Chapter 7 Circular Motion and Gravitation


5. What is the gravitational force between the Earth and the Sun? (Mass of Earth: $5.98 \times 10^{24}$ kg, Mass of Sun: $1.99 \times 10^{30}$, Radius of Earth’s orbit around sun: $1.50 \times 10^{11}$ m)
   a. $5.29 \times 10^{-13}$ N
   b. $3.53 \times 10^{22}$
   c. $7.94 \times 10^{44}$
   d. $5.29 \times 10^{33}$

7.2 Calculate force of gravity at a given distance given the force of gravity at another distance (making use of the inverse square relationship).

6. According to Newton’s Universal Law of Gravitation, the gravitational force between two masses
   a. Is always an attraction
   b. depends on how large the masses are
   c. depends inversely on the square of the distances between the masses
   d. all of the above

7. Two balls near each other have a certain gravitational force. What happens to the force if you triple the distance??
   a. 9x bigger
   b. 3x bigger
   c. 3x smaller
   d. 9x smaller

8. Suppose the gravitational force between two massive spheres is 20 N. If the magnitude of each mass doubles, then what is the force between the masses?
   a. 80 N
   b. 20 N
   c. 40 N
   d. 5 N
   e. 2.5 N

9. Suppose the gravitational force between two massive spheres is 40 N. If the distance between the spheres is cut in half, the force between the masses is
   a. 160 N
   b. 20 N
   c. 10 N
   d. 5 N
   e. 2.5 N
10. If the radius of the Earth increased (or you went on a mountain top), with no change in mass, your weight would technically
   a. Increase
   b. not change
   c. decrease
   d. disappear

C

7.3 Calculate the gravitational field strength surrounding a planetary body.

11. Lola the explorer stands atop a planet. The planet’s mass is 3.0 x 10^{25} kg and has a radius of 790,000 meters. Find the acceleration due to gravity (gravitational field strength) for dropped objects on this planet.
   a. 0.27 N/kg
   b. 3200 N/kg
   c. 9.80 N/kg
   d. 2.00 x 10^{15} N/kg

B

7.6 Calculate the velocity & period of an orbiting satellite.

12. Compared to the period of a satellite in orbit far to the Earth, the period of a satellite in orbit close to the Earth is
   a. Longer
   b. shorter
   c. the same
   d. not enough information

B

13. A satellite is placed in orbit around the Earth (mean radius of 6.38 x 10^{6} m) at a surface altitude of 3.00 x 10^{6} meters. The satellite’s mass is 750 kg and the mass of the Earth is 5.98 x 10^{24} kg. Find the speed of the Earth satellite.
   a. 7,727 m/s
   b. 6520 m/s
   c. 7,907 m/s
   d. 9.8 x 10^{-6} m/s

B

7.7 Calculate either the orbiting period or orbiting radius of a satellite using Kepler’s 3rd law.

14. Gaia is 4.2 units from the center of Jupiter and orbits Jupiter once every 3 days. Zeus orbits 8.4 units of distance from Jupiter, how many days orbit is Zeus from the center of Jupiter?
   a. 2.6 days
   b. 0.35 days
   c. 8.5 days
   d. 506 days.

C
7.8 Conceptually relate mass and distance separation to the gravitational force, field strength, orbiting velocity and period of orbit for planetary bodies.

15. The only factor that affects the Earth’s gravitational force of attraction on objects at or near the Earth’s surface is the mass of the Earth.

   A. True
   B. False

   B (the radius of the Earth matters also.)

7.9 Recognize fundamental applications of Earth satellites.

16. The speed of an orbiting object around the Sun changes as it circles the Sun.

   A. True
   B. False

   A

Newton's Law of Gravitation

1) Consider the planet Mars:
   
   [Earth mass; 5.98 x 10^{24} kg = 9.3 x Mars mass;  
   Earth radius; 6380. km = 1.89 x Mars radius]
   
   What is the acceleration of gravity on Mars?

   Answer: 3.8 m/s^2

   Diff: 2

3) Newton never knew the numerical value of "his" universal gravitational constant G.

   A. True
   B. False
   C.

   Answer: A. TRUE
   Diff: 1

5) A 63. kg astronaut walks upon the surface of the planet Krypton which has 100. times the mass of the Earth and 100. times the diameter of the Earth. What does she weigh on Krypton?

   Answer: 63. x 9.8 x 100 / 100^2 = 6.2 Newtons
   Diff: 3
7) James weighs 180 pounds. This means the Earth pulls James toward it with a 180 lb force. Since the Earth is \(7.3 \times 10^{22}\) times more massive than James, the Earth is attracted to James with a force of
   A) 0 lb.
   B) \(7.2 \times 10^{22}\) lb.
   C) \(7.3 \times 10^{24}\) lb.
   D) 180 lb.
   E) \(1.3 \times 10^{25}\) lb.

Answer: D
Diff: 1

9) The weight of an object on the Moon is what fraction of the weight of the same object on Earth? (Mass of Moon: \(7.35 \times 10^{22}\) kg Diameter of Moon: 3476 km)

Answer: \(\frac{1}{6}\)
Diff: 1

10) Consider a 2.4 kilogram feather (Big Bird) on the planet Mars. [Earth mass = \(6.0 \times 10^{24}\) kg = 9.3 x Mars mass; Earth radius = 6380 km = 1.89 x Mars radius]
   (a) What does the feather weigh on Mars?
   (b) What would the same feather weigh on Earth?

Answer: 9.1 N on Mars
   24 N on Earth
Diff: 3

Choose from the following list:
   (a) J
   (b) m/s
   (c) rad/s
   (d) N m^2/kg^2
   (e) rad/s^2
   (f) radians
   (g) seconds
   (h) s^2/m^3

11) The Universal Gravitational Constant is measured in which units?

Answer: (d) N.m^2/kg^2
Diff: 2
13) A spherically symmetric planet has four times the Earth's mass and twice its radius. If a jar of peanut butter weighs 12. N on the surface of the Earth, how much would it weigh on the surface of this planet?
   A) 18 N
   B) 12 N
   C) 30 N
   D) 6 N
   E) 24 N

   Answer: B
   Diff: 2

16) A spaceship is traveling to the moon. At what point is it beyond the pull of Earth's gravity?
   A) when it is closer to the moon than it is to Earth
   B) when it gets above the atmosphere
   C) when it is half-way there
   D) It is never beyond the pull of Earth's gravity.

   Answer: D
   Diff: 1

17) By how many Newtons does the weight of a 100. kg person change when he goes from sea level to an altitude of 5.00 km?

   Answer: 1.54N
   Diff: 2

19) A satellite encircles Mars at a distance above its surface equal to 3 times the radius of Mars. The acceleration of gravity at the satellite, as compared to the acceleration of gravity on the surface of Mars, is
   A) one-ninth as much.
   B) zero.
   C) the same.
   D) one-third as much.
   E) one-sixteenth as much.

   Answer: E
   Diff: 2

20) What is the gravitational force on a 70. kg person on the Earth, due to the Moon? The mass of the Moon is $7.36 \times 10^{22}$ kg and the distance to the moon is $3.82 \times 10^8$ m.

   Answer: 0.0024N
   Diff: 2
22) An astronaut lands on a previously unknown planet of radius 2350 km and she measures the acceleration of gravity to be 3.20 m/s²:
   (a) What is the mass of this new planet?
   (b) What does the astronaut weigh on this new planet if she weighs 384. N on Earth?

Answer: (a) 0.26 x 10²⁴ kg
       (b) 125. Newtons
Diff: 3

23) A mass which weighs 19.6 newtons on Earth is 2.3 meters away from a 2.00 kg mass.
   (a) Determine their mutual gravitational attraction to each other.

Answer: (a) 5.0 x 10⁻¹¹ N
Diff: 3

7.6 Kepler's Laws and Earth Satellites

3) As you know, the Earth has an orbital period of one year at an orbital radius of one AU. If a new "minor planet" were to be found in a circular orbit with radius 13. AU, what would be its period?

Answer: Remembering Kepler's 3rd law: T = 47. years at R=13. AU.
Diff: 2

6) Kepler’s discovery that \( T^2/r^3 = K \) applies
   A) to orbits where K is a universal constant.
   B) only to circular orbits.
   C) to lunar motion provided K is the same for planetary motion.
   D) to elliptical orbits where r is the average distance.

Answer: D
Diff: 2

7) The speed for a "low" circular orbit about the Earth is about
   A) 1.7 x 10⁴ km/s.
   H) 7.6 km/s.
   C) 2.1 km/s.
   D) 2.5 x 10⁴ km/s.
   E) 17. km/s.

Answer: B  Diff: 2
9) An astronaut goes out for a "space-walk" at a distance above the Earth equal to the radius of the Earth. Her acceleration will be
   A) \( g \)
   B) \( 0.5g \)
   C) zero
   D) \( 0.25g \)
   E) \( \sqrt{2}g \)

Answer: D  
Diff 2

10) If the Earth had four times its present mass, what would be its new period of revolution around the Sun, compared to its present orbital period?
   A) two times as much
   B) one-fourth as much
   C) four times as much
   D) one-half as much
   E) the same

Answer: E  
Diff: 2

11) The speed of Halley's comet, while traveling in its elliptical orbit around the sun,
   A) decreases as it nears the sun.
   B) increases as it nears the sun.
   C) is zero at two points in the orbit.
   D) is constant.

Answer: B  
Diff 1

13) A planet is discovered to orbit around a star in the galaxy Andromeda, with the same orbital diameter as the Earth around our sun. If that star has 4 times the mass of our sun, what will the period of revolution of that new planet be, compared to the Earth's orbital period?
   A) four times as much
   B) one-half as much
   C) one-fourth as much
   D) twice as much
   E) \( \sqrt{2} \) times as much

Answer: B  
Diff:2
14) An Earth satellite is in circular orbit 230 km above the surface of the Earth. It is observed to have a period of 89 min. From this information, estimate the mass of the Earth.

Answer: $6.0 \times 10^{24}$ kg
Diff: 2

15) The following statements refer to man-made, artificial satellites in orbit around Earth. Which is an accurate statement?
   A) The velocity required to keep a satellite in a given orbit depends on the mass of the satellite.
   B) The period of revolution of a satellite moving about the Earth is independent of the size of the orbit it travels.
   C) A satellite in a large diameter circular orbit will always have a longer period of revolution about the Earth than will a satellite in a smaller circular orbit.
   D) It is possible to have a satellite traveling at either a high speed or at a low speed in a given circular orbit.
   E) Only circular orbits are possible for artificial satellites.

Answer: C
Diff: 2

16) Europa, a moon of Jupiter, has an orbital diameter of $1.34 \times 10^9$ m, and a period of 3.55 days. What is the mass of Jupiter?

Answer: $1.89 \times 10^{27}$ kg
Diff: 2

18) Consider a small satellite moving in a circular orbit (radius r) about a spherical planet (mass M). The period does not depend upon
   A) g at the satellite position.
   B) the planet mass.
   C) the satellite mass.
   D) the radius r.
   E) the universal gravitational constant.

Answer: C
Diff: 2

20) A satellite orbits the Earth once every 6.0 hours in a circle. What is the radius of the orbit if it is a 2000. kg satellite?

Answer: $1.7 \times 10^7$ m
Diff: 2
21) Satellite A has twice the mass of satellite T, and rotates in the same orbit. Which of the following is true?
   A) The speed of T is twice the speed of A.
   B) The speed of T is one-fourth the speed of A.
   C) The speed of T is half the speed of A.
   D) The speed of T is equal to the speed of A.

Answer: D
Diff 2

23) A satellite is in a low circular orbit about the Earth (i.e., it just skims the surface of the Earth). How long does it take to make one revolution around the Earth?

Answer: 87 min
Diff: 2

29) David lands on planet X and observes objects free-falling with acceleration 4.9 m/s^2. If the planet is 3 times larger than the Earth, what is the planet MASS expressed in Earth masses?
   A) 9/4
   B) 2/3
   C) 3/2
   D) 1/2
   E) 9/2

Answer: E
Diff: 2

30) Who was the first person to realize that the planets move in elliptical paths around the sun?
   A) Kepler
   B) Copernicus
   C) Brahe
   D) Einstein
   E) Galileo

Answer: A
Diff I

31) The net force on an object in orbit is zero.

Answer: FALSE (To turn in a circle, it must have a centripetal force. This is supplied by gravity.)
Diff: 1

32) A satellite orbits the Earth once every 6.0 hours in a circle. What is the acceleration of the satellite (direction too)?

Answer: 1.4 m/s^2 toward center of Earth
Diff: 2