



GCE

Physics A

Advanced Subsidiary GCE

Unit **G481**: Mechanics

Mark Scheme for January 2012

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations available in scoris

| Annotation | Meaning |
|---|--|
|  | correct response |
|  | incorrect response |
|  | benefit of the doubt (where professional judgement has been used) |
|  | benefit of the doubt not given |
|  | error carried forward |
|  | information omitted |
|  | contradiction (in cases where candidates contradict themselves in the same response) |
|  | follow through |
|  | error in number of significant figures |
|  | error in the power of 10 in calculation |
|  | arithmetic or calculation error |
|  | not answered question |
|  | wrong physics |
|  | reading error |

Abbreviations, annotations and conventions used in the detailed Mark Scheme.

| | | |
|---------------|---|---|
| / | = | alternative and acceptable answers for the same marking point |
| (1) | = | separates marking points |
| allow | = | answers that can be accepted |
| not | = | answers which are not worthy of credit |
| reject | = | answers which are not worthy of credit |
| ignore | = | statements which are irrelevant |
| () | = | words which are not essential to gain credit |
| <u> </u> | = | underlined word (or the equivalent) must be present in answer to score a mark |
| ecf | = | error carried forward |
| AW | = | alternative wording |
| ora | = | or reverse argument |

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

- B** marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.
- M** marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.
- C** marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.
- A** marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

If the data given in a question is to 2 sf, then allow answers to 2 or more significant figures.

If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.


Any exception to this rule will be mentioned in the Additional Guidance.

(Significant figures are rigorously assessed in the practical skills.)

| Question | | Answers | Marks | Guidance |
|--------------|---------|--|----------------|--|
| 1 | (a) | acceleration = rate of <u>change</u> of <u>velocity</u> | B1 | Allow: $a = \frac{v-u}{t}$ where v = final velocity, u = initial velocity and t = time Allow: 'acceleration = change in <u>velocity</u> over time' Not: 'acceleration = rate of change of <u>speed</u> ' Not: mixture of quantity and unit, e.g. 'change of velocity per second' |
| | (b) (i) | $a = \frac{v-u}{t}$ (Any subject) $a = \frac{0-6.0}{2400}$ $a = (-) 2.5 \times 10^{-3} \text{ (m s}^{-2}\text{)}$ | C1 C1 A1 | Allow: $a = 6.0 / 2400$ Ignore sign |
| | (ii) | distance = <u>av speed</u> \times time or $v^2 = u^2 + 2as$ distance = 3.0×2400 or $0 = 6.0^2 - (2 \times 2.5 \times 10^{-3} \times s)$ distance = 7200 (m) | C1 A1 | Possible ecf. from (b)(i) Allow: $v^2 = u^2 + 2as$ with $v = 6.0$, $u = 0$ and $a = 0.0025$ Allow: Full credit for correct use of $s = ut + \frac{1}{2} at^2$ Note: Bald 7200 (m) scores 2 marks Allow: 1 mark for 's = $(6 \times 2400) + \frac{1}{2} \times 0.0025 \times 2400^2 = 21600$ (m)' |
| | (iii) | Correct shape of curve of <u>decreasing</u> gradient starting from 0,0 Graph passes through 40, 7.2 | M1 A1 | Possible e.c.f. from (b)(ii) Allow the A1 mark if x is between 5-10 km at 40 min |
| | (c) (i) | It has (constant) acceleration / It accelerates (down the ramp) | B1 | Allow: Its velocity / speed increases |
| | (ii) | The time taken by ball to travel between (successive) bells is the same / 'same as first trolley' / 'there is no change' (AW) Acceleration is independent of mass / acceleration is the same (for the heavier trolley) (AW) | B1 B1 | |
| Total | | | 11 | |

| Question | | Answers | Marks | Guidance |
|--------------|---------|---|------------------------|---|
| 2 | (a) | <p><u>total</u> energy of a (closed) system remains constant or Energy cannot be created or destroyed (it can only be transferred into other forms) or <u>total</u> initial energy = <u>total</u> final energy</p> | B1 | Not: 'Energy cannot be created / destroyed / lost' |
| | (b) | <p>work done = force × distance <u>moved</u> in the direction of the force Unit: N m or J</p> | M1 A1 B1 | <p>Allow: 'force × displacement' for the M1 mark Note: The unit mark is an independent mark</p> |
| | (c) (i) | <u>kinetic</u> energy → heat | B1 | Not: friction / deformation / sound / KE of dust / KE of Earth |
| | (ii) | <p>$(E = \frac{1}{2}mv^2)$ $8.4 \times 10^{16} = \frac{1}{2} \times 3.0 \times 10^8 \times v^2$ $v^2 = \frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}$ or $v = \sqrt{\frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}}$ $(v = 2.37 \times 10^4 \text{ m s}^{-1})$</p> | C1 C1 A0 | <p>Note: This mark is for correct substitution Allow: 2 marks for $v^2 = 5.6 \times 10^8$ Allow: 1 mark for a bald answer of 2.4×10^4</p> |
| | (iii) | <p>$8.4 \times 10^{16} = F \times 200$ $F = \frac{8.4 \times 10^{16}}{200}$ force = 4.2×10^{14} (N)</p> | C1 C1 A1 | <p>Possible ecf Allow: $a = (-)\frac{u^2}{2s}$ $a = (-)\frac{(2.37 \times 10^4)^2}{2 \times 200}$ or $a = (-)\frac{(2 \times 10^4)^2}{2 \times 200}$ C1 $a = 1.4 \times 10^6 \text{ (m s}^{-2}\text{)}$ or $a = 1.0 \times 10^6 \text{ (m s}^{-2}\text{)}$ C1 $F = 3.0 \times 10^8 \times 1.4 \times 10^6$ or $F = 3.0 \times 10^8 \times 1.0 \times 10^6$ force = 4.2×10^{14} (N) or force = 3.0×10^{14} (N) A1</p> |
| Total | | | 10 | |

| Question | | Answers | Marks | Guidance |
|----------|-----|---|-----------------------------------|---|
| 3 | (a) | A straight line through the <u>origin</u> | B1 | Ignore graph after 0.5 s. |
| | (b) | The speed (of the car) is constant | B1 | Note: This can only be scored if (a) is correct |
| | (c) | The <u>distance</u> travelled by the car after the brakes are applied until the car stops | B1 | Note: Must have reference to car 'stopping' to score the mark |
| | (d) | <p>Mass (of car) $(\frac{1}{2} mv^2 = Fx, \text{ hence braking}) \text{ distance} \propto \text{mass}$</p> <p>Speed / velocity (of car) $(\frac{1}{2} mv^2 = Fx, \text{ hence braking}) \text{ distance} \propto \text{speed}^2$</p> | <p>M1 A1</p> <p>M1 A1</p> | <p>Must use tick or cross on Scoris to show if the mark is awarded Allow: weight (of car) Not: 'distance increases with mass' Allow: distance $\propto m$</p> <p>Not: 'distance increases with speed' Allow: distance $\propto v^2$</p> |
| | (e) | <p>Increases time (of impact / to slow down) / increases the distance (travelled by the driver)</p> <p>Smaller deceleration / acceleration</p> <p>Force is smaller because $F = ma$ and a is smaller or force is smaller because $F = E_k/x$ and x is bigger or force is smaller because $F = \frac{\Delta p}{\Delta t}$ and Δt is bigger</p> | <p>B1</p> <p>B1</p> <p>B1</p> | <p>Must use tick or cross on Scoris to show if the mark is awarded</p> <p>Not: 'slow down acceleration'</p> <p>Allow: $E_k = Fx$ and x is bigger</p> <p>Not: Prevent crashing into windscreen / steering wheel</p> |
| | | Total | 10 | |


| Question | | Answers | Marks | Guidance |
|----------|---------|--|------------------------|--|
| 4 | (a) | moment = force \times <u>perpendicular</u> distance from <u>point</u> / <u>pivot</u>  The term <i>perpendicular</i> to be included and spelled correctly to gain the B1 mark | B1 | Must use tick or cross on Scoris to show if the mark is awarded |
| | (b) | Net force = 0 Net moment / torque = 0 | B1 B1 | Not: 'All forces are equal' or 'forces are balanced' or 'total forces up = total forces down' Allow: ' <u>sum</u> of clockwise moments = <u>sum</u> of anticlockwise moments' |
| | (c) (i) | The <u>point</u> where the weight (appears) to act | B1 | Not: 'The point where gravity acts' or 'point where mass acts/is concentrated' |
| | (ii) | moment = $(0.150 \times 18) + (0.460 \times 30)$ moment = 16.5 (N m) | C1 A1 | Allow: 2 sf answer of 17 N |
| | (iii) | 1 Same / equal to 16.5 (N m) / equal to clockwise moment 2 (perpendicular) distance between elbow and (the line of action of) F decreases or (the vertical force) $F \cos \theta$ is the same or $F \cos \theta = 412.5$ or $F \propto \frac{1}{\cos \theta}$ Hence the force increases | B1 M1 A1 | Possible ecf |
| | | Total | 9 | |

| Question | | Answers | Marks | Guidance |
|--------------|-----|--|--------------|---|
| 5 | (a) | $\text{mass} = \frac{590}{9.8(1)} (= 60 \text{ kg})$ | B1 | Allow: weight = $60 \times 9.8(1)$ Allow: $60 \times 9.8(1) = 588 \text{ (N)}$ or $60 \times 9.8(1) = 590 \text{ (N)}$ |
| | (b) | net force = $60 \times 0.50 (= 30 \text{ N})$ $R = 590 + 30$ $R = 620 \text{ (N)}$ | C1 A1 | Allow: 1 mark for ' $590 - 30 = 560 \text{ (N)}$ ' |
| | (c) | <u>resultant</u> force = 0 / ' <u>a</u> = 0 and <u>F</u> = ma = 0' | B1 | Not: Acceleration = 0 or 'forces are balanced' |
| | (d) | weight > R (for deceleration) / $R = 590 - 60a$ / $R = mg - ma$ Hence R decreases | M1 A1 | Allow: W or mg for 'weight' |
| Total | | | 6 | |

G481

Mark Scheme

January 2012

| Question | | Answers | Marks | Guidance |
|--------------|-----|---|----------------|---|
| 6 | (a) | The extension \propto (applied) force (on spring) (as long as the elastic limit is not exceeded) | B1 | |
| | (b) | (i) Gradient / slope (of line / graph) / force divided by extension  The term <i>gradient</i> / <i>slope</i> / <i>divided</i> to be included and spelled correctly to gain the B1 mark | B1 | Must use tick or cross on Scoris to show if the mark is awarded |
| | | (ii) Area (under the graph / line) | B1 | Allow: $\frac{1}{2} \times \text{force} \times \text{extension}$ Allow: $\frac{1}{2} \times \text{force constant} \times \text{extension}^2$ if (b)(i) is correct |
| | (c) | The extension (for the combination) is doubled Force (for each spring) is the same / constant (force constant = force/extension, hence it is halved) | B1 B1 | Allow: 1 mark for 'F is the same, x is doubled' Allow: 2 marks for 'the springs need half the force to give the same (total) extension' |
| | (d) | (i) Young modulus = stress/strain As long as the elastic limit is not exceeded / in the linear region of stress against strain graph / Hooke's law is obeyed | M1 A1 | |
| | | (ii) 1 $\text{stress} = \frac{4.2}{0.20 \times 10^{-6}}$ $\text{stress} = 2.1 \times 10^7 \text{ (Pa)}$ | C1 A1 | Allow: 1 mark for 2.1×10^n , $n \neq 7$ |
| | | (ii) 2 Young modulus = $\frac{2.1 \times 10^7}{0.015}$ Young modulus = $1.4 \times 10^9 \text{ (Pa)}$ | C1 A1 | Possible ecf from (ii)1 |
| | | (ii) 3 $\text{energy} = \frac{1}{2} Fx$ $x = 0.70 \times 0.015 \quad / \quad x = 0.0105 \text{ (m)}$ $\text{energy} = \frac{1}{2} \times 4.2 \times (0.70 \times 0.015)$ $\text{energy} = 2.2 \times 10^{-2} \text{ (J)}$ | C1 C1 A1 | |
| Total | | | 14 | |

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