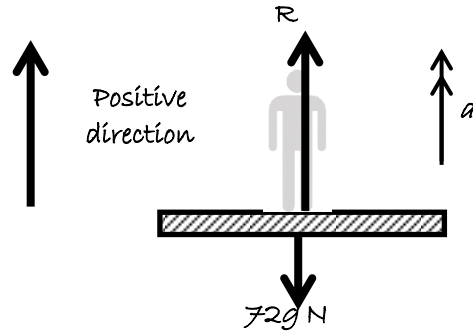


Section 3: Connected objects

Solutions to Exercise level 1

1. (i)



$$\begin{aligned} \text{(ii)} \quad R - 72g &= 72a \\ R - 72g &= 72 \times 0 \\ R &= 72g = 705.6 \text{ N} \end{aligned}$$

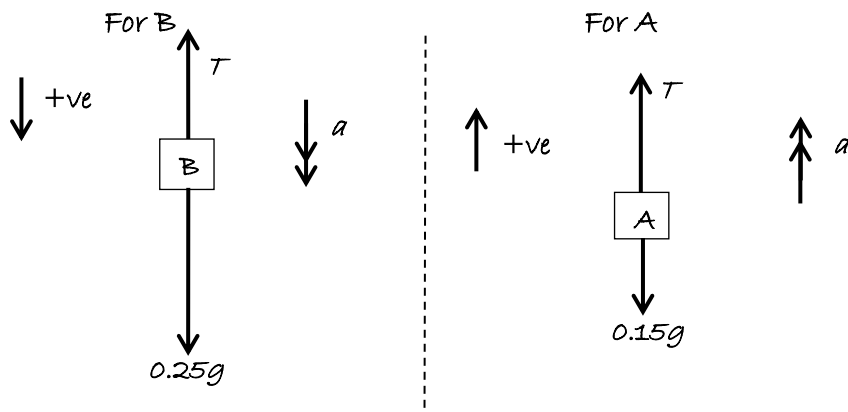
$$\begin{aligned} \text{(iii)} \quad R - 72g &= 72 \times 2 \\ R &= 144 + 72g = 849.6 \text{ N} \end{aligned}$$

$$\begin{aligned} \text{(iv)} \quad R - 72g &= 72 \times -3 \\ R &= -216 + 72g = 489.6 \text{ N} \end{aligned}$$

$$\begin{aligned} \text{(v)} \quad R - 72g &= 72 \times -2 \\ R &= -144 + 72g = 561.6 \text{ N} \end{aligned}$$

$$\begin{aligned} \text{(vi)} \quad \text{using downwards as the positive direction:} \\ 72g - R &= 72 \times -3 \\ R &= 72g + 216 = 921.6 \text{ N} \end{aligned}$$

2. (i)



$$\begin{aligned} \text{(ii)} \quad \text{For A: } T - 0.15g &= 0.15a \quad (1) \\ \text{For B: } 0.25g - T &= 0.25a \quad (2) \end{aligned}$$

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Exercise solns

(iii) (1) + (2): $0.1g = 0.4a$

$$a = 0.25g = 2.45 \text{ m s}^{-2}$$

(iv) Putting $a = 0.25g$ in (1):

$$T - 0.15g = 0.15 \times 0.25g$$

$$T = 0.15g + 0.0375g$$

$$T = 1.84 \text{ N (3 s.f.)}$$

(v) $s = 1$

$$u = 0$$

$$a = 2.45$$

$$t = ?$$

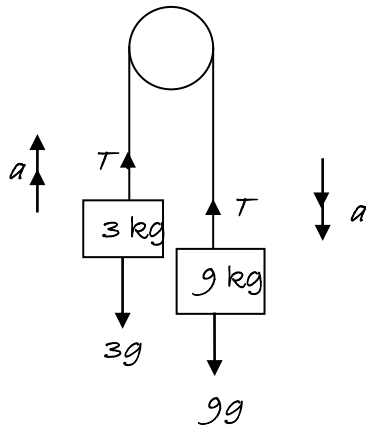
$$s = ut + \frac{1}{2}at^2$$

$$1 = 0 + \frac{1}{2} \times 2.45t^2$$

$$1 = 1.225t^2$$

$$t = 0.904 \text{ s (3 s.f.)}$$

3.



Considering 3 kg mass: $T - 3g = 3a$ (1)

Considering 9 kg mass: $9g - T = 9a$ (2)

Adding: $6g = 12a$

$$a = \frac{1}{2} \times 9.8 = 4.9$$

The acceleration of the system is 4.9 ms^{-2} .

(1) gives $T = 3g + 3a$

$$= 3(9.8 + 4.9)$$

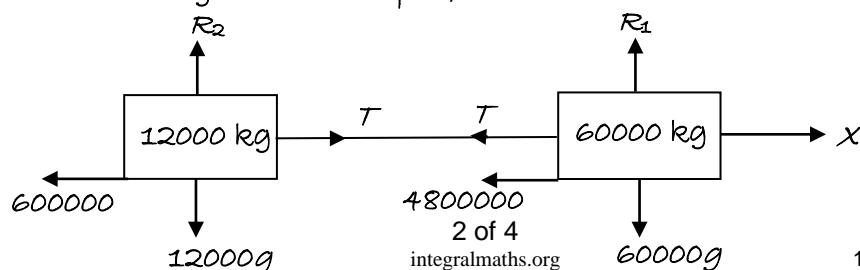
$$= 44.1$$

The tension in the string is 44.1 N.

4. Resistance experienced by engine = $60000 \times 80 = 4800000$

Resistance experienced by truck = $12000 \times 50 = 600000$

Train is travelling at constant speed, so acceleration is zero.



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Considering whole system: $X - 4800000 - 600000 = 0$

$$X = 5400000$$

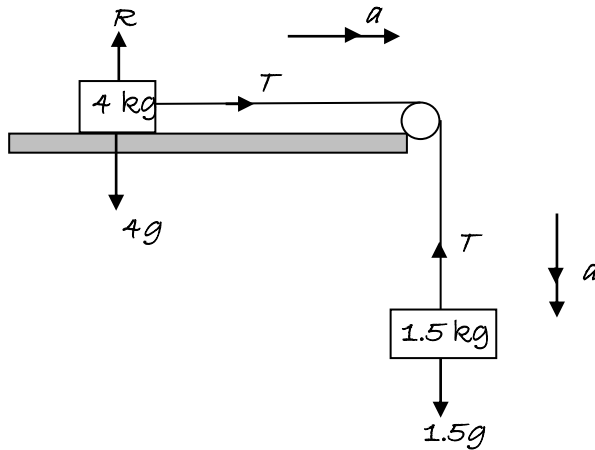
The driving force of the engine = 5400 kN.

Considering truck: $T - 600000 = 0$

$$T = 600000$$

The tension in the coupling = 600 kN.

5.



For the 4 kg mass: $T = 4a$ (1)

For the 1.5 kg mass: $1.5g - T = 1.5a$ (2)

Adding: $1.5g = 5.5a$

$$a = \frac{1.5 \times 9.8}{5.5} = 2.67$$

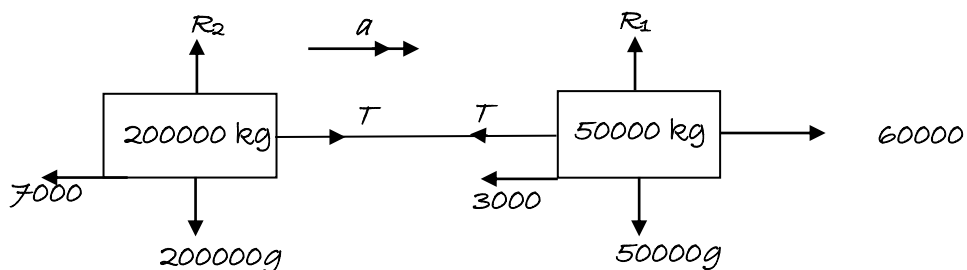
The acceleration of the system is 2.67 ms^{-2} (3 s.f.)

Substituting into (1): $T = 4a$

$$T = 4 \times \frac{1.5 \times 9.8}{5.5} = 10.7$$

The tension in the string is 10.7 N (3 s.f.)

6.



Considering the whole system: $60000 - 3000 - 7000 = 250000a$

$$50000 = 250000a$$

$$a = 0.2$$

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Exercise solns

The acceleration of the system is 0.2 ms^{-2} .

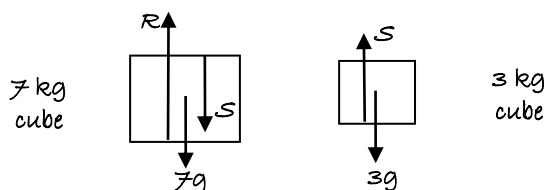
Considering the truck: $T - 7000 = 200000 \times 0.2$

$$T - 7000 = 40000$$

$$T = 47000$$

The tension in the coupling is 47000 N .

7. R is the reaction between the 7 kg cube and the table, and S is the reaction between the two cubes.



For the 3 kg cube: $S - 3g = 0$

$$S = 3g = 29.4$$

For the 7 kg cube: $R - S - 7g = 0$

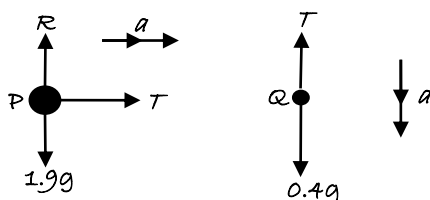
$$R = 3g + 7g = 10g$$

$$R = 98$$

The reaction between the two cubes is 29.4 N

The reaction between the larger cube and the table is 98 N

8.



For Q: $0.4g - T = 0.4a$ (1)

For P: $T = 1.9a$ (2)

Substituting (2) into (1): $0.4g - 1.9a = 0.4a$

$$0.4g = 2.3a$$

$$a = \frac{0.4 \times 9.8}{2.3} = 1.70 \text{ (3 s.f.)}$$

From (2): $T = 1.9 \times \frac{0.4 \times 9.8}{2.3} = 3.24 \text{ (3 s.f.)}$

The acceleration is 1.70 ms^{-2} and the tension in the string is 3.24 N .