Chapter 3: Dynamics (Momentum and Collisions) Solutions

Worked Example 1

B change in momentum,

Δp = area under F - t graph

$= \frac{1}{2}(8+4)(12) - \frac{1}{2}(2)(12)$

$= 60$ kg m s^{-1}

Change in velocity,

$\Delta v = \frac{\Delta p}{m} = \frac{60}{300 \times 10^{-3}} = 200$ m s^{-1}

Since u = 0 m s^{-1},

$\Rightarrow v - u = 200$

$\therefore v = 200$ m s^{-1}

ANS: B

1 **A** Subtract initial speed instead of adding it to the change in speed

B Forget to add the initial speed

C change in momentum,

Δp = area under F - t graph

$= \frac{1}{2}(8+4)(12) - \frac{1}{2}(2)(12)$

$= 60$ kg m s^{-1}

Change in velocity,

$\Delta v = \frac{\Delta p}{m} = \frac{60}{200 \times 10^{-3}} = 300$ m s^{-1}

Since u = 50 m s^{-1},

$\Rightarrow v - u = 300$

$\therefore v = 350$ m s^{-1}

D Add both areas under graph

ANS: C

2 **A** Did not account for change in direction and just take final speed minus initial speed as the change in velocity

B taking direction away from wall as positive,

Impulse on ball by the wall, $\Delta p = m\Delta v$

$= (0.080)(18 - (-23))$

$= 3.3$ N s

C Did not account for change in direction and just take final speed minus initial speed as the change in velocity and wrong direction

D Wrong direction

ANS: B

Worked Example 2

A Take total final momentum as the initial momentum of Y.

B Add both final momentum without considering the direction and equate it as the initial momentum of Y.

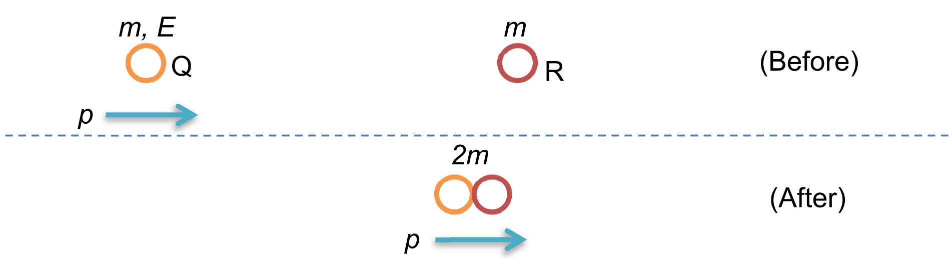
C Take rightward direction as positive.
By Principle of Conservation of Momentum,
Total initial momentum = Total final momentum
$22 + p_y = -2 + 10$
$p_y = -14$ N s

Magnitude of momentum of Y = 14 N s

D Take initial momentum of X as the initial momentum of Y.

ANS: C

3 **C**



By Principle of Conservation of momentum

Momentum of system before collision $=$ Momentum of system after collision

$\therefore$ Momentum of system after collision $= p$

P and Q are identical (having same mass) $\Rightarrow$ momentum of Q after collision $= \dfrac{p}{2}$

Intial kinetic energy, $E = \dfrac{1}{2}mv^2 = \dfrac{1}{2}\dfrac{(mv)^2}{m} = \dfrac{p^2}{2m}$

Kinetic energy of system after collision $= \dfrac{p^2}{2(2m)} = \dfrac{1}{2}\left(\dfrac{p^2}{2m}\right) = \dfrac{1}{2}E$

Kinetic energy of Q after collision $= \dfrac{(p/2)^2}{2m} = \dfrac{1}{4}\left(\dfrac{p^2}{2m}\right) = \dfrac{1}{4}E$

ANS: C

4 **(a)** Impulse exerted on the heavier truck by the lighter truck
= change in momentum of the heavier truck
= $M(V - U)$
= (66 000) (2.00 – 1.00) M1
= + 66 000 N s (towards the right) A1

(b) Total KE before collision = ½ (22 000)(3.00)^2 + ½ (66 000) (1.00)^2 = 132 000 J
Total KE after collision = 0 + ½ (66 000) (2.00)^2 = 132 000 J M1
Since Total KE before and after collision are the same, the collision is elastic. A1
OR
Since relative speed of approach = relative speed of separation = 2.00 m s^{-1}, the collision is elastic.

(c) At that instant, some of the kinetic energy has been converted into elastic potential energy in the springs. B1

5 **(a)** By Principle of Conservation of momentum,

$mu + 3m(-u) = (m + 3m)v_c$ M1

$v_c = -0.5u$

$\therefore$ Speed $= 0.5u$ A1

(b) Assume after the interaction:

Conservation of momentum:

$mu + 3m(-u) = mv_1 + 3mv_2$ M1

$\Rightarrow -2u = v_1 + 3v_2$ ----- (1)

Elastic collision:

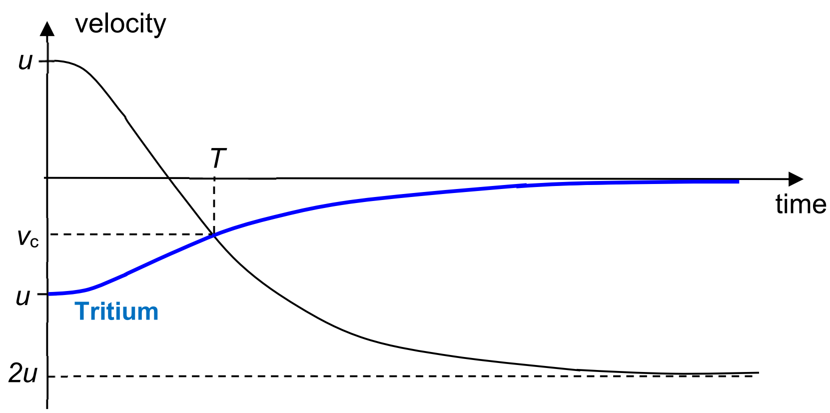
$u - (-u) = v_2 - v_1$ M1

$\Rightarrow 2u = v_2 - v_1$ ----- (2)

Solving (1) and (2) $\Rightarrow$ $v_1 = -2u$ ($2u$ travelling to the left), $v_2 = 0$

$\therefore$ Speeds are $v_1 = 2u$ and $v_2 = 0$. A2

(c)
(d)



B3

1 mark for shape of curve
1 mark for labelling v_c correctly
1 mark of labelling T correctly