

DISCUSSION & STUDY GUIDE

By Ryan Huxley

COURTESY OF



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Introduction

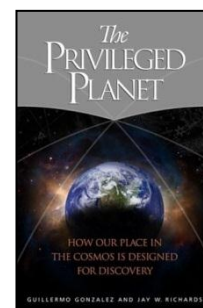
Have you ever looked up into the night sky and been awestruck by the immensity of what you see? Has the dazzling imagery of far off places in the universe produced fascination? Perhaps you've wondered *what's really out there, or how does it all work? Can we learn anything about our place by studying the heavens? Should we take note of the fact that we can even study what we see when we look up?*

Illustra Media's documentary *The Privileged Planet* provides an intriguing look at our home planet and the universe based on the book with the same name by Guillermo Gonzalez and Jay Richards. With expert interviews and engaging computer graphics, viewers are treated to a scientific and philosophical exploration of the Earth and beyond. This film highlights intelligent design (ID) concepts applied to astrobiology and cosmology. In doing so, the film shows how the scientific evidence points to the design of the cosmos and the life benefitting features of our planet.

This Discussion & Study Guide ("guide") is designed to help you and others learn about these concepts in more detail. It is broken into five segments and should be used in conjunction with viewing the Illustra Media film *The Privileged Planet*. The guide has short-answer-style questions, fill-in-the-blank, multiple-choice questions, and true/false statements as well as discussion questions. It can be used for individual or group study, though the discussion questions are best for group learning situations. Answers to questions are provided at the back of the guide. Because the discussion questions are sometimes more open ended, possible (though not exhaustive) answers are provided. Additional resources are referenced in the 'Answers' portion for those interested in gaining a more detailed understanding of a particular topic.

The short-answer questions are taken directly from the video. Tougher questions are usually at the end. Discussion questions are often open-ended and have been broken into two different categories: 1) those relating directly to a video topic, and 2) those that relate to a video topic, but are not explicitly covered in the video. Answering questions that extend the material covered in the video may require "a little digging" to arrive at an answer using additional resources.

There is also a wonderful book that this video is based upon by Guillermo Gonzalez and Jay W. Richards: *The Privileged Planet: How Our Place in the Cosmos is Designed for Discovery* (Regnery Publishing, Inc., 2004), available at www.privilegedplanet.com.



If you would like to start a club to discuss intelligent design and evolution at your school, university, or in your community, consider starting an Intelligent Design and Evolution Awareness (IDEA) Club! The IDEA Center helps students start IDEA Clubs on college and high school campuses, as well as in communities, around the U.S. and the world. The IDEA Center can provide resources to help you start an IDEA Club - and you do not have to be an ID expert to start one. Please see www.ideacenter.org for further information.

Please direct any feedback or input about the guide to ryan@ideacenter.org.

1. Video Chapters 1-3 (0:00-14:00)

Basic Questions:

1.1. What were the names and launching year for the space programs noted at the beginning of the video?

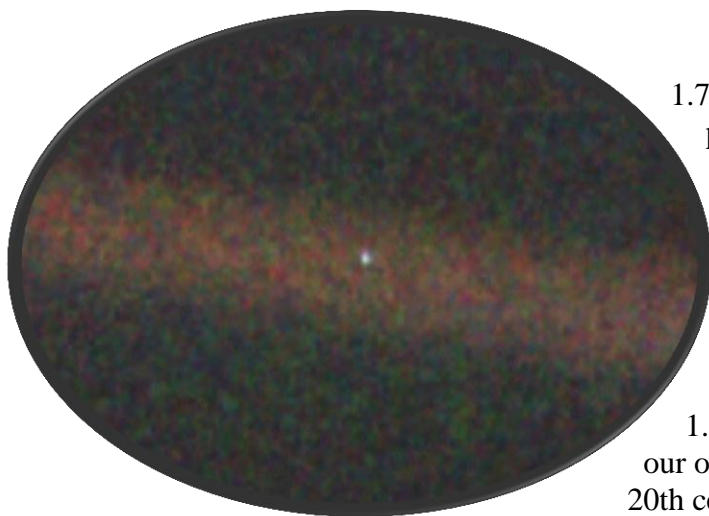
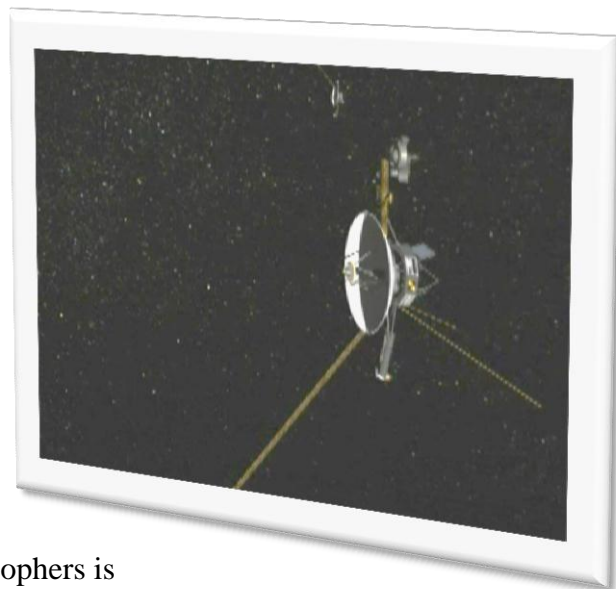
1.2. On February 14, 1990, the satellite took a picture of a “pale blue dot” viewed from millions of miles away. That dot was the _____.

1.3. Who were some of the early philosophers that pondered our planet's place in the universe?

1.4. The name of the theory put forth by these philosophers is _____, which states that the Earth is stationary and everything rotates about it.

1.5. This view persisted for many centuries until 1543 when _____ published his theory that the Sun is the center of our solar system.

1.6. The name of this new theory that eventually replaced the prior one is (circle one): atomic theory / golden ratio / heliocentrism.



1.7. The view that our Earth is rather plain was popularized by _____.

1.8. Paraphrase the quote that summarizes this view based on the pictures taken by the satellites.

1.9. Discoveries of other _____ beyond our own Milky Way by Edwin Hubble early in the 20th century (1900s) led to this view being readily accepted.

1. Video Chapters 1-3 (0:00-14:00)

1.10. What key question about the Copernican Principle is asked given the scientific discoveries made in recent decades?

1.11. The quote by Robert Jastrow summarizes the view that Earth is just one of _____ and life as we know it is just one of many _____.

1.12. SETI stands for _____
_____, the program started in the 1960s based on this popular view.

1.13. SETI is considered worthwhile by being undergirded by the following view: the universe is so vast that what happened on Earth likely happened elsewhere. True or false?

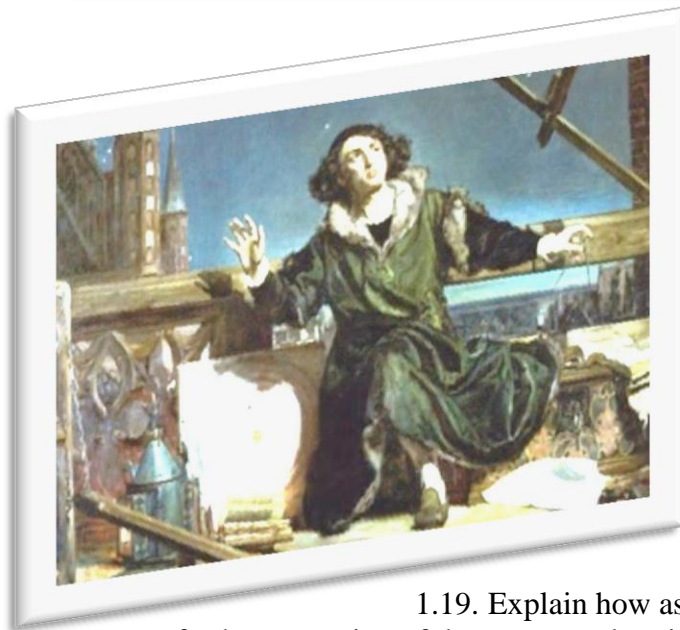


1.14. _____ is the first noted astrobiologist in the video who coauthored the book by the same title as the video.

1.15. This astrobiologist initially (circle one) agreed with / laughed at / criticized the view that life was plentiful in the universe.

1.16. Because of discoveries in the field of physics and the fact that they apply everywhere in the universe, astrobiologists believe that the factors required for life on Earth are also required everywhere else in the universe. True or false?

1. Video Chapters 1-3 (0:00-14:00)



Discussion Questions:

1.17. Explain why the discovery by Nicolaus Copernicus was important.

1.18. What did Copernicus' theory evolve into nearly 400 years later? What is another name for this theory and what does it imply?

1.19. Explain how astronomical discoveries by Edwin Hubble led to a further extension of the now popular view of our Earth being insignificant.

1.20. Name and describe the new area of science that emerged as a result of the modern Copernican view.

Discussion Questions Beyond the Video:

1.21. Astronomical discoveries by Edwin Hubble and others had a significant impact on the eventual development of another theory. What is that theory? Explain why Hubble's observations led to development of this theory.



1. Video Chapters 1-3 (0:00-14:00)

1.22. What famous intellectual later admitted he added something he should not have to a famous equation in a paper he wrote substantially prior to Hubble's observations? What motivated this intellectual to 'fudge' his equation?

1.23. Identify the underlying premise associated with the Copernican Principle that the vast universe provides?

1.24. Have you heard of the Copernican Principle before? If so, in what context did you hear it? Do you think it is a reasonable view? Why or why not?

1.25. For those who have seen the 1997 movie *Contact* (starring Jodie Foster and Matthew McConaughey; based on the book by Carl Sagan), describe how intelligent design concepts are used in the dramatic scenes in which the radio signal is first heard.

2. Video Chapters 4-6 (14:01-26:41)

Basic Questions:

2.1. _____ is a prerequisite required for life.

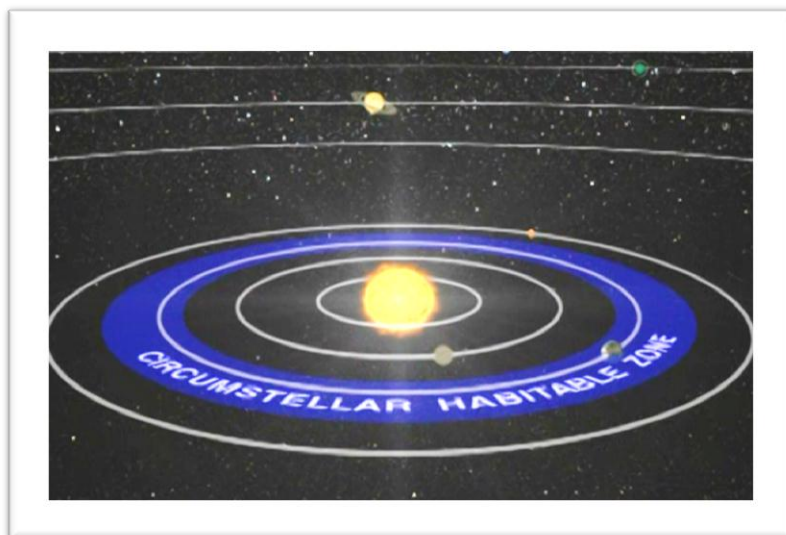
2.2. What other requirement makes this first one possible?

2.3. As planetary physicist Kevin Grazier notes, just as in real estate, a key features for a planet to support life is “_____”

2.4. The “just right” requirement discussed is also known as the (circle one) golden ratio / heliocentric theory / “Goldilocks zone” in the video.



2.5. List three of the many requirements for life.



2.6. The (circle one) Drake / general relativity / astrobiological equation has been used to determine the chance of having the correct parameters for life elsewhere in our galaxy.

2.7. The factors and how they interact in that equation has led astrobiologist Guillermo Gonzalez to think that complex technological life is common in the universe. True or false?

2.8. What is the name of the book written by astronomer Donald Brownlee regarding the likelihood of life in the universe?

2. Video Chapters 4-6 (14:01-26:41)

2.9. What is the key point of that book?

2.10. The illustrative example used to describe the chances of getting the right factors for the Earth as we know it is the _____.

Discussion Questions:

2.11. Explain why water is needed for life. Is the statement, “just add water and you will get life” correct? Why or why not?



2.12. For the three requirements in your answer to question 2.5, explain what life-benefitting parameter(s) is (are) associated with each.

2.13. For the equation used to determine the likelihood of life, explain the key feature to remember about how the individual probabilities for each parameter interact in the equation. What kind of numerical result does this lead to?

2. Video Chapters 4-6 (14:01-26:41)

2.14. What questions does philosopher Jay Richards ask about the overlapping of factors for life which also make discoveries about the universe possible?

Discussion Questions Beyond the Video:

2.15. Describe some of the unique properties of water relative to other similar kinds of molecules. Comment on the impact this has for the possibility of life.

2.16. Explain the life benefits provided to Earth by other large planets in the solar system.

2.17. Some may claim that existence of the extrasolar planets or exoplanets, including ‘Super-earths’, provide evidence that the Earth is probably not that unique. How would you respond to such claims?

2.18. Prior to seeing this video, were you aware of some of the narrowly defined parameters necessary for life on Earth? If so, which ones and how did you learn about them?

3. Video Chapters 7-8 (26:42-35:52)

Basic Questions:

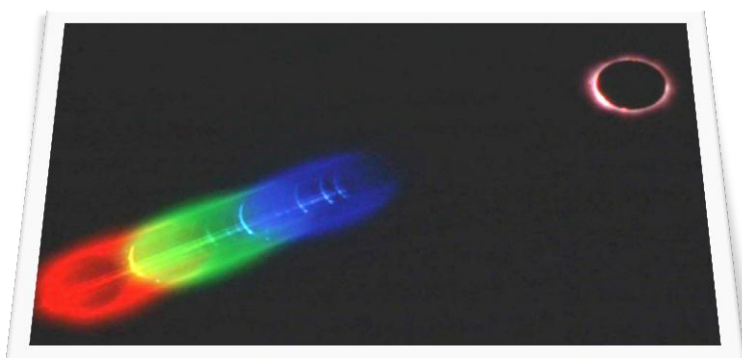
3.1. What astronomical event that occurred on October 24, 1995 led Gonzalez to begin asking questions?

3.2. The Sun is (circle one) 100 / 200 / 400 times larger than the Moon, but it is also (circle one) 100 / 200 / 400 times farther away.



3.3. As a result of these astronomical events, scientists learned about the make-up of the Sun's _____.

3.4. This discovery was made possible as a result of the _____, which occurs very briefly, shortly after the Sun is completely covered.



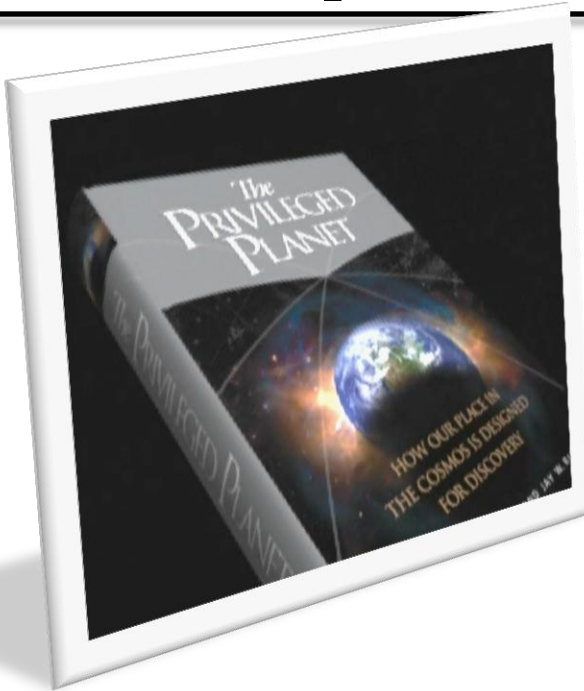
3.5. What atomic element was discovered as a result of these findings?

3.6. Gonzalez noticed that the parameters required for the eclipse and some of the factors required for life overlap. True or false?

3.7. What is the name of the article written by Gonzalez that caught Richards's eye?

3.8. Gonzalez's article caught Richards's attention because Richards was studying design inferences in cosmology through probability theory in fine-tuning of physical laws. However, Gonzalez's article seemed to be another avenue to determining a purpose to the universe. True or false?

3. Video Chapters 7-8 (26:42-35:52)



3.9. What is the main hypothesis proposed in the book *The Privileged Planet*?

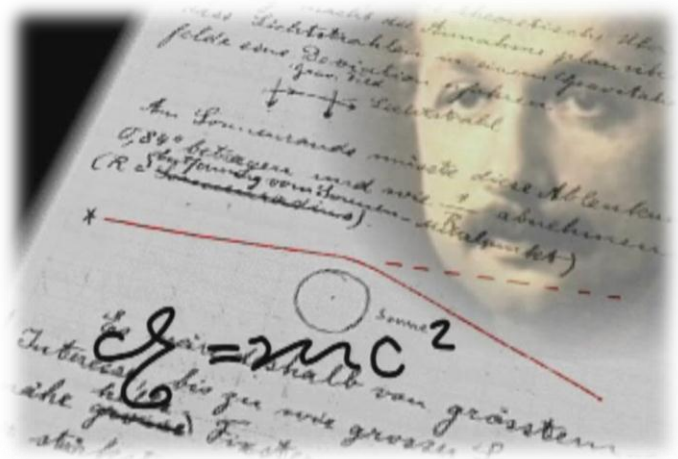
Discussion Questions:

3.10. Describe the basic requirements for a total eclipse.

3.11. What are the required life parameters that correlate with eclipses?

3.12. Why is the eclipse so important to understanding the rest of the universe?

3.13. What did the total eclipse also allow experimental confirmation of (it's a very well-known theory at a popular level)? Describe the basic features of the experiment.



3. Video Chapters 7-8 (26:42-35:52)

Discussion Questions Beyond the Video:

3.14. Are eclipses that occur for the Earth-Moon system similar for other planets in our solar system? Why or why not?

3.15. Throughout Earth's history, have eclipses as we see them today been possible? Will eclipses as we see them today continue to be possible for the rest of Earth's history? Why or why not?

3.16. Explain the giant impact hypothesis and some of the “just right” aspects leading to “life benefiting” effects associated with such an event.

3.17. Prior to seeing this video, had you heard of the Privileged Planet hypothesis? If so, what was the context?

4. Video Chapters 9-10 (35:53-47:18)

Basic Questions:

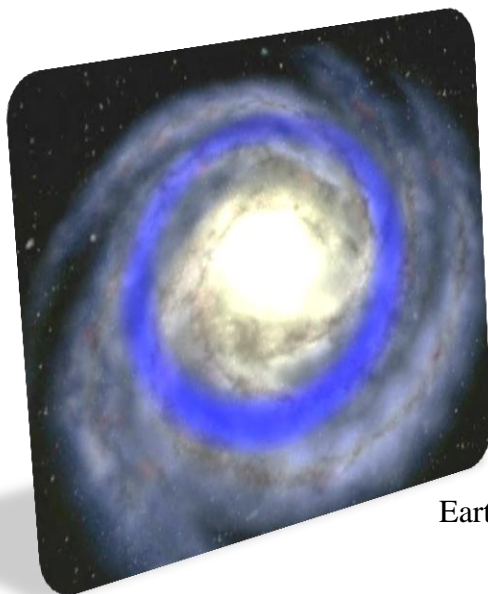
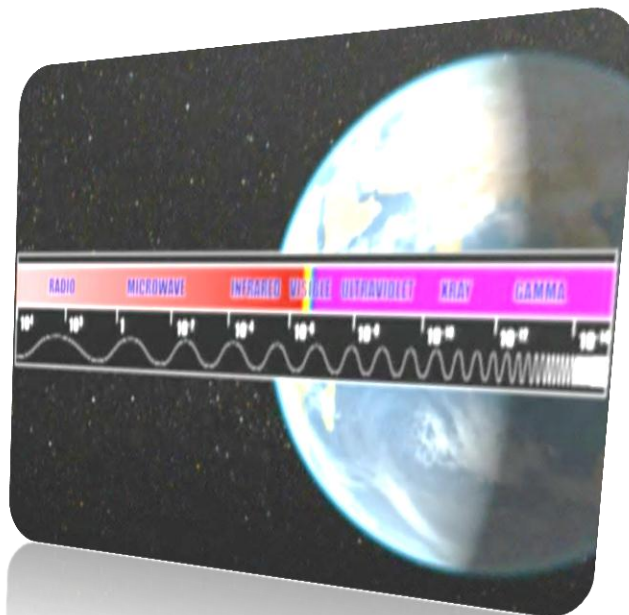
4.1. There are about (circle one) 50 / 60 / 70 planets and moons in our solar system, with only (circle one) 5 / 6 / 7 having a thick atmosphere.

4.2. Unlike the other planets or moons with an atmosphere, the Earth's is _____, which allows us to peer out beyond our world and also allows the type of light necessary for life processes.

4.3. Of the entire electromagnetic spectrum naturally produced in the universe, only about one percent (1%) is useful for life. True or false?

4.4. In addition to examining the Earth's location in our solar system, Gonzalez also examined the location of our solar system in our _____.

4.5. Complex life could benefit from being in or near the galactic center because of the abundance of light provided by all the stars to illuminate things. True or false?



4.6. What is missing or lacking for locations far away from the galactic center or arms?

4.7. The “just right” area for life in the galaxy is called the _____.

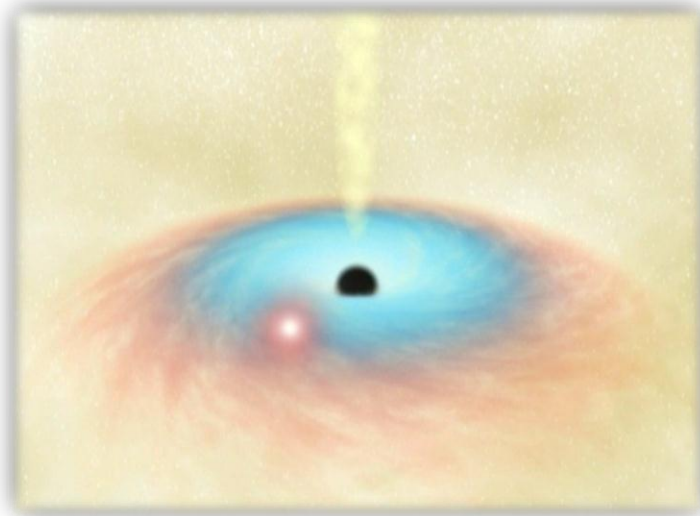
4.8. Unlike many other parameters, the type of galaxy is not important to make discoveries. True or false?

4.9. What key aspects of discovery are provided by the Earth's location in the galaxy?

4. Video Chapters 9-10 (35:53-47:18)

Discussion Questions:

4.10. Explain why the kind of transparency provided by Earth's atmosphere is important for life and making discoveries.



4.11. Describe some of the problems associated with being in the galactic center region or within a spiral arm from both a discovery and life perspective.

4.12. Explain why the galactic habitable zone is necessary to make discoveries.

Discussion Questions Beyond the Video:

4.13. In addition to spiral galaxies, what other basic galaxy types exist in the universe? Based on these other galaxy types and the concept of the galactic habitable zone, explain how the possibility of life and making discoveries could be affected in those galaxies.

4. Video Chapters 9-10 (35:53-47:18)

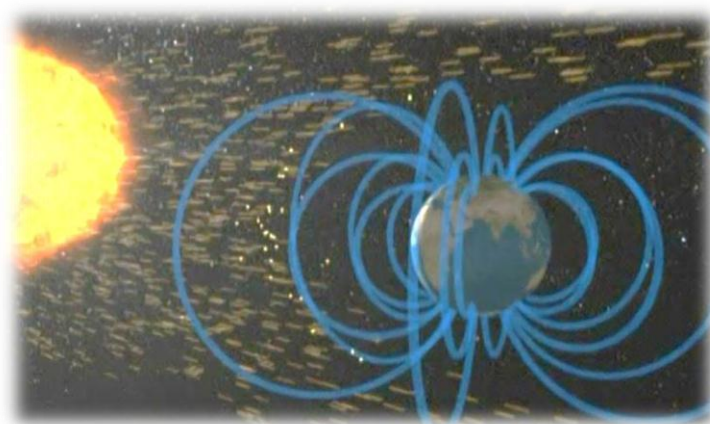
4.14. Until relatively recently, many astronomers thought most disk-like galaxies nearby ours had not changed much in the last 8 billion years. Recent galactic studies suggest that disk-like galaxies have changed, becoming more orderly over this time period. Based on this information and the prior discussion question, what are the implications for the possibility of life and making scientific discoveries? How is this similar to eclipses caused by the Moon?



4.15. Based on the discovery of a galactic habitable zone, should the Drake equation be revised? Why or why not? What impact does this have on the possibility of technological life elsewhere in our galaxy?

4.16. In addition to being used by almost all animals for respiration, what other benefits does atmospheric oxygen provide for life?

4.17. Explain why liquid iron inside the Earth is important for the atmosphere, which is outside of the Earth.



4. Video Chapters 9-10 (35:53-47:18)

4.18. Explain why a diversity of different stars nearby a given location is important for life and scientific discovery.

4.19. Similar to Earth, our Sun also has a magnetic field. Explain both the benefits and hazards this provides to Earth.

4.20. Explain how the Earth's magnetic field enables us to make scientific discoveries. What other life permitting feature facilitates this?

4.21. Some of the topics covered in this segment are rather technical. What did you find most interesting? Most difficult to understand? Most helpful illustration?

5. Video Chapter 11 (47:19-58:10)

Basic Questions:

5.1. What is the quote by Albert Einstein?

5.2. What does theoretical physicist and cosmologist Paul Davies think of the apparent correlation between life and making discoveries?



5.3. If the fundamental force of gravity was adjusted slightly, simple life forms would not be possible, but complex life could be possible because their technology allows them to deal with the forces of nature. True or false?

5.4. Chemistry is possible based, in part, on the existence of the strong nuclear force and the electromagnetic force. True or false?

5.5. The number of pieces of paper required to write out the fundamental physical laws would take is/are (circle one) one / tens / hundreds / thousands.

5.6. Based on the previous question's odd result, it suggests that the universe is supposed to be _____.

5.7. There is an immense and immediate survival benefit provided by being able to make sense of the fine details of the universe, which fits with Darwinian evolutionary theory. True or false?

5.8. Based on the apparent overlap of factors required for making discoveries and requirements for life, what 'catch phrase' does Richards's suggest this is indicative of?



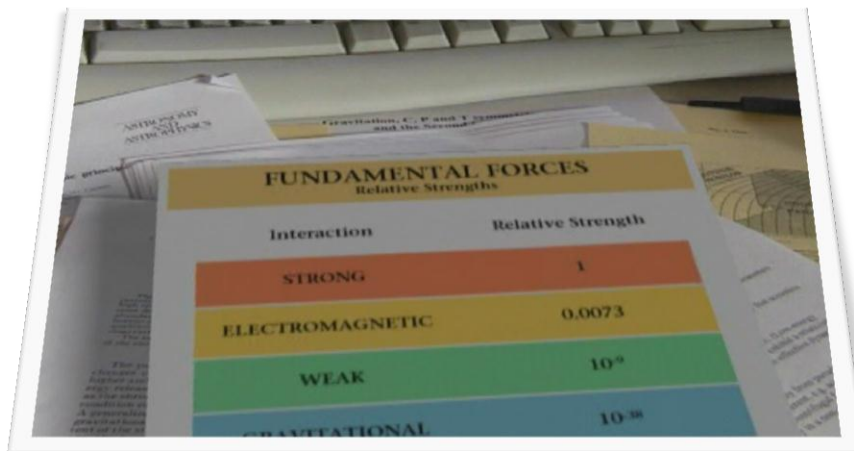
5. Video Chapter 11 (47:19-58:10)

5.9. Early astronomers and scientists like Nicolaus Copernicus, Johannes Kepler, Galileo Galilei, and Isaac Newton (some of the founders of modern science) thought the orderliness of the universe was the product of a mind. This thought compelled them to make their scientific investigations. True or false?

5.10. What does Davies say about the discovery of the physical laws governing the universe?

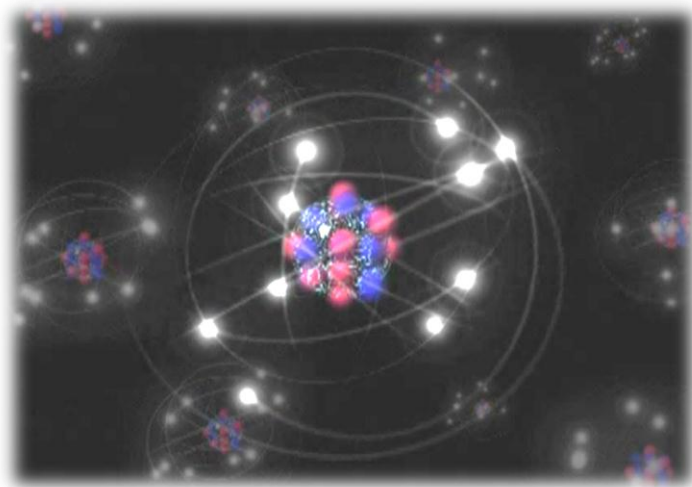
Discussion Questions:

5.11. Define the term “fine-tuning” as used in this video segment.



Interaction	Relative Strength
STRONG	1
ELECTROMAGNETIC	0.0073
WEAK	10^{-6}
GRAVITATIONAL	10^{-38}

5.12. Based on the information in the video, explain some of the problems that could occur if there was no gravity.



5.13. Explain what the strong nuclear force is and the life benefit it provides.

5. Video Chapter 11 (47:19-58:10)

Discussion Questions Beyond the Video:

5.14. Many of the founders of modern science were theologically motivated in their scientific endeavors. Explain why this casts doubt on the following claim: “believing some deity made things the way they are is a science stopper.”

5.15. Some critics claim intelligent design hypothesizes a transcendent designer. Is this correct? Explain.

5.16. Gonzalez was at Iowa State University at the time the video was made. What caused him to leave ISU?

5.17. Was the Big Bang a finely tuned or chaotic event? Based on your answer, explain the impact on the ability for life to exist.

5.18. Explain the *Kalam* Cosmological argument and why the Big Bang is relevant to it.

5.19. The design implications of the Privileged Planet hypothesis, Big Bang, and fine-tuning have caused some scientists to suggest novel ideas to explain these. What are the more popular ones you have heard of and how do/would you respond to their claims?

5. Video Chapter 11 (47:19-58:10)

5.20. Compared to other elements, what features of carbon make it such a ubiquitous element for life?

5.21. Discuss the fine-tuning associated with the creation of carbon and oxygen through stellar nuclear fusion.

5.22. Some critics claim that we should not be surprised that life is on Earth, because, after all, life is here, so the improbable must have occurred. How would you respond to such claims?

5.23. Some critics claim that the universe is not designed for life because most of the universe is not hospitable to life. How would you respond to such claims?

5.24. The issue of the underlying ability to discern our surroundings requires taking a step back from the normal ventures of science to look at the “bigger picture.” What other topics in this segment get into “bigger questions?” Did the information provided for those increase your interest in looking at these topics further? Why or why not?



Answers

Please note: Many of these answers contain links to other websites. These were accessed between December 2012 and March 2013. Simply because a link is provided does not necessarily imply endorsement of that site or the views expressed on that site. In the discussion questions, while answers are frequently provided, individual responses are likely to vary; the answers provided for the discussion questions give some of the basic points that could be included in a response.

1. Video Chapters 1-3 (0:00-14:00)

Basic Questions:

- 1.1. 1977, Voyager 1 & 2.
- 1.2. Earth.
- 1.3. Aristotle (384-322 B.C.), Ptolemy (90-168 A.D.).
- 1.4. geocentrism.
- 1.5. Copernicus.
- 1.6. Heliocentrism – the Sun is “stationary” at the center, and planets revolve around it.
- 1.7. Carl Sagan. He used his *Cosmos* miniseries shown on PBS in 1980 to promote his philosophy. It has since been rebroadcast multiple times and, over time, is considered the most watched documentary on PBS, believed to be seen by about 700 million viewers. For additional information, see “[Cosmos: A Personal Voyage](http://topdocumentaryfilms.com/cosmos/)” at <http://topdocumentaryfilms.com/cosmos/>.
- 1.8. Paraphrased quote from Carl Sagan: Our planet is a lonely speck in the great enveloping cosmic dark. Full quote: Because of the reflection of sunlight...the Earth seems to be sitting in a beam of light, as if there were some special significance to this small world. But, it’s just an accident of geometry and optics. Look again at that dot. That’s here. That’s home. That’s us...Our posturing, our imagined self-importance, the delusion that we have some privileged position in the universe, are challenged by this point of pale light. Our planet is a lonely speck in the great enveloping cosmic dark. (As will be seen later in the video, this view became challenged by other scientists based on later discoveries about the universe and Earth.)
- 1.9. galaxies.
- 1.10. Does the evidence still support the idea that Earth is not special?
- 1.11. innumerable Earths (or many planets); forms of life. Quote from Robert Jastrow: “The universe is populated by innumerable Earths and, perhaps, innumerable forms of life.”
- 1.12. Search for ExtraTerrestrial Intelligence (SETI).
- 1.13. True.
- 1.14. Guillermo Gonzalez.
- 1.15. agreed with.
- 1.16. True.

Discussion Questions:

- 1.17. Polish astronomer Nicolaus Copernicus wrote a book *On The Revolutions of the Heavenly Spheres*, where he argued that the Sun was the center of the solar system, not the Earth. The Earth moves, not the Sun. It provided the mathematical foundation for modern orbital mechanics; it solved one of the great mysteries of the universe.

Answers

- 1.18. The fact that the Earth was not the center of the universe eventually led people to the belief that the Earth was not special - this is known as the Copernican Principle.
Another name for this theory is The Principle of Mediocrity - our planet is nothing special.
- 1.19. People used to think our galaxy was the extent of our universe. Hubble's discoveries of other galaxies (which, up to that point, had been thought to be mere clouds of gas in our own galaxy) suggested that our entire galaxy, with hundreds of billions of stars, was a mere pin-point of light in the universe. (Note that while Hubble has often been given credit for discovering empirical evidence of the expanding universe, some historians of science suggest others contributed more so than previously recognized – see Helge Kragh, Robert W. Smith, “[Who Discovered the Expanding Universe?](#),” *History of Science*, 41: 141-162 (2003) at <http://adsabs.harvard.edu/full/2003HisSc..41..141K> for additional information.)
- 1.20. Astrobiology - the study of extrasolar planets that may have life and what is required for life from a planetary standpoint.

Discussion Questions Beyond the Video:

- 1.21. Big Bang theory. Hubble's observations of the galaxies moving away from each other suggested that there must have been a beginning to the universe – if things are moving further apart, they must have been together at some initial starting point. For additional information, see NASA's article “[The Big Bang](#)” at <http://science.nasa.gov/astrophysics/focus-areas/what-powered-the-big-bang/>.
- 1.22. Albert Einstein. Einstein added a constant, referred to as the ‘cosmological constant’, to ensure that his equation of general relativity would be consistent with the predominant view of the universe at that time – the steady state theory– which claims the universe had existed for all eternity. Einstein later admitted it was one of his biggest “blunders” of his life to have ‘fudged’ his equation. Later cosmological discoveries have brought back the cosmological constant, though of a different magnitude to that proposed by Einstein. For more information, see “[What is the Cosmological Constant?](#)” at <http://space.about.com/od/astronomybasics/a/What-Is-The-Cosmological-Constant.htm>, “[Vacuum Energy Density, or How Can Nothing Weigh Something?](#)” at http://www.astro.ucla.edu/~wright/cosmo_constant.html, and “[What is a Cosmological Constant?](#)” at http://map.gsfc.nasa.gov/universe/uni_accel.html.
- 1.23. The vast universe provides the probabilistic resources to ensure that anything that would normally be considered improbable is probable. This would make uniqueness or rarity insignificant.
- 1.24. Responses will vary depending on the individual. While some may not have heard of the Copernican Principle explicitly stated or identified, they likely are familiar with the basic concept: we are not special.
- 1.25. Shortly after Jodie Foster's character, Eleanor Arroway, hears the radio signal, she and her colleagues attempt to rule out other causes and eventually discern a pattern. Based on this discovery and other supplementary information, they infer it is a designed signal. This provides the basic reasoning (albeit in dramatic cinematic form) used when inferring design.

Further Reading:

1. [The Privileged Planet](http://www.theprivilegedplanet.com/) documentary website at <http://www.theprivilegedplanet.com/>.
2. For more information on the Voyager missions, refer to the following:

Answers

- Jet Propulsion Laboratory's site, *Voyager: The Interstellar Mission* at <http://voyager.jpl.nasa.gov/>.
- NASA's "Voyager: An Interstellar Journey" at http://www.nasa.gov/mission_pages/voyager/index.html.
- Videos:
 - o "ScienceCasts: Voyager" at <http://www.youtube.com/watch?v=oFT68U4i-Xw>.
 - o "ScienceCasts: Voyager 1 at the Final Frontier" at <http://www.youtube.com/watch?v=EFnJzyxd78o>.
- 3. Nicolaus Copernicus, *On The Revolutions of the Heavenly Spheres* at [http://www.geo.utexas.edu/courses/302d/Fall_2011/Full%20text%20-%20Nicholas%20Copernicus,%20De%20Revolutionibus%20\(On%20the%20Revolutions\)%201.pdf](http://www.geo.utexas.edu/courses/302d/Fall_2011/Full%20text%20-%20Nicholas%20Copernicus,%20De%20Revolutionibus%20(On%20the%20Revolutions)%201.pdf).
- 4. *Search for Extraterrestrial Intelligence* website at <http://www.seti.org/>.
- 5. Jay Richards, "The Search for Extraterrestrial Life: The Question That Won't Go Away," *The Colson Center* (May 19, 2010) at <http://www.discovery.org/a/14751>.
- 6. Astrobiology websites:
 - *Astrobiology Web* at <http://www.astrobiology.com/>.
 - *NASA Astrobiology* at <https://astrobiology.nasa.gov/>.
- 7. Jay Richards, Guillermo Gonzalez, "The Pale Blue Dot Revisited," (May 1, 2009) at <http://www.4truth.net/fourtruthpbscience.aspx?pageid=8589952951>.
- 8. Movie: *Contact* (1997), starring Jodie Foster and Matthew McConaughey, is based on a book by Carl Sagan, in which the SETI program and the Copernican Principle play a significant role.
- 9. Big Bang Theory:
 - "Big Bang Cosmology" at http://map.gsfc.nasa.gov/universe/bb_theory.html.
 - "Foundations of Big Bang Cosmology" at http://map.gsfc.nasa.gov/universe/bb_concepts.html.

2. Video Chapters 4-6 (14:01-26:41)

Basic Questions:

- 2.1. Liquid water.
- 2.2. Proximity to the sun - a planet's distance to its nearest star determines whether or not liquid water is possible on its surface.
- 2.3. location, location, location.
- 2.4. Goldilocks zone.
- 2.5. Answers may vary, but could include some of the following (this is not an exhaustive list):
 - Plate tectonics made possible by a thin crust – provides the ability to have a carbon cycle which recycles and distributes needed nutrients to different planet surface areas; regulates planet's interior temperature, mixes chemical elements essential to living organisms; shapes continents; for additional information on plate tectonics, refer to <http://pubs.usgs.gov/gip/dynamic/unanswered.html#anchor19928310> and <http://volcanoes.usgs.gov/about/edu/dynamicplanet/nutshell.php>.
 - Magnetic field from liquid iron outer core (provides protection from solar winds).
 - Oxygen/nitrogen atmosphere (provides correct combination or mix of elements for liquid water and complex life and protection from the sun's harmful rays).

Answers

- Dual planet/moon. This stabilizes Earth's tilt and, therefore, provides moderate weather; tidal movements help to mix water with other elements in the Earth's crust – for additional information on tidal effects caused by the Earth-Moon and Sun-Earth system, refer to NASA's <http://scijinks.nasa.gov/tides>.
 - Type of star and size (main sequence G2 dwarf star) affects the circumstellar habitable zone.
 - The circumstellar habitable zone. This provides for water to exist in three different phases – solid, liquid, vapor, with liquid being the most crucial.
 - Other large planets. These help to absorb asteroid/comet impacts due large gravitational pull drawing these objects towards them, thereby minimizing the chance a given asteroid/comet hits the Earth.
- 2.6. Drake.
- 2.7. False. Complex technological life must be rare.
- 2.8. Peter D. Ward, Donald M. Brownlee, *Rare Earth: Why Complex Life is Uncommon in the Universe* (Copernicus, 2003).
- 2.9. Just like the title, the Earth is an uncommon place. It is very special.
- 2.10. cosmic slot machine.

Discussion Questions:

- 2.11. Liquid water is excellent for life because it facilitates the transport of nutrients to cells; it's also a good solvent. The statement “just add water ...” is incorrect because life is far more complex than “just add water” - it requires far more ingredients. For a discussion of this, see Casey Luskin, “[The Implications of the Hypothetical Discovery of Martian Life for Intelligent Design,](http://www.evolutionnews.org/2008/07/the_implications_of_the_hypoth009101.html)” *Evolution News & Views* (July 30, 2008) at http://www.evolutionnews.org/2008/07/the_implications_of_the_hypoth009101.html.
- 2.12. Answers will vary. Refer to the answers in 2.5 above for the reasons why each parameter is a necessary component.
- 2.13. They must all be present simultaneously and, because they are independent of each other, they must be multiplied by each other to determine the chance of getting the correct parameters for life to have the possibility of existing. Note: just having the correct conditions are not sufficient in themselves for life to actually exist – several other criteria such as information processing systems, ability to use energy, ability to replicate, etc. - must be satisfied in order for life to arise. This leads to exceedingly small probabilities that life could exist in our galaxy.
- 2.14. Are these coincidental, or suggestive of something else – some underlying purpose or design? If there is a purpose, could we determine that was the case?

Discussion Questions Beyond the Video:

- 2.15. Answers may vary, but may include the following (this is not an exhaustive list):
- Solid phase is less dense than liquid phase (other molecules usually become more dense rather than less) – ice floats on water rather than sinking to bottom allowing sea life to move through what would otherwise be completely frozen oceans.
 - High boiling point means liquid phase is more common – liquid water is necessary for many life processes and is present across a substantial temperature range meaning processes requiring liquid water can function at a variety of temperatures.

Answers

- High specific heat – this allows water to absorb large amounts of heat (energy) input before it becomes hot itself, which provides the Earth the ability to absorb much of the Sun’s energy without vaporizing, thereby contributing to maintaining water mostly in a liquid phase on Earth (refer to the NASA video segment at <http://youtu.be/ujBi9Ba8hq5> from 2:45-3:05).
 - It acts as a solvent – due to the polarity associated with the molecule, water acts as a great solvent which is crucial for many life functions since various nutrients are dissolved in water or aqueous solution and transported by water to other areas where needed in a living organism.
 - High surface tension – this property, along with cohesion leads to capillary action which allows water to be “pulled” up by xylem in plants during transpiration without the water “column” separating.
- 2.16. Large planets have more gravity than Earth due to their larger mass. Because of this increased gravity, they are more likely to draw in and get hit by comets, asteroids, and meteors than the Earth. These larger planets help to decrease the likelihood that the Earth will be impacted by these objects. Impacts by these objects can be (and have been) catastrophic to life due to their size and speed at which they could (and have in the past) hit the Earth. The potential damage caused by these was observed by the Shoemaker-Levy 9 impacts on Jupiter. For an informative video clip from the BBC on this event, see <http://www.youtube.com/watch?v=HXgq3Iq4wOk>. Jupiter continues to absorb impacts from space debris, with observations even as recent as September, 2012: Tariq Malik, “[Explosion on Jupiter Spotted by Amateur Astronomers](http://www.space.com/17534-jupiter-impact-explosion-amateur-astronomers.html),” *Space.com* (September 11, 2012) at <http://www.space.com/17534-jupiter-impact-explosion-amateur-astronomers.html>. The effects of impacts on the Earth are well known in history and even recently when a large meteor exploded after entering Earth’s atmosphere over Russia on February 15, 2013. For additional information, see “[Asteroid and Comet Watch](http://www.nasa.gov/mission_pages/asteroids/news/asteroid20130215.html)” at http://www.nasa.gov/mission_pages/asteroids/news/asteroid20130215.html.
- 2.17. Answers may vary, but may include the following information (this is not exhaustive): Known exoplanets frequently do not share the many life-friendly characteristics. Of the roughly 861 exoplanets known as of March, 2013 (see <http://exoplanet.eu/>), not one has the majority of features that make Earth habitable. Many are gas giants (wrong atmosphere and too much gravity), orbit around different star types (affect the available light for life processes), are not located in a habitable zone (liquid water is not possible), are not in a relatively circular orbit (unstable weather), are tidally locked with the parent star (with only one side facing the star, making the temperature extremes on the planet severe, i.e., very hot or very cold). Therefore, the claim is premature and is not consistent with the evidence found thus far. Refer to the following short video which notes near the end (from 2:50-end) that just because an exoplanet is found does not mean it is habitable: “[ScienceCasts: Re-thinking an Alien World](http://www.youtube.com/watch?v=H_CZCmJ2om0)” at http://www.youtube.com/watch?v=H_CZCmJ2om0.
- 2.18. Answers will vary depending on the individual.

Further Reading:

1. Video: A view of our atmosphere from space: <http://vimeo.com/knatephoto/iss> and <http://vimeo.com/ajrclips/nightglow>.
2. [The Extrasolar Planets Encyclopedia](http://exoplanet.eu/) website at <http://exoplanet.eu/>.

Answers

3. Short video on the need for exoplanets to be in the “Goldilocks zone” and have other features similar to Earth to be habitable: “[ScienceCasts: Getting to Know the Goldilocks Planet](http://www.youtube.com/watch?v=diz4Q3ALi5k)” at <http://www.youtube.com/watch?v=diz4Q3ALi5k>.
4. Guillermo Gonzalez, Donald Brownlee, and Peter Ward, “[Refuges for Life in a Hostile Universe](#),” *Scientific American* (October, 2001).
5. “[Earth Is Barely ‘Habitable,’ Say Scientists. Could Have Fooled Us](#),” *Evolution News and Views* (February 4, 2013) at http://www.evolutionnews.org/2013/02/earth_is_barely068811.html.
6. BBC story and video of Shoemaker-Levy 9 comet impacting Jupiter: <http://www.youtube.com/watch?v=HXgq3Iq4wOk>.

3. Video Chapters 7-8 (26:42-35:52)

Basic Questions:

- 3.1. A total eclipse (in India).
- 3.2. 400, 400.
- 3.3. chromosphere.
- 3.4. “flash” spectrum.
- 3.5. helium.
- 3.6. True.
- 3.7. “Wonderful Eclipses” in the *Astronomy and Geophysics* journal.
- 3.8. True.
- 3.9. Quote: The same narrow circumstances that allow us to exist also provide us with the best overall setting for making scientific discoveries. (Paraphrased: Habitability correlates with measurability.)

Discussion Questions:

- 3.10. A luminous object (sun), an eclipsing body (moon), and an observer platform - all of which must be at the right location to provide a total eclipse.
- 3.11. The distance from the sun affects the possibility for liquid water and an oxygen-rich atmosphere. The Moon provides a stabilizing effect for the Earth’s axis of rotation to provide moderate weather and climates, as well as mix the warm and cold oceans through tidal effects.
- 3.12. Eclipses provide the ability to study and understand the chemistry of the Sun. Through observations of the flash spectrum during an eclipse, astronomers determined how the full light spectrum of the Sun is produced. Once this was determined, then light from other stars could be studied to determine their chemistry.
- 3.13. Einstein's theory of general relativity based on gravitational lensing. (Gravitational lensing causes light to be affected by massive objects, which slightly deflect the path of light. His theory totally changed the way we view the universe.) By looking at stars that appear near the Sun due to the Earth’s orbital location, their position appeared slightly different than when checked from other orbital locations. For additional information, see Guillermo Gonzalez and Jay Richards, “[Was Starlight Deflection Important for the Acceptance of General Relativity?](#),” *Discovery Institute* (August 2, 2004) at <http://www.discovery.org/a/2150> and “[Illuminating relativity: Experimenting with the stars](#)” at http://undsci.berkeley.edu/article/natural_experiments.

Answers

Discussion Questions Beyond the Video:

- 3.14. No, they are not similar. Based upon studies performed by Gonzalez, there are no other planets within our solar system with the total solar eclipses that our Earth-Moon system experiences. This is because the several parameters necessary for total eclipses (moon size, planet distance, relative size of moon from surface of planet, shape of moon) are not present for the other planets. For additional information, refer to Guillermo Gonzalez, “[Wonderful Eclipses](http://astrogeo.oxfordjournals.org/content/40/3/3.18.full.pdf),” *Astronomy & Geophysics*, 40, no. 3 (June, 1999) at <http://astrogeo.oxfordjournals.org/content/40/3/3.18.full.pdf>.
- 3.15. No and no. Based on the Moon’s orbit around the Earth, it is gradually getting further and further away from Earth. Therefore, in the past, the Moon used to cover up the entire Sun during eclipses because of how close it was, making it much more difficult to see the Sun’s chromosphere. In the future, the Moon will be too far away and the Sun will not be completely covered; this means that the corona will not be visible due to excessive light from the Sun not being covered up.
- 3.16. The giant impact hypothesis states that there were two planets (Earth1 and Orpheus/Theia) that collided about 4.5 billion years ago, which led to the current Earth (Earth2) and moon. For additional information, see G. Jeffrey Taylor, “[Origin of the Earth and Moon](http://solarsystem.nasa.gov/scitech/display.cfm?ST_ID=446)” at http://solarsystem.nasa.gov/scitech/display.cfm?ST_ID=446, and the short article “[Planetary Demolition Derby](http://www.spitzer.caltech.edu/video-audio/855-ssc2009-16v1-Planetary-Demolition-Derby),” with video animation clip at <http://www.spitzer.caltech.edu/video-audio/855-ssc2009-16v1-Planetary-Demolition-Derby>, as well as at about 1:40 into the short video at “[ScienceCasts: Did Earth Have Two Moons?](http://www.youtube.com/watch?v=YTVps-M46tI)” at <http://www.youtube.com/watch?v=YTVps-M46tI>.

Answers may vary for the remaining portion, but could include the following information, which is not exhaustive:

The fine-tuning aspects for this collision are:

- 1) speed of impact
- 2) angle of impact (if incorrect, the Earth could have been knocked out the habitable zone orbit in which it currently resides)
- 3) sizes of planets involved in impact

If any of the above three items were different, the collision could have knocked Earth out of the habitable zone orbit or other similar life-nullifying effect. While there may be many different scenarios that provide for the dual-planet Earth-Moon system, they are essentially unique combinations – that is, once a given parameter is specified (e.g., sizes of planets), the remaining parameters (e.g., speed and angle of impact) must fall within a certain limited range to arrive at the current condition. For additional life benefits, refer to those mentioned for the moon given in the answer for 3.11.

- 3.17. Answers will vary depending on the individual.

Further Reading:

1. Guillermo Gonzalez, “[Wonderful Eclipses](http://astrogeo.oxfordjournals.org/content/40/3/3.18.full.pdf),” *Astronomy & Geophysics*, 40, no. 3 (June, 1999) at <http://astrogeo.oxfordjournals.org/content/40/3/3.18.full.pdf>.
2. Guillermo Gonzalez, “[Mutual Eclipses in the Solar System](http://astrogeo.oxfordjournals.org/content/50/2/2.17.full.pdf),” *Astronomy & Geophysics*, 50, no. 2 (April, 2009) at <http://astrogeo.oxfordjournals.org/content/50/2/2.17.full.pdf>.
3. Guillermo Gonzalez, “[Is the Sun Anomalous?](http://astrogeo.oxfordjournals.org/content/40/5/5.25.full.pdf),” *Astronomy & Geophysics*, 40, no 5 (October, 1999) at <http://astrogeo.oxfordjournals.org/content/40/5/5.25.full.pdf>.
4. Updates to Giant Impact Hypothesis (links below include short video clips):

Answers

- Mike Wall, “[Huge Moon-Forming Collision Theory Gets New Spin](http://www.space.com/18106-moon-formation-earth-giant-impact.html),” *Space.com* (October 17, 2012) at <http://www.space.com/18106-moon-formation-earth-giant-impact.html>.
 - Jesse Emspak, “[Proof of Moon's Birth in Giant Impact Found in Zinc Study](http://www.space.com/18103-moon-formation-giant-impact-zinc.html),” *Space.com* (October 18, 2012) at <http://www.space.com/18103-moon-formation-giant-impact-zinc.html>.
 - Ron Cowen, “[Moon-forming impact theory rescued: Fast-spinning proto-Earth allows chemical mixing](http://www.nature.com/news/moon-forming-impact-theory-rescued-1.11610),” *Nature News* (October 17, 2012) at <http://www.nature.com/news/moon-forming-impact-theory-rescued-1.11610>.
5. Llyd Wells, John C. Armstrong, and Guillermo Gonzalez, “Reseeding of early earth by impacts of returning ejecta during the late heavy bombardment,” *Icarus*, 162, no. 1 (March 2003) with abstract at <http://adsabs.harvard.edu/abs/2003Icar..162...38W>.
6. Llyd Wells, John C. Armstrong, and Guillermo Gonzalez, “[Rummaging through Earth's Attic for Remains of Ancient Life](http://arxiv.org/pdf/astro-ph/0207316v2.pdf),” *Icarus*, 160, no. 1 (Nov. 2002) at <http://arxiv.org/pdf/astro-ph/0207316v2.pdf>. A summary PowerPoint for this paper is also available for viewing at <http://www.astro.umd.edu/~hamilton/ASTR688R/abstracts/zauderer.ppt>.
7. Videos:
- “[ScienceCasts: Total Eclipse of the Sun](http://www.youtube.com/watch?v=Hn5nKIMY5cI)” at <http://www.youtube.com/watch?v=Hn5nKIMY5cI>.
 - “[ScienceCasts: Solar Eclipse in the USA \(annular eclipse\)](http://www.youtube.com/watch?v=7YX2blo1eRk)” at <http://www.youtube.com/watch?v=7YX2blo1eRk>.

4. Video Chapters 9-10 (35:53-47:18)

Basic Questions:

- 4.1. 70, 7 (The seven objects with a thick atmosphere are the planets Venus, Earth, Saturn, Jupiter, Neptune, Uranus, and the Jovian moon Titan; all the others have either a thin atmosphere or none at all. For additional information on the various atmospheres for these objects, refer to the following:
- Abby Cessna, “[Atmosphere of the Planets](http://www.universetoday.com/35796/atmosphere-of-the-planets/),” *Universe Today* (July 24, 2009) at <http://www.universetoday.com/35796/atmosphere-of-the-planets/>.
 - Christopher McKay, “[Titan: A Moon with Atmosphere](http://www.astrobio.net/index.php?option=com_retrospection&task=detail&id=1755),” *Astrobiology Magazine* (October 27, 2005) at http://www.astrobio.net/index.php?option=com_retrospection&task=detail&id=1755.
- 4.2. Transparent.
- 4.3. False. Only a trillionth of a trillionth is useful, which is far smaller than 1%. For additional information on electromagnetic waves, refer to the following NASA link: http://missionscience.nasa.gov/ems/01_intro.html.
- 4.4. galaxy.
- 4.5. False. The center of the galaxy creates too much light to easily see other stars and especially other galaxies beyond that centralized area of the galaxy.
- 4.6. heavy elements (which affect the formation of giant planets).
- 4.7. galactic habitable zone.
- 4.8. False. The right kind of galaxy (spiral, relatively flat) is required to make meaningful observations of our galaxy and the wider universe.

Answers

4.9. Learn about both the nature of the galaxy we are in and the universe around us.

Discussion Questions:

4.10. Life benefits: An oxygen-rich and carbon-poor atmosphere is important for complex life. The particular kind of transparency provided by the atmosphere with the correct types of molecules lets in certain types of electromagnetic waves, which also happens to be useful for complex life (e.g., photosynthesis in plants) and is an abundant type emitted by our nearby star, the Sun.

Discovery benefits: An oxygen-rich and carbon-poor atmosphere is more likely to be transparent in the scientifically important visual region of the spectrum, thereby allowing the type of light required to make visual discoveries. For example, we can study the light spectrum from stars and galaxies and learn about their properties.

4.11. Answers may vary, but may include information from the following:

- Discovery problems:

- Difficulty in measuring the cosmic background radiation (which provided evidence for the Big Bang) amongst the radiation ‘noise’ caused by all the stars, dust, and supernovae remnants near the galactic center or the generally denser portions of the spiral arms.
- Lots of stars make it too bright to see clearly beyond the galactic center or denser portions of the spiral arms.
- Too much dust, which is lit up by all the stars, similar to a fog, thereby visually obscuring areas beyond the galactic center or spiral arm.

- Life problems:

- There are too many nearby supernovae explosions.
- Increased numbers of stellar objects negatively affect a stable orbit.
- The accretion disk around the black hole in the center of galaxy emits significant amounts of radiation that would be harmful to life. Additionally, getting very close to the black hole can rip apart stars and other objects or cause nearby objects to crash into a planet - see “[ScienceCasts: The Diner at the Center of the Galaxy](#)” at <http://www.youtube.com/watch?v=UP7ig8Gxftw> or, for a 20 minute video broken up into four segments on black holes and cosmic evolution, but with the often attendant metaphysical naturalistic viewpoint, see “[The Black Hole That Made You Possible](#),” the first of which is at <http://www.space.com/10025-ep-1-eruption-space-time.html>.

4.12. It enables us to make discoveries about the nature and structure of the nearby galaxy and universe.

Answers

Discussion Questions Beyond the Video:

- 4.13. There are two other basic galaxy types: irregular and elliptical. There are additional subtypes based on these and spiral galaxies, such as lenticular, barred spiral, etc. – see <http://www.galaxyzoo.org/> for additional information on the various types of galaxies. Answers may vary for the second question, but could include some of the following information, which is not exhaustive: These other types of galaxies probably do not have relatively large, somewhat well-defined galactic habitable zones (if at all) compared to spiral galaxies. Based on the information in the video, the galactic habitable zone is influenced by the type and location of stars. Stars have generally chaotic paths in both elliptical and irregular galaxies, which is the main cause for these galactic shapes. However, these random paths have the potential of wreaking havoc on stable planetary orbits, which is not good for the possibility of life. Elliptical galaxies have less dust and star formation and, thus, mostly older stars. This implies a lack of necessary elements for planet formation needed for life as well as reduce nearby star “diversity” to learn about different star types. On the other hand, irregular galaxies have much dust and star diversity. Yet, the amount of dust ends up causing “light pollution” (similar to spiral arms or being in the galactic center of the Milky Way) which can cause difficulty viewing other parts of the universe, not to mention an increased possibility of planetary collisions.
- 4.14. Answers may vary, but could include the following information: If disk-like galaxies have been changing (rather than remaining nearly constant), then complex life is more likely to be a recent possibility rather than existing in other locations for long periods of time. This, coupled with the prior discussion question, cuts down on the number of possibilities available for habitable planets providing a haven for complex life and a platform for making discoveries. This implies that there is a cosmic habitable age. For additional information (including two informative short videos), see “[Astronomers Uncover A Surprising Trend in Galaxy Evolution](#)” at <http://www.nasa.gov/topics/universe/features/galaxy-evol.html>. This is similar to eclipses caused by the Moon because there is only a certain window of time during which eclipses are possible – the Moon is receding away from the Earth and will eventually appear too small in our sky to block out the Sun for total eclipses in about 250 million years.
- 4.15. The Drake equation should be revised to account for being in the right location within the galaxy. This parameter was not previously known. The resulting modification to the equation will end up reducing the likelihood of other complex technological life in our galaxy. For additional information, refer to Appendix A in the book *The Privileged Planet*.
- 4.16. Answers may vary, but could include the following (this is not exhaustive): In Earth’s upper atmosphere (stratosphere), ozone (which is 3 oxygen atoms) provides protection against the Sun’s harmful ultraviolet rays. Oxygen is also part of carbon dioxide, and together with water vapor, they help to keep the Earth’s surface warm by trapping heat as greenhouse gases.

Answers

- 4.17. The liquid iron inside the Earth provides a protective magnetic field through its movement through a magnetic field, leading to electrical currents, which generate magnetic fields – similar to a dynamo. This magnetic field prevents Earth’s atmosphere from being stripped away by the Sun’s solar wind (see “[ScienceCasts: Terrifying Auroras](#)” at <http://www.youtube.com/watch?v=d94ZZFU8PWM> for a short video example of an exoplanet’s atmosphere being stripped away for this very reason). The solar wind is composed of electrically charged particles that emanate from the surface of the Sun at extremely high speeds (the aurora borealis are the result of some of the solar wind interacting with the Earth’s magnetic field – see “[ScienceCasts: Auroras Underfoot](#)” at http://www.youtube.com/watch?v=WL_-Zz7JDoA, “[ScienceCasts: Here Comes Solar Maximum](#)” at <http://www.youtube.com/watch?v=k87JdeyQ-m8>, and “[ScienceCasts: The Surprising Power of a Solar Storm](#)” at <http://www.youtube.com/watch?v=EEFQHDSYP1I> – this last link also shows additional benefits provided by the Earth’s atmosphere in its ability to diffuse heat gain from solar flare activity). If the atmosphere were stripped away, then there is no protection from the Sun’s life damaging radiation. For additional information, see “[Generation of the Earth's magnetic field](#)” at http://geomag.nrcan.gc.ca/mag_fld/fld-eng.php and the first 90 seconds (0-1:30) of the short segment from NASA video available at <http://youtu.be/ujBi9Ba8hqs> as seen at “[This Video Will Make You Grateful for the Earth’s Magnetosphere](#)” at <http://www.universetoday.com/95882/this-video-will-make-you-grateful-for-the-earths-magneosphere/>. Note: This last referenced NASA video states the following from 3:40 to the end: “Earth’s climate engine has countless moving parts ... all working [together] to equalize temperatures around the globe.” Notice how similar this language is to the concept of irreducible complexity, a term coined by intelligent design proponent Michael Behe. The interaction of the atmosphere, liquid water, and terrestrial topography provide an irreducibly complex system to not only attenuate solar energy input locally at the equator, but facilitate energy distribution to other parts of the Earth. This distribution minimizes drastic temperature variations across Earth’s surface, leading to generally moderate weather, as well as provides a larger habitable surface area across the globe.
- 4.18. Different kinds of stars are important for generating heavier elements than just helium over time. Heavier elements form inside stars through nuclear fusion of lighter elements. These heavier elements are necessary to obtain the different elements associated with terrestrial habitable planets. For additional information see “[Nucleosynthesis](#)” at <http://helios.gsfc.nasa.gov/nucleo.html> and “[History/Origin of Chemicals](#)” at <http://herschel.jpl.nasa.gov/chemicalOrigins.shtml>. Different star types nearby provide a way to understand the other star types in the universe because closer ones are easier to study – their spectral light, from which their constituent chemical makeup can be determined, provides a comparative basis for making scientific discoveries of other stars in the universe.
- 4.19. Benefit: Just as Earth’s magnetic field protects the Earth, the Sun’s magnetic field protects the planets within the solar system from harmful cosmic rays. It actually extends out from the Sun beyond the furthest planet in the solar system. See “[ScienceCasts: Big Surprise](#)” at <http://www.youtube.com/watch?v=yUt6mRDV5hY> and the first portion of the video “[ScienceCasts: Alien Matter in the Solar System](#)” at <http://www.youtube.com/watch?v=krDQFFk84I>.

Answers

Hazard: The Sun's magnetic field, along with its latitudinal differential rotation, seems to be associated with solar flares and coronal mass ejections. These ejections are high energy particles that strip away atomic elements (e.g., hydrogen, oxygen and water molecules made from oxygen and hydrogen) in the upper atmosphere of nearby planets, which is a contributing factor to Venus's choking toxic atmosphere. For additional information, see the initial portion (about one minute) of the following excerpt from "[This Video Will Make You Grateful For the Earth's Magnetosphere](http://www.universetoday.com/95882/this-video-will-make-you-grateful-for-the-earths-magnetosphere/)" at <http://www.universetoday.com/95882/this-video-will-make-you-grateful-for-the-earths-magnetosphere/>.

- 4.20. Earth's magnetic field, coupled with plate tectonic movements, provides a historical data recording of Earth's past magnetic field orientation. By studying magnetic rocks at different locations across tectonic plates we have discovered that Earth's magnetic poles have flipped many times in the past. For additional information on Earth's paleomagnetism, see "[Paleomagnetism and The Privileged Planet](http://www.discovery.org/a/2229)," *Discovery Institute* (October 5, 2004) at <http://www.discovery.org/a/2229>. Plate tectonics make such discoveries possible, while also playing a crucial role in Earth's carbon cycle. The carbon cycle allows different elements within the Earth's crust to be recycled and distributed throughout the crust rather than collecting in one or a few locations due to erosion or other similar effects.
- 4.21. Answers will vary depending on the individual.

Further Reading:

1. Guillermo Gonzalez, Donald Brownlee, and Peter Ward, "[The Galactic Habitable Zone: Galactic Chemical Evolution](http://arxiv.org/pdf/astro-ph/0103165v1.pdf)," *Icarus*, 152, no. 1 (2001) at <http://arxiv.org/pdf/astro-ph/0103165v1.pdf>.
2. Guillermo Gonzalez, "[The Galactic Habitable Zone](http://ebooks.cambridge.org/chapter.jsf?bid=CBO9780511536113&cid=CBO9780511536113A016)," in *Proceedings of the Space Telescope Science Institute Symposium* (2002) at <http://ebooks.cambridge.org/chapter.jsf?bid=CBO9780511536113&cid=CBO9780511536113A016>.
3. Guillermo Gonzalez, "[Habitable Zones in the Universe](http://204.121.6.57/ftp/astro-ph/papers/0503/0503298.pdf)," *Origins of Life & Evolution of Biospheres*, 35, no. 6 (December, 2005) at <http://204.121.6.57/ftp/astro-ph/papers/0503/0503298.pdf>.
4. David S. Spiegel, Edwin L. Turner, "[Life might be rare despite its early emergence on Earth: a Bayesian analysis of the probability of abiogenesis](http://arxiv.org/PS_cache/arxiv/pdf/1107/1107.3835v1.pdf)," *Proceedings of the National Academy of Sciences*, 109: 395-400 (2011) at http://arxiv.org/PS_cache/arxiv/pdf/1107/1107.3835v1.pdf. It is worth noting that regarding abiogenesis, the authors of this article commit a logical fallacy of affirming the consequent when commenting on the short period of time from when the Earth was habitable until life first appeared.
5. To obtain a better appreciation for the large and small scales as well as the small probabilities covered in this study guide, consider watching a video, "[Powers of Ten](http://apod.nasa.gov/apod/ap110201.html)" at <http://apod.nasa.gov/apod/ap110201.html> and an updated version at <http://www.youtube.com/watch?v=jfSNxVqprvM>.

5. Video Chapter 11 (47:19-58:10)

Basic Questions:

- 5.1. The most incomprehensible thing about the universe is that it is comprehensible.

Answers

- 5.2. He thinks it is all part of some type of plan: "...our ability to discern and understand the universe is a fundamental part of what makes the universe tick. So that we're linked into it - this isn't an accident, a trivial little by-product - it is something that is linked to the great cosmic scheme of things."
- 5.3. False. Only very simple, primitive life could exist; as philosopher Robin Collins notes, anything larger than a pea would simply be crushed by gravitational effects.
- 5.4. True.
- 5.5. one.
- 5.6. Intelligible / comprehensible / understandable.
- 5.7. False. There is no Darwinian benefit given by understanding the fine details of how the universe works – it is not required for day-to-day living.
- 5.8. Conspiracy theory - it seems the universe is designed not only for life, but for discovery as well.
- 5.9. True.
- 5.10. Davies suggests that these discoveries allow us to see how God made things: "I mean, what a thought—we can glimpse the mind of God. We can actually figure out how God put the universe together."

Discussion Questions:

- 5.11. The numerical values of the constants that will allow for the existence of life are very specific in their values and the equations describing physical laws must apply everywhere - you cannot vary the constants by much or remove a physical law without having a dramatic effect on life.
- 5.12. If there was no gravity, then there would be no ability to pull together matter to form stars, planets, or complex life forms. Without gravity, life is not possible.
- 5.13. The strong nuclear force keeps the protons and neutrons together in the nucleus or center of an atom. This force makes it possible for atoms to exist, thereby making chemistry possible which is crucial for biochemical life processes.

Discussion Questions Beyond the Video:

- 5.14. It suggests that it is false. Based upon past scientific explorations often having theological motivations, it shows that such claims are inconsistent with the historical evidence. Scientific researchers' curiosity about how things work is not squelched by their belief that a deity produced what they observe. Instead, because they believe an intelligence brought things about, they believe that they should be able to understand how things work.
- 5.15. No, this is incorrect. ID does not posit a transcendent designer. For additional information, refer to the following:
- "[FAQ: What is the Identity of the Designer?](http://www.ideacenter.org/contentmgr/showdetails.php/id/1204)" at <http://www.ideacenter.org/contentmgr/showdetails.php/id/1204>.
 - "[FAQ: Is intelligent design an appeal to miracles or the supernatural?](http://www.ideacenter.org/contentmgr/showdetails.php/id/1187)" at <http://www.ideacenter.org/contentmgr/showdetails.php/id/1187>.
 - "[FAQ: Is ID just a religious or theological concept?](http://www.ideacenter.org/contentmgr/showdetails.php/id/1162)" at <http://www.ideacenter.org/contentmgr/showdetails.php/id/1162>.

Answers

- 5.16. Gonzalez was on a tenure track at ISU prior to the release of *The Privileged Planet*. However, as a result of Hector Avalos, Professor of Religious Studies (who happens to be an atheist), taking the lead to prevent Gonzalez from obtaining tenure, Gonzalez eventually had to leave ISU. The movie *Expelled: No Intelligence Allowed*, featuring Ben Stein, documents parts of what occurred to Gonzalez and others who have promoted ID, even if not in their teaching capacity. For additional information, see “[Dr. Guillermo Gonzalez and Academic Persecution](http://www.discovery.org/a/2939)” at <http://www.discovery.org/a/2939> and *Expelled: No Intelligence Allowed* at <http://www.discovery.org/expelled/>. See also a defense of *Expelled* at <http://www.ncseexposed.com>.
- 5.17. It was an extremely fine-tuned event. The rate of the expansion has to be precise to within about 1 part in 10^{120} . See Lawrence Krauss, “[Cosmological Antigravity](http://www.cosmos.phy.tufts.edu/~zirbel/ast21/sciam/AntiGravity.pdf),” *Scientific American*, (January 1999, copyright 2002 – updated from 1999 version), p. 39 at <http://www.cosmos.phy.tufts.edu/~zirbel/ast21/sciam/AntiGravity.pdf>. For a short video explaining this further, see <http://www.youtube.com/watch?v=RGCSqviuUYQ>, which is a segment from a series, *What We Still Don't Know*, by cosmologist Sir Martin Rees. If the expansion were faster, gravity would not be able to coalesce matter into stars, planets, and galaxies. If it were slower, then gravity would overtake the expansion and cause the universe to fall back in on itself. Therefore, this delicate balance is an extremely important parameter for life to even be possible in the universe. (It should be noted that Krauss is a staunch opponent of intelligent design.) However, even this incredible precision is almost nothing when compared to the precision of the initial entropy associated with the Big Bang. Mathematical physicist Sir Roger Penrose has calculated that this fine-tuned parameter must not be varied by more than one part in 10 to the 10^{123} . For details, see Roger Penrose, *The Emperor's New Mind* (Oxford University Press, 1999), pp. 444-445. See also a short YouTube video at the blog post by Casey Luskin, “[Roger Penrose on Cosmic Fine-Tuning: 'Incredible Precision in the Organization of the Initial Universe'](http://www.evolutionnews.org/2010/04/roger_penrose_on_cosmic_finetu033691.html),” *Evolution News and Views* (April 10, 2010) at http://www.evolutionnews.org/2010/04/roger_penrose_on_cosmic_finetu033691.html. If you were to attempt to write a single zero on each atom in the universe, there would not be enough atoms in the universe to write this number out. It should be noted that Penrose is not known to be an ID proponent.
- 5.18. Briefly stated, the *Kalam* Cosmological argument is as follows:
- Premise 1) Anything that begins to exist has a cause;
 - Premise 2) The universe began to exist;
 - Conclusion: Therefore, the universe had a cause.
- The Big Bang provides the physical evidence for a beginning of the universe and, thus, supports premise 2.

Answers

- 5.19. Answers will vary depending on the individual. The multiverse is one example of an attempt to address the design implications noted. Others include an inflationary period shortly after the Big Bang, coupled with the anthropic principle and multiverses to address fine-tuning issues. A popular critic of fine-tuning is Victor Stenger, who has written a book, *The Fallacy of Fine-Tuning: Why the Universe is Not Designed for Us*. A rather technical and detailed response (including identification of specific inaccuracies) to Stenger is provided by Luke Barnes in his article “[The Fine-Tuning of the Universe for Intelligent Life](http://arxiv.org/pdf/1112.4647v2.pdf)” at <http://arxiv.org/pdf/1112.4647v2.pdf> or a shorter article L. A. Barnes, “[The Fine-Tuning of the Universe for Intelligent Life](http://www.publish.csiro.au/?act=view_file&file_id=AS12015.pdf),” *Publications of the Astronomical Society of Australia*, 29: 529-564 (2012) at http://www.publish.csiro.au/?act=view_file&file_id=AS12015.pdf. A somewhat less technical version of similar response arguments can be heard on a podcast featuring Bruce Gordon, “[The Argument for Design in Cosmology](http://www.idthefuture.com/2012/10/the_argument_for_design_in_cos_1.html),” at http://www.idthefuture.com/2012/10/the_argument_for_design_in_cos_1.html. A common feature of the various alternatives to the design implication is the apparent need to respond to the evidential support for design; there seems to be an implicit recognition that fine-tuning and small probabilities of chance occurrence are inherent features of designed objects. The multiverse view attempts to do away with these by increasing the probabilistic resources to a level that would imply that the improbable will occur. In other words, some of these views conveniently say there must be enough universes in existence to ensure that one was created – namely, ours - that allowed life in spite of the odds against it. This is tantamount to saying we “just happened,” which is not a very scientific statement. For some multiverse views, their scientific nature is also highly questionable since anything outside of our universe will not be observable to us. Therefore, there would not be any way to test or falsify the claims made – they end up being metaphysical claims made by scientists rather than scientific statements made by scientists. For a brief article by Gonzalez on the speculative nature of multiverses, see Guillermo Gonzalez, “[Order Without Design?](http://www.evolutionnews.org/2009/05/order_without_design020511.html),” *Evolution News & Views* (May 22, 2009) at http://www.evolutionnews.org/2009/05/order_without_design020511.html.
- 5.20. Due to carbon’s atomic make-up (i.e., it has four electrons in its outermost electron “shell”), it can form four covalent bonds with other atoms. In addition, the energy required to make or break these bonds is at a value that allows long, stable polymers (molecules) which are still chemically reactive. It is water soluble, meaning it is easily transported during many life processes, and also a very common element. While silicon or boron have been suggested as an alternate basis of life, they suffer significant problems. Silicon usually produces lattices, which leads to hard objects, like rocks, with a high melting temperature, rather than long chains (it’s limited to about 100 unit chains, thereby limiting complex molecular structures). Moreover, silicon is not water soluble, due to the lattice structure usually formed, and is not as chemically reactive as carbon-based molecular chain structures. While silicon is very common in the Earth’s crust (far more common than carbon), there are no silicon based life forms on Earth, which is consistent with the other noted problems. For boron: while it has better geometrical variability in molecular structures than silicon and carbon, it is not as plentiful as carbon.

Answers

- 5.21. Based on the resonance energy levels associated with carbon, it is slightly more stable than oxygen in stellar nuclear synthesis. Carbon is formed through nuclear fusion of helium and beryllium. Oxygen is formed by nuclear collisions of helium and carbon. However, due to the relations between the strong nuclear force (which keeps protons and neutrons together) and the electromagnetic force (which provides the attraction between electrons and protons), oxygen's resonance level is just shy by about 0.5% of the energy levels often associated with carbon and helium collisions at the high temperatures in stars, while carbon is relatively stable by comparison. This ensures that elemental carbon is present since if the oxygen resonance levels were 0.5% more, then all the carbon would be quickly converted to oxygen. The resonance levels for carbon and oxygen allow each to be present for life processes. Sir Fred Hoyle, who helped discover this, commented on it: "A common sense interpretation of the facts suggests that a superintellect has monkeyed with physics, as well as with chemistry and biology, and that there are no blind forces worth speaking about in nature. The numbers one calculates from the facts seem to me so overwhelming as to put this conclusion almost beyond question." See Fred Hoyle, "[The Universe: Past and Present Reflections](#)," *Engineering and Science*, p.12 (November, 1981) at <http://calteches.library.caltech.edu/3312/1/Hoyle.pdf>. (It should be noted that Hoyle was not a theist nor an ID proponent, and also subscribed to some rather controversial views, some being explicitly contrary to the scientific evidence.). A recent paper by Evgeny Epelbaum et al., "[Viability of Carbon-Based Life as a Function of the Light Quark Mass](#)," *Physical Review Letters*, 110: 112502 (2013) at <http://prl.aps.org/abstract/PRL/v110/i11/e112502>, has confirmed what Hoyle noted regarding oxygen and carbon synthesis which found that "more than a 2 or 3 percent change in the light quark mass would lead to problems with the abundance of either carbon or oxygen in the universe." See "[The Fine-Tuning of the Universe for Life Just Got Finer](#)," *Evolution News & Views* (March 15, 2013) at http://www.evolutionnews.org/2013/03/the_fine-tuning_1070091.html for a summary of the paper.
- 5.22. Logically speaking, this is begging the question – it assumes the very thing that is trying to be proved. Philosopher Richard Swinburne has provided a good illustration for this point, which is something like the following: Imagine that you are chained to a fence in front of fifty sharp shooters. The order is given, "Ready! Aim! Fire!" Shortly after hearing the guns go off, you are amazed to find that you are still alive! However, you should not be amazed to be alive, simply because you are indeed alive – the unlikely did occur; if it had not, you would be dead! Is this correct, rational thinking? Which is more likely: 1) that all 50 sharp shooters missed, or one of the following 2a) there were blanks in their guns, 2b) the sharp shooters intentionally missed? In other words, there was some plan to your survival or somehow there was a design to ensure your survival.
- 5.23. From a logical standpoint, this is a bit of a strawman since the claim about the universe being designed for life is not claiming that the universe is designed to be teeming with life everywhere. In fact, upon analyzing this claim further, it turns out that this criticism actually ends up supporting the key points in the Privileged Planet hypothesis. First, in order to make the claim that most of the universe is inhospitable requires our ability to discern this – we can discover that much of the universe is hazardous to life. Second, because most of the universe is perilous to life, the Earth seems to be a veritable and uncommon oasis. In other words, Earth provides us not only a great place to live in the universe, but also a place to make discoveries about the universe.

Answers

5.24. Answers will vary depending on the individual.

Further Reading:

1. Guillermo Gonzalez and Jay Richards, *The Privileged Planet: How Our Place in the Cosmos is Designed for Discovery* (Washington DC: Regnery, 2004). Also see the following:
 - The book's website: <http://www.privilegedplanet.com/>.
 - Summary articles by authors:
 - o “[Designed for Discovery](http://www.4truth.net/fourtruthpbscience.aspx?pageid=8589952941)” at <http://www.4truth.net/fourtruthpbscience.aspx?pageid=8589952941>.
 - o “[Are We Alone in the Universe?](http://www.discovery.org/a/2143)” *American Spectator* (May 1, 2004) at <http://www.discovery.org/a/2143>.
 - o “[Paleomagnetism and The Privileged Planet](http://www.discovery.org/a/2229),” *Discovery Institute* (October 5, 2004) at <http://www.discovery.org/a/2229>.
 - Authors' response to objections:
 - o “[A Response to Some Objections by Kyler Kuehn to The Privileged Planet](http://www.discovery.org/a/2016),” *Discovery Institute* (April 29, 2004) at <http://www.discovery.org/a/2016>.
 - o For additional responses to anticipated criticisms, refer to Chapter 16 in the book, or see <http://www.discovery.org/a/2729> for a list of topics covered.
 - Book Reviews:
 - o David Hughes, “[Review of The Privileged Planet](http://www.discovery.org/a/3235),” *The Observatory*, 125, no. 1185 (April, 2005) at <http://www.discovery.org/a/3235>.
 - o Mike Martin, “[Are We Alone in the Universe?](http://www.discovery.org/a/2314),” *Hispanic Magazine* (November 22, 2004) at <http://www.discovery.org/a/2314>.
 - o Amy Combs, “[Review of The Privileged Planet](http://www.discovery.org/a/2320),” *Astronomy* (December 1, 2004) at <http://www.discovery.org/a/2320>.
 - o Philip Gold, “[The Universe: A Lab Designed with Us in Mind?](http://www.discovery.org/a/2011),” *The Washington Times* (April 18, 2004) at <http://www.discovery.org/a/2011>.
2. Mario A. López, Eduardo Arroyo Pardo, “[An Interview with Dr. Guillermo Gonzalez](http://www.ideacenter.org/contentmgr/showdetails.php/id/1451)” at <http://www.ideacenter.org/contentmgr/showdetails.php/id/1451>.
3. D. Scott Birney, Guillermo Gonzalez and David Oesper, *Observational Astronomy* (Cambridge: Cambridge University Press, 2006).
4. Jay Richards's Quiz and Answers for his talk on *Cosmic Design* at the 2002 University of San Francisco IDEA Conference in 2002 at <http://www.ideacenter.org/contentmgr/showdetails.php/id/820>.
5. MJ Denton, “[The place of life and man in nature: Defending the anthropocentric thesis](http://bio-complexity.org/ojs/index.php/main/article/view/BIO-C.2013.1),” *BIO-Complexity*, 2013 (1): 1-15 (2013) at <http://bio-complexity.org/ojs/index.php/main/article/view/BIO-C.2013.1>. For a summary of this article, see David Klinghoffer, “[The Fine-Tuning of the Biosphere: In BIO-Complexity, Michael Denton Recovers the Lost Legacy of Lawrence Henderson](http://www.evolutionnews.org/2013/03/the_fine-tuning069931.html),” *Evolution News and Views* (March 11, 2013) at http://www.evolutionnews.org/2013/03/the_fine-tuning069931.html.

Answers

6. John Gribbin, *Alone in the Universe: Why Our Planet Is Unique* (Hoboken, NJ: John Wiley & Sons, 2011). Note: Gribbin proposes designed multiverses to explain the Earth but does not consider himself an intelligent design advocate – see David Klinghoffer, “[A Privileged Planet – with Space Aliens](#),” *Evolution News and Views* (December 21, 2012) at http://www.evolutionnews.org/2011/12/a_privileged_pl054481.html for additional information.
7. Ryan Huxley, “[A Response to eSkeptic’s Review of Illustra’s The Privileged Planet Video](#)” at <http://www.ideacenter.org/contentmgr/showdetails.php/id/1403>.
8. “[Primer: Cosmic Design in a Nutshell](#)” at <http://www.ideacenter.org/contentmgr/showdetails.php/id/1137>.
9. “[Evidence of the Design of the Universe through the Anthropic Principle](#)” at <http://www.ideacenter.org/contentmgr/showdetails.php/id/837>.
10. Guillermo Gonzalez and Jay Richards, “[Priest of the Cosmos](#),” *Touchstone* (November 2006) at <http://touchstonemag.com/archives/article.php?id=19-09-047-b>.
11. Paul Davies site at Arizona State University at <http://cosmos.asu.edu/index.html>.
12. Other Space Related Videos:
 - NASA Science Casts at <http://science.nasa.gov/science-news/sciencecasts/>
 - American Museum of Natural History video “[The Known Universe](#)” at <http://apod.nasa.gov/apod/ap100120.html>.
 - Jet Propulsion Laboratory videos at <http://www.space.com/video/>.
 - NASA Goddard videos at <http://www.youtube.com/user/NASAexplorer/featured>.
 - “[Voyage to the Virgo Cluster](#)” (narrated and with an explanation at the beginning to provide context for the video) at <http://youtu.be/WMXzIOEvINK>.
 - “[Voyage to the Virgo Cluster](#)” (without narration or explanation) at <http://youtu.be/mPMD8MS5NHo>.
13. “[IDEA Center FAQs and Primers](#)” at <http://www.ideacenter.org/resources/faq.php>.

For a good list of additional reading references, see the Discovery Institute’s essential reading list at <http://www.discovery.org/csc/essentialReadings.php>.

For several years’ worth of the “[Top Ten Darwin and Design News and Resources](#),” refer to <http://www.arn.org/top10/>.

As was noted in the introduction to this study guide, if you would like to start a club to discuss intelligent design and evolution at your school, university, or in your community, consider starting an IDEA Club! The IDEA Center can provide resources to help you with doing just that, and you do not have to be an ID expert to start one - see www.ideacenter.org for further information.