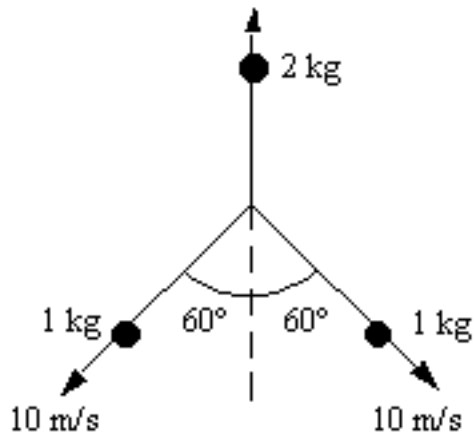Use the following to answer question 1:

A stationary 4-kg shell explodes into three pieces. Two of the fragments have a mass of 1 kg each and move along the paths shown with a speed of 10 m/s. The third fragment moves upward as shown.

1. What is the speed of the third fragment?
   A) zero m/s
   B) 1 m/s
   C) 5 m/s
   D) 10 m/s
   E) None of these

Use the following to answer question 2:

A 2.0-kg pistol fires a 1.0-g bullet with a muzzle speed of 1000 m/s. The bullet then strikes a 10-kg wooden block resting on a horizontal frictionless surface. The block and the embedded bullet then slide across the surface.


2. What is the speed of the "bullet + block" system immediately after the bullet is embedded in the block?
   A) 0.1 m/s
   B) 10 m/s
   C) 1000 m/s
   D) 10 000 m/s
   E)   None of these

3. A 50.0-kg boy runs at a speed of 10.0 m/s and jumps onto a cart as shown in the figure. The cart is initially at rest.
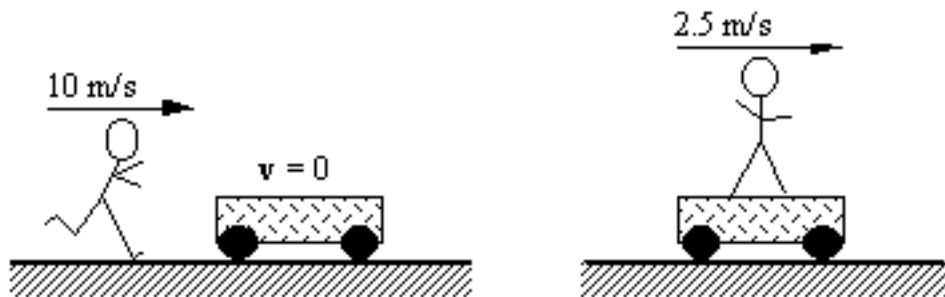
If the speed of the cart with the boy on it is 2.50 m/s, what is the mass of the cart?
A) 120 kg
B) 170 kg
C) 210 kg
D) 260 kg
E) None of these

4. A concrete block is pulled 7.0 m across a frictionless surface by means of a rope. The tension in the rope is 40 N; and the net work done on the block is 247 J.
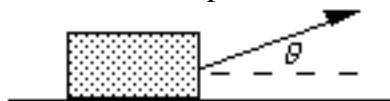
What angle does the rope make with the horizontal?
A) 28°
B) 41°
C) 47°
D) 62°
E) None of these

5. A warehouse worker uses a forklift to lift a crate of pickles on a platform to a height 2.75 m above the floor. The combined mass of the platform and the crate is 207 kg. If the power expended by the forklift is 1440 W, how long does it take to lift the crate?
A) 37.2 s
B) 5.81 s
C) 3.87 s
D) 18.6 s
E) None of these

6. A roller-coaster car is moving at 20 m/s along a straight horizontal track. What will its speed be after climbing the 15-m hill shown in the figure if friction is ignored?

A) 17 m/s
B) 7 m/s
C) 5 m/s
D) 8 m/s
E) None of these

7. A 10.0-g bullet traveling horizontally at 755 m/s strikes a stationary target and stops after penetrating 14.5 cm into the target. What is the average force of the target on the bullet?
A) 1.97×10^4 N
B) 2.07×10^5 N
C) 6.26×10^3 N
D) 3.13×10^4 N
E) None of these

8. The kinetic energy of a car is 8×10^6 J as it travels along a horizontal road. How much work is required to stop the car in 10 s?
A) zero joules
B) 8×10^4 J
C) 8×10^5 J
D) 8×10^6 J
E) None of these

9. A 0.25-kg ball attached to a string is rotating in a horizontal circle of radius 0.5 m. If the ball's rotational velocity is 100 RPM (revolutions per minute), what is the tension in the string?
A) 12 N
B) 22 N
C) 17 N
D) 14 N
E) None of these

10. A rope connects boat A to boat B. Boat A starts from rest and accelerates to a speed of 9.5 m/s in a time $t = 47$ s. The mass of boat B is 540 kg. Assuming a constant frictional force of 230 N acts on boat B, what is the magnitude of the tension in the rope that connects the boats during the time that boat A is accelerating?
    A) 160 N
    B) 1270 N
    C) 340 N
    D) 860 N
    E) None of these

11. A 70-kg woman stands on a bathroom scale in an elevator that is accelerating downward. The scale reads 500 N. What is the magnitude of the elevator's acceleration?
    A) 1.58 m/s^2
    B) 2.12 m/s^2
    C) 2.66 m/s^2
    D) 3.08 m/s^2
    E) None of these

12. A 20.0-kg is dropped from an air-balloon. At a particular instant, its acceleration is measured to be 7.0 m/s^2. Determine the force of air resistance on the package at that moment.
    A) 28 N
    B) 56 N
    C) 140 N
    D) 196 N
    E) None of these

13. A satellite is placed in a circular orbit to observe the surface of a planet from an altitude of 144 km. The satellite's tangential speed is 3070 m/s. The radius of the planet is 3397 km. What is the mass of the planet? ($G = 6.673$ x 10^{-11} N-m^2/kg^2)
    A) 5.0 x 10^{23} kg
    B) 4.7 x 10^{22}
    C) 2.9 x 10^{24}
    D) 3.4 x 10^{23}
    E) None of these

14. A 4-kg block and a 2-kg block on a table are acted on from the left by a 12-N force that pushes the larger block against the smaller one, causing them to accelerate together to the right. The coefficient of kinetic friction between the blocks and the table is 0.10. What is the approximate force exerted on the 2-kg block by the 4 kg block?

+12 N → 4 kg | 2 kg
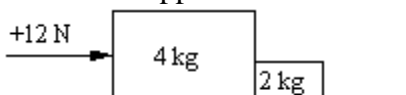
A) 1 N
B) 2 N
C) 3 N
D) 4 N
E) None of these

15. Two sleds are hooked together as shown in the figure. The rear sled has a mass m = 100 kg, and the front sled has twice the mass, 200 kg.

m   2m   T   F

The sleds are pulled along a frictionless surface by an applied force F = 600 N. What is the tension in the rope connecting the sleds?
A) 100 N
B) 200 N
C) 300 N
D) 400 N
E) None of these

16. At the center of a rope, a 20-kg ball is hung as shown. What is the tension in the rope if the angle θ in the drawing is 3.0°?

A) 1300 N
B) 940 N
C) 470 N
D) 1900 N
E) None of these

Use the following to answer question 17:

A 120-N force is pushing on a 10-kg block at an angle of 30° *below* the horizontal, causing the block to slide over a table top.   The coefficient of kinetic friction between the block and the table is 0.20.

17. What is the acceleration of the block?
    A)   8.8 m/s^2
    B)   6.4 m/s^2
    C)   4.6 m/s^2
    D)   3.2 m/s^2
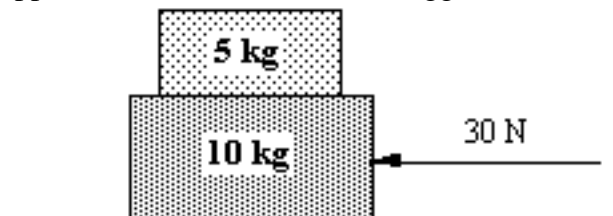   E)   None of these

18. A 4-kg block is connected by means of a string to a 2-kg block as shown in the figure. Both blocks are moving: the 4-kg block to the right, and the 2-kg block downward. If the coefficient of kinetic friction between the 4-kg block and the table is 0.20, what is the acceleration of the 2 kg block?
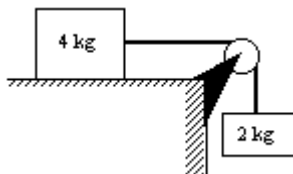
    A)   0.8 m/s^2
    B)   1.2 m/s^2
   C)   1.5 m/s^2
    D)   1.8 m/s^2
    E)   None of these

Use the following to answer question 19:

Two blocks rest on a horizontal *frictionless* surface as shown. The surface between the top and bottom blocks is roughened so that there is no slipping between the two blocks. A 30-N force is applied to the bottom block as suggested in the figure.

19. If the coefficient of kinetic friction between the bottom block and the table is 0.20, what is the magnitude of the acceleration of the bottom block?
    A) zero
    B) 0.04 m/s^2
    C) 1.14 m/s^2
    D) 0.60 m/s^2
    E) None of these

20. Note the following situations:

Case 1   Case 2   Case 3
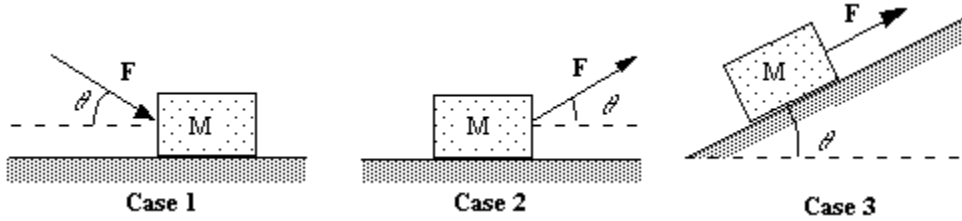
In which case will the magnitude of the normal force on the block be equal to ($Mg + F \sin \theta$)?
    A) case *1* only
    B) case *2* only
    C) both cases *1* and *2*
    D) both cases *2* and *3*
    E) case 3 only

Answer Key

1. C
2. A
3. E
4. D
5. C
6. E
7. A
8. D
9. D
10. C
11. C
12. B
13. A
14. B
15. B
16. D
17. E (7.23 m/s^2 is the correct answer)
18. E
19. B
20. E