

# Mark Scheme (Results)

January 2015

International GCSE Physics (4PH0 1P)

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## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

| Question number | Answer                                               | Notes | Marks |
|-----------------|------------------------------------------------------|-------|-------|
| 1 (a)           | B (no earth connection);                             |       | 1     |
| (b)             | C (the circuit cannot overheat if there is a fault); |       | 1     |
| (c)             | A (in parallel);                                     |       | 1     |

**Total 3 marks**

| Question number | Answer                                                                                                                                        | Notes                                                                                                                                                                                                                                                                       | Marks |                   |                |            |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------------|----------------|------------|
| 2 (a)           | 3 or 4 ticks correct;;<br>OR<br>2 ticks correct;                                                                                              | <b>ignore top line as this is given</b>                                                                                                                                                                                                                                     | 2     |                   |                |            |
|                 | Property                                                                                                                                      |                                                                                                                                                                                                                                                                             |       | Type of radiation |                |            |
|                 |                                                                                                                                               |                                                                                                                                                                                                                                                                             |       | Alpha particles   | Beta particles | Gamma rays |
|                 | most ionising                                                                                                                                 |                                                                                                                                                                                                                                                                             |       | (✓)               |                |            |
|                 | largest mass                                                                                                                                  |                                                                                                                                                                                                                                                                             |       | ✓                 |                |            |
|                 | most penetrating                                                                                                                              |                                                                                                                                                                                                                                                                             |       |                   |                | ✓          |
|                 | highest speed                                                                                                                                 |                                                                                                                                                                                                                                                                             |       |                   |                | ✓          |
|                 | negatively charged                                                                                                                            |                                                                                                                                                                                                                                                                             |       |                   | ✓              |            |
| (b) (i)         | Number of neutrons = 2;<br>Number of protons 2;                                                                                               | Allow same ideas expressed in words                                                                                                                                                                                                                                         | 2     |                   |                |            |
|                 | (ii) Any one of-<br>MP1. Charge is larger (than other radiations);<br>MP2. Mass is larger (than other radiations);                            | comparative statement needed<br>ignore<br><ul style="list-style-type: none"> <li>incorrect terminology e.g. more powerful</li> <li>references to protons and neutrons</li> </ul> no RA unless particles/radiation specified<br>condone 'alpha particles have more momentum' | 1     |                   |                |            |
| (c) (i)         | Idea of background radiation;                                                                                                                 | Allow<br>Idea that some alpha particles (from source) will get through smoke<br>air is all around = insufficient<br>allow                                                                                                                                                   | 1     |                   |                |            |
|                 | (ii) Idea that radioactivity is random;                                                                                                       | <ul style="list-style-type: none"> <li>fluctuates</li> <li>source emits different numbers of alphas</li> <li>background radiation varies</li> </ul> ignore<br><ul style="list-style-type: none"> <li>random movement of particles</li> </ul>                                | 1     |                   |                |            |
|                 | (iii) Idea that $\alpha$ particles are absorbed / deflected / stopped / scattered;<br><br>Idea that $\alpha$ particles are affected by smoke; | allow for both marks<br>smoke blocks the (alpha) particles                                                                                                                                                                                                                  | 2     |                   |                |            |

**Total 9 marks**

| Question number | Answer                                    | Notes                                                                                                        | Marks |
|-----------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------|-------|
| 3 (a)           | C (sound waves are longitudinal waves);   |                                                                                                              | 1     |
| (b) (i)         | C (the same as the amplitude of sound P); |                                                                                                              | 1     |
| (ii)            | 0.004 (s);                                | Allow answer by calculation or by reading from graph<br>Allow equivalent value with matching unit, e.g. 4 ms | 1     |
| (iii)           | 500 (Hz)                                  | Treat ii and iii as independent, but allow an ecf from ii to iii if seen<br>Accept "double" P                | 1     |

**Total 4 marks**

| Question number | Answer                                                                                                                                     | Notes                                                                                                                                                                                                                                                                                                                           | Marks |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 4 (a) (i)       | 6.1 (m);                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                 | 1     |
| (ii)            | any two from:-<br>MP1. (on distance-time graph,) flat line means zero speed / eq<br>MP2. (so) count when slope is zero;<br>MP3. 7 (times); | allow flat or horizontal for zero slope                                                                                                                                                                                                                                                                                         | 2     |
| (b) (i)         | (average) speed = $\frac{\text{(total) distance moved}}{\text{(total) time taken}}$                                                        | allow defined symbols ignore 'triangles'                                                                                                                                                                                                                                                                                        | 1     |
| (ii)            | Substitution;<br>Calculation;<br>Matching unit;<br><br>e.g.<br>Average speed = $\frac{6.1}{(7 \times 60)}$<br>= 0.0145 = 0.015 m/s         | allow both substitution and calculation marks for a correct value without working<br><br>allow 6.1, or ecf for distance 7 for time<br><br>allow alternatives with compatible unit, e.g.<br>1.45 cm/s OR 1.5 cm/s<br>14.5 mm/s OR 15 mm/s<br>0.87 m/minutes<br>87 cm/minute<br>870 mm/minute<br>Allow for 1 mark<br>6 / 7 or 0.9 | 3     |

Total 7 marks

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Notes                                                                                                                                                                              | Marks |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 5               | Any five of:<br>MP1. the air (molecules are/is) warmed / heated (by the coal fire);<br>MP2. air expands / molecules move apart;<br>MP3. air becomes less dense;<br>MP4. <b>hot</b> air or <b>less dense</b> air rises;<br>MP5. cooler air (from outside the furnace) displaces warm air;<br>MP6. (above the chimney) air cools / contracts / becomes more dense;<br>MP7. <b>cooled</b> air falls;<br>MP8. Process (of convection) is repeated / continuous; | NB 'convection' is in the stem<br><br>allow another gas for air<br><br>-1 for explanations which include the idea that the air particles become less dense/air particles expand/eq | 5     |

**Total 5 marks**



| Question number | Answer                                                                                                                                                                                                                             | Notes                                                                                                                                                                                                                                                         | Marks |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 6 (a)           |                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                               |       |
| (i)             | only 2.65 (mm) circled;                                                                                                                                                                                                            |                                                                                                                                                                                                                                                               | 1     |
| (ii)            | discards anomaly;<br>performs averaging;<br><br>quotes answer to 3sf / 2 d.p.;<br>e.g.<br>$3.60 + 3.62 + 3.63 + 3.61 + \cancel{2.65}$<br>$+ 3.62 + 3.60 + 3.61$<br>(= 25.29)<br>$25.29 \div 7 = 3.612857\dots$<br>= 3.61 (to 3 sf) | $\div 7$ or $\div 8$ sufficient even if sum is incorrect<br><br>e.g.<br>3.61 $\rightarrow$ 3 marks<br>3.6128 $\rightarrow$ 2 marks (wrong sf)<br>3.49 $\rightarrow$ 2 marks (includes anomaly)<br>3.4925 $\rightarrow$ 1 mark (includes anomaly and wrong sf) | 3     |
| (b)             |                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                               |       |
| (i)             | Bar chart/graph;                                                                                                                                                                                                                   | condone histogram                                                                                                                                                                                                                                             | 1     |
| (ii)            | Idea that (size) data is discontinuous;<br>and either of -<br>Idea that there are no values between sizes;<br>Idea that a line graph would indicate continuity;                                                                    | discrete, categoric, non continuous<br><br>allow "no half sizes"                                                                                                                                                                                              | 2     |
| (iii)           | Idea of inverse relationship;<br><br>Idea of non-linearity;                                                                                                                                                                        | allow<br>a pattern sentence,<br>condone<br>negative correlation<br>allow "almost" linear<br>Ignore idea of proportionality                                                                                                                                    | 2     |

| Question number | Answer                                                                                                                                                                                                                                                                                          | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Marks |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 6 (c)           | Any four of -<br>MP1. idea of a displacement method;<br>MP2. instrument to measure volume (of liquid displaced);<br>MP3. a relevant experimental detail;<br><br>MP4. second relevant experimental detail;<br>MP5. use of <b>known liquid density</b> to find volume from mass (if appropriate); | Allow overflow or rise in level<br>Allow balance if mass method used (see MP5)<br><br>Including <ul style="list-style-type: none"> <li>• idea of repetition or averaging at any stage</li> <li>• <b>full</b> immersion of object</li> <li>• check liquid level in displacement can,</li> <li>• subtracting before and after volume measurements ,</li> <li>• care with meniscus (e.g. in the measuring cylinder),</li> <li>• check zero or tare of balance</li> <li>• avoid parallax when reading scale</li> </ul> as above | 4     |

Total 13 marks

| Question number | Answer                                                                                                                                                                                                                                                                | Notes                                                                                                                                                                | Marks |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 7 (a) (i)       | pressure = $\frac{\text{force}}{\text{area}}$                                                                                                                                                                                                                         | Allow symbols and rearrangements<br>e.g. $p=F/A$                                                                                                                     | 1     |
| (ii)            | substitute;<br><br>rearrange;<br>evaluate;<br><b>matching</b> unit;<br>e.g. $270\,000 = F \div 0.016$ 1 mark<br>$F = 270\,000 \times 0.016$ 2 marks<br>4320    3 marks<br>N    4 <sup>th</sup> mark                                                                   | Substitution and rearrangement in either order<br>allow in words<br><br>Allow alternatives with matching unit, e.g.<br>4.32    3 marks<br>kN    4 <sup>th</sup> mark | 4     |
| (b)             | Any three of<br>MP1. idea of (continuous) random movement;<br>MP2. collisions / impact/eq;<br>MP3. with (inside) <b>walls</b> (of tyre);<br>MP4. idea that force is produced (by bombarding molecules);<br>MP5. idea of pressure as force on an area;                 | Allow momentum or NIII argument                                                                                                                                      | 3     |
| (c)             | any three of-<br>MP1. (now) more particles/molecules in the tyre;<br>MP2. molecules have more speed /more energy (because gas is warmer);<br>MP3. more impacts/more frequent impacts / harder impacts (with walls of tyre);<br>MP4. (hence) more force on the inside; | Allow change of momentum argument<br><br>Allow collisions with walls<br><br>do not award MP3 if the impacts are only with other molecules                            | 3     |

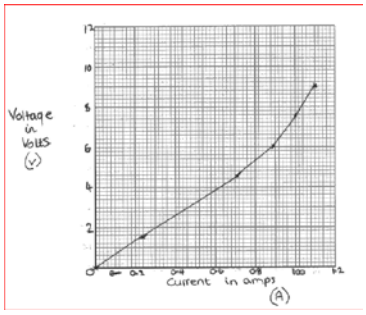
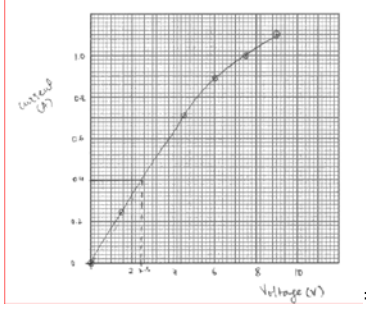
Total 11 marks

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                          | Notes                                                                                                                                                        | Marks |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 8 (a) (i)       | gravitational potential energy =<br>mass x g x height                                                                                                                                                                                                                                                                                                                                                                           | Allow symbols and rearrangements, e.g. GPE = $m \times g \times h$                                                                                           | 1     |
| (ii)            | Substitution into correct equation;<br>Calculation;<br>e.g.<br>GPE = $2.75 \times 10 \times 0.61$<br>= 17 (J)                                                                                                                                                                                                                                                                                                                   | 16.8, 16.775, 16.78 (J)<br>allow calculation with $g = 9.81$<br>=16.46 (J)                                                                                   | 2     |
| (iii)           | Any two of-<br>MP1. idea that system is inefficient<br>OR not 100% efficient;<br>MP2. idea that energy is lost /<br>wasted / dissipated ;<br><br>MP3. explanation /detail of fate of<br>energy;<br>e.g.<br>used when working against<br>{friction / drag / air<br>resistance}<br>as thermal energy to parts of<br>the apparatus or<br>surroundings<br>transferred to surroundings<br>by sound<br>converted into KE as mass fell | condone<br>used / transferred<br>elsewhere<br>Need mention of 'object'<br>Ignore light<br><br>allow to overcome friction<br>allow heat for thermal<br>energy | 2     |
| (iv)            | Substitution into correct equation;<br><br>Calculation;<br>e.g.<br>Energy transferred = $0.46 \times 12.7 \times 1.3$<br>7.6 (J)                                                                                                                                                                                                                                                                                                | allow answer without<br>working or equation seen<br>(7.5946)                                                                                                 | 2     |
| (b)             | three of the following ideas-<br>MP1. water has (initial) GPE;<br>MP2. KE of (moving) water;<br>MP3. Work done on turbine /<br>generator;<br>MP4. Work done against magnetic<br>force;<br>MP5. Electrical<br>energy/power/current/voltage<br>(produced);                                                                                                                                                                        | allow KE in turbine /<br>generator                                                                                                                           | 3     |

Total 10 marks

| Question number | Answer                                                                                                                                  | Notes                                                 | Marks |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-------|
| 9 (a) (i)       | density = $\frac{\text{mass}}{\text{volume}}$                                                                                           | Allow symbols and rearrangements, e.g. $\rho = m / V$ | 1     |
| (ii)            | substitution into correct equation;<br>calculation;<br>matching unit;<br>e.g.<br>Density = $138 \div 16.3$<br>= 8.47<br>$\text{g/cm}^3$ | 8.466, 8.5                                            | 3     |
| (b)             | B (incorrect and slightly too small)                                                                                                    |                                                       | 1     |

**Total 5 marks**

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Marks |   |     |    |     |    |     |    |     |    |     |    |     |    |   |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---|-----|----|-----|----|-----|----|-----|----|-----|----|-----|----|---|
| 10(a)           | any 3 mistakes identified from<br>MP1. cells are connected with wrong polarity;<br>MP2. ammeter is connected in parallel (with wire);<br>MP3. voltmeter is connected in series (with wire);<br>MP4. circuit has not got a switch;                                                                                                                                                                                                                                                                                                                                                                                     | allow RA for any MP<br><br>allow idea that meters should be swapped for two marks (MP2 and MP3)                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3     |   |     |    |     |    |     |    |     |    |     |    |     |    |   |
| (b) (i)         | suitable scale chosen (> 50% of grid used);<br>axes labelled with quantities and unit;<br>plotting correct to nearest half square (minus one for each plotting error) ; ;<br><br>line of best fit through zero;<br><br><div style="display: flex; align-items: center;">  <div style="margin-left: 10px;">= 4 not curve mark</div> </div><br><div style="display: flex; align-items: center;">  <div style="margin-left: 10px;">= 5</div> </div> | only scales in 1,2,5,10 or 8 acceptable<br>orientation unimportant<br><br>points must be shown clearly<br>i.e. two plotting errors = no marks for plotting<br>i.e. smooth curve<br><br><table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>I</th> <th>V</th> </tr> </thead> <tbody> <tr> <td>0.0</td> <td>0.</td> </tr> <tr> <td>0.2</td> <td>1.</td> </tr> <tr> <td>0.7</td> <td>4.</td> </tr> <tr> <td>0.8</td> <td>6.</td> </tr> <tr> <td>1.0</td> <td>7.</td> </tr> <tr> <td>1.1</td> <td>9.</td> </tr> </tbody> </table> | I     | V | 0.0 | 0. | 0.2 | 1. | 0.7 | 4. | 0.8 | 6. | 1.0 | 7. | 1.1 | 9. | 5 |
| I               | V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |   |     |    |     |    |     |    |     |    |     |    |     |    |   |
| 0.0             | 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |   |     |    |     |    |     |    |     |    |     |    |     |    |   |
| 0.2             | 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |   |     |    |     |    |     |    |     |    |     |    |     |    |   |
| 0.7             | 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |   |     |    |     |    |     |    |     |    |     |    |     |    |   |
| 0.8             | 6.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |   |     |    |     |    |     |    |     |    |     |    |     |    |   |
| 1.0             | 7.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |   |     |    |     |    |     |    |     |    |     |    |     |    |   |
| 1.1             | 9.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |   |     |    |     |    |     |    |     |    |     |    |     |    |   |
| (ii)            | 0.40 A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | range 0.39 A to 0.41 A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1     |   |     |    |     |    |     |    |     |    |     |    |     |    |   |
| (iii)           | One of -<br>MP1. Temperature (of wire) was not constant;<br>MP2. Resistance (of wire) was not constant;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1     |   |     |    |     |    |     |    |     |    |     |    |     |    |   |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                 | Notes                                                                                                                                                                                                                                                                   | Marks |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 10 (b) (iv)     | Any four of -<br><br>MP1. instrument to measure temperature;<br>MP2. means to maintain constant temperature (of wire);<br><br>MP3. use of $V = IR$ ;<br>MP4. idea of repeating / averaging (at same temperature);<br>MP5. idea of additional (interpolated) points;<br>MP6. use linear part of the graph;<br><br>MP7. use of gradient; | ignore all details about the circuit already given<br><br>e.g. water bath, switch off and allow wire to cool<br>$V \propto I$<br>obtain a range of values (of $V, I$ )<br><br>Allow reference to candidate's graph, e.g. current below 0.6 A<br>Orientation unimportant | 4     |

**Total 14 marks**

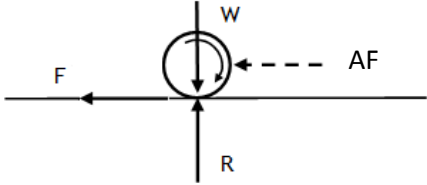
| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Marks |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 11 (a)          | D;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1     |
| (b)             | <p>Any four of -</p> <p>MP1. mention of ray box/pins;</p> <p>MP2. Use of protractor;</p> <p>MP3. (vary <math>i</math> to) obtain a range of values;</p> <p>MP4. statement of equation;<br/> <math display="block">n = \frac{\sin i}{\sin r}</math></p> <p>MP5. plot a graph of <math>\sin i</math> against <math>\sin r</math>;<br/> OR<br/> calculate/work out/ find <math>n</math>;</p> <p>MP6. find gradient of graph;<br/> OR<br/> calculate average of <math>n</math>;</p> <p>MP7. sensible experimental precaution;<br/> OR<br/> improvement to a basic method;</p> | <p>ignore reference to critical angle</p> <p>allow Snell's Law equation in words</p> <p>allow correct use of A and D from diagram</p> <p>including -</p> <ul style="list-style-type: none"> <li>• draw lines with a ruler,</li> <li>• use a thinner beam/slit,</li> <li>• use a monochromatic beam, e.g. red,</li> <li>• fix block firmly in position,</li> <li>• set any anomalous readings aside,</li> <li>• use a sharp pencil,</li> <li>• use a more precise protractor e.g. to <math>\frac{1}{2}^\circ</math></li> </ul> | 4     |

**Total 5 marks**



| Question number | Answer                                                                                                                                                                                                                                                                                           | Notes                                                                                                                                                                                                                                                                                                                                                                                                           | Marks |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 12 (a)          | Terminal (velocity / speed);                                                                                                                                                                                                                                                                     | allow bald 'terminal'                                                                                                                                                                                                                                                                                                                                                                                           | 1     |
| (b)             | Any four of -<br><br>MP1. weight acts downwards;<br><br>MP2. drag/friction acts upwards;<br><br>MP3. Idea that forces are balanced;<br><br>MP4. reference to $f_{(R)} = ma$ ;<br>MP5. Idea that when forces are balanced then acceleration is zero;<br>MP6. constant velocity = no acceleration; | ignore <ul style="list-style-type: none"> <li>• motion before terminal velocity</li> <li>• gravity</li> </ul> allow <ul style="list-style-type: none"> <li>• force of gravity</li> <li>• air resistance</li> <li>• acts to oppose motion</li> <li>• drag = weight</li> <li>• force up = force down</li> <li>• no resultant force</li> </ul> Allow answers in terms of N I<br><br>forces may be shown on diagram | 4     |

**Total 5 marks**

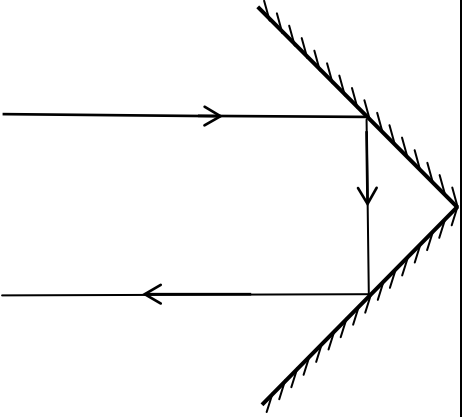
| Question number | Answer                                                                                                                                                                                                                                                                                                                                                             | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Marks |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 13 (a) (i)      | <p>Any two of -</p> <p>MP1. arrow downwards, labelled weight;</p> <p>MP2. arrow upwards, labelled reaction/contact force;</p> <p>MP3. arrow to the left, labelled air friction / air resistance / drag;</p> <p>MP4. arrow along the surface, labelled friction;</p> <p>e.g.</p>  | <p>In MP1, 2 &amp; 3, position of arrows unimportant, but direction must match label<br/>Allow initial letters as shown in example<br/>ignore</p> <ul style="list-style-type: none"> <li>• gravity</li> </ul> <p>allow</p> <ul style="list-style-type: none"> <li>• mg</li> <li>• force of gravity</li> </ul> <ul style="list-style-type: none"> <li>• arrow drawn on left or right</li> </ul> <p>Accept arrow in either direction for MP4</p> <p>N = normal contact force</p> | 2     |
| (ii)            | <p>Any three of -</p> <p>MP1. friction/resistance /drag (acts);</p> <p>MP2. (there is an) unbalanced force;</p> <p>MP3. (hence) ball decelerates;</p> <p>MP4. reference to <math>f_{(R)} = ma</math>;</p> <p>MP5. (kinetic) energy dissipates / fate of energy discussed;</p>                                                                                      | <p>ignore stem</p> <p>allow</p> <ul style="list-style-type: none"> <li>• resistive forces &gt; {forward/driving} force</li> <li>• there is a resultant force</li> <li>• its momentum changes</li> <li>• accelerates</li> </ul>                                                                                                                                                                                                                                                 | 3     |
| (b) (i)         | <p>idea that friction is (much) less in the air;</p>                                                                                                                                                                                                                                                                                                               | <p>allow</p> <ul style="list-style-type: none"> <li>• RA</li> <li>• no contact / ground friction</li> <li>• less energy lost</li> </ul>                                                                                                                                                                                                                                                                                                                                        | 1     |

| Question number | Answer                                                                                                                                                                                                                                               | Notes                                                                                                                                                                                                                                                                                                                                                      | Marks |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 13 (c) (i)      | KE = $\frac{1}{2} mv^2$ ;                                                                                                                                                                                                                            | Words or symbols                                                                                                                                                                                                                                                                                                                                           | 1     |
| (ii)            | Conversion to kg;<br>Substitution into correct equation;<br>Rearrangement;<br>Evaluation;<br><br>e.g. 45 g = 0.045 kg (or 1 kg = 1000 g etc)<br>$36 = \frac{1}{2} \times 0.045 \times v^2$<br>$v^2 = \frac{2 \times 36}{0.045}$ (= 1600)<br>40 (m/s) | allow <ul style="list-style-type: none"> <li>• 1000 seen</li> <li>• steps in any order</li> <li>• correct answer with no working for full marks</li> <li>• up to 3 marks for use of 45 kg <math>\rightarrow</math> 1.26 (m/s)-working must be seen</li> </ul>                                                                                              | 4     |
| (iii)           | Any one of- <ul style="list-style-type: none"> <li>• (Hit the ball transferring) more energy;</li> <li>• (Hit the ball with) more velocity;</li> <li>• (Hit the ball with) more speed;</li> <li>• (Hit the ball with) more force;</li> </ul>         | Ignore <ul style="list-style-type: none"> <li>• harder</li> <li>• power</li> </ul> Allow <ul style="list-style-type: none"> <li>• momentum</li> <li>• keep contact for a larger part of the swing</li> <li>• go to a place where g is less (e.g. on the moon)</li> <li>• hit ball at a steeper angle / vertically (e.g. use a more lofted club)</li> </ul> | 1     |

Total 12 marks

| Question number | Answer                                                                                                                                                                                                                                                          | Notes                       | Marks |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------|
| 14 (a) (i)      | any two ideas from:-<br>MP1. voltage / current is <u>induced</u> ;<br>MP2. (because) field in coil is changing / field (lines) cut;<br>MP3. current/voltage changes direction when magnet does;<br>MP4. magnet slows down causing decrease in amplitude;        | allow voltage for amplitude | 2     |
| (ii)            | Either of -<br>(voltage/current) changes direction;<br>Positive <u>and</u> negative (voltage/current);                                                                                                                                                          | Ignore "wave"               | 1     |
| (iii)           | any two of -<br>MP1. direction of magnet changes;<br>MP2. amount of field (lines) cut changes / rate of flux cutting;<br>MP3. direction of flux cutting changes;<br>MP4. speed of magnet changes / slows down;<br>MP5. as movement diminishes, so does voltage; |                             | 2     |
| (b)             | Any three of -<br>MP1. Alternating trace that diminishes;<br>MP2. Amplitude is larger;<br>MP3. Frequency is lower;                                                                                                                                              |                             | 3     |

Total 8 marks

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                  | Notes                                                                               | Marks |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------|
| 15 (a)          | Reflection at first surface correct;<br>Ray emerges parallel;<br>                                                                                                                                                                                                                                                                      | Judge diagram by eye                                                                | 2     |
| (b)             | rearrangement and correct substitution;<br>factor of 2 taken into account;<br>value given to at least 2 significant figures;<br><br>e.g.<br>Time to reach moon = $\frac{1}{2} \times 2.6 = 1.3$ (s)<br>Distance = time $\times$ speed = $1.3 \times 300\,000 = 390\,000$ (km)<br><br>OR<br><br>Total distance = $2.6 \times 300\,000 = 780\,000$<br>So distance to moon = $\frac{1}{2} \times 780\,000 = 390\,000$ (km) | working must be shown<br><br>Reverse argument (starting with 400000 km) allow 2 max | 3     |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                       | Notes                                                                                                                                                                                                                                                                                       | Marks |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 15              | (c) (i) Any three of -<br>MP1. idea that distance from Earth to Moon varies;<br>MP2. idea that orbit of Moon is not (quite) circular;<br>MP3. idea that change is cyclic / is regular / takes (about) a month;<br>MP4. idea that Earth is not (quite) at centre of (moon) orbit;<br>MP5. appropriate <u>use</u> of time data;<br>MP6. appropriate calculation of a distance; | allow<br>• further/nearer<br><br>• orbit elliptical<br>• orbit radius varies<br>• sinusoidal<br>• 26.5 / 27 days<br><br>E.g. largest time difference = $2.70 - 2.47 = 0.23$ s<br>e.g. $\Delta s = \frac{1}{2} \times ct$<br>= $\frac{1}{2} \times 3 \times 10^8 \times 0.23$<br>= 34 500 km | 3     |
|                 | (ii) Any one of -<br>MP1. (average) moon orbit radius becomes larger;<br>MP2. moon moving away (from Earth);<br>MP3. gravitational force (or gravity) becoming weaker;                                                                                                                                                                                                       | Allow reverse argument                                                                                                                                                                                                                                                                      | 1     |

Total 9 marks

