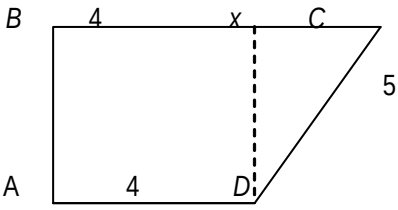
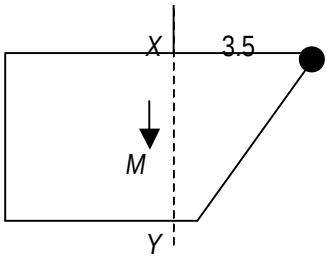
June 2005
6678 Mechanics M2
Mark Scheme

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)
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
	$\Rightarrow \quad 20\bar{x} = 24.5 + 27.5 + 8 = 60 \Rightarrow \bar{x} = 3$ 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)

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

$|\mathbf{v}| = 15 \Rightarrow 9^2 + (3c)^2 = 15^2$ 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)

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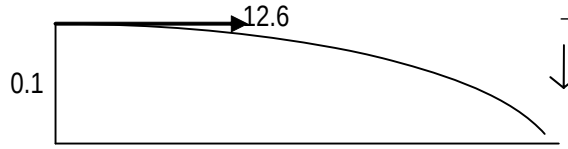
4 (a)



$\rightarrow$ $12.6t = x$ B1

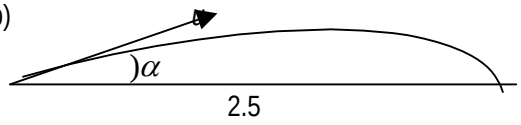
$\downarrow$ $0.1 = 4.9t^2$ B1

$\Rightarrow 0.1 = 4.9 \times \frac{x^2}{12.6^2}$ M1

$\Rightarrow x = 1.8$ m A1

(4)

(b)



$\rightarrow$ $u\cos\alpha.t = 2.5$ M1 A1

$\uparrow$ $u\sin\alpha.t = \frac{1}{2}gt^2$ M1 A1

$$u.\frac{24}{25}t = 2.5$$

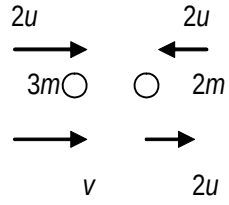
$$u.\frac{7}{25} = 4.9.\frac{2.5.25}{24u}$$

$$u^2 = \frac{4.9 \times 2.5 \times 25^2}{7 \times 24}$$

$\Rightarrow u \approx 6.75$ or 6.8 m s^{-1} M1 A1

(6)

5 (a)



CLM: $6mu - 4mu = 3mv + 4mu$ M1 A1

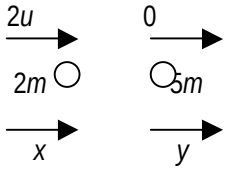
$\Rightarrow v = -\frac{2}{3}u$ A1

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

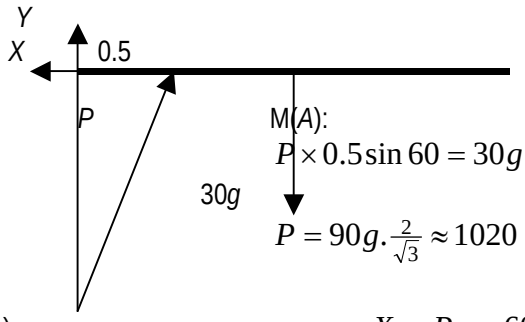
Solve: $x = -\frac{2}{7}u$ M1 A1

$\frac{2}{7}u < \frac{2}{3}u$ so *B* does not overtake *A* M1

So no more collisions A1 cso

(7)

6 (a)



M(*A*): $P \times 0.5\sin 60 = 30g \times 1.5$ M1 A2

$P = 90g.\frac{2}{\sqrt{3}} \approx 1020$ N (1000N) A1

(4)

(b) $\rightarrow$ $X = P\cos 60 = \frac{1}{2}P$ M1 A1

(≈ 509 N (510N))

$\uparrow$ $Y + P\cos 30 = 30g$ M1 A1

($\Rightarrow Y = -588$ N)

resultant = $\sqrt{(X^2 + Y^2)} = \sqrt{(509^2 + 588^2)} \approx 778$ N M1 A1

or 780N

(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): $Y \times 1.5 = 0 \Rightarrow Y = 0$ M1

Hence reaction is horizontal A1

7 (a) PE lost = $3\times g\times 8\sin 30 = 3\times g\times 8\times 0.5$ = 117.6 J ≈ 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

$F = \mu R \Rightarrow \mu = \dfrac{10}{25.46} \approx 0.393 \text{ or } 0.39$ — 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)