Newton's Laws of Motion, Momentum and Impulse

Supplementary Questions

Part 1

1. $p = mv$

$= 6.6 \times 10^{-26} \times 2.0 \times 10^{7}$

$= 1.32 \times 10^{-18}$ kg m/s

2. $p = mv$

$= 9.11 \times 10^{-31} \times 7.5 \times 10^{6}$

$= 6.83 \times 10^{-24}$ kg m/s

3. $F = \frac{\Delta p}{\Delta t}$; $\Delta p = m(v - u)$

$\Delta p = 1400 \times (0 - 20) = (-)\ 28{,}000$ kg m/s

$\therefore \Delta t = \frac{\Delta p}{F} = \frac{28{,}000}{480 \times 10^{3}} =$ 0.0583 seconds

4. $F = \frac{\Delta p}{\Delta t}$; $\Delta p = m(v-u)$

$\Delta p = 3.4 \times 10^{-6} \times (0 - 0.1)$

$= (-)\ 3.4 \times 10^{-7}$ kg m/s

$F = \frac{\Delta p}{\Delta t} = \frac{3.4 \times 10^{-7}}{2.2 \times 10^{-3}}$

$\therefore F = 1.55 \times 10^{-4}$ N

5. $F = \frac{\Delta p}{\Delta t}$; $\Delta p = m(v-u)$

$\Delta p = 50 \times 10^{-3} \times (40 - 0)$

$= 2$ kg m/s

$F = \frac{\Delta p}{\Delta t} = \frac{2}{3 \times 10^{-3}}$

$\therefore F = 667$ N

6. $F = \frac{\Delta p}{\Delta t} = \frac{m\Delta V}{\Delta t}$

$$F = \frac{m}{\Delta t} \cdot \Delta V$$

$$= 900 \times 40 \times 10^{3}$$

$$\therefore F = 3.6 \times 10^{7}\ N$$

7. i) $\Delta p = m(v-u)$

Δp per Second $= 75 \times 550$

$= 41250\ kg\,m/s^{2}$

ii) $F = \Delta p / \Delta t$

$= 41250\ N$

iii) $4 \times 41250 = 1.65 \times 10^{5}\ N$

8. i) $\Delta p = p_2 - p_1$

$= 30 \times 10^3 - 60 \times 10^3$

$= \underline{\underline{-30 \times 10^3 \text{ kg m/s}}}$

ii) $\Delta p = p_2 - p_1$

$= 45 \times 10^3 - 15 \times 10^3$

$= \underline{\underline{30 \times 10^3 \text{ kg m/s}}}$

iii) $p = 60 \times 10^3$ kg m/s

$m = 20 \times 10^3$ kg

$p = mv \Rightarrow v = \frac{p}{m} = \frac{60 \times 10^3}{20 \times 10^3}$

$\therefore \underline{\underline{v = 3 \text{ m/s}}}$

iv) $p = 45 \times 10^3$ kg m/s

$m = 30 \times 10^3$ kg

$p = mv \Rightarrow v = \frac{p}{m} = \frac{45 \times 10^3}{30 \times 10^3}$

$\therefore \underline{\underline{v = 1.5 \text{ m/s}}}$

v) $\Delta t = 1.00 - 0.64 = 0.36$ seconds.

$F = \frac{\Delta p}{\Delta t} = \frac{30 \times 10^3}{0.36} = \underline{\underline{8.33 \times 10^4 \text{ N}}}$

9.* i) $\Delta p = m(v-u)$

$= 4.8\times10^{-26} \times (500 - (-500))$

$= 4.8\times10^{-23}$ kg m/s

ii) $F = \frac{\Delta p}{\Delta t} = 4.8\times10^{-23}$ N for each molecule.

# of Molecules $= \frac{0.1}{4.8\times10^{-23}}$

$= \underline{\underline{2.08\times10^{21}}}$

iii) $A = 1\ mm^2$

$= 1\times10^{-6}\ m^2$

$P = \frac{F}{A} = \frac{0.1}{1\times10^{-6}}$

$\underline{\underline{P = 1.00\times10^{5}\ Pa}}$

Part 2

1. $\Delta p = m(v-u)$; $F = \frac{\Delta p}{\Delta t}$

$\therefore \quad m(v-u) = F \cdot \Delta t$

$\therefore$ Since $u = 0$,

$$v = \frac{F \cdot \Delta t}{m}$$

$$= \frac{75 \times 7.5 \times 10^{-3}}{0.23}$$

$$= \underline{\underline{2.45 \text{ m/s}}}$$

2. i) $\Delta p = F \cdot \Delta t$

$= 75 \times 0.03$

$= \underline{\underline{2.25 \text{ kg m/s}}}$

ii) $\Delta p = m(v-u)$; $u = 0$

$$v = \frac{\Delta p}{m} = \frac{2.25}{0.025} = \underline{\underline{90 \text{ m/s}}}$$

3. $F = \frac{\Delta p}{\Delta t}$

$= \frac{0.028 \times (10 - 0)}{0.035}$

$F = 8N$

4. $F = \frac{\Delta p}{\Delta t} = \frac{m}{\Delta t} . \Delta v$

$F = \frac{300 \times 18 \times 10^{-3}}{60} \times 550$

$\therefore F = 49.5N$

5. $F = \frac{\Delta p}{\Delta t}$

$\therefore F = \frac{60 \times 10^{-3} \times (52 - 0)}{0.065}$

$\therefore F = 48N$

6. i) $\Delta p = m(v-u)$

$= 60 \times 10^{-3} \times (25 - (-20))$

$= \underline{2.7 \text{ kg m/s}}$

ii) $\underline{2.7 \text{ kg m/s}}$

iii) $F = \frac{\Delta p}{\Delta t} = \frac{2.7}{0.09}$

$\therefore \underline{F = 30 \text{ N}}$