



# Mark Scheme (Results)

Summer 2016

Pearson Edexcel International GCSE  
in Physics (4PH0) Paper 1PR

Pearson Edexcel International in Science  
Double Award (4SC0) Paper 1PR

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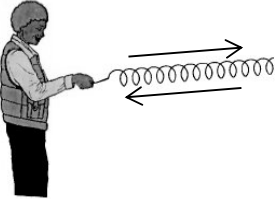
**General Marking Guidance**

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

| Question number | Answer                                                       | Notes                                                                                                                                           | Marks |
|-----------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1 (a)           | <p>all 4 lines;;;;<br/>any 2 lines;;;;<br/>any one line;</p> | (dotted line is given)                                                                                                                          | 3     |
| (b) (i)         | light dependent resistor / LDR;                              | allow <ul style="list-style-type: none"> <li>photo sensitive resistor</li> <li>light sensitive resistor</li> </ul> allow recognisable spellings | 1     |
| (ii)            | thermistor;                                                  | allow recognisable spellings<br><br>total marks = 5                                                                                             | 1     |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Notes                                                                                                                                                                                                                                                                                                                                                     | Marks |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 2 (a)           | <p>any suitable from:</p> <p>e.g.</p> <ul style="list-style-type: none"> <li>• asteroid;</li> <li>• meteor(ite);</li> <li>• (artificial) satellite;</li> <li>• a moon;</li> <li>• comet;</li> <li>• <u>named</u> planet;</li> </ul><br><ul style="list-style-type: none"> <li>• dwarf planet e.g. Pluto;</li> <li>• neutron star;</li> <li>• white dwarf;</li> </ul> <p>any two suitable from:</p> <ul style="list-style-type: none"> <li>• (the) Universe;</li> <li>• galaxy;</li> <li>• solar system;</li> <li>• star / Sun;</li> </ul><br><ul style="list-style-type: none"> <li>• <u>named</u> planet (1);</li> <li>• <u>named</u> planet (2);</li> </ul><br><p>galaxy;</p> | <p>accept appropriate correct answers</p><br><p>planets:</p> <ul style="list-style-type: none"> <li>• Mercury</li> <li>• Venus</li> <li>• Mars</li> </ul><br><p>'Sun and star' is 1 mark only</p> <p>planets should be gas giants:</p> <ul style="list-style-type: none"> <li>• Jupiter</li> <li>• Saturn</li> <li>• Uranus</li> <li>• Neptune</li> </ul> | 4     |
| (b) (i)         | gravitational force / gravitational pull / (force of) gravity;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                           | 1     |
| (ii)            | B;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                           | 1     |
| (iii)           | single straight arrow directed towards the Sun;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | judge by eye                                                                                                                                                                                                                                                                                                                                              | 1     |
| (iv)            | B;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                           | 1     |
| total marks = 8 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                           |       |

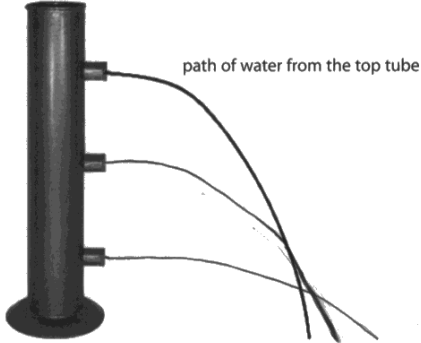
| Question number                                      | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Notes                                                                                                        | Marks    |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|----------|------------------------------|--|------------------------------------------|---|-------------------------------|---|------------------------------------------------------|---|--------------------------------------|--|--|---|
| 3 (a)                                                | minimum of three straight arrows for different particles (with different lengths);<br><br>arrows in different directions;                                                                                                                                                                                                                                                                                                                                                                         | judge by eye<br>arrows need not be attached to particles but it should be clear which particle they refer to | 2        |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |
| (b)                                                  | any three from:<br>MP1. particles collide/impact/eq;<br>MP2. with sides/walls of container;<br>MP3. idea that force is produced;<br><br>MP4. idea of pressure as force on an area;                                                                                                                                                                                                                                                                                                                | allow<br>hit for collide<br><br>allow particle changes momentum<br>$p = F/A$                                 | 3        |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |
| (c)                                                  | idea that pressure increases/eq;                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                              | 1        |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |
| (d)                                                  | <table><tr><th>Statement</th><th>Tick ( )</th></tr><tr><td>the gas particles get bigger</td><td></td></tr><tr><td>the mass of gas particles stays the same</td><td>✓</td></tr><tr><td>the gas particles move faster</td><td>✓</td></tr><tr><td>the average distance between gas particles increases</td><td>✓</td></tr><tr><td>the temperature of the gas decreases</td><td></td></tr></table><br><br>one mark for each correct;;;<br>if 4 ticks then max mark is 2<br>if 5 ticks then zero marks | Statement                                                                                                    | Tick ( ) | the gas particles get bigger |  | the mass of gas particles stays the same | ✓ | the gas particles move faster | ✓ | the average distance between gas particles increases | ✓ | the temperature of the gas decreases |  |  | 3 |
| Statement                                            | Tick ( )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                              |          |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |
| the gas particles get bigger                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                              |          |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |
| the mass of gas particles stays the same             | ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                              |          |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |
| the gas particles move faster                        | ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                              |          |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |
| the average distance between gas particles increases | ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                              |          |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |
| the temperature of the gas decreases                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                              |          |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |
|                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | total marks = 9                                                                                              |          |                              |  |                                          |   |                               |   |                                                      |   |                                      |  |  |   |

| Question number | Answer                                                                                                                                                                                      | Notes                                                                                                                                                                                                                 | Marks |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 4 (a) (i)       | <p>arrows in opposite directions and (roughly) parallel with the length of the spring;</p>                 | <p>allow</p> <ul style="list-style-type: none"> <li>a line with a double head</li> <li>arrows to R &amp; L</li> </ul> <p>ignore arrow length</p> <p>arrows need not be adjacent to the spring</p> <p>judge by eye</p> | 1     |
|                 | (ii)                                                                                                                                                                                        |                                                                                                                                                                                                                       |       |
|                 | any suitable example;<br>e.g.<br>sound<br>ultrasound<br>'p' wave                                                                                                                            | ignore waves in a slinky                                                                                                                                                                                              | 1     |
| (b) (i)         | <p>suitable horizontal line (labelled W);<br/>e.g.<br/>from peak to peak<br/>from trough to trough<br/>from midpoint to corresponding midpoint<br/>between any adjacent points in phase</p> | <p>judge by eye but should start and finish at suitable points</p>                                                                                                                                                    | 1     |
|                 | (ii)                                                                                                                                                                                        |                                                                                                                                                                                                                       |       |
|                 | 2.5 (cm)                                                                                                                                                                                    | do not allow<br>5/2<br>allow 2 ½                                                                                                                                                                                      | 1     |
|                 | (iii)                                                                                                                                                                                       |                                                                                                                                                                                                                       |       |
|                 | substitution into $f = 1/T$ ;                                                                                                                                                               | no mark for equation as it is given on page 2                                                                                                                                                                         | 3     |
|                 | evaluation;                                                                                                                                                                                 | -1 for POT error<br>ignore answers given as fractions                                                                                                                                                                 |       |
|                 | unit;                                                                                                                                                                                       |                                                                                                                                                                                                                       |       |
|                 | e.g.<br>$f = 1/15$<br>0.067<br>Hz                                                                                                                                                           | allow<br>0.07, 0.0667<br>$s^{-1}$<br>condone incorrect truncation e.g. 0.06, 0.066, 0.0666                                                                                                                            |       |

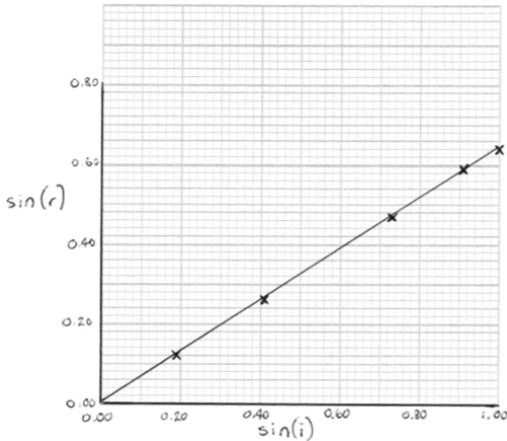
|      |                                                                                              |                                                                                                                                                                 |   |
|------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| (iv) | (ring oscillates) perpendicular / at right angles};<br>to the direction the wave travels/eq; | allow direction of energy transfer<br><br>reject 2 <sup>nd</sup> mark if reference to longitudinal wave e.g. 'ring moves parallel to the direction of the wave' | 2 |
| (v)  | any suitable example;<br>e.g.<br>a named EM wave<br>EM wave<br>'s' wave                      | allow wave on a rope<br><br><br>total marks = 10                                                                                                                | 1 |



| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Notes                                                                                                                                                                                                         | Marks |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 5 (a) (i)       | geothermal / geothermic;                                                                                                                                                                                                                                                                                                                                                                                                                                                  | allow nuclear                                                                                                                                                                                                 | 1     |
| (ii)            | any suitable resource or method;<br>e.g. <ul style="list-style-type: none"> <li>• wind (turbine)</li> <li>• hydro-electric</li> <li>• waves</li> <li>• tidal</li> <li>• solar (panels)</li> <li>• biofuels/biomass</li> </ul>                                                                                                                                                                                                                                             | ignore nuclear<br><br>ignore unqualified 'water'<br><br>allow photovoltaic cells, (sun)light<br>allow wood                                                                                                    | 1     |
| (b)             | any four from:<br><br>MP1. thermal energy is transferred from hot rock to cold water OR water heats up;<br>MP2. water molecules gain KE (as they are heated);<br>MP3. steam gains KE as it is heated by the rock;<br>MP4. GPE of steam increases as it gains height;<br>MP5. turbine gains KE from hot water/steam;<br>MP6. generator (coils) transfer KE (from turbine) into electrical energy;<br>MP7. electrical energy is transferred from pump into GPE/KE of water; | allow 'mechanical energy' for KE throughout<br><br>allow 'heat' for thermal energy<br><br>allow water turned into steam<br><br><br>allow turbine transfers KE to electrical energy<br><br><br>total marks = 6 | 4     |

| Question number | Answer                                                                                                                                                                               | Notes                                                                                                                                 | Marks |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------|
| 6 (a) (i)       | pressure difference = $\rho \times g \times h$                                                                                                                                       | accept in words or rearranged form<br>allow 'd' for density<br>do not accept 'gravity'<br>must be 'g' or gravitational field strength | 1     |
| (ii)            | both are curves;<br>lowest curve travels further than top curve (if extrapolated);<br>             |                                                                                                                                       | 2     |
| (iii)           | MP1. water at bottom has greater pressure / pressure increases with depth;<br><br>MP2. (therefore) force on water at the bottom is greatest;                                         | allow idea that there is more weight above a point, the lower the point is<br><br>allow water leaves lower holes with greater speed   | 2     |
| (b) (i)         | water level is constant in each vessel;<br>                                                       | ignore lines drawn in gaps between vessels                                                                                            | 1     |
| (ii)            | any two from:<br>MP1. vessels are connected;<br><br>MP2. same density / type of liquid in all;<br>MP3. air pressure is the same for all;<br>MP4. pressure only depends on the depth; | allow water flows to other vessels<br><br><br>allow pressure does not depend on (surface) area<br><br>total marks = 8                 | 2     |

| Question number | Answer                                                                                                                                     | Notes                                                                                                                            | Marks |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-------|
| 7 (a)           | any three from:<br>paper / pen / pencil;<br>protractor;<br>ruler / straight edge;<br>light source (& power supply);<br><br>(optical) pins; | allow cork board<br><br>ignore unqualified 'light'<br>allow needles                                                              | 3     |
| (b) (i)         | line drawn at P at $90^\circ$ to the flat surface;                                                                                         | judge by eye                                                                                                                     | 1     |
| (ii)            | $41^\circ$ ;<br>$21^\circ$ ;                                                                                                               | tolerance $\pm 3^\circ$<br>no ECF                                                                                                | 2     |
| (iii)           | change of medium / eq;<br><br>change in speed / wavelength;                                                                                | allow change of refractive index / (optical) density<br>ignore changes direction<br><br>reject second mark if contradiction seen | 2     |

| (c)      | (i)      | <p>label on both axes;<br/>scale on both axes;<br/>plotting;;</p>  | <p>ignore orientation<br/>ignore any units<br/>linear scale using<br/>≥50% of the grid<br/>tolerance is +/- 0.5<br/>square<br/>-1 for each error</p> <table><thead><tr><th><math>\sin i</math></th><th><math>\sin r</math></th></tr></thead><tbody><tr><td>0.19</td><td>0.12</td></tr><tr><td>0.41</td><td>0.26</td></tr><tr><td>0.73</td><td>0.47</td></tr><tr><td>0.91</td><td>0.59</td></tr><tr><td>1.00</td><td>0.64</td></tr></tbody></table> | $\sin i$ | $\sin r$ | 0.19 | 0.12 | 0.41 | 0.26 | 0.73 | 0.47 | 0.91 | 0.59 | 1.00 | 0.64 | 4 |
|----------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------|------|------|------|------|------|------|------|------|------|------|---|
| $\sin i$ | $\sin r$ |                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |          |      |      |      |      |      |      |      |      |      |      |   |
| 0.19     | 0.12     |                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |          |      |      |      |      |      |      |      |      |      |      |   |
| 0.41     | 0.26     |                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |          |      |      |      |      |      |      |      |      |      |      |   |
| 0.73     | 0.47     |                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |          |      |      |      |      |      |      |      |      |      |      |   |
| 0.91     | 0.59     |                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |          |      |      |      |      |      |      |      |      |      |      |   |
| 1.00     | 0.64     |                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |          |      |      |      |      |      |      |      |      |      |      |   |
|          | (ii)     | straight line of best fit (towards zero);                                                                                                           | points should be evenly distributed about the line                                                                                                                                                                                                                                                                                                                                                                                                 | 1        |          |      |      |      |      |      |      |      |      |      |      |   |
|          | (iii)    | $n = \sin i \div \sin r$                                                                                                                            | accept sine for sin                                                                                                                                                                                                                                                                                                                                                                                                                                | 1        |          |      |      |      |      |      |      |      |      |      |      |   |
|          | (iv)     | correct use of data from graph or table seen;<br>value in range 1.54-1.60;                                                                          | total marks = 16                                                                                                                                                                                                                                                                                                                                                                                                                                   | 2        |          |      |      |      |      |      |      |      |      |      |      |   |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                 | Notes                                                                                                                                                                                                 | Marks |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 8 (a) (i)       | $P = I \times V$ ;                                                                                                                                                                                                                                                                                                                                                                     | accept standard symbols or in words or rearranged                                                                                                                                                     | 1     |
| (ii)            | substitution and rearrangement;<br>evaluation;<br><br>e.g.<br>(I =) 110/230<br>(I =) 0.48 (A)                                                                                                                                                                                                                                                                                          | allow 0.5, 0.47826 (A)<br>condone 0.47, 0.4782                                                                                                                                                        | 2     |
| (b) (i)         | any suitable suggestion;<br>e.g.<br>carries a high(er) <u>current</u><br>has low(er) <u>resistance</u>                                                                                                                                                                                                                                                                                 | ignore references to cable<br>overheating/melting                                                                                                                                                     | 1     |
| (ii)            | L or live;                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                       | 1     |
| (iii)           | any suitable suggestion;<br>e.g.<br>double insulated<br>does not have a metal case / has a plastic case                                                                                                                                                                                                                                                                                | case is not a conductor / is an insulator                                                                                                                                                             | 1     |
| (c)             | substitution into a suitable equation;<br><br>time in correct units;<br><br>evaluation;<br><br>e.g.<br>( $E = I \times V \times t$ )<br>(E =) 0.17 x 230 x 55.....1 mark<br>(E =) 0.17 x 230 x 55 x 60...2 marks<br>(E =) 130 000 (J).....3 marks<br><br>OR<br><br>( $E = P \times t$ )<br>(E =) 40 x 55.....1 mark<br>(E =) 40 x 55 x 60.....2 marks<br>(E =) 130 000 (J).....3 marks | no mark for the equation as given in the paper<br>allow if x60 / 3300 seen anywhere in working<br><br><br>129 030 (J)<br>allow 131 835 for use of $V = 235V$<br><br>132 000(J)<br><br>total marks = 9 | 3     |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Notes                                                                                                                                                           | Marks |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 9 (a) (i)       | number of protons = 1;<br>number of neutrons = 2;                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                 | 2     |
| (ii)            | any three of the following<br><b>comparisons:</b><br>MP1. beta particle is negatively charged <u>and</u> alpha is positively charged;<br>MP2. beta particle has lower/less mass ORA;<br>MP3. beta particle has 1 charge but alpha has 2 charges;<br>MP4. beta particle is an electron but alpha is $2p + 2n$ /eq;<br>MP5. beta is less ionising;<br>MP6. beta has higher speed;<br>MP7. beta particles have larger range;<br>MP8. beta has higher penetrating ability; | ignore descriptions of applications of types of radiation<br><br>allow 'beta is lighter' ORA<br><br>allow beta can pass through paper but alpha will be stopped | 3     |
| (iii)           | any sensible suggestion;<br>e.g.<br><ul style="list-style-type: none"> <li>alpha is 4 nucleons, tritium has (only) 3 / eq</li> <li>tritium has only 1p, 2p are in alpha</li> <li>tritium has not got enough mass / mass number too low</li> <li>tritium has not got enough nucleons</li> <li>tritium has not got enough p / atomic number too low</li> <li>tritium has not got enough p+n</li> </ul>                                                                   | ignore tritium is too small                                                                                                                                     | 1     |
| (b)             | any two from:<br>MP1. energy explanation;<br>e.g. beta particles have given up all their KE on impact<br>MP2. absorption explanation;<br>e.g. beta particles have hit (and been absorbed by) phosphor<br>MP3. penetration explanation;<br>e.g. beta cannot penetrate (thick) glass / tube<br>MP4. range explanation;<br>e.g. signs are further away than the range of beta                                                                                             | ignore:<br><ul style="list-style-type: none"> <li>beta particles have low ionisation /OWTTE</li> <li>no gas can escape</li> </ul>                               | 2     |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                      | Notes                                                                                                                                                                                                                                                                                                                                                     | Marks |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 9 (c) (i)       | time taken;<br><br>and either of <ul style="list-style-type: none"> <li>• for (radio)activity to <b>halve</b>;</li> <li>• for <b>half</b> of (radioactive) nuclei / atoms / isotope to decay;</li> </ul>                                                                                                                                                                                    | allow<br>how long it takes<br>reject 'half the time'<br><br>allow count rate for activity<br>reject: <ul style="list-style-type: none"> <li>• particles</li> <li>• molecules</li> <li>• substance</li> <li>• 'break down'</li> <li>• 'reactivity'</li> <li>• a nucleus / an atom</li> <li>• halve in mass</li> <li>• to completely/fully decay</li> </ul> | 2     |
| (ii)            | working seen/appropriate line(s) on graph seen;<br>13.5 years;                                                                                                                                                                                                                                                                                                                              | tolerance $\pm 0.5$ years                                                                                                                                                                                                                                                                                                                                 | 2     |
| (d)             | MP1. correct judgment re claim;<br><br>MP2. (because) EITHER<br>correct statement re time (at which the activity is 400);<br><br>OR<br><br>activity (at 20 years);<br><br>e.g.<br>the manufacturer is correct because the time would be 21.5 years (to reach an activity of 400)<br><br>OR<br><br>the manufacturer is correct because the activity is 420 (counts per minute) (at 20 years) | allow range of 21-22 years<br><br><br><br><br><br>allow range of 410 to 440<br><br><br><br><br><br>total marks = 14                                                                                                                                                                                                                                       | 2     |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Notes                                                                                                                                                                                                                                                                                    | Marks |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 10              | <p>any six from:</p> <p><b>discussion of conduction</b><br/> MP1. metal spike conducts the thermal energy;<br/> MP2. thermal energy is conducted into middle of/inside the potato;</p> <p><b>discussion of convection</b><br/> MP3. convection (current) occurs;<br/> MP4. due to density of air decreasing / air expanding;<br/> MP5. potato receives hotter air near the top;</p> <p><b>discussion of radiation</b><br/> MP6. thermal energy is radiated/emitted from the black surface;<br/> MP7. potato absorbs thermal energy from all sides;</p> <p><b>general</b><br/> MP8. electrical energy is transferred into thermal energy in the heating element;</p> | <p>allow 'heat' for thermal energy throughout</p> <p>metal is a good conductor (of thermal energy)<br/> allow potato is heated / cooked from the inside</p> <p>ignore references to absorption at walls<br/> allow potato is heated / cooked from the outside</p> <p>total marks = 6</p> | 6     |



| <b>Question number</b> | <b>Answer</b>                                                                                                                                                                                                      | <b>Notes</b>                                                                                                                                                                                                     | <b>Marks</b> |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 11 (a)                 | 9100 (N)                                                                                                                                                                                                           |                                                                                                                                                                                                                  | 1            |
| (b) (i)                | F = m x a;                                                                                                                                                                                                         | accept standard symbols or in words or rearranged                                                                                                                                                                | 1            |
| (ii)                   | substitution and rearrangement; evaluation;<br><br>e.g.<br>(a =) 400/910<br>(a =) 0.44                                                                                                                             | -1 for POT error<br><br>allow<br>0.4, 0.43956044<br><br>0.43 gains 1 mark only                                                                                                                                   | 2            |
| (c)                    | any three from:<br><br>MP1. speed increases;<br>MP2. so drag {starts to act / increases};<br>MP3. downward forces increase;<br><br>MP4. (hence) acceleration decreases;                                            | ignore references to the initial acceleration<br><br>award 1 mark for mention of terminal velocity if no other mark awarded<br><br>allow air resistance / friction increases<br>allow unbalanced force decreases | 3            |
| (d)                    | acceleration increases;<br><br>with any one from: <ul style="list-style-type: none"> <li>• weight decreases / downward force reduces;</li> <li>• unbalanced force increases;</li> <li>• mass decreases;</li> </ul> |                                                                                                                                                                                                                  | 2            |
| total marks = 9        |                                                                                                                                                                                                                    |                                                                                                                                                                                                                  |              |

| Question number | Answer                                                                                                                                                                                                                                                                                                                            | Notes                                                                                              | Marks |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-------|
| 12 (a) (i)      | 94;                                                                                                                                                                                                                                                                                                                               |                                                                                                    | 1     |
| (ii)            | any two sensible suggestions:<br>e.g. <ul style="list-style-type: none"> <li>to make results (more) reliable;</li> <li>to produce an average reading;</li> <li>to identify anomalous results;</li> <li>because there may have been a temperature change;</li> <li>because there may have been friction in the syringe;</li> </ul> | ignore references to keeping it a fair test                                                        | 2     |
| (b) (i)         | any sensible suggestion:<br>e.g. <ul style="list-style-type: none"> <li>reduced scale gives fuller use of the grid;</li> <li>because the lowest value of <math>p</math> or <math>V</math> is 50/eq;</li> <li>because <math>p</math> or <math>V</math> cannot be zero;</li> </ul>                                                  | allow RA<br><br>ignore there are no values below 40                                                | 1     |
| (ii)            | idea of straight line having an even distribution of points about the line;<br><br>all points seem to be on the curve;                                                                                                                                                                                                            | no mark for a bald 'it's the curve' or 'it's the line'<br>allow points are very close to the curve | 2     |
| (iii)           | any sensible suggestion;<br>e.g. <ul style="list-style-type: none"> <li>keep the temperature constant</li> <li>ensure no air gets into/out of the syringe/eq</li> <li>keep apparatus exactly the same</li> <li>wait for same time after adding/removing loads to take the volume reading</li> </ul>                               |                                                                                                    | 1     |
| (iv)            | any two from:<br><br>MP1. increase sensitivity/resolution of instruments;<br><br>MP2. take reading(s) to fill in the middle of the graph/eq;<br>MP3. take reading(s) to extend the range of the graph;                                                                                                                            | ignore references to parallax error / accuracy<br>allow take readings with greater precision/eq    | 2     |

|     |                                                                                                                                                                                                            |                                 |                        |                                                                                                                                                                                                                                                                                            |   |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| (c) | MP1. one correct value of $p \times V$ calculated;<br><br>MP2. second correct value of $p \times V$ calculated;<br><br>MP3. statement of agreement with Boyle's Law (within bounds of experimental error); |                                 |                        | allow calculation of a pressure ratio<br><br>allow calculation of a volume ratio<br><br>e.g. <ul style="list-style-type: none"> <li>• <math>pV</math> is a constant</li> <li>• <math>p \propto 1/V</math></li> <li>• <math>p</math> is inversely proportional to <math>V</math></li> </ul> | 3 |
|     | Pressure in kPa                                                                                                                                                                                            | Average volume in $\text{cm}^3$ | Space for calculations |                                                                                                                                                                                                                                                                                            |   |
|     | 100                                                                                                                                                                                                        | 50                              | 5000                   |                                                                                                                                                                                                                                                                                            |   |
|     | 90                                                                                                                                                                                                         | 55.5                            | 4995                   |                                                                                                                                                                                                                                                                                            |   |
|     | 84                                                                                                                                                                                                         | 60                              | 5040                   |                                                                                                                                                                                                                                                                                            |   |
|     | 55                                                                                                                                                                                                         | 92                              | 5060                   |                                                                                                                                                                                                                                                                                            |   |
|     | 60                                                                                                                                                                                                         | 84                              | 5040                   |                                                                                                                                                                                                                                                                                            |   |
|     | 50                                                                                                                                                                                                         | 101                             | 5050                   |                                                                                                                                                                                                                                                                                            |   |
|     |                                                                                                                                                                                                            |                                 |                        | total marks = 12                                                                                                                                                                                                                                                                           |   |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                 | Notes                                                                                                                                                                               | Marks |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 13 (a)          | <p>any four from:</p> <p>MP1. there is a current in the rod;</p> <p>MP2. (therefore) magnetic field around rod;</p> <p>MP3. magnetic fields interact / overlap;</p> <p>MP4. producing a force (on the rod);</p> <p>MP5. catapult effect / motor effect / LH rule;</p> <p>MP6. rod moves to the right / towards the power supply;</p>                                   | <p>allow 'AB' for rod throughout</p> <p>allow current in the rail</p> <p>ignore references to cutting field lines</p> <p>accept the rod moves sideways / left</p>                   | 4     |
| (b)             | <p>any four from:</p> <p>MP1. alternating current changes direction (continuously);</p> <p>MP2. current in coil produces alternating magnetic field/eq;</p> <p>MP3. (producing) force on the coil/cone;</p> <p>MP4. reversing direction of current reverses direction of the force;</p> <p>MP5. hence coil/cone vibrates;</p> <p>MP6. cone vibrates air particles;</p> | <p>allow any marking point if clear from diagram</p> <p>allow changing magnetic field</p> <p>allow coil / cone moves in and out / backwards and forwards</p> <p>total marks = 8</p> | 4     |



