Question number		Scheme	Marks
1.	(*a*)	Use of $(8 + \lambda)m$	B1
		i: $3m \times 4 + \lambda m \times 4 = (8 + \lambda)m \times 2$	M1
		$\qquad$ Solving to $\lambda = 2$ $\qquad\qquad$ (*)	M1 A1 $\qquad$ (4)
		j: $5m \times (-3) + 2m \times 2 = 10m \times k$	M1 A1
		$\qquad\qquad k = -1.1$	A1 $\qquad$ (3)
			(7 marks)
2.	(*a*)	$T_r = \dfrac{24000}{12} \ (= 2000)$	M1
		N2L: $\ T_r - 1200 = 1000 \times f$	M1 A1ft
		$\qquad\qquad f = 0.08$	A1 $\qquad$ (4)
	(*b*)	Work Energy $\qquad \frac{1}{2} \times 1000 \times 14^2 = 1200d$	M1 A1
		$\qquad\qquad d = 81\frac{2}{3}$ $\qquad\qquad\qquad$ awrt 81.7	A1 $\qquad$ (3)
			B1 $\qquad$ (1)
	(*c*)	Resistances may *vary* with speed	
			(8 marks)

I

Question number	Scheme	Marks
3.	($\uparrow$)　　$R = 3mg$	B1
	M(B)	
	$mga \cos \alpha + 2mg \times \frac{3}{2} a \cos \alpha + Fr \times 2a \sin \alpha = R \times 2a \cos \alpha$	M1 A2 1,0
	Solving to $Fr = \frac{3}{4} mg$	M1 A1
	$Fr \le \mu R \Rightarrow \frac{3}{4} mg \le \mu \, 3mg$	M1
	$\mu \ge \frac{1}{4}$ (least value is $\frac{1}{4}$)	M1 A1　　(9)
		(9 marks)
4. (*a*)	MR　　　　$48a^2$　　　　$12a^2$　　　　$60a^2$	B1, B1ft
	CM　　　　$4a$　　　$(-)\frac{1}{3} \times 4a$　　　$\overline{x}$	B1
	$48a^2 \times 4a - 12a^2 \times \frac{4}{3} a = 60 \overline{x}$	M1 A1
	Solving to $\overline{x} = \frac{44}{15} a$　(*)	A1　　(6)
(*b*)	$\lambda M \times 4a = M \times \frac{44}{15} a$	M1 A1
	$\lambda = \frac{11}{15}$	A1　　(3)
		(9 marks)

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Question number		Scheme	Marks
5.	(*a*)	$v = \int a\,dt = 2t^2 - 8t \ (+c)$	M1 A1
		Using $v = 6$, $t = 0$; $v = 2t^2 - 8t + 6$	M1 A1 (4)
		$v = 0 \Rightarrow 2t^2 - 8t + 6 = 0, \Rightarrow t = 1,3$	M1 A1
		$S = \int (2t^2 - 8t + 6)\ dt = \left[\frac{2}{3}t^3 - 4t^2 + 6t\right]$	M1 A2, 1, 0
		$= 0 - 2\frac{2}{3}$	M1
		Distance is $(\pm)2\frac{2}{3}$ m	A1 (7)
			(11 marks)
6.	(*a*)	L.M. $2u = 2x + y$	M1 A1
		NEL $y - x = \dfrac{1}{3}u$	M1 A1
		Solving to $x = \dfrac{5}{9}u$ (*)	M1 A1
		$y = \dfrac{8}{9}u$ (*)	A1 (7)
	(*b*)	$(\pm)\dfrac{8}{9}eu$	B1
		L.M $\dfrac{10}{9}u - \dfrac{8}{9}eu = w$	M1 A1
		NEL $w = \dfrac{1}{3}\left(\dfrac{5}{9}u + \dfrac{8}{9}eu\right)$	M1 A1
		Solving to $e = \dfrac{25}{32}$ accept 0.7812s	M1 A1 (7)
	(*c*)	*Q* still has velocity and will *bounce back* from wall colliding with *stationary P*.	B1 (1)
			(15 marks)

Question number	Scheme	Marks
7. (*a*)	$\mathbf{I} = 0.4(15\mathbf{i} + 16\mathbf{j} + 20\mathbf{i} - 4\mathbf{j})$ $(= 0.4(35\mathbf{i} + 12\mathbf{j}) = 14\mathbf{i} + 4.8\mathbf{j})$	M1
	$|\mathbf{I}| = \sqrt{(14^2 + 4.8^2)}$ *or* $0.4\sqrt{(35^2 + 12^2)}$ M1 for any magnitude	M1 A1
	$= 14.8$ (Ns)	A1 (4)
(*b*)	Initial K.E. $= \frac{1}{2} m(15^2 + 16^2)$ $(= 240.5m = 96.2$ J$)$	M1
	$\frac{1}{2} mv^2 = \frac{1}{2} m(15^2 + 16^2) = m \times 9.8 \times 1.2$ −1 each incorrect term	M1 A2, 1,0
	$v^2 = 504.52$	M1
	$v = 22$ (m s^{-1}) accept 22.5	A1 (6)
(*c*)	$\arccos \dfrac{15}{22.5} = 48°$ accept 48.1°	M1 A1 A1 A1 (4)
(*d*)	Air resistance	
	Wind (problem not 2 dimensional)	
	Rotation of ball (ball is not a particle) any 2	B1, B1 (2)
		(16 marks)
Alt (*b*)	Resolve ↑ with 16 and 9.8	M1
	(↑) $v_y{}^2 = 16^2 + 2 \times (-9.8) \times (-1.2)$	M1 A1
	$(v_y{}^2 = 279.52, v_y \approx 16.7.....)$	
	$v^2 = 15^2 + 279.52$	M1 A1
	$v = 22$ (m s^{-1}) accept 22.5	A1 (6)
Alt (*c*)	$\arctan \dfrac{16.7}{15} = 48°$	M1 A1 A1 A1 (4)