

Solutions

Each answer shows the steps, then the **result**.

2.1

- impulse is force times contact time:

$$J = F\Delta t = (20 \text{ N})(3 \text{ s})$$

- $J = \mathbf{60 \text{ N s}}$ ($= 60 \text{ kg m s}^{-1}$)

2.2

- The change in momentum, Δp

2.3

- impulse equals the change in momentum, $J = m\Delta v$:

$$\Delta v = \frac{J}{m} = \frac{16 \text{ kg m s}^{-1}}{4 \text{ kg}}$$

- $\Delta v = \mathbf{4 \text{ m s}^{-1}}$

2.4

- For a fixed Δp , $F = \Delta p/\Delta t$; a larger Δt gives a smaller F

3.1 B

- impulse equals the change in momentum

3.2 B

- a longer time reduces the force

3.3

(a)

- take the incoming direction as positive, so $v_i = +10 \text{ m s}^{-1}$ and $v_f = -8 \text{ m s}^{-1}$:

$$\Delta p = m(v_f - v_i) = (0.15 \text{ kg})(-8 \text{ m s}^{-1} - 10 \text{ m s}^{-1})$$

- $\Delta p = \mathbf{-2.7 \text{ kg m s}^{-1}}$ (size 2.7, away from the wall)

(b)

- force is the rate of change of momentum:

$$F = \frac{\Delta p}{\Delta t} = \frac{2.7 \text{ kg m s}^{-1}}{0.02 \text{ s}}$$

- $F = \mathbf{135 \text{ N}}$

3.4

(a)

- force is the rate of change of momentum:

$$F = \frac{\Delta p}{\Delta t} = \frac{300 \text{ kg m s}^{-1}}{0.1 \text{ s}} = \mathbf{3000 \text{ N}}$$

(b)

- same Δp over a longer time:

$$F = \frac{\Delta p}{\Delta t} = \frac{300 \text{ kg m s}^{-1}}{0.5 \text{ s}}$$

- $F = \mathbf{600 \text{ N}}$