CAMBRIDGE
INTERNATIONAL EXAMINATIONS

JUNE 2002

GCE Advanced Subsidiary Level

MARK SCHEME

MAXIMUM MARK : 50

SYLLABUS/COMPONENT :9709 /4

MATHEMATICS
(Mechanics 1)

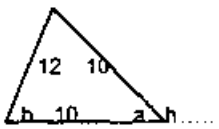
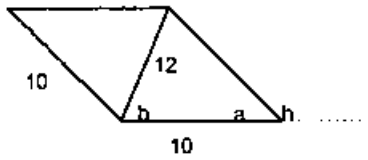
UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

1		For using WD = $Fd\cos\alpha$ or $P = Fv\cos\alpha$ and WD = Pt	M1	
		WD = 5(0.4 x 10)cos30°	A1	
		Work done is 17.3 J (or $10\sqrt{3}$)	A1	3
SR For candidates who calculate power (only) (max 1 out of 3) Power is 1.73 W B1				

Notes:
M1 – their distance; cos or sin but not just 5x4
Radians M1 A1 A0 (max 2 out of 3); answer 3.085 does not score final A mark but may imply the previous A1

2	(i)	For using $N = mg\cos\alpha$ [5g cos 12° (= 48.9)] and $F = \mu N$ [0.2 x 48.9]	M1	
		Frictional force is 9.78 N (9.59 from g = 9.8 and 9.60 from g = 9.81)	A1	2
	(ii)	Component of weight = 5g sin 12° (=10.4) (ft absence of g and/or sin/cos mix only)	B1 ft	
		For comparing component of weight with frictional force or for finding the acceleration (0.123) using both the component of weight and the frictional force	M1	
Alternative: For comparing μ with tan 12° or for comparing the 'angle' of friction with angle of inclination M1 0.2 < tan 12° or $\tan^{-1}0.2 < 12°$ A1				
		Speed increasing (ft for arithmetic errors only)	A1ft	3

Notes:
(i) M1 accept absence of g and/or sin/cos mix
(ii) B1 can be earned in (i)
Illustration: '5a = 1.04 – 9.78 ➔ a < 0 ➔ speed decreasing' scores A1 ft, whereas '5a = 10.4 + 9.78 ➔ a > 0 ➔ speed increasing' scores A0
Radians: Can score both M marks as per scheme, and allow one A mark for both 8.44 and –26.8 (or –27 or –30) (max 3 out of 5)

3	(i)	 or  (may be implied) or recognising that resultant acts along bisector or $12\cos\beta = 10 + 10\cos\theta$ and $12\sin\beta = 10\sin\theta$ or $X = 10 - 10\cos\alpha$ and $Y = 10\sin\alpha$	B1	
		Complete method for α [$\alpha = 2\sin^{-1}\frac{6}{10}$ or $12^2 = 10^2 + 10^2 - 2\times10^2\cos\alpha$] or resolving forces along the bisector [$2\times10\cos\frac{\theta}{2} = 12$] or squaring and adding and using $c^2\beta + s^2\beta = 1$ and $c^2\theta + s^2\theta = 1$ [$144 = 100 + 200\cos\theta + 100$]	M1	
		$\theta = 106.3^\circ$ or 1.85 rads	A1	3
	(ii)	For using component = $12\cos\frac{\theta}{2}$ [12 x 0.6] or $10 - 10\cos\alpha$	M1	
		Component is 7.2 N (ft only when B1 in part (i) is scored)	A1ft	2
SR for candidates whose diagram in (i) (actual or implied) has triangle with sides 10, 10, 12 and angle θ opposite the 12. (max 1 out of 2) Component is $\pm$ 7.2 N B1				
Alternative: For candidates who draw a scale diagram. As for first mark in scheme above B1 Value of θ in the range 105° to 107° obtained B1 $\theta = 106.3^\circ$ B1  For drawing relevant perpendicular and measuring appropriate length M1 Component is 7.2 N A1				

Notes:

Accept 7.19 or 7.20 or 7.21 (as well as 7.2) for final A1.

The wrong diagram case (diagram may or not appear). Triangle has sides 10, 10, 12 with angle θ opposite the 12. (i) M0, $12^2 = 10^2 + 10^2 - 2\times10^2\cos\theta$ M1 A0 (max 1 out of 3) (ii) Allow M1 as per scheme if appropriate, otherwise use SR.

4	**(i)**	$N = 4.5g$, $F = 15$	B1	
		For using $\mu = F/N$	M1	
		Coefficient is 1/3 or 0.333 (0.340 from g = 9.8 or 9.81)	A1	3
	(ii)	For using Newton's 2nd law [$-15 = 4.5a$]	M1	
		Deceleration is 10/3 ms^{-2} (or 3.33) or a = -10/3 (or –3.33)	A1	2
	(iii)	For using $v^2 = u^2 + 2as$ or $v = u + at$ and $s = \frac{u+v}{2}t$ [$0 = 4 + 2(-10/3)s$]	M1	
		Distance is 0.6 m	A1ft	2

Notes: Allow inequality for M mark in (i)
$4.5a = 15 \rightarrow a = 10/3$ in (ii) scores M1 A0 (unless a is said to be deceleration)
$v = 2$, $u = 0$ and $a = 10/3$ is OK for M1 in (iii) even if $a = +10/3$ is found in (ii). Allow A1 as well if 0.6m is found.
Accept 0.601 from a = -3.33 for A mark in (iii)

5 (i)	**(a)**	For using $v = u + at$ [$6 = 3 + (0.06)t$]	M1	
		Time taken is 50s	A1	2
	(b)	For using $v^2 = u^2 + 2as$ [$36 = 9 + 2(0.06)s$] or $s = ut + \frac{1}{2}at^2$ [$s = 3(50) + \frac{1}{2}(0.06)2500$] or $s = \frac{u+v}{2}t$ [$s = \frac{1}{2}(3 + 6)50$]	M1	
		Distance is 225m	A1	2
(ii)	**(a)**	For attempting to integrate kt^2	M1	
		$s = kt^3/3$	A1	
		For finding k by substituting for s and t in the expression for s obtained by integration or by using appropriate limits in the integration [$k50^3/3 = 225$]	DM1	
		$k = 0.0054$ or 27/5000 ft for 3 x (ans i(b)) / (ans i(a))^3	A1ft	4
	(b)	Speed is 13.5ms^{-1} ft for (ans ii(a)) x (ans i(a))^2	B1 ft	1
SR (For candidates who use constant acceleration formulae in part (ii)) (max 1 out of 5) For $k = 0.0036$ and speed at B is 9ms^{-1} (in either order) B1				

6	(i)(a)	For using PE = mgh [15 000x10(800sin2°)]	M1	
		Gain in PE is 4 190 000 J (4 187 900) (4 100 000 from g = 9.8 and 4 110 000 from g = 9.81)	A1	2
	(b)	WD by driving force is 5 600 000 J	B1	1
	(c)	For using WD = ans (b) – ans (a) or WD = (7000 – mgsin2°)×800	M1	
		WD against resistance is 1 410 000 J (ft candidate's ans (b) – ans (a) or (7000 – mgsin2°)×800 providing the value found is +ve) (1 500 000 from g = 9.8 and 1 490 000 from g = 9.81)	A1ft	2
	(ii)	For using KE loss = ½ $m(u^2 - v^2)$ [½ 15 000(400 – 100)]	M1	
		KE loss is 2 250 000 J May be implied by final answer	A1	
		WD against resistance is 900 x 800	B1	
		For using WD as a linear combination of 3 terms reflecting the PE, the KE and the resistance [4 190 000 - 2 250 000 + 720 000]	M1	
		WD by driving force is 2 660 000 J (2 657 900) (2 570 000 from g = 9.8 and 2 580 000 from g = 9.81)	A1	5
SR For candidates who assume, explicitly or implicitly, that the acceleration is constant. (max 3 out of 5) For using $v^2 = u^2 + 2as$ (a = -0.1875) and DF = $ma \pm 900 \pm mg\sin 2°$ M1 For multiplying by 800 M1 WD by driving force is 2 660 000 J A1				

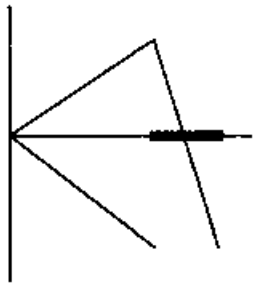
For incorrect use of multiple units (eg kJ) withold the A or B mark at the first occurrence, but do not penalise subsequently.

Allow cos or (1 – cos) instead of sin for M mark in (i)(a), but g must be present

Accept – 5 600 000 in (i)(b) and – 2 660 000 in (ii)

Allow ± the expressions for WD for M mark in (i)(c), but not for the A mark (including the ft)

Answer 2 250 000 in (ii) is almost certainly worth 0 out of 5 (unless it is an answer for the loss in KE); see notes distributed at meeting.

7	(i)	For applying Newton's 2nd law to A or B or for using $(m_1 + m_2)a = (m_2 - m_1)g$	M1	
		$0.15a = T - 0.15g$	A1	
		$0.25a = 0.25g - T$	A1	
Alternative for the above 2 A marks: $(0.15 + 0.25)a = (0.25 - 0.15)g$ A2				
		Acceleration is $2.5 ms^{-2}$ (ft only for 0.25 following the absence of g) (2.45 from g = 9.8 or g = 9.81)	A1ft	4
	(ii)	$v = 5$ ft for 2 x ans(i) (4.9 from g = 9.8 and 4.90(5) from g = 9.81)	B1 ft	
		For using $v = u + at$ to find time up or time down or total time up and down; acceleration *must* be $\pm g$	M1	
		$t = 2 \times \frac{5}{10}$ or $-5 = 5 - 10t$	A1ft	
		Slack for 1s	A1	4
	(iii)	 For 2 line segments representing motion with the string taut	B1	
		For the line segment representing motion of A with the string slack	B1	
		For the line segment $v = 0$ representing B stationary with the string slack	B1	3

Notes: Allow absence of g for the M mark in (i)
Allow $-a$ instead of a for the first two A marks in (i) if, and only if, it applies to both equations.
Third A mark is for 2.5 and if it follows a = -2.5 the answer must be properly justified.
For answer 1s + 2s = 3s in (ii) allow final A mark (ISW for + 2s = 3s)
Line segments must appear to be symmetric for first B mark in (iii)
The graphs can have v positive downwards, but for 1st B mark the line segments must appear to be reflections of each other in the t axis.
Accept separate graphs for particles A and B, providing the direction of positive v is the same for both.