CAMBRIDGE
International Education

Cambridge International AS & A Level

MATHEMATICS **9709/43**

Paper 4 Mechanics **October/November 2025**

MARK SCHEME

Maximum Mark: 50

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:
Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:
Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:
Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:
Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:
Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:
Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Mathematics-Specific Marking Principles

1 Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.

2 Unless specified in the question, non-integer answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.

3 Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.

4 Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).

5 Where a candidate has misread a number or sign in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 A or B mark for the misread.

6 Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

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Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	More information required
	Accuracy mark awarded zero
	Accuracy mark awarded one
	Independent accuracy mark awarded zero
	Independent accuracy mark awarded one
	Independent accuracy mark awarded two
	Benefit of the doubt
	Blank Page
	Incorrect
Dep	Used to indicate DM0 or DM1

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Annotation	Meaning
DM1	Dependent on the previous M1 mark(s)
FT	Follow through
~~	Indicate working that is right or wrong
Highlighter	Highlight a key point in the working
ISW	Ignore subsequent work
J	Judgement
JU	Judgement
M0	Method mark awarded zero
M1	Method mark awarded one
M2	Method mark awarded two
MR	Misread
O	Omission or Other solution
Off-page comment	Allows comments to be entered at the bottom of the RM marking window and then displayed when the associated question item is navigated to.
On-page comment	Allows comments to be entered in speech bubbles on the candidate response.
PE	Judgment made by the PE
Pre	Premature approximation
SC	Special case
SEEN	Indicates that work/page has been seen

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Annotation	Meaning
SF	Error in number of significant figures
	Correct
TE	Transcription error
XP	Correct answer from incorrect working

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Mark Scheme Notes

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

M Method mark, awarded for a valid method applied to the problem. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).

B Mark for a correct result or statement independent of method marks.

DM or **DB** When a part of a question has two or more 'method' steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly, when there are several B marks allocated. The notation DM or DB is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.

FT Implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only.

- A or B marks are given for correct work only (not for results obtained from incorrect working) unless follow through is allowed (see abbreviation FT above).
- For a numerical answer, allow the A or B mark if the answer is correct to 3 significant figures or would be correct to 3 significant figures if rounded (1 decimal place for angles in degrees).
- The total number of marks available for each question is shown at the bottom of the Marks column.
- Wrong or missing units in an answer should not result in loss of marks unless the guidance indicates otherwise.
- Square brackets [ ] around text or numbers show extra information not needed for the mark to be awarded.

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Abbreviations

AEF/OE	Any Equivalent Form (of answer is equally acceptable) / Or Equivalent
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
CAO	Correct Answer Only (emphasising that no 'follow through' from a previous error is allowed)
CWO	Correct Working Only
ISW	Ignore Subsequent Working
SOI	Seen Or Implied
SC	Special Case (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)
WWW	Without Wrong Working
AWRT	Answer Which Rounds To

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Question	Answer	Marks	Guidance
1(a)	$1.6\ \text{ms}^{-2}$	**B1**	oe e.g. $\frac{8}{5}$ etc. Condone -1.6.
		1	
1(b)	$[3\times]\frac{1}{2}\times10\times8$ or $[6\times]\frac{1}{2}\times5\times8$	**M1**	Correct expression for the area of either one of the right-angled triangles with base length 5 or one of the isosceles triangles of base length 10. Sight of 40 or 20 as part of a total distance calculation can score this mark.
	120 m	**A1**	
		2	

Question	Answer	Marks	Guidance
2(a)	Driving force $F=\frac{105000}{35}$ [=3000]	**B1**	OE e.g. $F\times35=105000$.
	$F-35\times c=400\times0.5$	**M1**	Use of N2L; allow sign errors but must be 3 terms. Allow F or any non-zero value for the driving force (but not 105000). If assuming a = 0 then e.g. $105000=c\times35^2$ ($\Rightarrow c=85.714...$) scores **B1 M0.**
	$\frac{105000}{35}-35\times c=400\times0.5\Rightarrow c=80$ $(2800=35c\Rightarrow c=80)$	**A1**	**AG** – a correct equation for c e.g. $3000-35\times c=400\times0.5$ followed by c = 80 scores **A1.**
		3	

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Question	Answer	Marks	Guidance
2(b)	$\frac{105000}{v} - 80 \times v - 400g \times \frac{3}{20}[=0]$ $\Rightarrow 80v^2 + 600v - 105000[=0]$	**B1**	**B1** for correct weight component: $\pm 400g \times \frac{3}{20}$ or $\pm 400g \times \sin\left(\sin^{-1}\left(\frac{3}{20}\right)\right)$. $[= \pm 600]$.
	OR $80v^2 + 600v = 105000$	**M1**	OE. **M1** for applying N2L with the correct number of dimensionally correct terms (with $a = 0$) **leading to a three term quadratic equation/expression in v**. Allow sign errors and sin/cos mix on the weight component. **Must** be using $c = 80$ for this mark.
	Speed = 32.7 m s^{-1} ONLY	**A1**	CWO. Allow exact $\frac{-15 + 5\sqrt{849}}{4}$ or AWRT 32.7. (For reference: 32.6720057…). If negative value (–40.172...) stated, then must be rejected for this mark.
		3	

Question	Answer	Marks	Guidance
3(a)	$R + 25\sin 36 = 4g \quad [\Rightarrow R = 25.30536...]$	***M1**	Attempt to resolve vertically to form an equation for the normal contact force for the block; correct number of dimensionally correct terms, condone sign errors, and sin/cos mix on the 25 N force term. Use of $R = 4g$ scores no marks in this part.
	Work done against friction $= 120 \times \frac{2}{5} \times (40 - 25\sin 36)$	**DM1**	Use of Work done = $0.4R \times 120$ ONLY so **M0** if subtracting/adding the Work done by the pulling force to this value e.g. a final answer of 1212 (or 1210) coming from $120 \times (25\cos 36 - 0.4 \times (40 - 25\sin 36))$ scores **M1 M0 A0.**
	1210 or 1215 J	**A1**	CWO 1210 or final AWRT 1215 or 1214 (usually coming from using $R = 25.3$). For reference: 1214.6576…
		3	

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Question	Answer	Marks	Guidance
3(b)	KE change = $\pm\left(\frac{1}{2}\times 4\times v_B{}^2-\frac{1}{2}\times 4\times 7^2\right)$	**B1**	SOI, by KE terms on opposite sides of an equation with the same sign so must imply a change in KE (e.g. $2v^2$ on one side and 98 on the other).
	Work Done by pulling force = $\pm 25\cos 36\times 120$ $\left[=\pm 2427.050...\right]$	**B1**	
	$\frac{1}{2}\times 4\times v_B{}^2-\frac{1}{2}\times 4\times 7^2=25\cos 36\times 120-'1214.65...'$ $\left[2v_B{}^2-98=2427.050...-'1214.65...'\right]$	**M1**	Attempt at work-energy equation using their work done against friction from **3(a)** with four dimensionally correct terms but allow sign errors and sin/cos mix on the pulling force term. Dependent on **both M1** marks in **3(a)** unless the total work done is recovered in this part e.g. a candidate might, in **3(a)**, find the total work done by the block (which if correct is 1212.39…) rather than the required work done against friction. Therefore, an answer of 1212.39… **3(a)** would score **M1 M0 A0** but then seeing $2v^2-98=1212.39...$ (or even 1210 but only if coming from 1212.39…) followed by 25.6 would score full marks in this part. **M0** if using 25×120 for the pulling force.
	$v_B=25.6\,\text{m s}^{-1}$	**A1**	AWRT 25.6. (For reference: 25.59680…).
	Special case for using N2L Maximum 2 marks		
	$25\cos 36-0.4(40-25\sin 36)=4a\Rightarrow a=2.53$	**B1**	This is for getting $a=2.53$. (For reference: a = 2.525819…).
	$v^2=7^2+2\times 2.5258...\times 120\Rightarrow v=25.6\ \text{m s}^{-1}$	**B1**	AWRT 25.6. (For reference: 25.59680…).
		4	

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Question	Answer	Marks	Guidance
4(a)	Attempt to differentiate $s = 0.01t^3 - 0.3t^2 - 2.07t$	***M1**	Decrease power by 1 and change of coefficient on the same term; $a = \frac{v}{t}$ is **M0.**
	$[v =] \, 0.03t^2 - 0.6t - 2.07$	**A1**	Allow un-simplified.
	$[a =] \, 0.06t - 0.6$ **OR** $[v] = 0.03(t-10)^2 - 5.07$	**A1**	Allow un-simplified. Must follow from the correct **3 term quadratic** in t for v so **A0** if coming from $v = 0.03t^2 - 0.6t$. Or the correct completing the square form for the correct expression for v.
	$0.06t - 0.6 = 0 \ \ (\Rightarrow t = 10)$	**DM1**	Setting their $a = 0$ where a is a two-term linear expression (of the form $k_1t + k_2$ where $k_1, k_2 \neq 0$) in t. Or setting their $t - 10$ (from completing the square on a three term quadratic in t) equal to 0.
	$s = -40.7$	**A1**	CWO (so first four marks must have been awarded). Must be negative so do not allow $s = -40.7 \Rightarrow s = 40.7$ so no ISW. Saying that $s = -40.7$ **or** 40.7 is **A0.**
	$v = -5.07 \Rightarrow$ speed is 5.07 m s^{-1}	**A1**	CWO (so first four marks must have been awarded or first three marks if completing the square). Must be positive – allow **A1** if negative sign is dropped without justification but saying speed is either -5.07 **or** 5.07 is **A0.**
		6	

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Question	Answer	Marks	Guidance
4(b)	$0.03t^2 - 0.6t - 2.07 = 0$	***M1**	Set their 3 term quadratic expression in t for v equal to zero – dependent on first **M1** mark in **4(a)**. This mark can be implied by a correct value of $t = 23$ appearing in this part.
	$t = 23$	**A1**	CWO Ignore mention of $t = -3$. Working might appear in **4(a)**, but this value must be stated in **4(b)** to earn this mark.
	$a = 0.06 \times 23 - 0.6$	**DM1**	Their positive t substituted into their two-term linear expression for a – this mark can be implied by a correct answer.
	$a = 0.78\,\text{m s}^{-2}$ ONLY	**A1**	OE e.g. $\frac{39}{50}$, etc. if -0.78 found then must be explicitly rejected.
		4	

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Question	Answer	Marks	Guidance
5(a)	Attempt at N2L for either A **or** B **or** the system	***M1**	Correct number of dimensionally correct terms, allow sign errors. Condone using $a = \pm 10$ (or another incorrect value of a) in either the equation for A or B for this mark **only.**
	A: $T - 2g = 2a$ B: $6g - T = 6a$ System: $6g - 2g = (2+6)a$	**A1**	For any two correct equations in a and T (or implied by correct answers) – note that T must be positive in one equation and negative in the other. Note that the three equations: $2g - T = 2a, T - 6g = 6a$ and $2g - 6g = 8a$ score **M1 A1** and lead to $T = 3g$ and $a = -0.5g$.
	Solving for T	**DM1**	From two N2L equations (both containing a) with the correct number of dimensionally correct terms OE.
	$a = 0.5g$ or 5 m s^{-2} **and** $T = 3g$ or 30 N	**A1**	a **must** be positive – allow those who say $a = -0.5g \Rightarrow a = 0.5g$ (or $a = -5 \Rightarrow a = 5$) without justification (but must be from correct working).
		4	

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Question	Answer	Marks	Guidance
5(b)	$-3.2 = 1.2t + \frac{1}{2} \times (-5) \times t^2$ **OR** $3.2 = -1.2t + \frac{1}{2} \times 5 \times t^2$	**M1**	Using $s = ut + \frac{1}{2}at^2$ with $s = \pm 3.2$, $u = \pm 1.2$ and their a from **5(a)** (not $\pm g$ but allow ± 10 if come from wrong working in **5(a)**) – dependent on either a system equation with the correct number of dimensionally correct terms from **5(a) or** from equations for A and B that both contain the correct number of dimensionally correct terms – or other complete method to find t.
	1.4(0) s	**A1**	AWRT 1.4 or $\frac{6 + 2\sqrt{209}}{25}$. (For reference: 1.39654…).
		2	
5(c)	Distance A travels from initial position to first time at rest: $0 = 1.2^2 + 2 \times (-5) \times s_1 \quad (\Rightarrow s_1 = 0.144)$ OR $0 = (-1.2)^2 + 2 \times (5) \times s_1 \; (\Rightarrow s_1 = -0.144)$ OR $s_1 = 1.2 \times 0.24 + \frac{1}{2} \times (-5) \times 0.24^2 \; (\Rightarrow s_1 = 0.144)$	**M1**	Attempt at finding the distance of A below its starting position when it first comes to instantaneous rest. Using 1.2 and their 5 from **5(a)** – same dependency as in **5(b)** for the value of a from **5(a).** If using $s = 1.2 \times t_1 + 0.5at_1^2$ then their t_1 must have come from $0 = 1.2 + a \times t_1$ with their value of a from **5(a).** Energy for A: $0 - \frac{1}{2} \times 2 \times 1.2^2 = 2 \times 10 \times s_1 - 30 \times s_1$. Energy for B: $0 - \frac{1}{2} \times 6 \times 1.2^2 = -6 \times 10 \times s_1 + 30 \times s_1$. Energy for system: . $0 - \left(\frac{1}{2} \times 2 \times 1.2^2 + \frac{1}{2} \times 6 \times 1.2^2 \right) = 2 \times 10 \times s_1 - 6 \times 10 \times s_1$. If using energy – must have the correct number of dimensionally correct terms but allow sign errors. If considering either A or B then their value of T (= 30) is dependent on both **M1** marks in **5(a)**.

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Question	Answer	Marks	Guidance
	$w^2 = 1.2^2 + 2\times5\times3.2$ or $w^2 = 0^2 + 2\times5\times(3.2+0.144)$ $\left(\Rightarrow w^2 = 33.44, w = 5.7827...\right)$ OR $w = 1.2 + 5(1.1565... - 0.24)$	***M1**	Correct method to find the speed or speed^2 of A/B after travelling 3.2 metres (oe) – using 1.2 and their a from **5(a)** – same dependency as in part **(b)** for the value of a from **5(a)**. If using $v = u + at$ then t must come from considering $t_2 - t_1$ (see reference on previous page).
	Distance A travels from a point 6.4 metres above the ground to rest: $0 = 33.44 + 2\times(-10)\times s_2$ $\left(\Rightarrow s_2 = 1.672\right)$	**DM1**	Attempt to find the distance travelled by A after B hits the ground, using their w, $a = -g$ and $v = 0$.
	Difference in distances is $s_1 + 3.2 + s_2 = 5.016$ m	**A1**	AWRT 5.02 or 5.01 CWO.
		4	

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Question	Answer	Marks	Guidance
6(a)	$m\times u+2\times(-3u)=m\times\left(-\frac{1}{3}u\right)+2\times v$	**M1**	Attempt at conservation of momentum with correct number of terms. **Allow sign errors ONLY** so **no** misreads in this part. However, if using g with either (or both) masses, then allow this mark but do not allow subsequent **A** marks.
	$v=\frac{2}{3}mu-3u$	**A1**	A correct (un-simplified) expression for the velocity of Q after the collision e.g. $\frac{(2m-9)u}{3}, \frac{4}{6}mu-3u,$ $\frac{mu-6u+\frac{1}{3}mu}{2}$, etc.
	$v>0\Rightarrow\frac{2}{3}mu-3u>0\therefore m>4.5$	**A1**	**AG** CWO – accept a correct expression for v put >0 followed by $m>4.5$. Note that $\frac{2}{3}mu-3u=0\Rightarrow m=4.5\therefore m>4.5$ is **A0**. Using trial and improvement to show that v is negative with value(s) of m that are less than 4.5 is **A0** unless they also show that $v=0$ when $m=4.5$. Similarly, if attempting to show that v is positive with value(s) of m that are greater than 4.5 they must also show that $v=0$ when $m=4.5$ for **A1**. This **A1** mark is dependent on the previous **A1** mark.
		3	

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Question	Answer	Marks	Guidance
6(b)	[Q's speed is reduced by 75% by its impact with the wall $\Rightarrow$] speed after impact is $\frac{1}{4}\left(\frac{2}{3}mu-3u\right)\left[=\frac{1}{6}mu-\frac{3}{4}u\right]$	***B1FT**	Follow through their v of the form k_1mu+k_2u (if simplified) for $k_1,k_2\neq 0$ from **6(a)** OE e.g. $\frac{(2m-9)u}{12}$ or possibly implied by later working e.g. $-\frac{1}{3}u\leqslant\frac{(9-2m)u}{12}$. Allow $\pm$ e.g. $-\frac{1}{4}\left(\frac{2}{3}mu-3u\right)$. **Look out for this expression embedded in later (possibly incorrect) working.**
	No further collisions therefore $\frac{1}{3}u\geqslant\frac{1}{6}mu-\frac{3}{4}u$	**DM1**	For $\frac{1}{3}u\geqslant\frac{1}{4}v$ with v of the form k_1mu+k_2u for $k_1,k_2\neq 0$ from **6(a) –** allow > or = for this mark Note that $\frac{4}{3}u=\frac{2}{3}mu-3u$ (which leads to m = 6.5) scores **B1 M1** ONLY.
	Solve inequality to obtain $m\leqslant 6.5$	**DM1**	Solve to obtain an inequality of the form '$m <$' or '$m \leqslant$'. **Dependent on both previous marks - M0** if an equation for m found rather than an inequality for a range of values of m.
	$(4.5<)m\leqslant 6.5\Rightarrow m=6$	**A1**	CWO – condone m = 6 from m < 6.5.
		4	

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Question	Answer	Marks	Guidance
7(a)	For resolving in any direction to form an equation	***M1**	Correct number of relevant dimensionally correct terms; allow sin/cos mix; allow sign errors. Forces that need resolving should be resolved, forces that do not need resolving should not be resolved.
	Perpendicular to plane: $R = 6g\cos\theta + 12\sin\theta$	**A1**	Or $12 + F\cos\theta = R\sin\theta$ (resolving horizontally).
	Parallel to plane: $F + 12\cos\theta = 6g\sin\theta$ **or** $6g\sin\theta - 12\cos\theta = \mu(...)$	**A1**	Or $R\cos\theta + F\sin\theta = 6g$ (resolving vertically).
	For use of $F = \mu R$ to get an equation in μ and θ only	**DM1**	From dimensionally correct equations with the correct number of relevant terms (forces that need resolving should be resolved, forces that do not need resolving should not).
	$6g\sin\theta - 12\cos\theta = \mu(6g\cos\theta + 12\sin\theta)$ leading to $\mu = \dfrac{5\tan\theta - 1}{5 + \tan\theta}$ With some evidence of intermediate step e.g. $\dfrac{12\cos\theta\left(\dfrac{5\sin\theta}{\cos\theta} - 1\right)}{12\cos\theta\left(5 + \dfrac{\sin\theta}{\cos\theta}\right)}$ OR $\dfrac{12\cos\theta(5\tan\theta - 1)}{12\cos\theta(5 + \tan\theta)}$ OR 'divide by cosine' OR use/mention of $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$ OR $\sin\theta = \tan\theta\cos\theta$, etc.	**A1**	**AG –** CWO must give some indication of how the equation in sin/cos leads to the given answer e.g. $\mu = \dfrac{6g\sin\theta - 12\cos\theta}{6g\cos\theta + 12\sin\theta}$ then 'divide through by cos' gives $\mu = \dfrac{5\tan\theta - 1}{5 + \tan\theta}$ scores **A1** (so therefore mentioning 'dividing by cos'). Seeing $\mu = \dfrac{6g\sin\theta - 12\cos\theta}{6g\cos\theta + 12\sin\theta} = \dfrac{5\tan\theta - 1}{5 + \tan\theta}$ **only** is **A0.**
		5	

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Question	Answer	Marks	Guidance
7(b)	$\mu > 0 \Rightarrow \tan\theta > \frac{1}{5}$	**M1**	Set the numerator of μ either =, > or $\geqslant$ to 0 and obtain $\tan\theta \square k$ where $\square$ is =, > or $\geqslant$ and $k \neq 0$ - ignore any consideration of an upper bound (e.g. saying that $\mu < 1$).
	$11.3 < \theta (< 90)$	**A1**	AWRT 11.3 (11.30993…). Must be strict inequality. Allow $\theta > 0.197(39...)$ - if anything other than < 90 then **A0.**
		2	

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