Name: _____

1. Which quantity has both a magnitude and a direction?

    A. energy
    B. impulse
    C. power
    D. work

2. Approximately how much time does it take light to travel from the Sun to Earth?

    A. $2.00 \times 10^{-3}$ s
    B. $1.28 \times 10^{0}$ s
    C. $5.00 \times 10^{2}$ s
    D. $4.50 \times 10^{19}$ s

3. What is the magnitude of the velocity of a 25-kilogram mass that is moving with a momentum of 100 kilogram-meters per second?

    A. 0.25 m/s
    B. 2,500 m/s
    C. 40 m/s
    D. 4.0 m/s

4. A 2.0-kilogram ball traveling north at 4.0 meters per second collides head-on with a 1.0 kilogram ball traveling south at 8.0 meters per second. What is the magnitude of the total momentum of the two balls after collision?

    A. 0 kg·m/s
    B. 8.0 kg·m/s
    C. 16 kg·m/s
    D. 32 kg·m/s

5. The vector diagram below represents the velocity of a car traveling 24 meters per second 35° east of north.
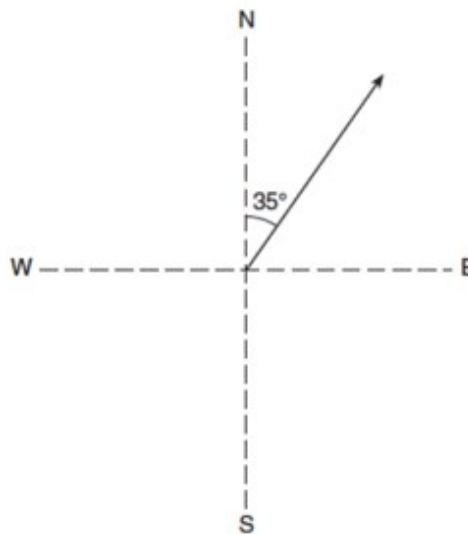


What is the magnitude of the component of the car's velocity that is directed eastward?

    A. 14 m/s
    B. 20. m/s
    C. 29 m/s
    D. 42 m/s

6. A bullet traveling at $5.0 \times 10^{2}$ meters per second is brought to rest by an impulse of 50. newton-seconds. What is the mass of the bullet?

    A. $2.5 \times 10^{4}$ kg
    B. $1.0 \times 10^{1}$ kg
    C. $1.0 \times 10^{-1}$ kg
    D. $1.0 \times 10^{-2}$ kg

7. What is the total distance traveled by an object that moves with an average speed of 6.0 meters per second for 8.0 seconds?

    A. 0.75 m
    B. 1.3 m
    C. 14 m
    D. 48 m

8. A baseball dropped from the roof of a tall building takes 3.1 seconds to hit the ground. How tall is the building? [Neglect friction.]

    A. 15 m
    B. 30 m
    C. 47 m
    D. 94 m

9. The map below shows the route taken by a school bus.
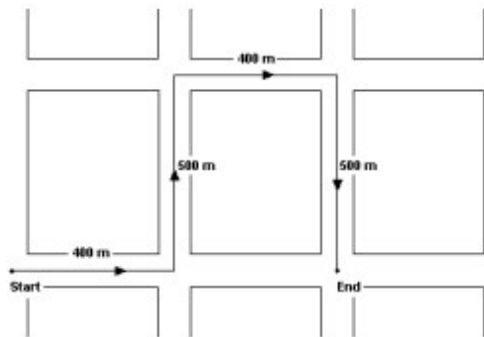


What is the magnitude of the total displacement of the school bus from the start to the end of its trip?

A. 400 m
B. 500 m
C. 800 m
D. 1,800 m

10. Cart *A* has a mass of 2 kilograms and a speed of 3 meters per second. Cart *B* has a mass of 3 kilograms and a speed of 2 meters per second. Compared to the inertia and magnitude of momentum of cart *A*, cart *B* has

A. the same inertia and a smaller magnitude of momentum
B. the same inertia and the same magnitude of momentum
C. greater inertia and a smaller magnitude of momentum
D. greater inertia and the same magnitude of momentum

11. Which pair of graphs represent the same motion?
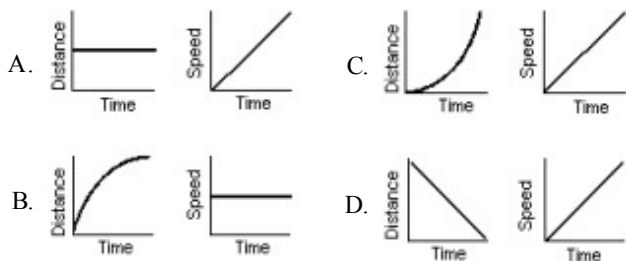


12. When a 1.0-kilogram cart moving with a speed of 0.50 meter per second on a horizontal surface collides with a second 1.0-kilogram cart initially at rest, the carts lock together. What is the speed of the combined carts after the collision? [Neglect friction.]

A. 1.0 m/s
B. 0.50 m/s
C. 0.25 m/s
D. 0 m/s

13. The speed of a car is increased uniformly from 20. meters per second to 30. meters per second in 4.0 seconds. The magnitude of the car's average acceleration in this 4.0-second interval is

A. 0.40 m/s$^2$
B. 2.5 m/s$^2$
C. 10 m/s$^2$
D. 13 m/s$^2$

14. In the diagram below, a 20.-newton force due north and a 20.-newton force due east act concurrently on an object, as shown in the diagram below.
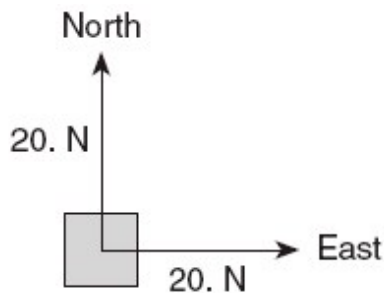


The additional force necessary to bring the object into a state of equilibrium is

A. 20. N, northeast
B. 20. N, southwest
C. 28 N, northeast
D. 28 N, southwest

15. In the graph, the acceleration of an object is plotted against the unbalanced force on the object.
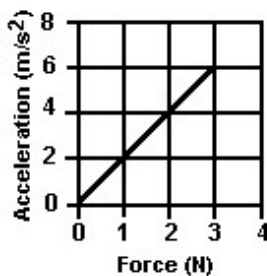


What is the object's mass?

A. 1 kg
B. 2 kg
C. 0.5 kg
D. 0.2 kg

16. An observer recorded the following data for the motion of a car undergoing constant acceleration.

| Time (s) | Speed (m/s) |
|----------|-------------|
| 3.0 | 4.0 |
| 5.0 | 7.0 |
| 6.0 | 8.5 |

What was the magnitude of the acceleration of the car?

A. 1.3 m/s$^2$

B. 2.0 m/s$^2$

C. 1.5 m/s$^2$

D. 4.5 m/s$^2$

17. Which body is in equilibrium?
   A. a satellite orbiting Earth in a circular orbit
   B. a ball falling freely toward the surface of Earth
   C. a car moving with a constant speed along a straight, level road
   D. a projectile at the highest point in its trajectory

18. One car travels 40. meters due east in 5.0 seconds, and a second car travels 64 meters due west in 8.0 seconds. During their periods of travel, the cars definitely had the same
   A. average velocity
   B. total displacement
   C. change in momentum
   D. average speed

**Figure 1**

The graph represents the linear motion of a car.
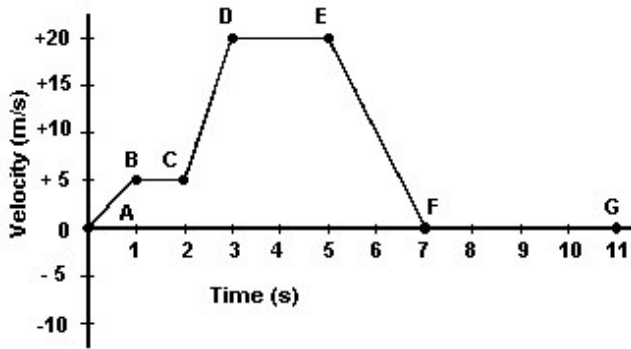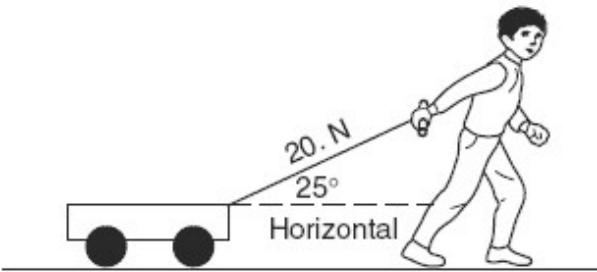


19. **[Refer to figure 1]**
The average velocity of the car during interval *DE* is

   A. 0 m/s
   B. 10. m/s
   C. 20. m/s
   D. 40. m/s

20. As shown in the diagram below, a child applies a constant 20.-newton force along the handle of a wagon which makes a 25° angle with the horizontal.



How much work does the child do in moving the wagon a horizontal distance of 4.0 meters?

   A. 5.0 J
   B. 34 J
   C. 73 J
   D. 80. J

21. A student throws a 5.0-newton ball straight up. What is the net force on the ball at its maximum height?

   A. 0.0 N
   B. 5.0 N, up
   C. 5.0 N, down
   D. 9.8 N, down

22. An object that is originally moving at a speed of 20. meters per second accelerates uniformly for 5.0 seconds to a final speed of 50. meters per second. What is the acceleration of the object?

   A. $14 \text{ m/s}^2$
   B. $10. \text{ m/s}^2$
   C. $6.0 \text{ m/s}^2$
   D. $4.0 \text{ m/s}^2$

23. A cart moving across a level surface accelerates uniformly at 1.0 meters per second$^2$ for 2.0 seconds. What additional information is required to determine the distance traveled by the cart during this 2.0-second interval?

   A.  coefficient of friction between the cart and the surface
   B.  mass of the cart
   C.  net force acting on the cart
   D.  initial velocity of the cart

24. The vector in the diagram below represents the resultant of two forces acting concurrently on an object at point *P*.
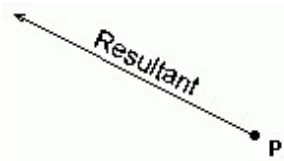


Which pair of vectors below best represents two concurrent forces that combine to produce this resultant force vector?



A.

B.

C.

D.
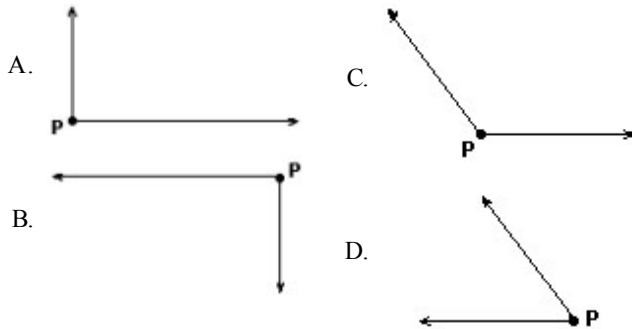
25. The diagram shows a person exerting a 300.-newton force on the handle of a shovel that makes an angle of 60.° with the horizontal ground.
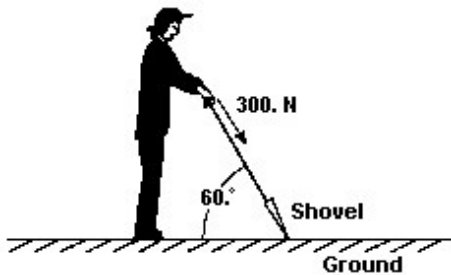


The component of the 300.-newton force that acts perpendicular to the ground is approximately

A. 150. N
B. 260. N
C. 300. N
D. 350. N

26. A 20-kilogram cart traveling east with a speed of 6 meters per second collides with a 30-kilogram cart traveling west. If both carts come to rest after the collision, what was the speed of the westbound cart before the collision?

A. 0 m/s
B. 9 m/s
C. 3 m/s
D. 4 m/s

**Figure 2**

Base your answer to the question on the information below.

A stream is 30. meters wide and its current flows southward at 1.5 meters per second. A toy boat is launched with a velocity of 2.0 meters per second eastward from the west bank of the stream.

27. **[Refer to figure 2]**
How much time is required for the boat to reach the opposite bank of the stream?

    A. 8.6 s
    B. 12 s
    C. 15 s
    D. 60. s

28. A different force is applied to each of four different blocks on a frictionless, horizontal surface. In which diagram does the block have the greatest inertia 2.0 seconds after starting from rest?
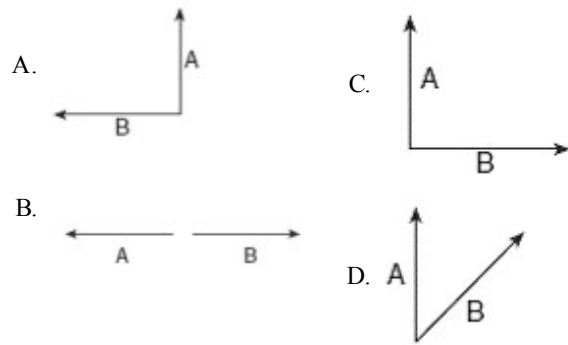
A. | 5.0 kg | 10. N →
C. | 15 kg | 3.0 N →
B. | 10. kg | 5.0 N →
D. | 20. kg | 2.0 N →
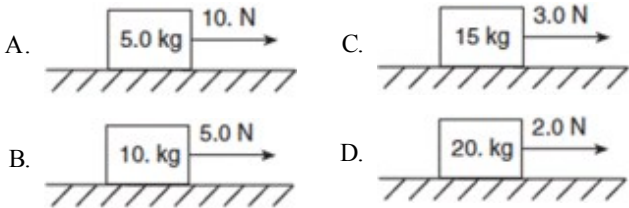
29. What is the average velocity of a car that travels 30. kilometers due west in 0.50 hour?

    A. 15 km/hr
    B. 60. km/hr
    C. 15 km/hr west
    D. 60. km/hr west

30. The diagram below shows a resultant vector, $R$.
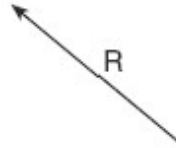
Which diagram best represents a pair of component vectors, $A$ and $B$, that would combine to form resultant vector $R$?

A.
C.
B.
D.

31. A student throws a baseball vertically upward and then catches it. If vertically upward is considered to be the positive direction, which graph best represents, the relationship between velocity and time for the baseball? [Neglect friction.]
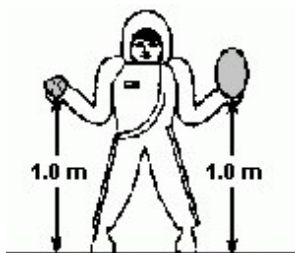
A.
C.
B.
D.
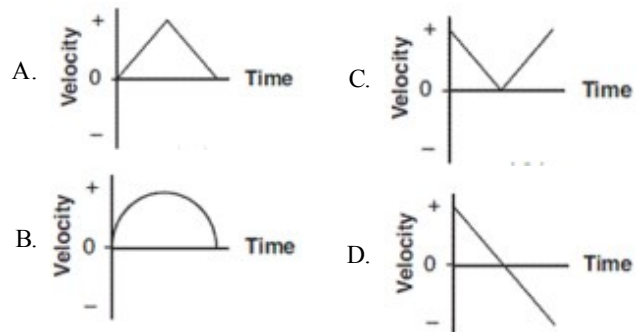
32. As shown in the diagram below, a painter climbs 7.3 meters up a vertical scaffold from *A* to *B* and then walks 11.0 meters from *B* to *C* along a level platform.
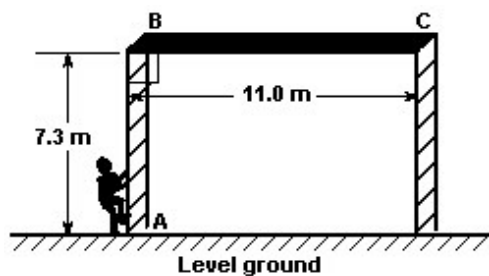


The magnitude of the painter's total displacement while moving from *A* to *C* is

- A. 3.7 m
- B. 13.2 m
- C. 18.3 m
- D. 25.6 m

33. As shown in the diagram below, an astronaut on the Moon is holding a baseball and a balloon. The astronaut releases both objects at the same time. What does the astronaut observe? [Note: The Moon has no atmosphere.]



- A. The baseball falls slower than the balloon.
- B. The baseball falls faster than the balloon.
- C. The baseball and balloon fall at the same rate.
- D. The baseball and balloon remain suspended and do not fall.

34. A 0.25-kilogram baseball is thrown upward with a speed of 30. meters per second. Neglecting friction, the maximum height reached by the baseball is approximately

- A. 15 m
- B. 46 m
- C. 74 m
- D. 92 m

35. A cart starting from rest travels a distance of 3.6 meters in 1.8 seconds. The average speed of the cart is

- A. 0.20 m/s
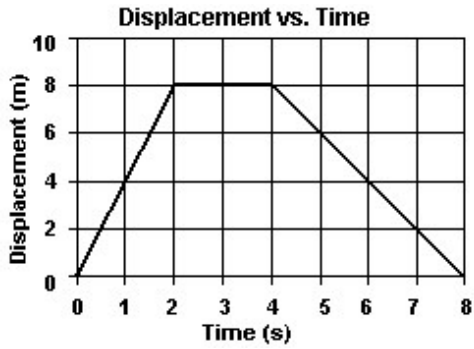- B. 2.0 m/s
- C. 0.50 m/s
- D. 5.0 m/s

36. In a baseball game, a batter hits a ball for a home run. Compared to the ball, the magnitude of the impulse imparted to the bat is

- A. less
- B. greater
- C. the same

**Figure 3**

The graph represents the relationship between the displacement of an object and its time travel along a straight line.

**Displacement vs. Time**



37. **[Refer to figure 3]**
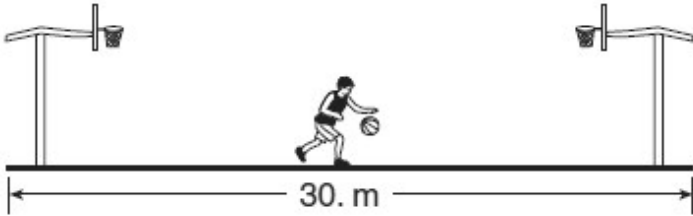What is the average speed of the object during the first 4.0 seconds?

    A. 0 m/s
    B. 2 m/s
    C. 8 m/s
    D. 4 m/s

**Figure 4**

Base your answer to the question on the information below.

In a drill during basketball practice, a player runs the length of the 30.-meter court and back. The player does this three times in 60. seconds.



30. m

(Not drawn to scale)

38. **[Refer to figure 4]**
The average speed of the player during the drill is

A. 0.0 m/s
B. 0.50 m/s
C. 3.0 m/s
D. 30. m/s

39. A 2.0-kilogram laboratory cart is sliding across a horizontal frictionless surface at a constant velocity of 4.0 meters per second east. What will be the cart's velocity after a 6.0-newton westward force acts on it for 2.0 seconds?

A. 2.0 m/s east
B. 2.0 m/s west
C. 10. m/s east
D. 10. m/s west

40. The velocity of a car changes from 60. meters per second north to 45 meters per second north in 5.0 seconds. The magnitude of the car's acceleration is

A. 9.8 m/s$^2$
B. 15 m/s$^2$
C. 3.0 m/s$^2$
D. 53 m/s$^2$

**Figure 5**

Base your answer to this question on the information below.

The instant before a batter hits a 0.14-kilogram baseball, the velocity of the ball is 45 meters per second west. The instant after the batter hits the ball, the ball's velocity is 35 meters per second east. The bat and ball are in contact for $1.0 \times 10^{-2}$ second.

41. **[Refer to figure 5]**
Determine the magnitude and direction of the average acceleration of the baseball while it is in contact with the bat.

    A. Magnitude: 10.0 m/s$^2$, Direction east

    B. Magnitude: $8.0 \times 10^3$ m/s$^2$, Direction east

    C. Magnitude: $1.0 \times 10^3$ m/s$^2$, Direction east

    D. Magnitude: $8.0 \times 10^1$ m/s$^2$, Direction east