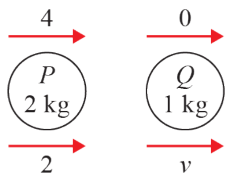
Exercise 6B

1 Conservation of momentum $(\rightarrow)$

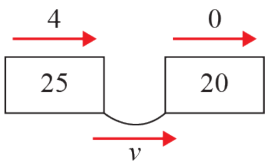
$$(2\times 4)+(1\times 0)=(2\times 2)+(1\times v)$$
$$8=4+v$$
$$4=v$$



The speed of Q after the collision is 4 m s^{-1}

2 Conservation of momentum $(\rightarrow)$

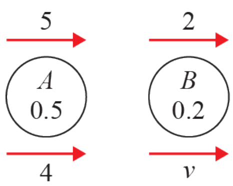
$$(4\times 25)+(20\times 0)=45v$$
$$100=45v$$
$$\frac{20}{9}=v$$



The common speed of the trucks is $\frac{20}{9}$ m s^{-1}

3 Conservation of momentum $(\rightarrow)$

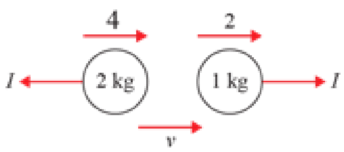
$$(0.5\times 5)+(0.2\times 2)=(0.5\times 4)+(0.2\times v)$$
$$2.5+0.4=2.0+0.2v$$
$$0.9=0.2v$$
$$4.5=v$$



The speed of B after the collision is 4.5 m s^{-1}

4 a Conservation of momentum $(\rightarrow)$

$$(2\times 4)+(1\times 0)=3v$$
$$8=3v$$
$$\frac{8}{3}=v$$



The common speed of the particles after the collision is $\frac{8}{3}$ m s^{-1}

4 b For the 1 kg particle:

$(\rightarrow) I = 1 \times v = \frac{8}{3}$

The magnitude of the impulse in the collision is $\frac{8}{3}$ N s

[Alternatively, for the 2 kg particle:

$(\leftarrow) I = 2(-v - (-4))$

$= 2(-\frac{8}{3} + 4)$

$= 2 \times \frac{4}{3} = \frac{8}{3}$]

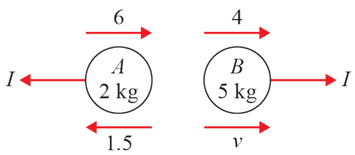
5 a Conservation of momentum $(\rightarrow)$

$(2 \times 6) + (5 \times (-4)) = (2 \times (-1.5)) + 5v$

$12 - 20 = -3 + 5v$

$-5 = 5v$

$v = -1$



The speed of B is 1 m s^{-1} and its direction of motion is unchanged by the collision.

b For A: $(\leftarrow)$ $I = 2(1.5 - (-6))$

$= 2 \times 7.5$

$= 15$

[or for B: $(\rightarrow)$ $I = 5(v - (-4))$

$= 5(-1 + 4)$

$= 15$]

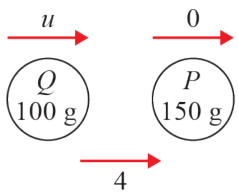
The magnitude of the impulse given to B is 15 N s

6 Conservation of momentum $(\rightarrow)$

$100u + (150 \times 0) = 250 \times 4$

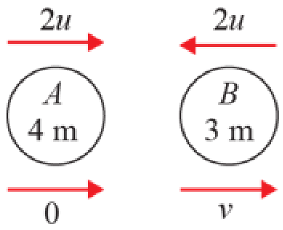
$100u = 1000$

$u = 10$



The value of u is 10.

7 a



Conservation of momentum $(\rightarrow)$

$$(4m \times 2u) + (3m \times (-2u)) = (4m \times 0) + (3m \times v)$$
$$8mu - 6mu = 3mv$$
$$2mu = 3mv$$
$$v = \frac{2u}{3}$$

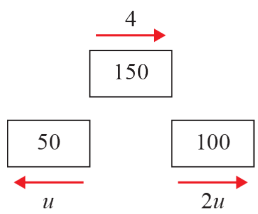
The velocity of B after the collision is $\frac{2u}{3}$ m s^{-1} in the opposite direction.

b For A: $(\leftarrow)$ $I = 4m(0-(-2u))$
$$= 8mu$$

The magnitude of the impulse given by A to B is $8mu$

[or for B: $(\rightarrow)$ $I = 3m(v-(-2u))$
$$= 3m\left(\frac{2u}{3} + 2u\right)$$
$$= 2mu + 6mu = 8mu$$]

8 Conservation of momentum $(\rightarrow)$

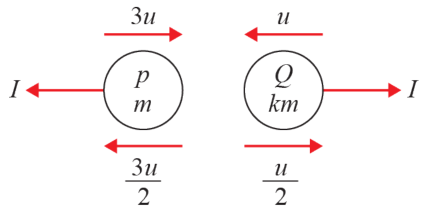


$$(150 \times 4) = (100 \times 2u) + (50 \times (-u))$$
$$600 = 200u - 50u$$
$$600 = 150u$$
$$4 = u$$

The larger has speed 8 m s^{-1} and the smaller part has speed 4 m s^{-1}

9 a Conservation of momentum $(\rightarrow)$

$$(m\times 3u)+(km\times(-u))=\left(m\times\frac{-3u}{2}\right)+\left(km\times\frac{u}{2}\right)$$
$$3mu-kmu=-\frac{3mu}{2}+\frac{kmu}{2}$$
$$6-2k=-3+k$$
$$3=k$$



The value of k is 3.

b For P: $(\leftarrow)$ $I=m\left(\frac{3u}{2}-(-3u)\right)=\frac{9mu}{2}$ [or for Q: $(\rightarrow)$ $I=km\left(\frac{u}{2}-(-u)\right)=3m\times\frac{3u}{2}=\frac{9mu}{2}$]

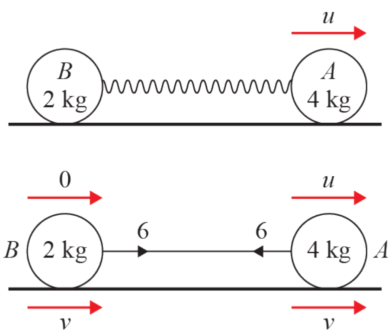
The magnitude of the impulse is $\frac{9mu}{2}$

10 a For $B:(\rightarrow)$

impulse–momentum principle

$6=2(v-0)$
$3=v$

The common speed is 3 m s^{-1}



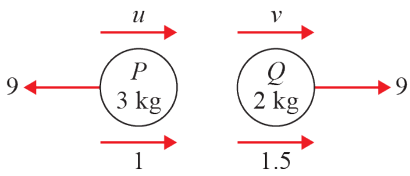
b Conservation of momentum $(\rightarrow)$

$4u=2v+4v=-6\times 3=18$
$u=4.5$

[or impulse–momentum principle for A: $(\rightarrow)$ $-6=4(3-u)$
$-1.5=3-u$
$u=4.5$]

The value of u is 4.5.

11 a For $P : (\leftarrow)$



impulse–momentum principle

$$9 = 3(-1-(-u))$$
$$9 = 3(-1+u)$$
$$3 = -1+u$$
$$4 = u$$

The speed of P before the collision is 4 m s^{-1} and it was moving in the same direction as it was after the collision.

b For $Q : (\rightarrow)$

impulse–momentum principle

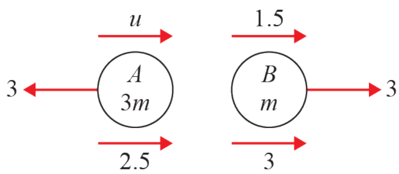
$$9 = 2(1.5 - v)$$
$$9 = 3 - 2v$$
$$2v = -6$$
$$v = -3$$

[or conservation of momentum $(\rightarrow)$

$$3u + 2v = (3\times 1) + (2\times 1.5)$$
$$12 + 2v = 3 + 3 = 6$$
$$2v = -6$$
$$v = -3]$$

The speed of Q before the collision was 3 m s^{-1} and it was moving in the opposite direction to its direction after the collision.

12 a Conservation of momentum $(\rightarrow)$



$$3mu + 1.5m = (3m\times 2.5) + (m\times 3)$$
$$3mu + 1.5m = 7.5m + 3m$$
$$3u = 9$$
$$u = 3$$

The speed of A before the collision is 3 m s^{-1}

12 b Using the impulse–momentum principle:

for $B:(\rightarrow)$

$$3 = m(3-1.5)$$
$$2 = m$$

[or for $A:(\leftarrow)$

$$3 = 3m(-2.5-(-u))$$
$$3 = 3m(-2.5+3)$$
$$1 = 0.5m$$
$$2 = m\,]$$

The mass of A is 6 kg.

Challenge

$P: I = \dfrac{9mu_1}{4}$ $\quad Q: I = \dfrac{3mu_2}{2}$

$\dfrac{9mu_1}{4} = \dfrac{3mu_2}{2}$ gives $u_1 = \dfrac{2u_2}{3}$