



1. **What is the Big Bang theory? What does it describe?:** - An effort to explain exactly what happened at the very beginning of the universe
- Time and space were created by a gigantic explosion that emanated from a singularity
2. **What are the three main lines of observation that support the Big Bang theory:**
 1. Doppler shift: When an object is coming towards it sounds differently then when you are walking away from sound
 2. Cosmic Microwave Background: Estimated that it was extremely hot in the first seconds of the universe and it expanded
 3. Abundance of light elements: hydrogen (75%), helium (25%), lithium (trace)
3. **What are the possible shapes of the universe?:** - Positive curvature: "closed" universe, finite size without boundary, eventually stop expanding and contract
- Negative curvature: "open", saddle-shaped, infinite and unbounded, parallel lines eventually diverge
- Flat: Infinite in spatial extent, no boundaries, parallel lines are always parallel
4. **What makes up the most matter in the Universe?:** Dark matter: 27%
Conventional matter: less than 5%
5. **How can we know the age of the universe?:**
 1. Observing the composition of gases around old stars
 2. Knowing the exact radioactive processes required to produce these gas compositions from the very first element created in the Big Bang
 3. Knowing all the time factors involved in breaking down one component to yield others
6. **How do we measure distances in space?:** Light years and astronomical units
7. **Explain how to use trigonometric parallax to tell the distance of nearby stars?:** Relies on an object appearing to be at a different place relative to the background, depending on your viewpoint
8. **Will the Milky Way ever crash with the Andromeda galaxy?:** Yes, the Andromeda galaxy is hurtling towards the Milky Way galaxy, they are expected to crash in about 3 billion years
9. **Formation of elements from light to heavy. Which ones form in the Big Bang, a star or a supernova?:** - Big Bang: H, He, Li
- Star: Fe
- Supernova: Heavy elements
10. **Describe the nebular hypothesis:** This hypothesis suggests that the solar system began as an enormous cloud of dust and gas. The cloud began to rotate,



heat was produced, and the cloud began to collapse toward the center. The sun formed at the center from this heat. Cooling of the cloud caused rocky and metallic materials to form the inner planets. The outer planets formed from lighter materials and gases.

11. The interior planets are made from condensed refractory materials, what happened to the more volatile gases?: Got swept out of the solar system -- not completely understood

12. Explain how changes in bombardment rates support the nebular hypothesis: The bombardment rate should have been very high early on, but fell off very quickly as time passed

13. The sun is a main sequence star T/F?: True

14. What is the structure of the Sun?: photosphere, chromosphere, corona

15. What is the most common element in the Sun?: Hydrogen 71%

16. What is the purpose of NASA's genesis mission and how was it accomplished?: - Set out to capture particles of solar wind and return them for study
- Travelled to the space between Earth and the Sun for 2 years

17. What was so surprising about the results of the Genesis mission?: The isotopic compositions of oxygen and nitrogen implanted in the wafers are significantly different to those in most of the solar system objects which we have measurements for

18. Does the Sun have a magnetic field: yes, it ejects large amounts of charged particles and plasma into space when solar storms occur.

19. How often does the Sun's magnetic field usually flip?: About every 11 years

20. Does the Solar Wind reach Earth?: No, Earth's magnetic field protects Earth's surface

21. What are 2 effects of magnetic storms on Earth caused by solar flares?: 1. aurora borealis
2. aurora australis

22. How does aurora borealis form?: On their way to Earth's magnetic poles, the solar particles interact with the molecules of gas in the upper atmosphere; the result is emission of a light photon from each collision

23. What are the stages of the Sun from birth to death?: - Birth in Big Bang
- Main sequence star
- Core H exhaustion



- Red Giant
- White Dwarf

24. Why is the Hubble Space telescope (HST) orbiting Earth?: To make up for the distortion Earth's atmosphere creates

25. What do non-optical telescopes do?: Detect radio waves, X-rays, ultraviolet and infrared light, gamma rays

26. Name the Planets in order from their distance to the Sun: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
(My Very Educated Mother Just Served Us Noodles)

27. What is the largest object in the asteroid belt?: Ceres

28. What does the Grand Track theory tell us about how quickly Jupiter formed?: Jupiter got "caught" by Saturn and both Jupiter and Saturn swung around to move back into their current positions

29. Bad Moon Hypotheses: - Fission Hypothesis: Moon broke off from a rapidly spinning Earth, this would require that Earth rotated every 2.5 hours rather than 24 hours

- Condensation Hypothesis: Both bodies formed from the same parental 'cloud' of dust and gas at the same time, the Moon would need to orbit Earth exactly on an equatorial plane

- Capture Hypothesis: Earth and Moon formed contemporarily from the same material, every single attempt to model a capture via computer failed

30. How did the Giant Impact affect Earth's structure?: Gave Earth a large metal core and remarkably high density

31. Was Theia large or small?: Around the size of Mars (half of Earth)

32. Earth size and density: 5th largest planet, densest planet

33. How did early life develop on Earth?: In water because it was protected from outside hostilities

34. What makes Earth unique among terrestrial planets?: The composition of the atmosphere, liquid water on surface and biosphere

35. Explain the role of accretion in the formation of Earth: The first large object would have attracted others by simple gravity; as the object grew larger, it attracted more and more material spin faster and faster soon becoming a protoplanet

36. How did differentiation form different zones on Earth?: During the period when Earth was molten, there was general donation of elements from heaviest at its core to lightest at its top



- 37. How do pressure, temperature and density change as you move from crust to core?:** From surface to core both pressure and temperature increase and from surface to core density increases
- 38. Why does Earth have a magnetic field?:** Earth can be thought of as a dipole (2-pole) magnet. Magnetic field lines radiate between Earth's North and south magnetic poles
- 39. What is the evidence that supported the hypothesis of continental drift?:** - Da Vinci found shells high in mountains that were once at seafloor
- Darwin observed the coastline of Chile had been raised up as a result of a great earthquake
- Alfred Wegener showed that a number of features could be connected across the gap of oceans -- Pangaea
- 40. What are the 3 types of plate margins?:** 1. Divergent: Plates moving apart (Mid-Atlantic Ridge)
2. Convergent: Plates moving toward each other (South American continents)
3. Transform Fault: Boundaries where 2 plates slide past each other (San Andreas Fault)
- 41. What mechanism drives plate tectonics?:** Convection
- 42. How old is Earth? Surface? Ocean floor?:** - Earth is 4.5 billion years old
- Surface is younger because Earth is an active planet
- Ocean floor is about 250,000 years old
- 43. Describe how the Earth's atmosphere, hydrosphere and biosphere are interconnected:** The atmosphere's composition, atmospheric pressure and density are all intimately connected to the fact that Earth is covered by vast quantities of water
- 44. Why does Earth's atmosphere differ from Mars and Venus?:** - Earth's atmosphere 1 bar
- Mars atmosphere 0.07 bars
- Venus atmosphere 90 bars
- 45. Where did Earth's water come from?:** - 4-4.5 billion years ago, Earth was pummelled by comets and asteroids containing small quantities of water
- As long as Earth's surface remained hot, water stayed as water vapour in the atmosphere, when surface cooled water vapour turned into rain
- 46. Explain 2 ways that biology has affected the composition of the atmosphere:** 1. Photosynthesis: Plants combine CO₂ and H₂O to form organic matter and O₂



2. Removal of carbon from atmosphere to form organic matter and limestone, the biosphere lowered the CO₂ content, temperature declined

47. How did prokaryotes that lived in anaerobic ancient oceans avoid the toxic effects of the oxygen they produced during photosynthesis?: - Abundant organisms means a lot of oxygen produced but this soon kills most organisms -- cycle repeats

- Most available iron is consumed, free oxygen began to appear
- Eukaryotes gained an advantage

48. Explain how studying impact craters can tell us the age of the Moon: The older a surface, the more impact craters, if we could estimate the rate of crater production, then we could count the number of craters and calculate a relative age

49. Are we more likely to see small craters hit the Earth or the Moon?: Earth -- bigger gravitational field

50. What are the general steps of crater formation?: - A shockwave or highly compressed energy zone compresses the asteroid or meteorite, compresses the rock and makes it deform the impact sites

- Upon penetrating the surface, this shockwave 'explodes' below surface, any rock layers that were initially flat are bent up and down

51. Why are all rocks on the Moon igneous?: They formed by cooling and solidification of molten rock

52. Why weren't sedimentary rocks found on the Moon?: Because the Moon never had liquid on its surface

53. What is the geological history of the Moon?: - Formed in molten state

- Period of cratering that began as soon as the crust solidified
- Such intense cratering led to lava flooding
- Final period of slow evolution

54. Why is it so hard for us to view Mercury's surface?: Because it is so close to the Sun

55. How is Mercury similar to the Moon? How is the surface different?: - For both, rotation has been altered by tidal attraction, their surfaces heavily cratered, their large craters flooded by ancient lava flows, both are small, airless and have ancient, inactive surfaces

- Mercury has enormous cliffs and lacks the great, dark lava plain so obvious on the Moon

56. What mission/craft provided us with most information about Mercury?: - MESSENGER in 2011



57. **Which is longer on Mercury a day or a year?:** Day
58. **Is the surface of Mercury hot or cold?:** Extreme temperatures vary because of the orbit, too small to keep an atmosphere
59. **What is the origin of the atmosphere on Mercury?:** Has a very thin atmosphere consisting of atoms blasted off its surface by the solar wind
60. **What is the evidence for lava flows on Mercury?:** Much of Mercury's surface is old and cratered but others called inter-crater plains are less so -- suggests they were produced by lava flows
61. **Why does Mercury have a low albedo?:** Because Mercury's surface is mainly composed of dark porous rock
62. **Since there are no plate tectonics on Mercury why do we see things like faults and scarps?:** It is still contracting
63. **How are hollows on Mercury formed?:** When material beneath were vaporized away asteroid impacts
64. **What is the geological history of Mercury?:** - Formed in the innermost part of the solar nebula, giant impact robbed it of some of its lower-density rock and left is a small, dense world with large metallic core
- Suffered heavy cratering by debris
- Flooding, formed smooth plains, ended quickly
- Slow surface evolution
65. **What 2 elements are surprisingly common the surface of Mercury?:** Sulphur and magnesium
66. **Is there water on the surface of Mercury?:** - Earth-based radar imaging indicated that sitting in shadowed craters was something highly reflective (water ice)
67. **Why is it hard for us to see Venus surface?:** The top layer is a cloud which never clears
68. **What are the 3 main sources for information on Venus?:** USSR Venera, USA Magellan, Venus Express
69. **Why does Venus rotate clockwise?:** Retrograde motion
70. **Which is longer on Venus a day or a year?:** Day
71. **What is the composition of the cloud layer? What is the main component of the atmosphere?:** - Cloud layer consists of liquid/solid sulphur and droplets of



sulphuric acid

- Main component of atmosphere is carbon dioxide

72. How does Greenhouse effect differ on Earth and Venus?: Earth avoided runaway greenhouse effect because it was further from the Sun and cooler thus it could form oceans to absorb carbon dioxide

73. Has there ever been evidence of water on Venus?: Yes, habitable zone, gravitational and tidal theory

74. Why are there fewer impact craters on Venus compared to the Moon and Mercury?: Result of the planets dense atmosphere

75. What is the evidence that the surface of Venus is so young?: Craters are rarely filled with lava, radar images show them to be rough -- they have not had time to erode

76. What volcanic features exist on the surface of Mars?: Clusters of small volcanic domes, immense volcanoes, immense blocky ridges and valleys bounded by faults

77. What causes a global volcanic event? Evidence?: Build up tremendous heat and like a gigantic pressure cooker periodically "boil over" into volcanic eruptions that resurface the whole planet

78. Why do rocks erode faster on Earth than on Venus?: Rocks must be dry on Venus to erode

79. What causes erosion on Venus?: Wind

80. What causes the weak magnetic field on Venus?: Does not come from interior, but solar wind and upper atmosphere

81. What is the proposed geological history of Venus?: Formed only slightly closer to the Sun than Earth, similar planet differentiated in a silicate mantle and molten lava core

82. Why is there no active plate tectonics on Venus?: The crust is so hot that it is halfway to the melting point of rock, not very stiff so it cannot form the rigid plates

83. Do canals exist on the surface of Mars? Why are people so excited about this?: No, an early astronomer drew lines that people believed were human made canals leading people to believe there was life on Mars

84. Is Mars smaller or larger than Earth?: Smaller

85. Is there greenhouse effect on Mars?: No



86. **Does Mars have satellites? Are they round?:** Yes Phobos and Deimos they are not round
87. **Are there seasons on Mars?:** Yes, as the northern and Southern Hemispheres turn alternately toward the Sun
88. **Which is longer on Mars a day or a year?:** Day
89. **What are the names of the spacecraft that explored Mars from its surface?:** Mars Curiosity and Mars Opportunity
90. **What are Curiosity's objectives and what is it looking for?:** - To investigate whether Mars could or has ever held microbial life
- To explore the presence of water on Mars
- To explore Martian climate
- To explore Martian geology
91. **Does Mars have an atmosphere? Primary composition? Water?:** Yes, 98% carbon dioxide, water vapour
92. **How did Mars atmosphere form?:** Venus, Earth and Mars atmospheres were all produced by the same mechanism -- similar planetary compositions so had similar atmospheres
93. **Implications of high versus low velocity to atmospheric composition:** The more massive the planet, the stronger its gravitational attraction, thus the higher its escape velocity and the more difficult it is for gas atoms to leak into space
94. **Can water escape Mars atmosphere? How is it lost? Was there ever liquid water on the surface?:** Yes through water vapour
95. **What evidence do we have for weather, storms or wind on the surface of Mars?:** - Areas warmed by sunlight emit water vapour into the air, when dawn happens this vapour freezes to form clouds or ground fogs of water ice crystals
- Ground for clings to channels and canyons
- Winter conditions led to freezing of CO₂, which creates a winter polar hood of CO₂ clouds over polar regions
96. **We have not found liquid water on Mars, but what evidence do we have that there was/is water on Mars?:** Many geological features were formed by running water, significant amounts of water in the crust -- gullies
97. **Where does water currently exist on Mars?:** - Ice caps
- Ice as permafrost just below the surface
- Water chemically bound to other elements in minerals and rocks
- Tiny amounts of water vapour (frost and ice deposits)



98. **Why does Mars surface lack the same regolith as the Moon?:** It cooled more slowly and its volcanism lasted longer

99. **Why are there few craters on the northern lowland?:** Resurfaced a billion years ago, used to be an ocean

100. **Give examples of surface features that tell us something about the crust of Mars:** - Shield volcanoes
- Largest volcano has not sunk into the crust -- thick

101. **Is Mars core molten? Metal? Is there a magnetic field?:** Thick syrupy iron core, does not have a magnetic field anymore

102. **How were Mars volcanoes formed:** Plumes

103. **What are the 4 stages of developmental history of Mars?:** 1. Differentiated into a core, mantle and crust, no trace of plate tectonics

2. Cratering -- heavy bombardment

3. Planet formation and flooding (magma and water)

4. Crust is now too thick to be active, lost much of its internal heat, lacks molten core, too thick for plate tectonics

104. **What is the greenhouse effect on Venus?:** As the surface of Venus warmed, any oceans that did exist evaporated, and thus Venus lost the ability to cleanse its atmosphere of CO₂. The high temperature baked CO₂ out of the surface, and the atmosphere began even less transparent