# Markscheme

## May 2021

## Physics

## On-screen examination

15 pages

The following are the annotations available to use when marking responses.

| Annotation | Explanation |
|---|---|
|  | Correct point, place at the point in the response where it is clear that the candidate deserves the mark. For use in analytically marked questions only. |
|  | Omission, incomplete |
| CON | Contradiction |
|  | Valid part (to be used when more than one element is required to gain the mark) |
|  | Error carried forward |
|  | Dynamic annotation, it can be expanded to surround work |
|  | Horizontal wavy line that can be expanded |
|  | Highlight tool that can be expanded to mark an area of a response |

| Annotation | Explanation |
|---|---|
|  | Not good enough |
|  | The candidate has given a response but it is not worthy of any marks |
|  | Text box used for additional marking comments |
|  | Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses |
|  | Vertical wavy line that can be expanded |
|  | Words to that effect |
|  | Award 1, 2, 3, 4 marks. For use in holistically marked questions only |

**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 <u>underlined</u> 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.

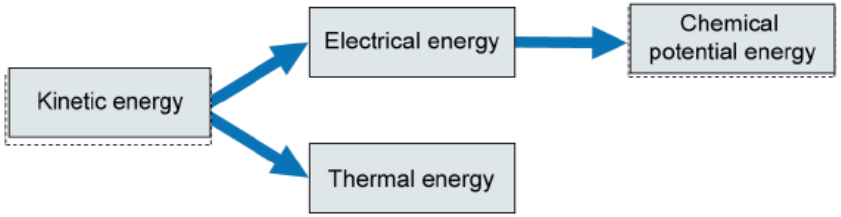
**18** Marks should not be awarded where there is a contradiction in an answer. Add *CON* to the candidate response at the point where the contradiction is made.

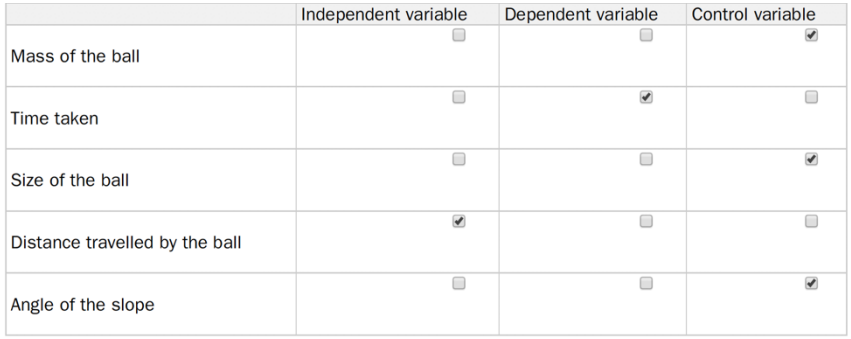
**19** Do not penalize candidates for errors in units or significant figures unless there is specific guidance in the Notes column.

**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. A candidate's work should be reviewed to determine holistically the mark for each row of the holistic grid and a mark awarded for each row.

| Question | | Answers | Notes | Total | Criterion |
|---|---|---|---|---|---|
| 1 | a | Radio waves travel [at the same speed as] light waves in a vacuum.<br>Radio waves have [a longer wavelength than] light waves. | | **2** | A |
| | **b** | Diffraction | | **1** | A |
| | **c** | Evidence of conversion of km to m<br>Correct answer (0.00002)<br>Expressed in standard form $2 \times 10^{-5}$ (s) | *Seen or implied*<br>*Award if an incorrect answer is expressed in standard form.*<br>*Award 3 marks if $2 \times 10^{-5}$ alone is seen* | **3** | A |
| | **d** | ***Accept any reasonable suggestion [max 2]***<br>• Able to communicate while moving (e.g. boats)<br>• Communication over larger distances ***or*** with other countries ***or*** to previously inaccessible locations<br>• High speed communication is possible<br>• No failures of wired connections ***or*** saves material ***or*** money required for wired connections<br>• Led to the development of (named) new technology | *Do not accept messages can be sent without the need for wires*<br>*Each named piece of technology can be awarded 1 mark* | **2** | D |

| | | | | | |
|---|---|---|---|---|---|
| **2** | **a** | 29 is the number of protons in the nucleus<br><br>63 is the total number of protons and neutrons in the nucleus | | **2** | A |
| | **b** | C<br><br>Correct image selected<br><br>Beta (particles) are electrons ***or*** beta (particles) are negatively charged<br><br>(so they are) deviated toward the positive plate in an electric field | *Only consider the justification if C is selected* | **3** | A |
| | **c** | Evidence of use of half-life ***or*** beginning mass of the sample is 100 g, half of it is 50 g<br><br>60 ± 2 (h) | *Award 2 marks for correct answer with no working shown* | **2** | A |
| | **d** | Half-life (time period) is suitable to allow treatment ***or*** short enough to limit the long-term effects<br><br>Beta or gamma radiation can kill cancer cells ***or*** tumours | *Ignore references to penetrating power* | **2** | A |

| | | | | | |
|---|---|---|---|---|---|
| **3** | **a** | Use of KE equation<br><br>468750(J) | *Seen or implied*<br><br>*Accept any correctly rounded answer to two or more sig figs for 2 marks*<br><br>*Accept answers correctly stated in kJ* | **2** | A |
| | **b** | Use of $v^2 = u^2 + 2as$<br><br>(–) 10.4166…<br><br>Rounded correctly to (–)10.4<br><br>m $s^{-2}$ or $m/s^2$ | *Accept* loss in KE = work done by force<br><br>*Award three marks if only 10.4 is seen*<br><br>*Award this unit mark separately. Superscripts must be used correctly. Do* ***not*** *accept ^2.* | **4** | A |
| | **c** | Heat energy cannot be used (by the car) ***or*** cannot perform work | *WTTE. Do* ***not*** *accept wasted / lost energy as this is given in the question* | **1** | A |
| | **d** |  <br>All correct for one mark | | **1** | A |
| | **e** | ***Accept any point from the list, [max 1]***<br>• energy (stored in the battery) can be transformed into kinetic energy<br>• energy (stored in the battery) can be transformed into electrical energy to drive the car | *Do* ***not*** *accept the car's battery is recharged*<br>*WTTE* | **1** | A |
| | **f** | Burning fuel produces carbon dioxide/ $CO_2$<br><br>Link to climate change ***or*** greenhouse effect | *Do* ***not*** *accept unnamed greenhouse gas emissions or pollution*<br><br>*WTTE* | **2** | D |

| | | | | | |
|---|---|---|---|---|---|
| **4** | a | How does the distance a ball roll affect the time taken? | *WTTE* | 1 | B |
| | b |  <br>IV – distance only<br><br>DV – time only<br><br>CV – mass, size, angle of slope only | | 3 | B |
| | c | weight of the ball ***or*** gravitational force ***or*** gravity<br><br>Use of Newton's Second Law or F = ma or Newton's First Law to correctly link force and acceleration | *No need to explain why the force is constant (and link this to the constant acceleration) for the second marking point* | 2 | B |
| | d | B<br><br>***Any two from [max 2]***<br>• graph goes through the origin, or when $s$ = 0 then $t2$ = 0<br>• relationship is proportional<br>• gradient = ½ a | *Only consider the justification if graph B is selected* | 3 | B |
| | e | Unit = $s^2$<br><br>4.7961 ***or*** 4.8 ***or*** 4.796 ***or*** 5<br><br>4.80 | *Do **not** accept s^2. Accept unit and value in table or response box.*<br><br>*Seen or implied. Accept 4.79 for 1 mark for correct calculated value incorrectly rounded*<br><br>*Award two marks for correctly rounded value to 2 dp only* | 3 | C |

| | | | | | |
|---|---|---|---|---|---|
| | f | ***Accept any reasonable response, for example [max 1]***<br>• not using common units<br>• measurements with a device like this relies on another person having the same tool to compare with<br>• all water clocks are different<br>• comment relating to difficulty in getting the regular flow of water required ***or*** difficulty of construction | *WTTE*<br><br>*Do not accept that the water clock is not an accurate/reliable instrument for measuring time without further details* | 1 | C |
| | g | Stopwatch ***or*** stopclock ***or*** chronometer ***or*** timer | | 1 | C |
| | h | Any reasonable single IV selected<br><br>***Any two reasonable CV, for example [max 2]***<br>• mass of the ball<br>• surface of the ramp<br>• size of the ball<br>• distance<br>• angle of slope<br><br>Any reasonable RQ linking IV and DV | *Do **not** accept distance or non-specific "type" of ball for IV*<br><br>*Do **not** accept temperature, gravity, pressure, same measuring equipment or IV given above for CV* | 4 | C |

<table>
<tr><td>5</td><td>a</td><td>(If) The surface area increases and (then) the time taken to fall will increase<br><br>(because) air resistance will increase<br><br>(because) the parachute will have more collisions with air particles</td><td>WTTE Accept correct responses appearing in any box</td><td>3</td><td>B</td></tr>
<tr><td></td><td>b</td><td>
<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>V<br>(Variables)</td><td>time implied as dependent variable</td><td>independent variable of surface area and dependent variable of time stated</td><td>independent variable of surface area and dependent variable of time stated and two control variables stated</td><td>independent variable of surface area and dependent variable of time stated and two control variables stated and with correct justification</td></tr>
<tr><td>E<br>(Equipment)</td><td>equipment to measure time or length</td><td>equipment to measure time and length</td><td></td><td></td></tr>
<tr><td>M<br>(Method)</td><td>attempt at a method linked to surface area or time</td><td>method is described with measurements of surface area and time but not detailed enough to be followed by another student</td><td>complete method is described with measurements of surface area and time and could easily be followed by another student</td><td></td></tr>
<tr><td>D<br>(Data)</td><td>at least five increments or three trials</td><td>at least five increments and three trials</td><td>at least five increments and three trials and plans to calculate an average</td><td></td></tr>
<tr><td>S<br>(Safety)</td><td>mentions a relevant precaution for example when working at height, use of scissors for cutting materials or to make sure the drop area is clear</td><td></td><td></td><td></td></tr>
</table>
</td><td>13</td><td>B</td></tr>
</table>

<table>
<tr><td rowspan="6">6</td><td>a</td><td>Correct reading from scale 42.8±0.1<br><br>$d_i$ = 12.8±0.1<br><br>cm</td><td><br><br>Allow ECF if calculation $d_i$ = (reading – 30) is evident<br><br>Unit mark can be awarded independently if seen anywhere in the answer<br><br>Award 3 marks for 12.8 cm with no working shown</td><td>3</td><td>C</td></tr>
<tr><td>b</td><td>Table Object<br><table><tr><th>Distance from candle to lens / cm</th><th>Distance from lens to screen / cm</th></tr><tr><td>10</td><td>90.1</td></tr><tr><td>20</td><td>16.4</td></tr><tr><td>30</td><td>12.8</td></tr><tr><td>40</td><td>11.6</td></tr><tr><td>50</td><td>11.1</td></tr></table><br>Column headings (using symbols or words) and units in header only<br><br>All data in order and complete<br><br>$d_o$ to one decimal place or nearest cm<br><br>All $d_i$ data expressed to consistent number of decimal places</td><td><br><br><br><br><br>Accept non-subscripts for do and di<br><br>Accept data in rows or columns<br><br>ECF from part a</td><td>4</td><td>C</td></tr>
<tr><td>c</td><td>m<br><br>5.87<br><br>0.170</td><td></td><td>3</td><td>C</td></tr>
<tr><td>d</td><td>0.187</td><td></td><td>1</td><td>C</td></tr>
<tr><td>e</td><td>C<br><br>A correct justification, for example [max 1]<br>• the equation shows that a straight line or linear relationship is expected<br>• the best fit line should not include the anomalous data point<br>• reference to numbers of data points above and below the best fit line</td><td><br><br>Correct graph must be selected to award the justification mark</td><td>2</td><td>C</td></tr>
</table>

| | | | | | |
|---|---|---|---|---|---|
| | f | Y intercept stated as 5.8 ± 0.1<br><br>$f$ = 0.172 ± 0.003 (m) | *ECF if wrong graph selected in e*<br>– graph A - *accept 4.7* ± 0.1<br>- graph B – accept 5.5 ± 0.1<br>- graph D – accept 4.5 ± 0.1<br><br>Award the second point for evidence of a calculation involving 1/intercept | 2 | C |

<table>
<tr><td>7</td><td>a</td><td>A<br><br>Forces are unbalanced or net force is not zero</td><td>WTTE</td><td>2</td><td>A</td></tr>
<tr><td></td><td>b</td><td colspan="2"><table>
<tr><th></th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Ad<br>(Advantages)</td><td>a statement of an advantage</td><td>a statement of two or more advantages<br>or<br>a statement of one advantage with an explanation</td><td>a statement of two or more advantages with at least one explained</td></tr>
<tr><td>Dis<br>(Disadvantages)</td><td>a statement of a disadvantage</td><td>a statement of two or more disadvantages<br>or<br>a statement of one disadvantage with an explanation</td><td>a statement of two or more disadvantages with at least one explained</td></tr>
<tr><td>Con<br>(Conclusion)</td><td>a simple conclusion</td><td></td><td></td></tr>
</table></td><td>7</td><td>D</td></tr>
</table>

**8**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| **Env (Environmental)** | a statement of one use of drones in environmental monitoring | a statement of one use of drones in environmental monitoring ***and*** how this use relates to science ***or*** at least two statements of the use of drones in environmental monitoring | a statement of at least two uses of drones in environmental monitoring ***and*** a statement of how **one** use is a benefit to science | a statement of at least two uses of drones in environmental monitoring ***and*** a statement of how these uses are a benefit to science |
| **Soc (Social implications)** | a positive ***or*** a negative social implication for an individual | a positive ***and*** a negative social implication for an individual | a positive ***and*** a negative social implication for an individual with ***one*** supported by further justification | a positive ***and*** a negative social implication for an individual with ***both*** supported by further justification |
| **Pol (Political implications)** | a positive ***or*** a negative political or security implication for a location | a positive ***and*** a negative political or security implication for a location | a positive ***and*** a negative political or security implication for a location with ***one*** supported by further justification | a positive ***and*** a negative political or security implication for a location with ***both*** supported by further justification |
| **Con (Concluding appraisal)** | a concluding opinion is given | a concluding appraisal linking to previous arguments | | |

14

D