EDEXCEL FOUNDATION

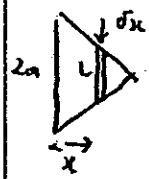
Stewart House 32 Russell Square London WC1B 5DN

June 2002

Advanced Subsidiary Advanced Level

General Certificate of Education

Subject **MECHANICS 6681** Paper No. **M5**

Question number	Scheme	Marks
1.	$(3\underline{i}+\underline{k})-(\underline{i}+\underline{j}+\underline{k}) = 2\underline{i}-\underline{j}$ $(5\underline{i}+\underline{j}-3\underline{k})\cdot(2\underline{i}-\underline{j}) = \frac{1}{2}\times\frac{1}{2}v^2$ $\underline{v = 6\,ms^{-1}}$	B1 M1 A1 A1 A1 (5)
2.(a)	$(2\underline{i}-\underline{j}+3\underline{k})+(\underline{i}+\underline{j}-4\underline{k})+(p\underline{i}+q\underline{j}+r\underline{k}) = 5\underline{i}-4\underline{j}+2\underline{k}$ $\underline{p=2,\ q=-4,\ r=3}$	M1 A2 (1 c.a.o.) (3)
(b)	$t=0$, $\underline{G} = (3\underline{i}-2\underline{j}+\underline{k})\times(5\underline{i}-4\underline{j}+2\underline{k})$ $= \underline{(-\underline{j}-2\underline{k})\,Nm}$	M1 A1 A1 (3) (6)
3.	$\frac{d\underline{v}}{dt} = 4\underline{v}$ $\underline{v} = \underline{A}e^{4t}$ $\underline{v} = (8\underline{i}-6\underline{j})e^{4t}$ $t=\frac{1}{2}\ln 2$, $\underline{v} = (8\underline{i}-6\underline{j})\cdot 4$ $\underline{|v| = 40\,ms^{-1}}$	M1 A1 A1 M1 A1 M1 A1 (7)
4.	 $\frac{L}{2a} = \frac{a\sqrt{3}-x}{a\sqrt{3}}$ $L = \frac{2}{\sqrt{3}}(a\sqrt{3}-x)$ $\delta m = \frac{2}{\sqrt{3}}(a\sqrt{3}-x)\delta x\cdot\frac{m}{a^2\sqrt{3}}$ $= \frac{2m}{3a^2}(a\sqrt{3}-x)\delta x$ $\delta I = \frac{2m}{3a^2}(a\sqrt{3}x^2-x^3)\delta x$ $I = \frac{2m}{3a^2}\int_0^{a\sqrt{3}} a\sqrt{3}x^2-x^3\,dx$ $= \frac{2m}{3a^2}\left[a\sqrt{3}\frac{x^3}{3}-\frac{x^4}{4}\right]_0^{a\sqrt{3}}$ $= \frac{2m}{3a^2}\cdot\frac{1}{12}\cdot 9a^4$ $= \underline{\frac{1}{2}ma^2}$	M1 A1 M1 A1 M1 M1 A1 m1 A1 (9)

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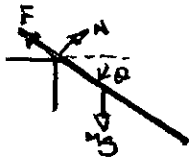
5.(a)	$m+\delta m$ ↑ $(v+\delta v)$ $-\delta m$ ↑ $(v-2000)$ $-mg\,\delta t = (m+\delta m)(v+\delta v) - \delta m(v-2000) - mv$ $-mg = m\frac{dv}{dt} + 2000\frac{dm}{dt}$ $m = 1000 - 10t$ $\frac{dm}{dt} = -10$ $-9.8(1000-10t) = (1000-10t)\frac{dv}{dt} - 20,000$ $-9.8(100-t) = (100-t)\frac{dv}{dt} - 2000$ *	M1 A2 (-1 e.e.o.o.) A1 B1 B1 M1 A1 c.s.o. (8)
(b)	$-9.8 + \frac{2000}{100-t} = \frac{dv}{dt}$ $\int_0^{60} -9.8 + \frac{2000}{100-t}\,dt = \int_0^{V_{max}} dv$ $[-9.8t - 2000\ln(100-t)]_0^{60} = V_{max}$ $-588 - 2000\ln 40 + 2000\ln 100 = V_{max}$ 1200 or 124 ms^{-1} $= V_{max}$	M1 M1 A1 (limits) A1 M1 A1 (6) (14)
6.(a)	$I = \frac{1}{12}m(4a)^2 + ma^2 = 7ma^2/3$ *	M1 A1 (2)
(b)	$\frac{1}{2}\cdot\frac{7ma^2}{3}\cdot\dot\theta^2 = mga\sin\theta$ $\dot\theta^2 = \frac{6g\sin\theta}{7a}$ *	M1 A1 A1 (3)
(c)	$2\dot\theta\ddot\theta = \frac{6g}{7a}\cos\theta\cdot\dot\theta \Rightarrow \ddot\theta = \frac{3g\cos\theta}{7a}$	M1 A1 (2)
(d)	 $mg\cos\theta - N = ma\ddot\theta$ $N = mg\cos\theta - m\cdot\frac{3g\cos\theta}{7}$ $= \frac{4mg\cos\theta}{7}$	M1 A1 M1 A1 (4)
(e)	$F - mg\sin\theta = ma\dot\theta^2$ $F = mg\sin\theta + \frac{m6g\sin\theta}{7}$ $= \frac{13mg\sin\theta}{7}$ slips when $F = \mu N \Rightarrow \frac{13mg\sin\theta}{7} = \mu\cdot\frac{4mg\cos\theta}{7}$ $\Rightarrow \tan\theta = 4\mu/13$ *	M1 A1 M1 A1 M1 A1 c.s.o. (6) (17)

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7. (a)	$I_B = \frac{1}{4}ma^2 + ma^2 = \frac{5}{4}ma^2$	M1 A1
	B, O, $\leftarrow u$ $mua = \left(\frac{5}{4}ma^2 + ma^2\right)\omega$ $\omega = \frac{4u}{9a}$ *	M1 A1 A1√ A1 (6)
(b)	$\frac{1}{2}\cdot\frac{9}{4}ma^2\left(\frac{4u}{9a}\right)^2 = 2mga(1-\cos\theta)$ $\cos\theta = 89/90$ $\theta \approx 8.5^\circ$ or 8.55° or 0.149^c or 0.15^c	M1 A1 A1√ M1 A1 (5)
(c)	B, θ, O, 2mg, $\ddot{\theta}$ $-2mga\sin\theta = \frac{9}{4}ma^2\ddot{\theta}$ $\ddot{\theta} = -\frac{8g}{9a}\theta \quad (\theta \leq 9^\circ)$ $T = \pi\sqrt{\frac{9a}{8g}}$ (ou) $= \frac{3\pi}{2}\sqrt{\frac{a}{2g}}$	M1 A1 A1√ M1 B1 ( ) A1 c.s.o. (6) (17)