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Mark Scheme (Results)

Summer 2013

GCE Mechanics 3 (6679/01)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes:

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- $\ast$ The answer is printed on the paper
- ⎾ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

8. In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme

General Rules for Marking Mechanics

- Usual rules for M marks: correct no. of terms; dim correct; all terms that need resolving (i.e. multiplied by cos or sin) are resolved.

- Omission or extra g in a resolution is accuracy error not method error.

- Omission of mass from a resolution is method error.

- Omission of a length from a moments equation is a method error.

- Omission of units or incorrect units is not (usually) counted as an accuracy error.

- DM indicates a dependent method mark i.e. one that can only be awarded if a previous specified method mark has been awarded.

- Any numerical answer which comes from use of g = 9.8 should be given to 2 or 3 SF.

- Use of g = 9.81 should be penalised once per (complete) question.

- N.B. Over-accuracy or under-accuracy of correct answers should only be penalised *ONCE* per complete question.

- In all cases, if the candidate clearly labels their working under a particular part of a question i.e. (a) or (b) or (c),……then that working can only score marks for that part of the question.

- Accept column vectors in all cases.

- Misreads – if a misread does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, bearing in mind that after a misread, the subsequent A marks affected are treated as A ft.

Question Number	Scheme	Marks
1.	R$(\uparrow)$ $R = mg$	
	$F = \mu mg$	B1
	20 revs per min $= \frac{20}{60} \times 2\pi$ rad s^{-1}	M1A1
	$\left(= \frac{2}{3}\pi \text{ rad s}^{-1}\right)$	
	R$(\rightarrow)$ $\mu mg = m \times 0.4 \times \left(\frac{2}{3}\pi\right)^2$	M1A1ft
	$\mu = \frac{0.4 \times 4\pi^2}{9g}$	
	$\mu = 0.18$ or 0.179	A1
		[6]

Notes for Question 1

B1 for resolving vertically and using $F = \mu R$ to obtain $F = \mu mg$. This may not be seen explicitly, but give B1 when seen used in an equation.

M1 for attempting to change revs per minute to rad s^{-1}, must see $(2)\pi$. (Can use 60 or 60^2)

A1 for $\frac{20}{60} \times 2\pi$ (rad s^{-1}) oe

M1 for NL2 horizontally along the radius - acceleration in either form for this mark, F or μmg or μm all allowed. r to be 0.4 now or later. This is not dependent on the previous M mark.

A1ft for $\mu mg = m \times 0.4 \times \left(\frac{2}{3}\pi\right)^2$ follow through on their ω

A1cso for $\mu = 0.18$ or 0.179, **must be 2 or 3 sf.**

NB: Use of $\leqslant$: is allowed, provided used correctly, until the final statement, which must be $\mu = \ldots$..

Question Number	Scheme	Marks
2		
(a)	$\left(2t+\frac{1}{2}\right)=0.5\frac{dv}{dt}$	M1
	$\int(4t+1)dt=\int dv$	
	$2t^2+t=v+c$	M1dep *c* not needed
	$t=0\ v=0 \qquad c=0$	
	$v=2t^2+t\ \ \text{m s}^{-1}$	A1 inc the value for *c* (3)
(b)	$\frac{dx}{dt}=2t^2+t$	
	$x=\frac{2}{3}t^3+\frac{1}{2}t^2+k$	M1
	$t=0\ x=0 \qquad k=0$	
	$x=\frac{2}{3}t^3+\frac{1}{2}t^2$	A1
	$v=6 \quad 6=2t^2+t \quad 2t^2+t-6=0$	
	$(2t-3)(t+2)=0 \quad t=\frac{3}{2}$	M1A1
	$x=\frac{2}{3}\times\left(\frac{3}{2}\right)^3+\frac{1}{2}\left(\frac{3}{2}\right)^2$	M1dep
	$x=\frac{27}{8}$ (oe 3.4, 3.375, 3.38) m	A1 cso (6) **[9]**

Notes for Question 2

(a)

M1 for NL2 with acceleration in the form $\frac{\mathrm{d}v}{\mathrm{d}t}$, seen explicitly or implied by the integration mass can be 0.5 or m

M1dep for integrating with respect to t - constant not needed

A1cso for **showing** that $c = 0$ and giving the final result $v = 2t^2 + t$ Must see $t = 0, v = 0$ as a minimum

By definite integration:

M1 as above

M1dep for integrating, ignore limits

A1 for substituting the limits 0 and v and 0 and t and obtaining $v = 2t^2 + t$

(b)

M1 for integrating their v with respect to t constant not needed

A1 for **showing** that $k = 0$ If no constant shown this mark is lost.

M1 for setting $v = 6$ using their answer from (a) **and** attempting to solve the resulting quadratic equation, any valid method. If solved by calculator, **both** solutions must be shown.

A1 for $t = \frac{3}{2}$ negative solution need not be shown with an algebraic solution

M1dep for using **their** (positive) value for t to obtain x = ... If two positive values were obtained, then allow M1 for substituting either value. Dependent on the first M1 of (b) but not the second.

A1cso for $x = \frac{27}{8}$ (oe eg 3.375, 3.38) (All marks for (b) must have been awarded)

By definite integration:

M1 for integrating their v with respect to t limits not needed

A1 for correct integration with lower limits 0.

M1 for setting $v = 6$ using their answer from (a) **and** attempting to solve the resulting quadratic equation, any valid method. If solved by calculator, **both** solutions must be shown.

A1 for $t = \frac{3}{2}$ negative solution need not be shown with an algebraic solution

M1dep for substituting **their** limits into **their** integrated v (sub should be shown). Dependent on the first M1 of (b) but not the second

A1cso for $x = \frac{27}{8}$ (oe eg 3.375, 3.38)

Question Number	Scheme	Marks
3 (i)	For Q $\quad T = 2mg$	B1
	For P $\quad T\cos\theta = mg$	M1
	$\cos\theta = \frac{1}{2} \quad \theta = 60°$ *	A1cso
(ii)	For P $\rightarrow \quad T\sin\theta = mr\omega^2$	M1A1
	$2mg\sin\theta = m \times 5l\sin\theta \times \omega^2$	M1depA1
	$\omega^2 = \frac{2g}{5l} \quad \omega = \sqrt{\frac{2g}{5l}}$ *	A1cso
		[8]

Notes for Question 3

In this question, award marks as though the question is not divided into two parts - ie give marks for equations wherever seen.

(i)

B1 for using Q (no need to state Q being used) to state that $T = 2mg$ or $T_Q = 2mg$ with $T_P = T_Q$ seen or implied later.

M1 for attempting to resolve vertically for P T must be resolved but sin/cos interchange or omission of g are accuracy errors.
$mg + 2mg = T + T\cos\theta$ gets M0

A1cso for combining the two equations to obtain $\theta = 60°$ *

NB: This is a "show" question, so if no expression is seen for T and just $2mg\cos\theta = mg$ shown, award 0/3 as this equation could have been produced from the required result, so insufficient working.

(ii)

M1 for attempting NL2 for P along the radius. The mass used must be m if the particle is not stated to be P; a mass of $2m$ would imply use of Q. T must be resolved. Acceleration can be in either form.

A1 for $T\sin\theta = mr\omega^2$ or $T\dfrac{\sqrt{3}}{2} = mr\omega^2$

M1 dep for eliminating T between the two equations for P and substituting for r in terms of l and θ dependent on the second but not the first M mark.

A1 for $2mg\sin\theta = m \times 5l\sin\theta \times \omega^2$ or $\dfrac{T\sin\theta}{T\cos\theta} = \tan\theta = 5l\sin\theta\left(\dfrac{\omega^2}{g}\right)$ θ or $60°$

A1cso for re-arranging to obtain $\omega = \sqrt{\dfrac{2g}{5l}}$ * ensure the square root is correctly placed

Alternatives: Some candidates "cancel" the $\sin\theta$ without ever showing it.

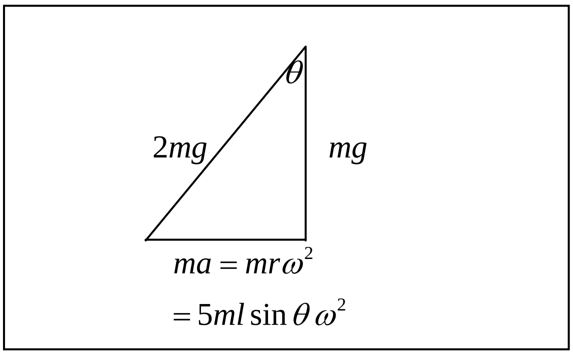
M1A1 for $T = m \times 5l\omega^2$

M1A1 for $2mg = 5ml\omega^2$

A1cso as above

Vector Triangle method: **Triangle must be seen**

$T = 2mg$	B1
$\cos\theta = \dfrac{mg}{2mg}$	M1
$\theta = 60°$	A1
Correct triangle	M1A1
$\sin\theta = \dfrac{5ml\sin\theta\omega^2}{2mg}$	M1A1
$\omega = \ldots$	A1cso (as above)



Question Number	Scheme	Marks
4		
(a)	$T = \frac{\lambda x}{l}$	
	$20 = \frac{\lambda \times 0.3}{1.2}$	M1A1
	$\lambda = 80$ N	A1
	Initial EPE = $\frac{\lambda x^2}{2l} = \frac{80 \times 0.3^2}{2.4}$ $(= 3 \text{ J})$	B1
	$\frac{80 \times 0.3^2}{2.4} - 0.4 \times 2g \times 0.3 = \frac{1}{2} \times 2v^2$	M1A1ft
	$v^2 = 0.648$	
	$v = 0.80$ or 0.805 m s^{-1}	A1 (7)
(b)	Comes to rest $0.4 \times 2g \times y = 3$	M1
	$y = \frac{3}{0.4 \times 2 \times 9.8} = 0.38$ or 0.383 m	A1 (2)
		[9]
	Alternatives: Energy from string going slack to rest:	
	$\frac{1}{2} \times 2 \times 0.648 = 0.4 \times 2g \times x$	
	$x = 0.8265...$	
	$y = 0.3 + 0.08265... = 0.38$ or 0.383	M1 Complete method A1
	NL2 to obtain the accel when string is slack $\left(-\frac{2g}{5}\right)$ and $v^2 = u^2 + 2as$	
	$0 = 0.648 + 2 \times \left(-\frac{2g}{5}\right)s$	
	$BC = \frac{0.648 \times 5}{4g} + 0.3 = 0.38$ or 0.383	M1A1

Notes for Question 4

(a)

M1 for attempting Hooke's Law, formula must be correct, either explicitly or by correct substitution.

A1 for $20 = \frac{\lambda \times 0.3}{1.2}$

A1 for obtaining $\lambda = 80$

B1 for the initial EPE $\frac{"\lambda" \times 0.3^2}{2.4}$ $(= 3 \text{ J})$ their value for λ allowed. May only be seen in the eqaution.

M1 for a work-energy equation with one EPE term, one KE term and work done against friction (Award if second EPE/KE terms included **provided** these become 0). The EPE must be dimensionally correct, but need not be fully correct (eg denominator 1.2 instead of 2.4)

A1ft for a completely correct equation follow through their EPE

A1 cao for $v = 0.80$ or 0.805 must be 2 or 3 sf

NB: This is damped harmonic motion (due to friction) so all SHM attempts lose the last 4 marks.

(b)

M1 for any **complete** method leading to a value for either *BC*. If the distance travelled after the string becomes slack is found the work must be completed by adding 0.3 Their EPE found in (a) used in energy methods.

MS method is energy from *B* to *C* ie work done against friction = loss of EPE.

OR Energy from point where the string becomes slack to *C* ie work done against friction = loss of KE and completed for the required distance

OR NL2 to obtain the acceleration $\left(-\frac{2g}{5}\right)$ while the string is slack **and** $v^2 = u^2 + 2as$ to find the distance and completed for the required distance

A1cso for $BC = 0.38$ or 0.383 (m) **must be 2 or 3 sf**

Question Number	Scheme	Marks
5(a)	$V=\int_0^2 \pi y^2\,\mathrm{d}x=\pi\int_0^2 (x+1)^4\,\mathrm{d}x$	M1
	$=\pi\left[\frac{1}{5}(x+1)^5\right]_0^2$	A1
	$=\frac{1}{5}\pi\left[3^5-1\right]\quad\left(=\frac{242\pi}{5}\right)$	M1
	$\int_0^2 \pi y^2 x\,\mathrm{d}x=\pi\int_0^2 x(x+1)^4\,\mathrm{d}x$	M1
	$=\pi\left[\frac{x(x+1)^5}{5}\right]_0^2-\pi\int_0^2\frac{(x+1)^5}{5}\mathrm{d}x,\ =\frac{2\times3^5\pi}{5}-\pi\left[\frac{(x+1)^6}{30}\right]_0^2$	A1
	$\left[\frac{2\times3^5}{5}-\frac{3^6}{30}+\frac{1}{30}\right]\pi\quad(=72.933...\pi)$	M1
	ALT: by expanding $=\pi\int_0^2\left(x^5+4x^4+6x^3+4x^2+x\right)\mathrm{d}x$	
	$=\pi\left[\frac{x^6}{6}+\frac{4}{5}x^5+\frac{6}{4}x^4+\frac{4}{3}x^3+\frac{1}{2}x^2\right]_0^2$	M1A1
	$=\pi\left[\frac{2^6}{6}+\frac{4}{5}\times2^5+\frac{6}{4}\times2^4+\frac{4}{3}\times2^3+\frac{1}{2}\times2^2\right]$	M1
	OR by subst: $\pi\int_1^3(u-1)u^4\mathrm{d}u,\ =\pi\left[\frac{u^6}{6}-\frac{u^5}{5}\right]_1^3,\ =\pi\left[\frac{3^6}{6}-\frac{3^5}{5}-\left(\frac{1}{6}-\frac{1}{5}\right)\right]$	M1A1M1
	$\bar{x}=\dfrac{\pi\left[\frac{2\times3^5}{5}-\frac{3^6-1}{30}\right]}{\frac{242\pi}{5}}$ OR $\dfrac{\pi\left[\frac{2^6}{6}+\frac{4\times2^5}{5}+\frac{6\times2^4}{4}+\frac{4\times2^3}{3}+\frac{2^2}{2}\right]}{\frac{242\pi}{5}},\ =1.5068$	M1, A1 (8)
(b)	hemisphere / S / T	
	Mass ratio: $10\times\frac{2\pi}{3}\times1$ / $\frac{242\pi}{5}$ / $\left(\frac{20}{3}+\frac{242}{5}\right)\pi=\frac{826}{15}\pi$	B1ft on S
	Dist from A: $2+\frac{3\times1}{8}$ / 0.493 / $\bar{x}$	B1ft on S
	$\frac{20}{3}\times\frac{19}{8}+\frac{242}{5}\times0.493=\left(\frac{20}{3}+\frac{242}{5}\right)\bar{x}$	M1A1ft
	$\bar{x}=0.7208...$ cm (awrt 0.72)	A1 (5) **[13]**

Notes for Question 5

NB: Some candidates will omit π throughout (as they know it cancels). In such cases award all marks if earned. If π is omitted from one integration only but then appears in the result of that integration at the last stage or is then omitted from the second integration, all marks can be gained. But if omitted from one integration, including the last stage, and included with the other mark strictly according to the MS.

(a)

M1 for using $V = \int_0^2 \pi y^2 \, dx = \pi \int_0^2 (x+1)^4 \, dx$ - limits not needed and attempting the integration by inspection or expansion (algebra **must** be seen)

A1 for correct integration - limits not needed

M1 for substituting the correct limits into **their** integrated function - no need to simplify

M1 for attempting to integrate $\int_0^2 \pi y^2 x \, dx = \pi \int_0^2 x(x+1)^4 \, dx$ - limits not needed - by parts. This mark can be awarded once the integral has been expressed as the difference of an appropriate integrated function and an integral

A1 for correct, complete integration $\pi\left[\frac{x(x+1)^5}{5}\right]_0^2 - \pi\left[\frac{(x+1)^6}{30}\right]_0^2$ or $\frac{2\times 3^5\pi}{5} - \pi\left[\frac{(x+1)^6}{30}\right]_0^2$ Limits not needed

M1 for substituting the correct limits into **their** integrated function - no need to simplify

Alternative methods for $\int_0^2 \pi y^2 x \, dx = \pi \int_0^2 x(x+1)^4 \, dx$

M1 for expanding and integrating or making a suitable substitution and attempting the integration - limits not needed

A1 for correct integration - limits not needed

M1 for substituting the correct limits into **their** integrated function - no need to simplify

M1 for using $\bar{x} = \dfrac{\int \pi y^2 x dx}{\int \pi y^2 dx}$ Their integrals need not be correct.

A1cao for $\bar{x} = 1.5068...$ Accept 1.5, 1.51 or better or $\frac{547}{363}$

(b)

B1ft for correct mass ratio, follow through their volume for *S* need π now

B1ft for correct distances, follow through their distance for *S*, but remember it must be 2 - answer from (a) if working from *A*. Distances from the common face are $-\frac{3}{8}$, ans from (a), $\bar{x}$ Distances from other end are $\frac{5}{8}$, $1+$ans from (a), $\bar{x}$

M1 for a dimensionally correct moments equation

A1ft for a fully correct moments equation, follow through their distances and mass ratio

A1cao for 0.7208...Accept 0.72 or better (Exact is $\frac{1191}{1652}$)

Question Number	Scheme	Marks
6(a)	$\frac{24e}{1.5} = \frac{18(1.5-e)}{0.75}$	M1A1
	$16e = 36 - 24e$	
	$e = 0.9$	A1
	$AO = 2.4\ \text{m}$*	A1ft (4)
(b)	$\frac{18(0.6-x)}{0.75} - \frac{24(0.9+x)}{1.5} = m\ddot{x}$ or $0.8\ddot{x}$	M1A1A1
	$14.4 - 24x - 14.4 - 16x = m\ddot{x}$ or $0.8\ddot{x}$	
	$\ddot{x} = -\frac{40x}{0.8 \text{ or } m}$ $(= -50x)$ $\therefore$ SHM	M1depA1 (5)
(c)	$\ddot{x} = -50x \Rightarrow \omega = \sqrt{50}$ or $5\sqrt{2}$	B1
	max. speed = $\sqrt{2} \Rightarrow a \times 5\sqrt{2} = \sqrt{2}$	M1
	$a = \frac{1}{5}$	A1
	$-0.1 = 0.2\cos(5\sqrt{2})t$	M1
	$t = \frac{1}{5\sqrt{2}}\cos^{-1}\left(-\frac{1}{2}\right)$	
	$t = \frac{1}{5\sqrt{2}} \times \frac{2\pi}{3} = \frac{\pi\sqrt{2}}{15}$ or 0.296s $(0.2961...)$ Accept 0.30, or better	A1 (5)
		[14]

Notes for Question 6

(a)

M1 for using Hooke's Law for each string, equating the two tensions and solving to find the extension in either string. The extensions should add to 1.5. The formula for Hooke's law must be correct, either shown explicitly in its general form or implicitly by the substitution.

A1 for a correct equation

A1 for $e = 0.9$

A1cso for 2.4 (m) *

Alternative: Find the ratio of the two extensions and divide 1.5 m in that ratio.
M1 complete method A1 correct ratio A1 extension in *AO*
A1 2.4 (m)

(b)
M1 for an equation of motion for *P*. There must be a difference of two tensions. The acceleration can be *a* or $\ddot{x}$ here and *x* should be measured from the equilibrium position (*O*) unless a suitable substitution is made later. Mass can be *m* or 0.8

A1,A1 for $\frac{18(0.6-x)}{0.75} - \frac{24(0.9+x)}{1.5} = m\ddot{x}$ or $0.8\ddot{x}$ or *a* instead of $\ddot{x}$ Give A1A1 if the equation is completely correct and A1 if only one error. Note that if the difference of the tensions is the wrong way round, this is *one* error

M1dep for simplifying to $\ddot{x} = \text{f}(x)$ Must be $\ddot{x}$ now.

A1 for $\ddot{x} = -\frac{40x}{0.8 \text{ or } m}$ $(= -50x)$ **and the conclusion** (ie $\therefore$ SHM)

(c)
B1 for $\omega = \sqrt{50}$ or $5\sqrt{2}$ need not be shown explicitly

M1 for using max speed $= a\omega = \sqrt{2}$ with **their** ω

A1 for $a = \frac{1}{5}$

M1 for using $x = a\cos\omega t$ with **their** ω and *a* and $x = \pm(0.3 - a)$ **or** $x = a\sin\omega t$ provided the work is completed by adding a quarter of their period is added to the time to complete the method.

A1cao for $t = \frac{\pi\sqrt{2}}{15}$ or 0.296 s $(0.2961...)$ Accept 0.30 or better

Question Number	Scheme	Marks
7 **(a)**	$T-5mg\cos\theta=\dfrac{5mv^2}{a}$	M1A1
	$\dfrac{1}{2}\times5mv^2-\dfrac{1}{2}\times5m\times\dfrac{9ag}{5}=5mga\cos\theta$	M1A1
	$5mv^2=10mga\cos\theta+9mga$	
	$T=5mg\cos\theta+10mg\cos\theta+9mg$	M1dep
	$T=3mg(5\cos\theta+3)$ *	A1 (6)
(b)	$T=0\quad\cos\theta=-\dfrac{3}{5}$	B1
	$v^2=\dfrac{9ag}{5}-\dfrac{6ag}{5}=\dfrac{3ag}{5}$	M1
	$v=\sqrt{\dfrac{3ag}{5}}$	A1 (3)
(c)	horiz comp of vel at $B=\sqrt{\dfrac{3ag}{5}}\times\dfrac{3}{5}$	M1
	vert comp = $\sqrt{\dfrac{3ag}{5}}\times\dfrac{4}{5}$	M1
(i)	$x=-\dfrac{4a}{5}+\dfrac{3}{5}\sqrt{\dfrac{3ag}{5}}t$	M1depA1
	$y-\dfrac{3a}{5}=\dfrac{4}{5}\sqrt{\dfrac{3ag}{5}}t-\dfrac{1}{2}gt^2$	M1depA1ft
(ii)	$y=\dfrac{4}{5}\sqrt{\dfrac{3ag}{5}}t-\dfrac{1}{2}gt^2+\dfrac{3a}{5}$	A1 (7) **[16]**

Notes for Question 7
(a) M1 for attempting NL2 along the radius when the string makes an angle θ with the downward vertical. The acceleration can be in either form, the weight must be resolved and T must be included (not resolved). Sin/cos interchange or omission of g are accuracy errors as is omission of 5 in one or both terms. Radius can be a or r. A1 for a correct equation $T - 5mg\cos\theta = \frac{5mv^2}{a}$ Acceleration must be in the $\frac{v^2}{r}$ form now. M1 for a conservation of energy equation from the horizontal to the same point. There must be a difference of 2 KE terms and a loss of PE term (which may be indicated by a difference of 2 PE terms). The initial KE can be $\frac{1}{2}\times mass\times\left(\sqrt{\frac{9ag}{3}}\right)^2$ or $\frac{1}{2}\times mass\times u^2$ for this mark. Omission of g and sin/cos interchange are accuracy errosr. Mass can be m or 5m here or just "mass". Use of $v^2 = u^2 + 2as$ gets M0 A1 for a fully correct equation $\frac{1}{2}\times(5m)v^2 - \frac{1}{2}\times(5m)\times\frac{9ag}{5} = (5m)ga\cos\theta$ M1dep for eliminating v^2 between the 2 equations. Dependent on both previous M marks. A1cso for $T = 3mg(5\cos\theta + 3)$ * **(b)** B1 for obtaining $\cos\theta = -\frac{3}{5}$ M1 for using **their** value for $\cos\theta$ - must be numerical - in the energy equation to get $v^2 = ...$ (no need to simplify) Accept with 5m or m. **OR** making $T = 0$ and $\cos\theta = -\frac{3}{5}$ (their value) in $T - 5mg\cos\theta = \frac{5mv^2}{a}$ A1cao for $v = \sqrt{\frac{3ag}{5}}$ oe Check square root is applied correctly. (c) M1 for resolving **their** v to get the horizontal component of the speed at B. May not be seen explicitly, but seen in their attempt at x. M1 for resolving **their** v to get the vertical component of the speed at B Both of these M marks can be given if sin and cos are interchanged or numerical substitutions not made. M1dep for attempting to obtain x by using the distance from B to the y-axis with the horizontal distance travelled (found using their horizontal component, so dependent on the first M1 of (c)) A1cso for $x = -\frac{4a}{5} + \frac{3}{5}\sqrt{\frac{3ag}{5}}t$

Notes for Question 7 Continued

M1dep for attempting to obtain y by using $s = ut + \frac{1}{2}at^2$ with **their** vertical component and using the initial vertical distance above the x-axis. Dependent on the second M mark of (c)

A1ft for $y - \frac{3a}{5} = \frac{4}{5}\sqrt{\frac{3ag}{5}}t - \frac{1}{2}gt^2$ Follow through their initial vertical component

A1cao for $y = \frac{4}{5}\sqrt{\frac{3ag}{5}}t - \frac{1}{2}gt^2 + \frac{3a}{5}$

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