

# Markscheme

November 2016

Physics

On-screen examination

This markscheme is **confidential** and for the exclusive use of examiners in this examination session.

It is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of the IB Global Centre, Cardiff.

## Markscheme instructions

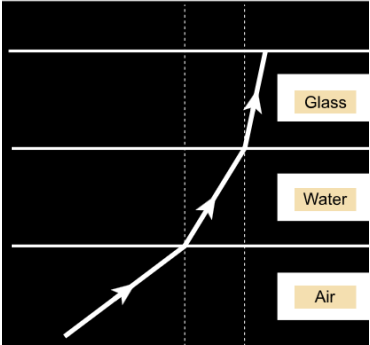
- 1 Mark positively. Give candidates credit for what they have achieved and what is correct. Do not deduct marks for incorrect responses.
- 2 Follow the markscheme provided and award only whole marks.
- 3 Each marking point appears on a separate line.
- 4 The maximum mark for each subpart is indicated in the “Total” column.
- 5 Where a mark is awarded a tick should be placed in the text at the precise point where it is clear the candidate deserves the mark.
- 6 Each marking point in a question part should be awarded separately unless there is an instruction to the contrary in the Notes column.
- 7 A question subpart may have more marking points than the total allows. This will be indicated by the word “**max**” in the Answer column. Further guidance may be given in the Notes column.
- 8 Additional instructions on how to interpret the markscheme are in bold italic text in the Answer column.
- 9 Alternative wording may be indicated in the Answer column by a slash (/). Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.
- 10 Alternative answers are indicated in the Answer column by “**or**”. Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.
- 11 If two related points are required to award a mark, this is indicated by “**and**” in the answer column.
- 12 Words in brackets ( ) in the Answer column are not necessary to gain the mark.
- 13 Words that are underlined are essential for the mark.

- 14 In some questions a reverse argument is also acceptable. This is indicated by the abbreviation *ORA* (or reverse argument) in the Notes column. Candidates should not be rewarded for reverse arguments unless *ORA* is given in the Notes column.
- 15 If the candidate's response has the same meaning or is clearly equivalent to the expected answer the mark should be awarded. In some questions this is emphasized by the abbreviation *WTTE* (words to that effect) in the Notes column.
- 16 When incorrect answers are used correctly in subsequent question parts the follow through rule applies. Award the mark and add *ECF* (error carried forward) to the candidate response.
- 17 The order of marking points does not have to be the same as in the Answer column unless stated otherwise.
- 18 Marks should not be awarded where there is a contradiction in an answer. Add *CON* to the candidate response at the point where the contradiction is made.
- 19 Do not penalize candidates for errors in units or significant figures unless there is specific guidance in the Notes column.
- 20 Questions with higher mark allocations will generally be assessed using a level response method using task specific clarifications developed with reference to the criteria level descriptors. Candidate's work should be marked using a best fit approach. A candidate's response should be reviewed to determine holistically the band in which the response falls. Once this has been determined, each bullet point within that band should be assessed to see if the candidate has met the requirements of the statement. Where those requirements are met, marks should be awarded, starting from the lowest available mark for that band.

Once this process has been completed if the highest (or lowest) mark available for that band has been determined, the examiner must check the band above (or below) to ensure that the initially correct determination of the band was correctly allocated. For example, there may be sufficient detail in the candidate's response to award the lowest mark of the band above.

**NB. Marks are distributed unevenly across the mark bands as candidates have to include much more detail in their responses to access the highest mark bands.**

| Question |   | Answers  | Notes   | Marks | Criterion |
|----------|---|--|---|-------|-----------|
| 1        | a | 50 (km h <sup>-1</sup> )   |   | 1     | A         |
|          | b | <p><b>any two reasonable suggestions, for example</b></p> <ul style="list-style-type: none"> <li>• head wind</li> <li>• drag</li> <li>• different weather systems such as rain</li> <li>• increasing fatigue <b>or</b> other physiological feature as they fly</li> <li>• behavioural flight patterns eg flying in groups</li> </ul> |   | 2     | A         |
|          | c | diagram 4  |   | 1     | A         |
|          | d | <p><b>force:</b><br/>between points C and D the retarding force is increasing <b>or</b> forces are no longer balanced</p> <p><b>speed:</b><br/>reducing to <u>zero</u></p> <p><b>acceleration:</b><br/>deceleration / retardation / negative acceleration</p> <p><b>Newton's law:</b><br/>second law <b>or</b> quoting F=ma</p>      | ECF from 1 <sup>st</sup> marking point for marking points 2, 3 and 4  | 4     | C         |
|          | e | <p>(20*120*0.5) <b>or</b> 1200 <b>or</b> 1.2</p> <p>m <b>or</b> km</p>   | Unit to agree with numerical value  | 2     | C         |
| 2        | a | <p><b>labels in order from top to bottom: wavelength – amplitude – compression - rarefaction</b></p> <p>any two labels correct</p> <p>all labels correct</p>   |   | 2     | A         |
|          | b | 12 (Hz)  |   | 1     | C         |
|          | c | A <b>and</b> B   |   | 1     | C         |
|          | d | <p>6 waves in 1 second <b>or</b> f = 6 Hz</p> <p>(wavelength = <math>\frac{330}{6}</math> =) <u>55 m</u></p>   | <p>Unit required for 2<sup>nd</sup> mark</p> <p>Award one mark only for correct wavelength without unit</p> | 2     | C         |
|          | e | wave D   |   | 1     | C         |

|          |          |  |   |          |   |
|----------|----------|--|---|----------|---|
|          | <b>f</b> | <p>identification of <u>diffraction</u></p> <p>general explanation of diffraction</p> <p>how diffraction relates to the specific situation</p>   |   | <b>3</b> | A |
| <b>3</b> | <b>a</b> | <p>Draggable items</p>  <p>air correctly identified</p> <p>water <b>and</b> glass correctly identified</p>  |   | <b>2</b> | A |
|          | <b>b</b> | <p>light refracts <b>or</b> changes direction <b>or</b> bends (when it changes medium)</p> <p>degree to which it refracts is dependent on change in density of the medium</p> <p><b>or</b></p> <p>degree to which it refracts is dependent on the relative change in the refractive index of the materials</p> <p><b>or</b></p> <p>degree to which it refracts is dependent on the change in its speed</p> <p>(because) the ray bends towards the <u>normal</u> as it slows down</p> | <p><i>WTTE but there must be an implied change in medium for marking point 2</i></p> <p>ORA</p> | <b>3</b> | A |

| 4       | a   | <table border="1"> <thead> <tr> <th></th> <th>Charge</th> </tr> </thead> <tbody> <tr> <td>Electron</td> <td>-1</td> </tr> <tr> <td>Proton</td> <td>+1</td> </tr> <tr> <td>Neutron</td> <td>0</td> </tr> </tbody> </table>  |  | Charge | Electron | -1 | Proton | +1 | Neutron | 0 |  | 1 | A |
|---------|---|--|--|--------|----------|----|--------|----|---------|---|--|---|---|
|         |   |  | Charge                                   |        |          |    |        |    |         |   |  |   |   |
|         |   | Electron   | -1                                       |        |          |    |        |    |         |   |  |   |   |
| Proton  | +1  |  |  |        |          |    |        |    |         |   |  |   |   |
| Neutron | 0   |  |  |        |          |    |        |    |         |   |  |   |   |
| b       | <p><u>electrons</u> are the only particle which can move</p> <p>electrons are transferred</p> <p>(so) a lack of electrons creates a positive charge</p>   | <p><i>Accept "negative charge in place of electron" for marks 2 and 3</i></p>  | 3  | A      |          |    |        |    |         |   |  |   |   |
| c       | <p>cat is charged by rubbing the carpet</p> <p>pellets are uncharged</p> <p>reference to the charge on the cat inducing <b>or</b> causing <b>or</b> creating an opposite charge in the pellets</p> <p>the charge on the cat is attracted to the electrons/protons/opposite charges in the pellets <b>or</b> the pellets are then attracted to the cat</p> |  | 4  | A      |          |    |        |    |         |   |  |   |   |
| 5       | a   | <p>conduction</p> <p>convection</p> <p>radiation</p>   |  | 3      | A        |    |        |    |         |   |  |   |   |
|         | b   | <p><b>any reasonable suggestion of equipment, for example</b></p> <ul style="list-style-type: none"> <li>• timer</li> <li>• balance</li> </ul> <p><b>correctly linked justification</b></p>  | <p><i>Do not accept ice or paper</i></p> | 2      | B        |    |        |    |         |   |  |   |   |
|         | c   | <p><b>statement of prediction that links number of sheets of <u>paper</u> and <u>mass</u> of ice that has melted, for example</b></p> <p>mass of ice melted decreases as number of sheets of paper increases</p> <p><b>correctly linked justification, for example</b></p> <p>number of sheets of paper is increasing gives more insulation which reduces mass of ice that melts</p> |  | 2      | B        |    |        |    |         |   |  |   |   |

|          |          |   |   |          |   |
|----------|----------|---|---|----------|---|
|          | <b>d</b> | statement of reasonable variable<br>statement of how the variable should be controlled<br>justification of why the variable should be controlled  |   | <b>3</b> | B |
|          | <b>e</b> | indication of how mass lost will be determined<br>collect at least five sets of data<br>repeat each set at least three times and average  |   | <b>3</b> | B |
| <b>6</b> | <b>a</b> | (not supported because) as the thickness increases the time taken to cool down follows no trend<br><b>or</b><br>2 mm coffee cup was the slowest to cool down  |   | <b>1</b> | C |
|          | <b>b</b> | <b>Four weaknesses and correctly linked scientific explanation of the effect of each weakness, for example</b><br>different thicknesses of cup were used<br>different materials were used which will have different thermal conductivities<br><br>different coloured materials were used<br>different coloured materials will radiate thermal energy / heat differently<br><br>volume was not the same each time<br>filling to the same height does not give the same volume as the dimensions are different<br><br>the cups were of different dimensions<br>the surface area exposed to the air was different for each cup<br><br>the room temperature was not measured<br>the room temperature may not have been controlled <b>or</b> could have varied | Accept answers relating to number of trials even though this is a procedural weakness | <b>8</b> | C |



|   |   |  |     |   |   |
|---|---|--|-----|---|---|
| 7 | a | IV – thickness of aluminium sheet<br>DV – amount / intensity of beta radiation absorbed <b>or</b> that penetrates  |     | 2 | B |
|   | b | electron<br><br>(that is) high-energy <b>or</b> fast-moving  |     | 2 | A |
|   | c | as the thickness of the aluminium sheet increases the intensity of the beta radiation that penetrates the sheet decreases<br><br>as the aluminium sheet is made thicker the electrons would have less chance of penetrating due to more energy loss <b>or</b> increased interaction <b>or</b> collisions with atoms  | ORA | 2 | B |
|   | d | <b>Four points describing the method given below</b><br><ul style="list-style-type: none"> <li>• at least five conditions of the independent variable</li> <li>• measurements repeated at least three times <b>or</b> counts averaged</li> <li>• count rate measured with no aluminium between source and GM tube</li> <li>• measurements taken with aluminium sheets of increasing number between source and GM tube</li> </ul><br><b>Any two further reasonable points, for example</b><br><ul style="list-style-type: none"> <li>• control variable e.g. distance/orientation between source and GM tube should be fixed</li> <li>• aluminium sheets of the same thickness</li> <li>• same source should be used for each test</li> </ul> |     | 6 | B |
|   | e | <b>Any reasonable source of background radiation, for example</b><br><ul style="list-style-type: none"> <li>• cosmic rays</li> <li>• rocks</li> <li>• fallout from nuclear testing</li> </ul>  |     | 1 | A |
|   | f | background radiation should be measured without the presence of the beta source<br><br>background count should be deducted from all future measurements  |     | 2 | B |

|   | <b>g</b>   | <p><b>any two reasonable precautions and correctly related reason, for example</b></p> <table border="1" data-bbox="275 288 1294 703"> <thead> <tr> <th data-bbox="275 288 629 339">Precaution</th> <th data-bbox="629 288 1294 339">Reason</th> </tr> </thead> <tbody> <tr> <td data-bbox="275 339 629 395">minimize time of exposure</td> <td data-bbox="629 339 1294 395">reduce dose because exposure~time</td> </tr> <tr> <td data-bbox="275 395 629 491">increase distance between source and person <b>or</b> use tongs</td> <td data-bbox="629 395 1294 491">reduce dose because exposure~1/distance</td> </tr> <tr> <td data-bbox="275 491 629 563">shielding/protective clothing</td> <td data-bbox="629 491 1294 563">reduce dose because radiation is absorbed by shielding</td> </tr> <tr> <td data-bbox="275 563 629 624">avoid pregnant women</td> <td data-bbox="629 563 1294 624">reduce risk of genetic abnormality</td> </tr> <tr> <td data-bbox="275 624 629 703">do not point source towards body</td> <td data-bbox="629 624 1294 703">reduce dose because <math>\beta</math> radiation is directional</td> </tr> </tbody> </table> | Precaution  | Reason          | minimize time of exposure | reduce dose because exposure~time | increase distance between source and person <b>or</b> use tongs | reduce dose because exposure~1/distance | shielding/protective clothing | reduce dose because radiation is absorbed by shielding | avoid pregnant women | reduce risk of genetic abnormality | do not point source towards body | reduce dose because $\beta$ radiation is directional | <p><i>Do not accept gloves or goggles</i></p> | <p><b>4</b></p> | <p><b>B</b></p> |
|---|--|---|---|-----------------|---------------------------|-----------------------------------|---|---|-------------------------------|--|----------------------|------------------------------------|----------------------------------|--|---|-----------------|-----------------|
| Precaution  | Reason   |   |   |                 |                           |                                   |   |   |                               |  |                      |                                    |                                  |  |   |                 |                 |
| minimize time of exposure                                       | reduce dose because exposure~time                      |   |   |                 |                           |                                   |   |   |                               |  |                      |                                    |                                  |  |   |                 |                 |
| increase distance between source and person <b>or</b> use tongs | reduce dose because exposure~1/distance                |   |   |                 |                           |                                   |   |   |                               |  |                      |                                    |                                  |  |   |                 |                 |
| shielding/protective clothing                                   | reduce dose because radiation is absorbed by shielding |   |   |                 |                           |                                   |   |   |                               |  |                      |                                    |                                  |  |   |                 |                 |
| avoid pregnant women  | reduce risk of genetic abnormality                     |   |   |                 |                           |                                   |   |   |                               |  |                      |                                    |                                  |  |   |                 |                 |
| do not point source towards body                                | reduce dose because $\beta$ radiation is directional   |   |   |                 |                           |                                   |   |   |                               |  |                      |                                    |                                  |  |   |                 |                 |
|   | <b>h</b>   | <p><b>hypothesis</b><br/>alpha particles would be stopped completely by the first aluminium sheet</p> <p><b>explanation</b><br/>alpha particles are less penetrating than beta particles<br/><b>or</b><br/>alpha particles have higher mass and have more interaction with matter than beta</p>   |   | <p><b>2</b></p> | <p><b>B</b></p>           |                                   |   |   |                               |  |                      |                                    |                                  |  |   |                 |                 |
| <b>8</b>  | <b>a</b>   | <p>six times identified</p> <p>values ranging between 0 and 100</p> <p>equally spaced values</p> <p>two averages calculated correctly</p> <p>all correct</p> <p>averages expressed as whole numbers</p>   | <p><i>Award the sig fig marks for <b>any</b> number correctly expressed</i></p> | <p><b>6</b></p> | <p><b>C</b></p>           |                                   |   |   |                               |  |                      |                                    |                                  |  |   |                 |                 |
|   | <b>b</b>   | <p>smooth curve</p>   |   | <p><b>1</b></p> | <p><b>C</b></p>           |                                   |   |   |                               |  |                      |                                    |                                  |  |   |                 |                 |

|          |          |  |  |          |   |
|----------|----------|--|--|----------|---|
|          | <b>c</b> | one half life correctly read from graph<br>two further half lives calculated<br>correct calculation of average   |  | <b>3</b> | C |
|          | <b>d</b> | 4 half lives<br>8 years  | <i>Award only one mark for four years</i>                    | <b>2</b> | A |
| <b>9</b> | <b>a</b> | <b><i>Any two reasonable suggestions, for example</i></b><br><ul style="list-style-type: none"> <li>• pollution from smoke</li> <li>• unsightly</li> <li>• noisy operation</li> <li>• large lorries delivering coal</li> </ul> | <i>Do not accept "dangerous"</i>                             | <b>2</b> | D |
|          | <b>b</b> | large quantity of water is required for cooling<br><b>or</b><br>large quantity of water is required to turn turbines<br><b>or</b><br>large quantity of water is required to generate steam                                     | <i>Do not accept "use water to dispose of nuclear waste"</i> | <b>1</b> | D |
|          | <b>c</b> | (the secondary current) halves   |  | <b>1</b> | A |
|          | <b>d</b> | energy loss is proportional to size of the current<br><br>increasing the voltage reduces the current<br><br>less heat is generated (so less energy is lost)  | <i>WTTE</i>  | <b>3</b> | D |

|                 |  |                                       |                 |          |
|-----------------|--|---------------------------------------|-----------------|----------|
| <p><b>e</b></p> | <p><b>for any two gases:</b><br/> <b>water vapour</b><br/> greenhouse gas<br/> collects in the atmosphere and acts to stop heat from the Earth escaping<br/> leads to climate change</p> <p><b>CO<sub>2</sub></b><br/> greenhouse gas<br/> collects in the atmosphere and acts to stop heat from the Earth escaping<br/> leads to climate change</p> <p><b>SO<sub>2</sub></b><br/> acid rain<br/> reacts with rain water to produce an acid<br/> acid rain causes damage eg to buildings and forests</p> | <p><i>WTTE</i></p> <p><i>WTTE</i></p> | <p><b>6</b></p> | <p>D</p> |
| <p><b>f</b></p> | <p>there is an excess of electrical energy at night<br/> <b>or</b><br/> lower demand at night time</p> <p>electrical energy cannot be stored</p> <p>in order to encourage people to use this energy it is sold more cheaply</p>  |                                       | <p><b>3</b></p> | <p>D</p> |

|           |          |   |       |  |           |   |
|-----------|----------|---|-------|--|-----------|---|
| <b>10</b> | <b>a</b> | any reasonable application requiring a constant source of electricity   |       |  | <b>1</b>  | D |
|           | <b>b</b> | <ul style="list-style-type: none"> <li>• incomplete statement of reason for constant source of electricity with no reference to application in 10a</li> <li>• advantage <b>or</b> disadvantage stated with no reference to 10a</li> </ul>   | 1-2   |  | <b>15</b> | D |
|           |          | <ul style="list-style-type: none"> <li>• reason for a constant source of electricity related to application in 10a is stated</li> <li>• advantage <b>and</b> disadvantage related to 10a is stated</li> <li>• an impact on society <b>or</b> an economic impact</li> </ul>  | 3-5   |  |           |   |
|           |          | <ul style="list-style-type: none"> <li>• reason for a constant source of electricity in application in 10a is clearly explained</li> <li>• advantage outlined</li> <li>• disadvantage outlined</li> <li>• an impact on society <b>and</b> an economic impact</li> </ul>   | 6-9   |  |           |   |
|           |          | <ul style="list-style-type: none"> <li>• reason for a constant source of electricity in application in 10a is clearly explained and justified</li> <li>• advantage explained in detail</li> <li>• disadvantage explained in detail</li> <li>• a clearly reasoned impact on society</li> <li>• a clearly reasoned economic impact</li> <li>• a concluding appraisal</li> </ul> | 10-15 |  |           |   |