipedia.org.
19. Templeton, geek.com.

    "Almost as accurate [as Tycho] were his European colleagues, such as Wolfgang Schuler, Thomas Digges, John Dee, Francesco Maurolico, Jerónimo Muñoz, Tadeáš Hájek, or Bartholomäus Reisacher". Source: "Blast From The Past: Astronomers Resurrect 16th-Century Supernova." Calar Alto Observatory. Science Daily, sciencedaily.com. Dec. 12, 2008. https://www.sciencedaily.com/releases/2008/12/081203133809.htm.
20. Brahe, Tycho. De mundi aetherei recentioribus phaenomenis (Uraniborg: Christophorus Weida, 1588). Ch. 6. escholarship.org. https://escholarship.org/content/qt3mp3t6tb/qt3mp3t6tb_noSplash_e09c94d0b54288fb78007e1de887b5b5.pdf?t=qsp319.; Weinberg, Steven, p. 159.
21. Ibid, pp. 159–161.; Tycho Brahe (1546–1601), hao.ucar.edu..; "Tycho Brahe," cs.mcgill.ca. Full title: *De nova et nullius aevi memoria prius visa stella. Loosely translates to The new star never before seen in memory*.
22. Høg, astro.ku.dk.

23. Ibid.
24. Christianson, jstor.org.
25. Van Helden, "The Galileo Project: Tycho Brahe (1546–1601)," galileo.rice.edu.; "Tycho Brahe Biography," the famouspeople.com.
26. "Explore Further: Tycho's Heavenly Castle," airandspace.si.edu. https://airandspace.si.edu/exhibitions/explore-the-universe/online/etu/html/naked_eye/uniborg.html. Retrieved Jul 15, 2020.; Christie, "The emergence of modern astronomy — a complex mosaic: Part XV," thonyc.wordpress.com.
27. "Tycho Brahe (1546–1601), hao.ucar.edu.: Haqq-Misra, bostonglobe.com,; Crowe, p. 137. Tycho also provided "occasional service as the king's astrological adviser."

    "Accuracy of the tower-mounted instrument was affected by vibration caused by the wind." Tycho's second observatory, Stjerneborg, was "effectively situated underground in a large pit to reduce wind vibration of the instruments." Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XV," thonyc.wordpress.com.
28. Templeton, geek.com.; Christie, "The emergence of modern astronomy — a complex mosaic: Part XV," thonyc.wordpress.com.
29. Templeton, geek.com.
30. "Mural Quadrant," princeton.edu.
31. "Tycho Brahe's Observations and Instruments," hao.ucar.edu.; "Mural Quadrant," princeton.edu.
32. The Danish astronomer's giant observational devices were made of metal. They were "of sufficient size to bear graduations down to an arc-minute," historian Ann Blair tells us. Brahe "devised an innovative method for 'subdividing degrees of arc through the use of transversal points and of tiny slit sights on alidades [sighting devices],' as he put it." This enabled remarkably accurate measurements — without the aid of a telescope, which had not been invented yet. Source: Blair, dash.harvard.edu.

    Brahe's ingenious instruments included 1) "a brass azimuthal quadrant, 65 centimeters in radius" with an "estimated accuracy of 48.8 seconds of arc;" 2) a "great globe about 1.6 meter in radius to record the position of stars" as well as "stellar and planetary positions;" 3) An "armillary sphere (a model of objects in the sky), 1.6 meter in radius;" 4) a "triangular sextant, about 1.6 meter in radius;" 5) a "great equatorial armillary, 3 meters in diameter" with an "estimated accuracy of 38.6 seconds of arc;" 6) a "revolving wooden quadrant, 1.6 meter in radius, with an estimated accuracy of 32.3 seconds of arc;" and 7) a "revolving steel quadrant, 2 meters in radius," with an "estimated accuracy of 36.3 seconds of arc." Source: "Tycho Brahe's Observations and Instruments." hao.ucar.edu.

33. Blair, dash.harvard.edu. "Tycho Brahe Biography," thefamouspeople.com.
34. Gingerich, physicstoday.scitation.org.
35. Crowe, p. 142.; Christie, "The emergence of modern astronomy — a complex mosaic: Part XV," thonyc.wordpress.com.
36. Brody & Brody, p. 16.
37. Tycho Brahe's Observations and Instruments," hao.ucar.edu. "Tycho's brass azimuthal quadrant, 65 centimeters in radius, was built in 1576 or 1577. It was one of the first instruments built at Hveen, and was used for observations of the 1577 comet."
38. Hannam, p. 280.
39. Tycho Brahe's Observations and Instruments," hao.ucar.edu.; Crowe, p. 138.; Christie, "The emergence of modern astronomy — a complex mosaic: Part XIV" thonyc.wordpress.com.

    "Tycho, Michael Mästlin and Thaddaeus Hagecius ab Hayek (1525–1600) . . . all determined that the observed phenomena were clearly supralunar . . confirmation by the leading Catholic astronomer, Christoph Clavius (1538–1612)" promoted widespread acceptance. Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part V," thonyc.wordpress.com.

    Aristotelian theory of comets had already begun to be questioned by Toscanelli, Peuerbach and Regiomontanus in the fifteenth century. Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XIV," thonyc.wordpress.com.
40. Tycho Brahe's Observations and Instruments," hao.ucar.edu.; Templeton, geek.com.
41. Crowe, p. 79.
42. Brahe letter to German mathematician Christoph Rothmann, August 1588 (VI, 147). As cited in Blair, dash.harvard.edu.
43. Crowe, p. 139.
44. Blair, dash.harvard.edu.
45. Gingerich, physicstoday.scitation.org.
46. Blair, dash.harvard.edu.
47. Ibid.
48. O'Connor & Robertson, "Tycho Brahe," st-andrews.ac.uk.; en:wikipedia; Temming, skyandtelescope.org. As noted, in 1838, German mathematician and astronomer Friedrich Bessel made "the first measurement of the parallax of a star," 61 Cygni. The parallax was measured at 0.314 arc seconds, "about 100 times smaller than Tycho Brahe's observational error".
49. Haqq-Misra, bostonglobe.com.
50. Ibid.

51. Crowe, p. 140.
52. Blair, dash.harvard.edu.
53. Crowe, p. 140.
54. Blair, dash.harvard.edu. Ancient Greek astronomer Heracleides of Pontus, a pupil of Plato, has said to have proposed a system somewhat similar to Brahe's goe-helio model in the 4th century bc. This is now seen as a misinterpretation. For details, see, for example: O'Connor & Robertson, "Heraclides of Pontus" st-andrews.ac.uk.
55. Crowe, p. 140.
56. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXIII," thonyc.wordpress.com.
57. Crowe, p. 138.
58. Ibid, p. 142.
59. Ursus published his geo-helio model in *Nicolai Raymari Ursi Dithmari Fundamentum astronomicum* (Straßburg 1588). Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XVI," thonyc.wordpress.com. Christie writes: "The itinerant mathematician/astronomer from Breslau, Paul Wittich (c. 1546–1586) . . . was probably the inspiration for both Tycho's and Ursus' decision to adopt a geo-heliocentric system. Wittich played around with the Capellan system, in which Mercury and Venus orbit the Sun in a geocentric system. David Origanus (1558–1629), who had been influenced by Wittich at the University of Frankfurt an der Oder, also 'independently' invented a geo-heliocentric system but with diurnal rotation like Ursus' system . . . physician and astrologer Helisaeus Roeslin (1545–1616) and the court mathematicus Simon Marius (1573–1625) . . . both claimed independent discovery of the system."
60. Crowe, p. 142.; "Tycho Brahe," cs.mcgill.ca.
61. Van Helden, "The Galileo Project: Tycho Brahe (1546–1601)," galileo.rice.edu.
62. "Tycho Brahe-Museet: Astronomical Museum on Ven," guidebook-sweden.com. 2019. https://www.guidebook-sweden.com/en/guidebook/destination/tycho-brahe-museet-astronomical-museum-ven.
63. Ibid
64. Van Helden, "The Galileo Project: Tycho Brahe (1546–1601)," galileo.rice.edu.; Templeton, geek.com.
65. "Tycho Brahe," cs.mcgill.ca.; Tycho Brahe's Observations and Instruments," hao.ucar.edu.

Chapter 21

1. "Kepler, Johannes," encyclopedia.com.; "Tycho Brahe Biography," thefamouspeople.com.; Christie, "The emergence of modern astronomy — a complex mosaic: Part XV," thonyc.wordpress.com.

   Charles IV was crowned king after his father, Frederick II died in 1588. Brahe stayed on in Denmark until 1597. Lack of funding for Uraniborg was due to enmity between the Danish astronomer and "powerful nobles surrounding the new king." Source: "Tycho Brahe Biography," thefamouspeople.com.
2. "Johannes Kepler: His Life, His Laws and Times," nasa.gov; J V Field, *Tycho Brahe* (Personal communication, 1995). As cited in O'Connor & Robertson, "Tycho Brahe," st-andrews.ac.uk.
3. Donahue, p. ix.
4. Crowe, p. 147.
5. Gingerich, physicstoday.scitation.org.
6. "Kepler, Johannes," encyclopedia.com.
7. Caspar, pp. 29–36; Connor, pp. 23–46; Koestler, Arthur. *The Sleepwalkers: A History of Man's Changing vision of the Universe* (New York: Penguin, 1990) p. 234 (translated from Kepler's family horoscope).
8. Grant, Robert. *History of Physical Astronomy: From the Earliest Ages to the Middle of the Nineteenth Century (1852)* (Whitefish, Mt: Kessinger, 2008) p. 305.
9. Rosen, p. 22.
10. Field, gap-system.org.

    "Earlier accounts claimed that [Mästlin taught Copernican heliocentricity] in secret but all available evidence suggests that he did so quite openly." Source: Christie, Thony. "The emergence of modern astronomy — a complex mosaic: Part XVII," thonyc.wordpress.com.
11. "Kepler, Johannes," encyclopedia.com.
12. Donahue, p. 41.
13. Field, gap-system.org.
14. Barker, Peter, and Goldstein, Bernard R.. "Theological Foundations of Kepler's Astronomy." *Osiris* 16 (2001): 88–113. Accessed May 23, 2021. http://www.jstor.org/stable/301981. pp. 99–103, 112–113.
15. Kepler, Johannes. *Gesammelte Werke (Collected Works) III*, 40. As cited in "Kepler, Johannes," encyclopedia.com.
16. Rosen p. 226.; Christie, Thony. "War, politics, religion and scientia," thonyc.wordpress.com.

As district mathematicus, Kepler was "responsible for surveying, cartography and above all yearly astrological prognostica: Source: Christie, "Christmas Trilogy 2018 Part 3: Johannes' battle with Mars," thonyc.wordpress.com.

17. Donahue, p. 58.
18. "The Platonic Solids," University of Illinois Urbana-Champaign, geom. uiuc.edu. http://www.geom.uiuc.edu/~sudzi/polyhedra/platonic.html.
19. Connor, p. 58.
20. Ibid, p. 58.
21. Christie, "Christmas Trilogy 2018 Part 3: Johannes' battle with Mars," thonyc.wordpress.com.
22. Conversation with the Sidereal Messenger [open letter to Galileo], Dissertatio cu Nuncio Sidereo (1610). As cited in Johannes Kepler. *Gesammelte Werke*, Vol 4, 308, 11, 9–10. https://todayinsci.com/K/Kepler_Johannes/KeplerJohannes-Quotations.htm.
23. Connor, p. 58.
24. "Kepler, Johannes," encyclopedia.com.
25. Ibid. "After several trials he formulated a relation for the ratios of the distances equivalent to $(\mathbf{p}_1/\mathbf{p}_2)^{1/2}$ rather than the correct $(\mathbf{p}_1/\mathbf{p}_2)^{2/3}$, but this gave a sufficiently satisfactory first result."
26. Letter to Brahe, 13 December 1597, letter number 82. As cited in Donahue, p. 42.
27. Christie, "Christmas Trilogy Part 3: The emergence of modern astronomy — a complex mosaic: Part XXVI," thonyc.wordpress.com.

    The Pythagoreans had considered Astronomy and Harmonics as sister sciences. "Kepler believed he could quite literally fine tune his model using the Pythagorean theory of the harmony of the spheres," writes Christie, "that is that the ratio of the planetary orbits builds a musical scale that is only discernable to the enlightened Pythagorean astronomer. The *Harmonices Mundi* of 1619 was that fine tuning."
28. Westman, britannica.org.
29. Christie, "War, politics, religion and scientia," thonyc.wordpress.com.

    "Largely because of the success of his prognostica, Kepler was granted an exemption. Source: Christie, "Christmas Trilogy 2018 Part 3: Johannes' battle with Mars," thonyc.wordpress.com.
30. "Kepler, Johannes," encyclopedia.com.
31. Ibid.
32. Ibid.
33. Ibid. Kepler moved to Prague with his wife, Kristen
34. "Kepler," phys.utk.edu.

35. Gingerich, physicstoday.scitation.org. Tycho's observations showed a 5-degree discrepancy versus Ptolemy's prediction and a 4-degree discrepancy for Copernicus.
36. Ibid.
37. Ibid.
38. Ibid.
39. Ibid. Gingerich writes: "In tracking the heliocentric (Sun-centered) positions of Mars, Kepler found that the use of a circular orbit led to an 8 arc-minute error at the octants of its orbit."
40. Brody & Brody, p. 17.
41. "Kepler, Johannes," encyclopedia.com.; Recent examination of Brahe's skeleton suggests he was not poisoned, but likely died of "obesity, diabetes, and alcoholism." Source: "Skeleton of Famed Astronomer Tycho Brahe Finally Reveals Cause of Death." forbes.com. May 24, 2018.

    https://www.forbes.com/sites/kristinakillgrove/2018/05/24/skeleton-of-famed-astronomer-tycho-brahe-finally-reveals-cause-of-death/?sh=3fa5cf651fd4.
42. Crowe, p. 152.; Christie, "The emergence of modern astronomy — a complex mosaic: Part XV," thonyc.wordpress.com.

    After only a year at his Benatky Castle observatory, Brahe had been ordered back to the city by Rudolph II. There he worked on his Rudolphine tables till his death. He is buried in the Church of Our Lady before Týn in Old Town Square in Prague. Source: "Tycho Brahe Biography," thefamouspeople.com.
43. Caspar, pp. 181–85. The full title is *Tertius Interveniens, das ist Warnung an etliche Theologos, Medicos vnd Philosophos, sonderlich D. Philippum Feselium, dass sie bey billicher Verwerffung der Sternguckerischen Aberglauben nict das Kindt mit dem Badt aussschütten vnd hiermit jhrer Profession vnwissendt zuwider handlen*, translated by C. Doris Hellman as Tertius Interveniens.
44. Westman, britannica.org.
45. "Kepler, Johannes," encyclopedia.com.
46. Donahue, p. 4.
47. Ibid, p. 45.
48. *Johannes Kepler Gesammelte Werke*, XIV, 178. As cited in "Kepler, Johannes," encyclopedia.com.
49. "Kepler, Johannes," encyclopedia.com. This velocity-distance relationship holds strictly only at aphelion and perihelion, but Kepler generalized it to the entire orbit.
50. Ibid.

51. Donahue, pp. 79, 89. Donahue writes (p. 45): ". . . Kepler had for a long time been puzzled that the earth was the only planet in the Copernican system that moved uniformly on its circle (without any epicycles). He believed on physical grounds that this could not be right, and sought a way to investigate earth's orbit more accurately."
52. "Kepler, Johannes," encyclopedia.com.
53. Kepler, Johannes. *Gesammelte Werke*, III, 156. As cited in "Kepler, Johannes," encyclopedia.com.
54. Ibid.
55. "Kepler, Johannes," encyclopedia.com.
56. Donahue, p. 79–80.
57. Ibid.
58. *The New Astronomy: Opening the Electromagnetic Window and Expanding our View of Planet Earth: A Meeting to Honor Woody Sullivan on his 60th Birthday* (Astrophysics and Space Science Library) edited by Wayne Orchiston. (Springer; 2005 edition), p. 254.
59. "Kepler, Johannes," encyclopedia.com.
60. Donahue, p. 85. Donahue writes "And since the area swept out on the eccentric represents the time (2nd law), Kepler could relate the distances to the times. The remaining problem was to find out how to relate these distances and times to the observed positions . . . What he discovered, by trial and error, was that the points on the eccentric circle had to be squeezed perpendicularly inward, toward the line of apsides (aphelion and perihelion) . . . Kepler knew from Commandino's commentary on Archimedes' *On Conoids and Spheroids* that the curve . . . would be an ellipse." Source: Donahue, p. 95.
61. "Johannes Kepler." Famous Scientists, famousscientists.org. Mar 12, 2015. https://www.famousscientists.org/johannes-kepler/.
62. Donahue, p. 27.
63. Gingerich, physicstoday.scitation.org.

    11th century Muslim astronomer Al-Zarqali had suggested that the planet Mercury's orbit is elliptical. Source: Rufus, W. C. "The influence of Islamic astronomy in Europe and the far east". *Popular Astronomy* **47** (5): 233–8. May 1939. http://adsabs.harvard.edu/full/1939PA.....47..233R.
64. Turnbull, et al., p. 436.
65. Donahue, p. 89. Donahue (p.11): "Many of Kepler's most perceptive insights originate in his consistency in viewing planetary motions in all three dimensions rather than as circles in a plane."
66. Schutz, p. 33.

67. Crowe, p. 153.; "Kepler," phys.utk.edu.; Field, gap-system.org; Brody & Brody.
68. "Calculating semi-minor axis of ellipse," math.stackexchange.com. https://math.stackexchange.com/questions/1259945/calculating-semi-minor-axis-of-an-ellipse.
69. Crowe, p. 152.
70. Ibid, p. 8.
71. Ibid, p. 43.
72. Gingerich, scitation.aip.org.
73. Ibid.
74. Donahue, p. 25.
75. Ibid, p. 19.
76. Ibid, p. 63.
77. Ibid, p. 9.
78. Ibid, p. 32.
79. Christie, "The emergence of modern astronomy — a complex mosaic: Part XVII," thonyc.wordpress.com.
80. Gilbert, William. *De magnete magneticisque corporibus et de magno Magnete Tellure physiologia nova* (London: 1600) English translation by P. Fleury Mottelay (New York: Wiley, 1893, repr. Dover, 1958 etc.). As cited in Donahue, p. 69.

    "Gilbert carried out many experiments with spherical magnets, which he called terella, from which he deduced his belief that the Earth itself is a spherical magnet. Based on his erroneous belief that a suspended terella rotates freely about its axis he came to accept and propagate diurnal rotation" of the Earth . . . Book VI of De magnete, the final book, is devoted to an analysis of the Earth as a spherical magnet based on the results of Gilbert's experiments with his terella." Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XVII," thonyc.wordpress.com.
81. Donahue, p. 9.
82. Ibid, p. 27.
83. Ibid, p. 67.
84. Ibid, p. 94.
85. Perry, Jacob & Von Laue, Chase. *Western Civilization*: *Ideas, Politics, and Society*. Chapter 17: "The Scientific Revolution: The Universe Seen as a Mechanism. Chapter Summaries." college.cengage.com, https://college.cengage.com/history/west/perry/western_civilization/9e/chapters/chapter17.html.

    For an excellent discussion on Kepler's prescient ideas on gravity, mass, Earth's tides and more, see Hecht, aapt.scitation.org.

"*Astronomia Nova* is almost unique amongst major scientific publications," Christie writes, "in that it appears to outline in detail the work Kepler undertook to arrive at his conclusions, including all of the false turnings he took, the mistaken hypotheses he used and then abandoned and the failures he made in his calculations." Source: Christie, "Christmas Trilogy 2018 Part 3: Johannes' battle with Mars," thonyc.wordpress.com.

86. Brody & Brody, p. 21. For the mathematically inclined, a derivation of his third law can be found in "Derivation of Kepler's Third Law" General Astronomy (29:61) Fall 2012 Lecture 9 Notes, physics.uiowa.edu. September 14, 2012.

    http://homepage.physics.uiowa.edu/~spangler/2961_12/Lec09_notes.pdf.
87. Christie, "Christmas Trilogy 2018 Part 3: Johannes' battle with Mars," thonyc.wordpress.com.
88. Ibid.
89. Swetz & Katz, mma.org; Field, gap-system.org.; Christie, Thony. "The emergence of modern astronomy — a complex mosaic: Part XXXVI," thonyc.wordpress.com.
90. "Johannes Kepler: Dates of his life," research.iac.es. Oct 2010. http://research.iac.es/proyecto/johanneskepler/timeline_final.htm. Retrieved Aug 24, 2021.

    "Some of this material has been taken (in translation) from the website of the Bavarian Academy of Sciences. www.kepler-kommission.de/index.html."
91. Gingerich, Owen. "Johannes Kepler and the Rudolphine Tables" *Sky and Telescope*, Vol. 42, No. 6, pp. 328–333, December, 1971. https://www.ias.ac.in/article/fulltext/reso/014/12/1223-1233. From RESONANCE, December 2009.Accuracy of transit predictions related by J. B. Riccioli in 1665.
92. Christie, "Christmas Trilogy Part 3: The emergence of modern astronomy — a complex mosaic: Part XXVI," thonyc.wordpress.com.
93. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXV," thonyc.wordpress.com. Swiss Jesuit Johann Baptist Cysat (c. 1587–1657) was "the first astronomer to observe a comet with a telescope," writes Christie. He gave "the first ever description of a comet's nucleus [in 1618] . . . He followed Tycho Brahe in believing that comets orbited the sun. He also demonstrated the orbit was parabolic not circular. . ."
94. Christie, "War, politics, religion and scientia," thonyc.wordpress.com.
95. Kepler refused to sign "the Formula of Concord, basically a commitment to Lutheran theology and a rejection of all other theologies. He was barred from Holy Communion, a severe blow for the deeply religious astronomer."

Source: Christie, "War, politics, religion and scientia," thonyc.wordpress.com.

96. "The Solid Declaration of the Formula of Concord," VII, The Holy Supper, Status Controversiae 9. https://bookofconcord.org/formula-of-concord-solid-declaration/article-vii/.; Nauman, Grace. "Science and Orthodoxy: The Faith of Galileo and Kepler." Winter 2011, Volume 5, Issus 1 http://augustinecollective.org/science-and-orthodoxy-the-faith-of-galileo-and-kepler/.
97. "The Congregation of the Index," The Galileo Project, Galileo.rice.edu. Galileo.rice.edu/chr/congregation.html.
98. "Thirty Years War," A&E Television Networks, history.com. Aug. 21, 2018. https://www.history.com/topics/reformation/thirty-years-war.; Christie, "War, politics, religion and scientia," thonyc.wordpress.com.
99. Christie, "War, politics, religion and scientia," thonyc.wordpress.com.
100. Ibid.
101. "List of Civil Wars," en: wikipedia.
102. Einstein letter to Paul Ehrenfest. As cited in Egdall, *Einstein Relatively Simple*, p. 221.
103. As cited in Donahue, p. 38.
104. Westman, britannica.org. Although "Kepler argued that stars are not suns, but his well-reasoned case rested on an erroneously large angular diameter of the stars." Source: "Kepler, Johannes," encyclopedia.com.
105. Herbert, George (1593–1633). From "Divinitie." As cited in Crowe, p. 179.
106. Hecht, aapt.scitation.org. The common belief at the time was that "celestial bodies were guided across the heavens by a kind of planetary intelligence (spirit or soul)," Kepler wrote in *Mysterium Cosmographicum*: "If we replace for the word 'soul' [*animi*] the word "force" [*Vini*] then we get just the principle which underlies my celestial physics . . . I came to the conclusion this force must be something corporeal, that is, an emanation which a body emits, but an immaterial one."

    "Before Kepler, 'gravity' meant weight or heaviness;" writes Hecht, "after Kepler, 'gravity' became an immaterial emanation that spread though aethereal space manifested as a material attraction of kindred material objects."
107. Kepler letter to J. G. Herwart von Hohenburg, February, 1605. As cited in "Kepler, Johannes," encyclopedia.com.
108. Weinberg, Steven, p. 169; Hurley, explainingscience.org.
109. Carl Sagan, *Cosmos: A Personal Voyage*, episode III: "The Harmony of the Worlds".
110. Christie, "Kepler was wot, you don't say?" thonyc.wordpress.com.

111. Cardil, Roberto. "Kepler: The Volume of a Wine Barrel — Kepler's 'Nova stereometria doliorum vinariorum.'"
http://www.maa.org/publications/periodicals/convergence/kepler-the-volume-of-a-wine-barrel-keplers-nova-stereometria-doliorum-vinariorum; "Kepler, Johannes," encyclopedia.com.; Hecht, aapt.scitation.org.
112. Hurley, explainingscience.org. In Kepler's *Dioptrice* of 1611.
113. Crowe, p. 155.
114. "Kepler, Johannes" encyclopedia.com; Westman, britannica.org.; "Thirty Years' War (1618–1648)," encyclopedia.com. May 8, 2018. https://www.encyclopedia.com/history/modern-europe/wars-and-battles/thirty-years-war.
Over the course of the Thirty Years War, up to 6 million died in the Holy Roman Empire alone. In Kepler's home region of Württemberg, the population was reduced by an estimated two-thirds. Fought primarily in Germany, the war saw the greatest number of Germans killed until World War II.

Chapter 22

1. Ohanian, p. 40; Sobel, pp. 6, 24; Christie, "Galileo was insufficiently woke?" thonyc.wordpress.com.
2. "Galileo Galilei," st-andrews.ac.uk.
3. Sharratt, pp. 202–04, Galilei, pp. 250–52, Favaro (1898, 8:274–75)) Favaro, A., ed. *Le Opere di Galileo Galilei, Edizione Nazionale* (in Italian). (Florence: Barbera, (1890–1909). As cited in en: wikipedia.
4. en: wikipedia.
5. Ohanian, p. 38.
6. Gribbin, John. *The Fellowship: Gilbert, Bacon, Harvey, Wren, Newton and the Story of the Scientific Revolution*. (New York: Overlook, 2008) p. 26; Crowe, p. 156.
7. Vincenzio Galilei, *Dialogue of Ancient and Modern Music*, trans. Claude V. Palisca. (New Haven, CT: Yale Univ. Press, 2013) As cited in Sobel, p. 17.
8. "Galileo Galilei," st-andrews.ac.uk.; Sobel, p. 17.
9. Sobel, p. 18.
10. "Galileo Galilei," History of Science and Technology, aburchill.com https://www.saburchill.com/HOS/astronomy/014.html.
11. Van Helden, "Galileo," britannica.com.
12. Brody & Brody, p. 27.
13. Sobel, p. 6.
14. Sobel, p. 19.
15. Historian Stillman Drake (1910–1993) argued that the experiment did take place. Details are given in Sobel, pp. 19, 20.

16. Christie, Thony. "The emergence of modern astronomy — a complex mosaic: Part XXIX," thonyc.wordpress.com. Christie writes:

    "Tartaglia applied mathematics to the problem of projectile motion . . . his [student], Giambattista Benedetti (1530–1590) . . . wrote and published in total three works on the subject that went a long way towards the theory that Galileo would eventually publish . . . He argued that . . . two objects of the same material but different weights would fall at the same speed . . . In Italy the Dominican priest Domingo de Soto (1494–1560) correctly stated that a body falls with a constant, uniform acceleration. In his *Opus novum* . . . (1570), Gerolamo Cardano (1501–1576) demonstrates that two balls of different sizes will fall from a great height in the same time. The humanist poet and historian, Benedetto Varchi (c. 1502–1565) in 1544 and Giuseppe Moletti (1531–1588), Galileo's predecessor as professor of mathematics in Padua, in 1576 both reported that bodies of different weights fall at the same speed . . . as did Jacopo Mazzoni (1548–1598), a philosopher at Padua and friend of Galileo, in 1597. However, none of them explained how they arrived at their conclusions. ". . . Girolamo Borro (1512–1592), one of Galileo's teachers in Pisa, [reported] experiments in which he threw objects of different material and the same weights out of a high window to test Aristotle's theory . . . Borro's work is known to have had a strong influence on Galileo's early work in this area . . . In 1586, Simon Stevin (1548–1620) "dropped lead balls of different weights from the thirty-foot-high church tower in Delft" in the Netherlands. He "determined empirically that they accelerated 'at the same speed, arriving at the ground at the same time.'"
17. Tests in space have also verified Galileo's principle on falling bodies See, for example: Cartlidge, Edwin. "Galileo's 400-year-old theory of free-falling objects passes space test," sciencemag.org. Nov. 28, 2017. https://www.sciencemag.org/news/2017/11/galileos-400-year-old-theory-free-falling-objects-passes-space-test.
18. Sobel, p. 22.; "Galileo Galilei," st-andrews.ac.uk.
19. Sobel, p. 52.
20. "Galileo Galilei," st-andrews.ac.uk.
21. Rosen, Edward. "Galileo and Kepler: Their First Two Contacts" *Isis*. Vol. 57, No. 2, Summer, 1966, Notes and Correspondence. p. 262–64. jstor.org, http://www.jstor.org/stable/227965?seq=1#page_scan_tab_contents.
22. Santillana, Giorgio de, *The Crime of Galileo* (Chicago, IL: University of Chicago Press, 1955). As cited in "Galileo-Kepler Correspondence, 1597," umkc.edu.
23. Ibid.
24. "Galileo Galilei," st-andrews.ac.uk.

25. Credit for what we now call the telescope has been claimed on behalf of three Dutch eyeglass makers: Hans Lippershey of Middelburg, his fellow townsman Zacharias Jansen, and Jacob Metius of Alkmaar. Lippershey is generally given credit because his patent application on September 25, 1608 is dated the earliest. Sources: "Zacharias Janssen — Inventor of the First Optical Telescope," historyoftelescope.com.; Cox, space.com.
26. "Galileo Galilei," st-andrews.ac.uk. "In a dispute over power, Sarpi sided with the Republic of Venice against the Pope . . . He refused to obey a summons to come to Rome and in 1607 was wounded by assassins widely thought to be sent" by Pope Paul V. Source: Van Helden, "The Galileo Project: Paolo Sarpi (1552–1623)" galileo.rice.edu.
27. Christie writes: "Sometime between the 25th and 29th of September [1608], Hans Lipperhey . . . gave the earliest known public demonstration of the telescope to Maurits of Nausau and assembled company at a peace conference in Den Hague . . . Simon Marius began his own astronomical observations sometime in 1609. Galileo . . . had in fact seen and handled a telescope before he began his own efforts at construction." Source: Christie, Thony. "The telescope — claims and counterclaims" thonyc.wordpress.com.

    "Both [Lippersey and Galileo's] instruments consisted of a tube with a biconvex or plano-convex objective lens at one end and a bi-concave or plano-concave eyepiece lens at the other end. The eyepiece lens also had a mask or stop to cut down the distortion caused around the edges of the lens. The only difference was in the focal lengths of the lenses used producing different magnitudes of magnification . . . numerous others . . . constructed telescopes independently in those first few years of telescopic astronomical observation." Source: Christie, "Today in something is wrong on the Internet," thonyc.wordpress.com.
28. Christie, "The telescope — claims and counterclaims," thonyc.wordpress.com.
29. Drake, *Galileo at Work.* As cited in Cox, space.com.
30. Christie, "Galileo's the 12th most influential person in Western History — Really?" thonyc.wordpress.com.; "Galileo Galilei," st-andrews.ac.uk.
31. Sobel, p. 31.
32. https://commons.wikimedia.org/wiki/File:Galileo_Donato.jpg
33. Crowe, p. 163.
34. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXI," thonyc.wordpress.com.
35. "Thomas Harriot, who drew telescopic images of the moon well before Galileo, did not realise what he was seeing." Source: Christie, Thony. "Galileo's the 12th most influential person in Western History — Really?" thonyc.wordpress.com.

36. Crowe, p. 160.
37. Sobel, p. 31.
38. Drake, *Galileo at Work.* p. 146. As cited in Sobel, p. 6. and en: wikipedia.
39. "Galileo Galilei," st-andrews.ac.uk.; Sobel, p. 6.
40. Brody & Brody, p. 30.
41. Drake, *Galileo at Work.* p. 152. As cited in Sobel, p. 6 and en: wilipedia.
42. Sharratt, p. 17. As cited in en: wikipedia.
43. Galileo's pamphlet, *Sidereus Nuncius (The Starry Messenger)*, March 1610. As cited in Brody & Brody, p. 30.
44. "Desert Astro," desert-astro.com.; Jones, Jane Houston. "Chasing Galileo-Jupiter and the four Galilean satellites" http://jane.whiteoaks.com/2009/06/11/chasing-galileo-jupiter-and-the-four-galilean-satellites/.
45. Crowe, p. 166.
46. Crowe, p. 163.
47. As of this writing, astronomers have confirmed the existence of 79 moons orbiting the planet Jupiter. Source: "Jupiter Moons" NASA Science. https://solarsystem.nasa.gov/moons/jupiter-moons/overview/. Retrieved Jul 28, 2021.
48. Drake, *Galileo at Work.* pp. 158–68, Sharratt, pp. 18–19. As cited in en: wikipedia.
49. Sobel, p. 39.
50. Christie, Thony. "The Starry Messenger What it Said and What that Really Meant!" thonyc.wordpress.com. Within a year, mathematician Antonio Santini (1577–1662) produced "a telescope of sufficient quality" and confirmed "the existence of the Jupiter moons. He then sent a telescope to the Collegio Romano, where the Jesuit astronomers were now also able to confirm all of Galileo's discovery." Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XXI," thonyc.wordpress.com.; Klus, Helen. "How We Came to Know the Cosmos: Space & Time" Ch. 3. "Models of the Universe" thestargarden.co.uk. http://www.thestargarden.co.uk/Heliocentric-models-of-the-Solar-System.html.
51. Sobel, p. 6.
52. "Kepler," gap-system.org. http://www.gap-system.org/~history/Biographies/Kepler.html.

    Galileo in fact sent one of his telescopes to Kepler, who "confirmed Galileo's discoveries." Source: Weinberg, Steven, p. 189.
53. Von Gebler, Karl. *Galileo Galilei*, (1879) p. 26. As cited in "Galileo-Kepler Correspondence, 1597." umkc.edu.
54. Ibid.
55. Crowe, p. 157.

56. Sobel, p. 34.; Christie, "The Starry Messenger What it Said and What that Really Meant!" thonyc.wordpress.com.

    Galileo wrote in clear, understandable prose, unencumbered by obtuse scientific text. The "brilliant science communicator" was the forerunner of popular science writers of today. Source: Christie, Thony. "Stylish writing is not necessarily good science," thonyc.wordpress.com.
57. Christie, Thony. "The Starry Messenger What it Said and What that Really Meant!" thonyc.wordpress.com.
58. Van Helden, "The Galileo Project: The Medici Family," galileo.rice.edu.
59. "Galileo Galilei," st-andrews.ac.uk.; Christie, "The emergence of modern astronomy — a complex mosaic: Part XXI," thonyc.wordpress.com.
60. Crowe, p. 167.
61. "The heliocentric phases of Venus were also discovered independently by Thomas Harriot, who, as always, didn't publish; by Simon Marius, whose discovery was published by Kepler; and by the Collegio Romano astronomers, who also didn't published but announced their discovery in their correspondence." Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XXII," thonyc.wordpress.com.
62. Christie, "Galileo, Foscarini, The Catholic Church, and heliocentricity in 1615 Part 1 — the occurrences: A Rough Guide," thonyc.wordpress.com.
63. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXXI," thonyc.wordpress.com.

    Four European astronomers observed the transit of Mercury across the Sun on November 7, 1631; Johann Rudrauf, Johann Baptist Cysat, Pierre Gassendi, and an unknown astronomer who "observed it from Ingolstadt." Using Kepler's Rudolphine Tables, amateur astronomers Jeremiah Horrocks and William Crabtree observed the transit of Venus across the Sun on November 24, 1639. That same year, "Italian Jesuit astronomer Giovanni Battista Zupi observed the orbital phases of Mercury." Source: Christie," The emergence of modern astronomy — a complex mosaic: Part XXXI, thonyc.wordpress.com.
64. Galileo "had seen the rings of Saturn, but by late 1612, the plane of the ring as seen from the earth had tilted to the point that Galileo's line of sight corresponded with the pale of the ring, making it invisible." Source: Crowe p. 168.

    "The astronomers of the Collegio Romano claimed priority on the Saturn discovery. Whether they or Galileo saw the phenomenon first cannot be determined." Christie, Thony. "The emergence of modern astronomy — a complex mosaic: Part XXII," thonyc.wordpress.com.

65. Drake, *Galileo at Work*, p. 209; http://csep10.phys.utk.edu/astr161/lect/history/galileo.html
66. Galileo, Scheiner, and David Fabricius "are generally regarded as rivals for the title to the discovery of sunspots . . . All had seen them by 1612, Fabricius being the first to publish his discovery." Source: Crowe, p. 170.
67. The *siderial* rotation period of the Sun at its equator is 24.47 days. The *synodic* rotation period, on the other hand, is 26.24 days. Why is it longer? Because the *synodic* rotation period is "the time for a fixed feature on the Sun to rotate to the same apparent position as viewed from Earth. Thus the Sun must rotate an extra amount due to the orbital motion of the Earth around the Sun." Observations also show that the Sun . . . "rotates faster at (its) equator and slower at its poles." Sources: Cain, Fraser. "Does the Sun Rotate? universetoday.com. Mar 13, 2012. http://www.universetoday.com/60192/does-the-sun-rotate/; "Solar Rotation," Solar Project 2010, star.bris.ac.uk.http://www.star.bris.ac.uk/bjm/solar/solarrot.html.

Chapter 23

1. "Galileo Galilei," pbs.org.
2. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXI," thonyc.wordpress.com.
3. Hawking, *A Brief History of Time*, p. 179.
4. Sobel, p. 60.
5. Brody & Brody, p. 33.
6. "Letter to Madame Christina of Lorraine, Grand Duchess of Tuscany" inters.org. http://inters.org/Galilei-Madame-Christina-Lorraine. As sited in Drake, *Discoveries and Opinions of Galileo*, pp. 173–216. Original Italian text published in *Opere di Galileo Galilei*, Edizione Nazionale edited by Antonio Favaro (Firenze: Giunti-Barbera, 1968), vol. V, pp. 309–348.

   For a synopsis of the story, see: Christie, Thony. "Galileo, Foscarini, The Catholic Church, and heliocentricity in 1615 Part 1 — the occurrences: A Rough Guide," thonyc.wordpress.com.
7. Brody & Brody, pp. 34–35; Sobel, pp. 65, 80.
8. "Letter to the Grand Duchess Christina of Tuscany (1615) (abridged) by Galileo Galilei," web.stanford.edu. file:///C:/Users/Owner/AppData/Local/Microsoft/Windows/INetCache/IE/O22F8R3J/Galileo-LetterDuchessChristina.pdf.
9. O'Connor & Robertson, "Galileo Galilei," st-andrews.ac.uk.
10. Christie, The emergence of modern astronomy — a complex mosaic: Part XXIV," thonyc.wordpress.com.

The complaints were regarding Galileo's Letter to Castelli (1613), which was "the basis of his subsequent letter to Grand Duchess Christina." Source: Finocchiaro, Maurice (1989). *The Galileo Affair*. (London, England: Univ. of California Press.1989). As cited in en:wikipedia.

11. Haqq-Misra, bostonglobe.com.

    Christie writes: "Carmelite theologian, Paolo Antonio Foscarini, submitted a book he had written to the Church censors in 1615, which contained very similar reinterpretations of the Bible to bring it into line with the Copernican heliocentric hypothesis . . . the anonymous censor thought the book to 'excessively favour the rash opinion' of Copernicus . . . Foscarini submitted both the text of his book and the censor's judgement to . . . Cardinal Bellarmino. . .. Having very firmly pointed out that neither Galileo nor Foscarini had the right to interpret or reinterpret Holy Scripture, Bellarmino . . . states very clearly that if there were proof of the heliocentric system then the Church would have to very carefully reinterpret the Bible, but he says, quite correctly, such proof does not exist at the moment . . ." Source: Christie, "Galileo, Foscarini, The Catholic Church, and heliocentricity in 1615 Part 1 — the occurrences: A Rough Guide," thonyc.wordpress.com.

12. Haqq-Misra, bostonglobe.com.
13. In addition, "Foscarini's book together with the books of the Protestants Michael Maestlin and Johannes Kepler were placed on the Index of Forbidden Books." Source: Christie, "Galileo, Foscarini, The Catholic Church, and heliocentricity in 1615 Part 1 — the occurrences: A Rough Guide," thonyc.wordpress.com.
14. Heilbron, John L. *Galileo*. (New York, NY: Oxford Univ. Press, 2010) p. 218; Jauch, cds.cern.ch.

    The Bellarmino meeting with Galileo occurred on February 26, 1616 in the presence of then Commissary General Michelangelo Seghizzi. Source: Mayer, jstor.org.

    Controversy surrounds the unsigned injunction of 1616. It was discovered in Vatican archives in 1870. Richard J. Blackwell, emeritus professor of philosophy at St. Louis University, and others argued that the injunction of 1616 is perhaps not real. The late Thomas. F. Mayer Professor Emeritus of History at Augustana College, refuted this claim. He argued (in my opinion correctly) that it is "most probability" that the decree was very much real. And that "Galileo did receive the precept, probably in the strongest form." The issue has been called out by some historians as critical in the subsequent trial of Galileo in 1633. Sources: Blackwell, nd.edu.; Mayer, jstor.org.; "Galileo Trial:1616 Documents," douglasallchin.net.; Jauch, cds.cern.ch.

15. Scotti, p. 204.
16. Christie, "Galileo, Foscarini, The Catholic Church, and heliocentricity in 1615 Part 1 — the occurrences: A Rough Guide," thonyc.wordpress.com.
17. Sobel, p. 74.
18. Ibid, p. 126.
19. Ibid, p. 72.
20. Brody & Brody, p. 28.
21. Ibid, p. 26; Martinez, Alberto A. "Was Giordano Bruno Burned at the Stake for Believing in Exoplanets?: Most historians say no, but new evidence suggests otherwise." scientificamerican.com. Mar 19, 2018. https://blogs.scientificamerican.com/observations/was-giordano-bruno-burned-at-the-stake-for-believing-in-exoplanets/. Retrieved Aug 26, 2021; en:wikipedia.
22. Galilei, Galileo. *The Assayer*. Written in the form of a letter to Monsignor Don Virginio Cesarini, Lincean Academician, and Chamberlain to the Pope, Rome, 1623. Selections translated by Drake, *Discoveries and Opinions of Galileo*, pp. 231–280.
23. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXV," thonyc.wordpress.com.

    On October 2, 1611 at a banquet at the court of Cosimo II, "Galileo debated floating bodies with a philosophy professor from Pisa." Cardinal Maffeo Barberini was in attendance. He "publicly took Galileo's side."
24. Hawking, *A Brief History of Time*, p. 179.
25. Blackwell, nd.edu.; Mayer, jstor.org.
26. Crowe, p. 158.
27. Blackwell, nd.edu.; Scotti, p. 231.

    In *Dialogo*, "there were frequent disclaimers throughout the text of the hypothetical nature of Copernicanism." Source: Scotti, p. 242.
28. Donahue, back cover.
29. "Dialogue Concerning the Two Chief World Systems — Ptolemaic and Copernican work by Galileo" britannica.com. https://www.britannica.com/topic/Dialogue-Concerning-the-Two-Chief-World-Systems-Ptolemaic-and-Copernican Retrieved July 16, 2020.; en:wikipedia.
30. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXXVI," thonyc.wordpress.com.; Christie, "Galileo, Foscarini, The Catholic Church, and heliocentricity in 1615 Part 1 — the occurrences: A Rough Guide," thonyc.wordpress.com.
31. Conversation with Will Harden, fellow author and my student at the University of Miami OSHER Lifelong Learning Institute on March 8, 2016.

    Galileo's *Dialogo* was "a four-day discussion set in Venice between Filippo Salviati, Geovanfrancesco Sagredo, and an Aristotelian professor called Simplicio. The first two were friends of Galileo now long dead. . .

Simplicio was a fictional character most likely named after the Greek philosopher and commentator on Aristotle of the sixth century AD, Simplicius of Cilicia." Source: Scotti, p. 231.

32. Galileo's "infamous theory of the tides, thought out by him and Paolo Sarpi in the 1590s . . . would go on to become the crowning glory as he saw it, of his *Dialogo*. This theory posited that the tides were the result of the oceans swapping about like water in a moving bowl, as a result of the motion of the earth. It suffered from one major failure, and lots of minor ones, it only allowed for one tide a day, whereas there are in reality two." Source: Christie, "Galileo, Foscarini, The Catholic Church, and heliocentricity in 1615 Part 1 — the occurrences: A Rough Guide," thonyc.wordpress.com.
33. Scotti, p. 242.
34. Quote from Scotti, p. 243.
35. Galileo, *Dialogo*, pp. 113–14. As cited in Scotti, p. 244.
36. Sobel, pp. 7, 145 Through Salviati, Galileo also described the behavior of sunspots over the seasons. Sunspots appear to move in an annual pattern, curving upward for half the year and curving downward for the other half. This, Galileo explained is due to the tilt of the Earth's rotational axis with respect to its orbit around the Sun; causing the apparent path of sunspots. Thus additional evidence for a Sun-centered solar system.
37. Hannam, p. 37.
38. Why don't we feel the change in direction of a spinning Earth? Look at the sky on a clear night. That oh so slow wheeling of the stars around the pole star is really the earth spinning. Let's calculate it: Earth's surface rotation speed at the equator is given as about 1000 miles per hour relative to its center. The circumference of the Earth is about 24,900 miles at the equator. The change in direction over one hour is: (1000 miles – 360 degrees) divided by 24,900 miles. This equals some 14 degrees. And 14 degrees in one hour is about 0.004 degrees per second of time — a change in direction at the surface of the Earth that is so slow we don't feel it.
39. Hannam, pp. 186–7. Nonetheless, Oresme rejected the idea of a moving Earth because of Psalm 93:1: "Yea, the World is established, that it cannot be moved."
40. Sobel, p. 256.
41. Christie writes: "On 8 March 1632 Cardinal Borgia castigated the Pope for not supporting King Philipp IV of Spain against the German Protestants. The situation almost degenerated into a punch up . . . Barberini decided to purge the Vatican of pro-Spanish elements. One of the most prominent men to be banished was Giovanni Ciampoli (1589–1643), Barberini's chamberlain. Ciampoli was an old friend and supporter of Galileo . . . He was highly active

in helping Galileo trick the censors and had read the manuscript of the *Dialogo*, telling Barberini that it fulfilled his conditions. His banishment was a major disaster for Galileo." Source: Christie, Thony. "The emergence of modern astronomy — a complex mosaic: Part XXVII," thonyc.wordpress.com.

42. Ohanian, p. 51.
43. Sobel, pp. 191–196, 225.
44. Blackwell, nd.edu.
45. "Galileo Galilei," pbs.org.
46. Gaul, Simon. *Malta, Gozo, and Comino*. (Wahroonga, Au: New Holland, 2007) p. 325.
47. Ibid; Blackwell, nd.edu; Brody & Brody, p. 87.l Scotti, p. 250.
48. Jauch, cds.cern.ch.
49. Ibid.; Sobel, p.242.; Scotti, p. 252.
50. Ibid.
51. Ibid.; Sobel, p. 253. Except for "eighteen days (12–30 April) when Galileo is held at the Dominican Convent of Santa Maria Sopra Minerva in the Piazza Minerva, the usual site of Holy Office hearings."
52. Linder, "Trial of Galileo (1633)," famous-trials.com.
53. Ibid. Galileo had guided Francesco Barberini to "successful completion of his doctoral studies at Pisa just weeks before Maffeo's election" as Pope Urban VIII. Source: Scotti, p. 222.
54. Blackwell, nd.edu.
55. Sobel, p. 256.
56. Linder, "Trial of Galileo (1633)," famous-trials.com.
57. "Galileo Trial: 1616 Documents," douglasallchin.net.
58. Blackwell, nd.edu.
59. Ibid.
60. Ibid.
61. Scotti, p. 258.
62. Blackwell, nd.edu.
63. Jauch, cds.cern.ch.
64. Sobel, pp. 69, 263.
65. Scotti, p. 259.
66. Blackwell, nd.edu.; Miller, adsabs.harvard.edu.
67. Linder, "Trial of Galileo (1633)," famous-trials.com.
68. "The verdict was preceded by the names of all ten cardinals . . . but the document carried signatures of only seven of them . . . the verdict was published 'by mistake' with names of all ten Cardinals." Source: Jauch, cds.cern.ch.
69. Blackwell, nd.edu.

70. Livio, Mario. "Did Galileo Truly Say 'And Yet in Moves'?' A Detective Story" *Scientific American*, blogs.scientificamerican.com. May 6, 2020. https://blogs.scientificamerican.com/observations/did-galileo-truly-say-and-yet-it-moves-a-modern-detective-story/.
71. Finocchiaro, M. A. *The Galileo Affair: A Documentary History.* (Berkeley: University of California Press, 1989) pp. 38, 291, 306.
72. Ohanian, p. 34; Sobel, pp. 273–80.
73. Drake, *Galileo at Work*, p. 367.
74. Miller, adsabs.harvard.edu.; Blackwell, nd.edu.
75. Scotti, p. 262.
76. Jauch, cds.cern.ch.
77. Sobel, p. 256.
78. Urban's change of heart was "partly due to events in Germany," writes David M. Miller, professor of Philosophy and Religious Studies at Iowa State University. In the ongoing Thirty Years War, the army of Protestant Sweden had recaptured Catholic Bavaria in April of 1633. Catholic Hapsburg "demands for troops, subsidies, and action" were again vehement. In dealing harshly with Galileo, "Urban wanted the Catholic world to know he led the fight against heresy." This view is rejected by Scotti. Sources: Miller, adsabs.harvard.edu.; Scotti, p. 234.
79. Jauch, cds.cern.ch.
80. Sobel, pp. 191–280, 317; Brody & Brody, p. 339.

    Christie: "The impact was much more minimal than is usually implied in all the popular presentations. Outside of Italy these actions of the Church had almost no impact whatsoever, even in other Catholic countries." Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XXVII," thonyc.wordpress.com.
81. Sobel, p. 258.
82. Sobel, p. 307.; Hawking, *A Brief History of Time*, p. 180.
83. Carney, Jo Eldridge. *Renaissance and Reformation, 1500–1620* (Portsmouth, NH: Greenwood, 2000).

    "The work summarized in the *Discorsi* was mostly carried out in the middle period of Galileo's life between 1589 and 1616." Source: Christie, "Galileo's the 12th most influential person in Western History — Really?" thonyc.wordpress.com.
84. "Galileo Galilei," st-andrews.ac.uk.

    Galileo rolled balls "down a smooth, wooden channel in an inclined plane that had been oiled to remove friction. He argued by analogy the results that he achieved by slowing down the acceleration by using an inclined plane were equivalent to those that would be obtained by dropping the balls

vertically . . . He released one ball at a time and timed them separately thus eliminating the synchronicity problem. Also, he was able with a water clock to time the balls with sufficient accuracy to make the necessary mathematical calculations. He put the laws of falls on a sound empirical and mathematical footing." Source: Christie, Thony. "The emergence of modern astronomy — a complex mosaic: Part XXIX," thonyc.wordpress.com.

85. Einstein, Albert. "Foreword". In Drake, S. (ed.). *Dialogue Concerning the Two Chief World Systems*. (Berkeley, CA: Univ. of California Press. 1954) p. 271. As cited in en:wikipedia.
86. McMullin, Ernan, ed. *The Church and Gaileo* (Notre Dame, IN: Univ. of Notre Dame Press, 2005) p. 6.
87. "Vatican admits Galileo was right." *New Scientist* (1846). *New Scientist*, newscientist.com.Nov7,1992.https://www.newscientist.com/article/mg13618460-600-vatican-admits-galileo-was-right/.
88. Owen, Richard. "Catholic Church abandons plan to erect statue of Galileo". London: TimesOnline News. Jan 29, 2009. https://www.thetimes.co.uk/article/catholic-church-abandons-plan-to-erect-statue-of-galileo-wp0cc8qf3ps.
89. Scotti, p. 261.
90. "Galileo Galilei," st-andrews.ac.uk.; Sobel, p. 362.
91. Scotti, p. 261.

Chapter 24

1. The famous quote "I do not know what I appear to the world . . ." is said to have been spoken by Isaac Newton shortly before his death. It can be found in: Brewster, David. *Memoirs of the life, writings, and discoveries of Sir Isaac Newton* (Edinburgh: T. Constable and Co; London: Hamilton, Adams, and Co., 1855) p. 407. (Chap. XXVII) https://archive.org/details/memoirslifewrit02brewgoog/page/n5.
2. Sobel, p. 89.
3. When Newton was Master of the Mint, John Conduit was his assistant. "After Newton's death in March 1727 Conduitt succeeded him" in that post. Source: "CONDUITT, John (1688–1737) of Cranbury Park, Hants". History of Parliament Online. Retrieved May 2019. As cited in en: wikipedia.
4. Christianson, p. 36.
5. Ibid, p. 36.

   Regarding the "scientific method," Bacon advised natural philosophers to: 1) observe a phenomenon and take data, 2) formulate a hypothesis (educated guess) to explain what is going on, and 3) test the hypothesis by additional

observation and experiment. The extent of Bacon's influence on Newton remains controversial.

6. Christianson, pp. 35–37.
7. "Boyle, Robert (1627–1691)" University of Illinois Urbana-Champaign, scs.illinois.edu. http://www.scs.illinois.edu/~mainzv/exhibit/boyle.htm.; "The Sceptical Chymist, britannica.com. Jan 21, 2021. https://www.britannica.com/topic/The-Sceptical-Chymist. Retrieved Mar 22, 2021.
8. Russell, Bertrand. *History of Western Philosophy* (Routledge, 2004) pp. 511, 516–7; Grosholz, Emily. *Cartesian method and problem of reduction* (Oxfordshire, UK: Oxford Univer. Press, 1991); Duignan, Brian. "Philosophers to Know, Part II: René Descartes," britannica.com. Mar 27, 2019. https://www.britannica.com/list/philosophers-to-know-part-ii; Christianson, p. 37.; Egdall, p. 20.

   Though his scientific methodology was steeped in metaphysics, Descartes advocated science based on observation and experiment, For a comprehensive discussion of the physics of Descartes, see: Slowik, Edward, "Descartes' Physics", *The Stanford Encyclopedia of Philosophy* (Fall 2017 Edition), Edward N. Zalta (ed.), https://plato.stanford.edu/archives/fall2017/entries/descartes-physics/.
9. "Civil War and Revolution," bbc.uk.com.
10. Hodges, Miles H. "The Spiritual Pilgrim, Our Story — the Wars of Religion," kingsacademy.com. http://www.kingsacademy.com/mhodges/12_Our-Story/22_wars.htm.
11. "Civil War and Revolution," bbc.uk.com.; Christie, "War, politics, religion and scientia," thonyc.wordpress.com.
12. Christianson, p. 44.
13. Christie, "War, politics, religion and scientia," thonyc.wordpress.com.
14. "Famous Premature Babies," lifeslittletreasures.org. https://www.lifeslittletreasures.org.au/prematurity/support-for-families/prematurity-articles/famous-premature-babies/; Christianson, p. 105.
15. Christianson, p. 4.
16. Brody & Brody, p. 41.
17. Christianson, pp. 5, 6.
18. Ibid, p. 7
19. Hatch, "Newton Timeline," ufl.edu.; "Isaac Newton," gap-system.org.
20. "Isaac Newton," gap-system.org.; Christianson, p. 12.
21. Christianson, p. 18.
22. Brody & Brody, p. 41.
23. Christianson, p. 13.

24. "Newton's Life and Work at a Glance," newtonproject.ox.ac.uk.; Hatch, "Sir Isaac Newton," ufl.edu.; "Isaac Newton," gap-system.org.
25. Christianson, p. 19.
26. "Isaac Newton," gap-system.org.
27. Ohanian, p. 61.
28. Christianson, pp. 45, 175.
29. Fowler, physics.virginia.edu.; Ohanian, p. 61.
30. Christianson, p. 48; http://www.genfiles.com/articles/legal-age/
31. Christianson, p. 49.
32. Hatch, "Sir Isaac Newton" ufl.edu.; "Isaac Newton," gap-system.org.
33. Ibid; Christianson, p. 57. But, according to Christianson, not "Galileo's two most important works, *Dialogue* and *Two New Sciences*." It appears Galileo's "open hostility to Aristotle made his books anathema to the authorities of Aristotelian Cambridge."
34. Christianson, p. 285.
35. "Isaac Newton," gap-system.org.
36. Ibid.
37. Brody, p. 49.
38. Christianson, p. 10.
39. Kaku, p. 5.
40. Christianson, p. 498.

    Newton suffered from an apparent mental breakdown in 1692–93. Some have argued it may have been mercury (or lead) poisoning in his alchemy investigations. Christianson tells us that "researchers . . . obtained samples of Newton's hair (and) spectrographic analysis revealed . . high concentrations of lead and mercury." Yet other symptoms of mercury poisoning were not present. "Most important of all, perhaps, is Newton's exceedingly rapid and seemingly complete recovery . . ." The only other mental disturbance to be documented with certainty occurred in 1664, well before alchemy had entered his life."
41. Christianson, p. 73.
42. Hatch, "Sir Isaac Newton," ufl.edu.
43. Christie, "Annus Mythologicus," thonyc.wordpress.com.; McRae, Mike. "Stop Saying Isaac Newton Was an Overachiever in Lockdown. Here's The Reality," sciencealert.com. Sept 19, 2020. https://www.sciencealert.com/stop-saying-isaac-newton-was-an-overachiever-in-lock-down-here-s-the-reality. Retrieved Sept 29, 2020.; Levenson, newyorker.com.

    From 1664 to 1669, Newton spent roughly the first two and a half years on mathematics and last three and a half on physics. He was home at home in Woolsthorpe for two periods: 1) some eight months from early July 1665

to March 1666. and 2) ten months from July 1666 to April 1667. He returned to Trinity in the interim. Sources: Christie, Thony. "Annus Mythologicus," thonyc.wordpress.com.; Levenson, newyorker.com.; Christianson, pp. 72, 3.

44. According to science historian Richard Westfall, by October 1666 "the calculus had been born — differing from what [Newton] would later publish only in the logical foundations on which it rested." This work was based on Descartes, French mathematician François Viète, and English mathematician John Wallis. Source: Westfall, jstor.org.
45. This was Newton's *De Analysi per Aequationes Infinitas* (On Analysis by Infinite Series), published in 1711. Source: Christianson, p. 122.
46. Newton also "performed experiments to measure gravity's pull." Source: Levenson, newyorker.com.

    As noted, the Great One also made breakthroughs in mechanics in the 1660's. He studied the principle of inertia of Descartes and derived what we now call the law of conservation of momentum (as did Huygens). He also investigated the dynamics of rotating motion. Source: Westfall, jstor.org.
47. Christie, "Annus Mythologicus," thonyc.wordpress.com.

    Newton's full statement: "*In the beginning of the year 1665 I found the Method of approximating series & the Rule for reducing any dignity of any Binomial into such a series. The same year in May I found the method of Tangets of Gregory & Slusius, & in November had the direct method of fluxions & the next year in January had the Theory of Colours & in May following I had entrance into ye inverse method of fluxions. And the same year I began to think of gravity extending to ye orb of the Moon & having found out how to estimate the force with wch [a] globe revolving within a sphere presses the surface of the sphere from Kepler's rule of the periodic times of the Planets being in sesquialterate proportion of their distances from the center of their Orbs, I deduced that the forces wch keep the Planets in their Orbs must [be] reciprocally as the squares of their distances from the centres about wch they revolve: & thereby compared the force requisite to keep the Moon in her Orb with the force of gravity at the surface of the earth, & found them answer pretty nearly. All this was in the two plague years of 1665–1666.*" Source: University Library Cambridge, Addendum Manuscript, Cambridge, England. 3968.41, f. 85^{r}. As cited in Christianson, pp. 73, 4.
48. Newton, Isaac. "A Letter of Mr. Isaac Newton … containing his New Theory about Light and Colors" *Philosophical Transactions of the Royal Society*, No 80 (19 Feb. 1671/2), pp. 3075–3087. Published online: Jan. 2003. http://www.newtonproject.ox.ac.uk/view/texts/normalized/NATP00006.
49. Christie, "Annus Mythologicus," thonyc.wordpress.com.

50. Christianson, p. 134.
51. Newton, Isaac. University Library Cambridge. Additional Manuscript, Cambridge, England. MS. 4002, p. 129. As cited in Christianson, p. 134. "For a detailed discussion and analysis of the experiment, see J. A. Lohne, "Experimentum Crucis," *Notes and Records of the Royal Society of London*, 23 (1968) 169–99."
52. Fowler, physics.virginia.edu.; *The Correspondece of Isaac Newton*. Eds. H. W. Turnbull, J. F. Scott, A. R. Hall, and Laura Tilling. 7 vols. Cambridge, England, 1959–77. 1:53–54. As cited in Christianson, p. 151.
53. Fara, royalsocietypublishing.org.
54. Hatch, "Sir Isaac Newton," ufl.edu.
55. Christianson, p. 172.
56. Ibid, p. 94.; Hatch, "Sir Isaac Newton," ufl.edu.
57. Fara, royalsocietypublishing.org.

    Under Newton's guidance, J.T. Desaguliers of the Royal Society repeated several of his optical experiments in 1715 to "a distinguished company of French savants." The first truly independent experiments were conducted by "Sebastein Tuchet, a Carmelite brother and honorary member of the Académie Royale" in 1721. Source: Christianson, p. 559.
58. Wilson, Raymond N. *Reflecting Telescope Optics: Basic Design Theory and Its Historical Development* (Berlin: Springer, 2004); Fara, royalsocietypublishing.org.

    Christie writes: "Although the theory that a curved mirror can focus an image was already known to Hero of Alexandria in antiquity and also discussed by Leonardo in his unpublished writings; as far as we know, the first person to attempt to construct a reflecting telescope was the Italian Jesuit Niccolò Zucchi . . . He was very disappointed with the result as the image was just a blur . . . Zucchi had stumbled on a problem that was to bedevil all the early attempts to construct a reflecting telescope. Mirrors that don't distort the image are much harder to grind and polish than lenses. . . The first to solve this problem was Isaac Newton, proving that he was as skilled a craftsman as he was a great thinker. Source: Christie, "The Jesuit Mirror Man" thonyc.wordpress.com.
59. Fowler, physics.virginia.edu.; "Isaac Newton," gap-system.org.

    Scientists did not yet know of the coupling of lenses of different glass materials (thus different refractive indices) to minimize chromatic aberration.
60. Christianson, p. 147.
61. Soffar, Heba. "What are advantages & disadvantages of Refracting Telescopes?" online-sciences.com. April 6, 2019. https://www.online-sci-

ences.com/technology/what-is-advantages-and-disadvantages-of-refracting-telescopes/.

62. Fara, royalsocietypublishing.org.
63. Christianson, pp. 145, 152.; Fara, royalsocietypublishing.org.
64. Christianson, p. 152.
65. "Isaac Newton," gap-system.org.
66. When Newton declared "his intention to resign from the Royal Society, Henry Oldenburg (c. 1619–1677), secretary of the Royal Society, offered to waive Newton's membership fees if he would stay. Newton stayed but had little or nothing more to do with the society till after Hooke's death in 1703." Source: Christie, Thony. "The emergence of modern astronomy — a complex mosaic: Part XXXIX," thonyc.wordpress.com.
67. "Isaac Newton," gap-system.org.; Newton, Isaac. *Opticks* (1704).
68. Christianson, p. 445.; Hall, newton.ac.uk. Hall writes: "The book was still imperfect: the colours of diffraction defeated Newton."
69. "Opticks, Isaac Newton's Theory of Light and Color . . ." historyofinformation.com. https://www.historyofinformation.com/detail.php?id=1724. Retrieved Jan 23, 2021. Newton wrote his two mathematical treatises "to establish his priority over Gottfried Wilhelm Leibniz in the invention of the calculus."

    "Other earlier work in mathematics began to appear in print, including a work on algebra, "Arithmetica Universalis" in 1707 and "De Analysi" and a tract on finite differences, "Methodis differentialis" in 1711." Source: "Isaac Newton," plato.standford.edu.

    "In an effort to give calculus a more rigorous explication and framework, Newton compiled in 1671 the *Methodus Fluxionum et Serierum Infinitarum.*" It was not published until 1736, nine years after his death in 1727. Source: Eves, Howard. *An introduction to the history of mathematics, 6th ed.)* (Independence, KY: Cengage Learning, 1990) p. 400.
70. Smith, William *et al*. "Isaac Newton: Math and Calculus," storyofmathematics.com. https://www.storyofmathematics.com/17th_newton.html. Retrieved Jan 23, 2020.
71. Review of draft chapter by Paul Heckert, Professor Emeritus of Physics and Astronomy at Western Carolina University, June 5, 2021.
72. Christianson, p. 82.
73. Brody & Brody, p. 42.
74. Brody & Brody, p. 46.
75. Hatch, "Sir Isaac Newton," ufl.edu.
76. Christianson, p. 80.
77. "Isaac Newton," gap-system.org.

78. Newton's estimate for the size of the Earth was also incorrect. According to physician Henry Pemberton, editor of Newton's Third edition of the *Principia*, "(Newton) took the common estimate . . . that 60 English miles were contained in one degree of latitude on the surface of the earth. But . . . each degree containing about 69½ of our miles . . ." Some twenty years later, the measurements of French astronomer Jean-Félix Picard provided an accurate measure for the size of the Earth. Source: Christianson, pp. 78–79, 294.
79. As cited in Christie, "The emergence of modern astronomy — a complex mosaic: Part XXXIX," thonyc.wordpress.com.
80. Egdall, p. 193.
81. Christie, "The emergence of modern astronomy — a complex mosaic: Part XXXIX," thonyc.wordpress.com.; Hatch, "Sir Isaac Newton" ufl.edu.

    Hooke realized that "the shape of a planet's orbit is determined by an attractive force from the sun varying with the distance," but lacked the skill to prove this mathematically. In a letter to Newton in January 1680, he wrote ". . . my supposition is that the Attraction always is in a duplicate proportion to the Distance from the Center Reciprocall to the Distance." Hooke later cited this letter as "proof that credit for setting forth the inverse square law defining planetary motion was due him as well." Source: Christianson, pp. 272–3.
82. Hatch, "Sir Isaac Newton," ufl.edu.; Fowler, physics.virginia.edu.; Christianson, pbs.org.
83. Christianson, p. 84.
84. Fowler, physics.virginia.edu.; Hatch, "Sir Isaac Newton," ufl.edu.
85. Prentis *et al.*, ui.adsabs.harvard.edu.

    Christie points out that "Kepler's third law being strictly empirical should have been immediately accepted and should have settled the discussion once and for all because it only works in a heliocentric system . . . it was Isaac Newton who first recognized its true significance as the major game changer." Christie, Thony. "The emergence of modern astronomy — a complex mosaic: Part XXXVI," thonyc.wordpress.com.
86. Prentis *et al.*, ui.adsabs.harvard.edu.
87. "Isaac Newton solved these problems in his *Mathematical Principles of Natural Philosophy*, published in 1687. Newton's Recipe is based on a hidden gem in Newton's *Principia* — the 'PQRST Formula,' which is a simple geometric version of $F = ma$. Given *any* kind of orbital curve (elliptical, spiral, etc.), this formula allows one to deduce the force simply by measuring the lengths of three line segments — the "shape parameters" of the orbit." Source: Prentis *et al.*, ui.adsabs.harvard.edu. See chart below.

Orbit Shape:	Location of "Sun":	Force Law:
Circle	Circumference	$1/r^5$
Spiral	Pole	$1/r^3$
Ellipse	Center	r
Ellipse	Focus	$1/r^2$

88. Newton discovered that "a body moves in a conic section, sweeping out equal areas in equal times about a focus, if and only if the motion is governed by an inverse-square centripetal force directed toward this focus." Source: Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
89. "Enlightenment: Newton," britannica.com.; Heckert, *Understanding Kepler's Laws: An Astronomy 1010 Tutorial*, amazon.com.
90. Rosenblum, B. & Kuttner, F. *Quantum Enigma* (London, UK: Oxford Univ. Press, 2011-pbk.) p. 31.
91. Ohanian, p. 69.

Chapter 25

1. Isaac Newton's famous letter to Robert Hooke, February 5, 1675 (Historical Society of Pennsylvania) As cited in Popova, Maria. Brainpickings.org. https://www.brainpickings.org/2016/02/16/newton-standing-on-the-shoulders-of-giants/. Retrieved May 11, 2020.
2. Egdall, p. 223.
3. Christianson, pp. 223, 304.
4. Hatch. "Newton Timeline," ufl.edu.
5. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
6. "Isaac Newton," gap-system.org.
7. Williams, E. Neville. *The Eighteenth-Century Constitution. 1688–1815*. (Cambridge, UK: Cambridge University Press, 1960) p. 26.
8. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
9. Christianson, pp. 313–314.
10. Christianson, p. 285.
11. To his friend the reverend Dr. Derham. Source: Christianson, p. 290.

[The *Principia*] abounds in contradictions and inconsistencies . . . and gaps in logic where Newton simply guessed what he could not prove." Some of the errors appear to have been "deliberate attempts to mislead." Source: Ohanian, p. 70.

12. Changes in the second edition of the *Principia* (1713) included the results of improved "vertical-fall experiments to measure resistance forces versus velocity" along with a "forcefully stated rejection of all vortex theories"; a major upgrade to "the treatment of the variation of surface gravity with latitude" based on new data "from near the Equator"; a revised "treatment of the wobble of the Earth producing the precession of the equinoxes to accommodate a much reduced gravitational force of the Moon on the Earth"; and "several further examples of comets" reflecting Halley's latest work. The third edition (1726) presented additional "refinements and new data," including "the variation of surface gravity with latitude, where Newton now concluded . . . the Earth has a uniform density." Source: Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
13. Fowler, physics.virginia.edu.
14. Christianson, pp. 281–3.
15. Hatch, "Sir Isaac Newton" ufl.edu.; Christie, "The man who inverted and squared gravity," thonyc.wordpress.com..
16. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
17. While in college at Cambridge, Newton "read classical Greek mathematics: Euclid, Archimedes and Apollonius. He became convinced that this ancient geometrical approach was more appropriate for describing the physical world." Source: "Isaac Newton: Development of Calculus and Recalculation of ϖ," math.hawaii.edu. http://math.hawaii.edu/~mchyba/documents/syllabus/Math499/Calculus/MI314_08_Newton.pdf. Retrieved Jan 24, 2021.
18. Whiteside, D. T. "The mathematical principles underlying Newton's *Principia Mathematica*," Journal for the History of Astronomy, vol.1 (1970), 116–138, especially p.120.; Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.Smith tells us Newton's approach involved the "use of mathematical theory to cover a full range of alternative theoretical possibilities, enabling the empirical world to select among them — not just to derive testable conclusions from hypotheses, as Galileo and Huygens had done." Source: Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
19. en: wikipedia.

20. Motte's translation of 1729 (at 3rd page of Author's Preface); See also Herivel, J. W. *The background to Newton's "Principia."* (Oxford, UK: Oxford University Press, 1965.
21. Egdall, p. 21.
22. Slowik, plato.stanford.edu.
23. Hecht, aapt.scitation.org.

    "Aristotle believed that things only moved when something moved them," Thony Christie writes, "people pushing things, draught animals pulling things. As soon as the pushing or pulling ceased so did the motion . . . when a stone left the throwers hand or the arrow the bowstring, they should automatically fall to the ground but of course they don't." Aristotle's muddled theory said "that the projectile parted the air through which it travelled, which moved round behind the projectile and pushed it further."
24. Egdall, p. 21; Needham, Joseph with Ling, Wang. *Science and Civilization in China*, Vol. II. *History of Scientific Thought* (Cambridge University Press, 1956).
25. Egdall, p. 21; Salam, Abdus. "Islam and Science -Concordance or Conflict" speech at UNESCO House, Paris, 1984. In Lai. C. H. *Ideals and Realities: Selected Essays of Abdus Salam*, 2nd ed. (Singapore: World Scientific, 1987), pp. 179–213.

    Medieval French "thinker" John Buridan also wrote on inertia (and momentum) in the 1300's. Some science historians propose Buridan's writings influenced 17th century scientists. Source: Graney, Christopher M. "Mass, Speed, Direction: John Buridan's 14th Century Concept of Momentum," *Phys. Teach.* **41** (Oct. 2013) 411.
26. "Galileo sort of got halfway there" on Inertia, Christie writes, "Still under the influence of the Platonic axioms, with their uniform circular motion, he argued that a homogenous sphere turning around its centre of gravity at the earth's surface forever were there no friction at its bearings or against the air. Because of this, Galileo is often credited with provided the theory of inertia as later expounded by Newton but this is false.

    "The Dutch scholar Isaac Beeckman (1588–1637) developed the concept of *rectilinear* inertia, as later used by Newton but also believed (falsely), like Galileo, in the conservation of constant circular velocity. For a time he was Descartes teacher . . . Descartes learnt the principle of inertia from Beeckman and it was . . . [Descartes'] writings that were Newton's source." Source: Christie, "The emergence of modern astronomy — a complex mosaic: Part XXIX," thonyc.wordpress.com.
27. Heckert, "Understanding Newton's Laws" Ch. 2, amazon.com.

As noted, Johannes Kepler was the first to define the physical concept of "mass" as the quantity of matter in a body. Newton adopted this definition in the *Principia*, Source: Hecht, aapt.scitation.org.

Newton also defined "quantity of motion" — what we now call "momentum" — as a body's mass times its velocity. From change in momentum of a body, he then introduces the concept of forces. Source: Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.

28. Christianson, p. 293.; "Action = Reaction," weebly.com. https://clarkscience8.weebly.com/action--reaction.html.

    Newton also examined centripetal force in the *Principia*. Kepler lacked Newton's understanding of centrifugal force . . . as well as a complete understanding of the law of inertia — as Kepler's *Astronomia Nova* of 1609 shows . . . because of his lack of an action/reaction law, Kepler did not realize that gravity involves "two forces in an interacting pair always equal in magnitude and opposite in direction." Source: Hecht, aapt.scitation.org.
29. Newton's second law "represented a fresh way of thinking about motion. The third was "well supported by recent work on collisions by Dutch mathematician Christiaan Huygens and others." Source: "Enlightenment: Newton," britannica.com.
30. Heckert, "Understanding Newton's Laws" Ch.4, amazon.com.
31. Newton, Isaac. "General Scholium." Essay appended to the *Principia*. As cited in Snobelen, newtonprojectca.files.wordpress.com.
32. Aiton, Eric J. "The Cartesian vortex theory," chapter 11 in *Planetary astronomy from the Renaissance to the rise of astrophysics, Part A: Tycho Brahe to Newton*, eds. R Taton & C Wilson, (Cambridge, UK: Cambridge Univ. Press, 1989) pp. 207–221. As cited in en: wikipedia.
33. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
34. Descartes had proposed that interplanetary space was filled with invisible "whirling *fluid* vortices." These whirlpools "carried the planets along with them," reminiscent of Aristotle's celestial spheres. Here Descartes envisioned large circling bands of minute material particles which circle the Sun. Somehow they form a series of "separate, interlocking vortices" — each of which orbit the Sun at various speeds. Each planet, including the Earth, is lodged within a particular vortex. Sources: Aiton, Eric J. *The Cartesian vortex theory*, chapter 11 in *Planetary astronomy from the Renaissance to the rise of astrophysics, Part A: Tycho Brahe to Newton*, eds. R Taton & C

Wilson, Cambridge (Cambridge, UK: Cambridge University press, 1989) pp. 207–221.; Slowik, plato.stanford.edu.

35. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
36. For example, Smith points out, Newton's "analysis of the vortex generated around a rotating cylinder or sphere involves fundamentally wrong physics. It defines steady state in terms of a balance of forces instead of torques across each shell element comprising the vortex." Source: Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
37. Newton had initially composed his book "in a popular method, that it might be read by many." Then, to "prevent the disputes" by readers who could not "lay aside the[ir] prejudices" he "reduced" it "into the form of propositions (in the mathematical way) which should be read by those only, who had first made themselves masters of the principles established in the preceding books." Source: Newton, Sir Isaac (1729). "Introduction to Book 3" *The Mathematical Principles of Natural Philosophy*, Volume II. (1729) p. 200. This "simpler" version can be read in English as *A Treatise of the System of the World.*
38. Book III is presented in four parts: "1) derivation of the law of gravity; 2) implications of the law of orbital and rotating bodies; 3) quantitative derivation of select linear inequalities and precession of the equinox from the law of gravity; and 4) a solution for comet trajectories." Source: Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
39. Greene, *The Elegant Universe*, p. 61.
40. Newton, Isaac, *Principia,* Book III. As cited in Hatch, "Sir Isaac Newton," ufl.edu.
41. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
42. Jenkins, forbes.com/quora.; Newton, Isaac. *The principia: mathematical principles of natural philosophy.* [S.l.]: (Plano, TX: Snowball Pub., 2010) p. 10.

    Newton first proposed centripetal force in the 1684 *De Motu Corporum.* Source: Christianson, p. 293.
43. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
44. As cited in Christie, "What Isaac actually asked the apple," thonyc.wordpress.com.
45. Fowler, physics.virginia.edu.

46. This circular orbit is a bit of a simplification here. Newton worked out the dynamics of gravity for *elliptical* orbits, taking into account the Conservation of Energy and the Conservation of Angular Momentum. An excellent detailed lay explanation of Newton's (and Einstein's) description of planetary motion is given by John Archibald Wheeler in *A Journey into Gravity and Spacetime,* pp. 168–179.
47. Brody & Brody, p. 42.
48. Christianson, p. 294.
49. "Isaac Newton," gap-system.org. In his writings, Kepler had also spoken of "the possibility of an inverse-square force acting on a planet." But he still held the Aristotelian view that an object in uniform (rectilinear) motion needs a force to sustain that motion. Source: Wheeler, *A Journey into Gravity and Spacetime,* p. 178.
50. Greene, Brian. "Light Falls" pbs.org. https://www.pbs.org/wnet/light-falls/.
51. Hatch, "Sir Isaac Newton" ufl.edu.
52. Alexander, Amir. Review of *The Universe Speaks in Numbers* by Graham Farmelo. Wall Street Journal, June 8–9, 2019.
53. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
54. Christianson, pp. 291–92.
55. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.; Newton, Sir Isaac. "Proposition 12, Corollary." *The Mathematical Principles of Natural Philosophy*, Volume II. (1729) p. 233.
56. Christianson, p. 296.
57. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
58. *Unpublished Scientific Papers of Isaac Newton,* eds. A. R. Hall and M. B. Hall, (Cambridge, UK: Cambridge University Press, 1962.) "Contains several manuscripts associated with the *Principia*.)" As cited in Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
59. "Enlightenment: Newton." britannica.com.
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61. Newton, Isaac. *Principia,* Book 2 (known as the 'Copernican scholium). As cited in Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.

62. Choi, Charles Q. "Strange but True: Earth Is Not Round" scientificamerican,com. April12, 2007. https://www.scientificamerican.com/article/earth-is-not-round/.

    "As Newton was fully aware, and Huygens and a few others realized, these are the only results in the *Principia* that depend on universal gravity — that is, inverse-square gravity directed toward every particle of matter forming the Earth." Source: Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.
63. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu. Newton could not establish the mass of the Moon — and thus its gravitational force on Earth — the way he did for the Sun, Jupiter, and Saturn; as the Moon had no bodies orbiting it. Newton estimated the Moon's force as 6 and 1/3 times the Sun's force from the "difference in heights of the tides when the Sun and Moon are in conjunction and opposition." From this he arrived at a "value for the rate of precession" which "was in good agreement with the known value." He reported this in the first edition of *Principia*. In the second edition, he revised the Moon's force to 4.4815 that of the Sun's. This was still "a factor of two greater than the correct value."
64. Hecht, aapt.scitation.org.
65. Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu. Newton "ignored the rotation of the Earth, and worse he considered only the radial component of solar and lunar gravitational forces" in his tidal analysis. The trans-radial component (perpendicular to the radial component) has a much greater effect on Earth's tides." Newton's tidal analysis was later rectified by Laplace in his 1770's "mathematical theory of tidal motion."
66. Christianson, p. 369.
67. This so-called "three-body problem" is also an issue in modeling the behavior of Saturn, which is influenced by the Sun and nearby and very massive Jupiter.
68. The three lunar inequalities are called: 1) Axial Precession — the precession of the spinning Moon's axis over time; 2) Inclination Changes — the tilting back and forth of the plane of the Moon's orbit. Also called the recession of the nodes; and 3) Variation — the systematic departure of from Kepler's area rule; Newton's mathematical treatment of the three lunar inequalities introduced the idea of successive approximations to attack "the problem of the true lunar orbit, an entirely new approach." This "perturbational approach" would "dominate all of celestial mechanics from the middle of the eighteenth century until late in the twentieth . . . Computers now allow the orbital

motions to be computed by means of numerical integration of the equations of motion." Source: Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu.

69. Wepster, Ch.2 "The Quest for Lunar Theory." pp. 9–10.
70. Ibid.; Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu. Smith writes, "A careful reading of the *Principia* makes clear that, although unforthcoming about any of the loose ends, Newton was perfectly aware of them all, in one way or another flagging each for the benefit of the highly astute reader." For a comprehensive discussion of loose ends in Newton's *Principia*, please see George Smith's excellent treatise: Smith, George, "Newton's Philosophiae Naturalis Principia Mathematica," plato.stanford.edu. *Principia* quote: Scholium to Prop. 35, Book 3.
71. Christianson, pp. 286-7.
72. *Dictionary of National Biography* Ed. Leslie Stephen, Vol XIX, Finch-Forman (New York: Macmillian and London: Smith, Elder, 1889) p. 244. (Palo Alto Library) John Flamsteed (1646-1719) was appointed England's first Astronomer Royal in 1675. In some forty years of meticulous observations at the new Royal Observatory at Greenwich, Flamsteed tracked nearly 3000 stars to unprecedented accuracy. His observations tripled the entries in Tycho Brahe's star catalogue. He was first to sight the planet Uranus, though he mistook it for a star. Source: Christianson, p. 366.
73. Galloway, newtonproject.sussex.ac.uk.; Silverman, Mark P. Review in the American Journal of Physics of: Clark, David H. and Clark, Stephen P. H. *Newton's Tyranny: The Suppressed Scientific Discoveries of Stephen Gray and John Flamsteed* (New York: W. H. Freeman and Company, 2001) http://www.trincoll.edu/~silverma/reviews_commentary/newtons_tyranny.html.
74. O'Connor & Robertson, "Flamsteed v Newton," st-andrews.ac.uk.; Christianson, pp. 451, 484, 487; Galloway, newtonproject.sussex.ac.uk.

    Newton's disturbing personal traits were generally unknown to the public well into the 1800's. It was an 1835 memoir by astronomer Francis Baily based on the Flamsteed's correspondence and private papers which first revealed Newton's nature. Sources: Galloway, newtonproject.sussex.ac.uk.; "The day that Francis died: Taking Isaac down a peg or two," thonyc.wordpress.com.
75. Sobel, Dava. Longitude: *The True Story of a Lone Genius Who Solved the Greattest Scientific Problem of His Time*. (New York: Walker, 1995)

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greater accuracy than any prior work." Source: Ridpath, Ian. "Flamsteed numbers — where they really came from". Ian Ridpath's Star Tales. Ianridpath.com. http://www.ianridpath.com/startales/flamsteed.htm. Retrieved 8 January 2012.

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78. Ibid. Smith tells us Newton employed a novel finite-difference method to fit a parabola interactively to comet trajectory data. Results showed that his inverse-square law of gravitational attraction also applies to comets. Newton also pointed out that comet trajectories could be ellipses, as a "parabola approximates the high-curvature end of ellipses with high eccentricity." Newton later wrote a detailed dissertation on his finite-difference methods in his "Methodis Differentialis.".
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Chapter 26

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Chapter 27

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    Written for a lay audience, *Exposition* contained five books: "(1) The apparent motion of celestial bodies; (2) the actual motion of celestial bodies; (3) force and momentum; (4) Newton's theory of universal gravitation along with the motion of the seas and shape of the Earth; and 5) A history of

astronomy, including his nebular hypothesis . . ." O'Connor & Robertson, "Pierre-Simon Laplace," st.-and.ac.uk.; Rouse Ball (1908).

11. The extraordinary accomplishments of Pierre-Simon Laplace:

    Mathematics — He pioneered developments in differential equations, probability theory, error theory, the least squares method, statistics, the general central limit theory, binomial distribution (as did Abraham de Moivre), the general theory of determinants, and triangulation methods for surveying, and geodesy. A number of mathematical methods are named after him, including the Laplace equation, the Laplace transform, and the Laplacian differential operator. Source: informationphilospher.com

    Physics — Laplace is famous for his work in classical mechanics, mechanical physics, and caloric heart theory and kinetic theory of molecular motion with chemist Antoine Lavoisier. Together they also invented the ice calorimeter. Laplace also made major advances in atmospheric refraction, the motion of solids and liquids, elastic fluids, the theory of capillary attraction, pressure and density, barometric pressure, forces acting between molecules, and double refraction. He advanced and corrected Newton's work on the shape of the Earth, the motion of the seas, and the velocity of sound. Sources: Stetson, Eric. "Laplace" Stetson University, Stetson.edu. https://www2.stetson.edu/~efriedma/periodictable/html/La.html.; O'Connor & Robertson, "Pierre-Simon Laplace" st.-and.ac.uk.; Whitrow, britannica.com.

    Astronomy — The great French polymath determined the masses of gas giants Jupiter, Saturn, and Uranus for the first time. He made pivotal advances in physical and mathematical astronomy, the transmission of gravity, celestial mechanics, gravitational potential, and the nebular hypothesis of the origin of the solar system. He performed early conceptual work on gravitational collapse and the possible existence of what we now call black holes. Laplace was also among those who verified William Hershel's "comet" was in fact a planet.

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    "The first Consul . . . addressed himself to Mr Laplace . . . and held a considerable argument with him in which he differed from that eminent mathematician. The difference was occasioned by an exclamation of the first Consul, who asked in a tone of exclamation or admiration (when we were speaking of the extent of the sidereal heavens): 'And who is the author of all this!' Mons. De la Place wished to shew that a chain of natural causes would

account for the construction and preservation of the wonderful system. This the first Consul rather opposed . . ."

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"*We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.* Source: Laplace, Pierre Simon. *A Philosophical Essay*, (New York: Wiley, London: Chapman & Hall, 1902) p. 4.
30. "Pierre-Simon, Marquis de Laplace," informationphilosopher.com.

    Laplace's view on determinism "is very similar to the one proposed by [Italian mathematician, physicist, and astronomer Roger Joseph] Boscovich as early as 1763 in his book *Theoria philosophiae naturalis*." Source: Cercignani, Carlo. *Ludwig Boltzmann, The Man Who Trusted Atoms*. Chapter 2: "Physics before Boltzmann." (Oxford, UK: Oxford Univ. Press, 1998)
31. Levenson, p. 26.
32. "Pierre-Simon, Marquis de Laplace," informationphilosopher.com.
33. Hahn, pp. 202, 233.
34. Ibid, p. 202. As Poisson later told Maurice.
35. "Extracts from Lectures delivered by Karl Pearson," *Biometrika*, vol. 21, Dec. 1929, pp. 202–216.
36. Janiak, plato.standford.edu.
37. Casper, Max. *Kepler*, trans. Hellman C Doris. (New York: Dover, 1993). As cited in en:wikipedia.
38. Mullaney, p. 3.
39. Oliveira, bbvaopenmind.com.; Mullaney, p. 3.; Christie, "The Jesuit Mirror Man," thonyc.wordpress.com.
40. Levenson, newyorker.com.; Mullaney, p. 4.
41. Sanford, R. F. "The Planet Uranus" Astronomical Society of the Pacific Leaflets, (May 1944) Vol. 4, No. 183, p. 254, 5.
42. Uranus" spaceplace.nasa.gov. May 8, 2015. https://spaceplace.nasa.gov/uranus/en/. Retrieved April 26, 2020.
43. Levenson, p. 14.; Tietz, scihi.org.; Oliveira, bbvaopenmind.com.

    Laplace had begun a detailed investigation of Uranus's motion two years after its discovery. He noted that his initial calculations of its "orbital

elements needed considerable refinement." Science historians are not sure who was first to determine that Hershel's "comet" was actually a planet.

44. Sachs, Abraham J. (2 May 1974). "Babylonian Observational Astronomy". *Philosophical Transactions of the Royal Society of London*. Royal Society of London. **276** (1257): 43–50 [45 & 48–9].
45. Tietz, scihi.org; Redd, "How Far is Uranus?" space.com. Herschel had proposed the new object be named "Georgium Sidus, the Georgian Star, after England's King George III. The flattery worked. Herschel was soon rewarded with an annual pension, which allowed him to give up teaching music and to devote himself almost completely to astronomy. Continental astronomers refused to accept Herschel's proposed name. In 1783 German astronomer Johann Elert Bode proposed Uranus, the name that eventually stuck." Source: "Enlightenment: Herschel." britannica.com.
46. Leverington, p. 151.
47. "William Herschel," britannica.com. Herschel accomplishments: He "cast, ground, and polished over 400 telescopes with mirrors from 6 to 48 inches in diameter." He cconstructed the largest telescope to that date, a 40-foot reflecting telescope with a 1.26 m (49½ inch) diameter primary mirror. He deduced the existence of infrared (IR) radiation. He was first to discover binary star systems. He "pioneered use of astronomical spectrophotometry" and discovered the two moons of Uranus and two of Saturn. His study of double stars proved "they are binary systems and not mere line-of-sight associations." His observations of Mars polar regions revealed that the planet has seasons. He coined the term "asteroid" for "large bodies observed in 1801." "He revealed, for example, that our galaxy is discoid and that the solar system is in constant motion." Herschel's "catalogue of 2500 celestial objects still in use today. Sources: Maurer, A.; Forbes, E. G. (1971). "William Herschel's Astronomical Telescopes". *Journal of the British Astronomical Association*. **81**: 284–291.; Roberts, Jacob (2017). "A Giant of Astronomy" Distillations. **3** (3): 6–11.; Redd, Nola Taylor.; "Herschel discovers infrared light" Cool Cosmos. Archived from the original on 25 February 2012. http://coolcosmos.ipac.caltech.edu/cosmic_classroom/classroom_activities/herschel_bio.html.; Tietz, scihi.org; Oliveira, bbvaopenmind.com.; "William Herschel, British-German Astronomer," britannica.com; Redd, "William Herschel Biography," space.com.
48. Redd, "How Far is Uranus?" space.com.
49. https://hubblesite.org/contents/news-releases/2005/news-2005-33.html; Williams, David R. "Planetary Fact Sheet — Ratio to Earth Values" gsfc.nasa.gov.

    https://nssdc.gsfc.nasa.gov/planetary/factsheet/planet_table_ratio.html.

Scientists "theorized that during the formation of the Solar System, an Earth-sized protoplanet collided with Uranus and tilted it onto its side." Source: *Universe Today*, universetoday.com. https://www.universetoday.com/19095/how-long-is-a-year-on-uranus/.

50. Levenson p. 33.; "Uranus facts for kids," Kids.kiddle.co. Mar. 1, 2020, https://kids.kiddle.co/Uranus Retrieved April 17, 2020.; Hayhurst, Chris. *Neptune* (New York: Rosen, 2005) Ch. 1.; Leverington, p. 166.; O'Connor & Robertson, "Alexis Bouvard," st-andrews.ac.uk.; Rines, jmconway.org.
51. Leverington, p. 166.; Rines, jmconway.org.: Krajnović, arxiv.org.

    Bouvard had access to data from a series of post-discovery observations from the observatories in Paris and Greenwich. Jean-Baptiste-Joseph Delambre had won the Grand Prix of the Académie des Sciences in 1789 for his estimate of the orbit of Uranus. It was not very accurate as it was based on limited observational data for the new planet.
52. Rines, jmconway.org.; Krajnović, arxiv.org.; Leverington, p. 152.

    Astronomers who had seen Uranus before Herschel include John Flamsteed, Tobias Mayer, James Bradley, Pierre Le Monnier, and J.J. Lalande. Sources: Rines; Krajnović; Leverington.

    The planet Uranus is visible to the naked eye (in ideal conditions). So why had no one discovered that it was a planet? Recall that an object appears to move slowly across our line of sight the further away it is. Uranus is 1.6 to nearly 2 billion miles (2.6 to 3.2 km) from Earth. Because the Sun's gravity is so weak that far out, it moves at a relatively slow speed. Due to this and its great distance from us, it appears to move very slowly across the sky. Thus no one noticed its movement against the "fixed stars." Those who spotted it thought it was a star.

    Uranus moves at 15,290 miles per hour (26,607 km/hr) with respect to the relative to the Sun — some four times slower than the Earth.
53. Krajnović, arxiv.org.; Rines, jmconway.org.; Miner, britannica.com.
54. Ibid; Krajnović, arxiv.org.; O'Connor & Robertson, "Alexis Bouvard," st-andrews.ac.uk.
55. Leverington, p.167.
56. Ibid.

    In his 2016 paper on the Uranus issue, astronomer Davor Krajnović explains: "The discrepancy between the predicted and observed position [of Uranus] was increasing towards the turn of the century [into the 1800's], just to stabilize and then start decreasing in the 1820s, almost disappear around 1830 and then to suddenly become larger than ever before by 1840s." Source: Krajnović, arxiv.org.

57. "Biography: Urbain Le Verrier," wonder-of-the-world.net.; O'Connor & Robertson, "Urbain Jean Joseph Le Verrier," st-and.ac.uk.; Müller, "Urbain-Jean-Joseph Le Verrier," newadvent.org.
58. Levenson, p. 63.
59. Rines, jmconway.org.
60. Sept. 25, 1877. Quoted in Lequeux, James. *Le Verrier — Magnificent and Detestable Astronomer* (New York: Springer, 2013) p 5. As cited in Levenson, p. 30
61. "Biography: Urbain Le Verrier," wonder-of-the-world.net.; Müller, "Urbain-Jean-Joseph Le Verrier," newadvent.org.
62. Levenson, p. 35.
63. Ibid, p. 36.
64. Rines, jmconway.org.
65. Levenson, p. 36.; O'Connor & Robertson, "Alexis Bouvard," st-andrews.ac.uk.
66. Levenson, p. 36.; Krajnović, arxiv.org.
67. Ibid, p. 37.
68. Levenson, p. 38. To estimate the distance from the Sun to the hypothetical planet, Le Verrier invoked Bode's Law, an empirical rule of thumb. Sources: Rines, jmconway.org.

    The mean distance of Uranus, at 19.2 AU, was noted to be very nearly equal to that predicted by Bode's law (19.6 AU). But Neptune would be at a distance of *38.8 AU* according to Bode's law. In actuality, it is only *30.1 AU* from the Sun." Source: Miner, britannica.com.
69. Levenson, p. 38.
70. Krajnović, arxiv.org.; Rines, jmconway.org.
71. Levenson, p. 38.
72. "The Illustrated London Almanac for 1847" p. 55.

    https://www.google.com/books/edition/the_illustrated_london_almanack_1847/1i8OAAAAQAAJ?hl=en&gbpv=1&dq=Le+Verrier+5+degrees+east+of+the+star+delta+Capricorn&pg=PA55&printsec=frontcover. Retrieved May 3, 2020.
73. Levenson, p. 39.
74. Ibid, pp. 39–40.

    Le Verrier wrote "in acknowledgement of receipt of a scientific paper" from Galle." In it, Le Verrier "urged him to search "for the hypothetical planet. Source: Rines, jmconway.org.
75. Krajnović, arxiv.org.
76. Ibid.
77. Ibid.

78. Ibid; Rines, jmconway.org.

    Bremiker had "painstakingly constructed this detailed star map to aid in the search for new asteroids." Source: Miner, britannica.com.
79. Levenson, pp. 40–41.
80. Krajnović, arxiv.org.; en.wikipedia.

    As noted Le Verrier's prediction of the new planet's *distance* was off by a lot. This was somewhat mitigated in the search because it was quite close to conjunction with Uranus in 1846. This reduced the error in its predicted location. Source: Levenson, p. 42.
81. Ibid, p. 41.
82. O'Connor & Robertson, "Urbain Jean Joseph Le Verrier," st-and.ac.uk.
83. https://earthsky.org/human-world/today-in-science-discovery-of-neptune.
84. Levenson, p. 42. Alexis Bouvard passed away three years before the discovery of Neptune. Source: O'Connor & Robertson, "Alexis Bouvard," st-andrews.ac.uk.
85. Levenson, p. 50.
86. Ibid, p. 53.
87. Krajnović, arxiv.org.
88. https://nssdc.gsfc.nasa.gov/planetary/factsheet/planet_table_ratio.html. "Neptune and Uranus are in near 1:2 resonance (less than 2% deviation), so the orbital periods introduce an important beat effect . . . as demonstrated by Lai *et al*., the phases of the two dominant terms are such that they nearly cancelled each other out in the early 1800s." Source: Krajnović, arxiv.org.

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https://www.scientificamerican.com/article/the-case-of-the-pilfered/. Retrieved Jan 20, 2011. As cited in en:wikipedia.
93. Levenson, p. 65.
94. Egdall, pp. 217–18.
95. Ibid, pp. 223.
96. Müller, "Urbain-Jean-Joseph Le Verrier," newadvent.org.
97. Ibid; Johnson, Liesi. "Make Your Point: Nunc Dimittis — definition" hilotutor.com. Accessed April 19, 2020. http://www.hilotutor.com/archives_nunc_dimittis.html.
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Chapter 28

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3. Desmond, brittanica.com.
4. Graves, Joseph L. *The Emperor's New Clothes: Biological Theories of Race at the Millennium.* (New Brunswick, NJ: Rutgers University Press, 2003) p. 57.
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13. Darwin. *The Autobiography of*, pp. 46–7, 57: Browne & Van Wyhe, darwin-on-line.org.
14. Ibid, p. 58.
15. Ibid, p. 62.
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17. "British History: Empire and Sea Power," bbc.co.uk. 2014. Retrieved Jan. 8, 2020. http://www.bbc.co.uk/history/british/timeline/empireseapower_timeline_noflash.shtml.
18. Ferris. p. 231.; Darwin. *The Autobiography of*, p. 50.; Darwin, *Charles Darwin and the voyage of the Beagle*; "Robert Fitzroy," britannica.com.; Browne, *Charles Darwin*, pp. 158–159.

    Early 19th century "marine chronometers were clocks suspended in gyroscopic boxes to help ships determine longitude." How does this work? There is "a direct relationship between time and longitude. At any instant in time, local solar time at a location varies by one hour for every 15 degrees change of longitude (360 degrees divided by 24 hours)." Before the voyage, the chronometer time would be set to a fixed reference — the time at Greenwich, England (zero longitude). This was then compared to local time at each place on the voyage to determine local longitude. Source: Pulvirent, Stephen. "And which one should you buy?" bloomberg.com. Aug. 19, 2015. https://www.bloomberg.com/news/articles/2015-08-19/what-is-a-chronometer-a-guide-to-these-top-notch-watches; "History of Longitude" en.wikipedia.org. Accessed Feb, 7, 2020. https://en.wikipedia.org/wiki/History_of_longitude.
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20. "Leonard Jenyns," darwinproject.ac.uk.

    Peacock had been asked through his friend, Francis Beauford, hydrographer for the British Admiralty. Peacock in turn asked the advice of John Steven Henslow in a letter of August 1831. Source: "George Peacock" Darwin Correspondence Project, darwinproject.ac.uk, https://www.darwinproject.ac.uk/george-peacock.
21. Darwin. *The Autobiography of*, p. 64.
22. Ibid, p. 60.
23. Browne, *Charles Darwin*, pp. 136–138.
24. "Leonard Jenyns," darwinproject.ac.uk.
25. Barlow, N. "Robert FitzRoy and Charles Darwin" *Cornhill Magazine (*April, 1932) 493–510. From Van Wyhe, John. Ed. Darwin Online, darwin-online.

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26. Darwin. *The Autobiography of*, p. 71.
27. Darwin's uncle Josiah Wedgwood was a Member of Parliament. His company was "responsible for the first bone china wares." Source: Wedgwood, Josiah C. (1908). *A History of the Wedgwood Family*. London: The St. Catherine Press, Ltd. pp. 188–191.
28. Darwin. *The Autobiography of*, Notes: Note Two, p. 227.
29. Ibid, pp. 228–9. "These were Dr. Robert Darwin's objections to the voyage, as reported to Uncle Josiah by Charles: (1) Disreputable to my character as a Clergyman hereafter; (2) A wild scheme; (3) That they must have offered to many others before me the place of Naturalist; 4) And from its not being accepted there must be some serious objection to the vessel or expedition; (5) That I should never settle down to a steady life hereafter; (6) That my accommodations would be most uncomfortable; (7) That you, that is, Dr. Darwin, should consider it as again changing my profession; (8) That it would be a useless undertaking." Source: Darwin. *The Autobiography of*, Notes: Note Two, p. 228.
30. Darwin, C. "Letter to W. D. Fox" July 9, 1831. DCP-LETT-101. Darwin Correspondence Project, darwinproject.ac.uk. Retrieved Feb. 6, 2020. https://www.darwinproject.ac.uk/letter/?docId=letters/DCP-LETT-101.xml;query=Darwin%20to%20Fox%209%20July%201831;brand=default.
31. Darwin. *The Autobiography of*, p. 76.
32. Ferris. p. 231.; Darwin. *The Autobiography of*, p. 50.; Darwin. *Charles Darwin's Beagle Diary*, Ed. Richard Keynes. pp. 4–17. Darwin's private diary is now accessible to all on the internet, likely to his great chagrin. The *Beagle* had attempted to leave from Barnett pool, Falmouth on December 10. The sea was so rough it was forced to turn back to Falmouth harbor.
33. Darwin. *The Autobiography of*, pp. 71, 77, 101.
34. "Charles Lyell: Principles of Geology," pbs.org. https://www.pbs.org/wgbh/evolution/library/02/4/l_024_01.html. Retrieved Aug 31, 2021.
35. Darwin. *Charles Darwin's Beagle Diary*, pp. 4–17.
36. Darwin, *Charles Darwin and the voyage of the Beagle*. vol. I, chapter VI: p. 266, letter to sister Susan Elizabeth Darwin (Aug 4, 1836)
37. "Darwin's Voyage," pol2e.com. Accessed Feb 27, 2020. http://digitalfirst.bfwpub.com/principles_of_life/act_1501_darwin_voyage.html.
38. Rookmaaker, darwin-online.org.uk.
39. Ferris, p. 232
40. Darwin, *Charles Darwin's Beagle Diary*. p. 59.

41. Here Darwin encountered Red Snow. "Subsequently I found under the microscope it consists of groups of minute red balls, the diameter of which is 1/1000th of an inch. He compared the "glorious view . . . the atmosphere resplendently clear, the sky an untense blue, the profound valleys . . . the bright colored rock . . . the quiet mountains of Snow" from the crest of mountain as to "hearing in the full Orchestra a Chorus of [Handel's] Messiah." (*Diary*, p. 293.)

    Darwin ascended Mount Wellington, 3100 ft high, "five-and-a-half hours of hard climbing to the summit . . ." In Cape Town, he climbed Table Mountain "to a height of 3500 feet." In Mauritius, he ascended Le Pouce, a mountain of 2600 feet. At Tahiti, he: scaled the "face of a naked rock" by "the aid of ropes . . . We continued to ascend sometimes by ledges & sometimes by knife edge ridges." Darwin. *Charles Darwin's Beagle Diary*, p. 293.
42. Darwin, C. 'Letter to Caroline Darwin," Apr 29, 1836. DCP-LETT-301. Darwin Correspondence Project, darwinproject.ac.uk. https://www.darwinproject.ac.uk/letter/DCP-LETT-301.xml.
43. Ferris, p. 232.
44. Darwin. *Charles Darwin's Beagle Diary*, p. 55.
45. Darwin, C. 'Letter to Caroline Darwin," Apr 29, 1836. DCP-LETT-301. Darwin Correspondence Project, darwinproject.ac.uk. https://www.darwinproject.ac.uk/letter/DCP-LETT-301.xml.
46. Darwin. *The Autobiography of*, p. 81.
47. Ibid. *The Autobiography of*, pp. 81–2. In a letter to FitzRoy, Darwin wrote: ". . . I do assure you I am a very great man at home — the five years voyage has certainly raised me a hundred per cent. I fear such greatness must experience a fall . . . your most sincere but unworthy Philos. Chas. Darwin." Source: Darwin, C. "Letter to Robert FitzRoy" Oct 6, 1836. DCP-LETT-310. darwinproject.ac.uk. https://www.darwinproject.ac.uk/letter/DCP-LETT-310.xml.
48. Darwin. *Charles Darwin's Beagle Diary.* Re: Divine services, see for example p. 30.
49. Ibid, pp. 425.
50. Von Tschudi, J. J. *Travels in Peru: On the Coast, in the Sierra, Across the Cordilleras and the Andes, Into Primeval Forests* (New York: Barnes & Co., 1854) Translated from the German by Thomasina Ross.
51. Darwin in his Diary: "Settlers . . . push further & further inland. — The thoughtless Aboriginal blinded by trifling advantages [e.g., borrowing English dogs and obtaining milk from English cows] is delighted at the approach of the White man; who seems predestined to inherit the country of

his children." Source: Darwin. *Charles Darwin's Beagle Diary, p.* 398–402.; Rachels, James. "Why Darwinians Should Support Equal Treatment for Other Great Apes," *The Great Ape Project: Equality Beyond Humanity* (1993), p. 152.

52. Ayala, "Evolution: History of evolutionary theory," britannica.com. "Christian theologians, from Aquinas on," Ayala writes "had argued that the presence of design, so evident in living beings, demonstrates the existence of a supreme Creator . . ."
53. Darwin, *The Red Notebook of Charles Darwin*. Sandra Herbert, Ed.
54. Ferris. p. 235.; Darwin, *The Essay of 1844*, p. 133.
55. Darwin later listed five key observations in his Autobiography: "(1) discovering in the Pampean formation great fossil animals covered with armour like that on the existing armadillos; (2) by the manner in which closely allied animals replace one another in proceeding southwards over the Continent; (3) by the South American character of most of the productions of the Galápagos archipelago, and more especially by the manner in which they differ slightly on each island; and (4) the innumerable cases in which organisms of every kind are beautifully adapted to their habits of life . . ." Source: Darwin. *The Autobiography of,* pp. 118, 119.
56. Dated March 1837. Source: Sample, Ian. "To understand a mockingbird: specimens that sparked Darwin's theory of evolution," theguardian.com. Nov 13, 2008. https://www.theguardian.com/science/2008/nov/14/evolution-charles-darwin.; Herbert, Sandra. ed. *The Red Notebook of Charles Darwin,* p. 24, Note 19.: From "Nora Barlow, ed., 'Darwin's Ornithological Notes', **Bulletin of the British Museum (Natural History)** Historical Series, vol. 2 (1963), p. 262.
57. Darwin, *The Red Notebook of Charles Darwin,* Herbert, Sandra. ed., pp. 15, 26.
58. As noted, Darwin had kept a series of private notebooks on the *Beagle* voyage to record his field observations. He began his Red Notebook in late May of 1836 while the *Beagle* headed from Mauritius to the Cape of Good Hope. On his return to England in October, Darwin continued to use the Red Notebook to record his thoughts on geology.

    Herbert writes: "Once filled, Notebook B gave way to Notebooks C, D, and E, and to at least one other notebook known only from fragments . . ." as well as "a new set of notebooks, labelled M and N, devoted in large part to the study of behavior . . . It is of course possible, even probable, that other notebooks from the post-*Beagle* period await discovery and reconstruction." Source: Herbert, Sandra. ed. *The Red Notebook of Charles Darwin,* p. 16.

59. "Famous entry of July 1837 in CD's 'Journal (Correspondence vol. 2, Appendix II, p. 431) http://darwin-online.org.uk/EditorialIntroductions/van-Wyhe_JournalDAR158.html.
60. Nicholls, Henry. "Darwin's London" Feb 12, 2008. blog.nature.com. http://blogs.nature.com/london/2008/02/12/darwin-s-london#:~:text=On%204%20January%201837%2C%20Darwin,group%2C%20containing%2012%20species.%E2%80%9D.
61. Herbert, Sandra. ed. *The Red Notebook of Charles Darwin,* p. 6. (RNB p. 129) and p. 155, note 155.

    Herbert writes on page 107, note 152: "The extinct llama is the *Macrauchenia patachonica* as described by Richard Owen. See Owen, *The Zoology of the Voyage of H.M.S. Beagle. Part I: Fossil Mammalia*, pp. 10–11, 35–56 and plates VI-XV. Darwin collected the fossil specimens in January 1834 at the port of San Julián, having 'no idea at the time, to what kind of animal these remains belonged.' (Darwin, Charles. *Journal of Researches* (1839), p. 208.) Owen's earliest known comment on the specimens occurs in a letter to Charles Lyell dated 23 January 1837 where he described them as follows: RUMINANTIA, Fam: *Camelidae*. 2 cervical vertebrae, portions of femur, & fragments of a Gigantic Llama! as large as a Camel, but an *Auchenia* (from the plains of Patagonia)."
62. "Lyell, Charles," *New World Encyclopedia*, newworldencyclopedia.org. Aug. 30, 2014. https://www.newworldencyclopedia.org/entry/Charles_Lyell.
63. Herbert, Sandra. ed. *The Red Notebook of Charles Darwin,* p. 91, note 67.
64. Ibid, p. 71. (RNB p. 153.)
65. Herbert, Sandra. ed. *The Red Notebook of Charles Darwin*, p. 8. Darwin also wrote: ". . . if one species does change into another [it is] not a gradual change . . . it must be per saltum [by leap or bound] . . ." (Quote reordered by me for clarity.) Source: Herbert, Sandra. ed. *The Red Notebook of Charles Darwin,* p. 66 (RNB p. 130.)

    Darwin is saying that if a species somehow transforms into a new species, it does not do it gradually as Lamarck had argued, but as a sudden one. "Lamarck held that species graded indistinguishably into one another," Herbert writes. Darwin felt that there are notable "differences between even the most closely related species." This has since been "confirmed by taxonomic authorities."

    The two South American ostriches are the common rhea (*Rhea americana)* and the lesser rhea (*Rhea darwinii*). They represent spatial succession. The extinct "Llama" or "Guanaco" (Darwin uses the terms Llama and Guanaco interchangeably) is the *Macrauchenia* **patachonica** and the

present-day Guanaco is the *Lama guanaco.* They represent temporal succession. Source: Herbert, Sandra. ed. *The Red Notebook of Charles Darwin,* p. 9. (RNB pp. 129–130.)

66. See: Darwin's notebooks and reading lists: An introduction by John van Wyhe. Darwin Online, darwin-online.org.uk. http://darwin-online.org.uk/EditorialIntroductions/vanWyhe_notebooks.html.
67. Interpretation of handwriting on Darwin's Tree of Life: "I think case must be that one generation should have as many living as now. To do this and to have as many species in same genus (as is) requires extinction. Thus between A + B the immense gap of relation. C + B the finest gradation. B+D rather greater distinction. Thus genera would be formed. Bearing relation" (next page begins) "to ancient types with several extinct forms."
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72. Darwin. *The Autobiography of,* p. 120.
73. "Timeline of the life of Charles Robert Darwin," darwin-online.org. Accessed Feb 24, 2020. http://darwin-online.org.uk/timeline.html.; Berra, blog.oup.com.
74. Scottish grain merchant and farmer Patrick Matthew (1790–1874) wrote an "early description of evolution by natural election in a book on forestry in 1831." It "bore similarities to several concepts "given in the 1858 Darwin-Wallace joint announcement. "Matthews's brief statement is mostly contained in the appendices and addendum of his 1831 book, *On Naval Timber and Arboriculture.*" Whether Darwin or Wallace knew of Matthew's work is unknown. After he published the first edition of *the Origin of Species* in 1859, Darwin was contacted by Matthew. Darwin acknowledged Matthew's

work in subsequent editions. Sources: Rafferty, John p. "Patrick Matthew: Scottish Landowner and Agriculturalist" britannica.com.

https://www.britannica.com/biography/Patrick-Matthew.; en:wikipedia.

75. Ayala, Francisco Jose. "Evolution: History of evolutionary theory" britannica.com. Last updated Nov 29, 2019. Retrieved Jan 20, 2020. https://www.britannica.com/science/evolution-scientific-theory/History-of-evolutionary-theory.
76. Darwin. *The Autobiography of*. Ed: Nora Barlow, p. 49.

    Nora Barlow writes: "Erasmus Darwin wrote of sexual selection: — 'The final cause of this contest among males seems to be, that the strongest and most active animal should propagate the species which should thus become improved.' This might be mistaken for a sentence written by Charles himself sixty-five years later; for here Erasmus has groped towards the idea of selection." Source: Darwin. *The Autobiography of,* Ed: Nora Barlow. Appendix, Part One, p. 151.
77. Herbert, Sandra. ed. *The Red Notebook of Charles Darwin,* p. 28.
78. Darwin. *The Autobiography of,* p. 120.
79. Darwin, *The Essay of 1844.* p. 64.
80. Ibid, p. 66.
81. In his *Essay of 1844*, Darwin writes: "As by our theory, all mammifers [mammals] must have descended from the same parent stock . . ." This is revolutionary! We are mammals. Source: Darwin, *The Essay of 1844*. p. 193.
82. Darwin, C. "Letter to J. D. Hooker," Jan 11, 1844. DCP-LETT-729. darwinproject.ac.uk https://www.darwinproject.ac.uk/letter/DCP-LETT-729.xml.

    Hooker had identified Darwin's plant specimens from the Galápagos Islands, like mockingbirds, as also unique to the archipelago, some unique to individual islands.
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87. en:wikipedia.; "Darwin in letters, 1851–1855: Death of a daughter." Darwin Correspondence Project. Jun 12, 2015. https://www.darwinproject.ac.uk/letters/darwins-life-letters/darwin-letters-1851-1855-death-daughter. Retrieved Aug 31, 2021.
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    On May 1, Lyell wrote to Darwin: "I wish you would publish some small fragment of your data pigeons if you please & so out with the theory & let it take date — & be cited — & understood." Sources: Desmond, Adrian; Moore, James. pp. 434–438;

    Lyell, C. "Letter to Charles Darwin" 1–2 May 1856. DCP-LETT-1862. darwinproject.ac.uk. Retrieved Jan 9, 2020. https://www.darwinproject.ac.uk/letter/DCP-LETT-1862.xml.; Darwin, C. "Letter to Charles Lyell" 3 Jun 1856. DCP-LETT-1866. darwinproject.ac.uk. Retrieved Jan 9, 2020. https://www.darwinproject.ac.uk/letter/DCP-LETT-1866.xml.
89. Darwin, C. "Letter to Asa Gray" 20 July 1857. DCP-LETT-2125. darwinproject.ac.uk. Retrieved Jan 11. 2020. https://www.darwinproject.ac.uk/letter/?docId=letters/DCP-LETT-2125.xml.; Darwin. *The Autobiography of*, p. 121.

    Grey had been corresponding with Darwin on "similarities between many eastern Asian and eastern North American plants." Source: *Wen, Jun.* "Evolution of Eastern Asian and Eastern North American Disjunct Distributions in Flowering Plants". Annual Review of Ecology and Systematics." (1999) **30***:* pp. 421–455.; "Gray's work in this area gave significant support to Darwin's theory of evolution and is one of the hallmarks of Gray's career." Source: Dupree, A. Hunter (1988). *Asa Gray, American Botanist, Friend of Darwin*. (Baltimore, MD: Johns Hopkins University Press, 1988) pp. 251–252, 258–259, 413–414.
90. Desmond, Adrian; Moore, James. pp. 453–454.
91. Darwin, C. "Letter to Asa Gray" 5 Sept 1857. DCP-LETT-2136. darwinproject.ac.uk. Retrieved Jan 10, 2020. https://www.darwinproject.ac.uk/letter/DCP-LETT-2136.xml Excerpts from Darwin's Enclosure:

    "Selection acts only by the accumulation of very slight or greater variations, caused by external conditions, or by the mere fact that in generation the child is not absolutely similar to its parent . . . I think it can be shown that there is such an unerring power at work, or Natural Selection (the title of my Book), which selects exclusively for the good of each organic being . . .Each new variety or species, when formed will generally take the places of and so exterminate its less well-fitted parent."
92. Ball, Philip "Shipping timetables debunk Darwin plagiarism accusations." *Nature News & Comment* (Dec 12, 2011) Retrieved Nov 11, 2020.

https://www.nature.com/news/shipping-timetables-debunk-darwin-plagiarism-accusations-1.9613.

93. Darwin. *The Autobiography of*, p. 121.
94. Darwin, C. "Letter to Charles Lyell" 18 Jun 1858. DCP-LETT-2285. darwinproject.ac.uk. Retrieved Jan 7, 2020. https://www.darwinproject.ac.uk/letter/DCP-LETT-2285.xml; Wallace, Vol. 1, p. 363.

    In his 1905 autobiography, Wallace recounted his letter to Darwin. (The original letter has not been found.) He said that he had hoped his idea was "as new to him [Darwin] as it was to me" and that "it would supply the missing factor to explain the origin of species." So, if Wallace's recollection is correct, it seems Wallace at the time did not know that Darwin had "solved the problem" of the origin of species — and until Wallace's letter, Darwin had not known that Wallace had solved it as well.

Chapter 29

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    Vestiges of the Natural History of Creation is an 1844 work of speculative natural history and philosophy by Robert Chambers. Anonymously published.
3. Van Wyhe. *Dispelling the Darkness*, pp. 103–105, 109; Desmond & Moore, pp. 453–454.
4. Ibid.
5. Ibid, pp. 105–111. Wallace completed "On the Law Which has Regulated the Introduction of New Species" in February1855. It was published in the July-Dec 1855 volume of *Annals and Magazine of Natural History.*
6. Blyth, E. "Letter to Darwin, C. R.," 8 December 1855" DCP-LETT-1792. darwinproject.ac.uk. Retrieved Jan. 4, 2020. https://www.darwinproject.ac.uk/letter/DCP-LETT-1792.xml.
7. "Darwin, C. R. "To Alfred Russel Wallace," 1 May 1857". DCP-LETT-2086. darwinproject.ac.uk. Accessed Jan 4, 2020. https://www.darwinproject.ac.uk/letter/?docId=letters/DCP-LETT-2086.xml;query=darwin;brand=default.
8. Darwin, *The Autobiography of.* p. 121.

9. Ibid, p. 97.; Berra, blog.oup.com.

   "Marriage between first cousins can more than double the risk of giving birth to a baby with a congenital anomaly such as heart or lung defects, or down syndrome, according to a study published in *The Lancet*. . . . the absolute risk is not so great . . . (older White British moms have an increase in risk from 2% to 4%) will develop a congenital anomaly" Source: "Marriage between Cousins Doubles Birth Defects Risk, Study Finds," acsh.org.
10. "Charles Lyell," darwinproject.ac.uk.; Darwin, *The Autobiography of*. p. 121.
11. Darwin, *The Autobiography of*. p. 122.; Darwin, *The Red Notebook of Charles Darwin*, Herbert, Sandra. ed. p. 27, note 35.

    The Darwin-Wallace papers were subsequently published on August 20 of that year in the Journal of the Proceedings of the Linnean Society. They were "entitled respectively 'On the Tendency of Species to form Varieties;' and 'On the Perpetuation of Varieties and Species by Natural Means of Selection' . . . there was no discussion of them at the end of the meeting." Sources: Browne, *Charles Darwin*, pp. 40–42.; *Charles Darwin's zoology notes & specimen lists from H.M.S. Beagle*, "June – August 1836" Ed: Richard Keynes, (Cambridge, UK: Cambridge University Press, 2000) p. 318. http://darwin-online.org.uk/content/frameset?itemID=F1840&viewtype=text&pageseq=1.
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13. Darwin, C. "Letter to A. R. Wallace" Jan 25, 1859. DCP-LETT-2405. darwinproject.ac.uk. Retrieved Apr 1, 2020. https://www.darwinproject.ac.uk/letter/DCP-LETT-2405.xml.
14. In 1868, Wallace, along with zoologist Edward Blythe, had spent two days with Darwin at it his house at Downe. Source: Gruber, Howard E. "The Origin of the Origin of Species" nytimes.com. Jul. 22, 1979. https://www.nytimes.com/1979/07/22/archives/the-origin-of-the-origin-of-species-darwin.html. Wallace would later claim that he alone had understood "the idea of constant variability of 'every common species in every part and organ.'" Source: Slotten, pp. 161, 2.
15. Ayala, britannica.com.
16. Ibid.
17. Ferris, p., 243.
18. Darwin, *The Autobiography of*. p. 122.
19. Darwin, *On the Origin of Species*, chapter XV: "Difficulties on Theory" p. 401.

20. Ibid, chapter XV: "Difficulties on Theory," p. 378. In the Recapitulation and Conclusion, Darwin wrote: "As this whole volume is one long argument . . ."
21. Darwin, *The Autobiography of.* p. 122.
22. Darwin, *The Autobiography of.* pp. 122-3.
23. "Letter from J. D. Hooker [12 December 1859]" DCP-LETT-2579, darwinproject.ac.uk. https://www.darwinproject.ac.uk/letter/DCP-LETT-2579.xml.
24. en:wikipedia.
25. Ferris, p., 243.
26. Ibid.
27. Darwin, *The Essay of 1844.* p. 196.
28. Darwin, *On the Origin of Species*, chapter I: " Variation under Domestication" pp. 19–43.
29. Ferris, pp. 236–238.
30. Ibid, p. 236.
31. "[In the Essay of 1844] I [had] overlooked one problem of great importance; . . . the tendency in organic beings descended from the same stock to *diverge* in character as they become modified. The solution, as I believe, is that the modified offspring of all dominant and increasing forms tend to *become adapted* to many and highly diversified places in the economy of nature." (My italics.) Source: Darwin, *The Autobiography of.* p. 120.

    How quickly does this diversity change over time? It depends on the rate at which new generations are produced. It is far more rapid for say, bacteria. They reproduce every 30 minutes or so. Humans generally produce new generations about every two to three decades.
32. Darwin, *The Essay of 1844.* pp. 109, 241.
33. Luykx, Peter, Critique of *Cosmic Roots* draft. Email of Aug 26, 2020.
34. Darwin, *Charles Darwin's Beagle Diary*. p. 307, note 1.
35. Darwin, *The Essay of 1844.* p 109.
36. Ferris, pp. 236–8.
37. Ibid, p. 238.

    "Natural Selection . . . is not perfect in its action," Darwin wrote in his Autobiography, "but tends only to render each species as successful as possible in the battle for life with other species, in wonderfully complex and changing circumstances." Source: Darwin, *The Autobiography of*, p. 90.
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39. "Charles Lyell," darwinproject.ac.uk. Lyell "rules out sudden catastrophes; no earth-destroying comets or mountains popping up."

40. Darwin, C. "Letter to Leonard Horner" Aug 29, 1844. DCP-LETT-771. darwinproject.ac.uk. Retrieved Apr 4, 2020. https://www.darwinproject.ac.uk/letter/DCP-LETT-771.xml.
41. Ferris, p. 238. Adhikari, Saugat. "The 7 Homo Species Close to Present Humans That Existed on the Earth" ancienthistorylists.com. April 2, 2019. https://www.ancienthistorylists.com/people/7-homo-species-close-present-human-existed-earth/.
42. Darwin, *On the Origin of Species*, Introduction, p. 3.
43. Ibid, chapter XIV: "Recapitulation and Conclusion," p. 484.
44. Darwin, *The Essay of 1844.* p. 250.
45. en:wikipedia.
46. Darwin, C. "Letter to J. D. Hooker" 13 July 1856. DCP-LETT-1924. darwinproject.ac.uk. Retrieved Jan 10, 2020. https://www.darwinproject.ac.uk/letter/?docId=letters/DCP-LETT-1924.xml;query=1856;brand=default. The Darwin quote is in reaction to a comment by Huxley.
47. There was some misinterpretation here. In an evolutionary context, "fitness" does not refer to an "organism's strength or athletic ability, but rather its ability to survive and reproduce." Source: Than & Taylor, livescience.com.

    The slogan "survival of the fittest" was coined by English philosopher Herbert Spencer. Source: Ayala, britannica.com.
48. Owen met with Darwin on *Origin* and said "my explanation was best ever published of manner of formation of species," as Darwin put it. "[Then Owen said] 'you must not at all suppose that I agree with in all respects.' . . . He added in most sneering tone . . . 'we do not want to know what Darwin believes & is convinced of, but what he can prove.'.—it was improbable in highest degree that I sh[d] succeed in this." Source: Darwin, C. "Letter to C. Lyell" 10 Dec 1859. DCP-LETT-2575. darwinproject.ac.uk. Accessed Jan 12, 2020, https://www.darwinproject.ac.uk/letter/DCP-LETT-2575.xml.

    Owen later wrote a scathing 46-page anonymous critique of the *Origin of Species* which appeared in the highly regarded *Edinburgh Review* in April, 1860. Source: Owen, Richard. "Review of Darwin's Origin of Species," *Edinburgh Review*, **3** (April 1860): 487–532. Published anonymously. Accessed from Darwin Online. http://darwin-online.org.uk/. On Jan 14, 2020.
49. Ayala, britannica.com.

    Hodge saw Darwin's theory as "far more atheistic than that of his predecessor Lamarck."
50. Herschel footnote to draft of *Physical Geography,* January 1861. As cited in Darwin, Francis; Seward, Albert Charles eds. *More letters of Charles*

Darwin: a record of his work in a series of hitherto unpublished letters. Vol. 1. (London, UK: Murray, 1903) p. 191.

51. Darwin, *The Autobiography of*, p. 76.
52. Henslow, John Stevens. "Letter from Professor Henslow," *Macmillan's Magazine*, **3**: 336. Letter dated January 1861. https://books.google.com/books?id=cyQg1DatmVwC&dq=editions:LCCN08020433&pg=PA336&hl=en#v=onepage&q&f=false.

    "[I] refused to allow that he [Darwin] was guided by any but truthful motives," Henslow wrote in a letter to J. D. Hooker, "and declared that he [Darwin] himself believed he was exalting & not debasing our views of a Creator, in attributing to him a power of imposing laws on the Organic World . . ." Source: Henslow, J. S. "Letter to J. D. Hooker" May 10, 1860. DCP-LETT- 2794. darwinproject.ac.uk. Retrieved Jan 16, 2020. https://www.darwinproject.ac.uk/letter/DCP-LETT-2794.xml.
53. "Essays & reviews by Asa Gray" darwinproject.ac.uk. https://www.darwinproject.ac.uk/commentary/religion/essays-reviews-asa-gray; Moore, Randy. *Evolution in the Courtroom: A Reference Guide.* (Santa Barbara, CA: ABC-CLIO, 2002) pp. 125, 307. Gray's essays appeared in "American magazines such as *Atlantic Monthly* and *The Nation*."
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    There was no official comment from the Vatican for several decades. In 1860 a council of the German Catholic bishops pronounced the belief that "man as regards his body, emerged finally from the spontaneous continuous change of imperfect nature to the more perfect, is clearly opposed to Sacred Scripture and to the Faith." Source: Harrison, Brian W. "Early Vatican Responses to Evolutionist Theology," *Living Tradition*, Organ of the Roman Theological Forum, May 2001.
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    Huxley's anonymous review of the *Origin of Species* appeared in the April 1860 edition of Westminster Review: . . . Everybody has read Mr. Darwin's book, or, at least, has given an opinion upon its merits or demerits; pietists, . . . decry it with the mild railing . . . bigots denounce it with ignorant invective; old ladies of both sexes consider it a decidedly dangerous book, and even savants . . . quote antiquated writers to show that its author is no better than an ape himself; while every philosophical thinker hails it as a veritable Whitworth gun in the armoury of liberalism; and all competent naturalists and physiologists . . . acknowledge that the work . . . is a solid contribution to knowledge and inaugurates a new epoch in natural history." Source: Huxley, Thomas H. "Darwin on the Origin of Species," *Westminster Review*, **17** (April 1860): 541–570. Published anonymously.
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62. British evolution scholar David Partridge points out a key refinement on the concept of evolutionary adaption: In Darwin's *Essay* of 1844, he wrote that an organism evolved to adapt to changing environments in "occasional intervals" which were "controlled by destabilizing events." In his *Origin of Species* of 1859, "organic adaptation occurred continuously, potentially modifying the descendants of all organisms." As Partridge points out, this may be another reason why Darwin held back on publishing until 1859. He sensed his theory was incomplete. Source: Partridge, Derek. J. "Darwin's two theories, 1844 and 1859." Hist Biol (2018) 51: 563. https://link.springer.com/article/10.1007/s10739-018-9509-z
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66. https://commons.wikimedia.org/wiki/File:Editorial_cartoon_depicting_Charles_Darwin_as_an_ape_(1871).jpg.
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72. Darwin, *The Autobiography of* p. 50.
73. *Darwin, The Autobiography of.* pp. 86–87.
74. https://en.wikisource.org/wiki/Popular_Science_Monthly/Volume_2/February_1873/Charles_Robert_Darwin. According to her daughter and biographer daughter Henrietta, Emma Darwin "was not only sincerely religious . . . She went regularly to church and took the Sacrament. She read the Bible with us and taught us a simple Unitarian Creed, though we were baptized and confirmed in the Church of England." Source: Darwin, *The Autobiography of,* Note Four: Mrs. Darwin's papers on Religion, Letter One, pp. 238–9.
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76. "Darwin's Book Publications" *American Museum of Natural History,* amnh.org. https://www.amnh.org/research/darwin-manuscripts/published-books. Retrieved Sept 2, 2021.
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Jennie Cohen writes: "Darwin suffered from a host of conditions beginning in his early 20s, primarily chronic vomiting, abdominal pain and gastrointestinal trouble. Later in life, he developed seemingly unrelated symptoms, including eczema, boils, weakness, vertigo, twitching and joint pain."

Darwin's last words were to Emma: "I am not the least afraid of death — Remember what a good wife you have been to me — Tell all my children to remember how good they have been to me." Source: Darwin, Emma. "Reminiscences of Charles Darwin's last years," (1882) darwin-online.org.uk. Accessed April 5, 2020. http://darwin-online.org.uk/content/frameset?viewtype=side&itemID=CUL-DAR210.9&pageseq=1.

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82. "Charles Darwin: Scientist and Writer," westminster-abbey.org.; Branch, ncse.ngo.
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Chapter 30

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   Mendel was a graduate of the prestigious Royal Imperial University of Vienna. His theory accounted for "biological inheritance through particulate factors (now known as genes) inherited one from each parent, which do not

mix or blend but segregate in the formation of the sex cells, or gametes." Source: Ayala, Francisco J. and Fitch, Walter M. "Genetics and the Origin of Species: An introduction" **Proc. Natl. Acad. Sci, USA** Vol. 94, p. 7691, July 1997.

Mendel describes his process of artificial fertilization in his 1865 paper: "the bud is opened before it is perfectly developed, the keel is removed, and each stamen carefully extracted by means of forceps, after which the stigma can at once be dusted over with the foreign pollen."

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10. Their mathematical studies confirmed that "natural selection acting cumulatively on small variations could yield major evolutionary changes in form and function." Source: Ayala, britannica.com.
11. Ayala, britannica.com. The "continuous variation (in such characteristics as body size, number of eggs laid, and the like) could be explained by Mendel's laws." Ayala tells us. "Dobzhansky's 1937 book *Genetics and the Origin of Species* may be considered the most important landmark in the formulation of what came to be known as the synthetic theory of evolution. It had an enormous impact on naturalists and experimental biologists, who rapidly embraced the new understanding of the evolutionary process as one of genetic change in populations."

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    Ayala writes: "This information determines the sequence of amino acid building blocks of protein molecules, which include, among others, structural proteins such as collagen, respiratory proteins such as hemoglobin, and numerous enzymes responsible for the organism's fundamental life processes."

    Pray writes: "Watson and Crick's discovery was also made possible by recent advances in model building, or the assembly of possible three-dimensional structures based upon known molecular distances and bond angles, a technique advanced by American biochemist Linus Pauling."
15. *Molecular Cell Biology*. ncbi.nlm.nih.gov.; Pray, nature.com.

    "Each DNA molecule is a long double helix that resembles a spiral staircase containing millions of steps. The steps of the staircase consist of pairs of four types of molecules called bases (nucleotides). In each step, the base adenine (A) is paired with the base thymine (T), or the base guanine (G) is paired with the base cytosine (C). Each extremely long DNA molecule is coiled up inside one of the chromosomes." Source: Finegold, merckmanuals.com.

    "Information is coded within DNA by the sequence in which the bases (A, T, G, and C) are arranged. The code is written in triplets. That is, the bases are arranged in groups of three. Particular sequences of three bases in DNA code for specific instructions, such as the addition of one amino acid to a chain . . . the sequence of amino acids in a protein is determined by the order of triplet base pairs in the gene for that protein on the DNA molecule. The process of turning coded genetic information into a protein involves transcription and translation." Source: Finegold, merckmanuals.com.
16. Ayala, britannica.com.; Pray, nature.com.
17. Caldwell, discovermagazine.com.; "Homeotic gene," britannica.com.
18. Caldwell, discovermagazine.com.
19. "The role of homeotic genes in embryonic development was elucidated by American geneticists Edward B. Lewis and Eric F. Wieschaus and German geneticist Christiane Nüsslein Volhard. These researchers shared the 1995 Nobel Prize for Physiology or Medicine for their discoveries." Source: "Homeotic gene," britannica.com.
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cytoplasm, endoplasmic reticulum, ribosomes, mitochondria, lysosomes, vacuoles, and Golgi body. Plant cells also have a cell wall and chloroplasts. Lysosomes are rare in plant cells. Source: "Cell Parts" easternlocal.com. https://www.easternlocal.com/userfiles/251/Classes/8643/Cell%20Parts%20Notes.pdf.

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29. Finegold, merckmanuals.com. Mutation can also occur "in the fertilized egg shortly after the egg and sperm cells unite. Source: What is a gene mutation and how do mutations occur? ghr.nlm.nih.gov.
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    Mutations in DNA are "very rare" and the overwhelming majority of mutations have very small effects. They can be "beneficial, harmful, or neutral." Most non-neutral mutations are harmful and "many mutations interact with each other." Evolutionary change is generally based on the accumulation of many mutations with small effects" over a number of generations. Source: Loewe, nature.com.
32. Carlin, J. L. "Mutations Are the Raw Materials of Evolution." *Nature Education Knowledge* 3(10):10. (2011). https://www.nature.com/scitable/knowledge/library/mutations-are-the-rawmaterials-of-evolution-17395346/.

    J. L. Carlin writes: "Mutations generally fall into two types: point mutations and chromosomal aberrations. In point mutations, one base pair is changed . . . Chromosomal aberrations are larger-scale mutations that can occur during meiosis [a type of cell division that results in four daughter cells each with half the number of chromosomes of the parent cell] in unequal crossing over events, slippage during DNA recombination or due to the activities of transposable events. Genes and even whole chromosomes can be substituted, duplicated, or deleted due to these errors."
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Chapter 31

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Appendix A

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Appendix B

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29. Harford, bbc.com. "Gutenberg figured out how to make large quantities of durable metal type," writes Harford, "and how to fix that type firmly enough to print hundreds of copies of a page, yet flexibly enough that the type could be reused to print an entirely different page."
30. Udías, p. 53.; Kaplan, washingtonpost.com.

Appendix C

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2. This circular orbit is a simplification here. Newton worked out the dynamics of gravity for *elliptical* orbits, taking into account the Conservation of Energy and the Conservation of Angular Momentum. An excellent detailed lay explanation of Newton's (and Einstein's) description of planetary motion is given by John Archibald Wheeler in *A Journey into Gravity and Spacetime* (New York: Freeman, 1999) pp. 168–179.
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   Stephen D. Snobelen. Assistant Professor. of History of Science and Technology at the University of King's College, Halifax, tells us that in Newton's "General Scholium," an essay appended to the *Principia*, "only a select few recognized the attack on the doctrine of the Trinity in the fourth through sixth paragraphs (which was precisely Newton's aim). The General

Scholium is constructed much like a Russian doll and, accordingly, restricts access to its ultimate meaning."

"In his footnote on God (added to the 1726 edition to the General Scholium" of the *Principia*), Newton refers to two scriptural texts — one from the Old Testament and one from the New Testament — that use the term "God" of Hebrew magistrates. By using John 10:35, in which Christ appears to be claiming that he is "God" in a similar official or honorary sense, Newton is hinting at what is explicit in his private manuscripts: only the Father is God, Christ is the Son of God, but not ontologically God." Source: Snobelen, newtonprojectca.files.wordpress.com.

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Appendix E

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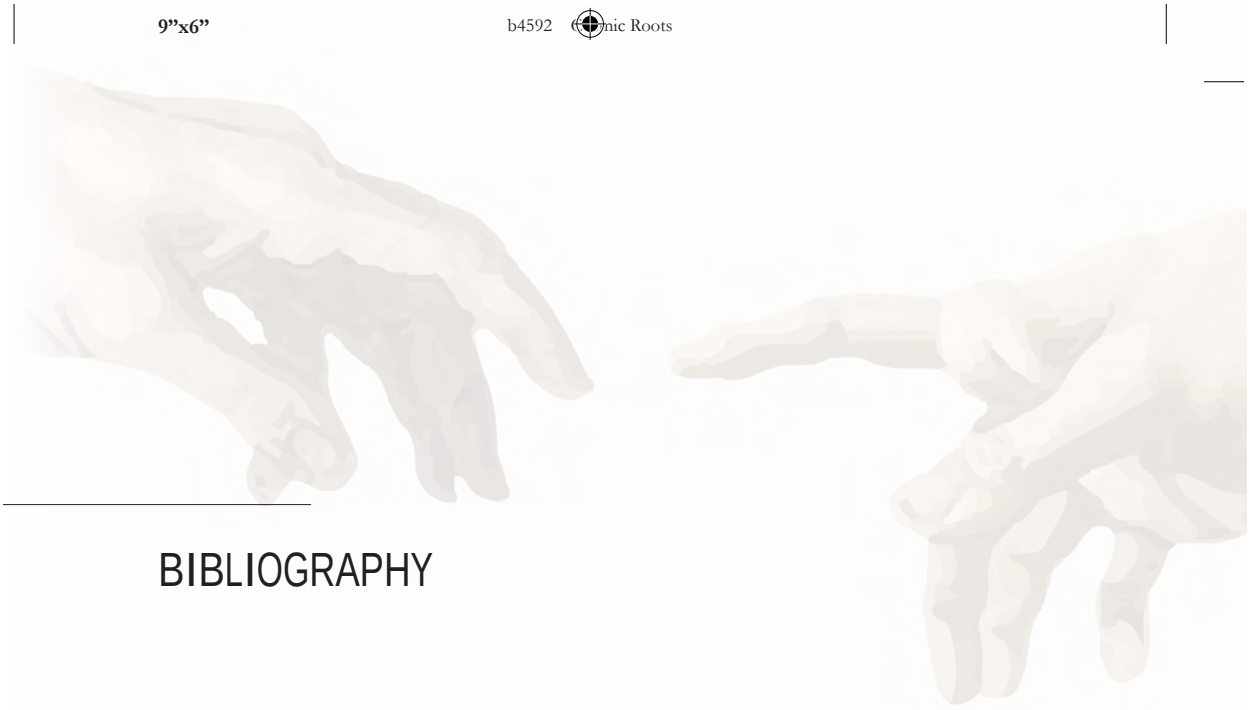

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