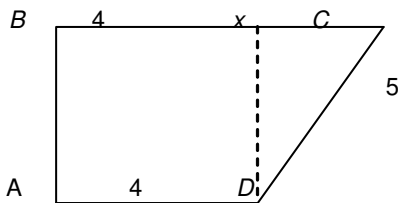
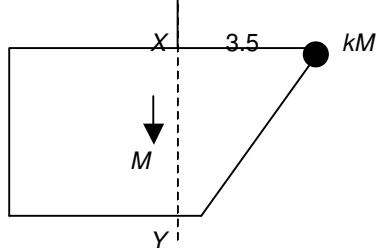
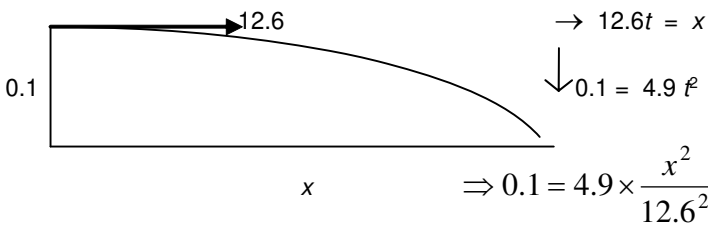
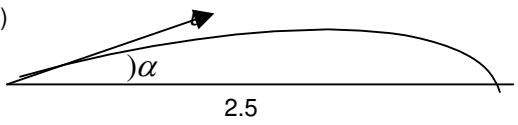
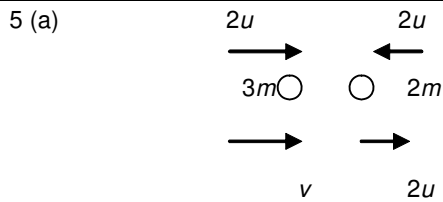


June 2005  
6678 Mechanics M2  
Mark Scheme

| Question Number | Scheme  | Marks                           |
|-----------------|---|---------------------------------|
| 1 (a)           | $\text{Driving force} = \frac{P}{v}$ $\frac{21000}{v} = 600 \Rightarrow v = 35 \text{ m s}^{-1}$  | B1<br>M1 A1<br>(3)              |
| (b)             | $\frac{P}{v} = 600 + 1200 \cdot g \cdot \frac{1}{14}$ <p style="text-align: center;">( = 1440 N)</p> $\frac{21000}{v} = 1440 \Rightarrow v = \frac{21000}{1440} \approx 14.6 \text{ or } 15 \text{ m s}^{-1}$   | M1 A1<br>M1 A1<br>(4)           |
| 2 (a)           |  <p style="text-align: right;">(x = 3)</p> $M(AB): 7 \times 3.5 + 5 \times 5.5 + 4 \times 2 = 20 \times \bar{x}$ $\Rightarrow 20\bar{x} = 24.5 + 27.5 + 8 = 60 \Rightarrow \bar{x} = 3 \text{ cm}$ | M1 A2,1,0<br>dep M1 A1<br>(5)   |
| (b)             |  $M(XY):$ $M \times (3.5 - 3) = kM \times 3.5$ $\Rightarrow k = \frac{1}{7}.$  | M1 A1 $\checkmark$<br>A1<br>(3) |

|       |   |          |
|-------|---|----------|
| 3 (a) | $v = (18 - 12t^2)\mathbf{i} + 2ct\mathbf{j}$        | M1 A1 A1 |
|       | $t = \frac{3}{2} : v = -9\mathbf{i} + 3c\mathbf{j}$ | M1       |
|       | $ v  = 15 \Rightarrow 9^2 + (3c)^2 = 15^2$          | M1       |
|       | $\Rightarrow (3c)^2 = 144 \Rightarrow c = 4$        | A1       |
|       | (6)   |          |
| (b)   | $a = -24\mathbf{i} + 8\mathbf{j}$                   | M1       |
|       | $t = \frac{3}{2} : a = -36\mathbf{i} + 8\mathbf{j}$ | M1       |
|       |   | A1 ✓     |
|       | (3)   |          |

|       |   |       |
|-------|---|-------|
| 4 (a) |    | B1    |
|       | $\rightarrow 12.6t = x$   | B1    |
|       | $\downarrow 0.1 = 4.9t^2$   |       |
|       | $\Rightarrow 0.1 = 4.9 \times \frac{x^2}{12.6^2}$                                   | M1    |
|       | $\Rightarrow x = 1.8 \text{ m}$   | A1    |
|       | (4)   |       |
| (b)   |  | M1 A1 |
|       | $\rightarrow u \cos \alpha \cdot t = 2.5$   | M1 A1 |
|       | $\uparrow u \sin \alpha \cdot t = \frac{1}{2}gt^2$                                  |       |
|       | $u \cdot \frac{24}{25}t = 2.5$  |       |
|       | $u \cdot \frac{7}{25} = 4.9 \cdot \frac{2.5 \cdot 25}{24u}$                         |       |
|       | $u^2 = \frac{4.9 \times 2.5 \times 25^2}{7 \times 24}$                              |       |
|       | $\Rightarrow u \approx 6.75 \text{ or } 6.8 \text{ m s}^{-1}$                       | M1 A1 |
|       | (6)   |       |



CLM:  $6mu - 4mu = 3mv + 4mu$   
 $\Rightarrow v = -\frac{2}{3}u$

M1 A1

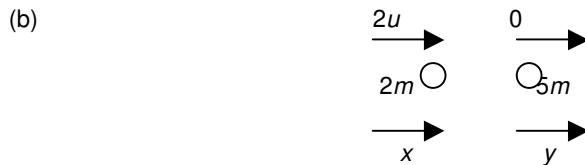
A1

NLI:  $2u - v = e \cdot 4u$   
 $\Rightarrow 4eu = \frac{8}{3}u \Rightarrow e = \frac{2}{3}$ .

M1 A1

M1 A1

(7)



$5my + 2mx = 4mu$

M1 A1

$y - x = \frac{3}{5} \cdot 2u = \frac{6}{5}u$

A1

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

M1 A1

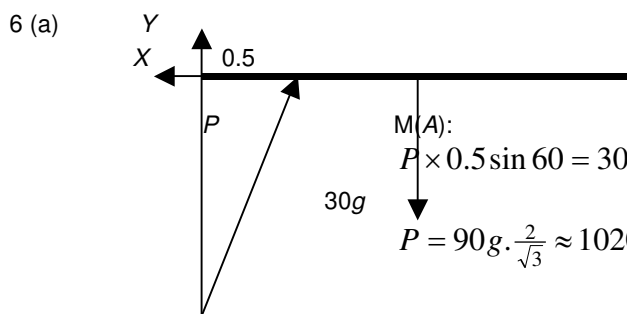
$\frac{2}{7}u < \frac{2}{3}u$  so B does not overtake A

M1

So no more collisions

A1 cso

(7)



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

M1 A2

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

A1

(4)

(b)  $\rightarrow X = P \cos 60 = \frac{1}{2}P$   
 $(\approx 509 \text{ N (510N)})$

M1 A1

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

M1 A1

$(\Rightarrow Y = -588 \text{ N})$

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

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

|  |   |                               |  |
|--|---|-------------------------------|--|
|  | <p>7 (a) PE lost = <math>3 \times g \times 8 \sin 30 = 3 \times g \times 8 \times 0.5 = 117.6 \text{ J} \approx 118 \text{ J}</math><br/> or 120J</p>   | M1 A1<br>(2)                  |  |
|  | <p>(b) KE gained = <math>\frac{1}{2} \times 3 \times 5^2 = 37.5 \text{ J}</math><br/> Work-energy: <math>F \times 8 = 117.6 - 37.5 = 80.1</math><br/> <math>\Rightarrow F = 10.0125 \approx 10 \text{ N}</math></p>                             | M1 A1<br>M1 A1√<br>A1<br>(5)  |  |
|  | <p>(c) <math>R = 3g \cos 30 (= 25.46 \text{ N})</math><br/> <math>F = \mu R \Rightarrow \mu = \frac{10}{25.46} \approx 0.393 \text{ or } 0.39</math></p>  | B1<br>M1 A1<br>(3)            |  |
|  | <p>(d) Work done by friction = 80.1 as before<br/> Work-energy: <math>\frac{1}{2} \times 3 \times v^2 = \frac{1}{2} \times 3 \times 2^2 + 117.6 - 80.1</math><br/> <math>\Rightarrow v \approx 5.39 \text{ or } 5.4 \text{ m s}^{-1}</math></p> | M1<br>M1 A2,1,0√<br>A1<br>(5) |  |

