



# Mark Scheme (Results)

January 2021

Pearson Edexcel IAL In Mechanics 1  
Paper WME01/01

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Marks      |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>1(a)</b>     | $v^2 = 20^2 - 2g \times (-3)$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | M1         |
|                 | $v = 21 \text{ or } 21.4 \text{ (m s}^{-1}\text{)}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | A1 (2)     |
| <b>1(b)</b>     | <p><u>Complete</u> method to find the <u>total</u> time:</p> <p>e.g.<br/> <b>either:</b> <math>-5 = 20t - \frac{1}{2}gt^2</math> using one equation</p> <p><b>or:</b><br/> <math>0 = 20 - gt_1 \Rightarrow t_1 = \frac{100}{49} = 2.040816\dots</math><br/> <math>s_1 = \left(\frac{20+0}{2}\right)t_1 \left(= \frac{1000}{49} = 20.40816\dots\right)</math><br/> (or <math>s_1 = 20t_1 - \frac{1}{2}gt_1^2</math>) using four equations<br/> <math>25.408\dots = \frac{1}{2}gt_2^2 \Rightarrow t_2 = 2.2771\dots</math><br/> <math>t = t_1 + t_2 = 4.31795\dots</math><br/> and many other methods</p> | M1         |
|                 | There are two A marks for all the equations they use, -1 each error                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | A1         |
|                 | <b>N.B.</b> The second M mark should be treated as an A mark                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | M(A)1      |
|                 | $t = 4.3 \text{ or } 4.32 \text{ (s)}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | A1         |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>(6)</b> |
|                 | <b>Notes for question 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |
| <b>1(a)</b>     | M1 <b>Complete</b> method to find the speed, must be using 3 or -3 (Allow 9.81 for g or just g), condone sign errors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |
|                 | A1 Correct answer (Must have used 9.8 and be positive)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |
| <b>1(b)</b>     | M1 <b>Complete</b> method to find the total time, condone sign errors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |
|                 | A1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |
|                 | M(A)1 There are now two A marks for the equation(s) that they use, -1 for each error. (Allow 9.81 for g or just g)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |
|                 | A1 Correct answer (Must have used 9.8)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |
|                 | <b>N.B. No isw for this question</b><br><b>e.g. If they had the correct quadratic but went on to add the roots, this would lose the M mark.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |

[illegible]

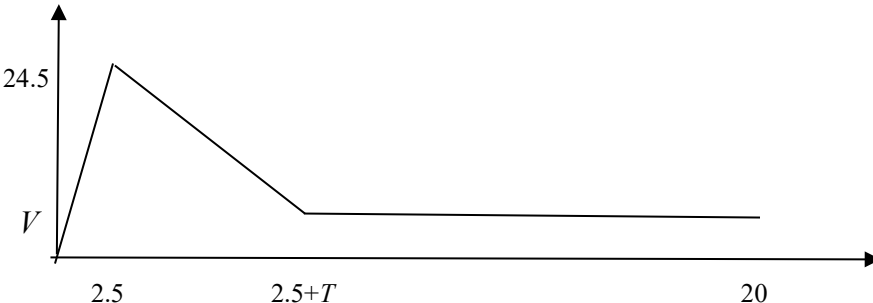


| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Marks |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 4.              | $M(D), 900 \times 5 = W(5 - x)$<br>Other possible equations:<br>$(\uparrow), 900 + R_D = W$<br>$M(A), Wx = 5R_D$<br>$M(B), (900 \times 6) + (R_D \times 1) = W(6 - x)$<br>$M(C), (900 \times 1) + W(x - 1) = 4R_D$<br>$M(G), 900x = R_D(5 - x)$<br><b>BUT</b> $R_D$ then needs to be eliminated to produce an equation in $W$ and $x$ <b>only</b> in order to earn the M mark.<br><br><b>N.B.</b> M0 if they never put $R_C = 0$<br>Allow consistent use of $Mg$ for $W$            | M1A1  |
|                 | $M(C), 1500 \times 5 = W(x - 1)$<br>Other possible equations:<br>$(\uparrow), 1500 + R_C = W$<br>$M(A), (1500 \times 6) + (R_C \times 1) = Wx$<br>$M(B), W(6 - x) = 5R_C$<br>$M(D), W(5 - x) + (1500 \times 1) = 4R_C$<br>$M(G), 1500(6 - x) = R_C(x - 1)$<br><b>BUT</b> $R_C$ then needs to be eliminated to produce an equation in $W$ and $x$ <b>only</b> in order to earn the M mark.<br><br><b>N.B.</b> M0 if they never put $R_D = 0$<br>Allow consistent use of $Mg$ for $W$ | M1A1  |
|                 | Solving for $x$                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | DM1   |
|                 | $x = 3.5$                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | A1    |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | (6)   |
|                 | <b>Notes for question 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |
|                 | M1 For an equation in $W$ and one unknown length. Correct no. of terms, dim correct but condone sign errors.<br>An extra g on one side is an A error.                                                                                                                                                                                                                                                                                                                               |       |
|                 | A1 Correct equation                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
|                 | M1 For an equation in $W$ and the same unknown length. Correct no. of terms, dim correct but condone sign errors.<br>An extra g on one side is an A error.                                                                                                                                                                                                                                                                                                                          |       |
|                 | A1 Correct equation                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
|                 | DM1 Solving for $x$ , dependent on the two previous M marks.                                                                                                                                                                                                                                                                                                                                                                                                                        |       |
|                 | A1 cao with no wrong working seen.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |



| Question Number | Scheme                                                                                                                                                                                                            | Marks          |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                 |                                                                                                                                                                                                                   |                |
| 6(a)            | $(11\mathbf{i} + 11\mathbf{j}) + t(3\mathbf{i} - \mathbf{j})$                                                                                                                                                     | M1A1 (2)       |
|                 |                                                                                                                                                                                                                   |                |
| 6(b)            | When $t = 6$ , $\mathbf{r}_A = (29\mathbf{i} + 5\mathbf{j})$                                                                                                                                                      | M1             |
|                 | $\mathbf{r}_B = (7\mathbf{i} + 16\mathbf{j}) + t(4\mathbf{i} - 2\mathbf{j}) = (29\mathbf{i} + 5\mathbf{j})$                                                                                                       | M1             |
|                 | Solve <b>both</b> $4t + 7 = 29$ and $16 - 2t = 5$ <b>explicitly</b> to give $t = 5.5$ for <b>both equations</b><br>(Division by vectors is DM0)                                                                   | DM1<br>A1* (4) |
|                 |                                                                                                                                                                                                                   |                |
| 6(c)            | $\overrightarrow{AB} = (7\mathbf{i} + 16\mathbf{j}) + t(4\mathbf{i} - 2\mathbf{j}) - \{(11\mathbf{i} + 11\mathbf{j}) + t(3\mathbf{i} - \mathbf{j})\}$                                                             | M1             |
|                 | $\overrightarrow{AB} = [(t - 4)\mathbf{i} + (5 - t)\mathbf{j}]$ m GIVEN ANSWER                                                                                                                                    | A1* (2)        |
|                 |                                                                                                                                                                                                                   |                |
| 6(d)            | $AB^2 = (t - 4)^2 + (5 - t)^2$ oe seen or implied by a numerical calculation                                                                                                                                      | M1             |
|                 | $= 2(t - 4.5)^2 + 0.5$                                                                                                                                                                                            | A1             |
|                 | Complete method using the above to find the minimum                                                                                                                                                               | M1             |
|                 | Minimum $AB = \sqrt{0.5} = 0.71$ m (or better)                                                                                                                                                                    | A1             |
|                 |                                                                                                                                                                                                                   |                |
|                 | <b>OR</b> $AB^2 = (t - 4)^2 + (5 - t)^2$ oe seen or implied by a numerical calculation                                                                                                                            | M1             |
|                 | $4t - 18$ or $2(t - 4) - 2(5 - t)$                                                                                                                                                                                | A1             |
|                 | <b>N.B.</b> Either of these could be implied by seeing $t = 4.5$                                                                                                                                                  |                |
|                 | Complete method using the above to find the minimum                                                                                                                                                               | M1             |
|                 | Minimum $AB = \sqrt{0.5} = 0.71$ m (or better)                                                                                                                                                                    | A1 (4)         |
|                 |                                                                                                                                                                                                                   |                |
|                 | <b>OR</b> $AB^2 = (t - 4)^2 + (5 - t)^2$ oe seen or implied by a numerical calculation                                                                                                                            | M1             |
|                 | $2t^2 - 18t + (41 - d^2) = 0$ ( $d = AB$ )                                                                                                                                                                        | A1             |
|                 | Complete method using $b^2 - 4ac = 0$ : $(-18)^2 - 4 \times 2(41 - d^2) = 0$ to find minimum                                                                                                                      | M1             |
|                 | Minimum $AB = \sqrt{0.5} = 0.71$ m (or better)                                                                                                                                                                    | A1             |
|                 |                                                                                                                                                                                                                   |                |
|                 |                                                                                                                                                                                                                   |                |
|                 | <b>Accept column vectors throughout except in (c)</b>                                                                                                                                                             | <b>(12)</b>    |
|                 | <b>Notes for question 6</b>                                                                                                                                                                                       |                |
| 6(a)            | M1 for an attempt at $\mathbf{r}_A$ with a correct structure                                                                                                                                                      |                |
|                 | A1 cao                                                                                                                                                                                                            |                |
| 6(b)            | M1 for putting $t = 6$ into their $\mathbf{r}_A$ to find $\mathbf{r}_P$                                                                                                                                           |                |
|                 | M1 for equating their $\mathbf{r}_B$ at time $t$ (with correct structure) to their $\mathbf{r}_P$                                                                                                                 |                |
|                 | <b>DM1</b> Solve their vector equation for <b>both</b> components, dependent on both previous M marks. Need to see 5.5 occurring <b>twice</b> .<br><b>N.B.</b> One ratio equation is not sufficient for this mark |                |

| Question Number | Scheme                                                                                                                                                                                                                               | Marks |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
|                 | A1* cao                                                                                                                                                                                                                              |       |
| 6(c)            | M1 for finding their $\mathbf{r}_B$ – their $\mathbf{r}_A$ or their $\mathbf{r}_A$ – their $\mathbf{r}_B$<br>M0 if they start with $\mathbf{r}_A = \mathbf{r}_B$                                                                     |       |
|                 | A1* for correctly establishing <i>exactly</i> (i.e. not a column vector) the given expression (allow omission of m), writing out <b>in full</b> the difference between the vectors before simplifying correctly to the given answer. |       |
| 6(d)            | M1 for a correct expression for either $AB$ or $AB^2$ seen or implied.                                                                                                                                                               |       |
|                 | A1 for a correct quadratic in completed square form                                                                                                                                                                                  |       |
|                 | M1 for a complete method using the completed square form to find the minimum value of $AB$ .                                                                                                                                         |       |
|                 | A1 cao                                                                                                                                                                                                                               |       |
|                 | <b>OR:</b>                                                                                                                                                                                                                           |       |
|                 | M1 for a correct expression for either $AB$ or $AB^2$ seen or implied                                                                                                                                                                |       |
|                 | A1 for a correct derivative ( <b>N.B.</b> can be implied by $t = 4.5$ )                                                                                                                                                              |       |
|                 | M1 for a complete method using the derivative to find the minimum value of $AB$ .                                                                                                                                                    |       |
|                 | A1 cao                                                                                                                                                                                                                               |       |
|                 | <b>OR:</b>                                                                                                                                                                                                                           |       |
|                 | M1 for a correct expression for either $AB$ or $AB^2$ seen or implied                                                                                                                                                                |       |
|                 | A1 for a correct equation                                                                                                                                                                                                            |       |
|                 | M1 for a complete method using the discriminant = 0 to find the minimum value of $AB$ .                                                                                                                                              |       |
|                 | A1 cao                                                                                                                                                                                                                               |       |
|                 |                                                                                                                                                                                                                                      |       |

| Question Number | Scheme                                                                                                                                                                                                                                                                                                                                                                                               | Marks                         |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
|                 |                                                                                                                                                                                                                                                                                                                                                                                                      |                               |
| 7(a)            | $v = 2.5 \times 9.8 = 24.5 \text{ (m s}^{-1}\text{)}$ Allow 2.5g                                                                                                                                                                                                                                                                                                                                     | B1 (1)                        |
| 7(b)            |                                                                                                                                                                                                                                                                                                                    | B1 shape<br>B1 figures<br>(2) |
| 7(c)            | $73.75 = \frac{(24.5 + (24.5 - 3.9T))T}{2}$ <p>OR <math>73.75 = 24.5T - \frac{1}{2} \times 3.9T^2</math></p> <p>OR <math>73.75 = (24.5 - 3.9T)T + \frac{1}{2} \times 3.9T \times T</math></p> <p>OR <math>V^2 = 24.5^2 + 2 \times (-3.9) \times 73.75</math> and then <math>5 = 24.5 - 3.9T</math></p> <p><math>T = 5</math></p> <p><b>N.B.</b> The second M mark should be treated as an A mark</p> | M1<br>A1A1M1<br>A1 (5)        |
| 7(d)            | Height = Total area under graph                                                                                                                                                                                                                                                                                                                                                                      |                               |
|                 | $= \left( \frac{1}{2} \times 24.5 \times 2.5 \right) + 73.75 + (20 - 2.5 - 5) \times (24.5 - 3.9 \times 5)$                                                                                                                                                                                                                                                                                          | M1A2                          |
|                 | =167 (m) nearest metre.                                                                                                                                                                                                                                                                                                                                                                              | A1 (4)                        |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                      | (12)                          |
|                 | <b>Notes for question 7</b>                                                                                                                                                                                                                                                                                                                                                                          |                               |
| 7(a)            | B1 cao                                                                                                                                                                                                                                                                                                                                                                                               |                               |
| 7(b)            | B1 Correct shape of graph with the second line less steep than the first<br>Graph may be reflected in the $t$ -axis.<br>B0 if solid vertical line at $t = 20$                                                                                                                                                                                                                                        |                               |
|                 | B1 All five values correctly placed (allow omission of 0 and appropriate delineators)                                                                                                                                                                                                                                                                                                                |                               |
| 7(c)            | M1 for a complete method to obtain an equation, with a correct structure, in $T$ only.                                                                                                                                                                                                                                                                                                               |                               |
|                 | A1A1M1(A1) For a correct equation or equations, -1 each error.                                                                                                                                                                                                                                                                                                                                       |                               |
|                 | A1 cao (must be a single answer i.e the other root (7.56) must be clearly rejected.                                                                                                                                                                                                                                                                                                                  |                               |
| 7(d)            | M1 for a complete method, using the total area under the graph oe, with a correct structure (i.e. triangle + trapezium + rectangle oe), to obtain an expression for the height of $H$ above the ground.                                                                                                                                                                                              |                               |
|                 | A2 For a correct equation, -1 each error.                                                                                                                                                                                                                                                                                                                                                            |                               |
|                 | A1 cao                                                                                                                                                                                                                                                                                                                                                                                               |                               |
|                 |                                                                                                                                                                                                                                                                                                                                                                                                      |                               |

| Question Number | Scheme                                                                                                                                     | Marks  |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------|
|                 |                                                                                                                                            |        |
|                 |                                                                                                                                            |        |
| <b>8(a)</b>     | $R = 2g \cos \alpha$ (Could be earned in (b) if used there)                                                                                | M1A1   |
|                 | $T - 2g \sin a - F = 2a$                                                                                                                   | M1A1   |
|                 | $4g - T = 4a$                                                                                                                              | M1A1   |
|                 | <b>OR</b> $4g - 2g \sin a - F = 6a$ (whole system) M1A1                                                                                    |        |
|                 | $F = 0.25R$ seen anywhere e.g on a diagram or in (b)                                                                                       | B1     |
|                 | Solve for $T$                                                                                                                              | M1     |
|                 | $T = 2.4g = \frac{12g}{5} = 24 \text{ or } 23.5 \text{ (N)}$                                                                               | A1 (9) |
|                 |                                                                                                                                            |        |
| <b>8(b)</b>     | $2.4g - 2g \sin a - 0.4g = 2a$ OR $4g - 2.4g = 4a$                                                                                         | M1     |
|                 | $a = 0.4g$                                                                                                                                 | A1     |
|                 | $v^2 = \frac{4gh}{5}$                                                                                                                      | M1     |
|                 | $-\frac{6g}{5} - \frac{2g}{5} = 2a'$ ( $a'$ is new acceleration of $A$ up the slope)<br>Allow +ve terms on LHS                             | B1     |
|                 | $0 = \frac{4gh}{5} - \frac{8g}{5}s$                                                                                                        | M1     |
|                 | $s = \frac{1}{2}h$                                                                                                                         | A1     |
|                 | $d > 1.5h$                                                                                                                                 | A1 (7) |
| <b>8(c)</b>     | Weight of string; extensibility of the string; friction at pulley                                                                          | B1 (1) |
|                 | <b>N.B.</b> Simply restating what's in the question is B0.                                                                                 | (17)   |
|                 |                                                                                                                                            |        |
|                 | <b>Notes for question 8</b>                                                                                                                |        |
| <b>8(a)</b>     | M1 Resolving perpendicular to the plane, correct no. of terms, condone sign errors and sin/cos confusion                                   |        |
|                 | A1 Correct equation                                                                                                                        |        |
|                 | M1 Equation of motion parallel to the plane, correct no. of terms, condone sign errors and sin/cos confusion                               |        |
|                 | A1 Correct equation                                                                                                                        |        |
|                 | M1 Equation of motion vertically, correct no. of terms, condone sign errors.                                                               |        |
|                 | A1 Correct equation                                                                                                                        |        |
|                 | <b>N.B.</b><br>Either equation of motion may be replaced by a whole system equation with usual rules.                                      |        |
|                 | B1 $F = 0.25R$ seen anywhere e.g. on diagram                                                                                               |        |
|                 | M1 Solve for $T$ (Must have <i>two</i> equations of <i>motion</i> with $a$ in each)                                                        |        |
|                 | A1 cao                                                                                                                                     |        |
| <b>8(b)</b>     | M1 Eliminate $T$ from their equations of motion to give an equation in $a$ <b>only</b> . (N.B. May be done in (a) but must be used in (b)) |        |

| Question Number | Scheme                                                                                                                              | Marks |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------|-------|
|                 | (Must have <i>two</i> equations of <i>motion</i> with $a$ in each)                                                                  |       |
|                 | A1 $a = 0.4g$ oe (N.B. May be found in (a) but must be used in (b))                                                                 |       |
|                 | M1 Complete method to give an equation in $v$ and $h$ only using their $a$ , which must have been found. (M0 if $0.4g$ or $g$ used) |       |
|                 | B1 Correct equation of motion, with forces in numerical form or in terms of $g$ , for $A$ after $B$ hits the ground in $a'$ only    |       |
|                 | M1 for an equation in $s$ and $h$ only, using their $a'$ (M0 if no $a'$ found)                                                      |       |
|                 | A1 For a correct expression for $s$ in terms of $h$ .                                                                               |       |
|                 | A1 cao                                                                                                                              |       |
| 8(c)            | B1 Any correct answer.<br>B0 if any incorrect extras included.                                                                      |       |
|                 |                                                                                                                                     |       |