

**MARK SCHEME for the October/November 2011 question paper
for the guidance of teachers**

9709 MATHEMATICS

9709/41

Paper 4, maximum raw mark 50

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	GCE AS/A LEVEL – October/November 2011	9709	41

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ISW	Ignore Subsequent Working
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SOS	See Other Solution (the candidate makes a better attempt at the same question)
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1	$d = 2 \times 8$	B1	
	$[25 \times 16 \cos 20]$	M1	For using $WD = Fd \cos \alpha$
	Work done is 376 J	A1	3
2		M1	For applying Newton's second law to either particle (3 terms)
	$0.65g - T = 0.65a$ and $T - 0.35g = 0.35a$	A1	Accept $(0.65 - 0.35)g = (0.65 + 0.35)a$ as an alternative to one of these equations
		M1	For solving for T
	Tension in the string is 4.55 N	A1	
	Magnitude of resultant is 9.1 N	B1ft	5
3	(i) (a) $[2 \times 12 \cos 40 - 15 \cos 50]$	M1	For resolving in direction AB
	Component is 8.74 N	A1	
	(b) Component is 11.5 N	B1	3
	(ii) Magnitude is 14.4 N or direction is 52.7° (or 0.920°) anticlockwise from i dir'n	M1	For using $R^2 = X^2 + Y^2$ or $\tan \theta = Y/X$
	Direction is 52.7° (or 0.920°) anticlockwise from i dir'n or magnitude is 14.4 N	A1 B1	3
4	(i) $1.76 = 0.8u + 0.32a$	M1	For using $s = ut + \frac{1}{2}at^2$ for AB
		A1	
	$[1.76 + 2.16 = (0.8 + 0.6)u + \frac{1}{2}(0.8 + 0.6)^2a$ or $2.16 = (u + 0.8a)0.6 + \frac{1}{2}0.6^2a]$	M1	For using $s = ut + \frac{1}{2}at^2$ for AC or $v = u + at$ for AB and $s = ut + \frac{1}{2}at^2$ for BC
	$3.92 = 1.4u + 0.98a$ or $2.16 = 0.6u + 0.66a$	A1	
	$u = 1.4$ and $a = 2$	M1	For solving for u and a
		A1	6
	(ii) $[2 = 10 \sin \theta]$	M1	For using $a = g \sin \theta$
5	(i) $F = 12 \cos \alpha$	B1	
		M1	For resolving forces vertically
	$R_1 = 2g + 12 \sin \alpha$	A1	
	$[12 \times 0.8 \leq \mu(2g + 12 \times 0.6)]$	M1	For using $F_1 \leq \mu R$
	$\mu \geq 9.6/27.2 = 6/17$	A1	5 AG

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6	(ii) $12\cos\alpha > \mu R_2$	B1		
	$R_2 = 2g - 12 \times 0.6$	B1		
	$\mu < 9.6/12.8 = 3/4$	B1	3	
	(i) PE gain = $1200g \times 45$	B1		
	WD = $1200g \times 45 + 360\,000$	M1		For WD by car's engine = PE gain + WD against resistance
	Work done is 900 000 J or 900 kJ	A1	3	
	(ii) WD against resistance = $360 \times \sin 5^\circ / \sin 1^\circ$ (kJ) or $\{360000 \div (45/\sin 5^\circ)\} \times (45/\sin 1^\circ)$ (J) or $697.24... \times 2578.44...$ (J) or 1798 (kJ)	B1		
	KE gain = $1660 + 540 - 1798$	B1ft		Accept $1660 + 540 - 1800$
	$[402000 = \frac{1}{2}1200(v^2 - 225)]$	M1		For using KE gain = $\frac{1}{2}m(v^2 - 15^2)$
	Speed is 29.9 ms^{-1}	A1	4	AG
	(iii) $\frac{P_B}{P_C} = \left(\frac{DF_B}{DF_C}\right) \times \frac{v_B}{v_C} = 1.5 \times 15/29.9$	M1		For using $P = Fv$
	Ratio is 0.75	A1	3	
7	(i) $v(100) = 0.16 \times 1000 - 0.016 \times 10000 = 0$	B1	1	AG
	(ii) $a = 1.5 \times 0.16t^{1/2} - 0.032t$	M1		For using $a = dv/dt$
		A1		
	$[t^{2/3} = 0.24/0.032 \rightarrow t = 56.25 \rightarrow$ $v_{\max} = 0.16 \times 421.875 - 0.016 \times 3164.0625]$	M1		For solving $a = 0$ and subst into $v(t)$
	Maximum speed is 16.9 ms^{-1} (or $16\frac{7}{8} \text{ ms}^{-1}$)	A1	4	
	(iii) $s = 2/5 \times 0.16t^{5/2} - 0.016t^3/3$	M1		For using $s = \int v dt$
		A1		
	Distance is 1070 m	A1	3	
	(iv) $\frac{1}{3}t^{3/2}(0.192 - 0.016\sqrt{t}) = 0$	M1		For attempting to solve $s(t) = 0$
	Value of t is 144	A1	2	

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	(ii) $[720/v > 48]$ $v < 15$ i.e. speed is less than 15 ms^{-1}	M1 A1	For using $P/v - R = ma$ and $a > 0 \rightarrow P/v > R$ 2
2	(i) $F = 0.2 \times 6g \cos 8$ $[6g \sin 8 - F = 6a]$ Deceleration is 0.589 ms^{-2}	B1 M1 A1	For use of Newton's second law 3 Accept $a = -0.589$
	(ii) Distance is 7.64 m	M1 A1	For use of $0 = u^2 + 2as$ 2
3		M1	For using $v = \int a dt$
	$v = (0.8/0.25)t^{0.25} + (C)$	A1	
	$C = 1.8$	B1	
		M1	For using $s = \int v dt$
	$s = (3.2/1.25)t^{1.25} + 1.8t + (K)$	A1ft	ft only from an incorrect non-zero value of C
	Distance is 111 m	A1	6
4	(i) For triangle of forces with 60° shown correctly, or $C \cos \phi = 4 \cos 30$ and $C \sin \phi = 10 - 4 \sin 30$, or $F = 4 \cos 30$ and $R = 10 - 4 \sin 30$	B1	
	$[C^2 = 4^2 + 10^2 - 2 \times 4 \times 10 \cos 60$ or $C^2 = (4 \cos 30)^2 + (10 - 4 \sin 30)^2]$	M1	For using cosine rule or for using $C^2 = (C \cos \phi)^2 + (C \sin \phi)^2$ or $C^2 = F^2 + R^2$
	$C = 8.72$	A1	3
	(ii) $[\mu = 4 \cos 30 / (10 - 4 \sin 30)]$ Coefficient is 0.433 (accept 0.43)	M1 A1	For using $\mu = F/R = C \cos \phi / C \sin \phi$ 2
4 Alternative Method			
	(i) For obtaining $\phi = 66.6^\circ$ or $\tan \phi = 4 \div \sqrt{3}$ from $4 \div \sin(90^\circ + \phi) = 10 \div \sin(150^\circ - \phi)$	B1	
	For using C N and (4 N or 10 N) in Lami's theorem to find C $[C \div \sin 120^\circ = (4 \div \sin 156.6^\circ \text{ or } 10 \div \sin 83.4^\circ)]$	M1	
	$C = 8.72$	A1	3
	(ii) $[\mu = \sqrt{3} \div 4 \text{ or } \mu = \cos 66.6^\circ \div \sin 66.6^\circ]$ Coefficient is 0.433 (accept 0.43)	M1 A1	For using $\mu = F/R = C \cos \phi / C \sin \phi$ 2

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5	(i)	M1	For applying Newton's second law to A or to B
	$0.9g - T = 0.9a$ or $T - 0.6g = 0.6a$	A1	
	$T - 0.6g = 0.6a$ or $0.9g - T = 0.9a$ or $(0.9 - 0.6)g = (0.9 + 0.6)a$	B1	
	Acceleration is 2 ms^{-2} and tension is 7.2 N	A1	4
6	(ii)	M1	For using $0 = u - gt$
	$u = 3$	A1	
	$[3^2 = 2 \times 2 \text{ h}]$	M1	For using $v^2 = 0^2 + 2ah$ with $v_{\text{taut}} = u_{\text{slack}}$ or for using KE gain = PE loss while the string is in tension
	$[\frac{1}{2}(0.9 + 0.6)3^2 = (0.9 - 0.6)gh]$		
	Height is 2.25 m	A1	4
	(i)	B1	
	KE loss = $\frac{1}{2} 16000(15^2 - 12^2)$	B1	
	PE gain = $16000g(AB/20)$	M1	For using WD by DF = PE gain + WD against resistance – KE loss
	$1200 = 0.8g(AB) + 1.24(AB) - 648$	A1	
	Distance AB is 200m	A1	5
	(ii)	B1	1
	(iii) WD against resistance =		
	$1240(BC) + 1860(300 - BC)$	B1ft	ft distance BD
		M1	For using KE loss = PE gain + WD against res'ce – WD by DF
	$\frac{1}{2} 16000(12^2 - 7^2) =$ $2400000 + (558000 - 620BC) - 7200 \times 300$	A1	
	Distance BC is 61.3 m	A1	4
	Alternative for Q6 part (iii).		
	For BC $16000a = 7200 - 1240 - 8000$ and for CD $16000a = 7200 - 1860 - 8000$	B1	
	For using $v^2 = u^2 + 2as$ for both BC and CD	M1	
	$v_C^2 = 144 - 2 \times 0.1275(BC)$ and $49 = v_c^2 - 2 \times 0.16625(300 - BC)$	A1	
	For eliminating v_c^2 and obtaining $BC = 61.3 \text{ m}$	A1	
	SR for candidates who assume that the acceleration is constant in part (i), although there is no justification for the assumption (max. 3/5)		
	For appropriate use of Newton's second law and $v^2 = u^2 + 2as$	M1	
	$[1200000 \div AB - 1240 - 160000/20 = 16000a \text{ and } a = (12^2 - 15^2)/2(AB)]$		
	For eliminating a and attempting to solve for AB	M1	
	Distance AB is 200m	A1	

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7	(i) (a)	$[2 \times \frac{1}{2}(1+9)400]$	M1	For using area property for distance
		Approximation is 4000 m	A1	2
	(b)		M1	For using the gradient property for acceleration
		Accelerations are 0.02 ms^{-2} and -0.02 ms^{-2}	A1	2 Accept deceleration is 0.02 ms^{-2}
	(ii) (a)		M1	For using $a = dv/dt$ and attempting to solve $a = 0.02$ or $a = -0.02$.
		$0.04 - 0.0001t = \pm 0.02$	A1ft	
		Values of t are 200 and 600	A1	3
	(b)	$v_1 - v = 0.02t + 1 - 0.04t + 0.00005t^2$	B1	
		$v_1 - v = [0.00005t^2 - 0.02t + 2 - 1]$ $= 0.00005(t^2 - 400t + 40000) - 1$ $= 0.00005(t - 200)^2 - 1$	B1	2 AG
	(c)	For using $(v_1 - v)_{\min}$ occurs when $t = 200 \rightarrow -1 \leq v_1 - v$	B1	
		For using $(v_1 - v)_{\max}$ occurs when $t = 0$ and when $t = 400 \rightarrow v_1 - v \leq 1$	B1	2

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1 (i)	M1	For using the gradient property for acceleration or $v = u + at$
Acceleration is 0.02 ms^{-2}	A1	
Acceleration is -0.21 ms^{-2}	A1	3
(ii) $[\frac{1}{2}(1.5 + 2.1) \times 30 + \frac{1}{2} 2.1 \times 10 - \frac{1}{2} 2.2 \times 20]$	M1	For using the area property for displacement
Distance AB is 42.5 m	A1	2
(iii) Total distance walked is 86.5 m	B1ft	1 ft error in '64.5' or '22.0' or both
2	M1	For resolving in i and j directions.
$X = 31 + 26\cos\alpha$, $Y = 58 - 26\sin\alpha$	A1	
$X = 55$, $Y = 48$	A1	May be implied
	dM1	For using $R = (X^2 + Y^2)^{1/2}$ or $\tan \theta = Y/X$
Resultant is 73N or Direction is at 41.1° to i direction	A1	
Direction is at 41.1° to i direction or Resultant is 73N	B1	6
Alternative solution for Q2		
$[\tan \theta_{12} = 58/31, R_{12}^2 = 31^2 + 58^2]$	M1	For finding an angle and the hypotenuse of a right angled Δ whose other sides are 31 & 58
$\theta_{12} = 61.9^\circ$ and $R_{12} = 65.76$	A1	
[Incl. angle = $(180 - \theta_{12} - \alpha)^\circ$, $R^2 = 26^2 + R_{12}^2 - 2 \times 26R_{12}\cos(\text{incl. angle})$]	M1	For finding the included angle between sides R_{12} and 26 and using the cosine rule to find R
Incl. angle = 95.5° , Resultant is 73 N	A1	
$[\sin \beta = 26\sin 95.5/73; \theta = 61.9 - \beta]$	M1	For using the sine rule in the triangle to find the angle opposite 26 and subtracting this from θ_{12}
Direction is at 41.1° to i direction	A1	
3	M1	For using Newton's second law
$0.9g - 7.2 = 0.9a$ (a = 2)	A1	
$[v^2 = 2 \times (0.9g - 7.2)/0.9 \times 2]$ (v = $\sqrt{8}$)	M1	For using $v^2 = (0^2) + 2ah$
$u_{\text{slack}} = v_{\text{taut}} = 2\sqrt{g - 8}$	B1ft	ft incorrect equation for a
[distance = $4 - 32/g$]	M1	For using $(0^2) = u^2 - 2gh$ and distance = 2h
Distance is 0.8 m	A1	6

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4 (i)	$0.8g \times 4$	B1	For finding PE at A
	$[\frac{1}{2} 0.8v^2 = 32]$	M1	For using $\frac{1}{2} mv_C^2 = PE_A$ or
	Speed at C = 8.94 ms^{-1}	A1	$\frac{1}{2} mv_B^2 = PE_A$ and $v_C = v_B$
(ii)	[Either $F = 0.3(0.8g)$ and $-2.4 = 0.8a$ or $F = 0.3(0.8g)$ and $WD = 2.4 \times 5$]	M1	For using $F = \mu mg$ and either Newton's 2 nd law to find a or $WD = F \times BC$
	$[v^2 = \text{ans(i)}^2 - 2 \times 3 \times 5 \text{ or } \frac{1}{2} 0.8v^2 = 32 - 12]$	M1	For using either $v^2 = u^2 + 2as$ or $\frac{1}{2} mv^2 = PE \text{ loss} - WD \text{ by } F$
	Speed at C = 7.07 ms^{-1}	A1	3
5 (i)	Displacement is $2t^3 - kt^4/4$	M1	For using $s = \int v dt$
		A1	2
	(ii) $t = 6/k$	B1	1
(iii)	$[2 \times 216/k^3 - k \times 1296/4k^4 = 108$ $\rightarrow 2 \times 216 - 1296/4 = 108k^3]$	dM1	For substituting for t in displacement and equating to 108
	$k = 1$	A1	2
	(iv) $dv/dt = 12t - 3kt^2$ $= 0$ when $t = (0), 4$ maximum value is 32	B1 B1 B1	3
6	$R = T \cos 30$	M1 A1	For resolving forces horizontally
		M1	For resolving forces vertically (either case)
	$F = T \sin 30 - 2g$	A1	(preventing upwards motion)
	$-F = T \sin 30 - 2g$	A1	(preventing downwards motion)
		M1	For using $F = \mu R$ (either case) and attempting to solve for T
	$T = 2g/(\sin 30 \pm 0.24 \cos 30)$ either case	A1	
	$T = 28.3$ and $T = 68.5$	A1	8

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7	(i) $DF = 30000/v$ or			
	WD by DF = 30000×100	B1		
	$DF = R = 750$ ($v = 40$) or			
	WD by DF = WD by $R = 750 \times AB$	B1		
	Distance AB is 4000 m	B1	3	
	(ii) $-750 = 600a$ ($a = -1.25$)	B1		
	$20^2 = 40^2 + 2(-1.25)BC$	M1		For using $v^2 = u^2 + 2as$
	Distance BC = 480 m	A1	3	
	<u>Alternative for (ii)</u>			
		M1		For using 'Loss of energy = WD against resistance'
	$\frac{1}{2} 600(40^2 - 20^2) = 750(BC)$	A1		
	Distance BC = 480 m	A1		
	(iii) WD by engine = 30000×14	B1		
	Gain in KE = $\frac{1}{2} 600 (30^2 - 20^2)$	B1		
	$[750 \times CD = 420\,000 - 150\,000]$	M1		For using $750 \times CD =$ WD by engine – gain in KE
	Distance CD is 360 m	A1	4	