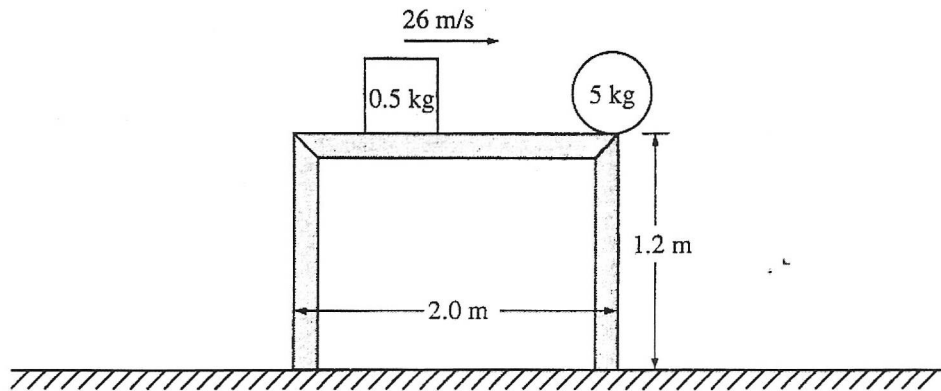


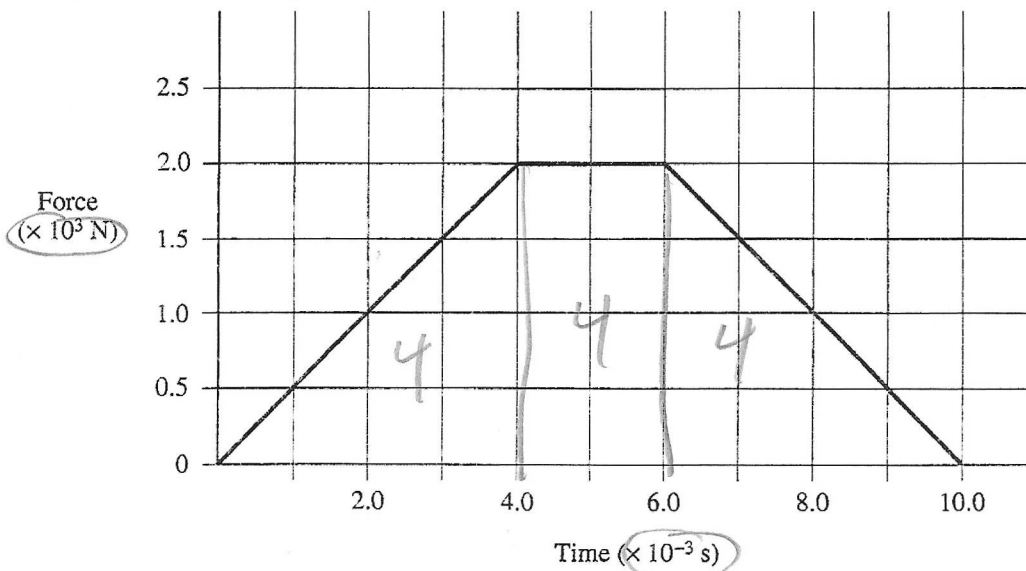
## 9: Energy and Momentum Combined Problems #1

1. A 5 kg ball initially rests on the edge of a 2-meter-long, 1.2-meter-high frictionless table, as shown below. A hard plastic cube of mass 0.5 kg slides across the table at a speed of 26 meters per second and strikes the ball, causing the ball to leave the table in the direction in which the cube was moving.



Note: Figure not drawn to scale.

The figure below shows a graph of the force exerted on the ball by the cube as a function of time.



- a) Determine the total impulse given to the ball.

$$J = A_{\text{area}} = 4 + 4 + 4 = 12 \text{ N}\cdot\text{m}$$

- b) Determine the horizontal velocity of the ball immediately after the collision.

$$J = \Delta P$$

$$12 \text{ N}\cdot\text{s} = 5 (V_f - V_i)$$

$$\boxed{V_f = 2.4 \text{ m/s}}$$

- c) Determine the following for the cube immediately after the collision.

- Its speed
- Its direction of travel (right or left), if moving

$$J = \Delta P$$

$$-12 \text{ N}\cdot\text{s} = 0.5 (V_f - 26)$$

$$-12 = \frac{1}{2} V_f - 13$$

$$1 = \frac{1}{2} V_f$$

$$\boxed{V_f = 2 \text{ m/s}}$$

- d) Determine the energy dissipated in the collision.

$$\Delta K = K_f - K_i$$

$$= 0.5(0.5)(2)^2 + 0.5(5)(2.4)^2 - 0.5(0.5)(26)^2$$

$$= 15.4 - 169$$

$$\boxed{\Delta K = -153.6 \text{ J}}$$

- e) Determine the distance between the two points of impact of the objects with the floor.

Vertical Projectile Motion

y-direction for time

$$Y = Y_i + V_{y_i} t + \frac{1}{2} a_y t^2$$

$$0 = 1.2 + 0 + \frac{1}{2} (-9.8) t^2$$

$$1.2 = 4.9 t^2$$

$$\boxed{t = 0.49 \text{ s}}$$

Block

$$x = V_x t$$

$$x = 2(0.49)$$

$$\boxed{x = 0.98 \text{ m}}$$

Ball

$$x = 2.4(0.49)$$

$$x = 1.176 \text{ m}$$

$$\boxed{\Delta x = 0.20 \text{ m}}$$