

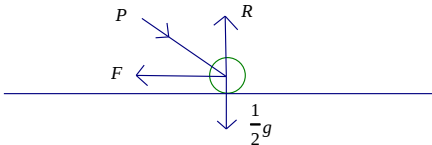


# Mark Scheme (Results)

Summer 2019

Pearson Edexcel IAL In Mechanics 1  
Paper WME01/01

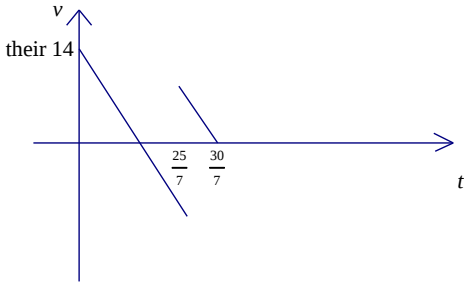
| Question Number | Scheme                                            | Marks | Notes                                                                                                                                                                       |
|-----------------|---------------------------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1(a)            | Use of CLM                                        | M1    | All four terms and dimensionally correct.                                                                                                                                   |
|                 | $6mu - 8mu = -3mu + 2mv$                          | A1    | Correct unsimplified                                                                                                                                                        |
|                 | $v = \frac{1}{2}u$                                | A1    | Must be positive                                                                                                                                                            |
|                 |                                                   | (3)   |                                                                                                                                                                             |
| (b)             | $I = 3m(u - -2u)$ or $I = 2m(\frac{1}{2}u - -4u)$ | M1    | Impulse momentum equation for either particle. Accept +/-<br>Correct process seen or implied. Dimensionally correct.<br>Must link correct masses with the respective speeds |
|                 | $I = 9mu$                                         | A1    | Must be positive                                                                                                                                                            |
|                 |                                                   | (2)   |                                                                                                                                                                             |
|                 |                                                   | (5)   |                                                                                                                                                                             |

| Question Number | Scheme                                                                            | Marks      | Notes                                                                                                                                 |
|-----------------|-----------------------------------------------------------------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 2.              |  |            | Condone if $P$ acting in the wrong direction but see SC below                                                                         |
|                 | $F = \frac{1}{4} R$                                                               | B1         | Use of $F = \mu R$ with $\mu = \frac{1}{4}$ seen or implied                                                                           |
|                 | $P \cos 40 = F$                                                                   | B1         | Resolve horizontally. Accept $F \cos 40^\circ = F_{\max}$ . Not $F \cos 40^\circ = F$                                                 |
|                 | Resolve vertically                                                                | M1         | All terms required, and dimensionally correct. $P \neq R$<br>Condone sign errors and sin/cos confusion                                |
|                 | $P \sin 40 + 0.5g = R$                                                            | A1         | Correct unsimplified equation                                                                                                         |
|                 | $P(4 \cos 40 - \sin 40) = 0.5g$                                                   | DM1        | Substitute for $R$ and solve for $P$ . Requires zero acceleration.<br>Dependent on previous M1                                        |
|                 | $P = 2.0 \text{ (N) or } 2.02 \text{ (N)}$                                        | A1         | 2 or 3 sf only                                                                                                                        |
|                 |                                                                                   | <b>(6)</b> | SC if $F$ opposes their $P$ , 6/6 available<br>If $P$ and $F$ inconsistent max score available<br>B1B0 M1A1follow their diagram DM1A0 |

| Question Number | Scheme                                                                                                                                                                                                                                                                           | Marks       | Notes                                                                                                                                                                             |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3(a)            | moments equation                                                                                                                                                                                                                                                                 | M1          | All terms required. Dimensionally correct<br>Condone sign errors                                                                                                                  |
|                 | $M(C), Mg \times 1.5 + 100g \times 3.5 = 637 \times 7$<br>$M(A): 2Mg + 400g = \frac{1}{2}T + 7.5 \times 637$<br>$M(P): 1.5T + 100g \times 2 = 637 \times 5.5$                                                                                                                    | A1          | Correct unsimplified equation                                                                                                                                                     |
|                 | Resolve vertically or a second moments equation                                                                                                                                                                                                                                  | M1          | All terms required. Dimensionally correct<br>Condone sign errors                                                                                                                  |
|                 | $(\uparrow), T + 637 = Mg + 100g$                                                                                                                                                                                                                                                | A1ft        | Correct unsimplified equation in $M$ or their $M$ , $T$ or their $T$                                                                                                              |
|                 | (i) $M = 70$                                                                                                                                                                                                                                                                     | A1          | 69.99... = 70 is A0 (from 9.81)                                                                                                                                                   |
|                 | (ii) $T = 1000\text{N}$ or $1030\text{ N}$                                                                                                                                                                                                                                       | A1          | Not 1029, not 105g                                                                                                                                                                |
|                 |                                                                                                                                                                                                                                                                                  |             | They need to form two independent equations.<br>M1A1 for first equation seen<br>M1A1ft for the second equation (ft on any result from the first eqn)<br>A1 for $M$ , A1 for $T$ . |
|                 |                                                                                                                                                                                                                                                                                  | (6)         |                                                                                                                                                                                   |
| (b)             | Assumed that the beam remains straight                                                                                                                                                                                                                                           | B1          | Not flexible B1, Does not bend B1,<br>Extra irrelevant (e.g. centre of mass at midpoint) B0                                                                                       |
|                 |                                                                                                                                                                                                                                                                                  | (1)         |                                                                                                                                                                                   |
| (c)             | $T + T = 60g + 100g + 48g$                                                                                                                                                                                                                                                       | M1          | Resolve vertically. Need all terms. Equal $T$ s. Condone sign errors                                                                                                              |
|                 | $(T = 104g \text{ or } 1019.2\text{N})$                                                                                                                                                                                                                                          | A1          | Correct unsimplified equation                                                                                                                                                     |
|                 | Moments equation                                                                                                                                                                                                                                                                 | M1          | All terms required. Dimensionally correct. Not using $T$ from (a)<br>Condone sign errors                                                                                          |
|                 | $M(C), 60g \times 1.5 + 100g \times 3.5 + 48g \times (x - 0.5) = T \times 7$<br>$M(A): 60g \times 2 + 100g \times 4 + 48gx = 0.5T + 7.5T$<br>$M(B): 0.5T + 7.5T = 48g(8 - x) + 4 \times 100g + 6 \times 60g$<br>$M(D): 100g \times 3.5 + 48g(7.5 - x) + 60g \times 5.5 - 7T = 0$ | A1          | Correct unsimplified equation                                                                                                                                                     |
|                 | Solve for $x$                                                                                                                                                                                                                                                                    | DM1         | Solve for our $x$ . Dependent on both preceding M marks                                                                                                                           |
|                 | $x = 6.5\text{ (m)}$                                                                                                                                                                                                                                                             | A1          |                                                                                                                                                                                   |
|                 | Watch out for “correct” answer from working that ignores the 100g                                                                                                                                                                                                                | (6)<br>(13) | As above, M1A1 for two independent equations, then DM1A1 for solving                                                                                                              |

| Question Number | Scheme                                                           | Marks    | Notes                                                                                                                                                                                                                                                |
|-----------------|------------------------------------------------------------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4(i)            | Equation of motion for the system                                | M1       | All terms required. Dimensionally correct.<br>Condone sign errors and sin/cos confusion                                                                                                                                                              |
|                 | $3050 - 300 - 2500g \sin \theta = 2500a$                         | A1<br>A1 | Unsimplified equation with at most one error.<br>Correct unsimplified equation<br>NB A sign error on the 300 or a sign error on $2500g \sin \theta$ counts as 2 errors (to be consistent with the penalty if they did this in 2 separate equations). |
|                 | $a = 0.4 \text{ (m s}^{-2}\text{)}$                              | A1       | Not $\frac{2}{5}$ (follows 9.8)                                                                                                                                                                                                                      |
|                 |                                                                  | (4)      |                                                                                                                                                                                                                                                      |
|                 |                                                                  |          |                                                                                                                                                                                                                                                      |
| (ii)            | Equation of motion for the truck                                 | M1       | All terms required. Dimensionally correct.<br>Condone sign errors and sin/cos confusion                                                                                                                                                              |
|                 | $T - 100 - 500g \sin q = 500a$<br>$T = 650 \text{ (N)}$          | A1<br>A1 | Unsimplified equation with at most one error. Condone negative $T$<br>Consistent sign for $T$ . Correct unsimplified equation (in $a$ or their $a$ )                                                                                                 |
|                 | $T = 650 \text{ (N)}$                                            | A1       | Must be positive                                                                                                                                                                                                                                     |
|                 |                                                                  | (4)      |                                                                                                                                                                                                                                                      |
| (ii) alt        | Equation of motion for the engine                                | M1       | All terms required. Dimensionally correct.<br>Condone sign errors and sin/cos confusion                                                                                                                                                              |
|                 | $3050 - 200 - 2000g \sin q - T = 2000a$<br>$T = 650 \text{ (N)}$ | A1<br>A1 | Unsimplified equation with at most one error. Condone negative $T$<br>Correct unsimplified equation                                                                                                                                                  |
|                 | $T = 650 \text{ (N)}$                                            | A1       | Must be positive                                                                                                                                                                                                                                     |
|                 |                                                                  | (4)      |                                                                                                                                                                                                                                                      |
|                 |                                                                  |          | (i) and (ii) can be solved together by forming the two separate equations of motion and solving using simultaneous equations.<br>M1A1A1 <b>for each equation</b> and A1A1 as above.                                                                  |
|                 |                                                                  |          | If the 100 N and the 200 N are associated with the wrong vehicles, treat this as a MR. This error gives them $T = 750$                                                                                                                               |
|                 |                                                                  | (8)      |                                                                                                                                                                                                                                                      |

| Question Number | Scheme                                                                                                                      | Marks | Notes                                                                                                                           |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------|
| 5(a)            | $\tan \theta = \frac{2}{3}$                                                                                                 | M1    | Use trig to find a relevant angle ( $56.3^\circ$ , $33.7^\circ$ )                                                               |
|                 | Angle is $\theta + 90^\circ = 123.69^\circ..$                                                                               | A1    | $124^\circ$ or better (2.16 radians)                                                                                            |
|                 |                                                                                                                             | (2)   |                                                                                                                                 |
|                 |                                                                                                                             |       |                                                                                                                                 |
| (b)             | $\mathbf{F}_1 + \mathbf{F}_2 = (a\mathbf{i} + 3\mathbf{j}) + (-4\mathbf{i} + b\mathbf{j}) (= k(3\mathbf{i} - 2\mathbf{j}))$ | M1    | Resultant force seen or implied: must be the sum, NOT the difference<br>As a column vector or in $\mathbf{i} / \mathbf{j}$ form |
|                 | Use direction to form equation in $a$ and $b$                                                                               | M1    | From ratio of scalars or 2 separate equations involving $k \neq 1$                                                              |
|                 | $\frac{a-4}{3+b} = \frac{3}{-2}$                                                                                            | A1    | Correct unsimplified equation                                                                                                   |
|                 | $0 = 2a + 3b + 1$ Given answer                                                                                              | A1    | Obtain <b>given answer</b> from correct working- need to see evidence                                                           |
|                 |                                                                                                                             | (4)   |                                                                                                                                 |
|                 |                                                                                                                             | (6)   |                                                                                                                                 |

| Question Number | Scheme                                                                              | Marks | Notes                                                                                                                                                   |
|-----------------|-------------------------------------------------------------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6(a)            | $s = ut + \frac{1}{2}at^2$                                                          | M1    | Complete method using <i>suvat</i> to <b>form</b> equation in <i>U</i> only                                                                             |
|                 | $-12\frac{1}{2} = \frac{25}{7}U - 4.9(\frac{25}{7})^2$                              | A1    | Correct unsimplified equation<br>Allow $12\frac{1}{2} = \frac{25}{7}U + 4.9(\frac{25}{7})^2$ even if it is not clear that they know why it is true      |
|                 | $U = 14$                                                                            | A1    | Must be positive                                                                                                                                        |
|                 |                                                                                     | (3)   |                                                                                                                                                         |
| (b)             | $s = vt - \frac{1}{2}at^2$                                                          | M1    | Complete method using <i>suvat</i> to <b>form</b> equation in <i>s</i> only                                                                             |
|                 | $s = 0 - \frac{1}{2}(-9.8)(\frac{5}{7})^2$                                          | A1    | Correct unsimplified equation                                                                                                                           |
|                 | $= 2\frac{1}{2} \text{ (m)}$                                                        | A1    |                                                                                                                                                         |
|                 |                                                                                     | (3)   |                                                                                                                                                         |
| (b) alt         | $0 = u - g(\frac{5}{7}) \quad u = 7$<br>$s = ut + \frac{1}{2}at^2$                  | M1    | Complete method using <i>suvat</i> to <b>form</b> equation in <i>s</i>                                                                                  |
|                 | $s = 7(\frac{5}{7}) - \frac{1}{2}9.8(\frac{5}{7})^2$                                | A1    | Correct unsimplified equation                                                                                                                           |
|                 | $= 2\frac{1}{2} \text{ (m)}$                                                        | A1    |                                                                                                                                                         |
|                 |                                                                                     | (3)   |                                                                                                                                                         |
| (c).            |  | B1    | 1 <sup>st</sup> line (existing for both +ve and -ve <i>v</i> ) ignore figures                                                                           |
|                 |                                                                                     | B1    | 2 <sup>nd</sup> line correct and stopping on the <i>t</i> axis. no other lines. Ignore figures. Parallel to upward portion of their first line if seen. |
|                 |                                                                                     | B1 ft | Figs. In the right places. Allow <i>U</i> for their 14                                                                                                  |
|                 |                                                                                     | (3)   |                                                                                                                                                         |
|                 |                                                                                     |       | Accept mirror image in the <i>t</i> axis                                                                                                                |
|                 |                                                                                     | (9)   |                                                                                                                                                         |

| Question Number | Scheme                                                                                                                                             | Marks | Notes                                                                                           |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------|
| 7(a)            | Use of $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}t$                                                                                                   | M1    | At least once. Must be adding, not subtracting                                                  |
|                 | $\mathbf{r}_A = (8\mathbf{i} + 7\mathbf{j}) + t(2\mathbf{i} - 14\mathbf{j})$                                                                       | A1    | $\mathbf{r}_A$ correct $\begin{pmatrix} 8 + 2t \\ 7 - 14t \end{pmatrix}$                        |
|                 | $\mathbf{r}_B = (\mathbf{i} + 2\mathbf{j}) + t(12\mathbf{i} - 4\mathbf{j})$                                                                        | A1    | $\mathbf{r}_B$ correct $\begin{pmatrix} 1 + 12t \\ 2 - 4t \end{pmatrix}$                        |
|                 | $\overrightarrow{BA} = (8\mathbf{i} + 7\mathbf{j}) + t(2\mathbf{i} - 14\mathbf{j}) - [(\mathbf{i} + 2\mathbf{j}) + t(12\mathbf{i} - 4\mathbf{j})]$ | M1    | Need to see an indication of method as leading to a given answer                                |
|                 | $= (7 - 10t)\mathbf{i} + (5 - 10t)\mathbf{j}$                                                                                                      | A1    | Obtain <b>given answer</b> from correct working                                                 |
|                 |                                                                                                                                                    | (5)   |                                                                                                 |
| (b)             | Use of Pythagoras to equate distance to 2 km                                                                                                       | M1    |                                                                                                 |
|                 | $(7 - 10t)^2 + (5 - 10t)^2 = 2^2$                                                                                                                  | A1    | Correct unsimplified equation in $t$                                                            |
|                 | $20t^2 - 24t + 7 = 0$                                                                                                                              | M1    | Form 3 term quadratic in $t$                                                                    |
|                 | $(10t - 7)(2t - 1) = 0$                                                                                                                            | DM1   | Solve for $t$ . Dependent on the preceding M1. Must see working if using an incorrect quadratic |
|                 | $t = \frac{7}{10} \text{ or } \frac{1}{2}$                                                                                                         | A1    |                                                                                                 |
|                 | Time = $\frac{7}{10} - \frac{1}{2}$                                                                                                                | DM1   | Correct method to find the time interval. Dependent on the preceding M1                         |
|                 | $= \frac{2}{10} \text{ h (12 min)}$                                                                                                                | A1    |                                                                                                 |
|                 |                                                                                                                                                    | (7)   |                                                                                                 |
|                 |                                                                                                                                                    | (12)  |                                                                                                 |

| Question Number | Scheme                                                | Marks     | Notes                                                                                                           |
|-----------------|-------------------------------------------------------|-----------|-----------------------------------------------------------------------------------------------------------------|
| 8(a)            | Equation of motion for $P$ or for $Q\&R$ .            | M1        | All terms required and dimensionally correct. Condone sign errors. If $m$ missing throughout, mark as a misread |
|                 | $5mg - T = 5ma$ or $T - 4mg = 4ma$                    | A1        | One correct unsimplified equation                                                                               |
|                 | Second equation of motion.                            | M1        | Condone if second equation is for the <b>whole system</b>                                                       |
|                 | $5mg - T = 5ma$<br>$T - 4mg = 4ma$                    | A1        | A second correct unsimplified equation                                                                          |
|                 | Solve for $a$ and $T$                                 | DM1       | Dependent on the first M mark                                                                                   |
|                 | $a = \frac{g}{9}$                                     | A1        | 1.09 or 1.1 not $\frac{49}{45}$                                                                                 |
|                 | $T = \frac{40mg}{9}$                                  | A1        | 43.6m, 44m                                                                                                      |
|                 |                                                       | (7)       | SC A whole system alone leading to correct $a$ scores<br>M0A0M1A1M0A1A0                                         |
| (b)             | All particles have acceleration of the same magnitude | B1<br>(1) | Particles all start to move at the same time B1<br>Extra irrelevant comments B0                                 |
| (c)             | $v^2 = \frac{2gd}{9}$                                 | M1        | Complete method to find $v$ or $v^2$ at the instant of separation                                               |
|                 | Two independent equations of motion                   | M1        | Dimensionally correct and contain correct terms                                                                 |
|                 | $3mg - T' = 3ma'$<br>$T' - 4mg = 4ma'$                | A1<br>A1  | A1 for each correct equation. Accept the combined eqn. for A2                                                   |
|                 | $a' = -\frac{g}{7}$                                   | A1        | Accept +/-                                                                                                      |
|                 | Use of <i>suvat</i> to find distance                  | DM1       | With $a \neq$ their $\frac{g}{9}$ or $g$<br>Dependent on the two preceding M marks                              |
|                 | $0 = \frac{2gd}{9} - 2\frac{g}{7}s$                   | A1ft      | Correct unsimplified equation. Follow their $a \neq$ their $\frac{g}{9}$                                        |
|                 | $s = \frac{7d}{9}$                                    | A1        | 0.78d, 0.778d or better. Must be positive. Do not ISW                                                           |
|                 |                                                       | (8)       |                                                                                                                 |
|                 |                                                       | (16)      |                                                                                                                 |