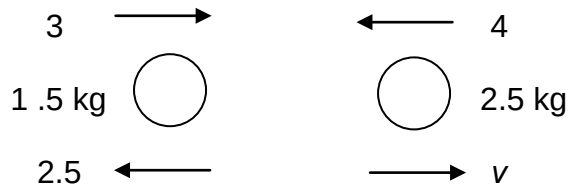
Final Mark scheme

January 2005

6677 Mechanics M1

Mark Scheme

Question Number	Scheme	Marks
1		
	(a) CLM: $1.5 \times 3 - 2.5 \times 4 = -1.5 \times 2.5 + 2.5 \times v$	M1 A1
	$\Rightarrow v = \underline{-0.7 \text{ m s}^{-1}}$ $\underline{\text{so speed} = 0.7 \text{ m s}^{-1}}$	A1 (3)
	(b) Direction of Q unchanged	A1√ (1)
	(c) Impulse = 1.5 (3 + 2.5)	M1
	= $\underline{8.25, \text{Ns}}$	A1, B1 (3)

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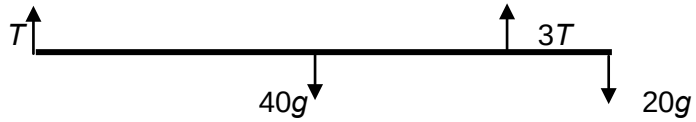
2		
	(a) R(↑): $T + 3T = 40g + 20g$	M1
	$T = 15g$, so tension at C is 45g or 441 N or 440 N	A1 (2)
	(b) M(B) $15g \times 3 + 45g \times d = 40g \times 1.5$	M1 A2,1,0√ ↓
	Solve: d = 1/3 or 0.33 or 0.333 m	M1 A1 (5)

Question Number	Scheme	Marks
3	(a) Distance = ½ x 4 x 9 + 16 x 9 **or** ½ (20 + 16) x 9	M1
	= <u>162 m</u>	A1 (2)
	(b) Distance over last 5 s = ½(9 + u) x 5	M1
	162 + ½(9 + u) x 5 = 200	M1 A1√
	$\Rightarrow u$ = <u>6.2 m s^{-1}</u>	A1 (4)
	(c) 6.2 = 9 + 5a	M1 A1√
	a = (–) <u>0.56 m s^{-2}</u>	A1 (3)

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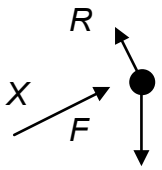
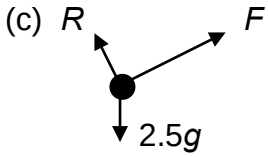
4	 (a) $R = 2.5g \cos 20$	M1
	$\approx$ <u>23.0 or 23 N</u>	A1 (2)
	(b) $X = 0.4 \times 23.0 + 2.5g \sin 20$	M1 A2,1,0√
	$\approx$ <u>17.6 or 18 N</u>	A1 (4)
	(c)  In equlib. $F = 2.5g \sin 20 \approx 8.38$ or 8.4 N	B1
	$\mu R = 0.4 \times 2.5g \cos 20 \approx 9.21$ or 9.2 N	B1
	$8.4 < 9.2$ (using '$F < \mu R$' **not** $F = \mu R$)	M1
	Since $F < \mu R$ remains in equilibrium (cso)	A1 (4)

Question Number	Scheme	Marks
5	(a) '$s = ut + \frac{1}{2}at^2$' for B: $0.4 = \frac{1}{2}a(0.5)^2$	M1 A1
	$a = \underline{3.2 \text{ m s}^{-2}}$	A1 (3)
	(b) N2L for B: $0.8g - T = 0.8 \times 3.2$	M1 A1√ ↓
	$T = \underline{5.28 \text{ or } 5.3 \text{ N}}$	M1 A1 (4)
	(c) A: $F = \mu \times 0.5g$	B1
	N2L for A: $T - F = 0.5a$	M1 A1 ↓
	Sub and solve $\mu = \underline{0.75 \text{ or } 0.751}$	M1 A1 (5)
	(d) Same acceleration for A and B.	B1 (1)

Question Number	Scheme	Marks
6	(a) $16^2 = 20^2 - 2 \times a \times 24 \Rightarrow a = \underline{3 \text{ m s}^{-2}}$	M1 A1 (2)
	(b) $v^2 = 20^2 - 2 \times 3 \times 30$	M1 A1√
	$v = \underline{\sqrt{220} \text{ or } 14.8 \text{ m s}^{-1}}$	A1 (3)
	(c) $0.3 = m \times 3 \Rightarrow m = 0.1$ kg (*)	M1 A1 (2)
	(d) $0.1(w + \sqrt{220}) = 2.4$	M1 A1√
	$w = 9.17$	A1
	↓	
	$0 = 9{,}17 - 3 \times t$	M1 A1√
	$t \approx \underline{3.06 \text{ s}}$	A1 (6)

Question Number	Scheme	Marks
7	(a) $\mathbf{v}_P = \{(29\mathbf{i} + 34\mathbf{j}) - (20\mathbf{i} + 10\mathbf{j})\}/3 = \underline{(3\mathbf{i} + 8\mathbf{j}) \text{ km h}^{-1}}$	M1 A1 (2)
	(b) $\mathbf{p} = (20\mathbf{i} + 10\mathbf{j}) + (3\mathbf{i} + 8\mathbf{j})t$	M1 A1√
	$\mathbf{q} = (14\mathbf{i} - 6\mathbf{j}) + 12t\mathbf{j}$	M1 A1 (4)
	(c) $\mathbf{q} - \mathbf{p} = (-6 - 3t)\mathbf{i} + (-16 + 4t)\mathbf{j}$	M1 A1
	$d^2 = (-6 - 3t)^2 + (-16 + 4t)^2$	↓ M1
	$= 36 + 36t + 9t^2 + 16t^2 - 128t + 256$	↓ M1
	$= 25t^2 - 92t + 292$ (*)	A1 (cso) (5)
	(d) $25t^2 - 92t + 292 = 225$	M1
	$25t^2 - 92t + 67 = 0$	A1
	$(t - 1)(25t - 67) = 0$	↓ M1
	$t = 67/25$ or 2.68	A1
	time ≈ 161 mins, or 2 hrs 41 mins, or 2.41 am, or 0241	A1 (5)