



# **Mark Scheme (Results)**

Summer 2018

Pearson Edexcel GCSE

In Physics (1PH0) Paper 1H

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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             |

\*there will be situations where an AO1 question will include elements of recall of knowledge directly from the specification (up to a maximum of 15%). These will be identified by an asterisk in the mark scheme.

| Question Number | Answer              | Additional Guidance                                                                                                                                                                                                 | Mark                 |
|-----------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| 1(a)            | foetal scanning (1) | ignore sonar<br>ACCEPT echo location<br>accept other examples e.g.<br>dog whistle<br>cat scarer<br>bat detector<br>kidney stones<br>cleaning jewellery<br>baby scanner<br>pregnancy scanner<br>faults in structures | <b>(1)</b><br>AO 1 1 |

| Question Number | Answer                                | Additional Guidance                                                                                                                                        | Mark          |
|-----------------|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1(b)            | studying the Earth's structure<br>(1) | accept other examples e.g.<br>detect meteor(ites)<br>seismic activity<br>named animals<br>communicating<br>e.g.<br>elephants<br><br>giraffes<br><br>whales | (1)<br>AO 1 1 |

| Question Number | Answer                                                                                                                                                                                                                 | Additional guidance                                                                                                                                                                                                           | Mark                                          |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| <b>1(c)</b>     | <p>recall (1)<br/> <math>v = \frac{x}{t}</math></p> <p>rearrangement (1)<br/> <math>t = \frac{x}{v}</math></p> <p>substitution (1)<br/> <math>\frac{14 \times 2}{1600}</math></p> <p>evaluation (1)<br/> 0.018 (s)</p> | <p>substitution and rearrangement in either order</p> <p>max 3 marks if 14 used as distance</p> <p>accept numbers that round to 0.018 e.g.<br/> 0.0175 (s)</p> <p>award full marks for the correct answer with no working</p> | <p><b>(4)</b></p> <p>AO 1 1</p> <p>AO 2 1</p> |

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**(Total for Question 1 = 6 marks)**

| Question Number | Answer                                                                                                                                                                                                                                                                                | Mark                            |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 2(a)(i)         | <p><b>D</b> refraction <b>is the only correct answer</b></p> <p><i>A 'deflection' is an incorrect distracting description</i></p> <p><i>B 'incidence' is incorrect, that would be angle X</i></p> <p><i>C 'reflection' is incorrect, no reflection being shown in the diagram</i></p> | <p><b>(1)</b></p> <p>AO 1 1</p> |

| Question Number | Answer                                                                                           | Additional guidance                                                                                                                                | Mark                            |
|-----------------|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 2(a)(ii)        | <p>any pair of coordinates selected from the line (1)</p> <p>in range → 0.6(0) to 0.7(0) (1)</p> | <p>e.g. 20 and (13 or 14)</p> <p>or 10 and (6 or 7)</p> <p>ignore any units given</p> <p>award full marks for a correct answer without working</p> | <p><b>(2)</b></p> <p>AO 2 1</p> |

| Question Number | Answer                                                                                                                                     | Additional guidance                                                                        | Mark                             |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------|
| 2(a)(iii)       | <p>an explanation linking:</p> <p>repeat (1)</p> <p>different angles / more values of X (1)</p> <p>for larger angles / values of X (1)</p> | <p>allow 'more measurements' / 'repeat experiment' / collect more data</p> <p>&gt; 20°</p> | <p><b>(3)</b></p> <p>AO 3 3a</p> |

| Question Number | Answer                                                                                                                                    | Additional guidance                                                                                                                                                                                                                                                                                                                                                                   | Mark                            |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>2(b)</b>     | <p>substitution (1)</p> $\frac{3.0 \times 10^8}{5.8 \times 10^{-7}}$ <p>evaluation (1)</p> $5.2 \times 10^{14}$ <p>unit (1)</p> <p>Hz</p> | <p>answers that round to <math>5.2 \times 10^{14}</math></p> <p>award 2 marks for a correct answer without working</p> <p>allow 1 mark for answers that round to 5.2 to any power of ten</p> <p>independent mark</p> <p>accept hz or <math>s^{-1}</math> or per sec(ond) or hertz</p> <p>accept kHz, MHz etc with correct power (<math>10^{11}</math> kHz, <math>10^8</math> MHz)</p> | <p><b>(3)</b></p> <p>AO 2 1</p> |

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

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Additional guidance                          | Mark                            |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------------------------------|
| <b>3(a)</b>     | <p>a description that combines 4 points from the following:</p> <ol style="list-style-type: none"><li>1. put rock(s) in front of/near tube (1)</li><li>2. measure (count rate) separately for the two different rocks (1)</li><li>3. measure each count for the same time period (1)</li><li>4. keep source-detector distance the same for both rocks (1)</li><li>5. take (into account)/measure background count (1)</li><li>6. repeat readings and take average(s) (1)</li></ol> | <p>not "in" tube</p> <p>keep rocks apart</p> | <p><b>(4)</b></p> <p>AO 2 2</p> |

| Question Number | Answer                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                       | Mark                             |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| 3(b)            | <ul style="list-style-type: none"> <li>point after first half-life<br/>6, 40 (1)</li> <li>point after second half-life<br/>12, 20 (1)</li> <li>point after third half-life<br/>18, 10 (1)</li> </ul> | <p>within 1 small square by eye</p> <p>smooth curve starting at 80, with a decreasing gradient passing through one correct half-life point scores 2 marks</p> <p>smooth curve starting at 80, with a decreasing gradient passing through two correct half-life points scores 3 marks</p> <p><b>if no other mark scored</b></p> <p>smooth curve showing decreasing gradient but not going through any correct points scores 1 mark</p> | <p><b>(3)</b></p> <p>AO 3 1a</p> |

| Question Number | Answer                                                                                                                                       | Mark                            |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 3(c)            | <p>an answer containing both of the following numbers in the correct places (1)</p> $\begin{array}{c} 99 \\ \hline 43 \end{array} \text{Tc}$ | <p><b>(1)</b></p> <p>AO 2 1</p> |

**(Total for Question 3 = 8 marks)**

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                         | Mark   |        |        |                                 |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|--------|---------------------------------|
| 4(a)            | <table border="1"> <tr> <td>D</td><td>vector</td><td>vector</td></tr> </table> <p><b>is the only correct answer</b></p> <p><b>A</b> 'scalar scalar' is incorrect, both force and velocity are vectors</p> <p><b>B</b> 'scalar vector' is incorrect, with force being described incorrectly as a scalar</p> <p><b>C</b> 'vector scalar' is incorrect, with velocity being described incorrectly as a scalar</p> | D      | vector | vector | <p><b>(1)</b></p> <p>AO 1 1</p> |
| D               | vector                                                                                                                                                                                                                                                                                                                                                                                                         | vector |        |        |                                 |

| Question Number | Answer                          | Additional guidance                                   | Mark                            |
|-----------------|---------------------------------|-------------------------------------------------------|---------------------------------|
| 4(b)(i)         | gravitational / centripetal (1) | accept gravity / weight/ gravitational field strength | <p><b>(1)</b></p> <p>AO 2 1</p> |

| Question Number | Answer                                                            | Additional guidance     | Mark                            |
|-----------------|-------------------------------------------------------------------|-------------------------|---------------------------------|
| 4(b)(ii)        | arrow from the satellite towards the centre of Earth - by eye (1) | direction must be clear | <p><b>(1)</b></p> <p>AO 2 1</p> |

| Question Number | Answer                                                                                                                  | Additional guidance                                                                                                                                           | Mark                            |
|-----------------|-------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 4(c)(i)         | <p>wavelength (of e.m. radiation) increased / frequency decreased (1)</p> <p>as the (star) moves away (from us) (1)</p> | <p>don't penalise planet instead of object</p> <p>stretched/moves to(wards) red end of spectrum</p> <p>spectral lines move to the red end of the spectrum</p> | <p><b>(2)</b></p> <p>AO 1 1</p> |

| Question Number | Answer                                                                                                                                                                 | Additional guidance                                                                                                                                                                      | Mark                 |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>4(c)(ii)</b> | an explanation linking: <ul style="list-style-type: none"> <li>big bang has expanding universe (1)</li> <li>with galaxies moving away (from each other) (1)</li> </ul> | from (original) explosion started at a point<br><br>accept stars moving away (not objects or planets now)<br><br>the further away they are the greater is their (recessional) speed idea | <b>(2)</b><br>AO 1 1 |

| Question Number  | Answer    | Additional guidance | Mark                 |
|------------------|-----------|---------------------|----------------------|
| <b>4(c)(iii)</b> | microwave |                     | <b>(1)</b><br>AO 1 1 |

| Question Number | Answer                                                              | Additional guidance           | Mark                 |
|-----------------|---------------------------------------------------------------------|-------------------------------|----------------------|
| <b>4(c)(iv)</b> | (radiation) that comes from all over the sky / space / the universe | from the big bang / explosion | <b>(1)</b><br>AO 1 1 |

| Question Number | Answer                                                                                                                                                                               | Additional guidance                                   | Mark                 |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|----------------------|
| <b>4(c)(v)</b>  | an explanation linking: <ul style="list-style-type: none"> <li>the Big Bang theory has a beginning / initial explosion (1)</li> <li>that releases/gives out radiation (1)</li> </ul> | explosion from a point<br><br>radiation still present | <b>(2)</b><br>AO 1 1 |

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

| Question Number | Answer                                                                                                                                                       | Additional guidance                                                                                                                                    | Mark                            |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>5(a)</b>     | <p>a description to include:</p> <p>(the prong makes the) air vibrate/oscillate (1)</p><br><p>in the same direction as /parallel to the wave travels (1)</p> | <p>causes compressions and rarefactions in air</p> <p>transfers ke to air</p><br><p>longitudinal</p> <p>credit can be given for a labelled diagram</p> | <p><b>(2)</b></p> <p>AO 1 1</p> |

| Question Number | Answer                                                                                                                               | Additional guidance                                                                     | Mark                            |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|---------------------------------|
| <b>5(b)</b>     | <p>in this order</p> <p>infrared (wave) / IR (1)</p> <p>micro(wave) (1)</p><br><p>radio (wave) (1)</p><br><p>gamma (ray/wave)(1)</p> | <p>accept <math>\mu</math>(wave)</p><br><br><p>accept <math>\gamma</math><br/>not X</p> | <p><b>(4)</b></p> <p>AO 1 1</p> |

| Question Number | Answer                                                                                                                                                                                              | Additional guidance                                                                                                    | Mark                            |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 5(c)            | <p>an explanation linking:</p> <p>(the colours have) different wavelengths (1)</p> <p>different wavelengths / colours travel at different speeds (1)</p> <p>so refract by different amounts (1)</p> | <p>allow the word frequencies for wavelengths</p> <p>for refract allow bend/change direction/follow different path</p> | <p><b>(3)</b></p> <p>AO 2 1</p> |

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**(Total for Question 5 = 9 marks)**

| Question Number | Answer                                                                                                                                                                                                                                                                                                   | Mark                            |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>6(a)</b>     | <p><b>C N/kg is the only correct answer</b></p> <p><i>A J/kg is not dimensionally the same as <math>m/s^2</math></i></p> <p><i>B <math>J/kg^2</math> is not dimensionally the same as <math>m/s^2</math></i></p> <p><i>D <math>N/kg^2</math> is not dimensionally the same as <math>m/s^2</math></i></p> | <p><b>(1)</b></p> <p>AO 1 1</p> |

| Question Number | Answer                                                                                                         | Additional guidance                                                               | Mark                            |
|-----------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------|
| <b>6(b)(i)</b>  | <p>substitution (1)</p> $\frac{2 \times 2.5}{0.74^2}$ <p>evaluation (1)</p> <p>9.1(3) (<math>m/s^2</math>)</p> | $\frac{5}{0.5476}$ <p>award full marks for the correct answer with no working</p> | <p><b>(2)</b></p> <p>AO 2 1</p> |

| Question Number | Answer                                                                | Additional guidance                                                                                                                           | Mark                                         |
|-----------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| <b>6(b)(ii)</b> | <p><math>(0.74 + 0.69 + 0.81) \div 3</math> (1)</p> <p>0.7(5) (1)</p> | <p>accept 0.7 or 0.75</p> <p>award full marks for the correct answer with no working</p> <p>0.746 or<br/>0.747 or<br/>0.750 scores 1 mark</p> | <p><b>(2)</b></p> <p>AO 3 2a<br/>AO 3 2b</p> |

| Question Number | Answer                                                                                                    | Additional guidance                                                                                                                                                     | Mark                             |
|-----------------|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>6(c)</b>     | <p>an explanation linking:</p> <p>use an electronic timer / (1)</p> <p>to eliminate reaction time (1)</p> | <p>light gate/ data logger</p> <p>there are other options which should be judged to this pattern</p> <p>( e.g. increase distance to reduce effect of reaction time)</p> | <p><b>(2)</b></p> <p>AO 3 3b</p> |

| Question Number | Answer                                                                                                                                                                                    | Additional guidance                                                                                                                                                   | Mark                            |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>6(d)</b>     | <p>rearrangement (1)</p> $a = \frac{(v^2 -)u^2}{2 \times}$ <p>substitution (1)</p> $a = \frac{(-)15^2}{2 \times 14}$ <p>evaluation (1)</p> <p>deceleration = 8(.04) (m/s<sup>2</sup>)</p> | <p>rearrangement and substitution in either order</p> <p>225/28 for 2 marks</p> <p>accept – 8(.04)</p> <p>award full marks for the correct answer with no working</p> | <p><b>(3)</b></p> <p>AO 2 1</p> |

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

| Question Number | Answer                                                                                                                                                                                                                                                       | Mark                            |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>7(a)</b>     | <p><b>B</b> natural gas <b>is the only correct answer</b></p> <p><i>A geothermal is not a non-renewable source of energy</i></p> <p><i>C tidal is not a non-renewable source of energy</i></p> <p><i>D solar is not a non-renewable source of energy</i></p> | <p><b>(1)</b></p> <p>AO 1 1</p> |

| Question Number | Answer                                                                                                                | Additional guidance                                                                                                                               | Mark                            |
|-----------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>7(b)</b>     | <p>an explanation linking:</p> <p>increased use of renewables/decrease use of nonrenewables (1)</p> <p>reason (1)</p> | <p>accept "them" as renewable</p> <p>accept reason why renewables are beneficial</p> <p>accept reason why non-renewable(s) are not beneficial</p> | <p><b>(2)</b></p> <p>AO 1 1</p> |

| Question Number | Answer                                                                                                                                                                                 | Additional Guidance                                                                                                                                                                                                    | Mark                                          |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| <b>7(c)(i)</b>  | <p>recall (1)</p> <p><math>(\Delta PE) = mgh</math></p> <p>substitution and rearrangement (1)</p> <p><math>h = \frac{1300}{7 \times 10}</math></p> <p>evaluation (1)</p> <p>19 (m)</p> | <p><math>1300 = 7 \times 10 \times h</math></p> <p>work done = force x distance</p> <p>accept answers that round up to 19 (m)<br/>(e.g. 18.57 (m) )</p> <p>award full marks for the correct answer with no working</p> | <p><b>(3)</b></p> <p>AO 1 1</p> <p>AO 2 1</p> |

| Question Number | Answer                                                                                                                                            | Additional guidance                                                                                                                                                | Mark                               |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| <b>7(c)(ii)</b> | recall (1)<br>$KE = \frac{1}{2} m v^2$<br>substitution and rearrangement (1)<br>$v = \sqrt{(2 \times 1100 \div 8)}$<br>evaluation (1)<br>17 (m/s) | $v^2 = \frac{2 \times 1100}{8}$<br><br>accept answers that round up to 17 (m/s) (e.g. 16.58 (m/s) )<br><br>award full marks for the correct answer with no working | <b>(3)</b><br><br>AO 1 1<br>AO 2 1 |

| Question Number | Answer                                                                                                                                        | Additional guidance                                                                                                                          | Mark                     |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>7(d)</b>     | reading energies from graph (1)<br>5.2 and 3.9 (kJ)<br><br>substitution (1)<br>e.g. $\frac{1.3 \times (100)}{5.2}$<br>evaluation (1)<br>25(%) | accept<br>5.0 to 5.4<br>and<br>3.7 to 4.1<br><br>0.18 to 0.32<br><br>18 to 32 (%)<br>award full marks for the correct answer with no working | <b>(3)</b><br><br>AO 2 1 |

**(Total for Question 7 = 12 marks)**

| Question Number | Answer                                                                                                            | Additional guidance                                                                                                                                | Mark                            |
|-----------------|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>8(a)</b>     | <p>a description to include:</p> <p>use a thermometer (1)</p> <p>measure temperature at regular intervals (1)</p> | <p>temp. sensor</p> <p>datalogger</p> <p>it must be clear that it is a number of readings – not just 2</p> <p>eg measure temperature over time</p> | <p><b>(2)</b></p> <p>AO 1 2</p> |

| Question Number: | Answer                                                                                                       | Additional guidance                                                                                           | Mark                                            |
|------------------|--------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| <b>8(b)</b>      | <p>a description to include:</p> <p>intensity reaches a peak value (1)</p> <p>additional information (1)</p> | <p>other peaks</p> <p>irregular curve</p> <p>non-linear</p> <p>most of radiation outside visible spectrum</p> | <p><b>(2)</b></p> <p>AO 3 1a</p> <p>AO 3 1b</p> |

| Question Number | Answer                                                                                                                                                                                                                                                         | Additional guidance                                                                                                                | Mark                                          |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| <b>8(c)(i)</b>  | <p>tangent drawn between 20 and 40 ms (1)</p> <p>selection of suitable values and substitution from their tangent (1)</p> <p>e.g. <math>130 \div 60</math></p> <p>evaluation (1)</p> <p>2.0</p> <p>unit (1)</p> <p><math>^{\circ}\text{C}/\text{ms}</math></p> | <p>range 1.8-2.5</p> <p>2000 <math>^{\circ}\text{C}/\text{s}</math></p> <p>award full marks for correct answer with no working</p> | <p><b>(4)</b></p> <p>AO 1 1</p> <p>AO 2 1</p> |

| Question Number | Answer                                                                                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                                                                                                                                                                           | Mark                                            |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| 8(c)(ii)        | <p>an explanation linking:</p> <p>the temp rises because the (rate of) energy supplied is greater than the (rate of) energy being radiated. (1)</p> <p>at constant temperature the lamp radiates energy at the same <b>rate</b> at which it is being supplied (2)</p> | <p>accept 'absorbed/in' for supplied.</p> <p>energy in greater than energy out</p> <p>lamp radiates more as temperature increases</p> <p>lamp radiates at the same <b>power</b> at which it is being supplied for 2 marks</p> <p><b>power</b> out = <b>power</b> in</p> <p>award 1 mark for at constant temperature the energy supplied = energy radiated</p> | <p><b>(3)</b></p> <p>AO 3 2a</p> <p>AO 3 2b</p> |

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**(Total for Question 8 = 11 marks)**

| Question Number | Answer                                                                                 | Additional guidance                                                                                                 | Mark                 |
|-----------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>9(a)(i)</b>  | a description to include:<br><br>add weight / mass (1)<br><br>to the weight hanger (1) | ignore references to friction here<br><br>by inclining runway<br><br>allow (component of) gravity to act on trolley | <b>(2)</b><br>AO 1 2 |

| Question Number | Answer                                                                                   | Additional guidance                                                                          | Mark                 |
|-----------------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|----------------------|
| <b>9(a)(ii)</b> | a description to include:<br><br>transfer mass (1)<br><br>between trolley and hanger (1) | allow weight(s) for mass<br><br>mass removed from trolley = mass added to hanger for 2 marks | <b>(2)</b><br>AO 1 2 |

| Question Number | Answer                                                                                                                                                                                                                                                | Additional guidance                                                                                                                                                                                                           | Mark                             |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| 9(a)(iii)       | <p>an explanation that links:</p> <p>raise one end of the runway (1)</p> <p>(so that) trolley (not attached to weight hanger) rolls at constant speed / just starts to move / (force of) gravity (on the trolley) balances forces of friction (1)</p> | <p>credit methods for reducing friction directly (e.g. oil wheels, runway etc.)</p> <p>to reduce (effects of ) friction</p> <p>allow credit for identifying magnitude of frictional forces and subtracting or using graph</p> | <p><b>(2)</b></p> <p>AO 3 3b</p> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Mark                            |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 9(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 style="text-align: center;"><b>AO1 (6 marks)</b></p> <ul style="list-style-type: none"> <li>• momentum = mass × velocity</li> <li>• action and reaction are equal and opposite (N 3)</li> <li>• force of R on Q = -force of Q on R</li> <li>• <math>\frac{\text{change in momentum of Q}}{\text{time}} = - \frac{\text{change in momentum of R}}{\text{time}}</math></li> <li>• time of collision same for both</li> <li>• change in momentum of Q = - change in momentum of R</li> <li>• no overall change in momentum</li> <li>• R accelerates because of force from Q</li> <li>• transfer of momentum between Q and R</li> </ul> | <p><b>(6)</b></p> <p>AO 1 1</p> |

| 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>An explanation that demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)</li></ul> <p>Presents an explanation with some structure and coherence. (AO1)</p>                                                                              |
| Level 2 | 3-4  | <ul style="list-style-type: none"><li>An explanation that demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)</li><li>Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)</li></ul> |
| Level 3 | 5-6  | <ul style="list-style-type: none"><li>An explanation that demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)</li><li>Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)</li></ul>                       |

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**(Total for Question 9 = 12 marks)**

| Question Number | Answer                                                                                                                                                                                                 | Additional guidance                 | Mark                            |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|---------------------------------|
| 10(a)(i)        | <p>an explanation linking:</p> <p>(high temperature means) high energy (1)</p> <p>(needed) to overcome (force of) repulsion (1)</p> <p>between nuclei / because they both have the same charge (1)</p> | accept "them" / hydrogen for nuclei | <p><b>(3)</b></p> <p>AO 2 1</p> |

| Question Number  | Answer                                                                                                                                                                                                               | Additional guidance                                                                                                                                            | Mark                     |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>10(a)(ii)</b> | substitution (1)<br>$4.5 \times 10^{-12} = m (3.0 \times 10^8)^2$<br><br>rearrangement (1)<br>$(m =) \frac{4.5 \times (10^{-12})}{9.0 \times (10^{16})}$<br><br>evaluation (1)<br>$5.0 \times 10^{-29} \text{ (kg)}$ | accept substitution and rearrangement in either order<br><br>ignore POT errors until evaluation<br><br>award full marks for the correct answer with no working | <b>(3)</b><br><br>AO 2 1 |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Mark                                          |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| 10(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 style="text-align: center;"><b>A01</b></p> <ul style="list-style-type: none"> <li>• neutrons released in a chain reaction</li> <li>• slow(er) neutrons needed for fission</li> <li>• (some) neutrons are too fast</li> <li>• control rods can be moved in and out</li> <li>• control rods control speed of the reaction</li> </ul> <p style="text-align: center;"><b>A02</b></p> <ul style="list-style-type: none"> <li>• graphite core is the moderator</li> <li>• graphite core slows down the neutrons</li> <li>• moveable rods absorb neutrons</li> <li>• moveable rods make more or fewer neutrons available for fission</li> </ul> | <p><b>(6)</b></p> <p>AO 1 1</p> <p>AO 2 1</p> |

| Level   | Mark | Descriptor                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | 0    | No awardable content                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Level 1 | 1-2  | <ul style="list-style-type: none"><li>• An explanation that demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)</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>• An explanation that demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)</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>• An explanation that demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)</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>                                     |

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**Total for Question 10 = 12 marks)**

