1. Which of the following objects has the greatest momentum?
   (1) a 1-kg object moving at 200 m/sec
   (2) a 10-kg object moving at 30 m/sec
   (3) a 20-kg object moving at 20 m/sec
   (4) a 100-kg object moving at 2 m/sec

   $p = mv$ 200 kg m/s, 300, 400, 200

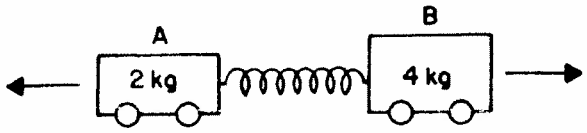
2. A 15-newton force acts on an object in a direction due east for 3.0 seconds. What will be the change in momentum of the object?
   (1) 45 kg-m/sec due east
   (2) 45 kg-m/sec due west
   (3) 5.0 kg-m/sec due east
   (4) 0.20 kg-m/sec due west

   $Ft = \Delta p$

3. A 0.025-kilogram bullet is fired from a rifle by an unbalanced force of 200 Newtons. If the force acts on the bullet for 0.1 second, what is the maximum speed attained by the bullet?
   (1) 5 m/s
   (2) 20 m/s
   (3) 400 m/s
   (4) 800 m/s

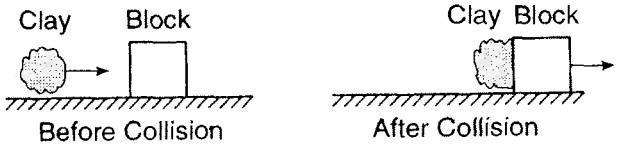
   $Ft = m\Delta v$, $Ft = m(v_f - v_i)$, $\frac{(200)(.1)}{.025\,kg} = 800$

4. Lab carts *A* and *B* are initially at rest with a compressed spring between them as shown in the diagram below.



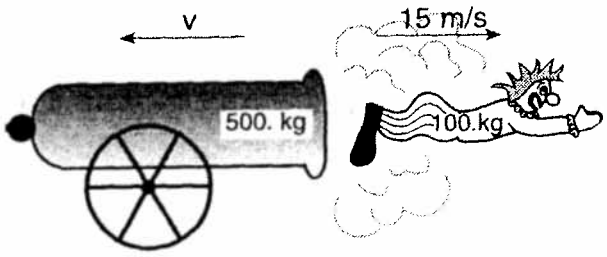
   Which statement best describes the motion of the carts after the spring is released?
   (1) Cart *A* has twice the momentum of cart *B*.
   (2) Cart *B* has twice the momentum of cart *A*.
   (3) Cart *A* has twice the velocity of cart *B*.
   (4) Cart *B* has twice the velocity of cart *A*.

5. As shown in the diagrams below, a lump of clay travels horizontally to the right toward a block at rest on a frictionless surface. Upon collision, the clay and the block stick together and move to the right.



   Compared to the total momentum of the clay and the block before the collision, the momentum of the clay-block system after the collision is
   (1) less
   (2) greater
   (3) the same

6. In the diagram below, a 100.-kilogram clown is fired from a 500.-kilogram cannon.



   $0 + 0 = (500)v + (100)15$

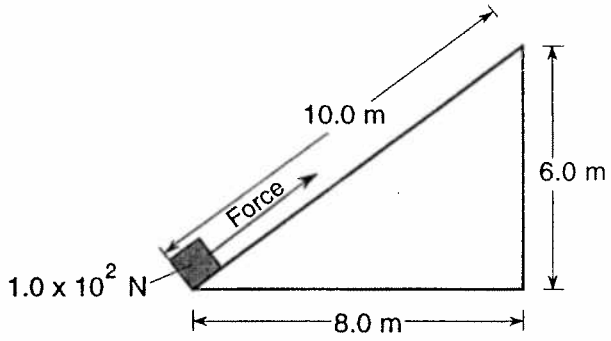
   If the clown's speed is 15 meters per second after the firing, the recoil speed (v) of the cannon is
   (1) 75 m/s
   (2) 15 m/s
   (3) 3.0 m/s
   (4) 0 m/s

7. A student drops two eggs of equal mass simultaneously from the same height. Egg *A* lands on the tile floor and breaks. Egg *B* lands intact, without bouncing, on a foam pad lying on the floor. Compared to the magnitude of the impulse on egg *A* as it lands, the magnitude of the impulse on egg *B* as it lands is
   (1) less
   (2) greater
   (3) the same

8. If the speed of an object is doubled, its kinetic energy will be
   (1) halved
   (2) doubled
   (3) quartered
   (4) quadrupled

   $KE = \frac{1}{2}mv^2$, 2^2

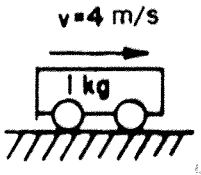
9. A box weighing 1.0×10^2 Newtons is dragged to the top of an incline, as shown in the diagram below.

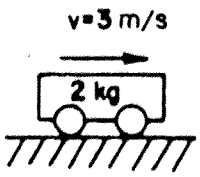


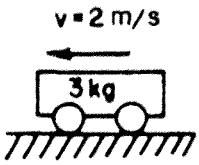
   The gravitational potential energy of the box at the top of the incline is approximately
   (1) 1.0×10^2 J
   (2) 6.0×10^2 J
   (3) 8.0×10^2 J
   (4) 1.0×10^3 J

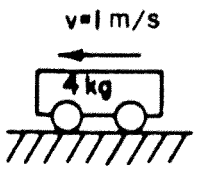
   mgh, $(1 \times 10^2 N)(6m) =$

10. Which cart shown below has the greatest kinetic energy?

(1) 

(2) 

(3) 

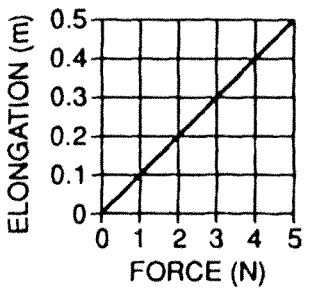
(4) 

11. A girl rides an escalator that moves her upward at constant speed. As the girl rises, how do her gravitational potential energy and kinetic energy change?
(1) Gravitational potential energy decreases and kinetic energy decreases.
(2) Gravitational potential energy decreases and kinetic energy remains the same.
(3) Gravitational potential energy increases and kinetic energy decreases.
(4) Gravitational potential energy increases and kinetic energy remains the same.

12. When a machine does 250 joules of work in 10. seconds, the power developed by the machine will be
(1) 2,500 watts
(2) 260 watts
(3) 240 watts
(4) 25 watts

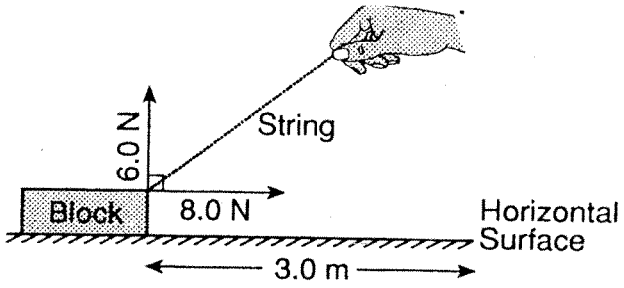
13. A 45-kilogram bicyclist climbs a hill at a constant speed of 2.5 meters per second by applying an average force of 85 Newtons. Approximately how much power does the bicyclist develop?
(1) 110 W
(2) 210 W
(3) 1100 W
(4) 1400 W

14. Below is a graph representing the elongation of a spring as different forces are added to it.



What is the value of the spring constant?
(1) 0.1 m/N
(2) 0.1 N/m
(3) 10 m/N
(4) 10 N/m

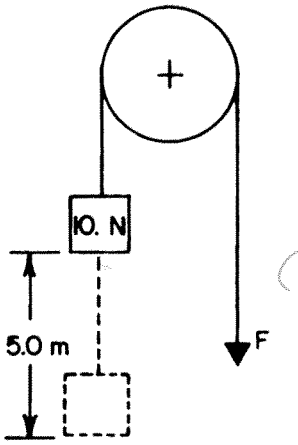
15. A student pulls a block 3.0 meters along a horizontal surface at constant velocity. The diagram below shows the components of the force exerted on the block by the student.



How much work is done against friction?
(1) 18 J
(2) 24 J
(3) 30. J
(4) 42 J

16. If the velocity of a car traveling around a circular track doubles, its centripetal acceleration would be
(1) 1/2 as great
(2) 2 times greater
(3) 1/4 as great
(4) 4 times greater

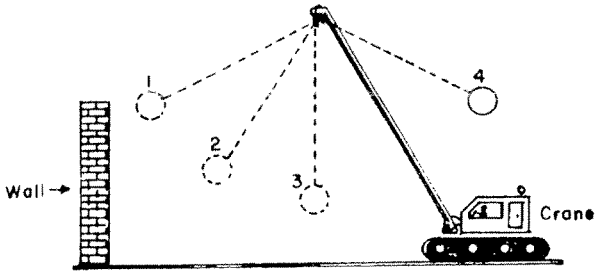
17. In the diagram below, 55 joules of work is needed to raise a 10.-newton weight 5.0 meters.



How much work is done to overcome friction as the weight is raised?

(1) 5 J
(2) 5.5 J
(3) 11 J
(4) 50. J

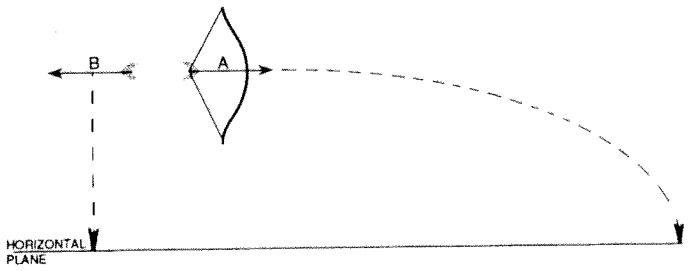
18. The wrecking crane shown below is moving toward a brick wall which is to be torn down.



At what point in the swing of the wrecking ball should the ball make contact with the wall to make a collision with the greatest kinetic energy?

(1) 1
(2) 2
(3) 3
(4) 4

19. Above a flat horizontal plane, an arrow, *A*, is shot horizontally from a bow at a speed of 50 meters per second, as shown in the diagram below. A second arrow, *B*, is dropped from the same height and at the same instant as *A* is fired.

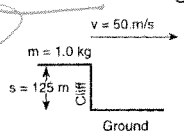


Neglecting air friction, compared to the amount of time *A* takes to strike the plane, the amount of time *B* takes to strike the plane is

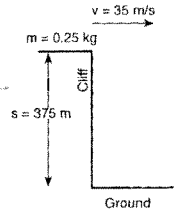
(1) less
(2) greater
(3) the same

20. Four different balls are thrown horizontally off the top of four cliffs. In which diagram does the ball have the shortest time of flight?

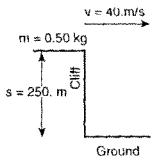
(1)



(2)

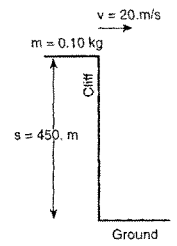


(3)



(3)

(4)



21. An object is thrown into the air and follows the path shown in the diagram above. Which vector best represents the acceleration of the object at point *A*? [Neglect air friction.]

(1)

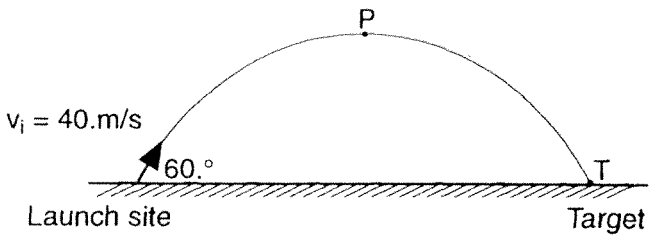
(2)

(3)

(4)

22. Base your answer to the following question on the information and diagram below.

A projectile is launched at an angle of 60.° above the horizontal at an initial speed of 40. meters per second, as shown in the diagram below. The projectile reaches its highest altitude at point *P* and strikes a target at point *T*. [Neglect air resistance.]

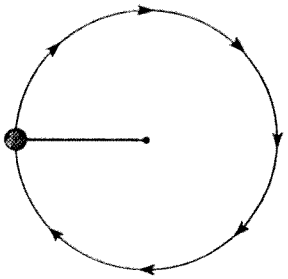


What is the magnitude of the vertical component of the projectile's initial speed?

(1) 35 m/s
(2) 20 m/s
(3) 9.8 m/s
(4) 4.3 m/s

$V_V = (\sin 60^\circ)(40\ m/s)$
$= 35\ m/s$

23. The diagram below represents a ball undergoing uniform circular motion as it travels clockwise on a string.



At the moment shown in the diagram, what are the correct directions of both the velocity and centripetal acceleration of the ball?

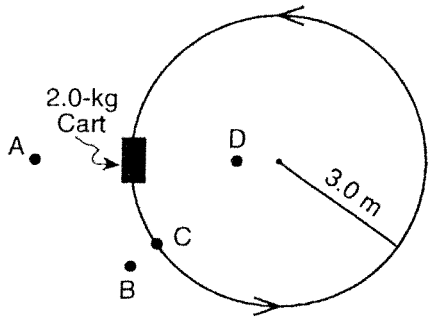
(1) v ↑ a →

(2) v → a ↑

(3) v ↓ a ←

(4) v → a ↓

24. Base your answer to the following question on the diagram below which shows a 2.0-kilogram cart traveling at a constant speed in a horizontal circle of radius 3.0 meters. The magnitude of the centripetal force of the cart is 24 Newtons.



What is the speed of the cart?

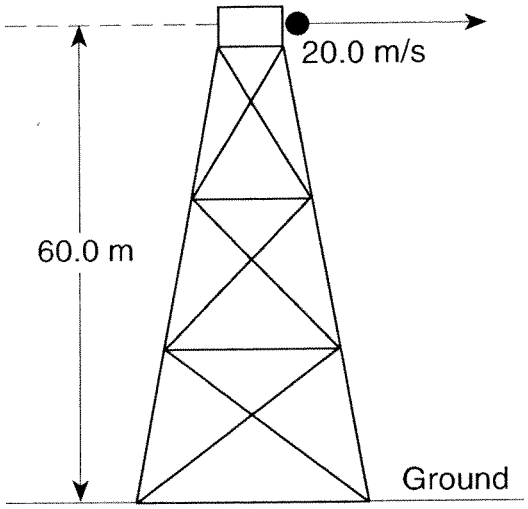
(1) 6.0 m/s
(2) 16 m/s
(3) 36 m/s
(4) 4.0 m/s

$v = \frac{d}{t} = \frac{2\pi r}{T} = \frac{(2)(\pi)(3m)}{T}$

$F_c = \frac{mv^2}{r}$ $v^2 = \frac{(24)(r)}{3m}$

25. Base your answer to the following question on the information and diagram below.

A ball is thrown horizontally with an initial velocity of 20.0 meters per second from the top of a tower 60.0 meters high.



What is the horizontal velocity of the ball just before it reaches the ground? [Neglect air resistance.]

(1) 9.81 m/s
(2) 20.0 m/s
(3) 34.3 m/s
(4) 68.6 m/s