Answers to Practice Questions
Topic 3; Earth in the Universe

Part A

1. (2)
   Doppler shift provides evidence of an expanding universe. A celestial object like a star can gives off it's own energy in the form of electromagnetic radiation. Visible light is given off and when two celestial bodies are moving away from each other, the wavelengths increase. Colored spectral lines are shifted toward the red end of the visible spectrum.

2. (4)
   Spectral lines will shift toward the red end of the spectrum, which means that the universe is currently expanding from the Big Bang (11-17 b.y.a.).

3. (4)
   Galaxy D is moving at a greater velocity because it is farthest from the gravitational pull from the sun.

4. (3)
   Earth's solar system is located approximately two-thirds from the center and on one of the spiral arms of the Milky Way Galaxy.

5. (4)
   Consult pg. 15 of the ESRT, "Characteristics of Stars". On the x-axis are surface temperature and color. On the y-axis are luminosity and size. Moving from right to left along the x-axis is increasing surface temperature. Moving from the top to bottom along the y-axis is decreasing luminosity. Where the two coordinates match up are the white dwarf stars.

6. (2)
   A star that is massive (high amount of matter) will tend to use up most of its fuel. A star's fuel is its ability to fuse two hydrogen atoms together to form helium. If the star does not have enough gas to survive, then it will live a short life.

7. (1)
   The original mass will determine its fate. A large massive star can end up as a blackhole or neutron star. A less massive star can end up as a black dwarf.

8. (3)
   A planet's atmosphere is dependent upon two factors, the mass of the planet and distance from the sun. As you increase distance from the sun, the planets become more gaseous. Remember that gases are least dense in comparison to solids and liquids. As a result, the less dense gases are toward the latter end of the solar system (Jovian planets). Also, the mass of the planet can attract matter.

The larger the mass of a planet, the more potential it has to keep its gases on the planet (gravity). Compare our moon to Earth. Moon is less massive and lacks an atmosphere.

9. (1)
    Consult pg. 15 of the ESRT, "Solar System Data". Based on Kepler's third law of planetary motion, the closer a planet is to the sun, the faster its period of revolution. Locate the column Period of Revolution and notice that as you increase distance from the sun, the planet's period of revolution is greater. As a result, the planet closest to the sun has traveled around the sun more than once in your lifetime.

10. (3)
    Consult pg. 15 of the ESRT, "Solar System Data". As the distance from the sun increases, the diameter of the planets varies. They do not remain the same, increase only, or decrease only. From the process of elimination, they both increase and decrease. Take the first few planets as an example. The planet diameters of Mercury, Venus, and Earth all increase; however, Mars is much smaller than Earth, so it decreases. After Mars, the planet size increases dramatically with Jupiter.

11. (2)
    If Earth were 1 meter, a true scale model of the sun would be 100 times larger. You can simply use cross multiplication:

    12,756km/1m = 1,392,000km/x

    12,756km (x) = 1,392,000km (m)

    x = 109.1m

12. (2)
    Consult pg. 15 of the ESRT, "Solar System Data". Notice that the diameter of Mars is approximately half of Earth's diameter. Take your ruler from pg.1 of the ESRT and measure Earth (1.7cm). That measurement will have to make Mars at 0.85cm.

13. (1)
    The question describes what an astronomical unit is. An AU, or astronomical unit is Earth's average distance from the sun. Consult pg. 15 of the ESRT, "Solar System Data" to find out the distance from the sun to Earth. The distance is approximately 150 million km. If one centimeter is equal to 0.2 AU then 5 centimeters is equal to 1.0 AU. Based on that relationship, use the centimeter ruler on pg.1 of the ESRT to measure 5 centimeters for Earth. The closest Earth is to 5 cm is choice (1).

14. (3)
    The planet has the axis of rotation drawn, which is perpendicular to the plane of this planet's orbit. There is a black circle on the far left on diagram A and it is moving to the far right side. As a result, these diagrams are depicting rotation.

15. (4)
    Based on Kepler's third law of planetary motion, the period of revolution is dependent on the mean distance from the sun.

16. (1)
    Kepler's first law of planetary motion states that all planets travel in elliptical orbits with the sun at one foci point. As the foci points decrease distance, the planet's orbit is more circular (less eccentric). As the foci points increase distance, the planet's orbit is more elliptical (more eccentric). The lowest eccentricity value is zero and the highest value is one. The zero value would look like circle.

17. (1)
    Based on Kepler's second law of planetary motion (equal areas in equal times) and Newton's gravitational laws, a celestial body orbital speed is fastest when it is closer to a foci point.

18. (1)
    Newton's gravitational law states that the attractive force that exists between any two objects in the universe is proportional to the product of the masses and inversely proportional to the square of the distance between their centers. In other words, as the planet's distance from the star increases, then their gravitational attraction decreases. However, as the planet's distance from the star decreases, then their gravitational attraction increases.

19. (2)
    Since Planet A has a greater mean distance from the sun than Planet B, then Planet A's revolution must be longer (Kepler's third law of planetary motion).

Part B

20. A constellation is a grouping of stars that form a pattern as viewed from Earth while a galaxy is the gravitational collection of millions or billions of stars.

21. A planet orbits a star and a moon orbits a planet.

22. (1)
    The newly discovered planet is 3.5 million kilometers away from the star (Ogle-Tr-3). Based the solar system's first planet, Mercury, which is 57.9 million kilometers away from the sun, the newly discovered planet's orbital revolution must be shorter than all of the planets.

23. (2)
Since the newly discovered planet is 20% as dense as Jupiter, a simply computation must be made:

1.3 g/cm^3 x 20% (0.20) = 0.26 g/cm^3

1.3 g/cm^3 + 0.26 g/cm^3 = 1.56 g/cm^3

Even though the above number is not any of the four choices, the density of the newly discovered planet is only 20% **as dense as Jupiter.** Since it is as dense as Jupiter, it cannot be choices (3) and (4). Lastly, choice (1) is much greater than 20%.

24. (3)
Based on the alignment of the sun-moon-earth, the Earth would pass through the umbra of the moon's shadow. This alignment is indicative of a solar eclipse.

25.
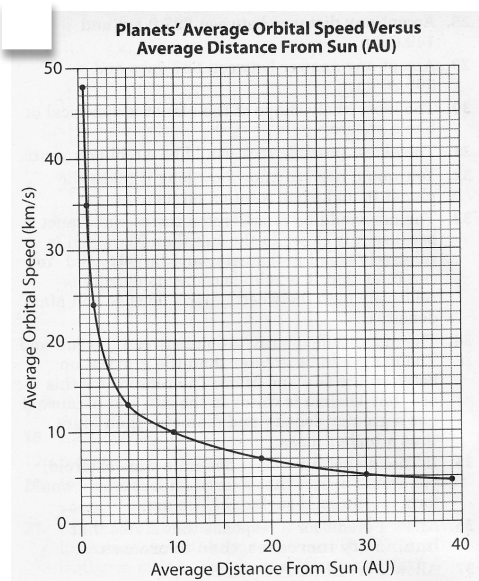
26. As the average distance from the sun increases, the average orbital speed decreases, or; as the average distance from the sun decreases, the average orbital speed increases.

27. Mars and Jupiter
Consult pg. 15 of the ESRT, "Solar System Data" under the column mean distance from the sun (million km).

28. Vesta

29. (a) Eccentricity = Distance between Foci/Length of Major Axis
    (b) Eccentricity = 4 cm/8 cm
    (c) Eccentricity = 0.5
    (d) The eccentricity of this spacecraft is more eccentric than Earth's eccentricity
    (0.017), or; the Earth's orbit is more round.

30. The following pieces of evidence are correct:
    - Cosmic background radiation remains;
    - There is a red shift in the light from the stars of distant galaxies;
    - The apparent expansion of the universe, or;
    - More distance stars are moving away from Earth at a greater rate than
      nearby stars.

31. Approximately 1,300 millions of years of Earth's geologic history elapsed
    between the formation of Earth and our Solar System (4,600 m.y.a.) and the
    formation of the oldest microfossil (~3,300 m.y.a.). Consult pg. 8 of the ESRT,
    "Geologic History of New York State". On the left side of the chart are the ages
    under the column Eon.

32. Betelgeuse, Polaris, Aldebaran, Sirius, and the Sun
    Consult pg. 15 of the ESRT, "Characteristics of Stars" and the y-axis labeled
    luminosity.

Part C

33. The Big Bang Theory states that the universe is continuing to expand. This
    would explain the observed red shift effect of most galaxies.

34. Any distance between 227.9 km and 149.6 km.
    Consult pg. 15 of the ESRT, "Solar System Data".

35. Any time between 687 days and 365.26 days
    Consult pg. 15 of the ESRT, "Solar System Data".

36. Spherical, or like a sphere.

37. Based on the origin of Earth and the Solar System, pg. 8 of the ESRT, "Geologic
    History of New York State", the oldest rock on Thelma could be 4.6 billions years
    old.

38. The duration, or period of rotation of Thelma.

39. Since Thelma is located halfway between Earth and Mars, this planet would be
    classified as a terrestrial planet. If it were located past the asteroid belt, then
    Thelma would be considered a Jovian planet.

40. The magnitude of gravitation between the sun and Thelma would be greater than the gravitation between the sun and Mars. The reasons for this are that Thelma is closer to the sun and because it has a greater density and diameter than Mars, thus a higher mass.

41. If a 5-mile wide asteroid struck Thelma, you would expect to find an impact crater on the solid surface. Regardless of an atmosphere, a 5-mile wide asteroid would not completely disintegrate.

42. The luminosity of the sun will increase then decrease toward the white dwarf stage.

43. Procyon B or 40 Eridani B
    Consult pg. 15 of the ESRT, "Characteristics of Stars.

44. The following pieces of evidence are correct:
    • A shift of light from distant galaxies toward the red end of the spectrum shows galaxies are moving away from Earth, or;
    • The red shift shows that the universe is expanding.

45. The following pieces of evidence are correct:
    • Earth and our solar system are younger than the Milky Way galaxy;
    • The estimated age of Earth and our solar system is 4.6 billion years and these distant galaxies are 12 billion years old, or;
    • Our solar system is about 5 billion years old, much younger than these 12 billion year old galaxies.

46.
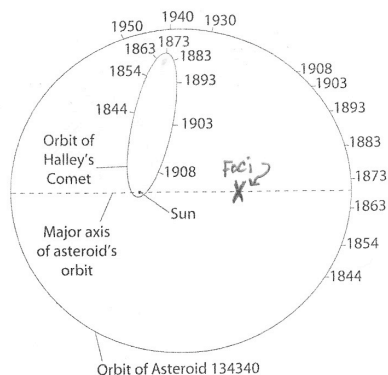
47. Halley's Comet traveled faster than the asteroid 134340 between the years 1903 and 1908 because it is closer to the sun.

48. Halley's Comet is part of our solar system regardless of its eccentric orbit because it revolves around the sun.