Markscheme

November 2021

Physics

On-screen examination

14 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
	Test 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 (or 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.

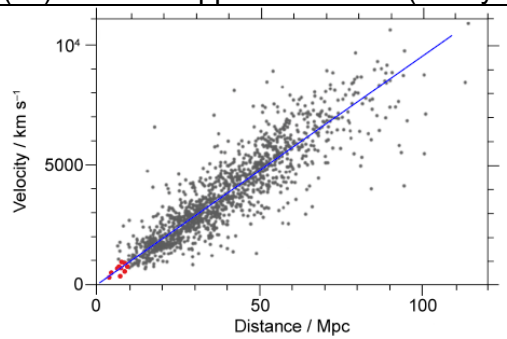
18 Marks should not be awarded where there is a contradiction in an answer. Add CON to the candidate response at the point where the contradiction is made.

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	Crit
1	a	Liquid ▾ Gas ▾ Solid ▾		1	A
	b	Table Object Change of state / Initial State / Final State Condensation: Gas ▾ / Liquid ▾ Vaporization: Liquid ▾ / Gas ▾ All correct		1	A
	c	the particles have greater (kinetic) energy ***or*** particles move faster the number of collisions per second is increased ***or*** particles collide with greater force (resulting in) greater pressure	*WTTE*	3	A
	d	air particles are moving (but are too small to be seen) (that) collide with (larger) smoke particles (that can be seen)	*WTTE*	2	A

2	**a**	 all correct		**1**	A
	b	Gravitational potential 80 J	*Award independently*	**2**	A
	c	KE=1/2mv^2 correct answer: 7.26636… stated to 2 sig figs: 7.3 (ms^{-1})	*Seen or implied* *Award 3 marks for correct final answer*	**3**	D
	d	substitution into E=mc^2 1.6398 x 10^{-13} (J)	*Ignore incorrect substitution of one mass only (*9.11 x 10$^{-31)}$ *for first mark* *Award 1 mark for 8.199 x 10^{-14} (J)*	**2**	A

3	**a**	Light is an example of a transverse electromagnetic wave.		**1**	A
	b	B the wavelength is stretched by the source moving away ***or*** the wavelength is increased as the source moves away	*WTTE Do **not** award second mark if incorrect wave is selected* *Accept correct reference to frequency*	**2**	A
	c	wavelength emitted from stars has increased (so) the stars appear more red (if they are moving away)		**2**	A
	d	 line passes through the origin line passes approximately through the centre of the data points	*judge by eye*	**2**	C
	e	As the distance (away from the Earth) increases, the velocity increases (there is a) proportional (relationship)		**2**	A
	f	suggests that there is an origin ***or*** everything was in the same place before (as) objects are moving away from each other ***or*** the universe is expanding		**2**	A
	g	the estimate is based on more data ***or*** the data we have is more reliable	*WTTE*	**1**	A

4	**a**	Table Object Voltage/V | Current/A 1.0 | 0.20 2.0 | 0.41 3.0 | 0.60 4.2 | 0.81 5.1 | 1.01 column headings voltage ***and*** current units of V ***and*** A in headers only all data complete and arranged in order of voltage ***or*** current all current readings rounded to 2d.p. correct conversion of 601 (mA) to 0.60(1) (A) <u>0.41</u> (A)	*Accept data arranged in rows or columns* *Accept ascending or descending* *Ignore 601 mA for this marking point* *Value must be quoted to 2 dp*	**6**	C

	b	doubling of voltage (approximately) doubles current ***or*** doubling of voltage does not exactly double current calculation of constant of proportionality, for at least two values ***or*** calculation of predicted current when voltage is doubled (so therefore) hypothesis is supported (within range of experimental precision) ***or*** hypothesis is rejected with correct reference to calculation	*Do **not** award third mark unless first or second mark is awarded.*	**3**	C
	c	graph is not straight ***or*** gradient is not constant (so) it is a non-ohmic conductor	*Do **not** award second mark unless first is awarded*	**2**	C
	d	easier to evaluate the visual representation of the relationship presented in a graph	*WTTE*	**1**	C
	e	5.0 (Ω) 15 (Ω) Ω ***or*** ohm(s)	*Unit must be visible in one answer*	**3**	C D
	f	C		**1**	B

5	**a**	$\frac{\rho}{A}$		**1**	C
	b	evidence of gradient calculation answer in the range 0.043 to 0.047 $\Omega\ m^{-1}$	*Award 2 marks for correct value alone* *Award unit mark separately. Accept Ω/m. Do not accept caret for exponent*	**3**	C
	c	length of zero should have a resistance of zero (and) graph doesn't intercept origin		**2**	C
	d	all values shifted by the same amount because the errors cancel out in gradient calculation (so therefore) statement is invalid	*award one mark for saying gradient calculation is not accurate because data are not accurate*	**3**	C
	e	***Accept any reasonable response, for example [max 1]*** • zero error • calibration error • additional resistance from other components in the circuit		**1**	C
	f	if the area of the wire increases, the resistance would decrease relationship is inversely proportional electrons are moving fewer pathways if the area is smaller	*ORA* *ORA, WTTE*	**4**	B

<table>
<tr><td>6</td><td>a</td><td>two bulbs in series

ammeter connected to measure current through bulbs

correct circuit with no additional components in series with the bulbs</td><td>Ignore switch or voltmeter added in parallel</td><td>3</td><td>B</td></tr>
<tr><td></td><td>b</td><td colspan="2">
<table>
<tr><th></th><th>1 mark</th><th>2 marks</th><th>3 marks</th></tr>
<tr><td>Research question</td><td>Research question links IV and DV</td><td></td><td></td></tr>
<tr><td>Hypothesis</td><td>A simple prediction that is incomplete or incorrect</td><td>Predicts that the current will decrease as the number of bulbs in series increases</td><td>Predicts that the current will decrease as the number of bulbs in series increases because resistance increases</td></tr>
<tr><td>IV and DV</td><td>Independent variable identified number of bulbs
or
dependent variable identified as current</td><td>Independent variable identified as number of bulbs
and
dependent variable identified as current</td><td></td></tr>
<tr><td>CV</td><td>supply voltage is the same</td><td>supply voltage is the same as increased supply voltage would increase the current flow</td><td></td></tr>
<tr><td>Data</td><td>Method implies a range of values</td><td>Method includes at least 5 values of IV</td><td></td></tr>
<tr><td>Method</td><td>Attempt at a method but detail is insufficient to follow</td><td>Method described and could easily be followed by another student</td><td></td></tr>
<tr><td>Equipment</td><td>some equipment is listed</td><td>power supply, bulbs</td><td>power supply, wires, bulbs and ammeter to measure DV</td></tr>
</table>
</td><td>15</td><td>B</td></tr>
<tr><td></td><td>c</td><td colspan="2">Accept any reasonable additional IV, for example [max 1]
• bulbs in parallel
• material of wires
• colour / type of light bulb
• different supply voltage</td><td>Do not accept length of wire, cross-sectional area of wire, resistors</td><td>1</td><td>C</td></tr>
<tr><td></td><td>d</td><td colspan="2">any reasonable research question linked to IV in part c and current</td><td></td><td>1</td><td>B</td></tr>
</table>

<table>
<tr><td rowspan="3">7</td><td>a</td><td><table><tr><th>Wood burning biomass</th><th>Geothermal power</th><th>Tidal power</th></tr><tr><td>Disadvantage
Needs a large amount of space for fuel production. There is also a time delay between planning the power plant and production beginning.</td><td>Disadvantage
Needs to be built in geologically suitable areas and the start-up costs are high.</td><td>Disadvantage
Needs to be built in coastal areas on land and may disrupt the ecosystem.</td></tr></table>
one disadvantage correct

two disadvantages correct

all disadvantages correct</td><td></td><td>3</td><td>D</td></tr>
<tr><td>b</td><td>Chemical potential → Thermal → Kinetic → Electrical

correct energy forms selected

in the correct order</td><td>Ignore order for this first mark</td><td>2</td><td>D</td></tr>
<tr><td>c</td><td><table><tr><th></th><th>1 mark</th><th>2 marks</th></tr><tr><td>Advantages</td><td>A statement of an advantage implicitly linked to a country</td><td>A statement of an advantage implicitly linked to a country with explanation</td></tr><tr><td>Disadvantages</td><td>A statement of a disadvantage implicitly linked to a country</td><td>A statement of two or more disadvantages implicitly linked to a country with explanation for each</td></tr></table></td><td></td><td>4</td><td>D</td></tr>
</table>

<table>
<tr><td>8</td><td>a</td><td>Nuclear power plant

uranium or nuclear fuel is a finite resource</td><td>WTTE</td><td>2</td><td>D</td></tr>
<tr><td></td><td>b</td><td colspan="2"><table>
<tr><th></th><th>1 mark</th><th>2 marks</th><th>3 marks</th><th>4 marks</th></tr>
<tr><td>Advantages of their method over oil</td><td>A statement of an advantage</td><td>A statement of two advantages
or
A statement of an advantage with justification</td><td>A statement of two advantages, one of which with justification</td><td></td></tr>
<tr><td>Political implications</td><td>A statement of a political implication</td><td>A statement of a political implication with further explanation
or
Statement of two political implications</td><td>Statement of two political implications both with further explanation</td><td></td></tr>
<tr><td>Economic implications</td><td>General reference to an economic implication for their option</td><td>An economic implication supported with general reference to data for their option</td><td>An economic implication supported with specific data quoted for their option compared with both of the other options</td><td>A comparative reference to two economic implications supported with data including evidence of data processing</td></tr>
<tr><td>Appraisal</td><td>A simple conclusion</td><td>A concluding appraisal with reference to issues raised</td><td></td><td></td></tr>
</table></td><td>12</td><td>D</td></tr>
</table>