GCE AS MARKING SCHEME

SUMMER 2018

AS (NEW)
FURTHER MATHEMATICS
UNIT 3 FURTHER MECHANICS A
2305U30-1

INTRODUCTION

This marking scheme was used by WJEC for the 2018 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

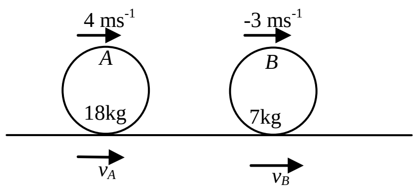
It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE Further Mathematics – AS Unit 3 Further Mechanics A

SUMMER 2018 MARK SCHEME

Q	Solution	Mark	Notes
1(a)	e = 0.75	B1	
1(b)			

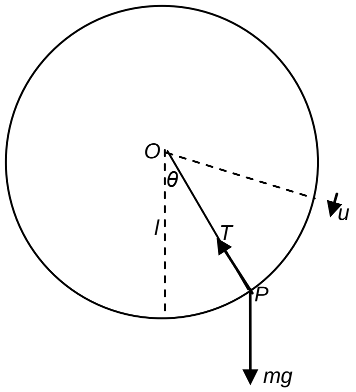


Q	Solution	Mark	Notes
	Conservation of momentum	M1	allow 1 sign error
	$18\times4 + 7\times(-3) = 18v_A + 7v_B$	A1	all correct
	Restitution	M1	allow one sign error
	$v_B - v_A = -\frac{5}{7}(-3-4)$	A1	all correct, any form
	$18v_A + 7v_B = 51$		
	$-7v_A + 7v_B = 35$		
	$25v_A = 16$	m1	one variable eliminated
	$v_A = 0.64$	A1	cao
	$v_B = 5.64$	A1	cao
1(c)	$I = 7[5.64-(-3)]$	M1	oe, ft v_A, v_B
	$I = 60.48$ Ns	A1	ft v_A, v_B
1(d)	Energy loss =		
	$0.5(18\times4^2+7\times3^2) - 0.5(18\times0.64^2+7\times5.64^2)$	M1	ft v_A, v_B
	= 60.48 (J)	A1	ft v_A, v_B provided answer +ve
1(e)	After collision *A* moves towards the wall.	B1	ft v_A

Q	Solution	Mark	Notes
2	Resistance $R = kv^2$	B1	si
	Tractive force $T = \frac{P}{v}$	M1	used
	N2L up slope	M1	dim correct equation
	$\frac{P}{14} - 14^2 k - 750g \times \frac{1}{10} = 0$	A1	correct equation,
			allow 750*a* RHS
	N2L down slope	M1	dim correct equation
	$\frac{P}{28} - 28^2 k + 750g \times \frac{1}{10} = 0$	A1	correct equation
	$\frac{4P}{14} - 4 \times 75g = 4 \times 14^2 k$		
	$\frac{P}{28} + 75g = 4 \times 14^2 k$		
	$\frac{7P}{28} = 5 \times 75g$	m1	one variable eliminated
	$P = 14700$	A1	cao *P* or *k*
	$\frac{14700}{14} - 75 \times 9 \cdot 8 = 14^2 k$	m1	
	$k = \frac{45}{28}$		
	Resistance R when v=10.5 = $\frac{45}{28} \times 10.5^2$		
	R = 177(.1875) (N)	A1	cao

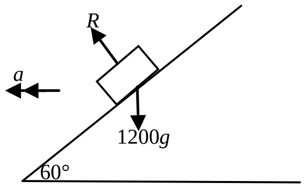
Q	Solution	Mark	Notes
3(a)	Let x be the extension in the string when P is instantaneously at rest for the 1st time.		
	Loss in PE = mgh	M1	attempted, h a distance.
	$= 30\times 9.8(0.9+x)$	A1	
	Gain in EE = $\frac{1}{2}\times\lambda\frac{x^2}{l}$	M1	attempted
	$= \frac{1}{2}\times 490\frac{x^2}{1.5}$	A1	
	Conservation of energy	M1	
	$\frac{1}{2}\times 490\frac{x^2}{1.5} = 30\times 9.8(0.9+x)$	A1	
	$x^2 - 1.8x - 1.62 = 0$	m1	attempt to solve quadratic.
	$x = \frac{1\cdot 8 \pm \sqrt{1\cdot 8^2 + 4\times 1\cdot 62}}{2}$		
	$x = 2.4588$		
	$AP = 3.96$ (m)	A1	cao
3(b)	When P is instantaneously at rest for the 2nd time $AP = 0.6$ (m)	B1	
	External resistance to motion have been assumed to be negligible.	B1	

Q	Solution	Mark	Notes
4(a)	$\mathbf{v} = \frac{d}{dt}\mathbf{x}$	M1	used
	$\mathbf{v} = 3\cos t\,\mathbf{i} + 8\sin 2t\,\mathbf{j} + 5\cos t\,\mathbf{k}$	A1	all correct
	For $\mathbf{v} = 0$, $\cos t = 0$	M1	equating either component to 0
	$t = \pi/2$, $(3\pi/2, \ldots..)$	A1	
	and $\sin 2t = 0$	M1	equating other component to 0
	$2t = 0, \pi, (2\pi, \ldots\ldots)$		
	$t = 0, \pi/2, (\pi, \ldots..)$	A1	
	Hence smallest value of t when $\mathbf{v} = 0$ is $\pi/2$.	A1	cao
4(b)	Mom. vector =		
	$3(3\cos t\,\mathbf{i} + 8\sin 2t\,\mathbf{j} + 5\cos t\,\mathbf{k})$	B1	ft **v** isw
4(c)	$\mathbf{F} = m\mathbf{a}$	M1	used
	$\mathbf{a} = -3\sin t\,\mathbf{i} + 16\cos 2t\,\mathbf{j} -5\sin t\,\mathbf{k}$	M1	**v** differentiated
	$\mathbf{F} = 3(-3\sin t\,\mathbf{i} + 16\cos 2t\,\mathbf{j} -5\sin t\,\mathbf{k})$	A1	ft v
	$\mathbf{F} = -9\sin t\,\mathbf{i} + 48\cos 2t\,\mathbf{j} -15\sin t\,\mathbf{k}$		isw

Q	Solution	Mark	Notes
5(a)(i)			
	Conservation of energy	M1	PE and KE equation
	$0.5mu^2 = 0.5mv^2 – mgl(\cos\theta – \cos 60^\circ)$	A1	PE correct
		A1	KE correct
	$v^2 = u^2 + 2lg\cos\theta – lg$	A1	si
	N2L towards centre	M1	dim correct *T* and component wt opposing
	$T – mg\cos\theta = \frac{mv^2}{l}$	A1	cao
	$T = mg\cos\theta + \frac{m(u^2 + 2\lg\cos\theta - lg)}{l}$	m1	
	$T = \frac{mu^2}{l} + 3mg\cos\theta – mg$	A1	
5(a)(ii)	For complete circles, when θ=180,T>0	M1	
	$\frac{mu^2}{l} > 4mg$		
	$u^2 > 4lg$	A1	

Q	Solution	Mark	Notes
5(b)	Circular motion ceases when T=0, u^2=3lg	M1	
	$T = 3mg + 3mg\cos\theta - mg = 0$		
	$\cos\theta = -\frac{2}{3}$, $\theta = 131.81°$	A1	cao
	When circular motion ceases, the particle P is subject to gravity and behaves as a projectile (with initial velocity upwards and tangential to the circular path).	E1	
5(c)	For complete circles, when θ=180, v^2>0	M1	
	$u^2 - 2lg - lg > 0$		
	$u^2 > 3lg$	A1	

Q	Solution	Mark	Notes
6			



Q	Solution	Mark	Notes
6(a)	Resolve vertically	M1	dim correct equation
	$R\cos60° = 1200g$	A1	
	$R = 2400g = 23520$ (N)	A1	cao
6(b)(i)	N2L towards centre	M1	dim correct equ.
	$R\sin60° = 1200a$		
	$R\sin60° = 1200\times\frac{v^2}{r}$	m1	
	$23520\times\frac{\sqrt{3}}{2} = 1200\times\frac{40^2}{r}$	A1	
	$r = 94.26$ (m)	A1	
6(b)(ii)	$\omega = \frac{v}{r} = 0.424$ rad s^{-1}	B1	
		B1	units
6(c)	The assumption was made that there are no external forces acting on the vehicle. If there is an external force with component acting horizontally towards the centre of motion, then the LHS of the equation in (b)(i) would be larger resulting in a smaller radius *r*. Similarly, if the component of force is acting away from the centre, the radius would be larger.	B1E1	