PQ 8e Q and A

Q1

A 4.0×10^3 kg train, moving at 4.5 m s^{-1} collides, and couples with a stationary carriage. They move at 2.0 m s^{-1}. Find the carriage's mass.

$m_1 = 4000$ kg; $u_1 = 4.5$ m s^{-1}; $m_2 = ?$; $u_2 = 0$; $v = 2.0$ m s^{-1}

$4000 \times 4.5 + m_2 \times 0 = (4000 + m_2) \times 2$

$4000 + m_2 = 4000 \times 4.5/2 = 9000$; $m_2 = 9000 - 4000 = 5000$ kg

Q2

A 2.5 g bullet, moving at 300 m s^{-1} is fired into a 20 kg bale of hay. The bullet embeds in the hay. Calculate the speed of the hay after being hit.

$m_1 = 2.5$ g; $u_1 = 300$ m s^{-1}; $m_2 = 20$ kg; $u_2 = 0$; $v = ?$

$0.0025 \times 300 + 20 \times 0 = (0.0025 + 20) \times v$

$v = (0.0025 \times 300)/(0.0025 + 20) = 0.0375$ m s^{-1}

Q3

A 10 kg child is sitting in a 25 kg shopping trolley when Dad throws a 2.0 kg packet of rice into the trolley at 2.5 m s^{-1}. Calculate the speed of the trolley as it rolls down the aisle.

$m_1 = (10 + 25)$ kg; $u_1 = 0$; $m_2 = 2.0$ kg; $u_2 = 2.5$ m s^{-1}; $v = ?$

$35 \times 0 + 2.5 \times 2.0 = (35 + 2.0) \times v$

$v = (2.5 \times 2.5)/(35 + 2.5) = 0.135$ m s^{-1} (Don't forget to add the 2 kg of rice.)

Q4

A 5.0 kg cart is rolling at 1.25 m s^{-1} when it runs into, and couples with a 2.0 kg cart moving at 0.5 m s^{-1} in the same direction. Calculate the speed at which the carts now move.

$m_1 = 5$ kg; $u_1 = 1.25$ m s^{-1}; $m_2 = 2.0$ kg; $u_2 = 0.5$ m s^{-1}; $v = ?$

$5 \times 1.25 + 2 \times 0.5 = (5 + 2) \times v$

$v = (5 \times 1.25 + 2 \times 0.5)/(5 + 2) = 1.036$ m s^{-1}

Q5

A coal truck of mass 1.5 tonnes carries a load of 7.5 tonnes of coal. It is moving at 0.6 m s^{-1} when it runs into, and couples with a stationary empty truck. The combination moves at 0.54 m s^{-1}. Calculate the mass of the empty truck.

$m_1 = (1.5 + 7.5)$ t; $u_1 = 0.6$ m s^{-1}; $m_2 = ?$; $u_2 = 0$; $v = 0.54$ m s^{-1}

$9 \times 0.6 + m_2 \times 0 = (9 + m_2) \times 0.54$

$9 + m_2 = 9 \times 0.6/0.54 = 10$; $m_2 = 10 - 9 = 1.0$ tonne

Q6

A 450 g toy train engine is moving at 30 cm s^{-1} when it collides, and couples with a 200 g carriage moving at 15 cm s^{-1} in the same direction. Calculate their combined speed.

$m_1 = 0.45$ kg; $u_1 = 0.3$ m s^{-1}; $m_2 = 0.2$ kg; $u_2 = 0.15$ m s^{-1}; $v = ?$

$0.45 \times 0.3 + 0.2 \times 0.15 = (0.45 + 0.2) \times v$

$v = (0.45 \times 0.3 + 0.2 \times 0.15)/(0.45 + 0.2) = 0.254$ m s^{-1} or 25.4 cm s^{-1}

Q7

A 750 kg car moving at 4.0 m s^{-1} collides with a 500 kg car moving in the same direction at 2.0 m s^{-1}. They stick together. Calculate the speed at which they move.

$m_1 = 750$ kg; $u_1 = 4.0$ m s^{-1}; $m_2 = 500$ kg; $u_2 = 2.0$ m s^{-1}; $v = ?$

$750 \times 4 + 500 \times 2 = (750 + 500) \times v$

$v = (750 \times 4 + 500 \times 2)/(750 + 500) = 3.2$ m s^{-1}

Q8

A 500 g toy engine pulls four 300 g carriages. They are moving at 0.3 m s^{-1} when they run into, and couple with, two identical carriages moving at 0.15 m s^{-1} in the same direction. Calculate the speed of the combination.

$m_1 = (0.5 + 4 \times 0.3)$ g; $u_1 = 0.3$ m s^{-1}; $m_2 = (2 \times 0.3)$ kg; $u_2 = 0.15$ m s^{-1}; $v = ?$

$1.7 \times 0.3 + 0.6 \times 0.15 = (1.7 + 0.6) \times v$

$v = (1.7 \times 0.3 + 0.6 \times 0.15)/(1.7 + 0.6) = 0.26$ m s^{-1}

Q9

A 2 tonne truck moving at 16.0 m s^{-1} runs into the back of a 1200 kg car moving at 10 m s^{-1}. At what speed does the truck push the car along?

$m_1 = 2$ t; $u_1 = 16$ m s^{-1}; $m_2 = 1.2$ t; $u_2 = 10$ m s^{-1}; $v = ?$

$2 \times 16 + 1.2 \times 10 = (2 + 1.2) \times v$

$v = (2 \times 16 + 1.2 \times 10)/(2 + 1.2) = 13.75$ m s^{-1}

Q10

A truck moving at 15 m s^{-1} runs into the back of a 750 kg car moving at 8 m s^{-1}. The truck pushes the car at 12 m s^{-1}. Find the mass of the truck.

$m_1 = ?$; $u_1 = 15$ m s^{-1}; $m_2 = 750$ kg; $u_2 = 8$ m s^{-1}; $v = 12.0$ m s^{-1}

$m_1 \times 15 + 750 \times 8 = (m_1 + 750) \times 12$

$12m_1 + 750 \times 12 = 15m_1 + 750 \times 8$

$15m_1 - 12m_1 = 750 \times 12 - 750 \times 8$

$3m_1 = 750 \times 4$; $m_1 = 750 \times 4/3 = 1000$ kg