Mark Scheme (Results)

November 2021

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.

- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.

- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.

- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.

- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.

- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.

- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.

- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
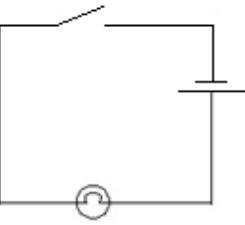
Mark schemes have been developed so that the rubrics of each mark scheme reflects the characteristics of the skills within the AO being targeted and the requirements of the command word. So for example the command word 'Explain' requires an identification of a point and then reasoning/justification of the point.

Explain questions can be asked across all AOs. The distinction comes whether the identification is via a judgment made to reach a conclusion, or, making a point through application of knowledge to reason/justify the point made through application of understanding. It is the combination and linkage of the marking points that is needed to gain full marks.

When marking questions with a 'describe' or 'explain' command word, the detailed marking guidance below should be consulted to ensure consistency of marking.

Assessment Objective		Command Word	
Strand	Element	Describe	Explain
AO1*		An answer that combines the marking points to provide a logical description	An explanation that links identification of a point with reasoning/justification(s) as required
AO2		An answer that combines the marking points to provide a logical description, showing application of knowledge and understanding	An explanation that links identification of a point (by applying knowledge) with reasoning/justification (application of understanding)
AO3	1a and 1b	An answer that combines points of interpretation/evaluation to provide a logical description	
AO3	2a and 2b		An explanation that combines identification via a judgment to reach a conclusion via justification/reasoning
AO3	3a	An answer that combines the marking points to provide a logical description of the plan/method/experiment	
AO3	3b		An explanation that combines identifying an improvement of the experimental procedure with a linked justification/reasoning

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

Question number	Answer	Additional guidance	Mark
1(a)	accept for filament bulb battery/cell symbol (1) lamp symbol (1) switch symbol (1) then complete series circuit shown (1)	ignore polarity of battery	**(4)** **AO3**

Question number	Answer	Additional guidance	Mark
1(b)	substitution (1) 0.15 x 40 evaluation (1) 6(.0) (V)	award full marks for correct answer without working	**(2)** **AO2**

Question number	Answer	Mark
1(c)	1.4 (A)	**(1)** **AO2**

Total for Question 1 =7 marks

Question number	Answer	Mark
2(a)	(i) gravitational (1) (ii) friction (1) (iii) electrostatic (1)	**(3)** **AO1**

Question number	Answer	Mark
2(b)	C It has direction and size Option C is the only correct combination for a vector quantity	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
2(c)	substitution (1) (moment) = 200 x 3(.0) evaluation (1) 600 (Nm) unit (1) Nm	award full marks for correct answer without working independent mark ignore J / Joules	**(3)** **AO2**

(Total for Question 2 = 7 marks)

Question number	Answer	Mark
3(a)	B hit the sides of the container more often Options A, C and D are incorrect associations	(1) AO1
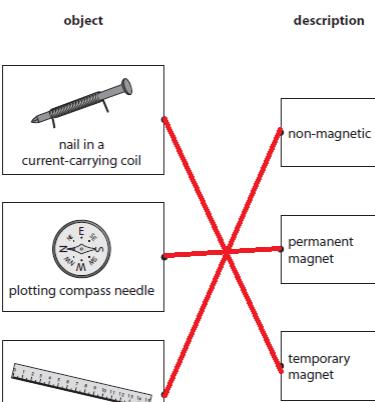
| Question number	Answer	Additional guidance	Mark
3bi	(headings to the table should have) **units** or **names** (1)	accept any correct unit suggestion e.g. cm^3 / Pascals or any correct name e.g. pressure / volume	(1) AO3

Question number	Answer	Additional guidance	Mark
3bii	attempts to find any 'in between number' (interpolates) (1) evaluation (1) 17.2, 17.3 or 17.25	accept any number between 16.6 and 17.9 award full marks for correct answer without working	(2) AO3

Question number	Answer	Additional guidance	Mark
3biii	Suggestions, including any **two** from: take intervening pressure reading(s) (1) give (plenty of) time between readings (1) use apparatus with smaller scale divisions (1) take repeat readings and average (1) make sure temperature stays constant (1)	e.g. steps of 0.2 cm^3 on volume scale allow repeat to check for anomaly e.g. check temperature of the room ignore any ideas of extending the investigation	(2) AO3
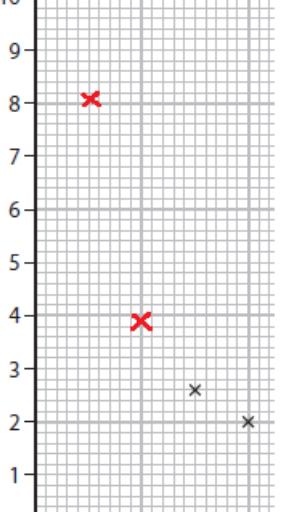
Question number	Answer	Additional guidance	Mark
3biv	An explanation including any **three** from: any reference to data from the table (1) (the product) p x V remains constant (1) for most readings p x V is similar / close to 2800 (1) which points to $p_1 \times V_1 = p_2 \times V_2$ (1) OR equation doesn't fit because values are different (mp4 dependent upon mp2 / mp3) last value(s) of p x V discordant compared with the others (1)	e.g. no, because almost all the (pV) values are different agrees / disagrees with hypothesis last value(s) values of pV don't agree	(3) AO3

(Total for Question 3 = 10 marks)

Question number	Answer	Additional guidance	Mark
4a		three links correct (2) one link correct (1)	(2) AO1

Question number	Answer	Additional guidance	Mark
4 (b) i	circle shown around wire (1)	allow tolerance for translation of 3D to 2D ignore any multiplicity of those circles	(1) AO1

Question number	Answer	Additional guidance	Mark
4 (b) ii	arrow indicating a clockwise direction (for magnetic field line drawn for i) (1)		(1) AO1

Question number	Answer	Additional guidance	Mark
4(c)i		One mark for each point plotted correctly, to within ± 1 small square	(2) AO2

Question number	Answer	Additional guidance	Mark
4(c)ii	smooth curve drawn fitting the plotted points (1)	judge by eye	(1) AO2

Question number	Answer	Additional guidance	Mark
4ciii	substitution using an attempt at calculation – any subtraction seen (1) e.g. 2(.0) – 1(.0) evaluation (1) (-) 1(.0) (mT)	accept any number that rounds to 1.0 award full marks for correct answer without working	(2) AO3

Question number	Answer	Mark
4 (c) iv	(size of) current	(1) AO1

(Total for Question 4 = 9 marks)

Question number	Answer	Additional guidance	Mark
5 (a) i	substitution (1) $(I = \dfrac{P}{V}) = \dfrac{1.9 \ (x \ 10^3)}{230}$ (1) evaluation (1) 8.3 (A)	8.3 / 8.26 (A) award full marks for correct answer without working award one mark for 8.26×10^{-3} / 0.0083	(2) AO2

Question number	Answer	Additional guidance	Mark
5 (a) ii	choice and substitution (1) $E = I \times V \times t$ $\quad = 7.4 \ x \ 230 \ x \ 120$ evaluation (1) 200000 (J)	accept 204000 / 204240 award full marks for correct answer without working award 1 mark for 3400 / 3404 (J) (using 2 minutes as time)	(2) AO2

Question number	Answer	Additional guidance	Mark
5 (b) i	Wire X ......earth........(1) Wire Y ......live........ (1)	accept 'life'	(2) AO1

Question number	Answer	Additional guidance	Mark
5 (b) ii	Component Z ….fuse…… (1)		(1) AO1

Question number	Answer	Additional guidance	Mark
5 (c)		rearrangement and substitution in either order	(3) AO2
	substitution (1) (I_p) x 230 = 19 x 2.37	allow numerical values written above equation	
	rearrangement (1) $(Ip) = (19.0 \times 2.37) \div 230$	$input\ voltage = (output\ voltage \times output\ current) \div input\ voltage$	
	evaluation (1) input current = 0.196 (A)	award full marks for any answer that rounds to 0.2(00) (A) award 1 mark for 5.1(07) (substitution with upside down rearrangement) award full marks for correct answer without working	

(Total for Question 5 = 10 marks)

Question number	Answer	Additional guidance	Mark
6(a)i	substitution (1) $(\Delta GPE) = 72 \times 10 \times 7.0$ evaluation (1) 5040 (J)	do not penalise any power of ten error (p.o.t.e.) at this stage do not accept an answer without value for g (10) being used) award full marks for correct answer without working	(2) AO2

Question number	Answer	Additional guidance	Mark
6aii	an explanation to include (potential / kinetic) energy is transferred / dissipated (1) to surroundings / water / air / slide (1)	 accept lost / deceases accept friction / air resistance acts accept to **thermal** (store)	(2) AO3

Question number	Answer	Additional guidance	Mark
6b	Explanation linking **two** from: choice of distance (1) 6.3 m (calculations of work done need) the distance moved in the direction of the force (1) (friction acts) along the slope / hypotenuse (1)	 accept pushed up the slope	(2) AO3

Question number	Answer	Additional guidance	Mark
6 (c)	substitution (1) $$KE = \tfrac{1}{2} \times 58\left(\times 10^{-3}\right) \times 28^2$$ conversion (1) uses 58×10^{-3} or 0.058 evaluation (1) 23 (J)	do not penalise p.o.t.e. at this stage award full marks for any answer that rounds to 23 (e.g. 22.736) (J) award max two marks for any answer that rounds to 2.3 to any other power of 10 consolation mark for not squaring 28 (8.1(2) to any p.o.t.) (maximum 1 mark)	**(3)** **AO2**

(Total for Question 6 = 9 marks)

Question number	Answer	Mark
7(a) i	A gained electrons Options B, C and D are incorrect explanations	(1) AO1

Question number	Answer	Additional guidance	Mark
7 (a) ii	A description to include electrons / negative charges **move** (1) down the wire / to earth (1)		(2) AO1

Question number	Answer	Additional guidance	Mark
7 (a) iii	A description including one row from: <table><tr><td>use</td><td>description</td></tr><tr><td>fuelling cars / plane (1)</td><td>charge / voltage could build up causing a spark / fire: (avoided by earthing (the pump) (1)</td></tr><tr><td>(insecticide / paint) sprayers (1)</td><td>earthed object gains (induced) charge(s) to attract paint / insecticide (1)</td></tr><tr><td>kettle / other electrical device (1)</td><td>earthing the outside prevents shock (to user) (1)</td></tr></table>	Other examples are possible in this context also allow to prevent shock	(2) AO1

Question number	Answer	Additional guidance	Mark
7 (b)	drawing lines to include any **two** from		(2) AO1
	any vertical line (in between plates) (1)	judge by eye	
	at least two parallel lines (1)	ignore any curved lines at the ends of the plates	
	any arrow downwards (to show direction) (1)	reject contradicting arrows for this mp	

Question number	Indicative content	Mark
7 (c)*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO2 (strand 2) (6 marks)** 1. rub a strip with the cloth 2. test to see its charge (positive or negative) by rubbing against the coulombmeter 3. place the strip in the holder 4. charge another strip by friction (rubbing) 5. test its charge with the meter 6. bring the second strip up towards the one in the holder; either attracts or repels 7. repeat 1-6 with another charged strip 8. repeat steps 1-3, but then charge an acetate strip, again detecting the sign of its charge, as before 9. bring the charged acetate (+) strip up to the charged polythene (-) strip; the one in the stirrup should now be attracted / move towards the other	(6) AO2

AO targeting: 6 marks AO2 strand 2

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1-2	• The explanation attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3-4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5-6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Summary for guidance

| Level | Mark | Additional Guidance | General additional guidance – the decision within levels

e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level. |
|-------|------|---------------------|-------------------|
| | 0 | No rewardable material. | |
| Level 1 | 1–2 | <u>Additional guidance</u>

A limited explanation with at least two steps of a suitable procedure | <u>Possible candidate responses</u>

rub a strip with the cloth / give it a charge
place the strip in the holder
explains consequent attraction / repulsion |
| Level 2 | 3–4 | <u>Additional guidance</u>

Partially complete explanation of a suitable procedure with at least three steps and some purpose indicated | <u>Possible candidate responses</u>

As above with
bring a second strip up towards the one in the holder
either attracts or repels
repeated with like / unlike charges
use of coulombmeter |
| Level 3 | 5–6 | <u>Additional guidance</u>

Detailed explanation of a suitable procedure with most steps and a clear logic in what is being proposed | <u>Possible candidate responses</u>

As above with
test charge with the meter
to see if it's (+) or (-)
detailed use of acetate / polythene strips with purpose |

Question 7 =13 marks

Question number	Answer	Mark
8(a)	D variable resistor Options A, B and C are all wrong identifications with both the circuit components shown	(1) AO1

Question number	Answer	Mark
8(b)	C ammeter in series with component, voltmeter in parallel Only option C is correct for both the ammeter and the voltmeter	(1) AO1

Question number	Answer	Additional guidance	Mark
8c(i)	A description including as the potential difference (voltage) increases so does the current (1) idea of gradient of graph decreasing as V increases (1)	positive correlation at a decreasing rate non-linear not directly proportional	(2) AO3

Question number	Answer	Additional guidance	Mark
8(c)(ii)	Award one mark for each row of the table <table><tr><td></td><td>voltage V</td><td>current in mA</td></tr><tr><td>point P</td><td>1(.00)</td><td>20</td></tr><tr><td>point Q</td><td>3.4 ±0.1</td><td>43 ±1</td></tr></table>	ignore any units added in the boxes	(2) AO2

Question number	Answer	Additional guidance	Mark
8(c)(iii)	substitution (1)		(2) AO2

| | $(R=) \dfrac{4.5}{51(\times 10^{-3})}$ | 0.088(2) or 8.8(2) or 0.88(2) or 0.09 seen scores 1 mark | |
| | evaluation (1)
88.(2) (Ω) | 0.088(2) kΩ
or 0.09 kΩ scores 2 marks

award full marks for correct answer without working | |

Question number	Answer	Additional guidance	Mark
8(c)(iv)	an explanation linking any three of: identification of resistance increasing (1) heating (of the filament)　(1) because of more collisions (1) of electrons (with ions / atoms / other electrons) (1)	temperature increases	(3) AO1

Question 8 =11 marks

Question number	Answer	Additional guidance	Mark
9(a)	descriptions to include any **two** of • particles / atoms in solid close(r) together (1) • particles / atoms in solid (vibrate) in fixed positions but particles in liquid move (freely) (1) • particles in a solid in regular arrangement but particles in liquid are randomly arranged (1) • particles in a liquid have more (kinetic) energy (than in a solid) (1)	reverse argument difference asked for, so **must compare** for subsequent marking points allow answers in terms of forces between particles	(2) AO1

Question number	Answer	Additional guidance	Mark
9(b)	volume substitution (1) 1.5 x 1.0 x 0.2(0) (= 0.3)		(3) AO2
	substitution in equation (1) mass = 2100 x (0.3(0))	ecf from calculated value of volume for this mark only	
	evaluation (1) = 630 (kg)	award 2 marks for 6.3 x any other power of 10 5670 gains 1 mark from use of 1.5+1.0+0.2=2.7 award full marks for correct answer without working	

Question number	Answer	Additional guidance	Mark
9(c)	statements to include any **two** from		(2) AO1
	use cladding / (extra) insulation (1)		
	use double thicknesses of the concrete (1)	create cavity	
	use silver / reflective / white (paint) (1)		
	plant trees around (wind break) (1)		
	use double glazed windows (1)		
	(properly) close window(s)/door	draft exclusion	

Question number	Indicative content	Mark

9 (d)*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.
	
	The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.
	
	AO1 (strand 2) (6 marks)
	
	Indicative content
	  • measure the length and width of a strip with the ruler / a metre rule
	  • measure the thickness of the strip with a more accurate device e.g. digital callipers OR place 5 (say) of the same strip on top of each other and measure their thickness with the ruler then ÷5 to calculate a single thickness [plus air gap]
	  • measure the mass of a strip with an electronic balance
	  • measure the mass of (say) 5 strips then ÷5 to calculate the mass of one of them
	  • calculate the volume (= l x w x t) in m^3 and the mass in kg
	  • use displacement can/measuring cylinder to find the volume
	  • mass / volume to get density
	  • check if it's near one of the teacher's two values of density given
	  • if it's close / not so far off it's safe to assume that strip is of the identified material
	  • repeat for the other strip
	  • other repeat measurements
		(6)
		AO1

AO targeting: AO1.2

| Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)
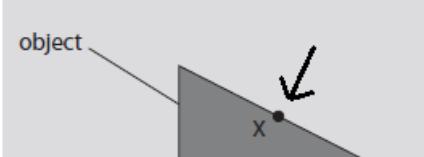
Summary for guidance

Level	Mark	Additional Guidance	General additional guidance – the decision within levels
			e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Partially complete description of a suitable procedure with at least two measurements OR one measurement and another procedural point	Possible candidate responses measure the length measure the width of a strip measure the mass/weight of a strip e.g. repeat measurements
Level 2	3–4	Additional guidance Mostly complete description of a suitable procedure with at least three measurements and some description of processing the results.	Possible candidate responses As above with measure the thickness of the strip calculate the volume (= l x w x t) OR immerse in liquid to get volume
Level 3	5–6	Additional guidance Detailed description of a suitable procedure with all necessary measurements and a clear description of processing the results.	Possible candidate responses As above with extra detail e.g. measure the mass of (say) 5 strips then ÷5 to calculate the mass of one of them detail of obtaining volume by immersion use density =mass /volume check if density value obtained is near one of the teacher's two values

Question 9 =13 marks

Question number	Answer	Additional guidance	Mark
10 ai	recall (1) $$p = \frac{F}{A}$$ substitution (1) $(p) = \frac{2400}{0.8}$ evaluation $(p) = 3000$ (Pa)　　(1)	may be implied by a correct substitution award full marks for the correct answer without working	**(3) AO2**

Question number	Answer	Additional guidance	Mark
10 aii	an explanation linking greater pressure (on bottom of tank) (1) with greater force **due to water** (above bottom of tank) (1)	 more weight of water more depth/height of water ignore simply 'more water' or 'greater amount of water'	**(2) AO1**

Question number	Answer	Additional guidance	Mark
10 aiii	an arrow perpendicular to the sloping side **and** pointing towards X	judge by eye	**(1) AO1**

Question number	Answer	Additional guidance	Mark
10 bi	data points correctly identified (1) 50 ±2 80 ±2 evaluation (1) (-)30 ±4 kPa	award 1 mark if 80 and 50 seen ignore the lack of minus sign allow ecf from incorrect reading of either pressure at 2000m or pressure at 6000m for one mark	**(2)** **AO3**

Question number	Answer	Additional guidance	Mark
10 bii	any **one** suggestion of greater density of atmosphere (1) greater depth of atmosphere (above the aeroplane) (1) greater temperature (of the atmosphere) (1)	accept reverse argument more particles (per cubic metre) the air gets thicker greater weight of the atmosphere	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
10 c	an explanation linking the area (of contact between person and bed) is smaller when standing up (1) same weight (over smaller area) so the pressure is greater when standing up (1)	accept reverse arguments weight is more concentrated / not distributed /not spread across bed (when standing up) uses p = F/A argument (as a consequence of the smaller area, pressure is bigger)	**(2)** **AO2**

Total for question 10 = 11 marks