Physics for Scientists and Engineers, 4e **(Giancoli)**

Chapter 8 Conservation of Energy

8.1 Conceptual Questions

1) Describe a conservative force.

Answer: A force is conservative force if the work done by the force on an object moving from one point to another depends only on the initial and final positions of the object, and is independent of the particular path taken.

OR

A force is conservative if the net work done by the force on an object moving around any closed path is zero.

Diff: 1 Page Ref: Sec. 8-1

2) What distinguishes a conservative force from a non-conservative force?

Answer: Work done by a conservative force is independent of the object's path and the work only depends upon the initial and final positions. A non-conservative force will generate work that is path-dependent.

Diff: 1 Page Ref: Sec. 8-1

3) State the principle of conservation of mechanical energy

Answer: If only conservative forces are doing work, the total mechanical energy of a system neither increases nor decreases in any process. It stays constant - it is conserved.

Diff: 1 Page Ref: Sec. 8-3

4) Discuss the various energy conversions that occur when a person performs a pole vault. Include as many conversions as you can, and consider times before, during, and after the actual vault itself.

Answer: The jumper’s initial kinetic energy is largely converted to a compressional, spring-like potential energy as the pole bends. The pole straightens out, converting its potential energy into gravitational potential energy. As the jumper falls, the gravitational potential energy is converted into kinetic energy, and finally, the kinetic energy is converted to compressional potential energy as the cushioning pad on the ground is compressed.

Diff: 2 Page Ref: Sec. 8-3

5) Define power in terms of both work and energy.

Answer: Power is the rate at which work is done; it is the rate at which energy is transformed.

Diff: 1 Page Ref: Sec. 8-8

6) Define efficiency for an engine. Is it possible for an engine to have an efficiency equal to one?

Answer: Efficiency is defined as the ratio of the useful power output to the power input. The efficiency is always less than one because no engine can create energy, and in fact, cannot even transform energy from one form to another without some going to friction, thermal energy, and other non useful forms of energy.

Diff: 2 Page Ref: Sec. 8-8

7) Discuss the differences between equilibrium, stable equilibrium, unstable equilibrium, and neutral equilibrium. Include references to potential energy diagrams in your discussion.

Answer: If an an object is in equilibrium, this simply means that the net force on the object is zero. Hence, its acceleration is zero.

An object that returns toward its equilibrium point when displaced slightly is said to be at a point of stable equilibrium. Any minimum in the potential energy curve represents a point of stable equilibrium.

An object that will not return to its equilibrium point when slightly displaced, but instead moves farther away is said to be at a point of unstable equilibrium. Any maximum in the potential energy curve represents a point of unstable equilibrium.

When an object is in a region over which the potential energy is constant, the force is zero over some distance. The object is in equilibrium and if displaced slightly to one side the force is still zero. The object is said to be in neutral equilibrium in this region.

Diff: 2 Page Ref: Sec. 8-9

8) The force acting on an object is said to be conservative if the work done by this force on the object is independent of the path chosen.

Answer: TRUE

Diff: 1 Page Ref: Sec. 8-1

9) A force is non-conservative if the net work done by the force on an object moving around any closed path is zero.

Answer: FALSE

Diff: 1 Page Ref: Sec. 8-1

10) The work done by a non-conservative force is recoverable.

Answer: FALSE

Diff: 1 Page Ref: Sec. 8-1

11) The gravitational force is a conservative force.

Answer: TRUE

Diff: 1 Page Ref: Sec. 8-1

12) The frictional force is a conservative force.

Answer: FALSE

Diff: 1 Page Ref: Sec. 8-1

13) A conservative force can be a function only of position, and cannot depend on other variables like time or velocity.

Answer: TRUE

Diff: 2 Page Ref: Sec. 8-1

14) Any location can be chosen for potential energy equal to zero.

Answer: TRUE

Diff: 1 Page Ref: Sec. 8-2

15) Potential energy belongs to a system, and not to a single object alone.

Answer: TRUE

Diff: 1 Page Ref: Sec. 8-2

16) Potential energy can be defined only for non-conservative forces.

Answer: FALSE

Diff: 1 Page Ref: Sec. 8-2

17) The sum of the kinetic and potential energies of an object is conserved only when the object is under the influence of conservative forces.
Answer: TRUE
Diff: 1 Page Ref: Sec. 8-3

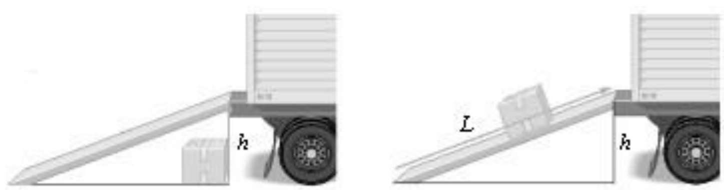
18) Non-conservative forces convert mechanical energy into other forms of energy, or convert other forms of energy into mechanical energy.
Answer: TRUE
Diff: 1 Page Ref: Sec. 8-5

19) Non-conservative forces can change the mechanical energy of a system.
Answer: TRUE
Diff: 1 Page Ref: Sec. 8-5

20) If work is done on a system by non-conservative forces, the total mechanical energy of a system stays constant.
Answer: FALSE
Diff: 1 Page Ref: Sec. 8-5

21) Is it possible for a system to have negative potential energy?
A) Yes, as long as the kinetic energy is positive.
B) Yes, as long as the total energy is positive.
C) Yes, since the choice of the zero of potential energy is arbitrary.
D) No, because the kinetic energy of a system must equal its potential energy.
E) No, because this would have no physical meaning.
Answer: C
Diff: 1 Page Ref: Sec. 8-2

FIGURE 8-1



22) You need to load a crate of mass m onto the bed of a truck. One possibility is to lift the crate straight up over a height h, equal to height of the truck's bed. The work done in this case is W_1. The other possibility is to slide the crate up the frictionless ramp of length L as shown in Fig. 8-1. In this case you perform work W_2. What statement is true?
A) $W_1 < W_2$
B) $W_1 = W_2$
C) $W_1 > W_2$
D) No simple relationship exists between W_1 and W_2.
Answer: B
Diff: 1 Page Ref: Sec. 8-2

23) You and your friend want to go to the top of the Eiffel Tower. Your friend takes the elevator straight up. You decide to walk up the spiral stairway, taking longer to do so. Compare the gravitational potential energy (U) of you and your friend, after you both reach the top.

A) It is impossible to tell, since the times are unknown.
B) It is impossible to tell, since the distances are unknown.
C) Your friend's U is greater than your U, because she got to the top faster.
D) Both of you have the same amount of potential energy.
E) Your U is greater than your friend's U, because you traveled a greater distance in getting to the top.

Answer: D

Diff: 1 Page Ref: Sec. 8-2

24) A potential energy function for a certain system is given by $U_1(x) = Cx^2 + Bx^3$. The potential energy function for a second system is given by $U_2(x) = A + Cx^2 + Bx^3$, where A is a positive quantity. If an object begins at the same initial position with the same initial velocity in both systems, how is the motion in the two systems related?

A) The motion in the first system will be with greater speed than in the second system because of the lower potential energy.
B) The motion in the second system will be at greater speeds in one direction and lower speeds in the other direction relative to the first system.
C) The motion in the two systems is identical.
D) The motion in the second system will be with greater speed than in the first system because of the greater potential energy.
E) The motion in the two systems will be in opposite directions.

Answer: C

Diff: 1 Page Ref: Sec. 8-2

25) A potential energy function for a certain system is given by $U_1(x) = Cx^2 + Bx^3$. The potential energy function for a second system is given by $U_2(x) = A + Cx^2 + Bx^3$, where A is a positive quantity. How does the force on system 1 relate to the force in system 2 at a given position?

A) The force in the two systems will be in opposite directions.
B) The force is identical in the two systems.
C) The force in the second system will be with less than the force in the first system.
D) There is no relationship between the force in the two systems.
E) The force in the second system will be with greater than the force in the first system.

Answer: B

Diff: 1 Page Ref: Sec. 8-2

26) The total mechanical energy of a system

A) is equally divided between kinetic energy and potential energy.
B) is either all kinetic energy or all potential energy, at any one instant.
C) can never be negative.
D) is constant, if only conservative forces act.
E) is not uniquely determined for most naturally occurring systems.

Answer: D

Diff: 1 Page Ref: Sec. 8-3

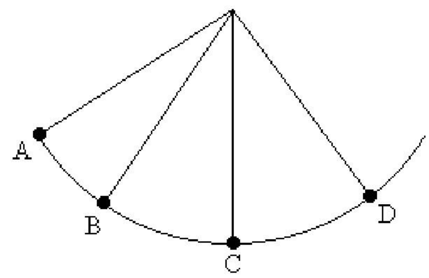
27) An object of mass m is held at a vertical height h from ground level. It is then released and falls under the influence of gravity. Which of the following statements is true in this situation? (Neglect air resistance.)
A) The total energy of the object is decreasing.
B) The kinetic energy of the object is decreasing.
C) The potential energy of the object is increasing.
D) The total energy of the object is increasing.
E) The potential energy of the object is decreasing and the kinetic energy is increasing.
Answer: E
Diff: 1 Page Ref: Sec. 8-3

28) Neglecting air resistance, when you toss a stone straight up in the air from Earth's surface, which of the following statements is true for the upward motion of the stone.
A) The stone's total energy increases.
B) The stone's kinetic and gravitational potential energies increase simultaneously.
C) The stone's kinetic and gravitational potential energies decrease simultaneously.
D) The stone's kinetic energy decreases while its gravitational potential energy increases.
E) The stone's kinetic energy increases while its gravitational potential energy decreases.
Answer: D
Diff: 1 Page Ref: Sec. 8-3

29) A particle is moving in three-dimensions and is not acted on by any non-conservative forces. The particle is moving with velocity $\vec{v}$ when it is located at point O. When the particle returns to point O at a later time, which statement is true about its velocity?
A) The magnitude of the velocity when the particle returns is the magnitude of $\vec{v}$.
B) The magnitude of the velocity when the particle returns will be greater than the magnitude of $\vec{v}$.
C) The velocity when the particle returns will again be $\vec{v}$.
D) The magnitude of the velocity when the particle returns will be less than the magnitude of $\vec{v}$.
E) Both statements A and C are true.
Answer: A
Diff: 1 Page Ref: Sec. 8-3

30) Two identical balls are thrown from the top of a building with the same speed. Ball 1 is thrown horizontally, while ball 2 is thrown at an angle θ above the horizontal. Neglecting air resistance, which ball will have the greatest speed when hitting the ground below?
A) Ball 1
B) Ball 2
C) Both balls reach the ground with the same speed.
D) Cannot be determined without knowing the height of the building.
E) Cannot be determined without knowing the time each ball is in the air.
Answer: C
Diff: 1 Page Ref: Sec. 8-4

FIGURE 8-2



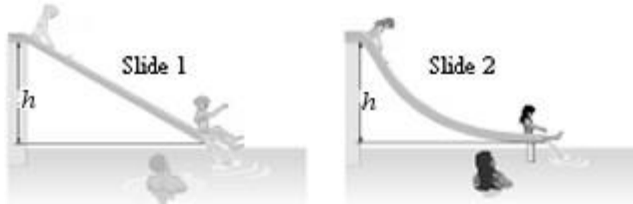
A mass is attached to one end of a string. The other end of the string is attached to a rigid support. The mass is released at A and swings in a vertical arc to points B, C, and D.

31) Refer to Fig. 8-2. At what point does the mass have the most potential energy?
A) A
B) B
C) C
D) D
E) none of the given points
Answer: A
Diff: 1 Page Ref: Sec. 8-4

32) Refer to Fig. 8-2. At what point does the mass have the most kinetic energy?
A) A
B) B
C) C
D) D
E) none of the given points
Answer: C
Diff: 1 Page Ref: Sec. 8-4

33) Refer to Fig. 8-2. At what point does the mass have its highest speed?
A) A
B) B
C) C
D) D
E) none of the given points
Answer: C
Diff: 1 Page Ref: Sec. 8-4

FIGURE 8-3



34) Swimmers at a water park have a choice of two frictionless water slides (see Fig. 8-3). Although both slides drop over the same height, h, slide 1 is straight while slide 2 is curved, dropping quickly at first and then leveling out. How does the speed v_1 of a swimmer reaching the end of slide 1 compares with v_2, the speed of a swimmer reaching the end of slide 2?

A) $v_1 > v_2$
B) $v_1 < v_2$
C) $v_1 = v_2$
D) No simple relationship exists between v_1 and v_2.

Answer: C
Diff: 2 Page Ref: Sec. 8-4

35) Two inclined planes A and B have the same height but different angles of inclination with the horizontal. Inclided plane A has a steeper angle of inclination than inclined plane B. An object is released at rest from the top of each of the inclined planes. How does the speed of the object at the bottom of inclined plane A compare with that of the speed at the bottom of inclined plane B?

A) The speed of the object at the base of inclined plane A would be grater than the speed of the object at the base on inclined plane B.
B) The speed of the object at the base of inclined plane B would be grater than the speed of the object at the base on inclined plane A.
C) The speed of the object is the same for both inclined planes.
D) There is not enough information to answer the question.

Answer: C
Diff: 2 Page Ref: Sec. 8-4

36) A lightweight object and a very heavy object are sliding with equal speeds along a level frictionless surface. They both slide up the same frictionless hill. Which rises to a greater height?

A) The heavy object, because it has greater kinetic energy.
B) The light object, because it has smaller kinetic energy.
C) The lightweight object, because it weighs less.
D) The heavy object, because it weighs more.
E) They both slide to the same height.

Answer: E
Diff: 2 Page Ref: Sec. 8-4

37) A ball drops some distance and gains 30 J of kinetic energy. Do not ignore air resistance. How much gravitational potential energy did the ball lose?

A) more than 30 J
B) exactly 30 J
C) less than 30 J
D) Cannot be determined from the information given.

Answer: A
Diff: 2 Page Ref: Sec. 8-6

38) A ball drops some distance and loses 30 J of gravitational potential energy. Do not ignore air resistance. How much kinetic energy did the ball gain?

A) more than 30 J
B) exactly 30 J
C) less than 30 J
D) Cannot be determined from the information given.

Answer: C
Diff: 2 Page Ref: Sec. 8-6

39) Block 1 and block 2 have the same mass, *m*, and are released from the top of two inclined planes of the same height making 30° and 60° angles with the horizontal direction, respectively. If the coefficient of friction is the same in both cases, which of the blocks is going faster when it reaches the bottom of its respective incline?

A) We must know the actual masses of the blocks to answer.
B) Both blocks have the same speed at the bottom.
C) Block 1 is faster.
D) Block 2 is faster.
E) There is not enough information to answer the question.

Answer: D
Diff: 2 Page Ref: Sec. 8-6

40) How do the escape velocities for two rockets, the first weighing 20 N and the second weighing 20,000 N compare?

A) The escape velocity for the lighter rocket is smaller than that for the heavier rocket.
B) The escape velocity for the lighter rocket is the same as that for the heavier rocket.
C) The escape velocity for the lighter rocket is greater than that for the heavier rocket.
D) It is impossible to compare the two escape velocities.

Answer: B
Diff: 1 Page Ref: Sec. 8-7

41) If an object is located in a region over which its potential energy is constant, the object is said to be in

A) neutral equilibrium.
B) stable equilibrium.
C) unstable equilibrium.
D) positive equilibrium.
E) negative equilibrium.

Answer: A
Diff: 1 Page Ref: Sec. 8-9

42) A minimum in the potential energy curve represents a point of

A) neutral equilibrium.
B) stable equilibrium.
C) unstable equilibrium.
D) positive equilibrium.
E) negative equilibrium.

Answer: B
Diff: 1 Page Ref: Sec. 8-9

43) A maximum in the potential energy curve represents a point of

A) neutral equilibrium.
B) stable equilibrium.
C) unstable equilibrium.
D) positive equilibrium.
E) negative equilibrium.

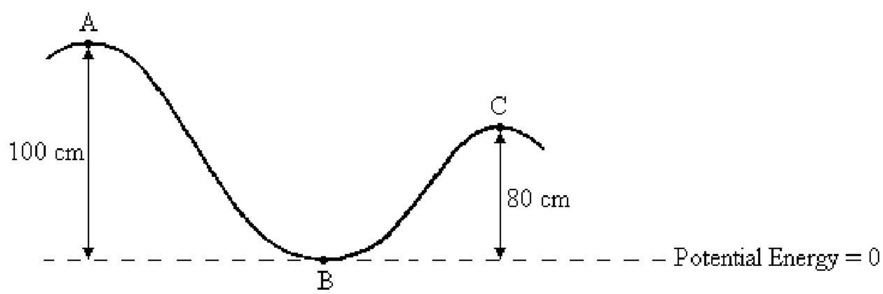
Answer: C
Diff: 1 Page Ref: Sec. 8-9

8.2 Quantitative Problems

1) The conservative force on an object moving in one dimension is given by $F(x) = (2.00\ \text{N/m})x + (1.00\ \text{N/m}^3)x^3$.
(a) What is the change in potential energy when the object moves from $x = 1.00$ m to $x = 2.00$ m?
(b) What is the change in kinetic energy when the object moves from $x = 1.00$ m to $x = 2.00$ m

Answer: (a) -6.75 J
(b) 6.75 J
Diff: 2 Page Ref: Sec. 8-3

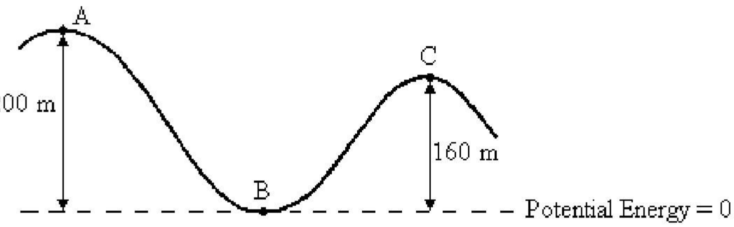
FIGURE 8-4



2) A 2.0 g bead slides along a wire, as shown in Fig. 8-4. At point A, the bead is at rest. Neglect friction.
(a) What is the potential energy of the bead at point A?
(b) What is the kinetic energy of the bead at point B?
(c) What is the speed of the bead at point B?
(d) What is the speed of the bead at point C?

Answer: (a) 2.0×10^{-2} J
(b) 2.0×10^{-2} J
(c) 4.4 m/s
(d) 2.0 m/s
Diff: 2 Page Ref: Sec. 8-4

FIGURE 8-5



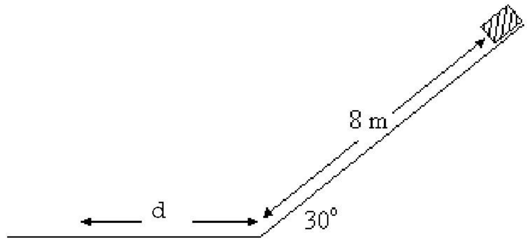
3) A roller coaster of mass 80.0 kg is moving with a speed of 20.0 m/s at position A as shown in Fig. 8-5. the vertical height at position A above ground level is 200 m. Neglect friction.
(a) What is the total energy of the roller coaster at point A?
(b) What is the total energy of the roller coaster at point B?
(c) What is the speed of the roller coaster at point B?
(d) What is the speed of the roller coaster at point C?
Answer: (a) 1.73×10^5 J
(b) 1.73×10^5 J
(c) 65.8 m/s
(d) 34.4 m/s
Diff: 2 Page Ref: Sec. 8-4

4) A simple pendulum of length 2.00 m is made with a mass of 2.00 kg. The mass has a speed of 3.00 m/s when the pendulum is 30.0° above its lowest position.
(a) What is the maximum angle away from the lowest position the pendulum will reach?
(b) What is the speed of the mass when the pendulum is 45° above its lowest position?
Answer: (a) 50.5°
(b) 1.66 m/s
Diff: 2 Page Ref: Sec. 8-4

5) A 50.0-kg skier starting from rest travels 200 m down a hill that has a 20.0° slope. When the skier reaches the bottom of the hill, her speed is 30.0 m/s.
(a) How much work is done by friction as the skier comes down the hill?
(b) What is the magnitude of the friction force if the skier travels directly down the hill?
Answer: (a) -1.11×10^4 J
(b) 55.3 N
Diff: 1 Page Ref: Sec. 8-6

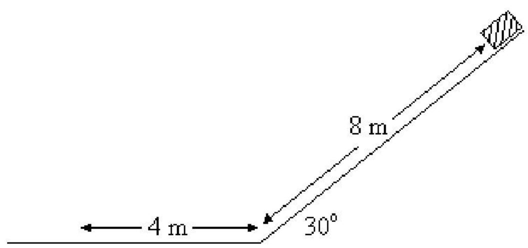
6) A 5.00-kg object moves clockwise around a 50.0 cm radius circular path. At one location, the speed of the object is 4.00 m/s. When the object next returns to this same location, the speed is 3.00 m/s.
(a) How much work was done by non-conservative forces as the object moved once around the circle?
(b) If the magnitude of the above non-conservative forces acting on the object is constant, what is the minimum value of this magnitude?
Answer: (a) -17.5 J
(b) 5.57 N
Diff: 2 Page Ref: Sec. 8-6

FIGURE 8-6



7) An object was a mass of 10.0 kg is at rest at the top of a frictionless inclined plane of length 8.00 m and an angle of inclination 30.0° with the horizontal. The object is released from this position and it stops at a distance *d* from the bottom of the inclined plane along a horizontal surface, as shown in Fig. 8-6. The coefficient of kinetic friction for the horizontal surface of 0.400.
(a) What is the kinetic energy of the object at the bottom of the inclined plane?
(b) What is the speed of the object at the bottom of the inclined plane?
(c) At what horizontal distance from the bottom of the inclined plane will this object stop?
Answer: (a) 392 J
(b) 8.85 m/s
(c) 10.0 m
Diff: 2 Page Ref: Sec. 8-6

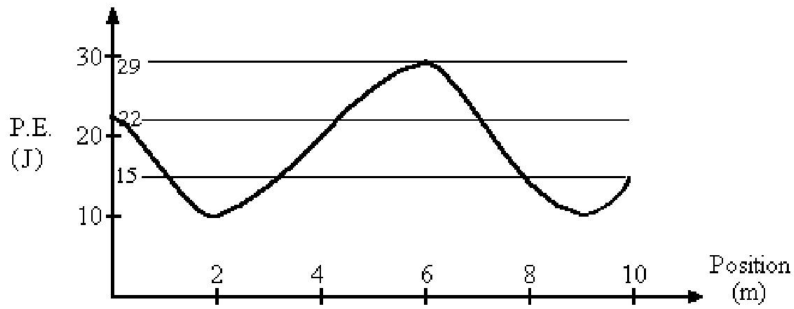
FIGURE 8-7



8) An object of mass *m* is at rest on a rough inclined plane with height *h*, length 8 m, and which makes an angle of 30° with the horizontal. The object is allowed to move and it stops on a rough horizontal surface, at a distance of 4 m from the bottom of the inclined plane, as shown in Fig. 8-7. The coefficient of kinetic friction on the inclined plane is 0.4.
(a) What is the speed of the object at the bottom of the inclined plane?
(b) What is the coefficient of kinetic friction for the horizontal surface?
Answer: (a) 5 m/s
(b) 0.3
Diff: 3 Page Ref: Sec. 8-6

9) A 60.0-kg satellite is in orbit a distance 2000 km above the surface of the earth. The mass of the earth is 5.976 x 10^{24} kg and the radius of the earth is 6.378×10^6 m.
(a) What is the change in the gravitational potential energy if the satellite moves to a circular orbit 5000 km above the surface of the earth?
(b) What is the change in kinetic energy if the satellite moves to a circular orbit 5000 km above the surface of the earth?
(c) How much work must be done on the satellite to move it to a circular orbit 5000 km above the surface of the earth?
Answer: (a) 7.53×10^8 J
(b) -3.76 x 10^8 J
(c) 3.76 x 10^8 J
Diff: 1 Page Ref: Sec. 8-7

FIGURE 8-8



10) A 2.0 kg mass is moving along the x axis. The potential energy curve as a function of position is shown in Fig. 8-8. The kinetic energy of the object at the origin is 12 J. The system is conservative. There is no friction.
(a) What will be the kinetic energy at 2.0 m along the $+x$-axis?
(b) What will be the speed of the object at 6.0 m along the $+x$-axis?
Answer: (a) 24 J
(b) 2.2 m/s
Diff: 1 Page Ref: Sec. 8-9

11) A 20-kg object is resting at the top of a table 1.6 m above ground level. The object is then picked up and moved to a height of 8.7 m above ground level. What is the change in the gravitational potential energy of this object? Use $g = 10\ \mathrm{m/s^2}$.
A) 71 J B) 140 J C) 1740 J D) 320 J E) 1390 J
Answer: E
Diff: 1 Page Ref: Sec. 8-2

12) A force on an object is given by $F(x) = (2.00\ \mathrm{N/m})x + (-3.00\ \mathrm{N/m^3})x^3$. What is a potential energy function for this conservative force?
A) $2.00\ \mathrm{N/m} - 9.00x^2$
B) $(-2.00\ \mathrm{N/m})x^2 + (3.00\ \mathrm{N/m^3})x^4$
C) $-2.00\ \mathrm{N/m} + (-3.00\ \mathrm{N/m^3})x^2$
D) $(-1.00\ \mathrm{N/m})x^2 + (0.750\ \mathrm{N/m^3})x^4$
E) $-2.00\ \mathrm{N/m} + 9.00x^2$
Answer: D
Diff: 1 Page Ref: Sec. 8-2

13) A force on an object is given by $F(x) = (-4.00\ \mathrm{N/m})x + (2.00\ \mathrm{N/m^3})x^3$. What is the change in potential energy in moving from $x = 1.00$ m to $x = 2.00$ m?
A) 10.0 J B) -1.50 J C) -10.0 J D) +1.50 J E) 12.0 J
Answer: B
Diff: 1 Page Ref: Sec. 8-2

14) A mass of 3.0 kg is subject to a force F(x) = 8.0 N - (4.0 N/m)x. The potential energy of the mass is zero at x = 0. What is the potential energy of the mass at x = 2.0 m?
A) 4.0 J B) 0.0 J C) 8.0 J D) -4.0J E) -8.0 J
Answer: E
Diff: 1 Page Ref: Sec. 8-2

15) A potential energy function is given by $U(x)$ = (3.00 N)x + (1.00 N/m^2)x^3. What is the force that is associated with this potential energy function?

A) 3.00 N + (1.00 N/m^2)x^2

B) -3.00 N - (3.00 N/m^2)x^2

C) (-0/500 N/m^2)x^2 + (-1.00 N/m^2)x^4

D) (0.500 N/m^2)x^2 + (1.00 N/m^2)x^4

E) -3.00 N - (1.00 N/m^2)x^2

Answer: B

Diff: 1 Page Ref: Sec. 8-2

16) A linear spring has a spring constant of 20 N/m. How far would it have to be stretched to have a potential energy of 0.10 J?

A) 0.10 m B) 200 m C) 0.0050 m D) 20 m E) 2.0 m

Answer: A

Diff: 1 Page Ref: Sec. 8-2

17) A force acting on a 2.00 kg object is given by $F(x)$ = (2.00 N/m)x + (1.00 N/m^3)x^3. An object starts at rest at x = 1.00 m. What is speed of the object when it reaches x = 2.00 m?

A) 1.23 m/s

B) 0.650 m/s

C) 2.60 m/s

D) 1.78 m/s

E) The object does not reach 2.00 m because the increase in potential energy would imply a negative kinetic energy.

Answer: C

Diff: 1 Page Ref: Sec. 8-3

18) Consider the motion of a 1.00-kg particle that moves with potential energy given by $U(x)$ = -(2.0 J·m)/x + (4.0 J·m^2)/x^2. Suppose the particle is moving with a speed of 3.00 m/s when it is located at x = 1.00 m. What is the speed of the object when it is located at x = 5.00 m?

A) 2.13 m/s

B) 3.00 m/s

C) 4.68 m/s

D) 3.67 m/s

E) This question cannot be answered. You need to know the direction of the velocity, not just the speed, when the particle is located at x = 1.00 m.

Answer: D

Diff: 2 Page Ref: Sec. 8-3

19) Consider the motion of a 1.00 kg particle that moves with potential energy given by $U(x)$ = -(2.0 J·m)/x + (4.0 J·m^2)/x^2. Suppose the particle is moving with a speed of 3.00 cm/s when it is located at x = 3.00 m. At which other position would the speed be equal to 3.00 cm/s?

A) 3.00 m

B) 6.00 m

C) 4.50 m

D) 5.00 m

E) The only position at which the speed is 3.00 cm/s is at x = 3.00 m.

Answer: B

Diff: 2 Page Ref: Sec. 8-3

20) A car on a roller coaster starts at zero speed at an elevation above the ground of 26 m. It coasts down a slope, and then climbs a hill. The top of the hill is at an elevation of 16 m. What is the speed of the car at the top of the hill? Neglect any frictional effects.

A) 14 m/s B) 18 m/s C) 10 m/s D) 9 m/s E) 6 m/s

Answer: A

Diff: 1 Page Ref: Sec. 8-4

21) A ball is thrown from the edge of a 20.0 m high cliff with a speed of 20.0 m/s at an angle of 30.0° below horizontal. What is the speed of the ball when it hits the ground below the cliff?

A) 37.6 m/s B) 28.1 m/s C) 31.4 m/s D) 43.2 m/s E) 29.8 m/s

Answer: B

Diff: 1 Page Ref: Sec. 8-4

22) A 0.500-kg object rests on a horizontal frictionless surface. It is in a position such that it is compressing a spring a distance 12.0 cm. If the object is released, the object leaves the spring at a speed of 20.0 cm/s. What is the spring constant of the spring?

A) 2.78 N/m B) 2.19 N/m C) 3.17 N/m D) 1.39 N/m E) 0.333 N/m

Answer: D

Diff: 1 Page Ref: Sec. 8-4

23) A projectile is fired from ground level at an angle of 40.0° above horizontal at a speed of 30.0 m/s. What is the speed of the projectile when it has reached a height equal to 0.500 of its maximum height?

A) 26.0 B) 27.4 C) 28.7 D) 26.7 E) 28.1

Answer: D

Diff: 2 Page Ref: Sec. 8-4

24) A mass of 2.0 kg traveling at 3.0 m/s along a smooth, horizontal plane hits a relaxed spring. The mass is slowed to zero velocity when the spring has been compressed by 0.15 m. What is the spring constant of the spring?

A) 800 N/m B) 400 N/m C) 9.0 N/m D) 18 N/m E) 20 N/m

Answer: A

Diff: 2 Page Ref: Sec. 8-4

25) An object of mass 1.00 kg is attached to a vertical spring with spring constant 100 N/m. The object is held at rest in a position such that the spring is stretched upward a distance 1.00 cm beyond its undisturbed length. If the object is released, how far will it drop before coming to rest?

A) 2.06 cm B) 2.00 cm C) 2.94 cm D) 3.06 cm E) 1.94 cm

Answer: D

Diff: 2 Page Ref: Sec. 8-4

26) A mass of 100 g is attached to one end of a massless rod, 10 cm in length, which is pivoted about the opposite end. The rod is held vertical, with the mass at the top, and released. The rod swings. What is the speed of the mass at the instant that the rod is horizontal?

A) 0.71 m/s B) 4.0 m/s C) 2.0 m/s D) 1.4 m/s E) 2.8 m/s

Answer: D

Diff: 2 Page Ref: Sec. 8-4

27) An 8 kg object moving with an initial velocity of 4 m/s comes to rest due to friction after it travels a horizontal distance of 10 m. If the initial speed of the object is doubled, what distance will it travel before coming to rest? Use $g = 10\ \text{m/s}^2$.

A) 10 m B) 20 m C) 30 m D) 40 m E) 80 m

Answer: D

Diff: 2 Page Ref: Sec. 8-6

28) An 8.0 kg object moving with an initial velocity of 8.0 m/s on a surface comes to rest due to friction after it travels a horizontal distance of 10 m. What is the coefficient of kinetic friction between the object and the surface? Use g = 10 m/s^2.

A) 0.13 B) 0.25 C) 0.32 D) 0.43 E) 0.80

Answer: C

Diff: 2 Page Ref: Sec. 8-6

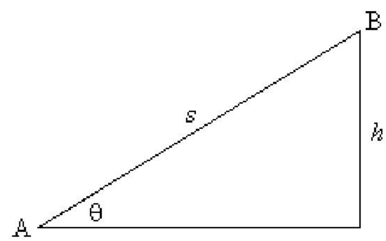
29) An object of mass m with a certain initial speed on a horizontal surface comes to rest after traveling a distance of 9.0 m. If the coefficient of kinetic friction between the object and the horizontal surface is 0.20, what is the initial speed of the object? Use g = 10 m/s^2.

A) 9.8 m/s B) 6.0 m/s C) 3.6 m/s D) 7.2 m/s E) 8.9 m/s

Answer: B

Diff: 2 Page Ref: Sec. 8-6

FIGURE 8-9



30) 6 J of work is needed to push an object of mass 2 kg from point A to point B of the frictionless inclined plane as shown in Fig. 8-9. If the angle of inclination is 30°, the height of the plane is h, what is the length of the inclined plane? Use g = 10 m/s^2.

A) 0.6 m B) 0.3 m C) 10 m D) 6 m E) 3 m

Answer: A

Diff: 2 Page Ref: Sec. 8-6

31) An object of mass 4 kg starts at rest from the top of a rough inclined plane of height 10 m as shown in Fig. 8-9. If the speed of the object at the bottom of the inclined plane is 10 m/s, how much work is done by the force of friction? Use g = 10 m/s^2.

A) -100 J B) 100 J C) 0 D) -200 J E) 200 J

Answer: D

Diff: 2 Page Ref: Sec. 8-6

32) An object of mass 2.00 kg starts at rest from the top of a rough inclined plane of height 20.0 m as shown in Fig. 8-9. If the work done by the force of friction is -150 J, what is the speed of the object as it reaches the bottom of the inclined plane? Use g = 10.0 m/s^2.

A) 15.8 m/s B) 150 m/s C) 10.0 m/s D) 20.0 m/s E) 200 m/s

Answer: A

Diff: 2 Page Ref: Sec. 8-6

33) An object with a mass of 10 kg is moving along a horizontal surface. At a certain point it has 40 J of kinetic energy. If the coefficient of friction between the object and the surface is 0.60, how far will the object go beyond that point before coming to a stop? Use g = 10 m/s^2.

A) 17 cm B) 42 cm C) 60 cm D) 5.7 cm E) 67 cm

Answer: E

Diff: 3 Page Ref: Sec. 8-6

34) A moon of mass 4.00×10^{15} kg is in a circular orbit of radius 1.00×10^{5} km about a planet of mass 6.00×10^{20} kg. Determine the potential energy of the system.

A) 1.60×10^{10} J

B) 2.40×10^{31} J

C) -1.60×10^{10} J

D) -6.67×10^{5} J

E) -1.60×10^{18} J

Answer: E

Diff: 1 Page Ref: Sec. 8-7

35) A projectile is shot from the surface of Earth by means of a very powerful cannon. If the projectile reaches a height of 35,000 m above Earth's surface, what was the speed of the projectile when it left the cannon?

A) 355 m/s B) 505 m/s C) 827 m/s D) 710 m/s E) 906 m/s

Answer: C

Diff: 2 Page Ref: Sec. 8-7

36) A space vehicle is orbiting Earth in a circular orbit with a radius of 10,300,000 m. What is the minimum increase in speed that is needed for the vehicle to escape Earth's gravitational field? The mass of Earth is 5.97×10^{24} kg and $G = 6.67 \times 10^{-11}$ $N \bullet m^2/kg^2$.

A) 6220 m/s B) 2580 m/s C) 3110 m/s D) 2840 m/s E) 7440 m/s

Answer: B

Diff: 2 Page Ref: Sec. 8-7

37) Neptune has a radius of 2.48×10^{7} m and an escape velocity of 23,300 m/s. What is the mass of Neptune? $G = 6.67 \times 10^{-11}$ $N \bullet m^2/kg^2$.

A) 1.01×10^{26} kg

B) 2.02×10^{26} kg

C) 3.03×10^{26} kg

D) 4.04×10^{26} kg

E) 5.05×10^{26} kg

Answer: A

Diff: 2 Page Ref: Sec. 8-7

38) A 50.0-kg satellite is in a circular orbit about a planet. The potential energy of the orbit is -4.00×10^{7} J. What is the speed of the satellite?

A) 1.26 km/s B) 2.11 km/s C) 1.44 m/s D) 3.22 km/s E) 894 m/s

Answer: E

Diff: 2 Page Ref: Sec. 8-7

39) The gravitational potential energy of a particle of mass m moving under the influence of a fixed mass M is given by $-\frac{GMm}{r}$, where G is the universal gravitational constant and r is the distance between the masses. What is the total energy of the mass m if it is in a circular orbit about mass M?

A) $-\frac{GMm}{2r}$ B) $-\frac{GMm}{r}$ C) $\frac{GMm}{2r}$ D) $\frac{GMm}{r}$ E) 0

Answer: A

Diff: 3 Page Ref: Sec. 8-7

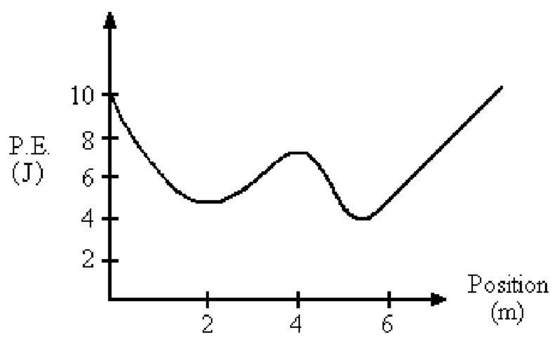
40) At what rate is a 60.0-kg boy using energy when he runs up a flight of stairs 10.0-m high, in 8.00 s?
A) 80.0 W B) 75.0 W C) 736 W D) 4.80 kW E) 48 W
Answer: C
Diff: 1 Page Ref: Sec. 8-8

41) A 25-N force is needed to move an object with a constant velocity of 2.0 m/s. What power must be delivered to the object by the force?
A) 0.50 W B) 1.0 W C) 5.0 W D) 50 W E) 100 W
Answer: D
Diff: 1 Page Ref: Sec. 8-8

42) A cyclist does work at the rate of 500 W while riding. How much force does her foot push with when she is traveling at 8.0 m/s?
A) 31 N B) 63 N C) 80 N D) 160 N E) 4000 N
Answer: B
Diff: 1 Page Ref: Sec. 8-8

43) A 1500-kg car accelerates from 0 to 25 m/s in 7.0 s. What is the average power delivered by the engine? (1 hp = 746 W)
A) 50 hp B) 60 hp C) 70 hp D) 80 hp E) 90 hp
Answer: E
Diff: 2 Page Ref: Sec. 8-8

FIGURE 8-10



A 2.0 kg mass is moving along the *x* axis. The potential energy curve as a function of position is shown in Figure 8-11. The system is conservative. There is no friction.

44) Refer to Figure 8-10. If the speed of the object at the origin is 4.0 m/s, what will be its speed at 7.0 m along the +*x*-axis?
A) 4.0 m/s B) 4.1 m/s C) 4.4 m/s D) 4.6 m/s E) 10 m/s
Answer: B
Diff: 1 Page Ref: Sec. 8-9

45) Refer to Figure 8-10. If the speed of the object at the origin is 4.0 m/s, what will be its speed at 4.0 m along the +*x*-axis?
A) 4.0 m/s B) 4.1 m/s C) 4.4 m/s D) 4.6 m/s E) 10 m/s
Answer: C
Diff: 1 Page Ref: Sec. 8-9

46) A potential energy function is given by $U(x) = (3.00\ \text{N/m})x - (1.00\ \text{N/m}^3)x^3$. At what position or positions is the force equal to zero?

A) $\sqrt{6.00}$ m and - $\sqrt{6.00}$ m
B) 0.00 m, $\sqrt{3.00}$ m and - $\sqrt{3.00}$ m
C) 1.00 m and -1.00 m
D) 3.00 m and -3.00 m
E) The force is not zero at any location.

Answer: C
Diff: 1 Page Ref: Sec. 8-9

47) The potential energy for a certain mass moving in one dimension is given by $U(x) = (2.0\ \text{J/m}^3)x^3 - (15\ \text{J/m}^2)x^2 + (36\ \text{J/m})x - 23\ \text{J}$. Find the location(s) where the force on the mass is zero.

A) 4.0 m, 5.0 m
B) (3.25 - 0.968i) m, (3.25 + 0.968i) m
C) 1.0 m
D) 2.0 m, 3.0 m
E) 3.0 m, 5.0 m

Answer: D
Diff: 2 Page Ref: Sec. 8-9

48) Consider the potential energy $U(x) = (1.0\ \text{J/m}^3)x^3 - (8\ \text{J/m}^2)x^2 + (15\ \text{J/m})x + 8.0\ \text{J}$. Find the turning points of the bound motion when the energy E is 8.0 J.

A) 1.0 m and 7.0 m
B) 3.0 m and 4.0 m
C) 2.0 m and 4.0 m
D) 3.0 m and 5.0 m
E) 1.44 m and 5.56 m

Answer: D
Diff: 2 Page Ref: Sec. 8-9

49) The potential energy of a particle is given by $U(x) = (9\ \text{J/m}^4)x^4 - (8\ \text{J/m}^2)x^2$. At what value of x would the particle be in unstable equilibrium?

A) 2/3 m
B) $\sqrt{\frac{8}{9}}$ m
C) -2/3 m
D) 0 m
E) $-\sqrt{\frac{8}{9}}$ m

Answer: D
Diff: 2 Page Ref: Sec. 8-9

50) Consider the motion of a 1.00 kg particle that moves with potential energy given by $U(x) = -(2.0\ \text{J·m})/x + (4.0\ \text{J·m}^2)/x^2$. Suppose the particle is moving with a speed of 30.0 cm/s when it is located at $x = 3.00$ m. What is the position with the greatest value of x at which the particle comes to rest?

A) 6.73 m
B) 5.48 m
C) 8.69 m
D) 9.21 m
E) 7.29 m

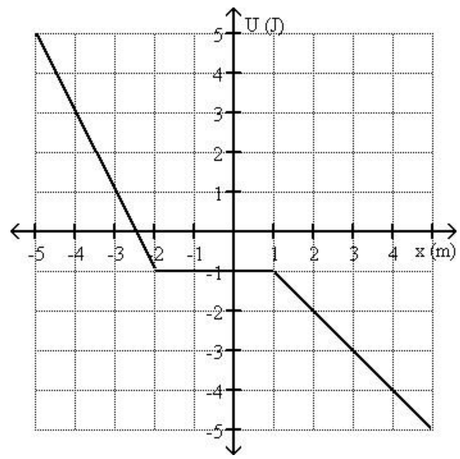
Answer: C
Diff: 2 Page Ref: Sec. 8-9

51) A 3.00-kg object moves in a potential $U(x) = A|x|$, where A is a positive constant. When the object is located at x = -1.50 m, it has a kinetic energy (2.00 m)A. What is the range of the object's motion?

A) -10.5 m to +10.5 m
B) -1.50 m to 1.50 m
C) -0.50 m to +0.50 m
D) -2.00 m to +2.00 m
E) -3.50 m to +3.50 m

Answer: E
Diff: 2 Page Ref: Sec. 8-9

FIGURE 8-11



52) Fig. 8-11 shows the potential energy of an object as a function of position. Determine the force as a function of position.

A) F(x) = -2.0 N for -5.0 m < x < -2.0 m
0 for -2.0 m < x < 1.0 m
-1.0 N for 1.0 m < x < 5.0 m
B) F(x) = 2.0 N for -5.0 m < x < -2.0 m
0 for -2.0 m < x < 1.0 m
1.0 N for 1.0 m < x < 5.0 m
C) F(x) = (-2.0 N)x for -5.0 m < x < -2.0 m
0 for -2.0 m < x < 1.0 m
(-1.0 N)x for 1.0 m < x < 5.0 m
D) F(x) = (-1.0 N)x^2 for -5.0 m < x < -2.0 m
(-1.0 N)x for -2.0 m < x < 1.0 m
(-0.50 N)x^2 for 1.0 m < x < 5.0 m
E) The force cannot be determined from the information presented in the graph.

Answer: B
Diff: 2 Page Ref: Sec. 8-9