**THE SOLAR SYSTEM: BRAIN & PENCIL**

The following questions all reference the slides that will be shown. (Each is worth two points which you may split.)

1) On this moon with a thick atmosphere, **Titan**
   a) it is possible to stand in a hydrocarbon rain on a methane/nitrogen lake.
   b) spectroscopy indicates the presence of free oxygen (O₂).
   c) the rotation rate is such that the same side always faces the sun.

2) On this world (oriented in the slide as it is seen in Earth’s sky),
   a) Mare Crisium (the Sea of Crisis) is visible mostly in the waning phases.
   b) the crater Copernicus is older than the flood basalts that form the maria.
   c) we are certain there are footprints of aliens. **Luna**

3) The deep blue feature is on a planet that
   a) is about 30 AU from the sun. **Neptune**
   b) absorbs more energy from the sun than it radiates.
   c) has ammonia compounds in its atmosphere.

4) This world is unique for
   a) active volcanoes. **Earth**
   b) solid water.
   c) sticks.

5) Valhalla, pictured here, is
   a) on Europa.
   b) the largest volcano in the solar system.
   c) the largest impact crater in the solar system.

6) The vertical striations in this image
   a) are caused by the solar wind impacting Earth’s magnetosphere and particles high in its atmosphere.
   b) show electrical discharges between the ionosphere and tropospheric thunderstorms
   c) are flaws on the film.

7) The Earth feature shown is the
   a) Barringer Meteor Crater in Arizona.
   b) Chicxulub Crater in Yucatán.
   c) Manicouagan Crater in Quebec. **Chicxulub**

8) The Galileo images of this world
   a) indicate motions in a liquid water mantle.
   b) show lots of impact craters.
   c) show powerful many volcanoes are active. **Io**

9) The mountain shown surrounded by clouds is
   a) on Earth. **Olympus Mons on Mars**
   b) the largest volcano in the solar system.
   c) the largest impact crater in the solar system.
The following questions do not reference slides but are still each worth two points.

10) Rift valleys are formed when
   a) continents are ripped apart by tectonic activity.
   b) the population of a valley such as the St. Lawrence valley
      are politically divided along sharp lines.
   c) the sea floor crumples due to the collision of tectonic plates.

11) The continents on the surface of Earth
   a) moved in the geologic past but are now in their final positions.
   b) are moving even as we sit here taking this silly exam.
   c) will erode away and eventually disappear.

12) Earth’s geologic activity is driven by
   a) heat from the sun being absorbed by the surface.
   b) the moon’s tidal forces.
   c) heat within the Earth created by radioactive decay.

13) The greenhouse effect
   a) occurs because the visible light absorbed by the ground is re-radiated as infrared light that is then
      absorbed by greenhouse gases like CO₂, CH₄, and H₂O, heating the atmosphere.
   b) occurs when the atmosphere lets infrared light in but not out (like a one-way mirror).
   c) does not operate on any planet other than Earth.

14) The age of the Earth is estimated at roughly
    a) 4.6 thousand years.
    b) 4.6 million years.
    c) 4.6 billion years.
    d) more than 10 billion years.

15) The free oxygen in Earth’s atmosphere
    a) was released by chemical reactions in the early oceans.
    b) allowed land life to evolve by forming the ozone layer.
    c) was present in the primeval atmosphere.

16) The day on Venus
    a) is many Earth months long.
    b) is only a few Earth hours long.
    c) is much brighter than the Venusian night.

17) The largest volcano in the solar system is
    a) Mauna Kea on Earth.
    b) Prometheus on Io.
    c) Olympus Mons on Mars.
18) In *The Driest Place on Earth*, they followed a number of lines of evidence to explain why it is so dry. Explain

a) the name and location of the driest place on Earth,
b) two lines of evidence as to how dry it is and
c) any two lines of evidence as to how long it has been so dry and why it is so dry.

a) The Atacama desert in Chile, west of the Andes is dry because
b) Any two of
  1. The official rain gauge has recorded < 1mm/year for 15 years. In the glass cylinder, the Sahara got a full cylinder, the Mohave about half and the Atacama a few drops
  2. Gypsum outcrop showed < 2” of rain in any one year in last 115 million years
  3. Geysers and coastal volcanoes show it was raised from sea bed to 2 miles high by Subduction of the Pacific plate. Dryness preserved copper (world’s largest mine)
  4. Pyroxene minerals that emit $^3$He due to cosmic radiation show boulders have not been moved in 23 million years … no tumbling in runoff … since S.Am. & Antarctica split.

c) Any two of
  2. It lies on the Tropic of Capricorn under the sub-tropical high
  5. Penguins on shore show cold current next to Chilean coast. Cold air can’t rise to bring rain to desert … held down by descending air from aloft (STHPC)
  7. Andes high enough to block rain from Amazon (SE Trades) for 10 million years
  8. Bacteria life in salt because it absorbs water from high humidity

19) If a 150 g piece of granite at 100°C is dropped into 150 mL (150 g) of water at 0°C, the final temperature will be only 16.2°C. Explain why the equal masses of stone and water don’t come to an equilibrium temperature of 50°C.

Water has a much higher heat capacity than granite … it takes a lot more energy to change the temperature of water (heating it) than to change the temperature of granite (cooling it)

20) Complete the table.

<table>
<thead>
<tr>
<th>World</th>
<th>Planet or Moon?</th>
<th>Dist. from Sol</th>
<th>Size</th>
<th>Notable Characteristic(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triton</td>
<td>Moon</td>
<td>30 AU</td>
<td>Smaller than Luna</td>
<td>Nitrogen geysers</td>
</tr>
<tr>
<td>Venus</td>
<td>Planet</td>
<td>0.7 AU</td>
<td>0.95 $R_E$</td>
<td>Thick Atmosphere, $H_2SO_4$ clouds, day longer than year</td>
</tr>
<tr>
<td>Enceladus</td>
<td>Moon</td>
<td>10 AU</td>
<td>Smaller than Luna</td>
<td>Water Geysers</td>
</tr>
<tr>
<td>Saturn</td>
<td>Planet</td>
<td>10 AU</td>
<td>9.5 $R_{Earth}$</td>
<td>Rings!!</td>
</tr>
</tbody>
</table>

The last word in ignorance is the person who says of an animal or plant: “What good is it?” If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first part of intelligent tinkering.

-- Aldo Leopold