Exam

Name_____

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

1) What is the correct unit of work expressed in SI units?
A) kg m/s^2 B) kg^2 m/s^2 C) kg m^2/s D) kg m^2/s^2

Answer: D

2) Can work be done on a system if there is no motion?
A) Yes, since motion is only relative.
B) No, because of the way work is defined.
C) No, since a system which is not moving has no energy.
D) Yes, if an outside force is provided.

Answer: B

3) If you push twice as hard against a stationary brick wall, the amount of work you do
A) remains constant but non-zero. B) is cut in half.
C) remains constant at zero. D) doubles.

Answer: C

4) A 50-N object was lifted 2.0 m vertically and is being held there. How much work is being done in holding the box in this position?
A) less than 100 J, but more than 0 J B) 100 J
C) more than 100 J D) 0 J

Answer: D

5) If you walk 5.0 m horizontally forward at a constant velocity carrying a 10-N object, the amount of work you do is
A) less than 50 J, but more than 0 J. B) equal to 50 J.
C) zero. D) more than 50 J.

Answer: C

6) A container of water is lifted vertically 3.0 m then returned to its original position. If the total weight is 30 N, how much work was done?
A) 180 J B) 90 J
C) 45 J D) No work was done.

Answer: D

7) Does the centripetal force acting on an object do work on the object?
A) No, because the object has constant speed.
B) Yes, since it takes energy to turn an object.
C) No, because the force and the displacement of the object are perpendicular.
D) Yes, since a force acts and the object moves, and work is force times distance.

Answer: C

8) You throw a ball straight up. Compare the sign of the work done by gravity while the ball goes up with the sign of the work done by gravity while it goes down.
A) Work is - on the way up and + on the way down.
B) Work is + on the way up and + on the way down.
C) Work is + on the way up and - on the way down.
D) Work is - on the way up and - on the way down.

Answer: A

9) The area under the curve, on a Force versus position (F vs. x) graph, represents
A) potential energy. B) kinetic energy. C) power. D) work.

Answer: D

10) On a plot of Force versus position (F vs. x), what represents the work done by the force F?
A) the slope of the curve
B) the product of the maximum force times the maximum x
C) the area under the curve
D) the length of the curve

Answer: C

11) The quantity $1/2\ mv^2$ is
A) the power supplied to the object by the force. B) the work done on the object by the force.
C) the potential energy of the object. D) the kinetic energy of the object.

Answer: D

12) If the net work done on an object is positive, then the object's kinetic energy
A) is zero. B) decreases. C) increases. D) remains the same.

Answer: C

13) If the net work done on an object is negative, then the object's kinetic energy
A) increases. B) decreases. C) remains the same. D) is zero.

Answer: B

14) If the net work done on an object is zero, then the object's kinetic energy
A) increases. B) is zero. C) decreases. D) remains the same.

Answer: D

15) A truck weighs twice as much as a car, and is moving at twice the speed of the car. Which statement is true about the truck's kinetic energy compared to that of the car?
A) All that can be said is that the truck has more kinetic energy.
B) The truck has 4 times the kinetic energy of the car.
C) The truck has 8 times the kinetic energy of the car.
D) The truck has twice the kinetic energy of the car.

Answer: C

16) Car J moves twice as fast as car K, and car J has half the mass of car K. The kinetic energy of car J, compared to car K is
A) 1 to 2. B) 4 to 1. C) 2 to 1. D) the same.

Answer: C

17) An object hits a wall and bounces back with half of its original speed. What is the ratio of the final kinetic energy to the initial kinetic energy?

A) 1/4 B) 2 C) 1/2 D) 4

Answer: A

18) A brick is moving at a speed of 3 m/s and a pebble is moving at a speed of 5 m/s. If both objects have the same kinetic energy, what is the ratio of the brick's mass to the rock's mass?

A) 5 to 3 B) 3 to 5 C) 12.5 to 4.5 D) 25 to 9

Answer: D

19) A 4.0-kg mass is moving with speed 2.0 m/s. A 1.0-kg mass is moving with speed 4.0 m/s. Both objects encounter the same constant braking force, and are brought to rest. Which object travels the greater distance before stopping?

A) the 1.0-kg mass
B) the 4.0-kg mass
C) Both travel the same distance.
D) cannot be determined from the information given

Answer: C

20) You slam on the brakes of your car in a panic, and skid a certain distance on a straight, level road. If you had been traveling twice as fast, what distance would the car have skidded, under the same conditions?

A) It would have skidded twice as far.
B) It would have skidded 4 times farther.
C) It would have skidded 1.4 times farther.
D) It is impossible to tell from the information given.

Answer: B

21) A planet of constant mass orbits the Sun in an elliptical orbit. Neglecting any friction effects, what happens to the planet's kinetic energy?

A) It decreases continually.
B) It increases continually.
C) It remains constant.
D) It increases when the planet approaches the Sun, and decreases when it moves farther away.

Answer: D

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

22) State the work-energy principle.

Answer: The net work done on an object is equal to the change in the object's kinetic energy.

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

23) The quantity mgy is

A) the kinetic energy of the object.
B) the gravitational potential energy of the object.
C) the power supplied to the object by the force.
D) the work done on the object by the force.

Answer: B

24) The quantity $1/2\ kx^2$ is

A) the work done on the object by the force.
B) the elastic potential energy of the object.
C) the kinetic energy of the object.
D) the power supplied to the object by the force.

Answer: B

25) Is it possible for a system to have negative potential energy?
A) No, because this would have no physical meaning.
B) No, because the kinetic energy of a system must equal its potential energy.
C) Yes, as long as the total energy is positive.
D) Yes, since the choice of the zero of potential energy is arbitrary.

Answer: D

26) An object is released from rest a height *h* above the ground. A second object with four times the mass of the first if released from the same height. The potential energy of the second object compared to the first is
A) twice as much.
B) four times as much.
C) one-half as much.
D) one-fourth as much.

Answer: B

27) A 0.200-kg mass attached to the end of a spring causes it to stretch 5.0 cm. If another 0.200-kg mass is added to the spring, the potential energy of the spring will be
A) the same.
B) 4 times as much.
C) 3 times as much.
D) twice as much.

Answer: B

28) The total mechanical energy of a system
A) is either all kinetic energy or all potential energy, at any one instant.
B) is equally divided between kinetic energy and potential energy.
C) can never be negative.
D) is constant, only if conservative forces act.

Answer: D

29) An acorn falls from a tree. Compare its kinetic energy K, to its potential energy U.
A) K increases and U increases.
B) K decreases and U increases.
C) K decreases and U decreases.
D) K increases and U decreases.

Answer: D

30) Describe the energy of a car driving up a hill.
A) entirely potential
B) entirely kinetic
C) gravitational
D) both kinetic and potential

Answer: D

31) 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 lightweight object, because it weighs less.
B) The heavy object, because it has greater kinetic energy.
C) They both slide to the same height.
D) cannot be determined from the information given

Answer: C

32) Consider two masses m_1 and m_2 at the top of two frictionless inclined planes. Both masses start from rest at the same height. However, the plane on which m_1 sits is at an angle of 30° with the horizontal, while the plane on which m_2 sits is at 60°. If the masses are released, which is going faster at the bottom of its plane?

A) m_2
B) m_1
C) They both are going the same speed.
D) cannot be determined without knowing the masses

Answer: C

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

33) State the principle of conservation of mechanical energy for conservative forces.

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

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

34) A ball falls from the top of a building, through the air (air friction is present), to the ground below. How does the kinetic energy (K) just before striking the ground compare to the potential energy (U) at the top of the building?

A) K is equal to U.
B) K is less than U.
C) K is greater than U.
D) It is impossible to tell.

Answer: B

35) 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) less than 30 J
C) exactly 30 J
D) cannot be determined from the information given

Answer: A

36) 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) less than 30 J
B) more than 30 J
C) exactly 30 J
D) cannot be determined from the information given

Answer: A

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

37) State the law of conservation of energy.

Answer: The total energy is neither increased nor decreased in any process. Energy can be transformed from one form to another, and transferred from one object to another, but the total amount remains constant.

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

38) The quantity Fd/t is
A) the power supplied to the object by the force.
B) the kinetic energy of the object.
C) the work done on the object by the force.
D) the potential energy of the object.
Answer: A

39) What is the correct unit of power expressed in SI units?
A) $kg^2\ m/s^2$
B) $kg\ m^2/s^3$
C) $kg\ m/s^2$
D) $kg\ m^2/s^2$
Answer: B

40) Of the following, which is not a unit of power?
A) watt
B) joule/second
C) watt/second
D) newton-meter/second
Answer: C

41) Compared to yesterday, you did 3 times the work in one-third the time. To do so, your power output must have been
A) one-third of yesterday's power output.
B) 9 times yesterday's power output.
C) 3 times yesterday's power output.
D) the same as yesterday's power output.
Answer: B

42) To accelerate your car at a constant acceleration, the car's engine must
A) maintain a constant turning speed.
B) develop ever-decreasing power.
C) develop ever-increasing power.
D) maintain a constant power output.
Answer: C

43) An object is lifted vertically 2.0 m and held there. If the object weighs 90 N, how much work was done in lifting it?
A) 0 J
B) 360 J
C) 90 J
D) 180 J
Answer: D

44) You lift a 10-N physics book up in the air a distance of 1.0 m, at a constant velocity of 0.50 m/s. What is the work done by the weight of the book?
A) +10 J
B) -10 J
C) -5.0 J
D) +5.0 J
Answer: B

45) A 500-kg elevator is pulled upward with a constant force of 5500 N for a distance of 50.0 m. What is the work done by the 5500 N force?
A) 2.75×10^5 J
B) -5.20×10^5 J
C) -2.45×10^5 J
D) 3.00×10^4 J
Answer: A

46) A 500-kg elevator is pulled upward with a constant force of 5500 N for a distance of 50.0 m. What is the work done by the weight of the elevator?
A) -5.20×10^5 J
B) -2.45×10^5 J
C) 3.00×10^4 J
D) 2.75×10^5 J
Answer: B

47) A 500-kg elevator is pulled upward with a constant force of 5500 N for a distance of 50.0 m. What is the net work done on the elevator?

A) 3.00×10^4 J B) -5.20×10^5 J C) 2.75×10^5 J D) -2.45×10^5 J

Answer: A

48) A 30-N box is pulled 6.0 m up along a 37° inclined plane. What is the work done by the weight (gravitational force) of the box?

A) -1.8×10^2 J B) -1.4×10^2 J C) -1.1×10^2 J D) -11 J

Answer: C

49) A 4.00-kg box of fruit slides 8.0 m down a ramp, inclined at 30.0° from the horizontal. If the box slides at a constant velocity of 5.00 m/s, what is the work done by the weight of the box?

A) -78.4 J B) -157 J + 78.4 J C) 78.4 J D) 157 J

Answer: D

50) Matthew pulls his little sister Sarah in a sled on an icy surface (assume no friction), with a force of 60.0 N at an angle of 37.0° upward from the horizontal. If he pulls her a distance of 12.0 m, what is the work done by Matthew?

A) 185 J B) 720 J C) 433 J D) 575 J

Answer: D

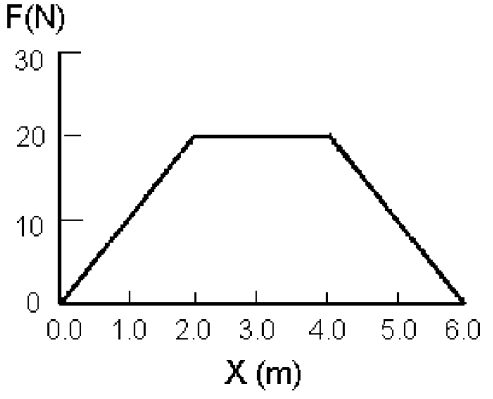

FIGURE 6-1

51) A force moves an object in the direction of the force. The graph in Fig. 6-1 shows the force versus the object's position. Find the work done when the object moves from 0 to 2.0 m.

A) 60 J B) 80 J C) 20 J D) 40 J

Answer: C

52) A force moves an object in the direction of the force. The graph in Fig. 6-1 shows the force versus the object's position. Find the work done when the object moves from 2.0 to 4.0 m.

A) 40 J B) 20 J C) 80 J D) 60 J

Answer: A

53) A force moves an object in the direction of the force. The graph in Fig. 6-1 shows the force versus the object's position. Find the work done when the object moves from 4.0 to 6.0 m.

A) 40 J B) 20 J C) 80 J D) 60 J

Answer: B

54) A force moves an object in the direction of the force. The graph in Fig. 6-1 shows the force versus the object's position. Find the work done when the object moves from 0 to 6.0 m.

A) 80 J B) 20 J C) 60 J D) 40 J

Answer: A

55) A horizontal force of 200 N is applied to move a 55-kg cart (initially at rest) across a 10 m level surface. What is the final kinetic energy of the cart?

A) 4.0×10^3 J B) 2.0×10^3 J C) 2.7×10^3 J D) 1.0×10^3 J

Answer: B

56) A horizontal force of 200 N is applied to move a 55-kg cart (initially at rest) across a 10 m level surface. What is the final speed of the cart?

A) 8.5 m/s B) 73 m/s C) 36 m/s D) 6.0 m/s

Answer: A

57) A 10-kg mass is moving with a speed of 5.0 m/s. How much work is required to stop the mass?

A) 50 J B) 125 J C) 75 J D) 100 J

Answer: B

58) If it takes 50 m to stop a car initially moving at 25 m/s, what distance is required to stop a car moving at 50 m/s under the same condition?

A) 100 m B) 200 m C) 50 m D) 400 m

Answer: B

59) A spring-driven dart gun propels a 10-g dart. It is cocked by exerting a force of 20 N over a distance of 5.0 cm. With what speed will the dart leave the gun, assuming the spring has negligible mass?

A) 10 m/s B) 20 m/s C) 17 m/s D) 14 m/s

Answer: D

60) A 100-N force has a horizontal component of 80 N and a vertical component of 60 N. The force is applied to a box which rests on a level frictionless floor. The cart starts from rest, and moves 2.0 m horizontally along the floor. What is the cart's final kinetic energy?

A) 120 J B) 160 J C) zero D) 200 J

Answer: B

61) An arrow of mass 20 g is shot horizontally into a bale of hay, striking the hay with a velocity of 60 m/s. It penetrates a depth of 20 cm before stopping. What is the average stopping force acting on the arrow?

A) 90 N B) 45 N C) 360 N D) 180 N

Answer: D

62) A 15.0-kg object is moved from a height of 7.00 m above a floor to a height of 13.0 m above the floor. What is the change in gravitational potential energy?

A) 1176 J B) 1910 J C) zero D) 1030 J

Answer: A

63) A 400-N box is pushed up an inclined plane. The plane is 4.0 m long and rises 2.0 m. If the plane is frictionless, how much work was done by the push?

A) 400 J B) 100 J C) 1600 J D) 800 J

Answer: D

64) A 10-kg mass, hung onto a spring, causes the spring to stretch 2.0 cm. What is the spring constant?
A) 4.9×10^3 N/m B) 20 N/m C) 5.0×10^3 N/m D) 2.0 N/m
Answer: A

65) A spring is characterized by a spring constant of 60 N/m. How much potential energy does it store, when stretched by 1.0 cm?
A) 3.0×10^{-3} J B) 600 J C) 0.30 J D) 60 J
Answer: A

66) Calculate the work required to compress an initially uncompressed spring with a spring constant of 25 N/m by 10 cm.
A) 0.10 J B) 0.17 J C) 0.25 J D) 0.13 J
Answer: D

67) What work is required to stretch a spring of spring constant 40 N/m from x = 0.20 m to 0.25 m? (Assume the unstretched position is at x = 0.)
A) 0.050 J B) 1.3 J C) 0.45 J D) 0.80 J
Answer: C

68) A spring with a spring constant of 15 N/m is initially compressed by 3.0 cm. How much work is required to compress the spring an additional 4.0 cm?
A) 0.012 J B) 0.0068 J C) 0.030 J D) 0.024 J
Answer: C

69) A 60-kg skier starts from rest from the top of a 50-m high slope. What is the speed of the slier on reaching the bottom of the slope? (Neglect friction.)
A) 41 m/s B) 22 m/s C) 9.8 m/s D) 31 m/s
Answer: D

70) A skier, of mass 40 kg, pushes off the top of a hill with an initial speed of 4.0 m/s. Neglecting friction, how fast will she be moving after dropping 10 m in elevation?
A) 7.3 m/s B) 49 m/s C) 196 m/s D) 15 m/s
Answer: D

71) An object slides down a frictionless inclined plane. At the bottom, it has a speed of 9.80 m/s. What is the vertical height of the plane?
A) 19.6 m B) 9.80 m C) 2.45 m D) 4.90 m
Answer: D

72) A 1.0-kg ball falls to the floor. When it is 0.70 m above the floor, its potential energy exactly equals its kinetic energy. How fast is it moving?
A) 45 m/s B) 14 m/s C) 3.7 m/s D) 6.9 m/s
Answer: C

73) A toy rocket, weighing 10 N, blasts straight up from ground level with a kinetic energy of 40 J. At the exact top of its trajectory, its total mechanical energy is 140 J. To what vertical height does it rise?
A) 10 m B) 1.0 m C) 14 m D) 24 m
Answer: A

74) A projectile of mass m leaves the ground with a kinetic energy of 220 J. At the highest point in its trajectory, its kinetic energy is 120 J. To what vertical height, relative to its launch point, did it rise?
A) 120/(mg) meters
B) 220/(mg) meters
C) 100/(mg) meters
D) Impossible to determine without knowing the angle of launch

Answer: C

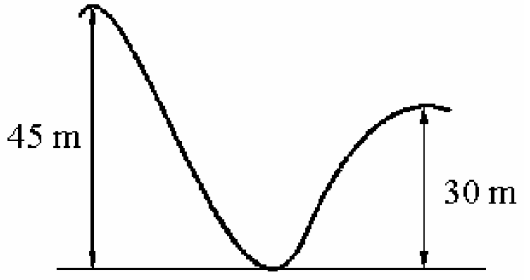

FIGURE 6-2

75) A roller coaster starts from rest at a point 45 m above the bottom of a dip (See Fig. 6-2). Neglect friction, what will be the speed of the roller coaster at the top of the next slope, which is 30 m above the bottom of the dip?
A) 14 m/s B) 30 m/s C) 17 m/s D) 24 m/s

Answer: C

76) A roller coaster starts with a speed of 5.0 m/s at a point 45 m above the bottom of a dip (See Fig. 6-2). Neglect friction, what will be the speed of the roller coaster at the top of the next slope, which is 30 m above the bottom of the dip?
A) 14 m/s B) 12 m/s C) 16 m/s D) 18 m/s

Answer: D

77) A roller coaster starts at a point 30 m above the bottom of a dip with a speed of 25 m/s (See Fig. 6-2). Neglect friction, what will be the speed of the roller coaster at the top of the next slope, which is 45 m above the bottom of the dip?
A) 18 m/s B) 20 m/s C) 16 m/s D) 14 m/s

Answer: A

78) What is the minimum speed of the ball at the bottom of its swing (point B) in order for it to reach point A, which is 1.0-m above the bottom of the swing?

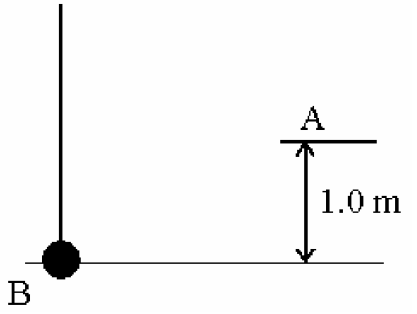

FIGURE 6-3

A) 3.1 m/s B) 4.4 m/s C) 4.9 m/s D) 2.2 m/s

Answer: B

79) A pendulum of length 50 cm is pulled 30 cm away from the vertical axis and released from rest. What will be its speed at the bottom of its swing?

A) 0.50 m/s B) 1.4 m/s C) 1.2 m/s D) 0.79 m/s

Answer: B

80) A 1500-kg car moving at 25 m/s hits an initially uncompressed horizontal spring with spring constant of 2.0×10^6 N/m. What is the maximum compression of the spring? (Neglect the mass of the spring.)

A) 0.51 m B) 0.17 m C) 0.34 m D) 0.68 m

Answer: D

81) A driver, traveling at 22 m/s, slows down her 2000 kg car to stop for a red light. What work is done by the friction force against the wheels?

A) -2.2×10^4 J B) -4.84×10^5 J C) -4.4×10^4 J D) -9.68×10^5 J

Answer: B

82) The kinetic friction force between a 60.0-kg object and a horizontal surface is 50.0 N. If the initial speed of the object is 25.0 m/s, what distance will it slide before coming to a stop?

A) 15.0 m B) 375 m C) 750 m D) 30.0 m

Answer: B

83) A 12-kg object is moving on a rough, level surface. It has 24 J of kinetic energy. The friction force on it is a constant 0.50 N. How far will it slide?

A) 12 m B) 2.0 m C) 48 m D) 24 m

Answer: C

84) A force of 10 N is applied horizontally to a 2.0-kg mass on a level surface. The coefficient of kinetic friction between the mass and the surface is 0.20. If the mass is moved a distance of 10 m, what is the change in its kinetic energy?

A) 20 J B) 61 J C) 46 J D) 39 J

Answer: B

85) A 60-kg skier starts from rest from the top of a 50-m high slope. If the work done by friction is -6.0×10^3 J, what is the speed of the skier on reaching the bottom of the slope?
A) 31 m/s B) 24 m/s C) 34 m/s D) 17 m/s
Answer: C

86) An 800-N box is pushed up an inclined plane. The plane is 4.0 m long and rises 2.0 m. It requires 3200 J of work to get the box to the top of the plane. What was the magnitude of the average friction force on the box?
A) greater than 400 N B) 0 N
C) 400 N D) non-zero, but less than 400 N
Answer: C

87) A 2.0-kg mass is released from rest at the top of a plane inclined at 20° above horizontal. The coefficient of kinetic friction between the mass and the plane is 0.20. What will be the speed of the mass after sliding 4.0 m along the plane?
A) 5.2 m/s B) 3.0 m/s C) 3.5 m/s D) 2.2 m/s
Answer: C

88) A 30.0-N stone is dropped from a height of 10.0 m, and strikes the ground with a velocity of 7.00 m/s. What average force of air friction acts on it as it falls?
A) 225 N B) 293 N C) 22.5 N D) 75.0 N
Answer: C

89) 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) 48 W B) 4.80 kW C) 75.0 W D) 735 W
Answer: D

90) A 10-N force is needed to move an object with a constant velocity of 5.0 m/s. What power must be delivered to the object by the force?
A) 1.0 W B) 50 W C) 0.50 W D) 100 W
Answer: B

91) How many joules of energy are used by a 1.0 hp motor that runs for 1.0 hr? (1 hp = 746 W)
A) 2.7×10^6 J B) 3.6×10^3 J C) 4.8 J D) 4.5×10^4 J
Answer: A

92) 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) 63 N B) 4000 N C) 31 N D) 80 N
Answer: A

93) 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) 90 hp B) 70 hp C) 60 hp D) 80 hp
Answer: A

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

94) Can a centripetal force ever do work on an object? Explain.

Answer: Since "centripetal" means "pointing to the center of curvature", then a centripetal force will not do work on an object, because if an object is moving in a curved path, by definition the direction towards the center of curvature is always perpendicular to the direction of motion. For a force to do work, the force must have a component in the direction of displacement. So the centripetal force does no work.

95) A woman swimming upstream is not moving with respect to the shore. Is she doing any work? If she stops swimming and merely floats, is work done on her?

Answer: The woman does work by moving the water with her hands and feet, because she must exert a force to move the water some distance. As she stops swimming and begins to float in the current, the current does work on her because she gains kinetic energy. Once she is floating the same speed as the water, her kinetic energy does not change, and so no net work is being done on her.

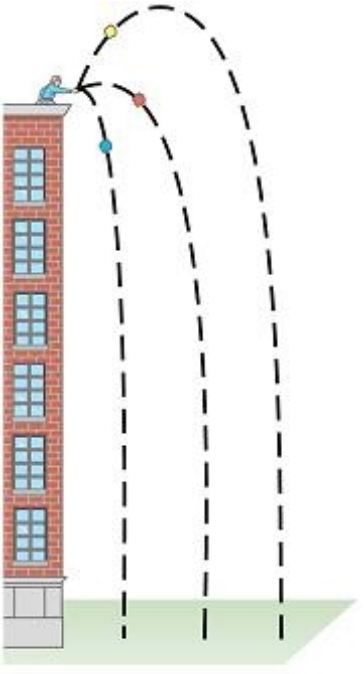

FIGURE 6-31

96) In Fig. 6-31, water balloons are tossed from the roof of a building, all with the same speed but with different launch angles. Which one has the highest speed on impact? Ignore air resistance.

Answer: Since each balloon has the same initial kinetic energy, and each balloon undergoes the same overall change in gravitational PE, each balloon will have the same kinetic energy at the ground, and so each one has the same speed at impact.

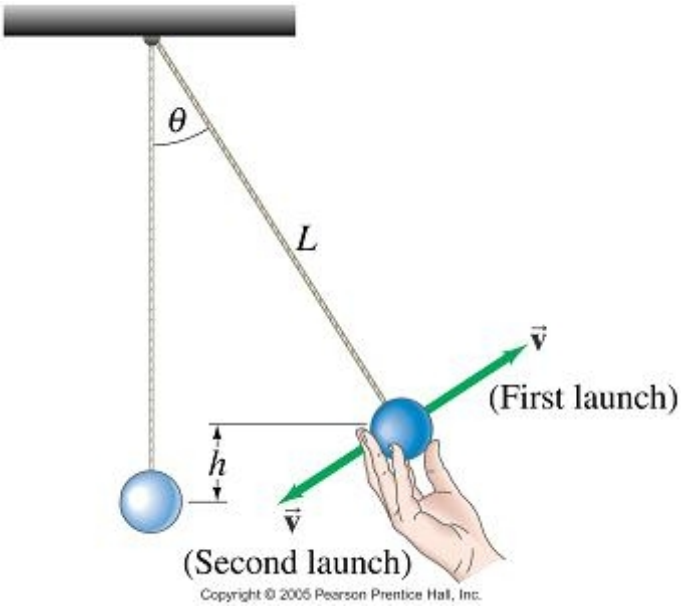

FIGURE 6-32

97) A pendulum is launched from a point that is a height h above its lowest point in two different ways (Fig. 6-32). During both launches, the pendulum is given an initial speed of 3.0 m/s. On the first launch, the initial velocity of the pendulum is directed upward along the trajectory, and on the second launch it is directed downward along the trajectory. Which launch will cause it to swing the largest angle from the equilibrium position? Explain.

Answer: The two launches will result in the same largest angle. Applying conservation of energy between the launching point and the highest point, we have $E_1 = E_2 \rightarrow \frac{1}{2}mv^2 + mgh = mgh_{max}$. The direction of the launching velocity does not matter, and so the same maximum height (and hence maximum angle) will results from both launches. Also, for the first launch, the ball will rise to some maximum height and then come back to the launch point with the same speed as when launched. That then exactly duplicates the second launch.

98) Two identical arrows, one with twice the speed of the other, are fired into a bale of hay. Assuming the hay exerts a constant frictional force on the arrows, the faster arrow will penetrate how much farther than the slower arrow? Explain.

Answer: If we assume that all of the arrow's kinetic energy is converted into work done against friction, then the following relationship exists:

$$W = \triangle KE = KE_f - KE_i \rightarrow F_{fr}\, d \cos 180° = \frac{1}{2}m v_f^2 - \frac{1}{2}m v_0^2 \rightarrow -F_{fr}\, d = -\frac{1}{2}m v_0^2 \rightarrow d = \frac{m v_0^2}{2F_{fr}}$$

Thus the distance is proportional to the square of the initial velocity. So if the initial velocity is doubled, the distance will be multiplied by a factor of 4. Thus the faster arrow penetrates 4 times further than the slower arrow.

99) Suppose you lift a suitcase from the floor to a table. The work you do on the suitcase depends on which of the following: (a) whether you lift it straight up or along a more complicated path, (b) the time it takes, (c) the height of the table, and (d) the weight of the suitcase?

Answer: The work done to lift the suitcase is equal to the change in PE of the suitcase, which is the weight of the suitcase times the change in height (the height of the table).
(a) Work does NOT depend on the path, as long as there are no non-conservative forces doing work.
(b) Work does NOT depend on the time taken.
(c) Work DOES depend on the height of the table - the higher the table, the more work it takes to lift the suitcase.
(d) Work DOES depend on the weight of the suitcase - the more the suitcase weighs, the more work it takes to lift the suitcase.

100) A box of mass 5.0 kg is accelerated by a force across a floor at a rate of 2.0 m/s^2 for 7.0 s. Find the net work done on the box.

Answer: 4.9×10^2 J

FIGURE 6-36

101) A 330-kg piano slides 3.6 m down a 28° incline and is kept from accelerating by a man who is pushing back on it *parallel to the incline* (Fig. 6-36). The effective coefficient of kinetic friction is 0.40. Calculate: (a) the force exerted by the man, (b) the work done by the man on the piano, (c) the work done by the friction force, (d) the work done by the force of gravity, and (e) the net work done on the piano.

Answer: (a) 3.8×10^2 N
(b) -1.4×10^3 J
(c) -4.1×10^3 J
(d) 5.4×10^3 J
(e) 0 J

102) (a) Find the force required to give a helicopter of mass M an acceleration of $0.10g$ upward. (b) Find the work done by this force as the helicopter moves a distance h upward.

Answer: (a) $1.10Mg$
(b) $1.10Mgh$

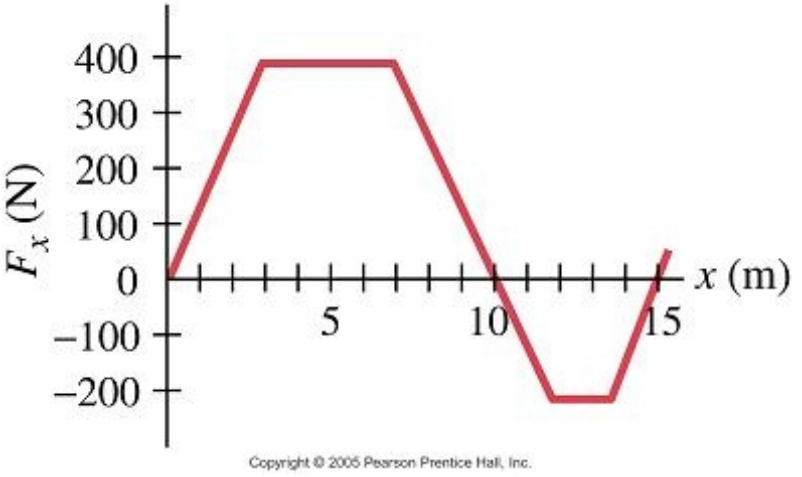

FIGURE 6-37

103) The force on an object, acting along the *x* axis, varies as shown in Fig. 6-37. Determine the work done by the force to move the object (a) from $x = 0.0$ to $x = 10.0$ m, and (b) from $x = 0.0$ to $x = 15.0$ m.

Answer: (a) 2.8×10^3 J
(b) 2.1×10^3 J

104) An 88-g arrow is fired from a bow whose string exerts an average force of 110 N on the arrow over a distance of 78 cm. What is the speed of the arrow as it leaves the bow?

Answer: 44 m/s

105) At an accident scene on a level road, investigators measure a car's skid mark to be 88 m long. The accident occurred on a rainy day, and the coefficient of kinetic friction was estimated to be 0.42. Use these data to determine the speed of the car when the driver slammed on (and locked) the brakes. (Why does the car's mass not matter?)

Answer: 27 m/s
The mass does not affect the problem, since both the change in kinetic energy and the work done by friction are proportional to the mass. The mass cancels out of the equation.

106) A 285-kg load is lifted 22.0 m vertically with an acceleration $a = 0.160\ g$ by a single cable. Determine (a) the tension in the cable, (b) the net work done on the load, (c) the work done by the cable on the load, (d) the work done by gravity on the load, and (e) the final speed of the load assuming it started from rest.

Answer: (a) 3.24×10^3 N
(b) 9.83×10^3 J
(c) 7.13×10^4 J
(d) -6.14×10^4 J
(e) 8.31 m/s

107) A 1200-kg car rolling on a horizontal surface has speed $v = 65$ km/h when it strikes a horizontal coiled spring and is brought to rest in a distance of 2.2 m.. What is the spring stiffness constant of the spring?

Answer: 8.1×10^4 N/m

108) A 55-kg hiker starts at an elevation of 1600 m and climbs to the top of a 3300 m peak. (a) What is the hiker's change in potential energy? (b) What is the minimum work required of the hiker? (c) Can the actual work done be more than this? Explain why.

Answer: (a) 9.2×10^5 J
(b) 9.2×10^5 J
(c) Yes. The actual work may be more than this, because the climber almost certainly had to overcome some dissipative forces such as air friction. Also, as the person steps up and down, they do not get the full amount of work back from each up-down event. For example, there will be friction in their joints and muscles.

109) In the high jump, Fran's kinetic energy is transformed into gravitational potential energy without the aid of a pole. With what minimum speed must Fran leave the ground in order to lift her center of mass 2.10 m and cross the bar with a speed of 0.70 m/s?

Answer: 6.45 m/s

110) A projectile is fired at an upward angle of 45° from the top of a 265 m cliff with a speed of 185 m/s. What will be its speed when it strikes the ground below? (Use conservation of energy.)

Answer: 199 m/s

111) A vertical spring (ignore its mass), whose spring stiffness constant is 950 N/m, is attached to a table and is compressed down 0.150 m. (a) What upward speed can it give to a 0.30 kg ball when released? (b) How high above its original position (spring compressed) will the ball fly?

Answer: (a) 8.3 m/s
(b) 3.6 m

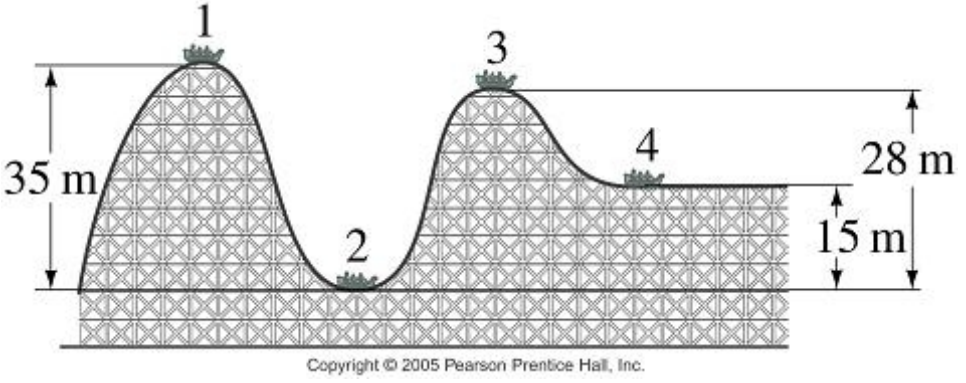

FIGURE 6-41

112) The roller-coaster car shown in Fig. 6-41 is dragged up to point 1 when it is released from rest. Assuming no friction, calculate the speed at points 2,3, and 4.

Answer: 26 m/s, 12 m/s, 20 m/s

113) A ski starts from rest and slides down a 22° incline 75 m long. (a) If the coefficient of friction is 0.090, what is the ski's top speed at the base of the incline? (b) If the snow is level at the foot of the incline and has the same coefficient of friction, how far will the ski travel along the level? Use energy methods.

Answer: (a) 21 m/s
(b) 2.4×10^2 m

114) A 145-g baseball is dropped from a tree 13.0 m above the ground. (a) With what speed would it hit the ground if air resistance could be ignored? (b) If it actually hits the ground with a speed of 8.00 m/s, what is the average force of air resistance exerted on it?

Answer: (a) 16.0 m/s
(b) 1.06 N

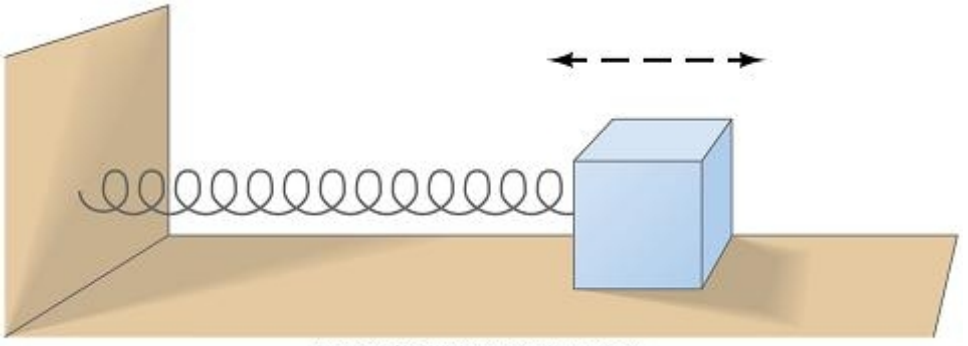

FIGURE 6-40

115) A 380-g wood block is firmly attached to a very light horizontal spring, Fig. 6-40. The block can slide along a table where the coefficient of friction is 0.30. A force of 22 N compresses the spring 18 cm. If the spring is released from this position, how far beyond its equilibrium position will it stretch on its first swing?

Answer: 0.18 m

116) A shot-putter accelerates a 7.3 kg shot from rest to 14 m/s. If this motion takes 1.5 s, what average power was developed?

Answer: 480 W

117) A pump is to lift 18.0 kg of water per minute through a height of 3.60 m. What output rating (watts) should the pump motor have?

Answer: 10.6 W

118) During a workout, the football players at State U. ran up the stadium stairs in 66 s. The stairs are 140 m long and inclined at an angle of 32°. If a typical player has a mass of 95 kg, estimate the average power output on the way up. Ignore friction and air resistance.

Answer: 1.0×10^3 W