PQ 8a Q and A

Momentum

Q1

Calculate the momentum of an object of mass 21 kg at 17 m s^{-1}.

$$p = mv = 21 \times 17 = 357 \text{ kg m s}^{-1}$$

Q2

A car of mass 740 kg has a momentum of 18 500 kg m s^{-1} north.

Calculate the velocity of the car.

$$v = \frac{p}{m} = \frac{18\,500}{740} = 25 \text{ m s}^{-1} \text{ north}$$

Q3

A ball moving at 16 m s^{-1} had a momentum of 12 kg m s^{-1} west.

$$m = \frac{p}{v} = \frac{12}{16} = 0.75 \text{ kg}$$

Q4

A truck of mass 1500 kg changed its velocity from 17 m s^{-1} south to 29 m s^{-1} south. Calculate the change in momentum.

$$\Delta p = m \times \Delta v = 1500 \times (29 - 17) = 18\,000$$

$$= 1.8 \times 10^4 \text{ kg m s}^{-1} \text{ south}$$

Q5

A ball of mass 0.500 kg struck a wall at 12.0 m s^{-1}, rebounding at 11.0 m s^{-1}. Calculate the change in momentum.

$$\Delta p = m \times \Delta v = 0.500(11.0 - [-12.0])$$

$$= 0.500 \times 23.0 = 11.5 \text{ kg m s}^{-1} \text{ away from the wall}$$

Q6

A loaded railway coal truck, total mass 4.0×10^4 kg moving at 3.5 m s^{-1} towards the north-east dumps 1.0×10^4 kg of coal as it moves over a hopper, continuing on at the same speed. Calculate the change in momentum that occurs.

$$\Delta p = \Delta m \times v = (-1.0 \times 10^4) \times 3.5 = -3.5 \times 10^4 \text{ kg m s}^{-1}$$

Q7

A rocket of mass 550 kg moving at 150 m s^{-1} upwards fired its motor, using 240 kg of fuel to achieve a velocity of 425 m s^{-1} upwards. Calculate the change in momentum of the rocket.

$$\text{Original momentum} = 550 \times 150 = 82\,500$$

$$\text{Final momentum} = (550 - 240) \times 425 = 131\,750$$

$$\text{Change of momentum} = 49\,250 \text{ kg m s}^{-1}$$

Q8

A person of mass 100 kg was standing beside a path when a trolley of mass 50 kg, moving at 3.0 m s^{-1} came past. As the trolley drew level with the person, they jumped onto the trolley causing it to slow down. If the combined momentum of the person and the trolley remained the same as that of the trolley before this incident, calculate the final velocity of the trolley with the person on it.

Original momentum of person and trolley

$= 100 \times 0 + 50 \times 3 = 150$

Final momentum of person and trolley $= 150$

$$v = \frac{p}{m} = \frac{150}{100 + 50} = 1 \text{ m s}^{-1}$$

Q9

A dynamics trolley ran into the back of another identical trolley loaded with 150 g moving in the same direction as shown in the diagram. After the collision, the two trolleys joined onto each other. Calculate the speed that the two trolleys move after the collision.

$$\text{Total original momentum} = m_1u_1 + m_2u_2$$

$$= 0.120 \times 0.4 + (0.120 + 0.150) \times 0.3 = 0.129 \text{ kg m s}^{-1}$$

$$\text{Final momentum} = \text{original momentum} = (m_1 + m_2)v$$

$$v = \frac{0.129}{(0.120 + 0.120 + 0.150)} = 0.331 \text{ m s}^{-1}$$