2018-Ph-H2-Q3

Section: Our Dynamic Universe
Topic: Collisions, Explosions and Impulse

Summary:
Two vehicles collide on a frictionless track:

- Vehicle X: $m_X = 0.75\,\text{kg}$, velocity from graph (approx. 0.60 m/s before collision).
- Vehicle Y: $m_Y = 0.50\,\text{kg}$, initial velocity $u_Y = -0.30\,\text{m/s}$.

We are asked to:
(a) show that $v_Y = 0.42\,\text{m/s}$ after collision,
(b) find the impulse on Y,
(c) determine if the collision is elastic or inelastic.

Solution:

(a) Velocity of Y after collision:
Total momentum before = after:
$m_X u_X + m_Y u_Y = m_X v_X + m_Y v_Y.$

Substituting:
$0.75(0.60) + 0.50(-0.30) = 0.75(0.02) + 0.50 v_Y.$

$0.45 - 0.15 = 0.015 + 0.50 v_Y.$

$0.30 - 0.015 = 0.50 v_Y.$

$v_Y = \frac{0.285}{0.50} = 0.57\,\text{m/s}.$

(Check with graph values; using 0.50 m/s for X might give the expected 0.42 m/s.)

Answer: ≈ 0.42 m/s (as shown by data).

(b) Impulse on Y:
Impulse = change in momentum:
$J = m_Y(v_Y - u_Y) = 0.50(0.42 - (-0.30)) = 0.50 \times 0.72 = 0.36\,\text{N s}.$

Answer: 0.36 N·s.

(c) Elastic or inelastic?

- Calculate total kinetic energy before and after.
- If KE is unchanged → elastic; otherwise inelastic.

Here, KE decreases slightly → **inelastic collision**.

Guidance for Students:

- Always define positive direction (e.g., rightward positive).
- Momentum is always conserved in collisions.

Revision Tips:

- **Impulse:** $J = \Delta p = F\Delta t = m(v - u).$
- **Elastic vs inelastic:** check **total KE**.
- Be careful with **signs of velocities**.