UNIT 1 REVIEW (Momentum and Impulse)

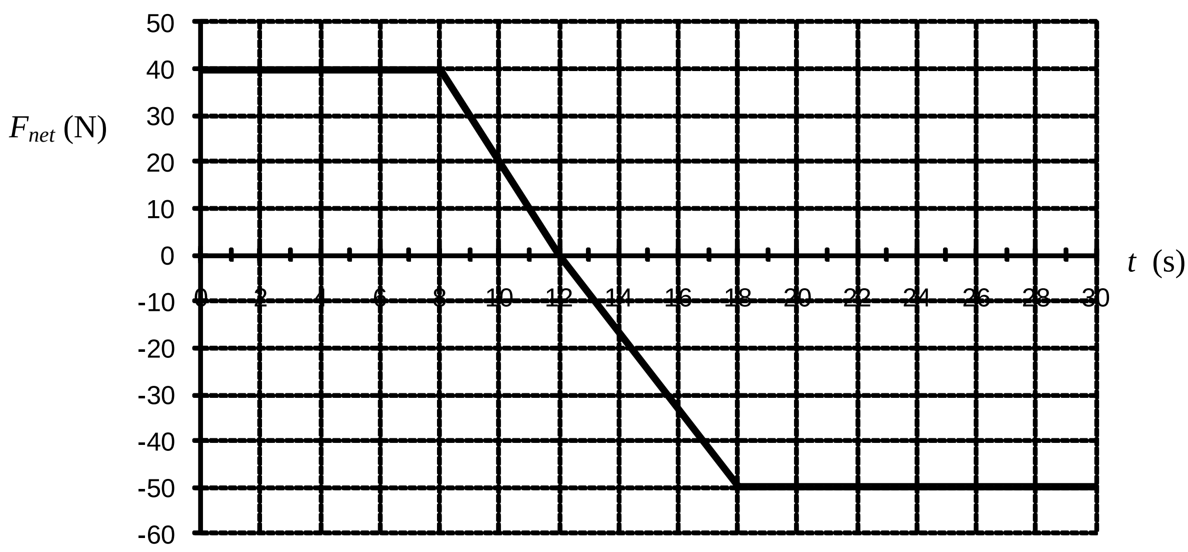
1. A 470 kg mass is lowered downward by a crane's cable at a constant speed of 2.80 m/s. If air resistance can be ignored, then determine:
   a) the force of tension in the cable
   b) the distance the mass travels in 5.50 seconds

2. A 35.0 kg industrial sled is being pulled to the right by a force *F*. If the force of friction is 87.0 N and the sled accelerates to the right at 1.62 m/s^2, then determine:
   a) the applied force *F*
   b) the time it takes the sled to travel 4.40 m, assuming it starts at rest

3. A 1400 kg car, travelling East at 36.0 km/h, experiences an impulse of 7.50 kN·s West. Determine the final velocity of the car.

4. A 620 gram ball hits the ground with a downward velocity of 18.4 m/s. If it rebounds with a speed of 11.7 m/s, and if the contact time with the ground is 330 milliseconds, then determine:
   a) the ball's change in kinetic energy
   b) the average net force (magnitude and direction) on the ball during the collision.

5. A changing net force is described using the graph below:



   a) This net force acts on an object that is initially at rest. If the object's velocity after 12 seconds is 7.75 m/s, then determine the object's mass.

   b) This net force acts on an object for 30 seconds. Determine the magnitude of the object's change in momentum.

6. Using the concepts of impulse, momentum, and force, explain why a huge landing mat reduces injuries on stunt persons when they fall from a building (compared to landing without a mat).

7. For the following situations, assume that momentum is conserved.

   a) The total momentum before a collision is 50 kgm/s right. What is the total momentum after the collision?

   b) The change in momentum of piece 1 is 100 kgm/s North. What is the change in momentum of the other piece?

   c) The impulse on piece 1 during an explosion is 400 Ns upward. What is the impulse on the other piece?

8. A 250 g ball, moving right at 6.0 m/s, collides with a 370 g ball moving left at 10.0 m/s, as shown. After the collision, the 250 g ball is moving left at 4.0 m/s.

   a) Determine the velocity of the 370 g ball after the collision. Describe the conditions required for your answer to be true.
   b) Is the collision elastic? Justify.

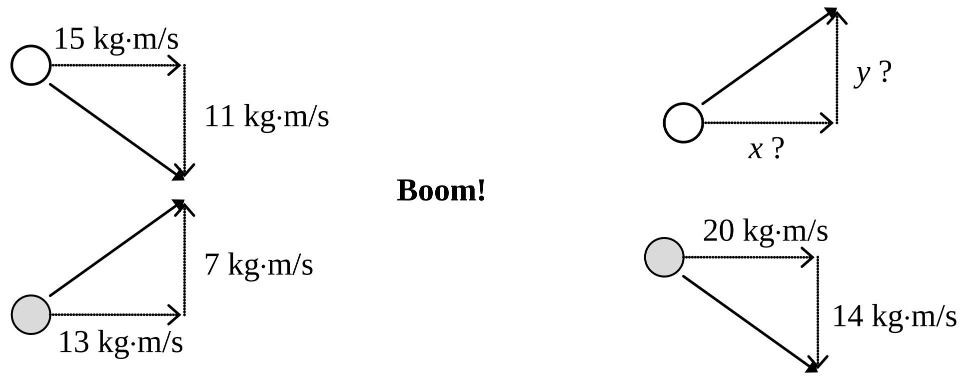
9. An object with mass M, moving North at a speed of 12 m/s, collides with another object with 4 times the mass (i.e. $4M$) that is at rest. If they stick together, determine their final speed.

10. A cannon, with a total mass of 144 kg (including the cannonball) is initially at rest. When the cannon explodes, it launches a 3.90 kg cannonball forward at a speed of 220 m/s. Determine the initial recoil velocity of the cannon.

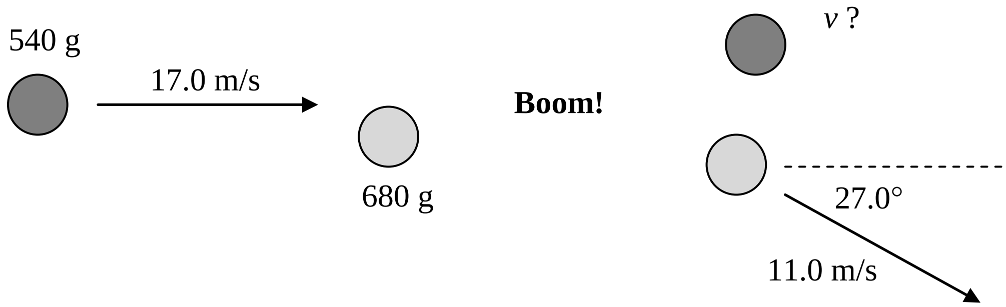
11. A 1300 kg car, travelling West at 58.0 km/h, collides with a 1900 kg truck moving North at 70.0 km/h. If they hit and stick together, then using a vector sum diagram, determine their velocity (magnitude and direction) right after the collision.

12. A 5.00 kg object is initially at rest on a frictionless table surface. It then explodes into 3 pieces. A 2.00 kg piece moves North at 72.0 m/s, while a 1.30 kg piece moves East at 61.0 m/s. Determine the final momentum of the third piece.

13. For the following collision, determine the unknown components (assuming momentum is conserved).



14. A 540 g object collides obliquely with a 680 g object, initially at rest.



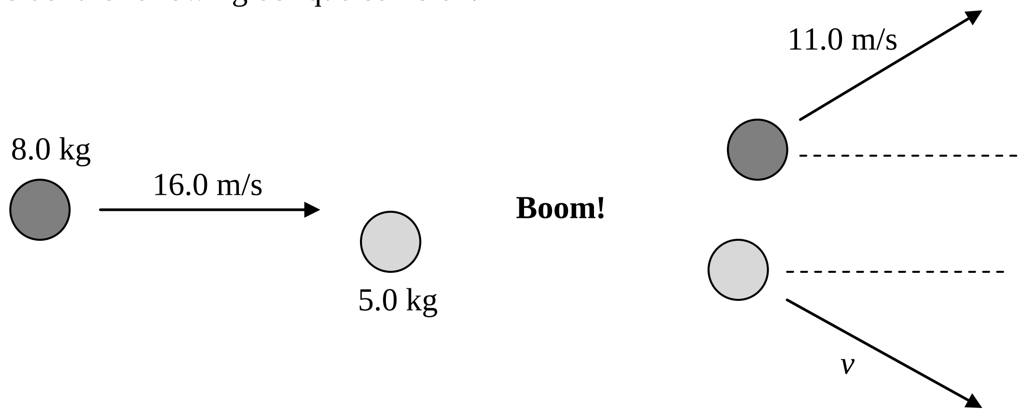
If, after the collision, the 680 g object had a velocity of 11.0 m/s at 27.0° S of E, then determine the final velocity of the 540 g object.

15. For the following collisions, determine whether momentum and kinetic energy are conserved.

    a) A 2.0 kg mass, moving right at 10 m/s, collides with a 5.0 kg mass initially at rest. They hit and stick together.

    b) A 4.0 kg ball, moving right at 5.0 m/s, collides with another 4.0 kg ball initially at rest. After the collision, the first 4.0 kg ball comes immediately to rest.

16. Consider the following oblique collision:



If the collision is elastic, then determine the final speed v of the 5.0 kg object.

SOLUTIONS

1. a) 4.61 kN b) 15.4 m
2. a) 144 N right b) 2.33 s
3. 4.64 m/s East
4. a) –62.5 J (lost) b) 56.6 N West
5. a) 52 kg b) 350 N·s
6. Impulse is unaffected. Force and time have an inverse relationship. Cushioning increases the time, and thus, it decreases the force.
7. a) 50 kg·m/s right b) 100 kg·m/s South c) 400 N·s downward
8. a) 3.2 m/s left ; assuming that the system is isolated (net force is zero on system)
   b) Ek_{Ti} = 23 J ; Ek_{Tf} = 3.9 J ; Not elastic (19 J is lost as heat / sound)
9. 2.4 m/s
10. 6.12 m/s backwards
11. 13.3 m/s (47.8 km/h) at 60.5° N of W (or 29.5° W of N)
12. 164 kg·m/s at 61.2° S of W (or 28.8° W of S)
13. x = 8 kg·m/s ; y = 10 kg·m/s
14. 7.83 m/s at 53.5° N of E (or 36.5° E of N)
15. a) Momentum is conserved, but kinetic energy is not conserved (inelastic).
    b) Both momentum and kinetic energy are conserved.
16. 14.7 m/s