

PQ 8b Q and A

Q1

A tennis racquet applied a force of 110 N for a period of 0.30 s to a ball initially at rest. Calculate the applied impulse.

$$\Delta p = F\Delta t = 110 \times 0.3 = 33 \text{ kg m s}^{-1} \text{ (N s)}$$

Q2

Calculate the size of the force needed to apply an impulse of 720 N s over a period of 0.060 s.

$$F = \frac{\text{impulse}}{\Delta t} = \frac{720}{0.060} = 12\,000 \text{ N}$$

Q3

Calculate the time during which a force of 1.6×10^2 N must act to supply an impulse of 8.0×10^{-1} N s.

$$\Delta t = \frac{\text{impulse}}{F} = \frac{8.0 \times 10^{-1}}{1.6 \times 10^2} = 5.0 \times 10^{-3} \text{ s}$$

Q4

Calculate the change in momentum one could expect from a force of 1.4×10^6 N acting for a period of 5.0×10^{-3} s.

$$\Delta p = F\Delta t = 1.4 \times 10^6 \times 5.0 \times 10^{-3} = 7000 \text{ kg m s}^{-1} \text{ (N s)}$$

Q5

A ball of mass 0.40 kg was acted on by an impulse of 4.8 N s.

Calculate the change of velocity that occurred.

$$p = mv$$

$$\Delta p = m \Delta v$$

$$\Delta v = \frac{\Delta p}{m} = \frac{4.8}{0.40} = 12 \text{ m s}^{-1}$$

Q6

A car of mass 840 kg travelling at 15.0 m s^{-1} accelerated to 25.0 m s^{-1} . Calculate the impulse that was applied to cause this change of speed.

$$\begin{aligned}\Delta v &= 25.0 - 15.0 \\ &= 10.0 \text{ m s}^{-1}\end{aligned}$$

$$\begin{aligned}\Delta p &= m \Delta v \\ &= m(v - u) \\ &= 840 \times 10 = 8400 \text{ N s}\end{aligned}$$

Q7

A ball of mass 0.600 kg struck a net at 12.0 m s^{-1} and rebounded at 10.0 m s^{-1} a quarter of a second later. Calculate the average force exerted by the ball on the net.

$$\text{Change of velocity} = 10.0 - (-12.0) = 22.0 \text{ m s}^{-1}$$

$$\Delta p = m \Delta v = 0.600 \times 22.0 = 13.2 \text{ kg m s}^{-1}$$

$$\Delta p = F \Delta t$$

$$F = \frac{\Delta p}{\Delta t} = \frac{13.2}{0.25} = 52.8 \text{ N}$$

Q8

Calculate the time a force of 2.7 N must act to bring an object of mass 3.4 kg to rest from a velocity of 3.0 m s⁻¹.

$$\Delta p = m\Delta v = 3.4 \times (0 - 3.0) = -10.2 \text{ kg m s}^{-1}$$

$$\Delta t = \frac{\Delta p}{F} = \frac{10.2}{2.7} = 3.78 \text{ s}$$

(Negative sign has no meaning in this case.)

Q9

A force of 8.6 N acted for 2.5 s on an object of mass 1.8 kg initially moving at 50.0 m s⁻¹. Calculate the object's new speed.

$$\Delta p = F\Delta t = 8.6 \times 2.5 = 21.5 \text{ kg m s}^{-1}$$

$$\Delta p = m\Delta v$$

$$21.5 = 1.8(v - 50.0)$$

$$v = \frac{21.5}{1.8} + 50.0 = 61.9 \text{ m s}^{-1}$$

Q10

A tennis ball of mass 50 g served at 35 m s^{-1} was returned at the same speed. If the ball was in contact with the receiver's racquet during the return of service for one fiftieth of a second, calculate the force that was exerted on the ball.

$$\begin{aligned}\Delta v &= 35 \text{ m s}^{-1} \text{ away from receiver's racquet} \\ &\quad - 35 \text{ m s}^{-1} \text{ towards receiver's racquet} \\ &= 70 \text{ m s}^{-1} \text{ away from receiver's racquet}\end{aligned}$$

$$\Delta p = m\Delta v = 0.050 \times 70 = 3.5 \text{ kg m s}^{-1}$$

$$\text{Impulse} = F\Delta t$$

$$F = \frac{\text{impulse}}{\Delta t} = \frac{\Delta p}{\Delta t} = \frac{3.5}{\frac{1}{50}} = 175 \text{ N}$$