

# Mark Scheme (Results) January 2008

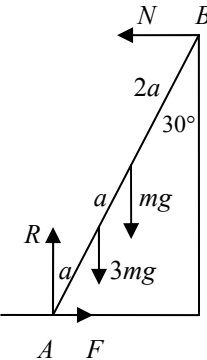
GCE

GCE Mathematics (6678/01)

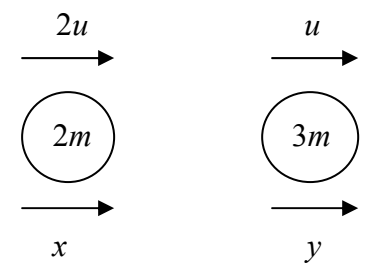
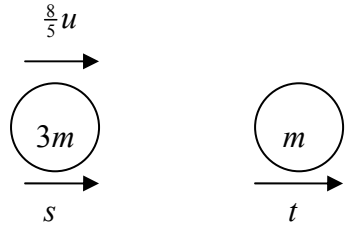
**January 2008  
6678 Mechanics M2  
Mark Scheme**

Question Number	Scheme	Marks
<b>1.</b>	<p>(a) KE lost is <math>\frac{1}{2} \times 2.5 \times 8^2 = 80</math> (J)</p> <p>(b) Work energy <math>80 = R \times 20</math> ft their (a) <math>R = 4</math></p> <p>Alternative to (b) <math>0^2 = 8^2 - 2 \times a \times 20 \Rightarrow a = (-)1.6</math> N2L <math>R = 2.5 \times 1.6</math> ft their <math>a</math> <math>= 4</math></p>	<p>M1 A1 (2)</p> <p>M1 A1 ft A1 (3) [5]</p> <p>M1 A1 ft A1 (3)</p>
<b>2.</b>	<p>(a) <math>\dot{\mathbf{p}} = (6t - 6)\mathbf{i} + (9t^2 - 4)\mathbf{j}</math> (<math>\text{ms}^{-1}</math>)</p> <p>(b) <math>9t^2 - 4 = 0</math> <math>t = \frac{2}{3}</math></p> <p>(c) <math>t = 1 \Rightarrow \dot{\mathbf{p}} = 5\mathbf{j}</math> ft their <math>\dot{p}</math> (+/-) <math>2\mathbf{i} - 6\mathbf{j} = 0.5(\mathbf{v} - 5\mathbf{j})</math> <math>\mathbf{v} = 4\mathbf{i} - 7\mathbf{j}</math> (<math>\text{ms}^{-1}</math>)</p>	<p>M1 A1 (2)</p> <p>M1 DM1 A1 (3)</p> <p>B1 ft M1 M1 A1 (4) [9]</p>

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3.	<p>(a) <math>20000 = 16F</math> (<math>F = 1250</math>)  <math>\nearrow</math> <math>F = 550 + 1000 \times 9.8 \sin \theta</math> ft their <math>F</math>  Leading to <math>\sin \theta = \frac{1}{14}</math> * cso</p> <p>(b) N2L <math>\nearrow</math> <math>550 + 1000 \times 9.8 \times \sin \theta = 1000a</math>  <math>(550 + 1000 \times 9.8 \times \frac{1}{14} = 1000a)</math>  or <math>1250 = 1000a</math>  <math>(a = (-)1.25)</math>  <math>v^2 = u^2 + 2as \Rightarrow 16^2 = 2 \times 1.25 \times y</math>  <math>y \approx 102</math> accept <b>102.4</b>, 100</p> <p>Alternative to (b)  Work-Energy <math>\frac{1}{2} \times 1000 \times 16^2 - 1000 \times 9.8 \times \frac{1}{14} y = 550y</math>  <math>y \approx 102</math> accept <b>102.4</b>, 100</p>	<p>M1 A1  M1 A1ft  A1 (5)</p> <p>M1 A1</p> <p>M1  A1 (4)  [9]</p> <p>M1 M1 A1  A1 (4)</p>
4.	<p>(a) Triangle Circle S  Mass ratio 126 <math>9\pi</math> <math>126 - 9\pi</math>  <math>\bar{x}</math> 7 5 <math>\bar{x}</math>  <math>\bar{y}</math> 4 5 <math>\bar{y}</math> 4, 7 seen</p> <p><math>126 \times 7 = 9\pi \times 5 + (126 - 9\pi) \times \bar{x}</math> ft their table values  <math>\bar{x} \approx 7.58</math> (<math>\frac{882 - 45\pi}{126 - 9\pi}</math>) awrt 7.6</p> <p><math>126 \times 4 = 9\pi \times 5 + (126 - 9\pi) \times \bar{y}</math> ft their table values  <math>\bar{y} \approx 3.71</math> (<math>\frac{504 - 45\pi}{126 - 9\pi}</math>) awrt 3.7</p> <p>(b) <math>\tan \theta = \frac{\bar{y}}{21 - \bar{x}}</math> ft their <math>\bar{x}, \bar{y}</math>  <math>\theta \approx 15^\circ</math></p>	<p>B1 B1ft</p> <p>B1</p> <p>M1 A1ft  A1</p> <p>M1 A1ft  A1 (9)</p> <p>M1 A1ft  A1 (3)  [12]</p>

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5.	<p>(a)</p>  <p>M(A) <math>N \times 4a \cos 30^\circ = 3mg \times a \sin 30^\circ + mg \times 2a \sin 30^\circ</math></p> $N = \frac{5}{4} mg \tan 30^\circ \left( = \frac{5}{4\sqrt{3}} mg = 7.07\dots m \right)$ <p><math>\rightarrow F_r = N</math> , <math>\uparrow R = 4mg</math></p> <p>Using <math>F_r = \mu R</math></p> $\frac{5}{4\sqrt{3}} mg = \mu R \text{ for their } R$ $\mu = \frac{5}{16\sqrt{3}} \quad \text{awrt } 0.18$ <p>Alternative method:</p> <p>M(B): <math>mg \times 2a \sin 30 + 3mg \times 3a \sin 30 + F \times 4a \cos 30 = R \times 4a \sin 30</math></p> $11mga \sin 30 + F \times 4a \cos 30 = R \times 4a \sin 30$ $\frac{11mg}{2} + F \frac{4\sqrt{3}}{2} = 2R$ <p><math>\uparrow R = 4mg</math> ,</p> <p>Using <math>F_r = \mu R</math></p> $8\mu\sqrt{3} = \frac{5}{2}, \quad \mu = \frac{5}{16\sqrt{3}}$	<p>M1 A2(1,0)</p> <p>DM1 A1</p> <p>B1, B1</p> <p>B1</p> <p>M1</p> <p>A1 <b>(10)</b></p> <p><b>[10]</b></p> <p>M1A3(2,1,0)</p> <p>DM1A1</p> <p>B1</p> <p>B1</p> <p>M1 A1</p>

<p><b>6.</b></p>	<p>(a) <math>\rightarrow 30 = 2ut</math>  <math>\uparrow -47.5 = 5ut - 4.9t^2</math>  <math>-47.5 = 75 - 4.9t^2</math>      eliminating <math>u</math> or <math>t</math>  <math>t^2 = \frac{75 + 47.5}{4.9} (= 25)</math>  <math>t = 5</math> *      cso</p> <p>(b) <math>30 = 2ut \Rightarrow 30 = 10u \Rightarrow u = 3</math></p> <p>(c) <math>\uparrow \dot{y} = 5u - 9.8t = -34</math>      M1 requires both  <math>\rightarrow \dot{x} = 2u = 6</math>      <math>\dot{x}</math> and <math>\dot{y}</math>  <math>v^2 = 6^2 + (-34)^2</math>  <math>v \approx 34.5 \text{ (ms}^{-1}\text{)}</math>      accept 35</p> <p>Alternative to (c)  <math>\frac{1}{2}mv_B^2 - \frac{1}{2}mv_A^2 = m \times g \times 47.5</math> with <math>v_A^2 = 6^2 + 15^2 = 261</math>  <math>v_B^2 = 261 + 2 \times 9.8 \times 47.5 (= 1192)</math>  <math>v_B \approx 34.5 \text{ (ms}^{-1}\text{)}</math>      accept 35</p> <p>BEWARE : Watch out for incorrect use of <math>v^2 = u^2 + 2as</math></p>	<p>B1  M1 A1  DM1  DM1  A1  <b>(6)</b></p> <p>M1 A1  <b>(2)</b></p> <p>M1 A1  A1  DM1  A1  <b>(5)</b></p> <p><b>[13]</b>  M1 A(2,1,0)  DM1  A1  <b>(5)</b></p>
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7.	<p>(a)</p>  <p style="text-align: center;"> <math>\xrightarrow{2u}</math>                      <math>\xrightarrow{u}</math>  <math>\bigcirc</math> <math>2m</math>                      <math>\bigcirc</math> <math>3m</math>  <math>\xrightarrow{x}</math>                              <math>\xrightarrow{y}</math> </p> <p>LM      <math>4mu + 3mu = 2mx + 3my</math>  NEL      <math>y - x = \frac{1}{2}u</math>  Solving to <math>y = \frac{8}{5}u</math> *</p> <p>(b)                              <math>x = \frac{11}{10}u</math>                      or equivalent</p> <p>Energy loss <math>\frac{1}{2} \times 2m \left( (2u)^2 - \left( \frac{11}{10}u \right)^2 \right) + \frac{1}{2} \times 3m \left( u^2 - \left( \frac{8}{5}u \right)^2 \right)</math>  <math>= \frac{9}{20}mu^2</math></p> <p>(c)</p>  <p style="text-align: center;"> <math>\xrightarrow{\frac{8}{5}u}</math>                      <math>\xrightarrow{u}</math>  <math>\bigcirc</math> <math>3m</math>                      <math>\bigcirc</math> <math>m</math>  <math>\xrightarrow{s}</math>                              <math>\xrightarrow{t}</math> </p> <p>LM      <math>\frac{24}{5}mu = 3ms + mt</math>  NEL      <math>t - s = \frac{8}{5}eu</math>  Solving to <math>s = \frac{2}{5}u(3 - e)</math></p> <p>For a further collision      <math>\frac{11}{10}u &gt; \frac{2}{5}u(3 - e)</math>  <math>e &gt; \frac{1}{4}</math>                      ignore <math>e \leq 1</math></p>	<p>M1 A1  B1  M1 A1      <b>(5)</b></p> <p>B1  M1 A(2,1,0)  A1      <b>(5)</b></p> <p>M1 A1  B1  M1 A1</p> <p>M1  A1      <b>(7)</b>  <b>[17]</b></p>