

EDEXCEL FOUNDATION

Stewart House 32 Russell Square London WC1B 5DN

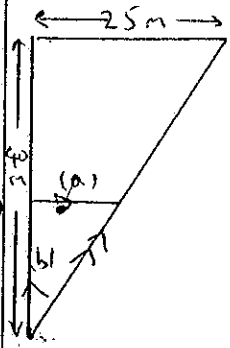
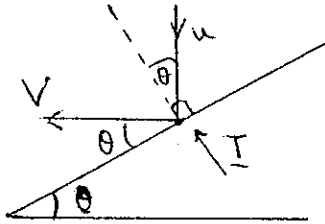
January 2002

Advanced Subsidiary / Advanced Level

General Certificate of Education

Subject MECHANICS 6680

Paper No. M4

Question number	Scheme	Marks
<p>1. (a)</p>  <p>(b)</p>	<p>Complete method for speed of current e.g. $= \frac{25\text{m}}{30\text{s}}$ or find $V(1.57)$, $\theta(32^\circ)$ and use $V \sin \theta$ or equiv. $= \frac{5}{6} \text{ms}^{-1}$ or $0.83(3) \text{ms}^{-1}$</p> <p>Complete method for speed of swimmer e.g. $= \frac{40\text{m}}{30\text{s}}$ or $\sqrt{V^2 - (a)^2}$ or $V_c \sin \theta_c$ $= \frac{4}{3} \text{ms}^{-1}$ or $1.3(3) \text{ms}^{-1}$</p>	<p>M1 A1 (2) M1 A1 (2)</p>
<p>2.</p>	<p>Equation of motion: $-mg - mkv = ma$; $\frac{dv}{dt} = -(g + kv)$</p> <p>Separating variables: $\int dt = - \int \frac{dv}{g + kv}$</p> <p>Integrating $t = -\frac{1}{k} [\ln(g + kv)] (+c)$</p> <p>Using limits to give $T = \frac{1}{k} [\ln(g + kv)]_0^u$ or using limits $[t=0, v=u]$ to find c:</p> <p>Completing to give $T = \frac{1}{k} \ln\left(\frac{g + ku}{g}\right)$</p> <p>[Mark finding greatest height as Mr]</p>	<p>(M) A1 (M) A1 (M) A1 ✓ MIA1 (8)</p>
<p>3. (a)</p>  <p>(b)</p>	<p>Parallel to plane: $u \sin \theta = V \cos \theta$</p> <p>Perpendicular to plane: $e u \cos \theta = V \sin \theta$</p> <p>Eliminating u and V: $e \cot \theta = \tan \theta$</p> <p>Given result: $e = \tan^2 \theta$ *</p> <p>Impulse = change in momentum = $m (V \sin \theta + u \cos \theta)$</p> <p>Expression in m, u and θ: $= m (e u \cos \theta + u \cos \theta) = mu \cos \theta (1 + \tan^2 \theta)$ or $= mu \left(\frac{\sin^2 \theta}{\cos \theta} + \cos \theta \right)$</p> <p>Completion $= mu \sec \theta$ *</p>	<p>(M) A1 (M) A1 (M) A1 (6) (M) A1 (M) A1 (4)</p>

EDEXCEL FOUNDATION

Stewart House 32 Russell Square London WC1B 5DN

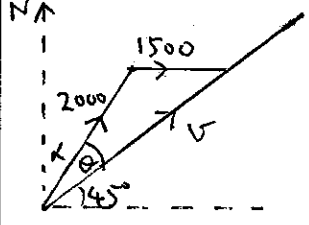
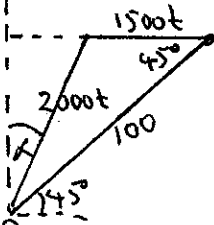
January 2002

Advanced Subsidiary / Advanced Level

General Certificate of Education

Subject MECHANICS 6680

Paper No. M4

Question number	Scheme	Marks
<p>4. (a)</p>	<p><i>Using velocity diagram</i></p>  <p>$\frac{\sin \theta}{1500} = \frac{\sin 45^\circ}{2000}$</p> <p>$\theta = 32^\circ (32.03)$</p> <p>Bearing = $90^\circ - (45^\circ + \theta) = 013^\circ$</p>	<p>M1A1 M1A1 M1A1 (6)</p>
<p>(b)</p>	<p>Method for v: e.g. (i) $v^2 = 1500^2 + 2000^2 - 2 \cdot 1500 \cdot 2000 \cdot \cos(90 + 13_c)^\circ$ or (ii) $v \cos 45^\circ = 2000 \cos 13_c^\circ$ or (iii) $\frac{\sin 45^\circ}{2000} = \frac{\sin 103^\circ}{v}$</p> <p>$v = 2756 \text{ km h}^{-1}$</p> <p>Time = $\frac{100}{v} \text{ h} = 131 \text{ s}$</p> <p>[Time = $\frac{100 \cos 45^\circ}{2000 \cos 13_c^\circ}$ gains M1M1A1 immediately, correct answer gains A2]</p> <p><i>Using displacement method (several variations)</i></p> <p>(i) In the case below α is bearing; but other relevant angle may be used</p>  <p>One equation in t and α: e.g. $2000 t \sin \alpha = 50\sqrt{2} - 1500 t$ Second equation in t and α: e.g. $2000 t \cos \alpha = 50\sqrt{2}$ Equation in one variable: e.g. $4 \cos \alpha - 4 \sin \alpha = 3$ Reducing to simple equation e.g. $4\sqrt{2} \cos(\alpha + 45^\circ) = 3$ Bearing = $(0)13^\circ$</p> <p>Sustituting for α to find t; $t = 131 \text{ s}$</p> <p>(ii) Using cosine rule: $(2000t)^2 = (1500t)^2 + 100^2 - 2 \cdot 100 \cdot 1500t \cos 45^\circ$ Quadratic form: $175t^2 + 15\sqrt{2}t - 1 = 0$ Solving: $t = 131 \text{ s}$ Equation in t and α Bearing = $(0)13^\circ$</p>	<p>M1A1√ A1 M1A1 (5)</p> <p>M1A1 M1A1 M1A1 M1A1√ A1 M1A1 M2A1A1 M1A1√ M1A1 M1A1 A1</p>

EDEXCEL FOUNDATION

Stewart House 32 Russell Square London WC1B 5DN

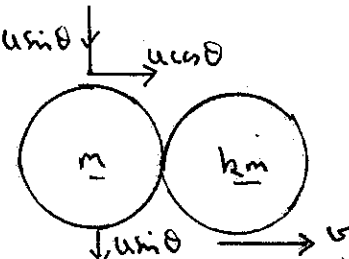
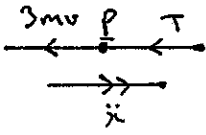
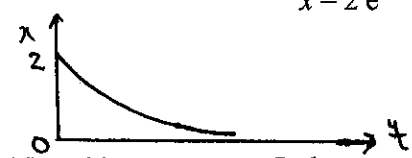
January 2002

Advanced Subsidiary / Advanced Level

General Certificate of Education

Subject MECHANICS 6680

Paper No. M4

Question number	Scheme	Marks
<p>5. (a)</p>	 <p>CLM: $mu \cos \theta = kmv$ NIL: $eu \cos \theta = v$ Eliminating θ</p> <p>$e = \frac{1}{k} *$</p> <p>(b)</p> <p>$\frac{1}{2} m v_a^2 + \frac{1}{2} (2m) (\frac{1}{2} u \cos \theta)^2 = \frac{3}{4} \cdot \frac{1}{2} m u^2$ (or equivalent) $\frac{1}{2} m (u \sin \theta)^2 + \frac{1}{2} (2m) (\frac{1}{2} u \cos \theta)^2 = \frac{3}{4} \cdot \frac{1}{2} m u^2$ [M1 for $v_a = u \sin \theta$] $[4 \sin^2 \theta + 2 \cos^2 \theta = 3]$ $4 \sin^2 \theta + 2(1 - \sin^2 \theta) = 3$ $\sin^2 \theta = \frac{1}{2}$</p> <p>$\theta = 45^\circ$</p> <p>[$\frac{1}{2} m (u \cos \theta)^2 - \frac{1}{2} (2m) (\frac{1}{2} u \cos \theta)^2 = \frac{1}{4} \cdot \frac{1}{2} m u^2$ accepted for first 4 marks unless it is clear that candidate is working along line of centres only; e.g. $\frac{1}{2} m (u \cos \theta)^2 - \frac{1}{2} (2m) (\frac{1}{2} u \cos \theta)^2 = \frac{1}{4} \cdot \frac{1}{2} m (u \cos \theta)^2$, then max M1]</p>	<p>(M1)A1 (M1)A1 (M1)</p> <p>A1 (6)</p> <p>(M1)A1 (M1)A1√ (M1)</p> <p>A1 (6)</p>
<p>6. (a)</p>	 <p>$T = \frac{2mL}{L} x$</p> <p>Equation of motion: $-3mx - T = m \ddot{x}$ $\Rightarrow \ddot{x} + 3\dot{x} + 2x = 0 *$</p> <p>(b) A.E. $m^2 + 3m + 2 = 0 \Rightarrow m = -1$ or -2 G.S. $x = A e^{-t} + B e^{-2t}$ $t = 0, x = 2: \Rightarrow A + B = 2$</p> <p>Differentiating $x = -A e^{-t} - 2B e^{-2t}$ $t = 0, \dot{x} = -4: \Rightarrow A + 2B = 4$ (any equivalent form) Correctly solving simultaneous equations $(A = 0, B = 2)$ $x = 2 e^{-2t}$</p> <p>(c)</p>  <p>Shape $(0, 2), x = 0$ asymptote Totally correct</p> <p>(d) No, with reason, e.g. P always moving</p>	<p>B1</p> <p>M1A1</p> <p>A1(cso) (4)</p> <p>(M1)A1 A1√ B1</p> <p>(M1)</p> <p>A1</p> <p>(M1)</p> <p>A1 (8)</p> <p>B1√ B1 (2)</p> <p>B1 (1)</p>

EDEXCEL FOUNDATION

Stewart House 32 Russell Square London WC1B 5DN

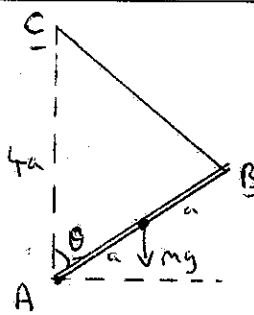
January 2002

Advanced Subsidiary / Advanced Level

General Certificate of Education

Subject MECHANICS 6680

Paper No. M4

Question number	Scheme	Marks
<p>7. (a)</p> 	<p>GPE: (from a fixed point) e.g. $mga \cos \theta$ (+C) EPE: $\frac{1}{2} mg \frac{(\text{ext})^2}{4a}$</p> <p>$BC^2 = (4a)^2 + (2a)^2 - 2 \cdot 4a \cdot 2a \cdot \cos \theta = 20a^2 - 16a^2 \cos \theta$ $\Rightarrow \text{EPE} = \frac{1}{2} mga [5 - 4 \cos \theta - 2\sqrt{5 - 4 \cos \theta}] + 1]$</p> <p>$V = \text{GPE} + \text{EPE} (+C)$ applied</p> <p>$= mga \{-\cos \theta - \sqrt{5 - 4 \cos \theta} + 3\} + C$ ($\sqrt{\quad}$ dep. on all Ms)</p> <p>$= mga \{-\cos \theta - \sqrt{5 - 4 \cos \theta}\} + \text{constant}$ * (no errors seen)</p> <p>(b)</p> $\frac{dV}{d\theta} = mga \left\{ \sin \theta - \frac{4 \sin \theta}{2\sqrt{5 - 4 \cos \theta}} \right\}$ <p>$\frac{dV}{d\theta} = 0$; $[\sin \theta \{ \sqrt{5 - 4 \cos \theta} - 2 \} = 0]$</p> <p>$\Rightarrow \sin \theta = 0$ or $\sqrt{5 - 4 \cos \theta} = 2$</p> <p>$\Rightarrow \theta = 0$ or π (0° or 180°)</p> <p>\Rightarrow or $\theta = \cos^{-1}(\frac{1}{4}) = 1.32$ (75.5°)</p>	<p>M1 B1</p> <p>(M1)A1 (M1)A1</p> <p>M1 A1√ A1 (9)</p> <p>M1A1 (M1) A1 (M1)A1 (6)</p>