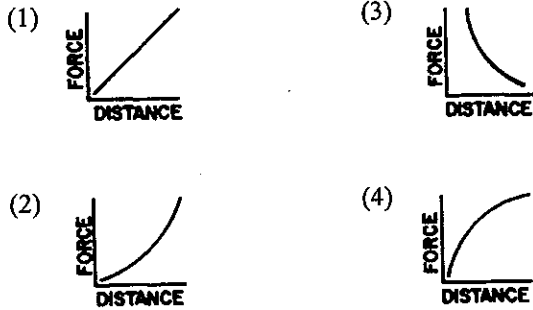


1. What is the momentum of a 1,200-kilogram car traveling at 15 meters per second due east?

- (1) 80. kg•m/s due east      (3)  $1.8 \times 10^4$  kg•m/s due east  
 (2) 80. kg•m/s due west      (4)  $1.8 \times 10^4$  kg•m/s due west

2. Which graph best represents the gravitational force between two point masses as a function of the distance between the masses?



3. A ball is thrown horizontally at a speed of 20. meters per second from the top of a cliff. How long does the ball take to fall 19.6 meters to the ground?

- (1) 1.0 s      (3) 9.8 s  
 (2) 2.0 s      (4) 4.0 s

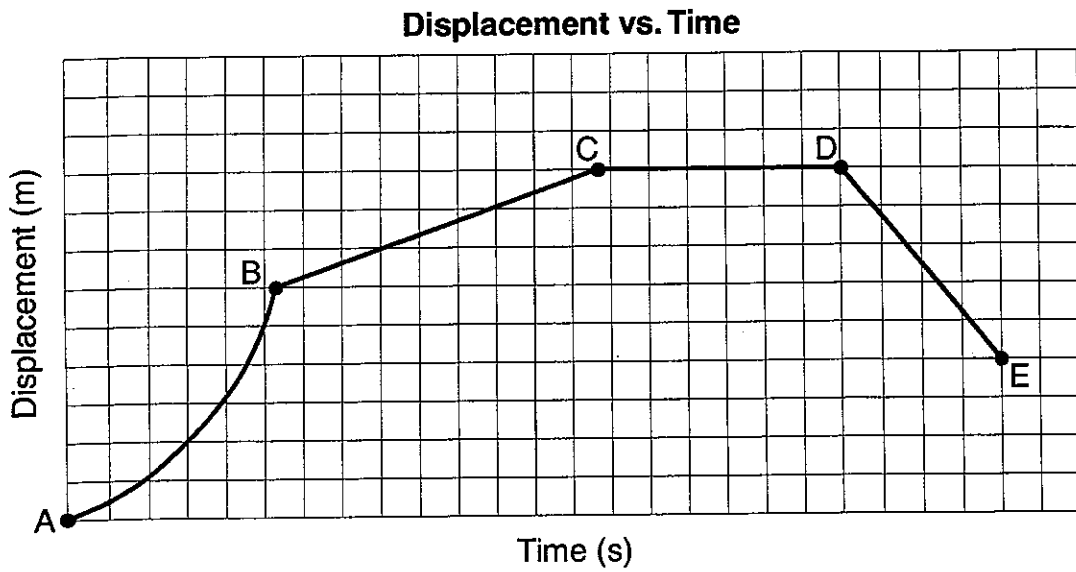
4. Jill is pulling a 200. newton sled through the snow at constant velocity using a horizontal force of 10. newtons. What is the kinetic coefficient of friction of the sled on the snow?

- (1) 0.02      (3) 0.20  
 (2) 0.05      (4) 20

5. Four cannonballs, each with mass  $M$  and initial velocity  $V$ , are fired from a cannon at different angles relative to the Earth. Neglecting air friction, which angular direction of the cannon produces the greatest projectile height?

- (1)  $90^\circ$       (3)  $45^\circ$   
 (2)  $70^\circ$       (4)  $20^\circ$

6. The displacement-time graph below represents the motion of a cart initially moving forward along a straight line.



During which interval is the cart moving forward at constant speed?

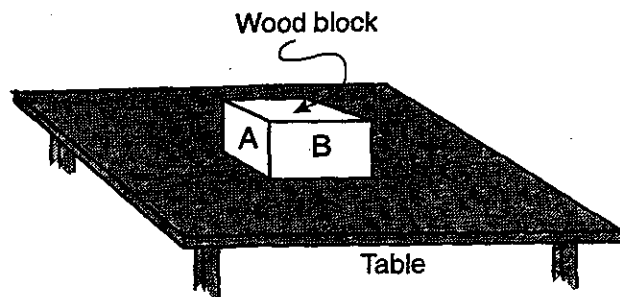
(1) *AB*

(2) *BC*

(3) *CD*

(4) *DE*

7. In the diagram below, surface *B* of the wooden block has the same texture as surface *A*, but twice the area of surface *A*

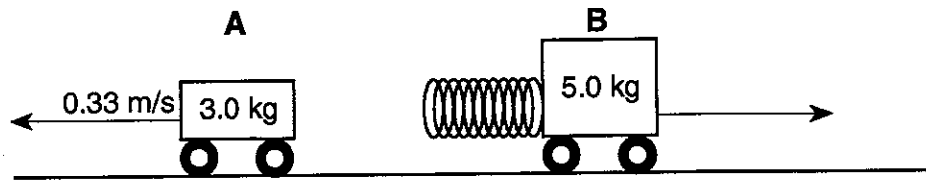


If force  $F$  is required to slide the block at constant speed across the table on surface *A*, approximately what force is required to slide the block at constant speed across the table on surface *B*?

- (1)  $F$   
(2)  $2F$

- (3)  $\frac{1}{2}F$   
(4)  $4F$

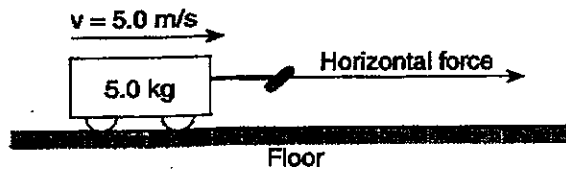
8. The diagram below shows two carts that were initially at rest on a horizontal, frictionless surface being pushed apart when a compressed spring attached to one of the carts is released. Cart *A* has a mass of 3.0 kilograms and cart *B* has a mass of 5.0 kilograms.



If the speed of cart *A* is 0.33 meter per second after the spring is released, what is the approximate speed of cart *B* after the spring is released?

- (1) 0.12 m/s                      (2) 0.20 m/s                      (3) 0.33 m/s                      (4) 0.55 m/s

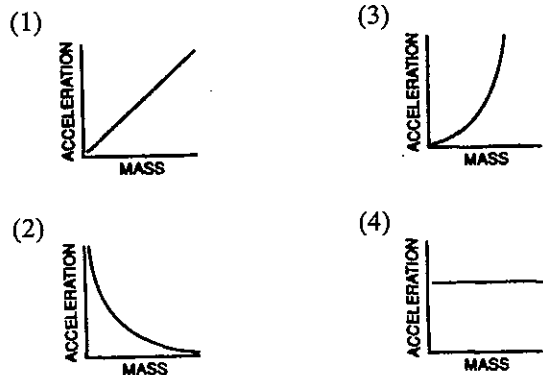
9. Two objects of fixed mass are moved apart so that they are separated by three times their original distance. Compared to the original gravitational force between them, the new gravitational force is
- (1) one-third as great                      (3) three times greater  
 (2) one-ninth as great                      (4) nine times greater
10. A horizontal force is used to pull a 5.0-kilogram cart at a constant speed of 5.0 meters per second across the floor, as shown in the diagram below.



If the force of friction between the cart and the floor is 10. Newtons, the magnitude of the horizontal force along the handle of the cart is

- (1) 5.0 N                                      (3) 25 N  
 (2) 10. N                                      (4) 50. N

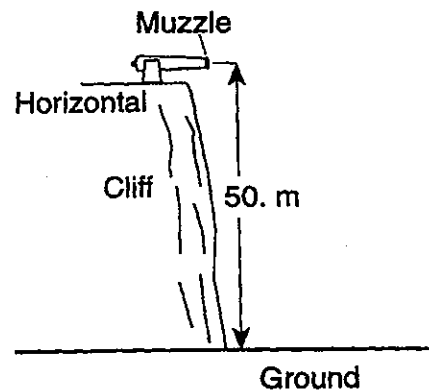
11. Which graph best represents the relationship between mass and acceleration due to gravity for objects near the surface of the Earth? [Neglect air resistance.]



12. When an unbalanced force of 10. Newtons is applied to an object whose mass is 4.0 kilograms, the acceleration of the object will be

- (1) 40. m/s<sup>2</sup>                                      (3) 9.8 m/s<sup>2</sup>  
 (2) 2.5 m/s<sup>2</sup>                                      (4) 0.40 m/s<sup>2</sup>

13. The diagram below shows the muzzle of a cannon located 50. meters above the ground. When the cannon is fired, a ball leaves the muzzle with an initial horizontal speed of 250. meters per second. [Neglect air resistance.]

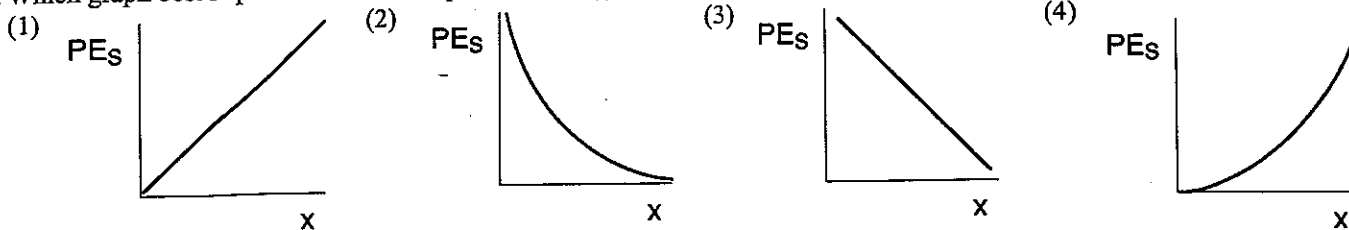


Which action would most likely increase the time of flight of a ball fired by the cannon?

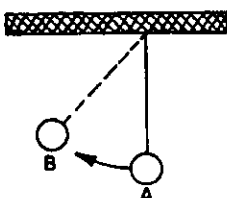
- (1) pointing the muzzle of the cannon toward the ground  
 (2) moving the cannon closer to the edge of the cliff  
 (3) positioning the cannon higher above the ground  
 (4) giving the ball a greater initial horizontal velocity



21. Which graph best represents the elastic potential energy stored in a spring ( $PE_s$ ) as a function of its elongation,  $x$ ?



22. As the pendulum swings freely from  $A$  to  $B$  as shown in the diagram to the right, the gravitational potential energy of the ball



- (1) decreases  
(2) increases  
(3) remains the same

23. A 60.-kilogram student running at 3.0 meters per second has a kinetic energy of

- (1) 180 J  
(2) 270 J  
(3) 540 J  
(4) 8100 J

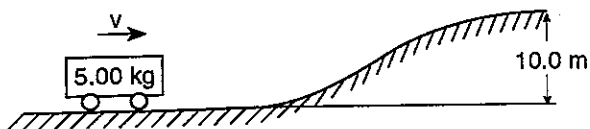
24. If the speed of a moving object is doubled, which quantity associated with the object must also double?

- (1) its momentum  
(2) its kinetic energy  
(3) its acceleration  
(4) its gravitational potential energy

25. An object travels in a circular orbit. If the speed of the object is doubled, its centripetal acceleration will be

- (1) halved  
(2) doubled  
(3) quartered  
(4) quadrupled

26. The diagram below shows a moving, 5.00-kilogram cart at the foot of a hill 10.0 meters high. For the cart to reach the top of the hill, what is the minimum kinetic energy of the cart in the position shown? [Neglect energy loss due to friction.]



- (1) 4.91 J  
(2) 50.0 J  
(3) 250. J  
(4) 491 J

27. What is the magnitude of the gravitational force between an electron and a proton separated by a distance of  $1.0 \times 10^{-10}$  meter?

- (1)  $1.0 \times 10^{-47}$  N  
(2)  $1.5 \times 10^{-46}$  N  
(3)  $1.0 \times 10^{-37}$  N  
(4)  $1.5 \times 10^{-36}$  N

28. Which is a scalar quantity?

- (1) kinetic energy  
(2) momentum  
(3) force  
(4) weight

29. A constant force of 1900 newtons is required to keep an automobile having a mass of  $1.0 \times 10^3$  kilograms moving at a constant speed of 20. meters per second. The work done in moving the automobile a distance of  $2.0 \times 10^3$  meters is

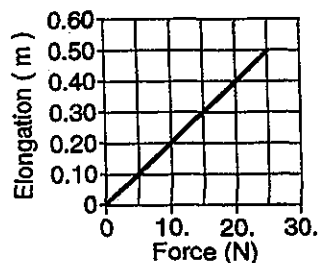
- (1)  $2.0 \times 10^4$  J  
(2)  $3.8 \times 10^4$  J  
(3)  $2.0 \times 10^6$  J  
(4)  $3.8 \times 10^6$  J

30. Which is a vector quantity?

- (1) acceleration due to gravity  
(2) mechanical equivalent of heat  
(3) rest mass of an electron  
(4) speed of an object

31. The graph below shows the relationship between the elongation of a spring and the force applied to the spring causing it to stretch.

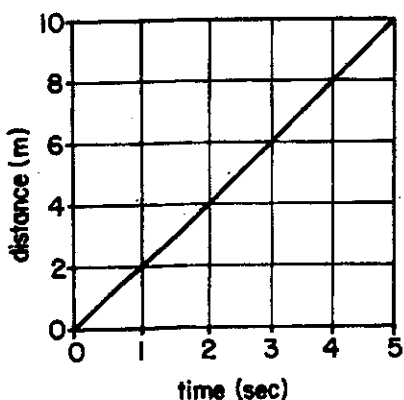
Elongation vs. Applied Force



What is the spring constant for this spring?

- (1) 0.020 N/m  
(2) 2.0 N/m  
(3) 25 N/m  
(4) 50. N/m

32. The uniform motion of a cart is shown in the distance versus time graph below. What is the average speed of the cart?



- (1) 0.5 m/s (2) 2 m/s (3) 5 m/s (4) 50 m/s
33. An object weighing 4 Newtons rests on a horizontal tabletop. The force of the tabletop on the object is  
 (1) 0 N (2) 4 N horizontally (3) 4 N downward (4) 4 N upward
34. A group of bike riders took a 4.0-hour trip. During the first 3.0 hours, they traveled a total of 50. kilometers, but during the last hour they traveled only 10. kilometers. What was the group's average speed for the entire trip?  
 (1) 15 km/hr (2) 30. km/hr (3) 40. km/hr (4) 60. km/hr
35. An 80.-kilogram skater and a 60.-kilogram skater stand at rest in the center of a skating rink. The two skaters push each other apart. The 60.-kilogram skater moves with a velocity of 10. meters per second east. What is the velocity of the 80.-kilogram skater? [Neglect any frictional effects.]  
 (1) 0.13 m/s west (2) 7.5 m/s west (3) 10. m/s east (4) 13. m/s east
36. A desk exerts a 15-newton force on an object placed on the desk. What is the force that the object exerts on the desk?  
 (1) 0 N (2) 1.5 N (3) 15 N (4) 147 N
37. A boat initially traveling at 10. meters per second accelerates uniformly at the rate of 5.0 meters per second<sup>2</sup> for 10. seconds. How far does the boat travel during this time?  
 (1) 50. m (2) 250 m (3) 350 m (4) 500 m

38. A motorcycle of mass 100 kilograms travels around a flat, circular track of radius 10 meters with a constant speed of 20 meters per second. What force is required to keep the motorcycle moving in a circular path at this speed

- (1) 200 N (2) 400 N (3) 2000 N (4) 4000 N

39. Compared to 8 kilograms of feathers, 6 kilograms of lead has

- (1) less mass and less inertia  
 (2) less mass and more inertia  
 (3) more mass and less inertia  
 (4) more mass and more inertia

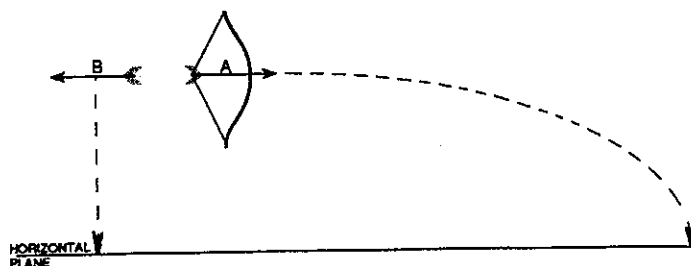
40. As the angle between two concurrent forces increases from 45° to 90°, the magnitude of their resultant

- (1) decreases (2) increases (3) remains the same

41. Concurrent forces of 10. Newtons east and 10. Newtons south act on an object. The resultant force is

- (1) 0 N (2) 5.0 N southeast (3) 14 N southeast (4) 20. N southeast

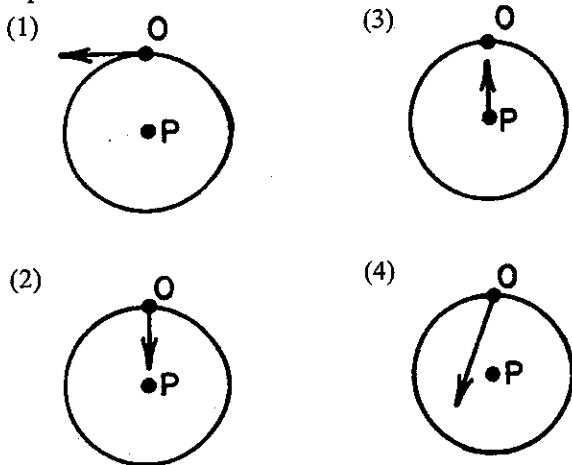
42. Above a flat horizontal plane, an arrow, *A*, is shot horizontally from a bow at a speed of 50 meters per second, as shown in the diagram below. A second arrow, *B*, is dropped from the same height and at the same instant as *A* is fired.



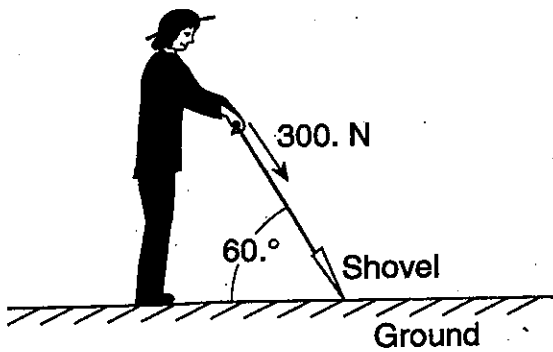
Neglecting air friction, compared to the amount of time *A* takes to strike the plane, the amount of time *B* takes to strike the plane is

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

43. If object O is moving in a uniform circular motion around point P at constant speed, which vector shown below represents a centripetal force?



44. The diagram below shows a person exerting a 300.-newton force on the handle of a shovel that makes an angle of  $60^\circ$  with the horizontal ground.



The component of the 300.-newton force that acts perpendicular to the ground is approximately

- (1) 150. N
- (2) 260. N
- (3) 300. N
- (4) 350. N

**Part 2 Questions**

Name \_\_\_\_\_

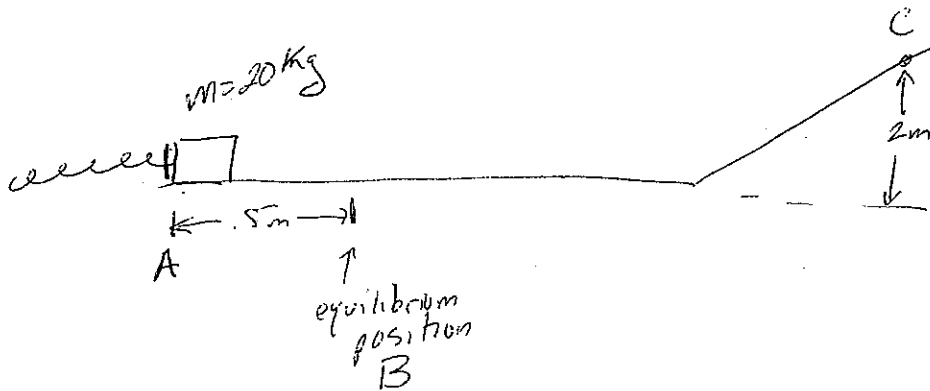
1. An object is subjected to a 400 Newton force due west, and a 600 Newton force  $30^\circ$  South of East.
  - a. Draw a vector diagram representing the forces, using a scale of 1 cm = 50 Newtons.
  - b. Construct the resultant force. Label the force with its magnitude in Newtons.
  - c. If the mass of the object is 50 kg, what will be its acceleration?



2. A 20 kg block slides down a  $40^\circ$  incline with an acceleration of  $2 \text{ m/s}^2$ . What is the coefficient of kinetic friction between the block and the plane?

3. A spring is used to launch a block across a horizontal frictionless surface, and up a frictionless incline, as shown. Fill out the chart, then use it to find...

- The velocity at point  $C$ .
- The spring constant of the spring.



	A	B	C
PE			
KE			
PEs			
TOT			