Answer Key to Solar System Test

1. Kepler's Laws (7 points)
   a. The orbits of planets are ellipses (1 point) with the Sun at one focus (1 point).
   b. Perihelion (1 point); at perihelion, the planet's distance from the Sun is shorter than at aphelion, so it must travel faster to sweep out an equal area that is swept out at aphelion when the planet is moving slower (1 point).
   c. 11.2 years (1 point)
   d. Total: 4 solar masses (1 point); A is 1 solar mass; B is 3 solar masses (1 point).

2. Eclipses (10 points)
   a. The moon looks copper-red (1 point for something similar) because of sunlight scattered through Earth's atmosphere (1 point).
   b. The moon's orbit is tipped a few degrees from the plane of Earth's orbit, so most full moons pass north or south of Earth's shadow, and most new moons cross north or south of the sun (2 points).
   c. The astronauts would be in Earth's shadow thus in total darkness (1 point). They can only see starlight and the refracted red ring of light from Earth's atmosphere (1 point).
   d. The moon would be completely black (1 point).
   e. chromosphere, corona, and prominences (0.5 point); photosphere (0.5 point)
   f. An annular solar eclipse occurs when the moon is in the farther part of its orbit during a solar eclipse (1 point). The moon does not have enough angular diameter to cover the photosphere, and observers see a ring around the moon (1 point).

3. Mercury (9 points)
   a. Image A depicts the Caloris Basin (1 point).
   b. MESSENGER (1 point)
   c. The weight of the lava flows caused the crust to sag (1 point).
   d. lobate scarps (1 point)
   e. As the metallic core cooled and contracted, the brittle crust broke to form lobate scarps (1 point).
   f. A large impact shattered and drove off some crust (1 point).
   g. After the heavy bombardment period, lava flows covered the older craters (1 point). Then craters accumulated from impacts (1 point).
   h. Lava flows from the Caloris impact smoothed out the surface, forming smooth plains (1 point).

4. The Moon (13 points)
   a. Mare Imbrium OR Imbrium Basin (1 point)
   b. Near the end of heavy bombardment (1 point), a planetesimal struck the moon and blasted out a giant multi ringed basin. Lava flows then flooded the basin, burying all but the highest parts (1 point).

c. The terminator (1 point)
d. The same side of the moon faces Earth at all times (1 point)
e. Large-Impact Hypothesis (1 point for something similar); a protoplanet nearly the size of Earth differentiates to form an iron core. Another body that has also formed an iron core strikes the larger body and merges, trapping most of the iron inside (1 point). Iron-poor rock from the mantles of the two bodies forms a ring of debris (1 point). Volatiles are lost to space as the particles in the ring begin to accrete into larger bodies. Eventually the moon forms from the iron-poor and volatile-poor matter in the disk (1 point).
f. Fission Hypothesis: The material that left the Earth would most likely result in the Pacific Ocean forming, but the Moon is made up of mantle material, not oceanic crust (1 point). Condensation Hypothesis: The moon does not possess an significant iron core (1 point). Capture Hypothesis: Capture into the moon's current orbit is improbable. Also, the lunar material received extra baking which cannot be explained by this hypothesis (1 point).
g. Much of the lunar crust was fractured by meteorite impacts (1 point).

5. Comparing and Contrasting Mercury and the Moon (6 points)
   a. Both were formed as a result of a large impact (1 point for something similar). The Imbrium Basin (Image C) is more deeply flooded with lava (1 point for something different that's not one is on the moon; the other is on Mercury).
   b. Both Mercury and the Moon are too small to retain internal heat, preventing them from becoming geologically active (2 points).
   c. The moon does not have a large metal core, thus the interior would not have contracted as much, so major lobate scarps would not be produced (2 points; give only 1 point for an answer involving destruction of surface features by early bombardment.)

6. Venus (12 points)
   a. CO_2 and N_2 (1 point)
   b. H_2SO_4 (1 point); due to extreme heat, gases escaped from the rocks and combined with the air to form sulfuric acid molecules (1 point).
   c. Volcano Sapas Mons (1 point)
   d. Magellan (1 point)
   e. Young lava is brighter, and it flows over the solidified, older, and darker flows (1 point).
   f. Basaltis Vallis (1 point), the largest lava-flow channel in the solar system (1 point)
   g. Lava drained from beneath the crust (1 point).
   h. Plate tectonics does not occur in Venus's crust (1 point).
   i. Sif Mons (1 point)
   j. On the surface, the rock looks gray (1 point).

7. Mars (19 points)
   a. CO_2 (1 point)

b. Mars has no magnetic field to shield from solar wind (1 point).
c. Olympus Mons (1 point); it is the largest volcano in the Solar System (1 point; do NOT accept largest mountain).
d. Tharsis Bulge (1 point)
e. Mars does not have any plate tectonics, so the crust does not constantly reshape itself (1 point).
f. The crust is quite thick (1 point).
g. 1. Noachian period (0.5 point): Valley networks formed during this period, which suggests that the atmosphere was denser than, and water fell as rain or snow. Ended by heavy cratering 3.7 billion years ago (1.5 points if students get most of this). 2. Hesperian period (0.5 point): began as cratering declined and massive lava flows resurfaced some regions. The climate was colder and the atmosphere was thinner with water frozen in the crust. Massive floods and outflow channels seem to have been produced by sudden melting of subsurface ice (1.5 points if students get most of this). 3. Amazonian period (0.5 point): extended from about 3 billion years ago to the present. It is marked by continued low-rate cratering and erosion by wind, and by small amounts of water seeping from subsurface ice (1.5 points if students get most of this).
h. North Polar Ice Cap (1 point)
i. Water ice (1 point)
j. South Polar Ice Cap (1 point)
k. Dry ice (1 point)
l. H (1 point)
m. The atmospheric pressure is too low, so water will vaporize quickly (1 point).

8. Deimos and Phobos (4 points)
   a. Phobos (1 point)
   b. The moons were asteroids that were pulled into orbit by Mars's gravity (1 point).
   c. They are not large enough to to possess enough gravity to pull themselves into a spherical shape (1 point)
   d. Phobos and Deimos are too small to retain any internal heat. With no energy flowing outwards, there can be no volcanism (1 point).

9. Io (3 points)
   a. Tidal heating from Jupiter's gravity (1 point)
   b. Due to tidal forces, craters are constantly destroyed or buried as fast as they form (1 point)
   c. Sulfur compounds from the volcanoes color the surface yellow.

10. Asteroid Belt (7 points)
    a. Ceres (1 point)

b. The core is rocky (1 point for something similar), and the mantle is icy (1 point).
c. Vesta is clearly differentiated (1 point).
d. Kirkwood gaps are gaps in the semi-major axes of asteroids. There is an extremely low density of asteroids in orbital paths that are in resonance with Jupiter's orbit (1 point). Asteroids in orbital resonance with Jupiter will experience tugs that will cause strain and force them out of this orbit or collapse (1 point).
e. Dawn (1 point)