Chapter 7: KINETIC ENERGY AND WORK

1. Which of the following is NOT a correct unit for work?
   A. erg
   B. ft·lb
   C. watt
   D. newton·meter
   E. joule

   ans: C

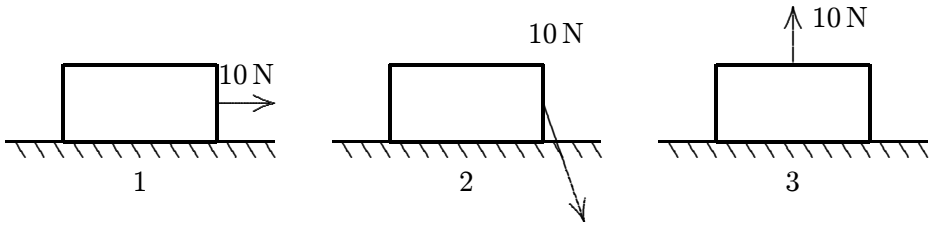
2. Which of the following groups does NOT contain a scalar quantity?
   A. velocity, force, power
   B. displacement, acceleration, force
   C. acceleration, speed, work
   D. energy, work, distance
   E. pressure, weight, time

   ans: B

3. A boy holds a 40-N weight at arm's length for 10 s. His arm is 1.5 m above the ground. The work done by the force of the boy on the weight while he is holding it is:
   A. 0
   B. 6.1 J
   C. 40 J
   D. 60 J
   E. 90 J

   ans: A

4. A crate moves 10 m to the right on a horizontal surface as a woman pulls on it with a 10-N force. Rank the situations shown below according to the work done by her force, least to greatest.



   A. 1, 2, 3
   B. 2, 1, 3
   C. 2, 3, 1
   D. 1, 3, 2
   E. 3, 2, 1

   ans: E

5. An object moves in a circle at constant speed. The work done by the centripetal force is zero because:

   A. the displacement for each revolution is zero
   B. the average force for each revolution is zero
   C. there is no friction
   D. the magnitude of the acceleration is zero
   E. the centripetal force is perpendicular to the velocity

   ans: E

6. An object of mass 1 g is whirled in a horizontal circle of radius 0.5 m at a constant speed of 2 m/s. The work done on the object during one revolution is:

   A. 0
   B. 1 J
   C. 2 J
   D. 4 J
   E. 16 J

   ans: A

7. The work done by gravity during the descent of a projectile:

   A. is positive
   B. is negative
   C. is zero
   D. depends for its sign on the direction of the y axis
   E. depends for its sign on the direction of both the x and y axes

   ans: A

8. A baseball is hit high into the upper bleachers of left field. Over its entire flight the work done by gravity and the work done by air resistance, respectively, are:

   A. positive; positive
   B. positive; negative
   C. negative; positive
   D. negative; negative
   E. unknown since vital information is lacking

   ans: D

9. A line drive to the shortstop is caught at the same height as it was originally hit. Over its entire flight the work done by gravity and the work done by air resistance, respectively, are:

   A. zero; positive
   B. zero; negative
   C. positive; negative
   D. negative; positive
   E. negative; negative

   ans: B

10. A 2-kg object is moving at 3 m/s. A 4-N force is applied in the direction of motion and then removed after the object has traveled an additional 5 m. The work done by this force is:

A. 12 J
B. 15 J
C. 18 J
D. 20 J
E. 38 J

ans: D

11. A sledge (including load) weighs 5000 N. It is pulled on level snow by a dog team exerting a horizontal force on it. The coefficient of kinetic friction between sledge and snow is 0.05. How much work is done by the dog team pulling the sledge 1000 m at constant speed?

A. 2.5×10^4 J
B. 2.5×10^5 J
C. 5.0×10^5 J
D. 2.5×10^6 J
E. 5.0×10^6 J

ans: B

12. Camping equipment weighing 6000 N is pulled across a frozen lake by means of a horizontal rope. The coefficient of kinetic friction is 0.05. The work done by the campers in pulling the equipment 1000 m at constant velocity is:

A. 3.1×10^4 J
B. 1.5×10^5 J
C. 3.0×10^5 J
D. 2.9×10^6 J
E. 6.0×10^6 J

ans: C

13. Camping equipment weighing 6000 N is pulled across a frozen lake by means of a horizontal rope. The coefficient of kinetic friction is 0.05. How much work is done by the campers in pulling the equipment 1000 m if its speed is increasing at the constant rate of $0.20\,\mathrm{m/s^2}$?

A. -1.2×10^6 J
B. 1.8×10^5 J
C. 3.0×10^5 J
D. 4.2×10^5 J
E. 1.2×10^6 J

ans: D

14. A 1-kg block is lifted vertically 1 m by a boy. The work done by the boy is about:

A. 1 ft · lb
B. 1 J
C. 10 J
D. 0.1 J
E. zero

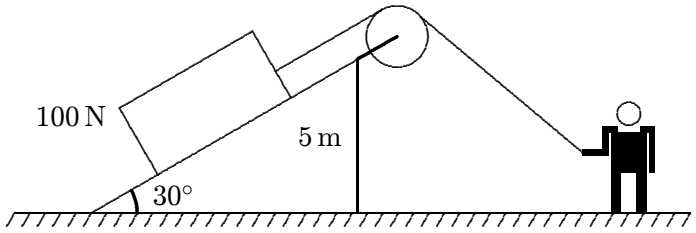
ans: C

15. A 0.50-kg object moves in a horizontal circular track with a radius of 2.5 m. An external force of 3.0 N, always tangent to the track, causes the object to speed up as it goes around. The work done by the external force as the mass makes one revolution is:

A. 24 J
B. 47 J
C. 59 J
D. 94 J
E. 120 J

ans: B

16. A man pulls a 100-N crate up a frictionless 30° slope 5 m high, as shown. Assuming that the crate moves at constant speed, the work done by the man is:



A. −500 J
B. −250 J
C. 0
D. 250 J
E. 500 J

ans: E

17. A man pushes an 80-N crate a distance of 5.0 m upward along a frictionless slope that makes an angle of 30° with the horizontal. His force is parallel to the slope. If the speed of the crate decreases at a rate of 1.5 m/s^2, then the work done by the man is:

A. −200 J
B. 61 J
C. 140 J
D. 200 J
E. 260 J

ans: C

18. A man pushes an 80-N crate a distance of 5.0 m upward along a frictionless slope that makes an angle of 30° with the horizontal. The force he exerts is parallel to the slope. If the speed of the crate is constant, then the work done by the man is:

A. −200 J
B. 61 J
C. 140 J
D. 200 J
E. 260 J

ans: D

19. An 80-N crate slides with constant speed a distance of 5.0 m downward along a rough slope that makes an angle of 30° with the horizontal. The work done by the force of gravity is:

A. $-400\,\text{J}$
B. $-200\,\text{J}$
C. $-69\,\text{J}$
D. $200\,\text{J}$
E. $400\,\text{J}$

ans: D

20. A man pulls a sled along a rough horizontal surface by applying a constant force $\vec{F}$ at an angle θ above the horizontal. In pulling the sled a horizontal distance d, the work done by the man is:

A. Fd
B. $Fd\cos\theta$
C. $Fd\sin\theta$
D. $Fd/\cos\theta$
E. $Fd/\sin\theta$

ans: B

21. A man wishes to pull a crate 15 m across a rough floor by exerting a force of 100 N. The coefficient of kinetic friction is 0.25. For the man to do the least work, the angle between the force and the horizontal should be:

A. 0
B. 14°
C. 43°
D. 66°
E. 76°

ans: A

22. A particle moves 5 m in the positive x direction while being acted upon by a constant force $\vec{F} = (4\,\text{N})\hat{\text{i}} + (2\,\text{N})\hat{\text{j}} - (4\,\text{N})\hat{\text{k}}$. The work done on the particle by this force is:

A. $20\,\text{J}$
B. $10\,\text{J}$
C. $-20\,\text{J}$
D. $30\,\text{J}$
E. is impossible to calculate without knowing other forces

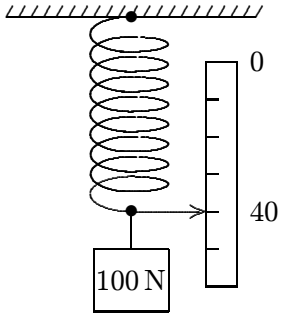
ans: A

23. A block is attached to the end of an ideal spring and moved from coordinate x_i to coordinate x_f. The relaxed position is at $x = 0$. The work done by spring is positive if:

A. $x_i = 2\,\text{cm}$ and $x_f = 4\,\text{cm}$
B. $x_i = -2\,\text{cm}$ and $x_f = 4\,\text{cm}$
C. $x_i = -2\,\text{cm}$ and $x_f = -4\,\text{cm}$
D. $x_i = 2\,\text{cm}$ and $x_f = -4\,\text{cm}$
E. $x_i = -4\,\text{cm}$ and $x_f = -2\,\text{cm}$

ans: E

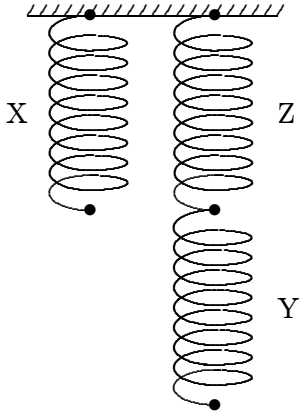
24. An ideal spring, with a pointer attached to its end, hangs next to a scale. With a 100-N weight attached, the pointer indicates "40" on the scale as shown. Using a 200-N weight instead results in "60" on the scale. Using an unknown weight X instead results in "30" on the scale. The weight of X is:



A. 10 N
B. 20 N
C. 30 N
D. 40 N
E. 50 N

ans: E

25. Three identical ideal springs (X,Y,Z) are arranged as shown. When a 4.0-kg mass is hung on X, the mass descends 3.0 cm. When a 6.0-kg mass is hung on Y, the mass descends:



A. 2.0 cm
B. 4.0 cm
C. 4.5 cm
D. 6.0 cm
E. 9.0 cm

ans: E

26. When a certain rubber band is stretched a distance x, it exerts a restoring force of magnitude $F = Ax$, where A is a constant. The work done by a person in stretching this rubber band from $x = 0$ to $x = L$, beginning and ending at rest, is:

A. AL^2
B. $A + 2L$
C. $A + 2L^2$
D. A/L
E. $AL^2/2$

ans: E

27. When a certain rubber band is stretched a distance x, it exerts a restoring force of magnitude $F = ax + bx^2$, where a and b are constants. The work done in stretching this rubber band from $x = 0$ to $x = L$ is:

A. $aL^2 + bLx^3$
B. $aL + 2bL^2$
C. $a + 2bL$
D. bL
E. $aL^2/2 + bL^3/3$

ans: E

28. An ideal spring is hung vertically from the ceiling. When a 2.0-kg mass hangs at rest from it the spring is extended 6.0 cm from its relaxed length. A downward external force is now applied to the mass to extend the spring an additional 10 cm. While the spring is being extended by the force, the work done by the spring is:

A. -3.6 J
B. -3.3 J
C. -3.4×10^{-5} J
D. 3.3 J
E. 3.6 J

ans: A

29. An ideal spring is hung vertically from the ceiling. When a 2.0-kg block hangs at rest from it the spring is extended 6.0 cm from its relaxed length. A upward external force is then applied to the block to move it upward a distance of 16 cm. While the block is moving upward the work done by the spring is:

A. -1.0 J
B. -0.52 J
C. -0.26 J
D. 0.52 J
E. 1.0 J

ans: A

30. Which of the following bodies has the largest kinetic energy?
    A. Mass $3M$ and speed V
    B. Mass $3M$ and speed $2V$
    C. Mass $2M$ and speed $3V$
    D. Mass M and speed $4V$
    E. All four of the above have the same kinetic energy

    ans: C

31. Two trailers, X with mass 500 kg and Y with mass 2000 kg, are being pulled at the same speed. The ratio of the kinetic energy of Y to that of X is:
    A. 1:1
    B. 2:1
    C. 4:1
    D. 9:1
    E. 1500:1

    ans: C

32. A 8000-N car is traveling at 12 m/s along a horizontal road when the brakes are applied. The car skids to a stop in 4.0 s. How much kinetic energy does the car lose in this time?
    A. 4.8×10^4 J
    B. 5.9×10^4 J
    C. 1.2×10^5 J
    D. 5.8×10^5 J
    E. 4.8×10^6 J

    ans: B

33. The velocity of a particle moving along the x axis changes from v_i to v_f. For which values of v_i and v_f is the total work done on the particle positive?
    A. $v_i = 5\,\text{m/s}$, $v_f = 2\,\text{m/s}$
    B. $v_i = 5\,\text{m/s}$, $v_f = -2\,\text{m/s}$
    C. $v_i = -5\,\text{m/s}$, $v_f = -2\,\text{m/s}$
    D. $v_i = -5\,\text{m/s}$, $v_f = 2\,\text{m/s}$
    E. $v_i = 2\,\text{m/s}$, $v_f = -5\,\text{m/s}$

    ans: E

34. An object is constrained by a cord to move in a circular path of radius 0.5 m on a horizontal frictionless surface. The cord will break if its tension exceeds 16 N. The maximum kinetic energy the object can have is:
    A. 4 J
    B. 8 J
    C. 16 J
    D. 32 J
    E. 64 J

    ans: A

35. The weight of an object on the moon is one-sixth of its weight on Earth. The ratio of the kinetic energy of a body on Earth moving with speed V to that of the same body moving with speed V on the moon is:

A. 6:1
B. 36:1
C. 1:1
D. 1:6
E. 1:36

ans: C

36. Which of the following is the correct combination of dimensions for energy?

A. MLT
B. LT^2/m
C. ML^2/T^2
D. M^2L^3T
E. ML/T^2

ans: C

37. The amount of work required to stop a moving object is equal to:

A. the velocity of the object
B. the kinetic energy of the object
C. the mass of the object times its acceleration
D. the mass of the object times its velocity
E. the square of the velocity of the object

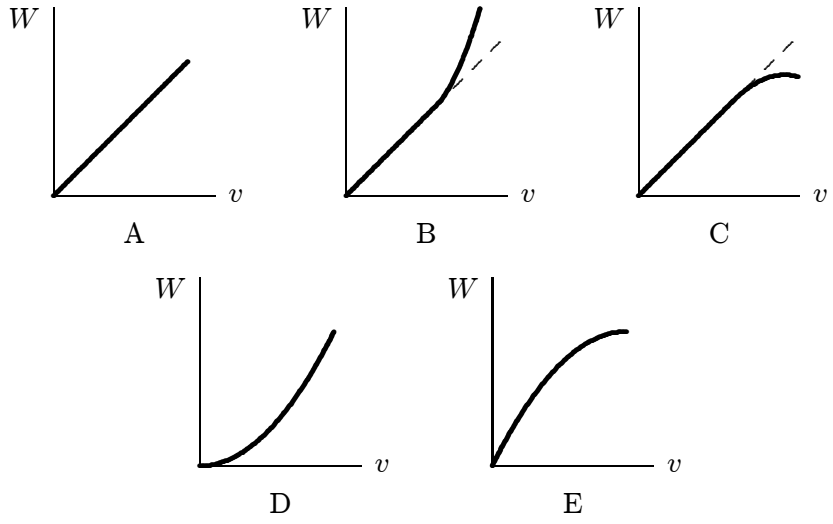
ans: B

38. A 5.0-kg cart is moving horizontally at 6.0 m/s. In order to change its speed to 10.0 m/s, the net work done on the cart must be:

A. 40 J
B. 90 J
C. 160 J
D. 400 J
E. 550 J

ans: C

39. A crate is initially at rest on a horizontal frictionless table. A constant horizontal force F is applied. Which of the following five graphs is a correct plot of work W as a function of the crate's speed v?



ans: D

40. An 8-N block slides down an incline. It has an initial speed of 7 m/s. The work done by the resultant force on this block is:

A. 3 J
B. 6 J
C. 56 J
D. impossible to calculate without more information
E. none of these

ans: D

41. A 4-kg cart starts up an incline with a speed of 3 m/s and comes to rest 2 m up the incline. The total work done on the car is:

A. 6 J
B. 8 J
C. 12 J
D. 18 J
E. impossible to calculate without more information

ans: D

42. Two objects with masses of m_1 and m_2 have the same kinetic energy and are both moving to the right. The same constant force $\vec{F}$ is applied to the left to both masses. If $m_1 = 4m_2$, the ratio of the stopping distance of m_1 to that of m_2 is:

A. 1:4
B. 4:1
C. 1:2
D. 2:1
E. 1:1

ans: E

43. A Boston Red Sox baseball player catches a ball of mass m that is moving toward him with speed v. While bringing the ball to rest, his hand moves back a distance d. Assuming constant deceleration, the horizontal force exerted on the ball by his hand is:

A. mv/d
B. mvd
C. mv^2/d
D. $2mv/d$
E. $mv^2/(2d)$

ans: E

44. A 0.50-kg object moves on a horizontal circular track with a radius of 2.5 m. An external force of 3.0 N, always tangent to the track, causes the object to speed up as it goes around. If it starts from rest its speed at the end of one revolution is:

A. 9.8 m/s
B. 14 m/s
C. 15 m/s
D. 19 m/s
E. 21 m/s

ans: B

45. A 0.50-kg object moves on a horizontal frictionless circular track with a radius of 2.5 m. An external force of 3.0 N, always tangent to the track, causes the object to speed up as it goes around. If it starts from rest, then at the end of one revolution the radial component of the force of the track on it is:

A. 19 N
B. 38 N
C. 47 N
D. 75 N
E. 96 N

ans: B

46. A 2-kg block is attached to a horizonal ideal spring with a spring constant of 200 N/m. When the spring has its equilibrium length the block is given a speed of 5 m/s. What is the maximum elongation of the spring?

A. 0
B. 0.05 m
C. 5 m
D. 10 m
E. 100 m

ans: C

47. At time $t = 0$ a particle starts moving along the x axis. If its kinetic energy increases uniformly with t the net force acting on it must be:

A. constant
B. proportional to t
C. inversely proportional to t
D. proportional to $\sqrt{t}$
E. proportional to $1/\sqrt{t}$

ans: E

48. At time $t = 0$ a 2-kg particle has a velocity of $(4\,\text{m/s})\hat{\text{i}} - (3\,\text{m/s})\hat{\text{j}}$. At $t = 3\,\text{s}$ its velocity is $(2\,\text{m/s})\hat{\text{i}} + (3\,\text{m/s})\hat{\text{j}}$. During this time the work done on it was:

A. 4 J
B. -4 J
C. -12 J
D. -40 J
E. $(4\,\text{J})\hat{\text{i}} + (36\,\text{J})\hat{\text{j}}$

ans: C

49. A particle starts from rest at time $t = 0$ and moves along the x axis. If the net force on it is proportional to t, its kinetic energy is proportional to:

A. t
B. t^2
C. t^4
D. $1/t^2$
E. none of the above

ans: C

50. A 1.5-kg crate falls from a height of 2.0 m onto an industrial spring scale with a spring constant of 1.5×10^5 N/m. At its greatest compression the reading on the scale is:

A. 15 N
B. 30 N
C. 1.5×10^3 N
D. 2.1×10^3 N
E. 3.0×10^3 N

ans: E

51. A particle moving along the x axis is acted upon by a single force $F = F_0 e^{-kx}$, where F_0 and k are constants. The particle is released from rest at $x = 0$. It will attain a maximum kinetic energy of:

A. F_0/k
B. F_0/e^k
C. kF_0
D. $1/2(kF_0)^2$
E. ke^kF_0

ans: A

52. The mechanical advantage of any machine is:
    A. the efficiency of the machine
    B. the work done by the machine
    C. the ratio of the work done by the machine to the work expended on it
    D. the ratio of the force exerted by the machine to the force applied to it
    E. the ratio of the force applied to the machine to the force exerted by it

    ans: D

53. In raising an object to a given height by means of an inclined plane, as compared with raising the object vertically, there is a reduction in:
    A. work required
    B. distance pushed
    C. friction
    D. force required
    E. value of the acceleration due to gravity

    ans: D

54. A watt is:
    A. $\mathrm{kg \cdot m/s^3}$
    B. $\mathrm{kg \cdot m^2/s}$
    C. $\mathrm{kg \cdot m^2/s^3}$
    D. $\mathrm{kg \cdot m/s}$
    E. $\mathrm{kg \cdot m^2/s^2}$

    ans: C

55. Power has the dimensions of:
    A. $\mathrm{ML^2/T^2}$
    B. $\mathrm{MT/L^2}$
    C. $\mathrm{ML/T^2}$
    D. $\mathrm{ML^2/T^3}$
    E. none of these

    ans: D

56. Which of the following five units represents a quantity that is NOT the same as the other four?
    A. joule
    B. erg
    C. watt
    D. foot·pound
    E. newton·meter

    ans: C

57. Which of the following five quantities is NOT an expression for energy? Here m is a mass, g is the acceleration due to gravity, h and d are distances, F is a force, v is a speed, a is an acceleration, P is power, and t is time.

A. mgh
B. Fd
C. $1/2mv^2$
D. ma
E. Pt

ans: D

58. A watt·second is a unit of:

A. force
B. power
C. displacement
D. speed
E. energy

ans: E

59. A watt per hour is a unit of:

A. energy
B. power
C. force
D. acceleration
E. none of these

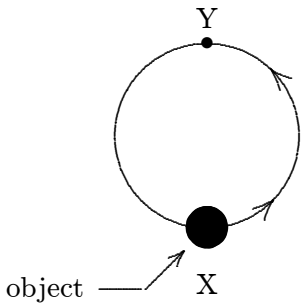
ans: E

60. A kilowatt·hour is a unit of:

A. power
B. energy/time
C. work
D. power/time
E. force/distance

ans: C

61. A man moves the 10-g object shown in a vertical plane from position X to position Y along a circular track of radius 20 m. The process takes 0.75 min. The work done by the man is about:



A. 1 J
B. 2 J
C. 4 J
D. 6 J
E. 12 J

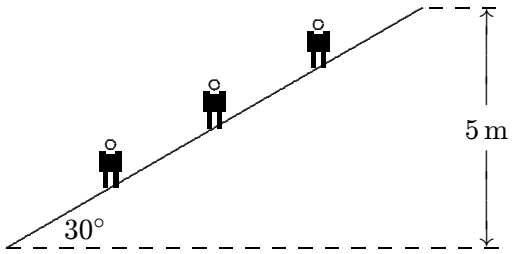
ans: C

62. A woman lifts a barbell 2.0 m in 5.0 s. If she lifts it the same distance in 10 s, the work done by her is:

A. four times as great
B. two times as great
C. the same
D. half as great
E. one-fourth as great

ans: C

63. An escalator is used to move 20 people (60 kg each) per minute from the first floor of a department store to the second floor, 5 m above. Neglecting friction, the power required is approximately:



A. 100 W
B. 200 W
C. 1000 W
D. 2000 W
E. 60,000 W

ans: C

64. A person holds an 80-N weight 2 m above the floor for 30 seconds. The power required to do this is:

A. 80 W
B. 40 W
C. 20 W
D. 10 W
E. none of these

ans: E

65. A 50-N force is the only force on a 2-kg object that starts from rest. When the force has been acting for 2 s the rate at which it is doing work is:

A. 75 W
B. 100 W
C. 1000 W
D. 2500 W
E. 5000 W

ans: D

66. A 50-N force is the only force a 2-kg crate that starts from rest. At the instant the object has gone 2 m the rate at which the force is doing work is:

A. 2.5 W
B. 25 W
C. 75 W
D. 100 W
E. 500 W

ans: E

67. A particle starts from rest and is acted on by a net force that does work at a rate that is proportional to the time t. The speed of the particle is proportional to:

A. $\sqrt{t}$
B. t
C. t^2
D. $1/\sqrt{t}$
E. $1/t$

ans: A