Forces and motion 10C

1 $F = ma$
$120 = 400a$
$a = 0.3$

The acceleration is $0.3\,\text{m s}^{-2}$

2 $W = mg$
$= 4 \times 9.8$
$= 39.2$

The weight of the particle is 39.2 N

3 $F = ma$
$30 = 1.2m$
$m = 25$

The mass of the object is 25 kg.

4 On Earth: W = 735 N, g = 9.8 m s^{-2}, m = ?

$W = mg$
$735 = m \times 9.8$
$m = 735 \div 9.8 = 75$ kg

On the moon: W = 120 N, g = ?, m = 75
$W = mg$
$120 = 75 \times g$
$g = 120 \div 75 = 1.6$

On the Moon, the acceleration due to gravity is 1.6 m s^{-2}.

5 Always resolve in the direction of acceleration.

a $R(\uparrow)$, $P - 2g = 2 \times 3$
$P = 25.6$

The magnitude of P is 25.6 N

b $R(\downarrow)$, $4g + 10 - P = 4 \times 2$
$49.2 - P = 8$
$P = 41.2$

The magnitude of P is 41.2 N

6 a $R(\downarrow)$, $mg - 10 = m \times 5$

$9.8m - 10 = 5m$

$m = 2.1 \quad (2\text{ s.f.})$

The mass of the body is 2.1 kg

b $R(\uparrow)$, $20 - mg = m \times 2$

$20 - 9.8m = 2m$

$m = 1.7 \quad (2\text{ s.f.})$

The mass of the body is 1.7 kg

7 a $R(\downarrow)$, $2g - 8 = 2a$

$5.8 = a$

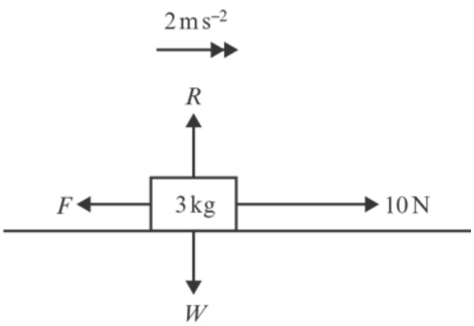
The acceleration of the body is 5.8 m s^{-2}

b $R(\uparrow)$, $100 - 8g = 8a$

$2.7 = a$

The acceleration of the body is 2.7 m s^{-2}

8 W and R can be ignored, as they act at right angles to the motion.



Resultant force = ma

$m = 3$ kg, $a = 2\text{ ms}^{-2}$

$R(\rightarrow)$, $10 - F = 3 \times 2 = 6$

$F = 10 - 6$

The force due to friction is 4 N.

9 a $u = 0,\ v = 3,\ s = 5,\ a = ?$

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

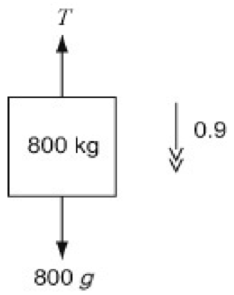
$3^2 = 0^2 + 2a \times 5$

$9 = 10a$

$a = 0.9$

The acceleration of the lift is 0.9 m s^{-2}

9 b



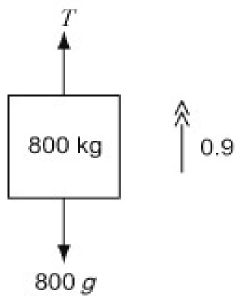
$R(\downarrow)$, $800g - T = 800 \times 0.9$

$7840 - T = 720$

$T = 7120$

The tension in the cable is 7120 N.

c



$R(\uparrow)$, $T - 800g = 800 \times 0.9$

$T - 7840 = 720$

$T = 8560$

The tension in the cable is 8560 N.

10 a $u = 0,\ v = 1,\ t = 2,\ a = ?$

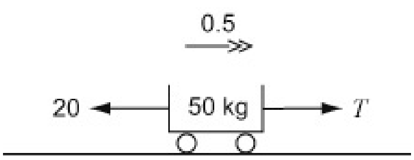
$v = u + at$

$1 = 0 + a \times 2$

$a = 0.5$

The acceleration of the trolley is $0.5\,\text{m}\,\text{s}^{-2}$

b

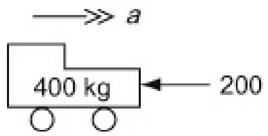


$R(\rightarrow)$, $T - 20 = 50 \times 0.5$

$T = 45$

The tension in the rope is 45 N.

11 a



$R(\rightarrow)$, $\quad -200 = 400a$

$a = -0.5$

$u = 16,\ v = 0,\ a = -0.5,\ t = ?$

$v = u + at \quad (\rightarrow)$

$0 = 16 - 0.5t$

$0.5t = 16$

$t = 32$

It takes 32 s for the van to stop.

b $u = 16,\ v = 0,\ a = -0.5,\ s = ?$

$v^2 = u^2 + 2as \quad (\rightarrow)$

$0^2 = 16^2 + 2(-0.5)s$

$0 = 256 - s$

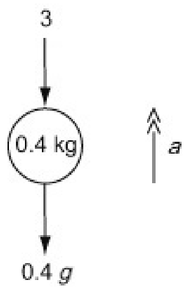
$s = 256$

The van travels 256 m before it stops.

c Air resistance is unlikely to be of constant magnitude. (It is usually a function of speed.)

Challenge

a



$R(\uparrow)$, $\quad -3 - 0.4g = 0.4a$

$a = -17.3$

$u = 10,\ v = 0,\ a = -17.3,\ s = ?$

$v^2 = u^2 + 2as \quad (\uparrow)$

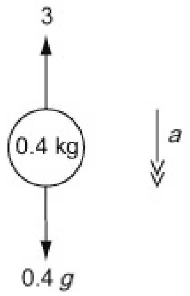
$0 = 10^2 + 2(-17.3)s$

$0 = 100 - 34.6s$

$s = 2.89\ldots = 2.9 \quad (2\text{ s.f.})$

The stone rises to a height of 2.9 m above the bottom of the pond.

b



$R(\downarrow),\quad 0.4g-3=0.4a$
$0.92=0.4a$
$a=2.3$

$u=0,\ s=\frac{100}{34.6},\ a=2.3,\ v=?$
$v^2=u^2+2as\quad(\downarrow)$
$v^2=0^2+2\times2.3\times\frac{100}{34.6}$
$v=3.646..=3.6\quad(2\text{ s.f.})$

The stone hits the bottom of the pond with speed $3.6\,\text{m}\,\text{s}^{-1}$

c $u=10,\ v=0,\ a=-17.3,\ t=?$
$v=u+at\quad(\uparrow)$
$0=10-17.3t,$
$t_1=\frac{10}{17.3}=0.57803\ldots$

$u=0,\ a=2.3,\ s=\frac{100}{34.6},\ t=?$
$s=ut+\frac{1}{2}at^2\quad(\downarrow)$
$\frac{100}{34.6}=0+\frac{1}{2}\times2.3t_2^2$
$t_2^2=\dfrac{2\times100}{2.3\times34.6}=2.51319$
$t_2=1.585$

$t_1+t_2=0.57803+1.585=2.16$

The total time is 2.16 s (3 s.f.)