Momentum 1 MS

Q1.

7(a)	$0.3g\sin 30 = 0.3a$ $(a = 5)$ (**M1** for applying Newton's second law parallel to the plane)	**M1**
	$v^2 = 0 + 2 \times 2.5 \times a$	**M1**
	$v = 5$	**A1**
	$0.3 \times 5 + 0 = 0.3 \times 2 + 0.2w$	**M1**
	Velocity of $Q = 4.5$ ms^{-1}	**A1**
		5

7(b)	$0.3 \times z + 0 = 0.5 \times 1.2$	**M1**
	Velocity of P before collision $z = 2$	**A1**
	Friction force on P after reaches horizontal plane $F = \mu \times 0.3g$	**B1**
	$\mu \times 0.3g \times 1.5 = \frac{1}{2} \times 0.3 \times 5^2 - \frac{1}{2} \times 0.3 \times 2^2$	**M1**
	Coefficient $\mu = 0.7$	**A1**
	Alternative method for question 7(b)	
	$0.3 \times z + 0 = 0.5 \times 1.2$	**M1**
	Velocity of P before collision $z = 2$	**A1**
	Friction force on P after reaches horizontal plane $F = \mu \times 0.3g$	**B1**
	$a = (5^2 - 2^2) / (2 \times 1.5) = 7$, $F = 0.3 \times 7$	**M1**
	Coefficient $\mu = 0.7$	**A1**
		5

Q2.

4(a)	$4 \times 10\ [+0] = 4 \times 0.5v + 2v$	**M1**
	$v_A = 5$ and $v_B = 10$	**A1**
		2
4(b)	Conservation of momentum B, C $2 \times 10\ [+0] = 2 \times v + 3v$	**M1**
	$v = 4$	**A1**
	$v_A > v_B$, hence another collision	**A1**
		3
4(c)	Conservation of momentum A, B	**M1**
	$4 \times their5 + 2 \times their4 = 4v + 2v \qquad v = \frac{14}{3}$ (ms^{-1})	**A1**
	KE initial $= \frac{1}{2} \times 4 \times 10^2$	**M1**
	KE final $= \frac{1}{2} \times 6 \times their(\frac{14}{3})^2 + \frac{1}{2} \times 1 \times their12^2$	**A1**
	Loss of KE $= 200 - \frac{412}{3} = \frac{188}{3}$	**A1**
		5

Momentum 1 MS

Q3.

1	Use of conservation of momentum	**M1**
	$m \times 2 + 0 = m \times (-0.5) + 0.2 \times 1$	**A1**
	$m = 0.08$	**A1**
		3

Q4.

1(a)	$6 \times 2.5 = 2.5v + 5v$	**M1**	Apply conservation of momentum, 3 terms implied
	$v = 2$ ms^{-1}	**A1**	
		2	
1(b)	Use KE = ½ mv^2 either before or after collision	**M1**	Allow this for either particle
	KE(before) = $0.5 \times 2.5 \times 6^2$ KE(after) = $0.5 \times 7.5 \times 2^2$	**A1 FT**	Both correct FT on v
	Loss of KE = 30 J	**A1**	
		3	

Q5.

1(a)	Momentum = $0.2 \times 2 = 0.4$ kg ms^{-1}	**B1**	
		1	
1(b)	$0.4 = 0.2 \times 0.3 + 0.5v$	**M1**	Apply conservation of momentum, 3 terms
	$v = 0.68$ ms^{-1}	**A1 FT**	FT on answer in **1(a)**
		2	

Q6.

4	For using conservation of momentum (either case)	**M1**	
	$6 \times 4 = 3m + 4 \times 1.5$ **or** $6 \times 4 = 3m - 4 \times 1.5$	**A1**	
	$m = 6$ **and** $m = 10$	**A1**	
	KE_A initial = ½ $\times 4 \times 6^2$ (72 J) or KE_A after = ½ $\times 4 \times 1.5^2$ (4.5 J) or KE_B after = ½ $\times 6 \times 3^2$ (27 J) or KE_B after = ½ $\times 10 \times 3^2$ (45 J)	**B1 FT**	KE = ½ $\times m \times v^2$ FT 4.5m for KE_B
	KE loss = [½ $\times 4 \times 6^2$ – ½ $\times 4 \times 1.5^2$ – ½ $\times 6 \times 3^2$] or [½ $\times 4 \times 6^2$ – ½ $\times 4 \times 1.5^2$ – ½ $\times 10 \times 3^2$]	**M1**	Uses KE loss = KE before – KE after
	Loss of KE = 40.5 J or 22.5 J	**A1**	
		6	

Momentum 1 MS

Q7.

1	$\pm 0.2 \times 0.5$ or $\pm 0.3 \times 1$	**B1**	For initial momentum for either particle. Allow kg or g.
	$0.2 \times 0.5 + 0.3 \times (-1) = 0.2 \times v + 0$	**M1**	For conservation of momentum. Dimensions correct. Allow if 3 relevant momentum terms are seen regardless of sign.
	Speed = 1 m s^{-1}	**A1**	Allow if final answer given as $v = 1$ or speed = 1 from an equation whose solution is $v = -1$
		3	

Q8.

3(a)	Use of conservation of momentum, 3 terms	**M1**	Correct dimensions
	$0.1\times5+0=0.1\times(-1)+0.2\times(\pm v)$	**A1**	
	$v = 3$ m s^{-1}	**A1**	A0 for $v = -3$
		3	
3(b)	$0.2\times \textit{their}\, 3+0=0.2\times u+0.5V$	**M1**	Use of conservation of momentum, 3 terms, correct dimensions. Allow $u = 0$ used or if Q and R coalesce
	$u \geqslant -1$	**B1**	Allow $u = -1$. Allow equality for finding greatest value of V. Condition for no collision with P, may be a statement.
	Greatest $V = 1.6$	**A1 FT**	FT on *their* 3 from **3(a)** if $u = -1$ used.
		3	

Q9.

6	$s_A = \pm\left(30t - 5t^2\right)$ or $s_B = \pm 5t^2$	**B1**	Use of constant acceleration equations to find expressions for displacements of A or B.
	$s_A + s_B = 15$ leading to $15 = 30t$ leading to $t = 0.5$	**B1**	Use $s_A + s_B = 15$ to find time at which particles collide.
	$t = 0.5$ leading to $v_A = \pm 25$ and $v_B = \pm 5$	**B1**	Find speed of particles at $t = 0.5$ before collision.
	$t = 0.5$ leading to $h_A = \pm\left(30\times0.5-\frac{1}{2}g\times0.5^2\right) = \pm 13.75$	**B1**	Find position of A or B at which collision occurs at $t = 0.5$ Alternatively allow $h_B = \pm 1.25$ as displacement of B
	$25\times(2m)-5(m)=(3m)v \rightarrow v_1 = 15$ $25(m)-5\times(2m)=(3m)v \rightarrow v_2 = 5$	**M1**	Use of conservation of momentum, either case, using *their* v_A and $v_B \neq 0$ or 30, with 3 terms.
		A1	Both values of v correct

Momentum 1 MS

6	Particle C_1 $-13.75 = 15t - 5t^2$ Particle C_2 $-13.75 = 5t - 5t^2$	**M1**	Use of $s = ut + \frac{1}{2}at^2$ OE to find t, using either *their* numerical v_1 or numerical v_2 from a relevant conservation of momentum equation.
	$t_{C_1}, t_{C_2} = 3.74, 2.23$ leading to $T = 1 + \sqrt{5} - \sqrt{3} = 1.50$	**A1**	Find $T = t_{C_1} - t_{C_2}$ from $t_{C_1} = 3.736$ and $t_{C_2} = 2.232$
		8	Subscripts 1 and 2 refer to the two cases.
	Alternative method for the final two marks		
	$0 = 15 - gt_1$, $0 = 5 - gt_2 \rightarrow t_1 = 1.5$, $t_2 = 0.5$ Total heights $h_1 = 13.75 + 11.25 = 25$ Or $h_2 = 13.75 + 1.25 = 15$ $25 = 5T_1^2$ and $15 = 5T_2^2 \rightarrow T_1 = \sqrt{5}$, $T_2 = \sqrt{3}$	**M1**	Use of $v = u - gt$ to find time to highest point for either case and use of $v^2 = u^2 - 2gs$ to find total height reached for either case, using either *their* numerical v_1 or numerical v_2 from a relevant conservation of momentum equation. Use $s = 0 + \frac{1}{2}gT^2$ to find time to reach ground (either case).
	$T = 1.5 + \sqrt{5} - (0.5 + \sqrt{3}) = 1 + \sqrt{5} - \sqrt{3} = 1.50$	**A1**	Find difference in total times $T = (t_1 + T_1) - (t_2 + T_2)$

Q10.

1	$0.4 \times 2.5 - 0.5 \times 1.5$	**M1**	Attempt momentum before impact.
	$0.4 \times 2.5 - 0.5 \times 1.5 = 0.4v + 0.5 \times 2v$	**M1**	Use of conservation of momentum, either case.
	$0.4 \times 2.5 - 0.5 \times 1.5 = 0.4v + 0.5 \times 2v$ or $0.4 \times 2.5 - 0.5 \times 1.5 = -0.4v + 0.5 \times 2v$	**A1**	One correct equation
	Speed is $0.179\ \text{m s}^{-1}$ or $0.417\ \text{m s}^{-1}$	**A1**	Both values
		4	