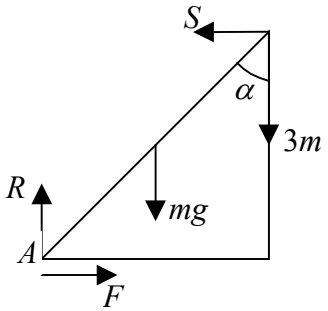
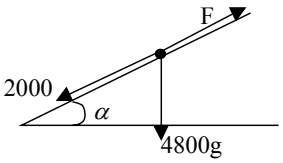
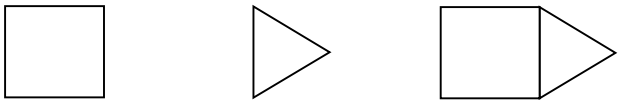
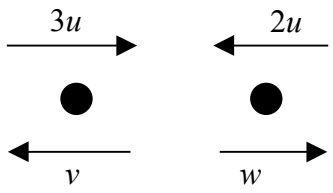
Question Number	Scheme	Marks
1.	$0.5\mathbf{v} - 0.5(-20\mathbf{i}) = 15\mathbf{i} + 10\mathbf{j}$ $\Rightarrow \mathbf{v} = 10\mathbf{i} + 20\mathbf{j}$ $\therefore$ Speed $= \sqrt{(10^2 + 20^2)} \approx 22.4$ m s^{-1}	M1 A1 A1 M1 A1 ft (5) **(5 marks)**
2.	$F \times 0.02, = \frac{1}{2} \times 0.006\,(400^2 - 250^2)$ $F \approx 14600$ N	M1 A1, M1 A1 A1 ft (5) **(5 marks)**
3. (a)	$\mathbf{u} = (3t^2 - 3)\mathbf{i} + 8t\mathbf{j}$	M1 A1 (2)
(b)	$//^e \mathbf{i} + \mathbf{j} \Rightarrow 3t^2 - 3 = 8t$ $3t^2 - 8t - 3 = 0$ $(3t + 1)(t - 3) = 0$ $t = -\frac{1}{3}, 3 \quad t = 3$	M1 A1 ft M1 A1 A1 ft (5) **(7 marks)**
4.	$R(\uparrow)\ R = mg + 3mg = 4mg$ $R(\rightarrow)\ S = F$ M(A) $mg.a \sin\alpha + 3\,mg.\,2a \sin a = S.2a \cos\alpha$ $\rightarrow S = \frac{7}{2}\,mg \tan\alpha$  $\therefore F = S = \frac{7}{2}\,mg \tan\alpha, R = 4mg$ $F \le \frac{1}{4}R \Rightarrow \frac{7}{2}mg \tan\alpha \le mg \Rightarrow \tan\alpha \le \frac{2}{7}$	M1 A1 B1 M1 A1 A1 ft M1 M1 A1 (9) **(9 marks)**

Question Number		Scheme	Marks
5.	(a)	$F = 2000 + 4800g.\frac{1}{20}, = 4352$ N	M1 A1, A1
		P = 12 × 4652 W ≈ 52.2 kW	M1 A1 ft (5)
			
	(b)	$4800a = 4352 - 2000$	M1 A1 ft
		$a = 0.49$ m s^{-2}	A1 (3)
	(c)	Max speed $\frac{52224}{V} = 2000$	M1 A1
		$V \approx 26.1$ ms^{-1}	A1 (3) **(11 marks)**
6.	(a)	Initial vertical speed = "u sin α" = $25\frac{5}{13}$ ms^{-1}	B1
		"$v^2 = u^2 + 2as$" $100 = 2gh$	M1
		$h = \frac{100}{2g} \approx 5.1$ m	A1
		$\therefore$ Ht + 5.1 + 0.8 = 5.9 m	A1 ft (4)
	(b)	$\leftrightarrow$ Horizontal speed = "u cos α" = 24 ms^{-1}	B1
		Time to window 36 = $24t \Rightarrow t = 1.5$s	M1 A1
		$h = 0.8 + 10 \times 1.5 - \frac{1}{2} \times 9.8 \times 1.5^2$	M1 A1 A1 ft
		≈ 4.8 m	A1 (7)
	(c)	One of, e.g., air resistance; spin of ball; variation in g; wind.	B1 (1) **(12 marks)**

Question Number	Scheme	Marks
7. (a)	Ht of $\Delta = \sqrt{(15^2 - 9^2)}$	M1
	$= 12$ cm	A1
		
	Area: 324 | 108 | 432	M1 A1
	Distance of CM from AE: 9 | $18 + \frac{1}{3}.12 = 22$ | $\bar{x}$	B1 B1 ft
	$9.324 + 22.108 = 432\,\bar{x}$	M1 A1
	$\bar{x} = 12.25$ cm	A1 (9)
(b)	Distance of G from $BD = 9$ cm	B1
	$\tan\theta = \frac{18 - 12.25}{9}$	M1 A1
	$\theta = 32.6°$	A1 (4)
		(13 marks)

Question Number	Scheme	Marks
8.		
(a)	$3mu - 2mu = 2mw - mv$	M1 A1
	$4eu = w + v$	M1 A1
	Solve $w = \frac{1}{3}(1 + 4e)u$	M1 A1 (6)
(b)	$v = \frac{1}{3}(8e - 1)u$	M1 A1
	$v > 0 \Rightarrow e > \frac{1}{8}$	A1 (3)
(c)	rebound speed of $B = \frac{1}{6}(1 + 4e)u$	B1
	2^{nd} collision $\Rightarrow \frac{1}{6}(1 + 4e)u > \frac{1}{3}(8e - 1)u$	M1
	$1 + 4e > 16e - 2$	
	$3 > 12e$	
	$e < \frac{1}{4}$	M1 A1 (4)
		(13 marks)