ASSESSMENT and QUALIFICATIONS ALLIANCE

# Mark scheme January 2004

# GCE

## Mathematics & Statistics B

## Unit MBM1



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# Key to mark scheme

| | | |
|---|---|---|
| **M** | mark is for | method |
| **m** | mark is dependent on one or more M marks and is for | method |
| **A** | mark is dependent on M or m mark 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 |
| **CAO** | | correct answer only |
| **AWFW** | | anything which falls within |
| **AWRT** | | anything which rounds to |
| **AG** | | answer given |
| **SC** | | special case |
| **OE** | | or equivalent |
| **A2,1** | | 2 or 1 (or 0) accuracy marks |
| **– *x* EE** | | Deduct *x* marks for each error |
| **NMS** | | No method shown |
| **PI** | | Perhaps implied |
| **c** | | Candidate |

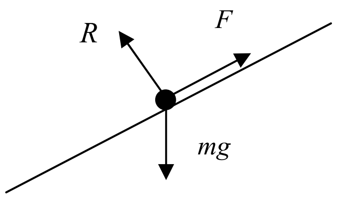
# Abbreviations used in marking

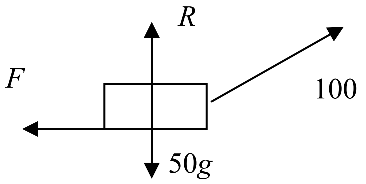
| | |
|---|---|
| **MC – *x*** | deducted *x* marks for miscopy |
| **MR – *x*** | deducted *x* marks for misread |
| **ISW** | ignored subsequent working |
| **BOD** | gave benefit of doubt |
| **WR** | work replaced by candidate |

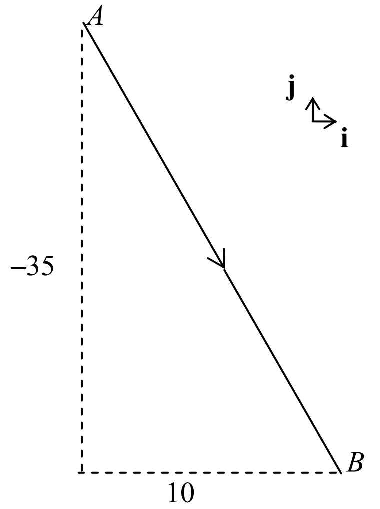
# Application of mark scheme

| | |
|---|---|
| Correct answer without working | mark as in scheme |
| Incorrect answer without working | zero marks unless specified otherwise |

Award method and accuracy marks as appropriate to an alternative solution using a correct method or partially correct method.

| Question Number and Part | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| 1(a) | $9 = 3 + 1.2t$ | M1 | | Forming constant acceleration equation |
| | $t = \dfrac{9-3}{1.2} = 5$ seconds | A1 | 2 | Correct result from correct working |
| (b) | $s = \dfrac{1}{2}(3+9)\times 5 = 30$ metres | M1 | | Forming constant acceleration equation |
| | | A1 | 2 | Correct distance |
| (c) | $F = 1200 \times 1.2 = 1440$ N | M1 | | Applying Newton's second law with $a = 1.2$ |
| | | A1 | 2 | Correct $F$ |
| | **Total** | | **6** | |
| 2(a) | $0.1\times 5 + 0.4\times 3 = 0.5v$ | M1 | | Using conservation of momentum |
| | | A1 | | Correct equation |
| | $v = \dfrac{1.7}{0.5} = 3.4\ \text{m s}^{-1}$ | A1 | 3 | Correct $v$ |
| (b) | $0.1\times 5 + 0.4\times 3 = 0.1v + 0.4\times 3.5$ | M1 | | Using conservation of momentum |
| | | A1 | | Correct equation |
| | $v = \dfrac{1.7-1.4}{0.1} = 3\ \text{m s}^{-1}$ | m1 | | Solving for $v$ |
| | | A1 | 4 | Correct $v$ |
| | **Total** | | **7** | |
| 3(a) |  | B1 | 1 | Correct force diagram |
| (b) | $R = 5\times 9.8\cos 40° = 37.5$ N | M1 | | Resolving perpendicular to slope |
| | | A1 | 2 | Correct $R$ |
| (c) | $F = 0.2R = 7.51$ N | M1 | | Using $F = \mu R$ |
| | | A1 | 2 | Correct $F$ from correct working |
| (d) | $5\times 9.8\sin 40° - F = 5a$ | M1 | | Resolving parallel to slope to give 3 term equation of motion |
| | | A1 | | Correct equation |
| | $a = \dfrac{5\times 9.8\sin 40° - F}{5} = 4.80\ \text{m s}^{-2}$ | m1 | | Solving for $a$ |
| | | A1 | 4 | Correct $a$ from correct working |
| (e) | $10^2 = 2^2 + 2\times 4.80s$ | M1 | | Forming constant acceleration equation |
| | | A1 | | Correct equation |
| | $s = \dfrac{100-4}{9.6} = 10.0$ m | A1 | 3 | Correct $s$ |
| | **Total** | | **12** | |

| Question Number and Part | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| 4(a) | $14a = 14g\sin 45° - T$ | M1 | | Equation of motion for one particle |
| | $6a = T - 6g$ | A1 | | Correct equation |
| | $14a = 14g\sin 45° - (6a + 6g)$ | M1 | | Equation of motion for other particle |
| | | A1 | | Correct equation |
| | $a = \dfrac{14g\sin 45° - 6g}{20} = 1.91\ \mathrm{ms^{-2}}$ | M1 | | Solving for $a$ |
| | | A1 | 6 | Correct $a$ from correct working |
| (b) | $T = mg$ | M1 | | Equation for one particle |
| | $T = 14g\cos 45°$ | M1 | | Equation for other particle |
| | | A1 | | Correct $m$ |
| | $m = 14\cos 45° = 9.90\ \mathrm{kg}$ | A1 | 4 | |
| | **Total** | | **10** | |
| 5(a) |  | B1 | 1 | Correct force diagram |
| (b) | $50 \times 9.8 = R + 100\sin 30°$ | M1 | | Resolving vertically |
| | $R = 440\ \mathrm{N}$ | A1 | | Correct equation |
| | | A1 | 3 | Correct $R$ from correct working |
| (c) | $100\cos 30° \le \mu \times 440$ | M1 | | Use of $F \le \mu R$ or $F = \mu R$ |
| | $\mu \ge 0.197$ $\quad \therefore k = 0.197$ | A1 | | Correct equation |
| | | A1 | 3 | Correct $k$ from correct working |
| (d) | $50a = 100\cos 30° - 0.1 \times 440$ | M1 | | Resolving horizontally to obtain a 3 term equation of motion |
| | | A1 | | Correct equation |
| | $a = 0.852\ \mathrm{ms^{-2}}$ | m1 | | Solving for $a$ |
| | | A1 | 4 | Correct $a$ |
| | | | | Allow 0.680 or 0.681 |
| | **Total** | | **11** | |
| 6(a)(i) | $10 \times 9.8 \times 0.5 = 2T$ | M1 | | Moments about pivot with 2 terms |
| | $T = 24.5$ | A1 | | Correct moment equation |
| | | A1 | 3 | Correct tension from correct working |
| (ii) | $10 \times 9.8 \times 0.5 + 40 \times 9.8 \times 3 = 2T$ | M1 | | Moments about pivot with 3 terms |
| | $T = 613\ (\text{to 3 sf})$ | A1 | | Correct moment equation |
| | | A1 | 3 | Correct tension from correct working |
| (b) | No change, as the ratios of the distances | B1 | | No |
| | from the pivot would be the same. | B1 | 2 | Reason |
| | **Total** | | **8** | |

| Question Number and Part | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| 7(a) | $0 = 10\sin 70° t - 4.9t^2$ | M1 | | Equation for height equal to zero |
| | $t = 0$ or $t = \dfrac{10\sin 70°}{4.9} = 1.918\text{ s}$ | M1 | | Solving for $t$ |
| | | A1 | | Correct $t$ |
| | $R = 10\cos 70° \times 1.918 = 6.56\text{ m}$ | M1 | | Calculating range |
| | | A1 | 5 | Correct range |
| (b) | $-2 = 10\sin 70° t - 4.9t^2$ | M1 | | Forming equation for vertical motion when ball lands |
| | | A1 | | LHS correct |
| | | A1 | | RHS correct |
| | $4.9t^2 - 10\sin 70° t - 2 = 0$ | | | |
| | $t = 2.11$ or $-0.193$ | M1 | | Solving quadratic equation |
| | | A1 | | Correct solution |
| | $R = 10\cos 70° \times 2.11 = 7.22\text{ m}$ | M1 | | Calculating range |
| | | A1 | 7 | Correct range |
| | **Total** | | **12** | |
| 8(a) | $19\mathbf{i} - 25\mathbf{j} = \frac{1}{2}\mathbf{a} \times 10^2 + 9\mathbf{i} + 10\mathbf{j}$ | M1 | | Using both position vectors to form a constant acceleration equation |
| | $50\mathbf{a} = 10\mathbf{i} - 35\mathbf{j}$ | A1 | | Correct equation |
| | | M1 | | Solving for $\mathbf{a}$ |
| | $\mathbf{a} = 0.2\mathbf{i} - 0.7\mathbf{j}$ | A1 | 4 | Correct $\mathbf{a}$ |
| (b) | $\mathbf{v} = 10(0.2\mathbf{i} - 0.7\mathbf{j})$ | M1 | | Use of $\mathbf{v} = \mathbf{a}t$ |
| | $= 2\mathbf{i} - 7\mathbf{j}$ | A1 | | Correct velocity |
| | $v = \sqrt{2^2 + 7^2} = 7.28\text{ m s}^{-1}$ | m1 | | Finding speed from velocity |
| | | A1 | 4 | Correct speed |
| (c) | $15.4 = \frac{1}{2} \times 0.2 \times t^2 + 9$ | M1 | | Finding $t$ from one component |
| | $t = 8$ | A1 | | Correct $t$ |
| | $\frac{1}{2} \times (-0.7) \times 8^2 + 10 = -12.4$ | M1 | | Using $t = 8$ with other component |
| | | A1 | 4 | Correct result |
| (d) |  | B1 | | Straight line |
| | | B1 | 2 | Correct direction |
| | **Total** | | **14** | |
| | **TOTAL** | | **80** | |