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# Mark Scheme (Results)

# October 2025

International Advanced Level in Mechanics M1

WME01/01A

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October 2025
Question Paper Log Number P87438A
Publication Code WME01_01A_2510_MS
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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.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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# EDEXCEL IAL 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 and can be used if you are using the annotation facility on ePEN.

   - bod – benefit of doubt
   - ft – follow through
   - the $\surd$ symbol 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)
   - d… or dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - * The answer is printed on the paper or ag- answer given
   - or d… The second mark is dependent on gaining the first mark

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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. If you are using the annotation facility on ePEN, indicate this action by 'MR' in the body of the script.

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.

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## General Principles for Mechanics Marking

*(NB specific mark schemes may sometimes override these general principles)*

- Rules for M marks:
  - correct number of terms
  - dimensionally correct
  - all terms that need resolving (i.e. *multiplied* by cos or sin) are resolved
  - only terms that need resolving are resolved
  - +/– errors are condoned
  - sin/cos confusion is condoned
- Omission or extra $g$ in a resolution is an accuracy error not method error.
- Omission of mass from a resolution is a 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(s) has been awarded.
- Any numerical answer which comes from use of $g = 9.8$ should be given as a decimal 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. However, premature approximation should be penalised every time it occurs.
- Marks must be entered in the same order as they appear on the mark scheme.
- 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

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## Mechanics Abbreviations

| | |
|---|---|
| M(A) | Taking moments about A |
| N2L | Newton's Second Law (Equation of Motion) |
| NEL | Newton's Experimental Law (Newton's Law of Impact) |
| HL | Hooke's Law |
| SHM | Simple harmonic motion |
| PCLM | Principle of conservation of linear momentum |
| RHS | Right hand side |
| LHS | Left hand side |

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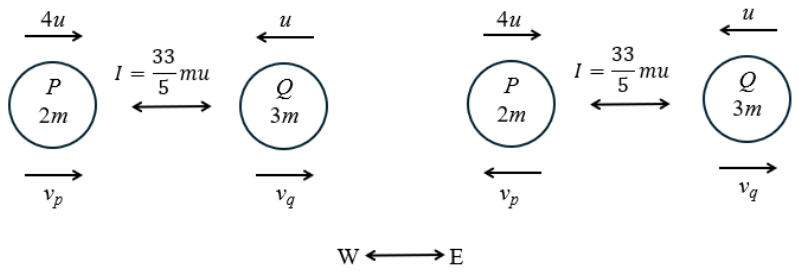
| Question Number | Scheme | Marks |
|---|---|---|
| 1 |  | |
| (a) | Impulse-momentum equation for $P$ | M1 |
| | $-\frac{33}{5}mu = 2m(v_P - 4u)$ or $-\frac{33}{5}mu = 2m(-v_P - 4u)$ | A1 |
| | (speed of $P$ =) $0.7u$ due East | A1 |
| | | (3) |
| (b) | Impulse-momentum equation for Q | M1 |
| | $\frac{33}{5}mu = 3m(v_Q - -u)$ | A1 |
| | (speed of Q =) $1.2u$ due East | A1 |
| | | (3) |
| | | **[6]** |

| **Notes** | |
|---|---|
| **Note: Parts (a) and (b) may be marked together. Allow part (b) to be answered before part (a).** | |
| **1(a)** | |
| **M1** | Form an equation to find $v_P$.<br>Either<br>Form a dimensionally correct impulse-momentum equation for $P$ (using $2m$ and $4u$). Must attempt difference in momenta. M0 if g's are included on RHS. Condone sign errors.<br>Or<br>Form a dimensionally correct CLM equation in $v_P$ ($m$ and $u$) only. Allow consistent extra $g$'s and cancelled $m$'s and sign errors but masses and velocities must be correctly paired. Condone sign errors. |
| **A1** | A correct unsimplified equation in $v_P$ ($m$ and $u$) only<br>CLM: $2m(4u) + 3m(-u) = 2m(v_p) + 3m(1.2u)$ |
| **A1** | Correct answer, both speed and direction. Direction must be stated, not just seen on a diagram. For direction, accept E (or 'unchanged', 'same' or 'continues in its original direction' or 'towards Q').<br>A0 if only 'to the right' or 'positive direction' |

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| 1(b) | |
|---|---|
| **M1** | Form an equation to find $v_Q$.<br>Either<br>Form a dimensionally correct impulse-momentum equation for Q (using $3m$ and $u$). Must attempt difference in momenta. M0 if g's are included on RHS. Condone sign errors.<br>Or<br>Form a dimensionally correct CLM equation in $v_Q$ ($m$ and $u$) only. Allow consistent extra $g$'s and cancelled $m$'s and sign errors but masses and velocities must be correctly paired. |
| **A1** | Correct unsimplified equation in $v_Q$ ($m$ and $u$) only<br>CLM: $2m(4u)+3m(-u)=2m(0.7u)+3m(v_q)$ |
| **A1** | Correct answer, both speed and direction. Direction must be stated, not just seen on a diagram. For direction, accept E (or 'reverses direction' or 'opposite direction' or 'in the original direction of $P$', 'away from $P$')<br>A0 if only 'to the right' or 'positive direction' or 'changed direction' |

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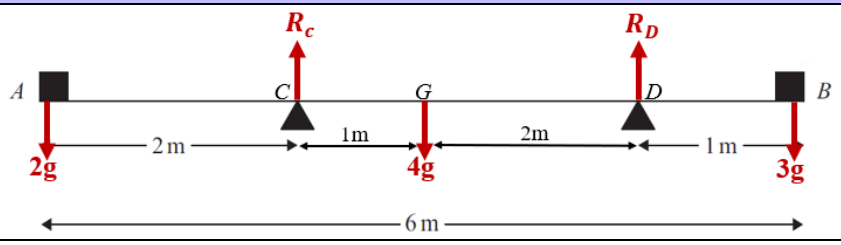
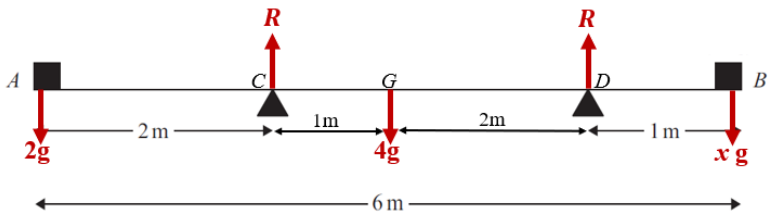
| Question Number | Scheme | Marks |
|---|---|---|
| **2** **(a)** |  | |
| | (i) Form an equation to solve for $R_C$ | M1 |
| | Relevant equations<br>M(*D*): $3R_C+(1\times3g)=(2\times4g)+(5\times2g)$<br>Vert: $R_C+R_D=4g+2g+3g$<br>M(C): $3R_D+(2\times2g)=(1\times4g)+(4\times3g)$<br>M(*A*): $2R_C+5R_D=(3\times4g)+(6\times3g)$<br>M(*B*): $4R_C+1R_D=(3\times4g)+(6\times2g)$<br>M(*G*): $1R_C+(3\times3g)=2R_D+(3\times2g)$ | A1 |
| | $R_C=49$ (N) | A1 |
| | (ii) Form an equation to solve for $R_D$ | M1 |
| | Correct equation | A1 |
| | $R_D=39$ or $39.2$ (N) | A1 |
| | | (6) |
| **(b)** |  | |
| | Moments equation in *x* with new Reaction forces | M1 |
| | M(*B*): $4R_C+1R_D=(3\times4g)+(6\times2g)$<br>M(*D*): $3R_C+(1\times xg)=(2\times4g)+(5\times2g)$<br>M(C): $3R_D+(2\times2g)=(1\times4g)+(4\times xg)$<br>M(*A*): $2R_C+5R_D=(3\times4g)+(6\times xg)$<br>M(*G*): $1R_C+(3\times xg)=2R_D+(3\times2g)$ | A1 |
| | Complete method to find *x* using $R_C=R_D$ | dM1 |
| | $x=3.6$ | A1 |
| | | (4) |
| | | **[10]** |

| **Notes** | |
|---|---|
| **2(a)** | **Note: mark parts (i) and (ii) together.** |
| **(i)** | |

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| | |
|---|---|
| **M1** | Form a relevant equation in $R_C$. Dimensionally correct and the correct number of terms. A consistent missing *g* or including *m* with every mass term is an A error. If solving simultaneous equation in $R_C$ and $R_D$, mark the first equation seen. If more than 2 equations are written, mark the ones used. |
| **A1** | Correct unsimplified equation |
| **A1** | Correct reaction at *C* seen in part (a), accept 5g. |
| **(ii)** | |
| **M1** | Form a relevant equation in $R_D$. Dimensionally correct and the correct number of terms. A consistent missing *g* or including *m* with every mass term is an A error. If solving simultaneous equation in $R_C$ and $R_D$, mark the second equation seen. If more than 2 equations are written, mark the ones used. |
| **A1** | Correct unsimplified equation |
| **A1** | Correct reaction at *D* seen in part (a), accept 4g. |
| **2(b)** | |
| **M1** | Form a moments equation in *x* and *R*. Condone re-using notation $R_C$ and $R_D$<br>M0 if a previous *R* value is used. If more than one moments equation is used, award this mark for their best equation. |
| **A1** | Correct unsimplified moments equation. If more than one moments equation is used, award this mark for their best equation. |
| **dM1** | Dependent on previous method mark. Dimensionally correct equation with the correct terms. Complete method to find *x*. Must use $R_C = R_D$ and a second equation. The second equation may be another moments equation or vertical equilibrium.<br>Vert: $R_C + R_D = 4g + 2g + xg$ |
| **A1** | Correct answer oe, accept $\frac{18}{5}$ |
| | **SC:** In part (b) max mark M1A1 dM1A1 if there is a complete method with a consistent missing *g* in both equations or for including *m* with every mass term in both equations. |

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| Question Number | Scheme | Marks |
|---|---|---|
| **3(a)** | Resultant force with terms collected<br>$(2\mathbf{i}-3\mathbf{j})+(p\mathbf{i}+q\mathbf{j})=(p+2)\mathbf{i}+(q-3)\mathbf{j}$ | M1 |
| | Use parallel vector to form an equation in $p$ and $q$ only | M1 |
| | $\frac{p+2}{q-3}=\frac{1}{2}$ | A1 |
| | $4+2p=-3+q$ | dM1 |
| | $2p-q+7=0$ * | A1* |
| | | (5) |
| **3(b)** | $q=11\Rightarrow p=2$ | B1 |
| | Find the resultant force with their $p$<br>$\mathbf{R}=(p+2)\mathbf{i}+(11-3)\mathbf{j}\quad(=4\mathbf{i}+8\mathbf{j})$ | M1 |
| | Use of N2L with their **R** or $\lvert\mathbf{R}\rvert$<br>Either **F** = m**a** $\Rightarrow$ $4\mathbf{i}+8\mathbf{j}=2\mathbf{a}$ $(\mathbf{a}=2\mathbf{i}+4\mathbf{j})$<br>or $\lvert\mathbf{F}\rvert = m\lvert\mathbf{a}\rvert$ $\Rightarrow$ $4\sqrt{5}=2\lvert\mathbf{a}\rvert$ | M1 |
| | Correct use of Pythagoras to find $\lvert\mathbf{a}\rvert$ or $\lvert\mathbf{R}\rvert$<br>$\lvert\mathbf{a}\rvert=\sqrt{2^2+4^2}$ or $\lvert\mathbf{R}\rvert=\sqrt{4^2+8^2}$ | M1 |
| | $(\lvert\mathbf{a}\rvert=)\sqrt{20}=4.5$ or better $(\mathrm{m\,s^{-2}})$ | A1 |
| | | (5) |
| | | **[10]** |

| **Notes** | |
|---|---|
| **Accept column vectors throughout** | |
| **3(a)** | |
| **M1** | Find the resultant force ($\mathbf{F}_1+\mathbf{F}_2$) and collect terms in the form $\mathbf{R}=a\mathbf{i}+b\mathbf{j}$. May be implied by the components $(p+2)$ and $(q-3)$ used correctly in working. |
| **M1** | Use the parallel vector to form a scalar equation in $p$ and $q$ only. For the method mark, condone the reciprocal, $\frac{p+2}{q-3}=\frac{2}{1}$.<br>Note:<br>If using the multiplier approach, the mark is awarded when the equation is reduced to $p$ and $q$ only. However, M0 if $\lambda=1$<br>$\left.\begin{matrix}p+2=\lambda\\ q-3=2\lambda\end{matrix}\right\}\Rightarrow\quad q-3=2(p+2)$ |
| **A1** | Correct equation in $p$ and $q$ only (accept any equivalent form) |

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| Question Number | Scheme | Marks |
|---|---|---|
| **dM1** | Dependent on both previous method marks. Complete and correct method to obtain given answer. | |
| **A1*** | Obtain the given answer from complete and correct working with no errors and exact values. There must be at least one stage of working between the initial equation in $p$ and $q$ only and the given answer. Allow rearrangement but must equal zero. A0 for unconventional vector notation, eg $\frac{(2+p)\mathbf{i}}{(-3+q)\mathbf{j}} = \frac{(1)\mathbf{i}}{(2)\mathbf{j}}$ | |
| **3(b)** | | |
| **B1** | Correct value seen | |
| **M1** | Use $p$ or their $p$ with $q = 11$ to find the resultant force as a vector. Must sum the forces. M0 if weight is included with resultant force. | |
| **M1** | Correct use of N2L with their $\mathbf{R}$ or $\lvert\mathbf{R}\rvert$, must attempt ($\mathbf{F}_1 \pm \mathbf{F}_2$) only. Condone $g$ in $ma$ or $m\mathbf{a}$ term but M0 if weight is included with the resultant force. Allow with $p$ or their $p$. | |
| **M1** | Correct use of Pythagoras (must involve square and add) to find the magnitude of their acceleration or the magnitude of their resultant force. Must have two non-zero components. M0 if using just $\lvert\mathbf{F}_1\rvert$ or $\lvert\mathbf{F}_2\rvert$. Allow with $p$ or their $p$. | |
| **A1** | Correct answer from correct working. Accept any equivalent form eg $2\sqrt{5}$ | |

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| Question Number | Scheme | Marks |
|---|---|---|
| **4(a)** | Correct use of *suvat* to form an equation in *h* only<br>$7^2 = 0^2 + 2gh$ | M1 |
| | $(h =)\ 2.5$ | A1 |
| | | (2) |
| **4(b)** | Correct use of CLM with common velocity after impact | M1 |
| | $9\times 7 = 9v + 1.5v \quad (v = 6)$ | A1 |
| | Correct use of *suvat* with their *v* to form an equation in *a* only | M1 |
| | $0^2 = 6^2 + 2a(0.12) \qquad (a = -150)$ | A1 |
| | Correct use of N2L with their acceleration | M1 |
| | $10.5g - R = 10.5\ (-150)$ | A1 |
| | $R = 1680 \quad \text{or } 1700$ | A1 |
| | | (7) |
| | | **[9]** |

| **Notes** | |
|---|---|
| **Note: only penalise use of 9.81 once per whole question, only penalise over or under accuracy once per whole question.** | |
| **4(a)** | |
| **M1** | Use of *suvat* to form relevant equation(s) to solve for *h* |
| **A1** | Correct answer, must be positive and a decimal. |
| **4(b)** | |
| **M1** | Use CLM to find the speed of the blocks after impact. Dimensionally correct equation. Must have a common velocity after impact. |
| **A1** | Correct unsimplified equation in one unknown |
| **M1** | Correct use of *suvat* to form an equation in *a* only. Allow $\pm a$ . Allow with their *v* for the method mark where *v* is a calculated value from CLM. Condone use of 12 or 1.2 instead of 0.12. M0 if using $u = 7$. |
| **A1** | Correct unsimplified equation in $\pm a$ only |
| **M1** | Correct use of N2L to form an equation in *R*. Allow with *a* or their calculated *a* for the method mark but M0 if $a = \pm g$ |
| **A1** | Correct unsimplified equation in *R* only. |
| **A1** | Correct answer. Must be positive with 2sf or 3sf.<br>A0 if $g = 9.81$ is used unless already penalised in this question. |
| **(b) ALT1** | **Note**: You may see an energy approach for last 5 marks (WME02 candidate). |
| **M1 M1** | Energy equation with all required terms present and no extra. Each term must have the correct structure. Condone sign errors and 12. |

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| | | |
|---|---|---|
| | KE + GPE = work done<br>$\frac{1}{2}(10.5)6^2 + (10.5)g(0.12) = 0.12R$ | |
| **A1** | Correct equation with at most one error | |
| **A1** | Correct equation | |
| **A1** | 1680 or 1700 , correct answer, 2 or 3 sf | |

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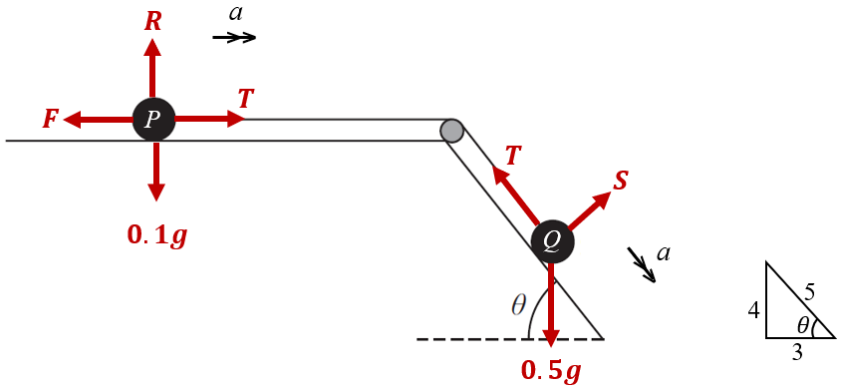
| Question Number | Scheme | Marks |
|---|---|---|
| |  | |
| **5 (a)** | Correct use of *suvat* to form an equation in *a* only. | M1 |
| | $0.75 = 0 + \frac{1}{2}a(0.5)^2$ | A1 |
| | ($a$ =) 6 | A1 |
| | Correct use of N2L for Q | M1 |
| | $0.5g\sin\theta - T = 0.5a$ | A1ft |
| | ($T$ =) 0.92 (N) | A1 |
| | | (6) |
| **5 (b)** | $R = 0.1g$ | B1 |
| | Correct use of N2L with *P* | M1 |
| | Either *P*: $T - F = 0.1(6)$<br>Or system: $0.5g\sin\theta - F = (0.5+0.1)(6)$ | A1 |
| | Use of $F = \mu R$ for *P*, $\mu \times$ *their R* | M1 |
| | $\mu = 0.327$ or 0.33 | A1 |
| | | (5) |
| | | **[11]** |

**Notes**

**Note: only penalise use of 9.81 once per whole question, only penalise over/under accuracy once per whole question.**

| | |
|---|---|
| **5 (a)** | |
| M1 | Use of *suvat* to form sufficient equation(s) to form an equation in *a* only. If using more than one equation, award the method mark when an equation in *a* only has been reached. |
| A1 | Correct equation in *a* only |
| A1 | Correct acceleration |

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| | |
|---|---|
| M1 | Correct use of N2L for Q to form an equation in $T$ (and $a$). There is no need to substitute for the trig value or acceleration but M0 if $a = g$. Dimensionally correct and correct terms. Condone sin/cos confusion and sign errors. Including $m$ with every mass term is an A error. |
| A1ft | Correct equation in $T$ (no need to replace trig). Maybe in $a$ or follow through their calculated $a$. |
| A1 | Correct answer, must be a decimal. |
| **5(b)** | **Note: If both surfaces are assumed to be rough, max possible mark B1 M0A0 M1A0** |
| B1 | Correct expression for $R$ for $P$ seen or implied |
| M1 | Use of N2L horizontally for $P$ or for the whole system (indicated by the mass in the $ma$ term). No need to replace $T$ or $a$ but M0 if $a = g$. If the equation is seen in earlier working, it must be used in (b) to earn the marks here. Dimensionally correct and correct terms. Condone sin/cos confusion and sign errors. Including $m$ with every mass term or $g$ in the $ma$ term is an A error. |
| A1 | Correct unsimplified equation.<br>(Allow with their tension from part (a) if using N2L for $P$ only) |
| M1 | Use of $F = \mu R$. Must be used with their $R$ for $P$, not simply stated as a formula. |
| A1 | $\mu = 0.327$ or $0.33$ Must be a decimal with 2 or 3sf. |

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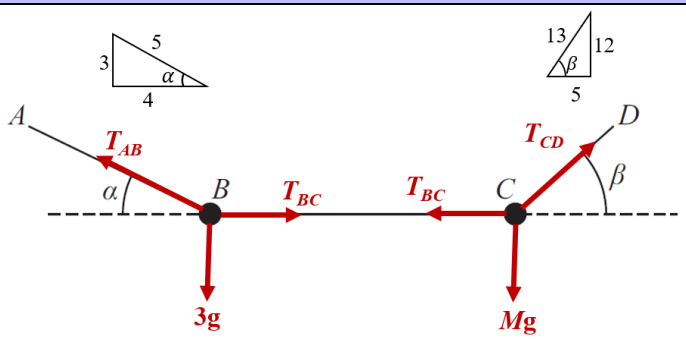
| Question Number | Scheme | Marks |
|---|---|---|
| |  | |
| **6 (a)** | Use of $\sin\alpha=\frac{3}{5}$ or $\cos\alpha=\frac{4}{5}$ or $\alpha=37$ or better | B1 |
| | Vert equilibrium at *B* | M1 |
| | $T_{AB}\sin\alpha=3g$ | A1 |
| | $T_{AB}=49\ (\text{N})$ | A1 |
| | | (4) |
| **6(b)** | Horiz equilibrium at *B* | M1 |
| | $T_{AB}\cos\alpha=T_{BC}$ | A1 |
| | $T_{BC}=39$ or $39.2\quad(\text{N})$ | A1 |
| | | (3) |
| **6(c)** | Use equilibrium to form at least one equation in $T_{CD}$ | M1 |
| | At least one correct out of:<br>• H at C: $T_{CD}\cos\beta=T_{BC}\quad(102\cos\beta=T_{BC})$<br>• V at C: $T_{CD}\sin\beta=Mg\quad(102\sin\beta=Mg)$<br>• H sys: $T_{AB}\cos\alpha=T_{CD}\cos\beta\quad(\frac{4}{5}T_{AB}=102(\frac{5}{13}))$<br>• V sys: $T_{AB}\sin\alpha+T_{CD}\sin\beta=3g+Mg\quad(\frac{3}{5}T_{AB}+102(\frac{12}{13})=3g+Mg)$ | A1 |
| | Two correct equations in $T_{CD}$ | A1 |
| | Form an equation in *M* only<br>Eg $\tan\beta=\frac{Mg}{T_{BC}}\Rightarrow\frac{12}{5}=\frac{Mg}{"T_{BC}"}$ | dM1 |
| | $(M=)9.6$ | A1 |
| | | (5) |
| | | **[12]** |
| **Note** | | |

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| Question Number | Scheme | Marks |
|---|---|---|
| **Note: only penalise use of 9.81 once per whole question, only penalise over or under accuracy once per whole question.** | | |
| **6 (a)** | | |
| **B1** | Either correct trig ratio for $\alpha$ seen anywhere or implied. | |
| **M1** | Method to form an equation in $T_{AB}$ (and $\alpha$) using equilibrium at $B$. Trig does not need to be replaced. Including $m$ with a numerical mass term is an A error. Dimensionally correct and condone sin/cos confusion. | |
| **A1** | Correct unsimplified equation, trig does not need to be replaced. | |
| **A1** | Correct answer, accept 5g. | |
| **6(b)** | | |
| **M1** | Method to form an equation in $T_{BC}$ (and $\alpha$) using equilibrium at $B$. Trig does not need to be replaced. Condone re-using the letter $T$ in an equation but M0 if clearly assuming the same tension value in different sections of the string. Including $m$ with a numerical mass term is an A error. Dimensionally correct and condone sin/cos confusion. | |
| **A1** | Correct unsimplified equation, trig does not need to be replaced. | |
| **A1** | Correct answer, accept 4g. | |
| **6(c)** | | |
| **M1** | Method to form a dimensionally correct equation in $T_{CD}$ using equilibrium at $C$ or the whole system. Trig and tensions do not need to be replaced. If more equations are listed, mark the two that are used. Relevant equations may be seen in earlier working but must be used here to earn the mark. Condone re-using the letter $T$ in an equation.<br>**SC:** Note that $T_{CD}$ =101.92. If the answer to part (b) is 102 (or better) and then 102 is used correctly in (c) then all marks are available in part (c). | |
| **A1** | At least one correct unsimplified equation. Trig and tensions do not need to be replaced. | |
| **A1** | Two correct equations. Trig and tensions do not need to be replaced. | |
| **dM1** | Dependent on previous method mark to form an equation in $M$ only. Must use at least one valid equation but dM0 if $T_{CD} = T_{AB}$ (eg use $T_{CD} = 49$) | |
| **A1** | Correct answer, accept 9.60 and $\frac{48}{5}$ since $g$ cancels. | |

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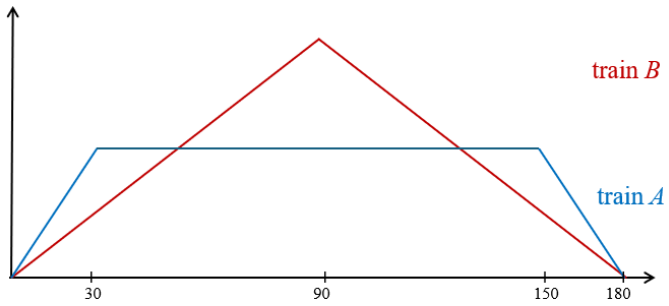
| Question Number | Scheme | Marks |
|---|---|---|
| **7(a)** |  | B1 (trap)<br><br>B1 (triangle with 2 inters.)<br><br>B1 all figs |
| | | (3) |
| **7(b)** | Using train $A$, method to find the distance or half distance | M1 |
| | For example, area of trapezium or half trapezium or *suvat*<br>• $\frac{1}{2}(180+120)20$<br>• $\frac{1}{2}(90+60)20$ | A1 |
| | Combining with train $B$, complete method to find the acceleration | M1 |
| | For example, area of triangle or half area of triangle or *suvat*<br>• $"1500"=\frac{1}{2}(90\times V) \Rightarrow V=\frac{100}{3} \Rightarrow a=\frac{V}{90}$<br>• $"3000"=\frac{1}{2}(180\times V) \Rightarrow V=\frac{100}{3} \Rightarrow a=\frac{V}{90}$<br>• $"1500"=\frac{1}{2}a90^2$ | A1 ft |
| | $(a=)\frac{10}{27}$ , 0.37 or better | A1 |
| | | (5) |
| **7(c)** | Method to form an equation in $t$ | M1 |
| | $"a"t_1="\frac{2}{3}\times 30"$ | A1 ft |
| | $t_1=54\,(s)$ **or** $t_2=126\,(s)$ | A1 |
| | $t_1=54\,(s)$ **and** $t_2=126\,(s)$ | A1 |
| | | (4) |
| **7(d)** | | |
| | Method to find maximum speed of train $B$<br>$"a"\times 90 \quad \left(=\frac{100}{3}=33.\dot{3}\right)$ | M1 |

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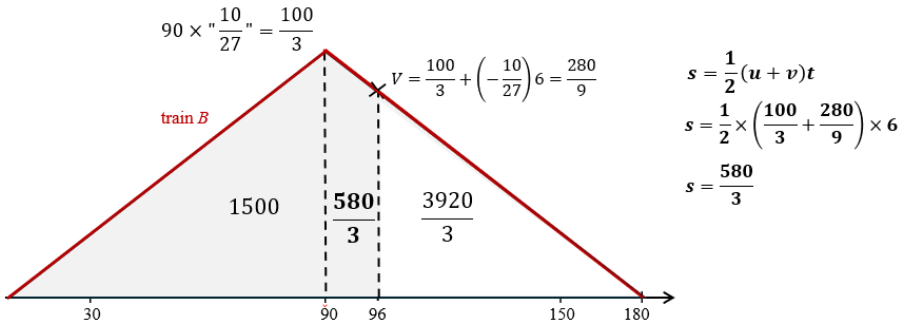
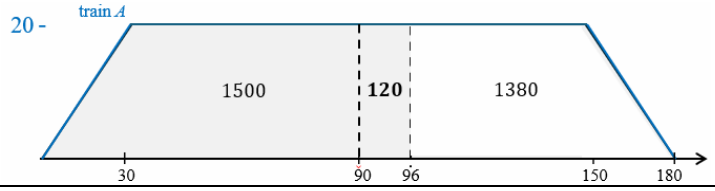
| | | |
|---|---|---|
| | Complete method to find the distance moved by train *B* for $90,, t,, 96$ or $84,, t,, 90$<br> | M1 |
| | Correct distance, for example,<br>• Area of trapezium/suvat $\frac{1}{2}\left(\frac{100}{3}+\frac{280}{9}\right)6 \quad \left(=\frac{580}{3}=193.\dot{3}\right)$<br>• suvat $\frac{100}{3}\times 6-\frac{1}{2}\left(\frac{10}{27}\right)6^2 \quad \left(=\frac{580}{3}=193.\dot{3}\right)$ | A1 |
| | Complete and correct method to fnd the required distance.<br>For example $\frac{580}{3}-(6\times 20)$<br> | dM1 |
| | $=\frac{220}{3}$, accept 73 or better (m) | A1 |
| | | (5) |
| | | **[17]** |
| **Notes** | | |
| **7 (a)** | | |
| **B1** | Shape of graph for train *A*: isosceles (approx.) trapezium, start and finish on the horizontal axis. | |
| **B1** | Shape of graph of train *B*: should be an isosceles (approx.) triangle. Must start and finish on the horizontal axis. The graphs should intersect at two points. | |
| **B1** | All figures on the same horizontal axis: 30, 90, 150, 180. Accept equivalent delineators. | |
| **7(b)** | | |
| **M1** | Complete method using train *A* to find the distance (or half the distance) between the stations.<br>May use area of their graph but it must be a trapezium. The formula for the area of a trapezium or a triangle must have the correct structure.<br>May use of *suvat* but M0 if $a=\frac{2}{3}$ for $t>30$. May see 20 or their $\frac{2}{3}\times 30$. | |
| **A1** | Correct unsimplified expression for the distance or half distance. | |

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| | |
|---|---|
| **M1** | A complete method by combining with train *B* to find the required acceleration. |
| **A1ft** | Correct unsimplified equation in *a*, follow through their distance. |
| **A1** | Correct answer, accept 0.37 or better |
| **7(c)** | |
| **M1** | Correct method using train *B* to form an equation in a relevant time, *t* |
| **A1ft** | Correct expression, follow through their *a* and their 20<br>If using second half, with $v = u + at$, follow through their *a*, 20 and $\frac{100}{3}$ |
| **A1** | At least one correct time |
| **A1** | Both correct times |
| **7(d)** | |
| **M1** | Method to find the maximum speed of train *B*. This may appear on a graph or in earlier working. It must be used in part (d) to earn the mark here. |
| **M1** | Method to find the distance travelled by train *B* in the 'extra' 6 seconds<br><br>**Note**: the method to find the area of the additional trapezium leads straight to the final answer<br>$\frac{1}{2}\left(\frac{40}{3}+\frac{100}{9}\right)6 \quad \left(=\frac{220}{3}\right)$<br>The final 4 marks are all available.<br><br>$s = \frac{1}{2}\times\left[\left(\frac{100}{3}-20\right)+\left(\frac{280}{9}-20\right)\right]\times 6$ |
| **A1** | Correct distance, accept rounded values in their working<br>eg $\frac{1}{2}\left(\frac{100}{3}+\frac{280}{9}\right)6$ or $\frac{1}{2}(33.3+31.1)6$ |
| **dM1** | Dependent on both previous method marks. Complete method comparing train *A* and train *B* distances to find the required distance. Must use a correct method for calculating distances before subtraction. |
| **A1** | Correct answer, accept 73 or better. Accept more significant figures but must be rounded correctly to their choice of s.f. Exact value is $73.\dot{3}$ |
| **(d)** | |
| **ALT 1** | For candidates who do not use the maximum speed and use the distance from the end. |
| **M1** | Complete method to find the distance from the end point for train *B*. |
| **M1** | |
| **A1** | $s = 0-\frac{1}{2}\left(-\frac{10}{27}\right)84^2 \quad \left(=\frac{3920}{3}=1306.\dot{6}\right)$ |
| **dM1** | Dependent on both previous method marks. Complete and correct method comparing train *A* and train *B* distances to find the required distance. Must use a correct method for calculating distances before subtraction: $1380-\frac{3920}{3}$ |

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| | |
|---|---|
| **A1** | Correct answer, accept 73 or better. Accept more significant figures but must be rounded correctly to their choice of s.f. Exact value is $73.\dot{3}$ |