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ASSESSMENT and QUALIFICATIONS ALLIANCE

## General Certificate of Education

# Mathematics 6360

## MM1B Mechanics 1B

# Mark Scheme

*2007 examination - June series*

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.



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## Key to mark scheme and abbreviations used in marking

| | |
|---|---|
| M | mark is for method |
| m or dM | mark is dependent on one or more M marks and is for method |
| A | mark is dependent on M or m marks and is for accuracy |
| B | mark is independent of M or m marks and is for method and accuracy |
| E | mark is for explanation |

| | | | |
|---|---|---|---|
| √or ft or F | follow through from previous incorrect result | MC | mis-copy |
| CAO | correct answer only | MR | mis-read |
| CSO | correct solution only | RA | required accuracy |
| AWFW | anything which falls within | FW | further work |
| AWRT | anything which rounds to | ISW | ignore subsequent work |
| ACF | any correct form | FIW | from incorrect work |
| AG | answer given | BOD | given benefit of doubt |
| SC | special case | WR | work replaced by candidate |
| OE | or equivalent | FB | formulae book |
| A2,1 | 2 or 1 (or 0) accuracy marks | NOS | not on scheme |
| –*x* EE | deduct *x* marks for each error | G | graph |
| NMS | no method shown | c | candidate |
| PI | possibly implied | sf | significant figure(s) |
| SCA | substantially correct approach | dp | decimal place(s) |

**No Method Shown**

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

**Otherwise we require evidence of a correct method for any marks to be awarded.**

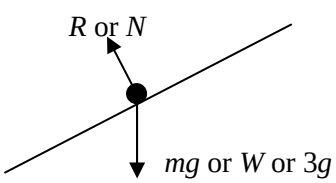
**MM1B**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **1(a)** | $v = 0 + 1.5 \times 9.8$ | M1 | | Use of constant acceleration equation to find $v$ |
| | $= 14.7$ ms$^{-1}$ | A1 | 2 | AG Correct $v$ from correct working<br>$1.5 \times 9.8 = 14.7$ is not enough on its own |
| **(b)** | $h = \frac{1}{2} \times 9.8 \times 1.5^2$ | M1 | | Use of constant acceleration equation with $a = 9.8$ to find $h$ |
| | $= 11.0$ m (to 3 sf) | A1 | 2 | Correct $h$<br>Allow 11 m; ignore negative signs |
| **(c)** | $5^2 = 0^2 + 2 \times 9.8s$ | M1 | | Use of constant acceleration equation with $u = 0$ to find $s$ |
| | | A1 | | Correct equation |
| | $s = \frac{25}{19.6} = 1.28$ m (to 3 sf) | A1 | 3 | Correct $s$<br>Accept 1.27 |
| | **OR** | | | |
| | $t = \frac{5}{9.8} = 0.510$<br>$s = \frac{1}{2}(0+5)\frac{5}{9.8} = 1.28$ m | | | |
| | **OR** | | | |
| | $s = 0 + \frac{1}{2} \times 9.8 \times \left(\frac{5}{9.8}\right)^2 = 1.28$ m | | | |
| | **Total** | | **7** | |
| **2(a)** | $2\begin{bmatrix} 3 \\ -2 \end{bmatrix} + 3\begin{bmatrix} -4 \\ 1 \end{bmatrix} = 5\mathbf{v}$ | M1 | | Three term vector equation, with a '+' sign, for conservation of momentum |
| | | A1 | | Correct equation<br>Deduct this first A mark for use of $mg$ |
| | $\mathbf{v} = \frac{1}{5}\begin{bmatrix} -6 \\ -1 \end{bmatrix} = \begin{bmatrix} -1.2 \\ -0.2 \end{bmatrix}$ | A1 | 3 | Correct velocity |
| **(b)** | $v = \sqrt{1.2^2 + 0.2^2} = 1.22$ ms$^{-1}$ | M1 | | Finding speed from their velocity in part (a)<br>(Must include addition of two terms) |
| | | A1F | 2 | Correct speed from their velocity<br>Accept 1.21 |
| | **Total** | | **5** | |

**MM1B (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **3(a)** | $T_1 \sin 35° = T_2 \sin 35°$ | M1 | | Resolving two forces and forming an equation, with different tensions for each string |
| | $T_1 = T_2$ | A1 | 2 | Correct result from correct working |
| | **OR** | | | |
| | $T_1 \cos 55° = T_2 \cos 55°$ | | | |
| | $T_1 = T_2$ | | | |
| **(b)** | $T_1 \cos 35° + T_2 \cos 35° = 2 \times 9.8$ | M1 | | Resolving forces to form a three term vertical equation |
| | $T_1 \cos 35° + T_1 \cos 35° = 2 \times 9.8$ | A1 | | Correct equation |
| | | A1 | | $T_1$ or $T_2$ eliminated correctly |
| | | dM1 | | Solving for $T_1$ or $T_2$ |
| | $T_1 = \dfrac{2 \times 9.8}{2 \cos 35°} = 12.0$ N (to 3sf) | A1 | 5 | Correct tension<br>Accept 12 N or 11.9 N |
| **(c)** | $2 \times 40 \cos 35° = 9.8m$ | M1 | | Forming an equation with two tensions to find $m$ |
| | | A1 | | Correct equation |
| | $m = \dfrac{80 \cos 35°}{9.8} = 6.69$ kg | A1 | 3 | Correct mass<br>Accept 6.68 |
| | **OR** | | | |
| | $m = \dfrac{40}{11.96} \times 2$ | (M1) | | |
| | | (A1) | | |
| | $= 6.69$ kg | (A1) | | |
| | **Total** | | **10** | |
| **4(a)** | $T - 800 = 1200 \times 0.4$ | M1 | | Three term equation of motion for the car |
| | | A1 | | Correct equation |
| | $T = 800 + 480$ | | | |
| | $= 1280$ N | A1 | 3 | Correct tension<br>Treat calculation of two tensions as two methods unless one selected<br>Treat sum or difference of two tensions as an incorrect method |
| **(b)** | $3000 - 800 - F = 4000 \times 0.4$ | M1 | | Four term equation of motion (truck or both) |
| | | A1 | | Correct terms |
| | | A1 | | Correct signs |
| | $F = 3000 - 800 - 1600$ | | | |
| | $F = 600$ N | A1 | 4 | AG Correct resistance force from correct working |
| | **OR** | | | |
| | $3000 - 1280 - F = 2800 \times 0.4$ | | | |
| | $F = 3000 - 1280 - 1120$ | | | |
| | $F = 600$ N | | | |
| **(c)** | Increase, because a greater tension would be needed so that the horizontal component would be the same as the tension above. | B1 | | Greater |
| | | B1 | 2 | Reason<br>Second B1 dependent on the first B1 mark |
| | **Total** | | **9** | |

**MM1B (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **5(a)** | $V = 150\tan 30°$ | M1 | | Using trigonometry (usually tan or sine rule) to find $V$ |
| | $= 86.6$ ms$^{-1}$ | A1 | 2 | AG Correct answer from correct working (Division by 2 only acceptable if sin30° or cos60° seen) |
| | **OR** $\frac{V}{\sin 30°} = \frac{150}{\sin 60°}$ AG $V = 86.6$ ms$^{-1}$ | | | |
| **(b)** | $\frac{150}{v} = \cos 30°$ | M1 | | Using trigonometry or Pythagoras to find $v$ |
| | | A1 | | Correct expression |
| | $v = \frac{150}{\cos 30°} = 173$ ms$^{-1}$ (to 3sf) | A1 | 3 | Correct answer |
| | **Total** | | **5** | |
| **6(a)(i)** |   | B1 | 1 | Correct diagram with arrows and labels |
| **(ii)** | $3a = 3g\sin 30°$ | M1 | | Two term equation of motion |
| | $a = g\sin 30° = 4.9$ ms$^{-2}$ | A1 | 2 | AG Correct acceleration from correct working (Allow $a = g\sin 30°$) |
| **(b)(i)** | $5 = \frac{1}{2}a \times 2^2$ | M1 | | Constant acceleration equation with $u = 0$ |
| | $a = 2.5$ ms$^{-2}$ | A1 | 2 | AG Correct answer from correct working. (Use of $v = 5$ must be justified) |
| **(ii)** | $3 \times 2.5 = 3g\sin 30° - F$ | M1 | | Three term equation of motion |
| | | A1 | | Correct equation |
| | $F = 3g\sin 30° - 7.5$ $= 7.20$ N (to 3 sf) | A1 | 3 | Correct $F$ Accept 7.2 N |
| **(iii)** | $R = 3g\cos 30°$ (= 25.46) | M1 | | Resolving perpendicular to the slope to find $R$ |
| | | A1 | | Correct $R$ |
| | $7.2 = \mu \times 3g\cos 30°$ | M1 | | Use of $F = \mu R$ |
| | | A1F | | Correct expression |
| | $\mu = \frac{7.2}{3g\cos 30°} = 0.283$ | A1F | 5 | Correct $\mu$ Accept 0.282 (Follow through from incorrect $F$ from above, but not an incorrect $R$) |
| **(iv)** | Reduce $a$, as the air resistance would reduce the magnitude of the resultant force or because the air resistance increases as the velocity increases towards its terminal value | B1 | | Reduces |
| | | B1 | 2 | Explanation Second B1 dependent on the first B1 mark |
| | **Total** | | **15** | |

**MM1B (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **7(a)** | A particle or no spin | B1 | | First assumption |
| | No air resistance or no wind or only gravity acting | B1 | 2 | Second assumption<br><br>If more than 2 assumptions given, subtract one mark for each incorrect additional assumption |
| **(b)** | $0 = 25\sin 40° t - 4.9t^2$ | M1 | | Equation for time of flight |
| | | A1 | | Correct equation |
| | $0 = t(25\sin 40° - 4.9t)$ | dM1 | | Solving for $t$ |
| | $t = 0$ or $t = \dfrac{25\sin 40°}{4.9}$ | | | |
| | Time of flight = 3.28 s | A1 | 4 | AG Correct final answer from correct working<br>(Verification method M1A1M1A0) |
| **(c)** | $s = 3.28 \times 25\cos 40° = 62.8$ m | M1 | | Finding range |
| | | A1 | 2 | Correct range |
| **(d)** | 25 $ms^{-1}$ at 40° **below** the horizontal | B1 | | Speed |
| | | B1 | 2 | Direction |
| **(e)** | $v_{min} = 25\cos 40° = 19.2$ $ms^{-1}$ | M1 | | Horizontal component of velocity |
| | | A1 | 2 | Correct speed<br>Accept 19.1 $ms^{-1}$ |
| | **OR** | | | |
| | $v_{min} = \dfrac{62.807}{3.2795} = 19.2$ $ms^{-1}$ | | | |
| | **Total** | | **12** | |

**MM1B (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **8(a)** | $\mathbf{u} = 5\mathbf{i}$ or $\begin{bmatrix} 5 \\ 0 \end{bmatrix}$ | B1 | 1 | Correct velocity |
| **(b)** | $\mathbf{v} = 5\mathbf{i} + (-0.2\mathbf{i} + 0.25\mathbf{j})t$ | M1 | | Use of constant acceleration equation, with **u** and **a** not zero |
| | | A1 | 2 | Correct velocity<br>M1A0 for using 5**j** or just 5 |
| | **OR**<br>$\mathbf{v} = \begin{bmatrix} 5 - 0.2t \\ 0.25t \end{bmatrix}$ | | | |
| **(c)** | $5 - 0.2t = 0$ | M1<br>A1 | | Easterly component zero<br>Correct equation |
| | $t = \frac{5}{0.2} = 25$ seconds | A1 | 3 | Correct $t$ |
| **(d)** | $\mathbf{r} = 5\mathbf{i} \times 25 + \frac{1}{2}(-0.2\mathbf{i} + 0.25\mathbf{j}) \times 25^2$ | M1 | | Use of constant acceleration equation with $t$ from part (c) |
| | | A1F | | Correct expression based on $t$ from part (c) |
| | $= 62.5\mathbf{i} + 78.125\mathbf{j}$ | A1 | | Correct simplification CAO |
| | $\theta = \tan^{-1}\left(\frac{62.5}{78.125}\right)$ | dM1<br>A1F | | Using tan to find the angle<br>Correct expression based on $t$ from part (c), with correct two values(either way) |
| | $= 038.7°$ | A1 | 6 | Correct angle<br>Accept 38.6° or 039° |
| | **OR** | | | |
| | $\mathbf{r} = \frac{1}{2}(5\mathbf{i} + 6.25\mathbf{j}) \times 25$ | (M1)<br>(A1F) | | |
| | $\theta = \tan^{-1}\left(\frac{5}{6.25}\right) = 038.7°$ | (A1)<br>(dM1)<br>(A1F)<br>(A1) | | |
| | **Total** | | **12** | |
| | **TOTAL** | | **75** | |