



# Mark Scheme (Results)

Summer 2019

Pearson Edexcel GCSE  
In Physics (1PH0) Paper 1F

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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.

Mark schemes have been developed so that the rubrics of each mark scheme reflects the characteristics of the skills within the AO being targeted and the requirements of the command word. So for example the command word 'Explain' requires an identification of a point and then reasoning/justification of the point.

Explain questions can be asked across all AOs. The distinction comes whether the identification is via a judgment made to reach a conclusion, or, making a point through application of knowledge to reason/justify the point made through application of understanding. It is the combination and linkage of the marking points that is needed to gain full marks.

When marking questions with a 'describe' or 'explain' command word, the detailed marking guidance below should be consulted to ensure consistency of marking.

| Assessment Objective |           | Command Word                                                                                                                    |                                                                                                                                         |
|----------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Strand               | Element   | Describe                                                                                                                        | Explain                                                                                                                                 |
| AO1                  |           | An answer that combines the marking points to provide a logical description                                                     | An explanation that links identification of a point with reasoning/justification(s) as required                                         |
| AO2                  |           | An answer that combines the marking points to provide a logical description, showing application of knowledge and understanding | An explanation that links identification of a point (by applying knowledge) with reasoning/justification (application of understanding) |
| AO3                  | 1a and 1b | An answer that combines points of interpretation/evaluation to provide a logical description                                    |                                                                                                                                         |
| AO3                  | 2a and 2b |                                                                                                                                 | An explanation that combines identification via a judgment to reach a conclusion via justification/reasoning                            |
| AO3                  | 3a        | An answer that combines the marking points to provide a logical description of the plan/method/experiment                       |                                                                                                                                         |
| AO3                  | 3b        |                                                                                                                                 | An explanation that combines identifying an improvement of the experimental procedure with a linked justification/reasoning             |

| Question Number | Answer                                                  | Mark |
|-----------------|---------------------------------------------------------|------|
| 1(a) (i)        | <p>all three correct (2)<br/>one or two correct (1)</p> | (2)  |

| Question Number | Answer                                                                     | Additional guidance                                                                                           | Mark |
|-----------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------|
| 1(a)(ii)        | <p>Q and S</p> <p>Q (1) (and) S (1)</p> <p>OR</p> <p>S (1) (and) Q (1)</p> | <p>in either order</p> <p>maximum of 1 mark if 3 letters given</p> <p>no marks if 4 or more letters given</p> | (2)  |

| Question Number | Answer                                                                                                       | Additional guidance                                                                                                                                                                                                                                                                                                                                | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1(a)(iii)       | <p>substitution (1)</p> <p>(distance =) <math>30 \times 100</math></p> <p>evaluation (1)</p> <p>3000 (m)</p> | <p>for 1<sup>st</sup> mp accept <math>100 \times 30</math></p> <p>OR <math>(30 \times 50) \times 2</math></p> <p>award full marks for the correct answer without working</p> <p>allow <b>1 mark</b> for</p> <p>EITHER</p> <p><math>30 \times 50</math></p> <p>OR</p> <p><math>30 \times 150</math></p> <p>OR</p> <p><math>30 \times 250</math></p> | (2)  |

| Question Number | Answer                                                           | Additional guidance                                                                                                                                                                                                                  | Mark       |
|-----------------|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>1(b)</b>     | substitution (1)<br>1800 x 1.2<br><br>evaluation (1)<br>2200 (N) | accept $1800 \text{ kg} \times 1.2 \text{ m/s}^2$<br>reject $1800 \times 1.2^2$<br><br>2160<br><br>award full marks for the correct answer without working<br><br>allow 1 mark total for 2200<br>OR 2160 with any other power of ten | <b>(2)</b> |

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**(Total for Question 1 = 8 marks)**

| Question Number | Answer       | Additional guidance | Mark |
|-----------------|--------------|---------------------|------|
| 2(a)(i)         | 1840 (J) (1) |                     | (1)  |

| Question Number | Answer                                                                                   |                                                                                 | Mark |
|-----------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|------|
| 2(a)(ii)        | substitution (1)<br>(efficiency =) $\frac{160}{2000}$<br>evaluation (1)<br>0.08 OR 8 (%) | Ignore any units<br><br>award full marks for the correct answer without working | (2)  |

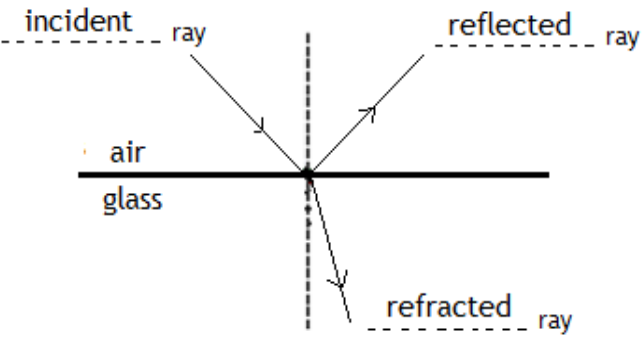
| Question Number | Answer                                                                                                                                                        | Additional guidance                                                                                                               | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|------|
| 2(a)(iii)       | reference to :<br>thermal (energy) (1)<br>OR<br>(lost to) environment /surroundings/dissipated (1)<br>OR<br>transferred/changed to another form of energy (1) | IGNORE gets re-used / recycled<br><br>heat<br>OR<br>(to) atmosphere / (to) the air /sky/ steam<br><br>accept named form of energy | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                             | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2(a)(iv)        | <p>an answer that makes reference to <b>any two from</b></p> <p>produces/ releases/makes/gives off carbon dioxide / CO<sub>2</sub> /greenhouse gases (1)</p> <p>produces carbon monoxide / CO (1)</p> <p>produces air pollution (1)</p> <p>produces sulphur dioxide/ SO<sub>2</sub> (1)</p> <p>produces soot /smoke (1)</p> <p>mining coal (1)</p> | <p>IGNORE unqualified pollutes/pollution</p> <p>IGNORE ozone layer</p> <p>IGNORE non-renewable</p> <p>IGNORE 'fumes'</p> <p>(causes) greenhouse effect OR contributes to global warming/climate change</p> <p>allow CO<sub>2</sub></p> <p>causes carbon monoxide poisoning</p> <p>accept (harmful) particles /dust</p> <p>causes <u>acid rain</u></p> <p>blackens/ stains buildings/statues</p> <p>slag heaps/ mining damages the landscape/habitats/ecosystem OR ground needs to be dug up</p> | (2)  |

| Question Number | Answer                                                                                                                     | Additional guidance                                                                                                                     | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------|
| 2(b)            | substitution (1)<br>$\frac{1}{2} \times 8 \times 1.5^2$<br>calculation of $v^2$ (1)<br>2.25<br>evaluation (1)<br>9(.0) (j) | 9000 (j) scores 2 marks<br>6(.0)(j) scores 2 marks<br>6000 (j) scores 1 mark<br>award full marks for the correct answer without working | (3)  |

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**(Total for Question 2 = 9 marks)**

| Question Number: | Answer                                                                            | Additional guidance                                                                               | Mark |
|------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|------|
| 3(a)             |  | <p>All 3 labels correct 3 marks</p> <p>2 labels correct 2 marks</p> <p>1 label correct 1 mark</p> | (3)  |

| Question Number | Answer                                                                                                                                                                                                                                                   | Mark        |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 3(b)(i)         | <p><b>The only correct answer is C red-shifted</b></p> <p>A is not correct because the spectrum is not blue-shifted<br/> B is not correct because the spectrum is not green-shifted<br/> D is not correct because the spectrum is not violet-shifted</p> | (1)<br>comp |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                  | Mark        |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 3(b)(ii)        | <p><b>The only correct answer is D Universe</b></p> <p>A is not correct because the shift does not provide evidence for the expansion of Earth.<br/> B is not correct because the shift does not provide evidence for the expansion of the Milky Way Galaxy<br/> C is not correct because the shift does not provide evidence for the expansion of the Solar system</p> | (1)<br>comp |

| Question Number | Answer                                                              | Additional guidance                                                                                                                                                           | Mark |
|-----------------|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 3(c)            | substitution (1)<br><br>300 : 1500<br><br>evaluation (1)<br><br>1:5 | $\frac{300}{1500}$<br><br>0.2 OR $\frac{1}{5}$<br><br>ignore any units<br><br>award full marks for the correct answer without working<br><br>allow 1 mark for either 5:1 OR 5 | (2)  |

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**(Total for Question 3 = 7 marks)**

| Question Number | Answer                                                                                                                               | Additional guidance                                     | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|------|
| 4(a)(i)         | <p>Atoms may form positive ions by <b>losing</b> electrons. (1)</p> <p>The electrons involved are the <b>outer</b> electrons (1)</p> | accept any clear indication that correct word is in gap | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                       | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 4(a)(ii)        | <p>The only correct answer is <b>C gamma</b></p> <p>A is not correct because alpha radiation is not electromagnetic</p> <p>B is not correct because beta minus radiation is not electromagnetic</p> <p>D is not correct because neutron radiation is not electromagnetic</p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                     | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 4(a)(iii)       | <p>The only correct answer is <b>A alpha</b></p> <p>B is not correct because beta minus travels further in air than alpha</p> <p>C is not correct because beta plus travels further in air than alpha</p> <p>D is not correct because gamma travels further in air than alpha and beta</p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                               | Additional guidance                                                                                                                                       | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 4(b)(i)         | <p>one from:</p> <p>(radiation from them) (can cause) cancer / tumours (1)</p> <p>radiation sickness / radiation poisoning (1)</p> <p>(radiation from them can) mutate / alter/ deform / damage / ionise / kill {cell OR DNA OR genes} (1)</p> <p>burns skin (1)</p> | <p>accept any named type of cancer</p> <p>accept birth defects OR sterilisation</p> <p>Ignore<br/>unqualified poisoning<br/>kills you<br/>skin damage</p> | (1)  |

| Question Number | Answer                                                                                          | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Mark |
|-----------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 4(b)(ii)        | <p><b>neutron</b> (in the nucleus) (1)</p> <p>becomes a <b>proton</b> (and an electron) (1)</p> | <p><b>down quark / d</b> (in the neutron)</p> <p>OR mass/nucleon number stays same</p> <p>becomes an <b>up quark / u</b></p> <p>OR atomic/proton number increases by 1</p> <p><math>n &gt; p + e^-</math> ) scores 2 marks</p> <p>if no other mark scored allow for 1 mark (it) emits an electron</p> <p>OR</p> <p>beta (minus) is an electron</p> <p>OR</p> <p>energy is released</p> <p>OR</p> <p>loses a proton and gains a neutron</p> <p>IGNORE gaining/losing/becoming electron(s)</p> | (2)  |

| Question Number | Answer                      | Mark       |
|-----------------|-----------------------------|------------|
| 4(c)            | <b>B</b> $10^{-10}\text{m}$ | <b>(1)</b> |

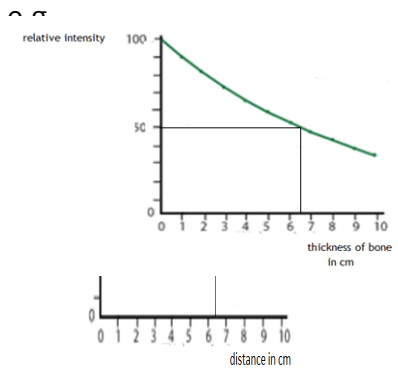
| Question Number | Answer                                                                                                                                          | Additional guidance                                                                                                                                                                                                                                                                                                      | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 4(d)            | substitution (1)<br>$\frac{1.6726 \times 10^{-27}}{9.1094 \times 10^{-31}}$<br><br>evaluation (1)<br>1836<br><br>evaluation to 2 sf (1)<br>1800 | Allow 1 mark for answers that round to 1.836 to any power of ten for this mark<br><br>$1.836 \times 10^3$ OR $1.80 \times 10^3$<br>accept 1840 or any rounding of 1836.125<br><br>$1.8 \times 10^3$<br><br><b>any number</b> shown to 2 sf gets this mark<br><br>award full marks for the correct answer without working | <b>(3)</b> |

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**(Total for Question 4 = 11 marks)**

| Question Number | Answer                                                                                                  | Additional guidance                                                                   | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|------|
| 5(a)(i)         | <p>A description to include:</p> <p>diagnosing / locating / identify/look for (1)</p> <p>tumour (1)</p> | <p>brain scan</p> <p>cancer</p> <p>award 2 marks for 'seeing where the cancer is'</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                      | Additional guidance                                                                                                                                                                    | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 5(a)(ii)        | <p>Any two precautions to do with:</p> <p><b>mp1</b> short half-life isotopes (1)</p> <p><b>mp2</b> shielding (1)</p> <p><b>mp3</b> distance (1)</p> <p><b>mp4</b> isolation (1)</p> <p><b>mp5</b> exposure time (1)</p> <p><b>mp6</b> transportation (1)</p> <p><b>mp7</b> storage (1)</p> | <p>protective clothing</p> <p>lead shielding</p> <p>working in another room</p> <p>working</p> <p>radiation badges</p> <p>to and around the hospital</p> <p>appropriate containers</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                      | Additional guidance                                     | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|------|
| 5(b)(i)         | <p>Constructs a line across at an intensity of 50 (with a vertical to the thickness axis) (1)</p>  <p>(thickness =) 6.5 - 6.7 (cm) (1)</p> | award full marks for the correct answer without working | (2)  |

| Question Number | Answer                                                                                                                 | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------|------|
| 5(b)(ii)        | <p><b>The only correct answer is B J/kg</b></p> <p>None of the other options have units which are the same as J/kg</p> | (1)  |

| Question Number | Answer                                                                                                                                                                               | Additional guidance                                                                                                                                                                          | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 5(c)(i)         | Any two advantages from:<br><br>no CO <sub>2</sub> produced / reduces global warming<br><br>more energy (per kg)<br><br>no cross-country pipelines<br><br>no cross-country pipelines | no harmful waste gases to atmosphere<br><br>high energy density fuel<br><br><br><br><br>IGNORE reference to unqualified non-pollution cost<br>renewable<br>efficiency<br>speed of production | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                             | Additional guidance | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| 5(c)(ii)        | Any <b>two</b> reasons for unpopularity from<br><br><b>mp1</b> public perception that radioactivity is dangerous<br><br><b>mp2</b> radiation leaks from plant<br><br><b>mp3</b> nuclear accidents<br><br><b>mp4</b> risks of terrorist attacks<br><br><b>mp5</b> production/storage of nuclear waste<br><br><b>mp6</b> (nuclear) waste radioactive for a long time |                     | (2)  |

(Total for Question 5 = 11 marks)

| Question Number | Answer                                                                                                                                                                                                      | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 6(a)(i)         | <p>The only correct answer is <b>C 20 m/s</b></p> <p>A is not correct because 0.2 m/s is too slow</p> <p>B is not correct because 2 m/s is too slow</p> <p>D is not correct because 200 m/s is too fast</p> | (1)  |

| Question Number | Answer                                                                                                                                                                | Additional guidance                                                                                                                                                                                                                                                             | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 6(a)(ii)        | <p>recall (1)</p> $(\Delta GPE) = m \times g \times \Delta h$ <p>substitution (1)</p> $(\Delta GPE =) 75 \times 10 \times 20$ <p>evaluation (1)</p> <p>15 000 (J)</p> | <p>NO PoT error</p> <p>NO ecf from wrong equation</p> <p>mgh or <math>m \times g \times h</math></p> <p>75 x 10 x 20 scores the first 2 marks</p> <p>accept 14700 (J) from using <math>g = 9.8</math> (N/kg)</p> <p>award full marks for the correct answer without working</p> | (3)  |

| Question Number | Answer                                                                            | Additional guidance                                                                                                             | Mark |
|-----------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------|
| 6(b)            | substitution (1)<br>$\frac{80(2) - 0^2}{2 \times 4}$<br>evaluation (1)<br>800 (m) | allow 1 mark for seeing $\frac{80}{8}$<br><br>ignore any minus signs<br>award full marks for the correct answer without working | (2)  |

| Question Number | Answer              | Additional guidance                                          | Mark |
|-----------------|---------------------|--------------------------------------------------------------|------|
| 6(c)(i)         | (metre) rule(r) (1) | accept<br>measuring tape/stick<br>tape measure<br>light gate | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                    | Additional guidance                                                                                                                                                        | Mark                  |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 6(c)(ii)        | <p>A description that combines the following points to produce a logical method:</p> <p>hang/attach/add/put/increase {masses / weights} (1)</p> <p>on/to (the end of) the string (over the pulley wheel) (1)</p> <p>OR</p> <p>apply a force to the trolley /string (1)<br/>(by a) pull / push / rubber band (1)</p> <p>OR</p> <p>putting trolley on a slope (1)<br/>allow the trolley to run down (1)</p> | <p>accept on/at/from the pulley wheel</p> <p>'pull the string'<br/>OR<br/>push the trolley scores 2 marks</p> <p>slanting the bench<br/>(let) gravity pull the trolley</p> | (2)<br><br><b>exp</b> |

| Question Number | Answer                                                                                                         | Additional guidance                                                              | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|------|
| 6(c)(iii)       | <p>Any one from:</p> <p>speed (at the start/end of the run) (1)</p> <p>time (between changes in speed) (1)</p> | <p>(different/additional) speed / velocity</p> <p>appropriate ticker tape(s)</p> | (1)  |

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**(Total for Question 6 = 10 marks)**

| Question Number | Answer                                                                                                                                                                                                                                                                                  | Additional guidance                                                                                                                                                                                                                                                                 | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 7(a)            | <p>an explanation linking <b>two</b> from:</p> <p>identifies curve Q is the black can OR that curve P is for the silver can (1)</p> <p>(because, as) black is a better emitter</p> <p>(then) (curve) Q shows a faster rate of cooling (1)</p> <p>OR</p> <p>(curve) Q is steeper (1)</p> | <p>IGNORE reference to absorb</p> <p>allow Q is at a lower temperature/stays cooler</p> <p>OR</p> <p>P is at a higher temperature /stays hotter</p> <p>may quote numbers from graph e.g. curve Q cools by 75(°C) in 20 minutes but curve P only shows a 60(°C) in the same time</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 7(b)            | <p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><b>AO targeting: 6 marks AO1 strand 2 (6 marks)</b></p> <ul style="list-style-type: none"> <li>• uses a thermometer</li> <li>• inserted into the can</li> <li>• uses a stopwatch / timer</li> <li>• uses a measuring cylinder / beaker with markings</li> <li>• sets up apparatus with lamp a fixed distance from each can</li> <li>• that distance is the same for each can</li> <li>• the measured volume is the same for each can</li> <li>• a starting temperature is measured</li> <li>• (aiming) to get the same start temperature</li> <li>• each, in turn, is heated for the same time</li> <li>• as measured on a stopwatch</li> <li>• a final (maximum) temperature is read</li> <li>• OR takes a series of temperature readings with time</li> <li>• and plots a graph of temperature(s) against time</li> <li>• the one heating up the most is the best absorber</li> </ul> <p>N.B. fully credit any of these in a diagram e.g. bullet points 1-8 may all be seen in a diagram</p> | (6)  |

| Level   | Mark | Descriptor                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | 0    | <ul style="list-style-type: none"> <li>No rewardable material.</li> </ul>                                                                                                                                                                                                                                                                                                                                               |
| Level 1 | 1-2  | <ul style="list-style-type: none"> <li>Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1)</li> <li>Presents a description which is not logically ordered and with significant gaps. (AO1)</li> </ul>                                                                                                      |
| Level 2 | 3-4  | <ul style="list-style-type: none"> <li>Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1)</li> <li>Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)</li> </ul> |
| Level 3 | 5-6  | <ul style="list-style-type: none"> <li>Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1)</li> <li>Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)</li> </ul>                                                                 |

## Summary for guidance

| Level   | Mark | Additional Guidance                                                                                       | General additional guidance – the decision within levels                                                                                                                                                                            |
|---------|------|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | 0    | No rewardable material.                                                                                   | Eg - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.                                                                             |
| Level 1 | 1–2  | <u>Additional guidance</u><br><br>isolated statement about apparatus or procedure or the science involved | <u>Possible candidate responses</u><br>(diag?)<br>uses/puts a thermometer in the can/water<br>OR<br>measures a temperature<br>OR<br>uses heater to heat the cans<br>Or<br>puts water in the cans                                    |
| Level 2 | 3–4  | <u>Additional guidance</u><br><br>some procedure detail but with omissions                                | <u>Possible candidate responses</u><br>(diag?)<br>uses a thermometer to measure the temperature rise in the cans<br>OR<br>uses the heater to heat the cans for a fixed time<br>Or<br>uses the same amount of water in each can      |
| Level 3 | 5–6  | <u>Additional guidance</u><br><br>more detailed and structured procedure                                  | <u>Possible candidate responses</u><br>(diag?)<br>uses a thermometer to measure the temperature rise in the cans<br>AND<br><br>uses the heater to heat the cans for a fixed time<br>Or<br>uses the same amount of water in each can |

| Question Number | Answer                                                  | Additional guidance                                         | Mark |
|-----------------|---------------------------------------------------------|-------------------------------------------------------------|------|
| 7(c)(i)         | one of:<br><br>X-ray(s) (1)<br><br><br>gamma (rays) (1) | X<br><br><br>y<br><br>any other waves mentioned contradicts | (1)  |

| Question Number | Answer                                                                                                                                                                                                                        | Additional guidance  | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------|
| 7(c)(ii)        | an explanation linking <b>two</b> from:<br><br>blue (star) emits light at higher energy (than red)<br><br>blue has shorter wavelength/higher frequency than red<br><br>so blue star has higher (surface) temperature than red | or reverse arguments | (2)  |

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(Total for Question 7 = 11 marks)

| Question Number | Answer                                                                                                                                                                                                                                                                                                   | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 8(a)            | <p>C red</p> <p><b>The only correct answer is C red</b></p> <p><b>A</b> is not correct because blue has a shorter wavelength than red</p> <p><b>B</b> is not correct because green has a shorter wavelength than red</p> <p><b>D</b> is not correct because yellow has a shorter wavelength than red</p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                               | Additional guidance                                              | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|------|
| 8(b)            | <p>an explanation linking:</p> <p>infrared is absorbed / blocked (by the armchair/objects) / cannot pass through it</p> <p><b>OR</b></p> <p>radio waves can go through (the armchair/objects) (1)</p> <p><b>WITH</b></p> <p>(infrared and radio have) different wavelengths / frequencies</p> <p>OR infrared requires 'line-of-sight' (idea)</p> <p>OR radio waves do not require 'line-of-sight' (idea)</p> <p>OR diffraction (idea)</p> <p>(1)</p> | <p>allow stopped</p> <p>transmitted</p> <p>accept comparison</p> | (2)  |

| Question Number | Answer                                                                           | Additional guidance                                                                                                                                                              | Mark       |
|-----------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>8(c)(i)</b>  | evidence of use of scale on horizontal distance axis only (1)<br><br>12 (cm) (1) | may be seen on the diagram<br><br>range 11.5 to 12.5 (cm)<br><br>award full marks for the correct answer without working<br><br>6 (cm) or 30(cm) scores 1 mark (evidence of use) | <b>(2)</b> |

| Question Number: | Answer                                                                                                                                   | Additional guidance                                                                                                                                 | Mark       |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>8(c)(ii)</b>  | a description to include:<br><br>moves up and down (1)<br><br>at right angles / normal / perpendicular to (direction of) wave/travel (1) | independent marking points<br><br>vertical (oscillations)<br><br>not in the (direction of) wave / travel<br><br>accept 'transverse wave' for 2nd MP | <b>(2)</b> |

| Question Number: | Answer                                                                                                           | Additional guidance                                                                                                                           | Mark |
|------------------|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|
| 8(d)             | <p>recall and substitution (1)<br/> <math>(v =) 0.25 \times 1.5</math></p> <p>evaluation (1)<br/> 0.38 (m/s)</p> | <p>accept 0.375 or 0.37 (m/s)</p> <p>accept 37.5, 37 or 38 for 1 mark only</p> <p>award full marks for the correct answer without working</p> | (2)  |

**(Total for Question 8 = 9 marks)**

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| Question Number: | Answer                                                                                                                                                                    | Additional guidance | Mark |  |  |   |   |  |   |   |  |     |     |                                                                                                   |     |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|--|--|---|---|--|---|---|--|-----|-----|---------------------------------------------------------------------------------------------------|-----|
| 9(a)             | <table><tr><td></td><td></td><td></td></tr><tr><td></td><td>7</td><td>6</td></tr><tr><td></td><td>8</td><td>6</td></tr><tr><td></td><td>(1)</td><td>(1)</td></tr></table> |                     |      |  |  | 7 | 6 |  | 8 | 6 |  | (1) | (1) | <p>one mark for each column</p> <p>must have both numbers in a column correct to get the mark</p> | (2) |
|                  |                                                                                                                                                                           |                     |      |  |  |   |   |  |   |   |  |     |     |                                                                                                   |     |
|                  | 7                                                                                                                                                                         | 6                   |      |  |  |   |   |  |   |   |  |     |     |                                                                                                   |     |
|                  | 8                                                                                                                                                                         | 6                   |      |  |  |   |   |  |   |   |  |     |     |                                                                                                   |     |
|                  | (1)                                                                                                                                                                       | (1)                 |      |  |  |   |   |  |   |   |  |     |     |                                                                                                   |     |

| Question Number | Answer                      | Additional guidance                                                                                                                                                                       | Mark |
|-----------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 9(b)(i)         | Geiger (Müller counter) (1) | <p>GM {tube/meter} or other appropriate detector e.g. dosimeter, film badge, scintillation counter</p> <p>accept incorrect spellings such as "giga"</p> <p>ignore radioactive counter</p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                          | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 9(b)(ii)        | <p>any <b>two</b> acceptable sources from :</p> <p><b>cosmic</b> (rays) (1)</p> <p>Sun (1)</p> <p>rocks / ground (1)</p> <p>{nuclear / atomic} tests / nuclear waste (1)</p> <p>(nuclear) power stations (1)</p> <p>plant (sources) (1)</p> <p>buildings (1)</p> <p>food (1)</p> <p>water (1)</p> <p>medical (1)</p> <p>radon (1)</p> | <p>cosmic microwave background radiation (CMBR)</p> <p>accept nuclear accidents (Chernobyl, Fukushima etc)</p> <p>accept named foods</p> <p>accept X-rays, radiotherapy</p> <p>ignore alpha, beta, gamma</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                           | Additional guidance                                                                                                                           | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|
| 9(c)            | <p>processing (1)</p> <p><math>\frac{125\,000}{1\,000\,000}</math></p> <p>OR</p> <p><math>\frac{1}{8}</math></p> <p>OR</p> <p>3 half-lives or <math>3 \times 5700</math></p> <p>evaluation (1)</p> <p>17 100</p> | <p>accept an appropriate attempt using more than one halving</p> <p>17 000</p> <p>award full marks for the correct answer without working</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 9(d)            | <p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;"><b>A03 and A02 (6 marks)</b></p> <p><b>A03</b></p> <ul style="list-style-type: none"> <li>• most go straight through to P</li> <li>• some are deflected through small angles to Q</li> <li>• few have deflections greater than 90° to R</li> <li>• or are even reflected (bounce back off the foil) to R</li> </ul> <p><b>A02</b></p> <ul style="list-style-type: none"> <li>• alpha positive is repelled by positive nucleus</li> <li>• atom being mostly empty space</li> <li>• atoms have a small nucleus</li> <li>• nucleus has a big mass / density</li> <li>• +ve charge concentrated into a very small space</li> </ul> | (6)  |

| Level   | Mark | Descriptor                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | 0    | <ul style="list-style-type: none"> <li>No awardable content</li> </ul>                                                                                                                                                                                                                                                                                                                                                              |
| Level 1 | 1–2  | <ul style="list-style-type: none"> <li>Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3)</li> <li>The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)</li> </ul> |
| Level 2 | 3–4  | <ul style="list-style-type: none"> <li>Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3)</li> <li>The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)</li> </ul>                                       |
| Level 3 | 5–6  | <ul style="list-style-type: none"> <li>Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3)</li> <li>The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)</li> </ul>                               |

## Summary for guidance

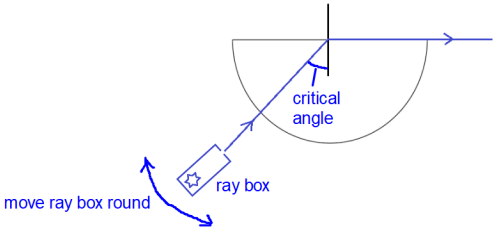
| Level   | Mark | Additional Guidance                                                                                      | General additional guidance - the decision within levels                                                                                                                                                                                                                                                                         |
|---------|------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | 0    | No rewardable material.                                                                                  | Eg - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.                                                                                                                                                                          |
| Level 1 | 1-2  | <u>Additional guidance</u><br>unlinked statement from the diagram or table or knowledge of the atom      | <u>Possible candidate responses</u><br>most particles go to P ( <i>from table</i> )<br>OR<br>particles refract/bend to Q ( <i>from diagram</i> )                                                                                                                                                                                 |
| Level 2 | 3-4  | <u>Additional guidance</u><br>One link between any TWO of diagram, table, knowledge about atoms.         | <u>Possible candidate responses</u><br>Most particles go straight through (the gold) to P ( <i>from table and diagram</i> )<br>OR<br>Most particles go to P which means an atom is mainly space ( <i>from table and knowledge</i> )<br>OR<br>particles are reflected because there is a nucleus ( <i>diagram and knowledge</i> ) |
| Level 3 | 5-6  | <u>Additional guidance</u><br>One link between diagram <b>AND</b> table <b>AND</b> knowledge about atoms | <u>Possible candidate responses</u><br>Most particles go straight through (the gold) to P which means an atom is mainly space<br>OR<br>A few particles reflected back to R which means an atom has a nucleus                                                                                                                     |

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(Total for Question 9 = 13 marks)

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                     | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 10(a)(i)        |  <p><input type="checkbox"/> B</p> <p><b>The only correct answer is B</b></p> <p>A is not correct because it has a smaller power than B</p> <p>C is not correct because it is a diverging lens</p> <p>D is not correct because it is a diverging lens</p> | (1)  |

| Question Number | Answer                                                                                                           | Additional guidance                                                                                | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------|
| 10(a)(ii)       | <p>rearrangement and substitution (1)</p> $\frac{1}{5}$ <p>unit conversion and evaluation (1)</p> <p>20 (cm)</p> | <p>award full marks for the correct answer without working</p> <p>accept 0.2 for one mark only</p> | (2)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Additional guidance                                                                                                                                                                                                                                                                                                                 | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 10(b)           | <p>a description to include any <b>four</b> from:</p> <p>shine a ray (of light) into the block (1)</p> <p>into the block through the curved surface along a radius (1)</p> <p>{change angle / move ray(box)} until the angle of refraction is <math>90^\circ</math> / TIR just occurs (1)</p> <p><b>measure</b> angle of incidence {when refracted angle is <math>90^\circ</math> / when TIR just occurs} (1)</p> <p>repeat measurement of critical angle (1)</p> |  <p>credit marking points in the diagram if they are clear</p> <p>allow 'calculate' for 'measure'</p> <p>plot angle <math>i</math> against angle <math>r</math></p> <p>if light only enters block at straight edge, maximum 1 mark ( for MP1)</p> | (4)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                    | Additional guidance                                | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|------|
| 10(c)(i)        | <p>examples:</p> <p>planets have moons (1)</p> <p>the Earth rotates (spins) (1)</p> <p>planets orbit the Sun (1)</p> <p>Pluto is no longer a planet (1)</p> <p>orbits are elliptical (not circular) (1)</p> <p>there are more planets than previously thought (1)</p> <p>ours is not the only solar system (1)</p> <p>Earth is {round/spherical/not flat} (1)</p> <p>planets are not wandering stars.</p> | <p>answers must be to do with the solar system</p> | (1)  |

| Question Number: | Answer                                                                                                                                                                                                                             | Additional guidance                                                                                                                                                                                                                   | Mark       |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>10(c)(ii)</b> | <p>smooth curve drawn on the graph (1)</p> <p>horizontal line drawn from 4.6 Earth years to intercept the drawn line/curve (1)</p> <p>EITHER:<br/>their reading from line / curve (1)</p> <p>OR</p> <p>430±30 (million km) (1)</p> | <p>accept curve up to Mars followed by a straight line</p> <p>plot point at year length = 4.6</p> <p>reading on distance axis ± half small square from their graph</p> <p>award full marks for the correct answer without working</p> | <b>(3)</b> |

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**(Total for Question 10 = 11 marks)**

