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International Education

# Cambridge International AS & A Level

**MATHEMATICS** **9709/43**

Paper 4 Mechanics **October/November 2024**

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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## 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 | $KE_{before} = \frac{1}{2} \times m \times 5^2$<br>$KE_{after} = \frac{1}{2} \times m \times 6^2$ | **B1** | For either correct.<br>Do not allow $\frac{1}{2} \times m \times (6-5)^2$.<br>Note: Difference = $\frac{1}{2} \times m \times 11$. |
| | WD against resistance<br>$= 50 \times 24 \quad [=1200]$ | **B1** | Do not allow if errors such as e.g. $(m-24) \times 50$. |
| | $\frac{1}{2} \times m \times (6^2 - 5^2) + 50 \times 24 = 1541$<br>$5.5m = 1541 - 1200$ | **M1** | Attempt at work energy equation with 4 relevant terms; dimensionally correct. Allow sign errors.<br>M0 for $\frac{1}{2} \times m \times (6-5)^2$. |
| | $m = \frac{341}{5.5} = 62$ | **A1** | |
| | **SC for constant acceleration method (question only gives total work done, and does not suggest constant force)** | | |
| | $a = 0.11$ | **SCB1** | From $6^2 = 5^2 + 2 \times a \times 50$ SOI. |
| | $m = 62$ | **SCB1** | From $\frac{1541}{50} - 24 = m \times 0.11$ or $30.82 - 24 = m \times 0.11$. |
| | | **4** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 2 | Resolving either direction | **M1** | With correct number of relevant terms. Allow sin/cos mix. Allow sign errors. Do not allow 'forces to the left = forces to the right' e.g. $12\cos30-8\sin30=16\sin30$ unless subsequently 'corrected'. |
| | $\pm(12\sin30+24+8\cos30-16\cos30)\left[=F_x \text{ or } F\cos\theta \text{ or } F\sin\alpha\right]$ | **A1** | $F_x=\pm\left(30-4\sqrt{3}\right)\quad[=23.07\ldots]$. |
| | $\pm(12\cos30-8\sin30-16\sin30)\left[=F_y \text{ or } F\sin\theta \text{ or } F\cos\alpha\right]$ | **A1** | $F_y=\pm\left(6\sqrt{3}-12\right)\quad[=-1.607\ldots]$. |
| | $F=\sqrt{\left(6\sqrt{3}-12\right)^2+\left(30-4\sqrt{3}\right)^2}$<br>$F=\dfrac{30-4\sqrt{3}}{\cos(their\,\theta)}$<br>$F=\dfrac{6\sqrt{3}-12}{\sin\left(their\,\theta\right)}$ | **M1** | Attempt to find $F$.<br>Must have correct number of relevant terms. (Forces must have or not have components as required). All forces resolved/not resolved as appropriate, but allow consistent sin/cos muddle.<br><br>Allow use of their $\theta$ provided correctly derived from equations with the correct number of relevant terms. |
| | $\theta=\tan^{-1}\left(\dfrac{6\sqrt{3}-12}{30-4\sqrt{3}}\right)$<br>$\theta=\cos^{-1}\left(\dfrac{30-4\sqrt{3}}{their\,F}\right)$ Note: this will not give the correct answer unless $F$ given to several significant figures<br>$\theta=\sin^{-1}\left(\dfrac{6\sqrt{3}-12}{their\,F}\right)$ | **M1** | Attempt to find $\theta$.<br>Must have correct number of relevant terms. (Forces must have or not have components as required). All forces resolved/not resolved as appropriate, but allow consistent sin/cos muddle. Allow upside down so $\tan^{-1}\left(\dfrac{30-4\sqrt{3}}{6\sqrt{3}-12}\right)$.<br>Allow use of their $F$ provided correctly derived from equations with the correct number of relevant terms.<br>Note: watch for use of $\sin^{-1}\left(\dfrac{6\sqrt{3}-12}{30-4\sqrt{3}}\right)$ or $\sin^{-1}\left(\dfrac{1.607}{23.07}\right)$ which leads to correct answer of angle 4.0° scores M0A0. |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 2 | $F$ = 23.1 N<br>$\theta = 3.99^\circ$ above the negative $x$-axis oe | **A1** | [23.1277…] Both correct Allow 4.0° but not simply 4° .<br>$[3.986...]$ Allow answers about the direction such as 'Above the west', 'north of west' etc, or clockwise 183.99 from $x$ axis, or resultant sketch with angle indicated. If not specified in working please check original diagram to see if direction specified there instead. Allow a bearing of $274.0°$. Allow explanation of direction that could be drawn uniquely.<br>Or e.g. 86.0° to left of the $y$-axis or 176.0° from the positive $x$-axis. |
| | | **6** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 3(a) | Resolving up slope.<br>If correct should see<br>$DF = 240 + 1600g \times 0.08 \quad [= 240 + 1280 = 1520]$ | **M1** | Must have correct number of relevant terms (weight component and 240 N resistance). Allow sign errors. Allow cos 4.58 or cos 4.6. Do not allow $g$ missing. Using $\sin^{-1} 0.08$ or sin 0.08 scores M0B0A0.<br>Must have either 0.08 or $\sin 4.58…$ or sin 4.6, not just $\sin\theta$. |
| | Power $= their(1520) \times 32$ | **B1** | OE. E.g. $\frac{\text{Power}}{32} = their 1520$ .<br>Allow any driving force provided it has a resistance and a weight component. |
| | Power = 48640 W | **A1** | Allow 48 600 W or 48.64 kW or 48.6 kW. Must state units if given in kW. |
| | | **3** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 3(b) | $\text{DF} = \frac{0.95 \times \textit{their}\ 48640}{24}$ or $\frac{46208}{24} = \frac{5776}{3}$ or 1925.3… | **B1FT** | $\text{DF} = \frac{\text{Power}}{v}$ oe e.g. $0.95 \times \textit{their}\ 48640 = \text{DF} \times 24$<br>FT their power from part **(a)** Do not allow if not using power from part **(a)**<br>Note: candidates who use sin 0.08 in part **(a)** should get a DF of 332.3 N, which can score B1FT and use of $\sin^{-1} 0.08$ should get a DF of 93299 N, can score B1FT. If candidate uses 48600 DF = $\frac{46170}{24} = 1923.75$<br>Candidates who omit the weight component in part **(a)** should get a DF of 304 N, and can score B1FT |
| | $\textit{their}\ \text{DF} - 240 - 1600g \times 0.08 = 1600a$ | **M1** | N2L Must have correct number of relevant terms (weight component and 240 N resistance). Allow sign errors. Must be dimensionally correct. Allow without using 95% or with using 5%. Must have either 0.08 or $\sin 4.58\ldots$ or sin 4.6, not just $\sin\theta$ or $\sin^{-1} 0.08$ or sin 0.08. |
| | $a = 0.253 \quad \text{m s}^{-2}$ | **A1** | Allow $\frac{19}{75}$ Note: 0.25 scores A0.<br>If candidate uses 48600 they must get 0.252(34…) rather than 0.253. |
| | | **3** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 4 | For attempt at use of conservation of momentum. | ***M1** | Must have three non-zero terms. Allow sign errors. Must have correct masses with relevant velocities. Their $v$ may be in the opposite direction.<br>If $g$ included with the masses:<br>Allow M1A0A1 for first three marks. Can then score M1M0A0 for final three marks. |
| | $3\times8=3\times2+6v$<br>Or $3\times8=-3\times2+6v$ | **A1** | |
| | $v=3 \quad [v=5]$ | **A1** | Allow finding only $v=3,$ but if both speeds found they must both be correct |
| | $\text{KE}_{after}$<br>$=0.5\times3\times2^2+0.5\times6\times their\, v_B{}^2 \quad [=33]$ if correct | **DM1** | Allow use of any $v_B$ even if $<0$<br>Using speed of5, $\text{KE}_{after}=0.5\times3\times2^2+0.5\times6\times their\, 5^2 \quad [=81]$<br>Candidates may work out the loss for each particle separately which only scores DM1 when losses subsequently added together. |
| | $KE_{loss}=\pm\left(0.5\times3\times8^2-\left(0.5\times3\times2^2+0.5\times6\times their\, 3^2\right)\right)$<br>$[=96-33]$ if correct | **DM1** | If two speeds found then FT their lower speed, even if later choose the wrong loss.<br>If only one speed found then FT their speed.<br>If the candidate thinks that the particles coalesce then score M0 here |
| | Loss = 63 [J] | **A1** | If both losses found, must state which is the greater.<br>Only award this mark if no errors – e.g. the KE loss for $v=5$ should be 15 J. If wrong then A0.<br>Allow –63 [J].<br>Can score full marks even if only $v=3$ is found. |
| | | **6** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 5(a) | Attempt at resolving in at least one direction | ***M1** | Correct number of relevant terms with $T$ resolved; allow sign errors; allow sin/cos mix.<br>Can score M1 for any $F = T\cos 30$.<br>Do not allow $g$ missing in the equation for $R$. Must have 12, not just $m$.<br>Could see $R$ as part of an equation for $F$. E.g. $F = 0.5(12g - T\sin 30)$. |
| | $R + T\sin 30 = 12g$<br>$F = T\cos 30$ | **A1** | Both correct. |
| | Use of $F = 0.5R$ to form an equation in $T$ or $R$ only | ***DM1** | Allow sign errors in $R$; allow consistent sin/cos mix in $R$ but no other errors. Must be two term $R$ as a linear combination of weight and a component of $T$, and $F$ must be a single term which is a component of $T$. Do not allow $g$ missing.<br>If correct $T\cos 30 = 0.5(120 - T\sin 30)$ or $\frac{\sqrt{3}}{2}T = 60 - 0.25T$.<br>If no working shown to eliminate $T$ or $R$, then DM2 for getting $T$ value correct for their equations and A1 if fully correct. Could use $0.5R = T\cos 30$ and solve simultaneously. |
| | Attempt to solve for $T$ | **DM1** | Allow consistent sin/cos mix and allow sign errors. Must get to $'T ='$.<br>Dependent on both previous M1s. |
| | $T = 53.8$ N | **A1** | $[53.7622\ldots]$<br>Note: For sign errors:<br>$R - T\sin 30 = 12g$ answer should be 97.3985…<br>$R - T\sin 30 = -12g$ answer should be -97.3985…<br>$R + T\sin 30 = -12g$ answer should be -53.7622……<br>Each of the above would usually get M1A0M1M1A0. |
| | | **5** | |

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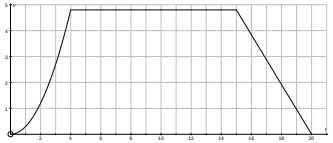


| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 5(b) | $T\cos 30 - F = 12 \times 0.2$ | ***M1** | Attempt at N2L; correct number of relevant terms with $T$ resolved; allow sign errors; allow sin/cos mix, but can be $F$ or any reasonable attempt at friction. |
| | Use of $F = 0.5R$ to form an equation in $T$ and solve | **DM1** | Must be a two term $R$ as a linear combination of weight and a component of $T$. Allow sign errors and consistent sin/cos mix. Must get to $'T ='$.<br>The equations if correct should be<br>$T\cos 30 - 0.5(120 - T\sin 30) = 12 \times 0.2$<br>or $\frac{\sqrt{3}}{2}T - 60 + 0.25T = 2.4$ or $T\left(\frac{\sqrt{3}}{2} + 0.25\right) = 62.4$ and these must be solved.<br>Any use of $T$ or $R$ from part (a) scores DM0 here. |
| | $T = 55.9$ N | **A1** | $T = 55.9127\ldots$<br>Note: For sign errors:<br>$R - T\sin 30 = 12g$ answer should be 101.294…<br>$R - T\sin 30 = -12g$ answer should be –93.5026…<br>$R + T\sin 30 = -12g$ answer should be –51.6117…<br>Each of the above would usually get M1M1A0. |
| | | **3** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 6(a) | $v = \int 0.6t \ \mathrm{d}t = \frac{0.6}{2}t^2 \left[= 0.3t^2\right] [+0]$<br>$[t = 4] \quad V = 0.3 \times 4^2$ or $0.3 \times 16 = 4.8$ | **B1** | **AG** Must see $\frac{0.6}{2}t^2$ or $0.3t^2$ and 4 must be actually shown substituted. Merely stating $t = 4$ is not enough to score this mark. Do not allow use of $s = ut + \frac{1}{2}at^2$ which leads to 4.8 if $a = 0.6$ is used. |
| | | **1** | |
| 6(b) | Quadratic with correct curvature starting from (0, 0) to (4, 4.8). | **B1** | <br>Note: the grid is for reference – not shown in QP.<br>Their graph does not need to be to scale. |
| | Horizontal line at from (4, 4.8) to (15, 4.8) | **B1** | The points should be specified somehow, but for an accurate sketch allow a line just below 5 without specifying 4.8. |
| | Line from (15, 4.8) to (20, 0) | **B1** | The points should be specified somehow, but for an accurate sketch allow a line just below 5 without specifying 4.8. Allow all 3 marks if using $V$ instead of 4.8. ISW any extra out of the range for $t$ of 0 to 20.<br>If no marks scored then SC B1 for a correct shaped graph with no numbers.<br>If using a value of $v \neq 4.8$, allow SC B1 for the first section correct and SC B1 for the second and third both correct. |
| | | **3** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 6(c) | Attempt to find acceleration | **M1** | For calculation $\frac{0-4.8}{20-15}$ oe $[=-0.96]$ Allow $+0.96$. |
| | $[v=]19.2-0.96t$ | **A1** | Oe e.g. Allow $[v=]4.8-0.96(t-15)$. |
| | | **2** | |
| 6(d) | $\left[\int_0^4 0.3t^2\,dt\right]\ \frac{0.3}{3}t^3\left[=0.1t^3\right]$ | ***M1** | Attempt to integrate their $v$ from part **(a)** provided this came from integration, but allow a restart here. The power of $t$ must increase by 1 with a change of coefficient. Use of $s=vt$ scores M0. No need for limits.<br>If no integration seen allow SCM1 for answer of 6.4 in place of M1M1. |
| | $0.1\times4^3\left[-0.1\times0^3\right]$ | **DM1** | Correct use of correct limit(s) (expect 6.4). |
| | $4.8\times11+0.5\times4.8\times5$<br>$[=52.8+12=64.8]$ | **B1** | Both correct and added. May be done in one go using a trapezium $\frac{(11+16)\times4.8}{2}$.<br>Could do the last stage by integration.<br>Maximum B1 for final answer 74.4 from thinking the first section is also straight. |
| | Distance = 71.2 m | **A1** | |
| | | **4** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(a) | $T-3g=\pm 3a$<br>$5g-T=\pm 5a$<br>$5g-3g=\pm(3+5)a$ | ***B1** | For one correct equation. |
| | | ***B1** | For any two correct consistent equations. If tensions $T_A$ and $T_B$ both stated must at some point state or imply that they are equal to score the second B1. |
| | Attempt to solve for $T$ | **DM1** | May find $a$ first $[a=2.5]$ Must get to $'T='$. Dep on both B marks. |
| | $T=37.5\,\text{N}$ or $\frac{75}{2}$ N | **A1** | Allow without working. |
| | Correct use of suvat with *their a* and solve for $t$ | **DM1** | E.g. $2=0.5\times 2.5\times t^2$ Must get to $'t='$. Dep on both B marks or the B1 for the equation $5g-3g=\pm(3+5)a$ if this used to find $a$, but not on first M1 mark.<br>Could find $v=\sqrt{10}$ then use $2=\frac{0+their\sqrt{10}}{2}t$. |
| | $t=1.26$ or $\frac{\sqrt{40}}{5}$ or $\frac{2\sqrt{10}}{5}$ | **A1** | $t=1.2649\ldots$ If candidates do not try to find $T$ but do attempt to find the time, they can score B1B1M0A0M1A1. Do not allow if also give negative answer and do not discard. Note: $t=\sqrt{1.6}$ only, scores A0 . |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(a) | **Alternative for final 2 marks, even if nothing scored earlier** | | |
| | Use of energy to find velocity at plane and then suvat to find $t$ | **M1** | PE loss = KE gain: $5g\times 2-3g\times 2 = \frac{1}{2}\times 5v^2+\frac{1}{2}\times 3v^2$,<br>Or PE loss – WD by tension = KE gain: $5g\times 2-\textit{their}\,37.5\times 2 = \frac{1}{2}\times 5v^2$,<br>Or WD by tension – PE gain = KE gain:<br>$\textit{their}\,37.5\times 2-3g\times 2=\frac{1}{2}\times 3v^2$,<br>$v=\sqrt{10}$ or $v=3.16$ then $2=\frac{0+v}{2}t$,<br>Dependent on both B marks only if candidate uses tension, but otherwise not dependent on either B mark. |
| | $t\left[=\sqrt{1.6}\right]=1.26$ or $\frac{\sqrt{40}}{5}$ or $\frac{2\sqrt{10}}{5}$ | **A1** | $t=1.2649\ldots$ |
| | | **6** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(b) | Correct use of suvat before B hits the plane or when *A* has risen 2 m, to attempt to find velocity of *A* when string becomes slack<br>Using *their a* and/or *their t*. | ***M1** | $v^2 = 0 + 2\times 2.5\times 2$. Must use $s = 2$ and $u = 0$,<br>OR $v = 0 + 2.5\times\sqrt{1.6}$ Must use $u = 0$ ,<br>OR $2 = \frac{1}{2}(0+v)\sqrt{1.6}$ Must use $s = 2$ and $u = 0$.<br>Must be complete method to find $v$ or $v^2$ $\left[v = \sqrt{10}\right]$.<br>Could have found $v = \sqrt{10}$ in part **(a)** and give M1 if used in part **(b).** |
| | Correct use of suvat for motion of *A* (between height of 3m and 3.25 m), to form an equation in *t*, using $a = -g$ | ***DM1** | $3.25 - 3 = \left(their\sqrt{10}\right)t + 0.5\times(-10)\times t^2$. |
| | Solving a 3 term quadratic for *t* to get at least one (unsimplified) value using their 2.5 (or using any other correct method) | **DM1** | If correct should get $t = 0.093, 0.540$ or $\frac{\sqrt{10}-\sqrt{5}}{10}$, $\frac{\sqrt{10}+\sqrt{5}}{10}$,<br>0.09262… or 0.53978…<br>Could use formula and realise that the time for at least 3.25 m,<br>$= 2\frac{\sqrt{b^2-4ac}}{2a} = 2\frac{\sqrt{10-4\times5\times0.25}}{2\times5}$ which gets DM1. |
| | Time = 0.447 s or $\frac{\sqrt{5}}{5}$s or $\frac{1}{\sqrt{5}}$ | **A1** | Time $= 0.53978\ldots - 0.09262\ldots = 0.44721\ldots$<br>$2\left(\frac{\sqrt{10}}{10} - \frac{\sqrt{10}-\sqrt{5}}{10}\right) = 0.44721\ldots$ |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(b) | **Alternative for last 3 marks of Q7(b) finding max height** | | |
| | For attempt to find max height using correct suvat with $a=-g$ | ***DM1** | $0^2=\left(their\sqrt{10}\right)^2+2\times(-10)s$ Where $s$ is distance above 3 metres.<br>(which leads to a maximum height of 3.5 m). |
| | For attempt to find time from .25 m below top to top | **DM1** | $t=\ \pm0.224$ or $\frac{\sqrt{5}}{10}$ [0.22360….] probably from $\left[3.5-3.25=0t+0.5\times10t^2\right]$. Dep on both previous M1s. |
| | Time = 0.447 s or $\frac{\sqrt{5}}{5}s$ | **A1** | For doubling. |
| | **Alternative for last 3 marks of Q7(b) by finding velocity at height of 3.25 m** | | |
| | Correct use of suvat for motion of *A* (between height of 3m and 3.25 m), to form an equation to find speed at height of 3.25 m | ***DM1** | $w^2=their\sqrt{10}^2+2\times(-g)\times0.25$. $\left[w^2=5\right]$ or $\left[w=\sqrt{5}\right]$. |
| | For correct use of suvat to find time to max height | **DM1** | $0=\sqrt{5}+(-g)\times t$ $\left[t=\frac{\sqrt{5}}{10}\right]$. |
| | Time = 0.447 s or $\frac{\sqrt{5}}{5}s$ | **A1** | For doubling. |

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GradeMax



| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(b) | **Alternative using energy** | | |
| | Correct use of energy before B hits the plane or when *A* has risen 2 m, to attempt to find velocity of *A* when string becomes slack using *their T* if necessary. | ***M1** | PE loss = KE gain: $5g\times 2-3g\times 2 = \frac{1}{2}\times 5v^2+\frac{1}{2}\times 3v^2$,<br>Or PE loss – WD by tension = KE gain: $5g\times 2-\textit{their}\,37.5\times 2 = \frac{1}{2}\times 5v^2$,<br>Or WD by tension – PE gain = KE gain: $\textit{their}\,37.5\times 2-3g\times 2=\frac{1}{2}\times 3v^2$.<br>Must be complete method to find $v$ or $v^2$ $\left[v=\sqrt{10}\text{ or}3.162\ldots\right]$.<br>Do not allow sign errors. |
| | Correct use of energy to find velocity of *A* at height of 3.25 m | ***DM1** | PE gain = KE loss: $3g\times 0.25=\frac{1}{2}\times 3\times\sqrt{10}^2-\frac{1}{2}\times 3w^2$.<br>Must be complete method to find $w$ or $w^2$ $w=\sqrt{5}\,\text{or}\,2.236\ldots$<br>Do not allow sign errors. |
| | For attempt to find time from .25 m below top to top | **DM1** | $t=\pm 0.224$ or $\frac{\sqrt{5}}{10}$ [0.22360….] probably from $0=\sqrt{5}-10t$.<br>Dep on both previous M1s.<br>Do not allow sign errors. |
| | Time = 0.447 s or $\frac{\sqrt{5}}{5}s$ | **A1** | For doubling. |
| | | **4** | |

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