The correct answers are written in **bold, italic and underlined**.

The most important questions to study for the exam are **highlighted**.

1. Venus appears to be very bright in our sky at certain times because
   - *it is covered in reflective clouds and is relatively close to the Sun.*
   - it is glowing from the heat of its surface, where the temperature is 750 K.
   - the exposed surface of the planet is mostly new lava and is reflecting sunlight effectively.

2. What is the color of the clouds of Venus, and why?
   - *Yellowish due to sulfur and sulfur compounds*
   - Brownish, reddish, and bluish due to phosphorous compounds and other impurities
   - White due to water droplets as in the Earth's clouds

3. What interesting result do spacecraft measurements show about sulfur on the planet Venus?
   - Sulfur and sulfur compounds are essentially absent in the atmosphere of Venus, in contrast to the Earth where significant levels of sulfur are maintained by intermittent volcanic activity.
   - *Sulfur is an important component of Venus' atmosphere, producing hydrogen sulfide in the atmosphere and sulfuric acid in the clouds.*
   - Sulfur is continuously being ejected by Venusian volcanoes, covering large areas of the planet with white sulfur dioxide frost and colorful sulfur compounds.

4. What evidence is there for ongoing volcanic activity on a terrestrial planet besides the Earth?
   - Large volcanoes and a major fault valley on Mars
   - *Varying amounts of short-lived sulfur compounds in the atmosphere of Venus*
   - Fault scarps and lava-flooded craters on Mercury

5. The temperature in the atmosphere of Venus decreases smoothly with increasing altitude all the way from the surface (hottest) to the outermost parts of the atmosphere (coolest). What does this observation tell us about the atmosphere of Venus? (/Hint: Think about why the temperature in the Earth's atmosphere differs from this.)
   - Venus has essentially no convection in its atmosphere.
   - Venus has no distinct layers of clouds or aerosols in its atmosphere.
   - *Venus has essentially no ozone in its atmosphere.*

6. Compared to the Earth's atmosphere, that of Venus has
   - much lower temperatures (200 K), due to the dense cloud cover, and higher pressure (90 atmospheres).
   - *much higher atmospheric pressure (90 atmospheres) and temperature (750 K).*
much higher temperature (750 K) and hence much lower surface pressure (1/100 atmosphere).

7. The key gas on Venus that is responsible for the greenhouse effect, the build-up of high temperatures in its lower atmosphere, is
- H₂O (water vapor).
- \( \text{CO}_2 \) (carbon dioxide).
- sulfuric acid vapor.

8. The so-called greenhouse effect that produces very high temperatures on the surface of Venus is
- the absorption by the CO₂ gas of the planet's atmosphere of infrared radiation emitted by the hot planet surface, which itself is heated by sunlight.
- the trapping of hot gases ejected by continuously active volcanoes under the dense cloud cover.
- the absorption of solar visible radiation by the CO₂ gas of the Venusian atmosphere, thereby heating this gas.

9. If Venus had an atmosphere of about the same density as the Earth's and no greenhouse effect, what would be the probability of life existing on its surface?
- Quite high since Venus is in the same part of the solar system as the Earth
- Hard to say in the absence of any information on which to base a decision
- Essentially zero

10. The method used to map and image most of the surface of Venus from an orbiting spacecraft was
- exploration by remotely controlled vehicles on the surface of Venus, equipped with television cameras.
- the reflection of microwave radiation from the surface.
- direct photography from the Earth and the Hubble Space Telescope using electronic cameras.

11. What is Ishtar Terra, and on which planet would you find it?
- A continent-like plateau on Venus ringed by mountains
- An extensive dome-shaped feature on Mars topped by three large, extinct volcanoes
- A multi-ringed impact basin on Mercury partially flooded with lava

12. How does the surface of Venus compare to that of the Earth?
- The two are very similar, with several continent-sized highland regions separated by very wide, deep basins.
- Venus' surface is much flatter, made up almost entirely of lava plains.
- Venus' surface is more extreme, with folded mountain ranges alternating with long, deep trenches over most of the planet.

13. As inferred from relative crater counts on the Venustian surface, the age of this surface compared to that of Earth is
- much younger and of a relatively uniform age all over the planet.
- very uneven in age, with many areas much older than any Earth rock and many other areas of much younger volcanic rock.
- much older and of the same age in all regions of the planet.
14. The reason why Venus' surface is only lightly cratered appears to be that
   • crustal melting has obliterated the early cratering, and there has been little recent cratering.
   • the heavy bombardment that cratered our Moon did not reach in as far as Venus and Mercury.
   • the dense atmosphere protected the surface from ever being heavily bombarded by debris from space.

15. There is some evidence that Venus' crust has melted several times since Venus formed. What is believed to have been the cause of this melting?
   • Periodic heavy bombardment by asteroids releases enough heat to melt the crust to a depth of at least 500 m.
   • The CO$_2$ atmosphere becomes extremely dense, producing an intense greenhouse effect. The atmospheric temperature then builds up until the crust melts.
   • The crust becomes quite thick and insulates Venus' interior. Heat then builds up below the crust until the crust melts.

16. What is distinctive about the rotation of Venus about its axis?
   • It rotates in retrograde direction, opposite to that of most of the other planets.
   • Its spin axis is almost parallel to its orbital plane so that each pole points almost directly at the Sun once each orbit.
   • It rotates much more rapidly than the Earth or Mars, completing one rotation in about 10 hours.

17. Venus is about the same size as the Earth; but whereas the Earth has a significant magnetic field, Venus does not. Which of the necessary requirements for generating an intense magnetic field is not met by Venus?
   • Molten interior
   • Rapid rotation
   • Iron core

18. Venus does not have a global magnetic field generated in its core, even though Venus is similar in size to Earth and its core appears to be molten. What conditions appear to be preventing the formation of such a global magnetic field at Venus?
   • Venus' molten interior is non-magnetic, being composed mainly of aluminum and sulfur, not iron, cobalt, and nickel.
   • Venus has a molten core dominated by iron, cobalt, and nickel, but it rotates too slowly to drive an internal magnetic dynamo.
   • Venus is much closer to the Sun than the Earth is, and the ionized solar wind swirling around the planet cancels any internal magnetic field.

19. The volcanoes of Mars are active and spewing sulfur and other compounds into the atmosphere continuously, more like geysers than volcanoes.
   • small, extinct now, and in lines across the planet, indicative of plate tectonic action in the past.
massive, extinct, and solitary structures.

20. What process is believed to have caused the Valles Marineris (Mariner Valleys) of Mars?

- **Crustal fracture by subsurface tectonic activity**
- Sudden, enormous flash floods due to melting of subsurface ice
- Erosion by an ancient river and its tributaries