Lecture 4 - Kepler's laws (part 2)

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Why is Newton's version of Kepler's third law so useful to astronomers? 1) _____
   A) It tells us that more–distant planets orbit the Sun more slowly.
   B) It can be used to determine the masses of many distant objects.
   C) It allows us to calculate distances to distant objects.
   D) It explains why objects spin faster when they shrink in size.

2) Which statement must be true in order for a rocket to travel from Earth to another planet? 2) _____
   A) It must have very large engines.
   B) It must attain escape velocity from Earth.
   C) It must be launched from space, rather than from the ground.
   D) It must carry a lot of extra fuel.

3) Imagine another solar system, with a star of the same mass as the Sun. Suppose a planet with a mass twice that of Earth ($2M_{\text{Earth}}$) orbits at a distance of 1 AU from the star. What is the orbital period of this planet? 3) _____
   A) 2 years
   B) 6 months
   C) 1 year
   D) It cannot be determined from the information given.

4) What is the difference between a *bound* orbit and an *unbound* orbit around the Sun? 4) _____
   A) A bound orbit is circular, while an unbound orbit is elliptical.
   B) An object on a bound orbit follows the same path around the Sun over and over, while an object on an unbound orbit approaches the Sun just once and then never returns.
   C) An object on a bound orbit has a gravitational attraction to the Sun, while an object on an unbound orbit does not.
   D) A bound orbit is an orbit allowed by the universal law of gravitation, and an unbound orbit is not.

5) The allowed shapes for the orbits of objects responding only to the force of gravity are 5) _____
   A) ellipses only.
   B) ellipses, parabolas, and hyperbolas.
   C) circles and ellipses.
   D) ellipses, spirals, and parabolas.

6) Two planets having equal masses are in circular orbit around a star. Planet *A* has a smaller orbital radius than planet *B*. Which statement is true? 6) _____
   A) Planet *A* has more kinetic energy, less potential energy, and more mechanical energy (potential plus kinetic) than planet *B*.
   B) Planet *A* has more kinetic energy, more potential energy, and more mechanical energy (potential plus kinetic) than planet *B*.
   C) Planet *A* has more kinetic energy, less potential energy, and less mechanical energy (potential plus kinetic) than planet *B*.
   D) Planet *A* and planet *B* have the same amount of mechanical energy (potential plus kinetic).

7) What do we mean by the *orbital energy* of an orbiting object (such as a planet, moon, or satellite)? 7) _____

A) Orbital energy is the object's kinetic energy as it moves through its orbit.
B) Orbital energy is the amount of energy required for the object to leave orbit and escape into space.
C) Orbital energy is a measure of the object's speed as it moves through its orbit.
D) Orbital energy is the sum of the object's kinetic energy and its gravitational potential energy as it moves through its orbit.

8) Imagine another solar system, with a star *more massive* than the Sun. Suppose a planet with the same mass as Earth orbits at a distance of 1 AU from the star. How would the planet's year (orbital period) compare to Earth's year? 8) _____

A) The planet's year would be the same as Earth's.
B) The planet's year would be shorter than Earth's.
C) The planet's year would be longer than Earth's.
D) An orbit at a distance of 1 AU would not be possible around a star more massive than the Sun.

9) *Sputnik I* was launched into orbit around Earth in 1957. It had a perigee (the closest approach to Earth, measured from Earth's center) of 6.81×10^6 m and an apogee (the furthest point from Earth's center) of 7.53×10^6 m. What was its speed when it was at its perigee? The mass of Earth is 5.97×10^{24} kg and $G = 6.67 \times 10^{-11}$ N • m^2/kg^2. 9) _____

A) 8230 m/s
B) 11,000 m/s
C) 13,400 m/s
D) 7840 m/s
E) 7180 m/s

10) What is the period (in hours) of a satellite circling Mars 100 km above the planet's surface? The mass of Mars is 6.42×10^{23} kg, its radius is 3.40×10^6 m, and $G = 6.67 \times 10^{-11}$ N • m^2/kg^2. 10) _____

A) 1.75 h B) 1.45 h C) 1.25 h D) 1.00 h E) 1.15 h

11) Jupiter completes one revolution about its own axis every 9.92 hours. What is the radius of the orbit required for a satellite to revolve about Jupiter with the same period? Jupiter has a mass of 1.90×10^{27} kg and $G = 6.67 \times 10^{-11}$ N • m^2/kg^2. 11) _____

A) 1.04×10^7 m
B) 3.41×10^8 m
C) 1.60×10^8 m
D) 7.45×10^8 m
E) 2.26×10^9 m

12) The moons of Mars, Phobos (Fear) and Deimos (Terror), are very close to the planet compared to Earth's Moon. Their orbital radii are 9,378 km and 23,459 km respectively. What is the ratio of the orbital speed of Phobos to that of Deimos? 12) _____

A) 0.2528 B) 2.858 C) 3.956 D) 1.582 E) 0.3998

13) Spaceman Speff orbits spherical asteroid *X* with his spaceship. To remain in a circular orbit at 421 km from the asteroid's center, he should maintain a speed of 80 m/s. What is the mass of planet *X*? ($G = 6.67 \times 10^{-11}$ N • m^2/kg^2) 13) _____

A) 4.0×10^{16} kg
B) 5.1×10^{17} kg
C) 4.0×10^{19} kg
D) 5.1×10^{14} kg

14) Find the orbital speed of an ice cube in the rings of Saturn. The mass of Saturn is 5.68×10^{26} kg and the rings have an average radius of 100,000 km. ($G = 6.67 \times 10^{-11}$ N • m^2/kg^2) 14) _____

A) 1.95 km/s
B) 13.8 km/s
C) 19.5 km/s
D) 27.5 km/s

15) Suppose we want a satellite to revolve around the earth 5 times a day. What should be the radius of its orbit? (The mass of the earth is 5.97×10^{24} kg, $G = 6.67 \times 10^{-11}$ N • m^2/kg^2, and you can neglect the presence of the moon.) 15) _____

A) 7.22×10^{7} m
B) 0.690×10^{7} m
C) 2.11×10^{7} m
D) 1.44×10^{7} m

16) Ekapluto is an unknown planet that has two moons in circular orbits. The table summarizes the hypothetical data about the moons. ($G = 6.67 \times 10^{-11}$ N • m^2/kg^2) 16) _____

	Mass	*Radius*	*Orbital radius*	*Orbital period*
Moon A	4.0×10^{20} kg		2.0×10^{8} m	4.0×10^{6} s
Moon B	1.5×10^{20} kg	2.0×10^{5} m	3.0×10^{8} m	

The mass of Ekapluto is closest to

A) 1.0×10^{22} kg.
B) 1.0×10^{24} kg.
C) 3.0×10^{23} kg.
D) 3.0×10^{22} kg.
E) 1.0×10^{23} kg.

17) A planet has two small satellites in circular orbits around the planet. The first satellite has a period 18.0 hours and an orbital radius 2.00×10^{7} m. The second planet has an orbital radius 3.00×10^{7} m. What is the period of the second satellite? 17) _____

A) 33.1 h
B) 27.0 h
C) 60.8 h
D) 9.80 h
E) 12.0 h

18) A planet has two small satellites in circular orbits around the planet. The first satellite has a period 12.0 hours and an orbital radius 6.00×10^7 m. The second planet has a period 16.0 hours. What is the orbital radius of the second satellite? 18) _____

A) 7.27×10^7
B) 4.50×10^7
C) 8.00×10^7
D) 9.24×10^7
E) 3.90×10^7

19) Two moons orbit a planet in nearly circular orbits. Moon *A* has orbital radius *r*, and moon *B* has orbital radius 4*r*. Moon *A* takes 20 days to complete one orbit. How long does it take moon *B* to complete an orbit? 19) _____

A) 160 d B) 20 d C) 80 d D) 40 d E) 320 d

20) Ekapluto is an unknown planet that has two moons in circular orbits. The table summarizes the hypothetical data about the moons. 20) _____

	Mass	*Radius*	*Orbital Radius*	*Orbital period*
Moon A	4.0×10^{20} kg		2.0×10^8 m	4.0×10^6 s
Moon B	1.5×10^{20} kg	2.0×10^5 m	3.0×10^8 m	

The orbital period of Moon *B* is closest to

A) 5.6×10^6 s.
B) 6.9×10^6 s.
C) 6.0×10^6 s.
D) 6.4×10^6 s.
E) 7.3×10^6 s.