

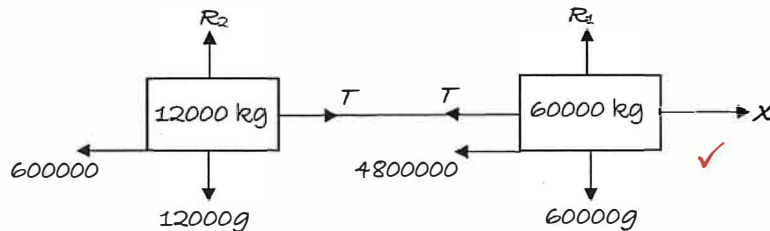
Mechanics 6 – Connected Particles

Section 1

- (a) $\mathbf{v} = 6\mathbf{i} - 8\mathbf{j}$ (b) $\mathbf{v} = -12\mathbf{i} + 9\mathbf{j}$ (c) $\mathbf{v} = -4.5\mathbf{i} + 6\mathbf{j}$ (d) $\mathbf{v} = 5\mathbf{i} + 5\mathbf{j}$
 (e) $\mathbf{v} = -4\mathbf{i} + 6\mathbf{j}$ (f) $\mathbf{v} = 3\sqrt{2}\mathbf{i} - 5\sqrt{2}\mathbf{j}$ (g) $\mathbf{v} = -4\sqrt{3}\mathbf{i} - 2\sqrt{3}\mathbf{j}$ (h) $\mathbf{v} = -3\sqrt{5}\mathbf{i} + 6\sqrt{5}\mathbf{j}$

Section 2

1. 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.



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

$$X = 5400000 \quad \checkmark$$

The driving force of the engine = 5400 kN.

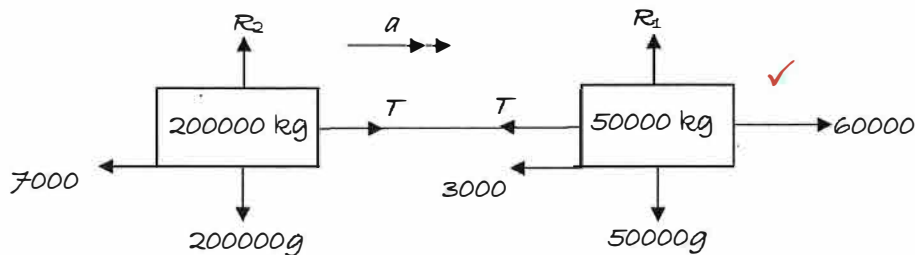
Considering truck: $T - 600000 = 0$ ✓

$$T = 600000 \quad \checkmark$$

The tension in the coupling = 600 kN.

(7 marks)

2.



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

$$50000 = 250000a \quad \checkmark$$

$$a = 0.2$$

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 marks)

3. (i) Consider A, B and the pan as one particle; $T - (0.8 + 0.3)g = (0.8 + 0.3) \times 1.5$ ✓

$$\Rightarrow T = 1.1g + 1.65 = 12.4 \text{ N (3 s.f.)}$$
 ✓

(ii) Consider particle A only; $R - 0.3g = 0.3 \times 1.5$ ✓

$$\Rightarrow R = 0.3g + 0.45 = 3.39 \text{ N}$$
 ✓

(iii) Consider A and B as a single particle; $R - 1.1g = 1.1 \times 1.5$ ✓

$$\Rightarrow R = 1.1g + 1.65 = 12.4 \text{ N (3 s.f.)}$$
 ✓

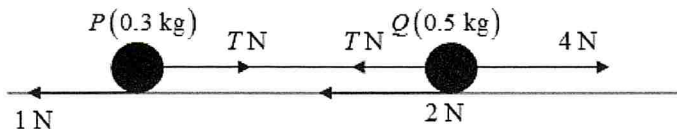
(9 marks)

4.		
(a) Car + trailer:	$2100a = 2380 - 280 - 630$ $= 1470 \Rightarrow a = \underline{0.7 \text{ m s}^{-2}}$	M1 A1 A1 (3)
(b) e.g. trailer:	$700 \times 0.7 = T - 280$ $\Rightarrow T = \underline{770 \text{ N}}$	M1 A1 ✓ A1 (3)
(c) Car:	$1400a' = 2380 - 630$ $\Rightarrow a' = 1.25 \text{ m s}^{-2}$ $\text{distance} = 12 \times 4 + \frac{1}{2} \times 1.25 \times 4^2$ $= \underline{58 \text{ m}}$	M1 A1 ↓ A1 M1 A1 ✓ A1 (6)
(d) Same acceleration for car and trailer		B1 (1)
		13 marks

(Total 36 marks)

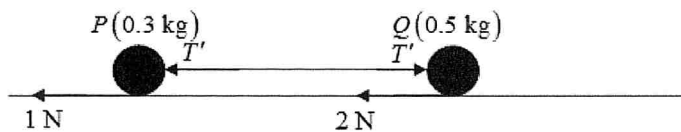
Section 3

(a)	For system, $(\uparrow), T - 950g - 50g = 1000 \times -2$ $T = 7800 \text{ N}$	M1 A1 A1 (3)
(b)	For woman, $(\uparrow), R - 50g = 50 \times -2$ $R = 390 \text{ N}$	M1 A1 A1 (3) [6]



(a)	For system N2L $4 - 3 = 0.8a$ $a = 1.25 \text{ (m s}^{-2}\text{)}, 1.3$	M1 A1 A1 (3)
(b)	$v = u + at \Rightarrow v = 0 + 1.25 \times 6 = 7.5 \text{ (m s}^{-1}\text{)}$	M1 A1 (2)
(c)	For P N2L $T - 1 = 0.3 \times 1.25$ $T = 1.375 \text{ (N)}, 1.38, 1.4$	fit their a M1 A1ft A1 (3)

OR For Q N2L $4 - 2 - T = 0.5 \times 1.25$



(d)	For system N2L $-3 = 0.8a \Rightarrow a = -3.75$ $v^2 = u^2 + 2as \Rightarrow 0^2 = 7.5^2 - 2 \times 3.75s$ $s = 7.5 \text{ (m)}$	M1 A1 M1 A1 (4)
(e)	For P N2L $T' + 1 = 0.3 \times 3.75$ $T' = 0.125 \text{ (N)}, 0.13$	M1 A1 A1 (3) [15]