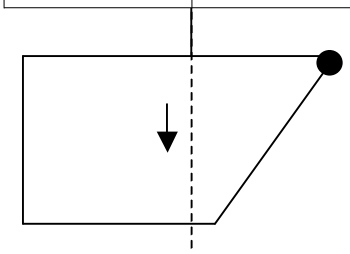
June 2005
6678 Mechanics M2
Mark Scheme (Final)

Question Number	Scheme	Marks
1 (*a*)	Driving force = $\frac{P}{v}$	B1
	$\frac{21000}{v} = 600 \Rightarrow v = 35$ m s^{-1}	M1 A1 (3)
(*b*)	$\frac{P}{v} = 600 + 1200.g.\frac{1}{14}$	M1 A1
	(= 1440 N)	
	$\frac{21000}{v} = 1440 \Rightarrow v = \frac{21000}{1440} \approx 14.6$ or 15 m s^{-1}	M1 A1 (4)
	[7]	
2 (a)	(x = 3)	
	M(AB): $7 \times 3.5 + 5 \times 5.5 + 4 \times 2 = 20 \times \bar{x}$	M1 A2,1,0
	$\Rightarrow$ $20\bar{x} = 24.5 + 27.5 + 8 = 60 \Rightarrow \bar{x} = 3$ cm dep	M1 A1 (5)
(b) 		
	M(XY): $M \times (3.5 - 3) = kM \times 3.5$	M1 A1
	$\Rightarrow k = \frac{1}{7}$.	A1 (3)
	[8]	
3. (a)	$\mathbf{v} = (18 - 12t^2)\mathbf{i} + 2ct\mathbf{j}$	M1 A1 A1
	$t = \frac{3}{2}$: $\mathbf{v} = -9\mathbf{i} + 3c\mathbf{j}$	M1
	$\lvert\mathbf{v}\rvert = 15 \Rightarrow 9^2 + (3c)^2 = 15^2$	M1
	$\Rightarrow (3c)^2 = 144 \Rightarrow c = 4$	A1 (6)
(b)	$\mathbf{a} = -24t\mathbf{i} + 8\mathbf{j}$	M1
	$t = \frac{3}{2}$: $\mathbf{a} = -36\mathbf{i} + 8\mathbf{j}$	M1 A1 √ (3)
	[9]	

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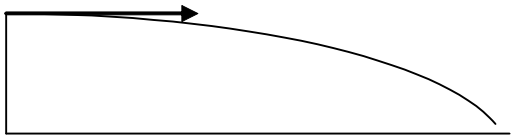
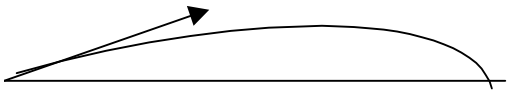


4. (a)

	$\rightarrow\ 12.6t = x$	B1	
		$\uparrow\ 0.1 = 4.9$	

t^2 B1

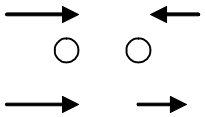
	$\Rightarrow 0.1 = 4.9 \times \dfrac{x^2}{12.6^2}$ M1	
	$\Rightarrow\ x = 1.8$ m A1 (4)	



(*b*)	2.5	
	$\rightarrow\ u\cos\alpha.t = 2.5$ M1 A1	
	$u\sin\alpha.t = \frac{1}{2}gt^2$ M1 A1	
	$u.\dfrac{24}{25}t = 2.5$	
	$u.\dfrac{7}{25} = 4.9.\dfrac{2.5.25}{24u}$	
	$u^2 = \dfrac{4.9 \times 2.5 \times 25^2}{7 \times 24}$	
	$\Rightarrow u \approx 6.75$ or 6.8 m s-1 M1 A1 (6)	
	[10]	

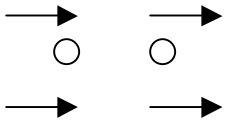
Question Number	Scheme	Marks	

5. (a)



	CLM: $6mu - 4mu = 3mv + 4mu$ M1 A1	
	+	
	NLI: $2u - v = e.4u$ M1 A1	
	$\Rightarrow 4eu = \frac{8}{3}u \Rightarrow e = \frac{2}{3}.$ M1 A1 (7)	

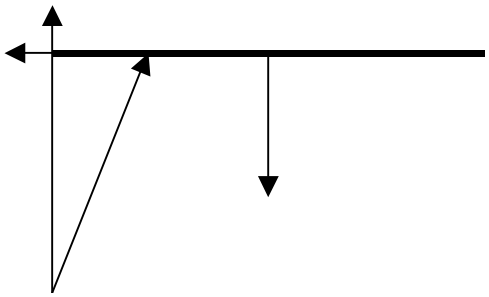
(b)



	$5my + 2mx = 4mu$ M1 A1	
	$y - x = \frac{3}{5}.2u = \frac{6}{5}u$ A1	
	Solve: $x = -\frac{2}{7}u$ M1 A1	
	$\frac{2}{7}u < \frac{2}{3}u$ so B does not overtake A M1	
	So no more collisions A1 cso (7)	
	[14]	

Question Number	Scheme	Marks

6. (a)



	P × 0.5 sin 60 = 30g × 1.5 M1 A2	
	30g	
	$P = 90g.\frac{2}{\sqrt{3}} \approx 1020$ N (1000N) A1 (4)	
(b)	$\rightarrow$ $X = P\cos 60 = \frac{1}{2}P$ M1 A1	
	($\approx$ 509 N (510N))	
	$Y + P\cos 30 = 30$ M1 A1	
	($\Rightarrow$ Y = -588 N)	
	resultant = $\sqrt{(X^2 + Y^2)} = \sqrt{(509^2 + 588^2)} \approx$ 778 N or 780N M1 A1 (6)	
(c)	In equilibrium all forces act through a point M1	
	P and weight meet at mid-point; hence reaction also acts through mid-point so reaction horizontal A1 cso (2)	
	OR M(mid-point): Y × 1.5 = 0 $\Rightarrow$ Y = 0 M1	
	Hence reaction is horizontal A1	
	[12]	

Question Number	Scheme	Marks	
7. (a)	PE lost = $3\times g\times 8\sin 30 = 3\times g\times 8\times 0.5 = 117.6$ J $\approx$ 118J or 120J	M1 A1 (2)	
(b)	KE gained = $\frac{1}{2}\times 3\times 5^2 = 37.5$ J	M1 A1	
	Work-energy: $F\times 8 = 117.6 - 37.5 = 80.1$	M1 A1√	
	$\Rightarrow F = 10.0125 \approx 10$ N	A1 (5)	
(c)	$R = 3g\cos 30$ (= 25.46 N)	B1	
	$F = \mu R \Rightarrow \mu = \dfrac{10}{25.46} \approx 0.393$ or 0.39	M1 A1 (3)	
(d)	Work done by friction = 80.1 as before	M1	
	Work-energy: $\frac{1}{2}\times 3\times v^2 = \frac{1}{2}\times 3\times 2^2 + 117.6 - 80.1$	M1 A2,1,0√	
	$\Rightarrow v \approx 5.39$ or 5.4 m s^{-1}	A1 (5)	
	[15]		