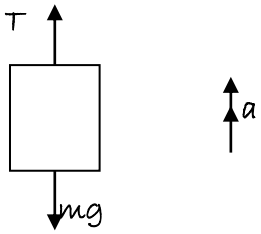
Section 2: Newton's second law

Solutions to Exercise level 3

1. (i) $255 \times \frac{1}{5} = 51$

(ii)



$T - mg = ma = \frac{1}{5}mg$

$T = \frac{6}{5}mg$

so the reading will be multiplied by $\frac{6}{5}$

$255 \times \frac{6}{5} = 306$

2. (i) During descent, it decelerates from 2 ms^{-1} to rest, over 1 metre.

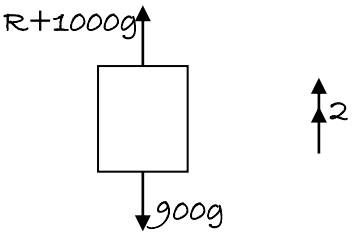
$v^2 = u^2 + 2as$

$0 = 2^2 + 2a \times 1$

$a = -2$

Buoyancy force = 1000g N

Let resistance from flaps = R



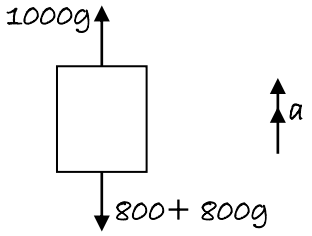
Newton's 2nd law: $900g - R - 1000g = -2 \times 900$

$R = 1800 - 100g$

$R = 800$ N

(ii) Resistance of 800 N now acts downwards, mass is now 800 kg.

Edexcel AS Maths Force Newton's laws 2 Exercise solutions



$1000g - 800g - 800 = 800a$

$1200 = 800a$

$a = 1.5$

For upward travel, $v^2 = u^2 + 2as$

$= 0 + 2 \times 1.5 \times 1$

$v = \sqrt{3}$

$v = u + at$

$\sqrt{3} = 0 + 1.5t$

$t = \dfrac{2\sqrt{3}}{3}$

The time taken is 1.15 s, and its speed when it reaches the surface is 1.73 ms^{-1}.

3. $15.5 \text{ kmh}^{-1} = \dfrac{15500}{3600} = \dfrac{155}{36}$

$30.5 \text{ kmh}^{-1} = \dfrac{30500}{3600} = \dfrac{305}{36}$

$58.5 \text{ kmh}^{-1} = \dfrac{58500}{3600} = \dfrac{585}{36}$

$118.5 \text{ kmh}^{-1} = \dfrac{118500}{3600} = \dfrac{1185}{36}$

(i) For first stage, taking 5 seconds, $v = u + at$

$$\frac{155}{36} = 0 + 5a_1 \quad \Rightarrow a_1 = \frac{31}{36}$$

Newton's 2nd law: $\frac{1}{2}P - R = \frac{31}{36}m$

For second stage, taking 10 seconds, $v = u + at$

$$\frac{305}{36} = \frac{155}{36} + 10a_2 \quad \Rightarrow a_2 = \frac{15}{36}$$

Newton's 2nd law: $\frac{1}{4}P - R = \frac{15}{36}m$

$\Rightarrow \frac{1}{2}P - 2R = \frac{30}{36}m$

Subtracting: $R = \frac{1}{36}m = \frac{1}{36} \times 12000 = 333.3$ N

Edexcel AS Maths Force Newton's laws 2 Exercise solutions

(ii) From above, $\frac{1}{2}P - \frac{1}{36}m = \frac{31}{36}m \quad \Rightarrow P = \frac{64}{36}m$

For 3rd stage, Newton's 2nd law: $\frac{1}{8}P - \frac{1}{36}m = ma_3$

$$\frac{8}{36}m - \frac{1}{36}m = ma_3$$

$$a_3 = \frac{7}{36}$$

$v = u + at$

$$\frac{585}{36} = \frac{305}{36} + \frac{7}{36}t \quad \Rightarrow t = 40$$

For 4th stage, Newton's 2nd law: $\frac{1}{16}P - \frac{1}{36}m = ma_4$

$$\frac{4}{36}m - \frac{1}{36}m = ma_4$$

$$a_4 = \frac{3}{36}$$

$v = u + at$

$$\frac{1185}{36} = \frac{585}{36} + \frac{3}{36}t \quad \Rightarrow t = 200$$

so total time taken = 255 seconds.

(iii) It is unlikely to be constant in practice.