Godalming College

Mechanics 7 – Connected Particles

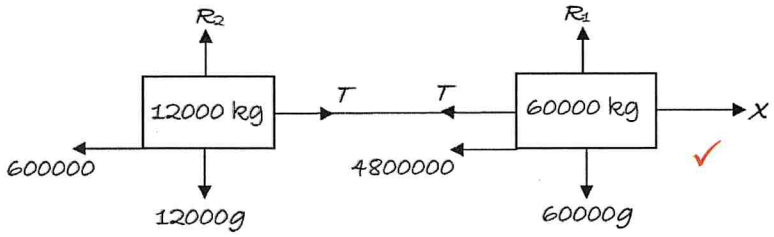
Section 1

(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: $X - 4800000 - 600000 = 0$ ✓

$X = 5400000$ ✓

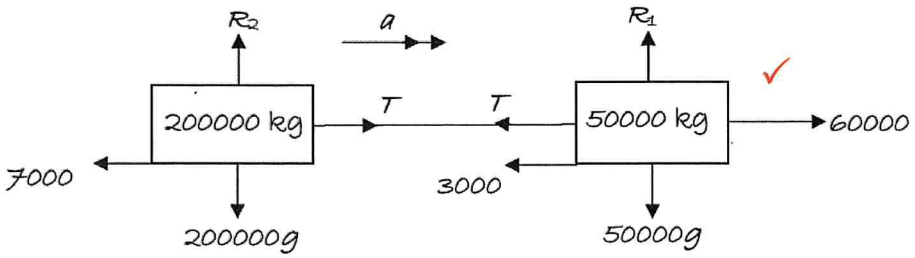
The driving force of the engine = 5400 kN.

Considering truck: $T - 600000 = 0$ ✓

$T = 600000$

The tension in the coupling = 600 kN. ✓ (7 marks)

2.



✓

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

$50000 = 250000a$ ✓

$a = 0.2$

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; $T - (0.8 + 0.3)g = (0.8 + 0.3) \times 1.5$ ✓ ✓

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

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

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

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

$\Rightarrow R = 1.1g + 1.65 = 12.4$ N (3 s.f.) ✓ (9 marks)

4.

(a) Car + trailer: $2100a = 2380 - 280 - 630$ M1 A1

$= 1470 \Rightarrow a = \underline{0.7 \text{ m s}^{-2}}$ A1 (3)

(b) e.g. trailer: $700 \times 0.7 = T - 280$ M1 A1√

$\Rightarrow T = \underline{770 \text{ N}}$ A1 (3)

(c) Car: $1400a' = 2380 - 630$ M1 A1

$\Rightarrow a' = 1.25 \text{ m s}^{-2}$ A1

distance = $12 \times 4 + \frac{1}{2} \times 1.25 \times 4^2$ M1 A1√

$= \underline{58 \text{ m}}$ A1 (6)

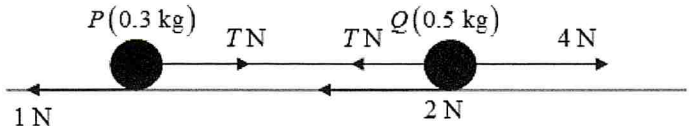
(d) Same acceleration for car and trailer B1 (1)

13 marks

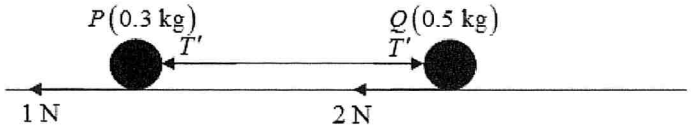
(Total 36 marks)

Section 3

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



(a) For system N2L	$4 - 3 = 0.8a$ $a = 1.25\ (\text{m s}^{-2})$, 1.3	M1 A1 A1 **(3)**
(b)	$v = u + at \Rightarrow v = 0 + 1.25 \times 6 = 7.5\ (\text{m s}^{-1})$	M1 A1 **(2)**
(c) For P N2L	$T - 1 = 0.3 \times 1.25$ $T = 1.375\ (\text{N})$ 1.38, 1.4	ft their a M1 A1ft A1 **(3)**
OR For Q N2L	4 - 2 – T = 0.5 x 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]**