Mark Scheme (Results)

Summer 2022

Pearson Edexcel GCSE In Physics (1PH0) Paper 2H

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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.

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Question number	Answer	Additional guidance	Mark
1 (a)	at least three **radial** lines from the charge (1) direction shown away from the charge (1)	do not allow curved lines ignore circles without arrows consistently	**(2)** **AO1.2**

Question number	Answer	Additional guidance	Mark
1 (b)	an explanation linking any **two** from charged by **friction** (1) electrons / negative charges rubbed off ruler (1) woolly jumper becomes negative (1)	 electrons / negative charges transfer to jumper ignore positive electrons / charges / particles	**(2)** **AO2.1**

Question number	Answer	Additional guidance	Mark
1 (c)	an explanation including any **three** from: the leaf (becomes) charged (1) opposite to charge on droplets / spray (1) charges on leaf are **induced** (1) opposite charges attract (1) as a result of movement of electrons (between earth and leaf) (1) idea of spray reaching parts of the back of the leaf (1) charged droplets repel each other (having the same charge) (1)	**accept marks scored on diagram** ignore polarity for this marking point states charge opposite to what they have on the leaf ignore positive electrons / charges / particles allow all over	**(3)** **AO1.1**

Total 7 marks

Question number	Answer	Additional guidance	Mark
2 (a)(i)	Substitution and evaluation (1) 15 (Ω)		**(1)** **AO2.1**

Question number	Answer	Additional guidance	Mark
2 (a)(ii)	select / recall (1) (power =) V x I or (power =) I^2 x R or (power =) $\frac{V^2}{R}$ substitution and evaluation (1) (power =) 1.4 (W)	 (power =) 4.5 x 0.3 0.3^2 x 15 $\frac{4.5^2}{15}$ allow 1.3(5) (W) award full marks for the correct answer without working	**(2)** **AO2.1**

Question number	Answer	Additional guidance	Mark
2 (b)	an explanation linking any **three** from: lamp in second circuit is dimmer (than lamp in first circuit) (1) current in second circuit is less (than in first circuit) (1) potential difference / voltage across each lamp (in second circuit is) less / shared (1) idea that power of each lamp (in second circuit) is less / shared (1) the (total) resistance of the second circuit is more (than in first circuit) (1)	accept reverse arguments throughout	**(3)** **AO1.1**

Question number	Answer	Additional guidance	Mark
2 (c)	a diagram of a circuit including **all** of the following: power supply / cell(s) / battery identifiable resistance wire an ammeter a voltmeter (1) plus any **two** from ammeter in series (1) voltmeter in parallel (1) indication of tapping off / using 50cm of resistance wire (1)	accept symbols accept ohmmeter with resistance wire only ignore lamp(s) / additional resistors allow ohmmeter (across wire) instead of ammeter and voltmeter for 1 mark e.g. (crocodile) clips	**(3)** **AO2.2**

Total 9 marks

Question number	Answer	Mark
3 (a)	[x] **B** bigger than in water / less than water A is incorrect because the density of steam is less than water. C is incorrect because the space between the particles increases. D is incorrect because the space between the particles increases and density of steam is less than water.	**(1) AO1.1**

Question number	Answer	Additional guidance	Mark
3 (b)	calculation of change in volume (1) (530 cm^3 – 490 cm^3) = 40 (cm^3) substitution (1) $7.9 = \frac{mass}{40}$ rearrangement and evaluation (1) (mass = 7.9 x 40) (mass =) 316 (g) evaluation to 2 sig fig (1) 320 (g)	measurement mark – using scale allow use of incorrect volume answers without working 316 (g) scores 3 marks 0.316 kg scores 3 marks 316 to any other power of 10 scores 2 marks 4187 or 3871 scores 2 marks (incorrect volume) **any answer** written to 2sf independent mark answers without working 320 scores 4 marks 320 to any other power of ten scores 3 marks 4200 scores 3 marks 3900 scores 3 mark	**(4) AO2.2**

Question number	Answer	Additional guidance	Mark
3 (c)	an explanation linking density of wood less (than that of water) (1) less (volume of) water displaced (than volume of wood) (1)	 allow wood floats / should be submerged allow wood absorbing water allow (idea of) incorrect volume reading allow (idea that) the volume cannot be measured this way	**(2) AO2.2**

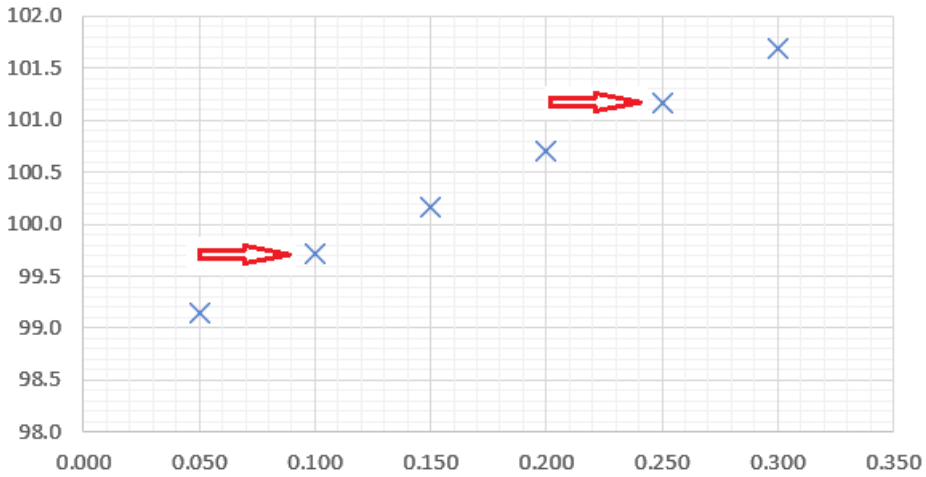
Question number	Answer	Additional guidance	Mark
3 (d)	A description including idea of change of state / solid **changes** (1) to gas / vapour (directly) (1)	 accept equivalents e.g. turns into / goes from to allow reverse i.e. gas → solid may be via appropriate example e.g. ice → water vapour / steam or reverse (2 marks)	**(2) AO1.1**

Total 9 marks

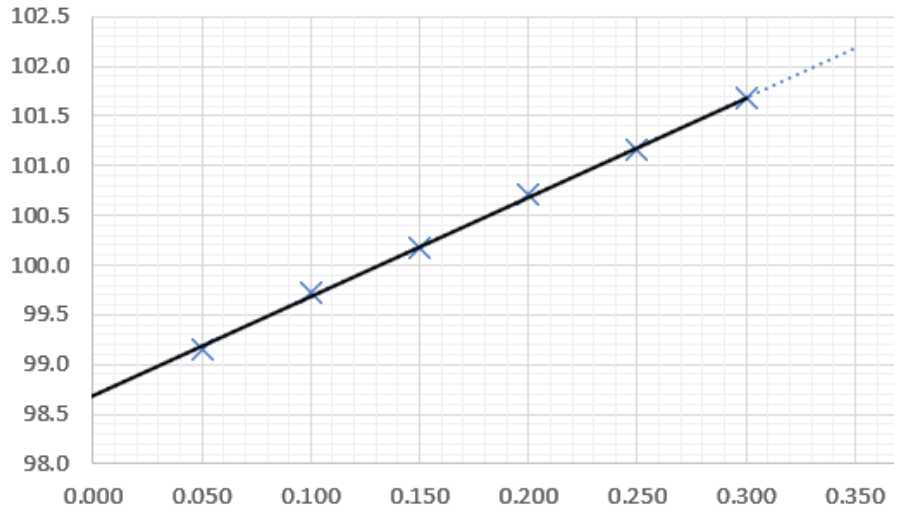
Question number	Answer	Additional guidance	Mark
4 (a) (i)	substitution (1) (pressure =) $\frac{2500}{4 \times 0.022}$ evaluation (1) 28 000 (Pa)	 any number rounding to 28 000 e.g. 28 400, 28 410, 28 409 award full marks for the correct answer without working award **one** mark for numbers that round to 110 000 (Pa) (missing 4 in denominator) award 1 mark for 454 545 (times by 4)	**(2) AO2.1**

Question number	Answer	Additional guidance	Mark
4 (a) (ii)	An explanation linking any **two** from camel is less likely to sink into the soft ground (1) (same) force / weight is distributed / spread out (1) camel's hoof has greater (surface) area (than donkey) (1) camel's hoof exerts less pressure (than it would if hoof were smaller) (1)	ORA for donkey ignore pressure is spread out wider if no other marks scored then allow 1 mark for split in camel hoof enables better grip (as it walks)	**(2) AO3.1**

Question number	Answer	Additional guidance	Mark
4 (b)(i)	points plotted to within ± 1 small square (0.100, 99.7) (1) (0.250, 101.15) (1)		**(2)** **AO2.1**



Question number	Answer	Additional guidance	Mark
4 (b)(ii)	best fit straight line passing through at least four of the points (1)	do not accept tramlining (multiple lines / curves) ignore slight shakiness in drawing	**(1)** **AO2.1**

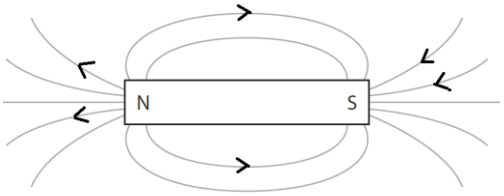


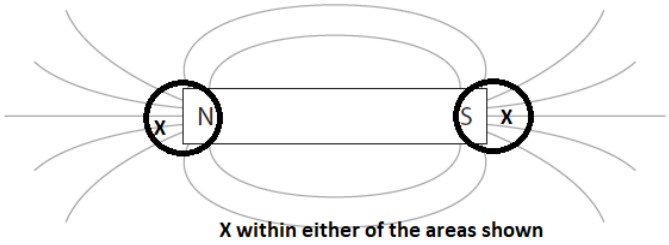
Question number	Answer	Mark
4 (b)(iii)	**D** $y = mx + c$ Figure 10 shows a linear graph with a positive gradient and intercept	**(1)** **AO1.1**

Question number	Answer	Additional guidance	Mark
4 (b)(iv)	answer between 98.6 and 98.8 (kPa)	allow ecf from their line of best fit in b(ii)	**(1)** **AO3.2**

Question number	Answer	Additional guidance	Mark
4 (c)	any two from pressure(s) would be greater (values) (1) steeper gradient of graph (1) both straight lines (1) intercept (on pressure axis) the same (1)	**credit mark points seen on graph** bigger gradient / steeper line (of best fit) both linear pressure at surface is the same	**(2)** **AO3.2**

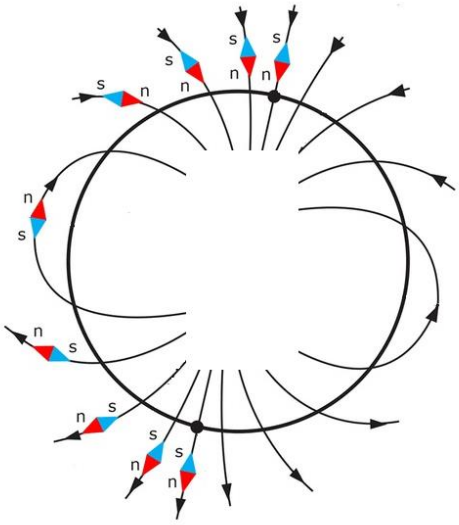
Question 4 11 marks

Question number	Answer	Additional guidance	Mark
5 (a) (i)	consistent arrows showing magnetic field direction(s) (1)  	arrows showing direction out of N, towards and into S minimum of two arrows all arrows shown must be in the correct direction	**(1)** **AO1.2**

Question number	Answer	Additional guidance	Mark
5 (a) (ii)	'X' placed just/immediately to the left of the N pole or just/immediately to the right of S pole (1)  **X within either of the areas shown**	allow on the letters N or S do not allow further inside the magnet	**(1)** **AO1.1**

Question number	Answer	Additional guidance	Mark
5 (a) (iii)	A description to include any **two** from: (in comparison with bar magnet's field shown the uniform field has:) 1. only one direction (1) 2. straight lines (1) 3. parallel lines (1) 4. equidistant lines (1) 5. same strength of field everywhere (1)	(in comparison with uniform field the bar magnet's field lines:) vary in direction curved lines converge / diverge vary in distance(s) apart / gap vary in strength of field if no other mark is awarded, credit any diagram showing a uniform magnetic field for 1 mark	**(2)** **AO3.2**

Question number	Answer	Additional guidance	Mark
5 (b)	(inside) a solenoid / long coil (with a current / power supply) (1)	give credit for diagrams accept: horseshoe magnet (between / using) pair of Magnadur / flat magnets (between / using) Helmholtz coils (between / using) two bar magnets, with unlike poles facing each other	**(1)** **AO1.2**

Question number	Answer	Additional guidance	Mark
5 (c) (i)	Sketch including any **two** from at least two field lines outside the Earth approximately aligning with compasses (1) at least two field lines continue inside the Earth towards imaginary poles (1) all arrows on lines drawn in the correct direction(s) outside the Earth (1) 	 field lines need to have a gap inside the Earth ignore arrows on field lines inside the Earth	**2** **AO3.1**

Question number	Answer	Additional guidance	Mark
5 (c) (ii)	(magnetic outer) **core** (1)	moving charges/ions	**(1)** **AO1.1**

Question number	Answer	Additional guidance	Mark
5(d)	rearrangement and substitution (1) $(B = \frac{F}{I \times l})$ $= \frac{1.11 \times 10^{-5}}{93(.1 \times 10^{-3}) \times 0.6(000)}$ evaluation (1) 2.0×10^{-4} (T)	0.0002 (T) accept any number that rounds to 2.0×10^{-4} (T) e.g. 1.989×10^{-4} (T) any number that rounds to 2.0×10^{-7} (T) e.g. 1.987×10^{-7} (T) is awarded 1 mark only award full marks for the correct answer without working	**(2)** **AO2.1**

Total 10 marks

Question number	Answer	Mark
6 (a)	☒ **A** acceleration This is the only vector quantity from the options given	**(1)** **AO1.1**

Question number	Answer	Additional guidance	Mark
6(b) (i)	substitution and rearrangement (1) (force = $\frac{\text{moment}}{\text{distance}}$) = $\frac{0.6}{3(\times 10^{-1})}$ evaluation (1) 2(.0) (N)	 reject 0.6 x 3 = 1.8 award full marks for the correct answer without working ignore significant figures 2(.0) to any other power of ten scores 1 mark maximum	**(2)** **AO2.1**

Question number	Answer	Additional guidance	Mark
6(b) (ii)	 correct calculation of one moment (1) correct calculation of second moment and adding of moments seen (1)	**show that** question either 2x0.1 or 1x0.5 seen 2(.0)x0.1(0) + 1(.0)x0.5 scores 2 marks 0.2+0.5 scores 2 marks accept calculations in alternative units (e.g. N cm) if correct conversion(s) seen if no other marks scored, the addition of two other moments can score 1 mark maximum	**(2)** **AO2.1**

Question number	Answer	Additional guidance	Mark
6 (b) (iii)	explanation linking **three** from: **{sum** of / **total }** clockwise moments = **{sum** of / **total }** anticlockwise moments (1) for a system in equilibrium / balance (1) clockwise and anticlockwise moments compared (1) **so** rod not in equilibrium (1)	 about the same point / about a point e.g. clockwise moment > anticlockwise moment or reverse argument 0.7 > 0.6 0.7 ≠ 0.6 rod will **rotate clockwise** MP4 can only be scored if MP3 awarded	**(3)** **AO3.2**

Question number	Answer	Additional guidance	Mark
6(c)	counting teeth on the pinion (1) evaluation (1) 1.6 (m)	allow between 18 and 22 inclusive 20 x 0.08 ecf number of teeth answer in range 1.44 to 1.76 scores 2 marks award full marks for the correct answer without working power of 10 error scores 1 mark maximum	**(2)** **AO3.1**

Total 10 marks

Question number	Answer	Additional guidance	Mark
7(a) (i)	select and substitute (1) (ΔGPE = m x g x Δh) = 1100 x 3.7 x 1.8 (x 10^3) evaluation (1) 7 326 000 (J) evaluation to 2 s.f. (1) 7 300 000 (J)	 any number rounding to 7 300 000 7326 scores 1 mark **independent mark -** any final answer stated to 2 s.f.	**(3) AO2.1**

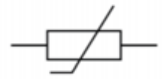
Question number	Answer	Additional guidance	Mark
7(a) (ii)	select and substitute (1) (ΔKE = ½ m x v^2) = ½ 1100 x 88^2 evaluation (1) 4 300 000 (J)	ignore minus signs accept numbers that round to 4 300 000 (J) e.g. 4 259 200 (J) award full marks for the correct answer without working	**(2) AO2.1**

Question number	Answer	Additional guidance	Mark
7 (a) iii	A description linking **three** from: 1. work is done against / by gravity (1) 2. **idea of** work done by the thrusters / jets (on the rover) (1) 3. (work done) by air/atmospheric resistance on the parachute (and rover) (1) 4. this reduces the kinetic energy (store) (1) 5. (there is a) decrease in the gravitational potential energy (store) of the rover (1) 6. (there is a) transfer of chemical energy from the thrusters (1) 7. energy transferred to thermal energy (store) (1) 8. (transfer) mechanically (to the thermal store) (1)	**KEY: attempt to explain <u>how work done</u> contributes towards the energy changes / conservation of energy** if no other mark scored allow one mark for work = force x distance	**(3) AO2.1**

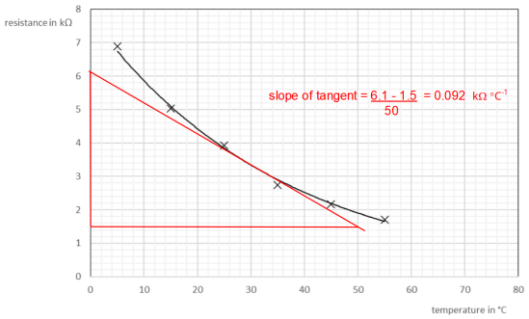
Question number	Answer	Additional guidance	Mark
7(b) (i)	select and substitute (1) (E = P x t) = 1200 x 30 x 60 (in J)	all three numbers needed to **show that** allow 1800 (seconds) for 30x60 ignore evaluation	**(1) AO1.1**

Question number	Answer	Additional guidance	Mark
7(b) (ii)	select, rearrange and substitute (1) (input energy supplied = energy provided by panel / efficiency) = 2.16 (MJ) / (0.)27 evaluation (1) 8(.0) x 10^6 (J)	 2 160 000 / (0.)27 8 000 000 (J) 8(.0) MJ award full marks for the correct answer without working 8(.0) x 10^4 (J) gains 1 mark (uses 27% incorrectly)	**(2) AO2.1**

TOTAL 11 marks

Question number	Answer	Mark
8 (a)	☒ C  Only this is the correct symbol for a thermistor	**(1)** **AO1.1**

Question number	Answer	Additional guidance	Mark
8 (b) (i)	A description to include as temperature increases resistance decreases (1) non-linear / decreasing gradient (1)	 ORA allow exponential / inversely proportional in this context curve gets less steep as temperature increases ignore negative correlation unqualified quoted values are insufficient	**(2)** **AO3.1**

Question number	Answer	Additional guidance	Mark
8(b) (ii)	uses a right-angled triangle to calculate slope with a line of grazing incidence at θ = 30° C (1)  evaluation (1) (-) 0.092 (kΩ / °C) unit (1) kΩ / °C or kΩ °C^{-1}	tangent seen and used, drawn between θ = 25 and 35 °C accept for 2 marks either between 0.087 and 0.097 (kΩ / °C) or between 87 and 97 (Ω / °C) kohm/K or kohm K^{-1}	**(3)** **AO3.2**

Question number	Answer	Additional guidance	Mark
8 (c) (i)	explanation linking a suitable improvement (1) with a matching reason (1)	for example place thermometer close(r) to the thermistor stirring digital thermometer thermometer measures same temperature as thermistor to get uniform temperature (for stirring) thermometer with better resolution or scale	**(2)** **AO3.3**

Question number	Answer	Additional guidance	Mark
8 (c) (ii)	an explanation including: method 2 has measurements to more significant figures / more decimal places (than method 1) (1) so the calculated answer can have more s.f.'s / d.p.'s (1)	 may be shown via a calculation accept an alternative argument in terms of consistency in final calculated answer ignore restating stem of question – e.g. so more precise ignore more accurate	**(2)** **AO3.2**

TOTAL 10 marks

Question number	Answer	Additional guidance	Mark
9(a)	an explanation linking specific heat capacity concerns change in temperature (1) whereas specific latent heat concerns change of state (1)	 accept specific heat capacity concerns heating <u>up</u> / cooling accept any named change of state e.g. melting / freezing / evaporating /boiling accept specific latent heat related to no change in temperature	**(2)** **AO1.1**

Question number	Answer	Additional guidance	Mark
9 (b)	an explanation linking any **three** from: stir the water before taking a reading of temperature (1) (continue to) observe temperature**s** after switching off (1) record the maximum / highest / peak temperature reached (1) take temperature reading at eye level (1) conduction (and convection) take time (1)	 allow "for **longer** than 10 minutes" allow wait(ing period) in correct context until the temperature stops changing takes time (for water / thermometer) to heat through	**(3)** **AO1.2**

SSQ NO:	CS NO:	Answer	Mark
9(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. **AO1 strand 1 (6 marks)** • particles move faster (at a higher temperature) • greater velocity / speed means greater kinetic energy • since KE = ½ m v^2 • heating increases KE (store) • KE (store) increase leads to higher (average) speeds • faster particles (at higher temperature so) hit container with more force / momentum exchange • bigger pressure because p = F / A • particles hit container more frequently (at higher temperature) • so **more** force exerted on (walls of) container	**(6)** **AO1.1**

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation 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 Eg - 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 isolated idea(s) of physics e.g. recognising the speed-temperature relationship or the pressure temperature relationship	Possible candidate responses particles faster (at higher temperature) KE increases pressure increases (at a higher temperature)
Level 2	3–4	Additional guidance limited details about KE **or** limited details about pressure **or** linked ideas about kinetic energy and pressure	Possible candidate responses faster particles have greater kinetic energy (store) (particles) hitting container more often causes greater pressure faster particles cause greater force bigger pressure because force increased
Level 3	5–6	Additional guidance understanding is detailed and fully developed. includes detail about **both** kinetic energy **and** force involvement in pressure, but one aspect may be covered in greater detail than the other one	Possible candidate responses greater speed means greater kinetic energy since KE = ½ m v^2 **AND** bigger pressure because more frequent collisions causes an increase in force greater speed means greater kinetic energy **AND** bigger pressure because p = F / A and (total) force increased because of hitting container walls with bigger momentum (changes)

Total 11 marks

Question number	Answer	Additional guidance	Mark
10 (a)	an explanation linking **three** from: needle oscillates (1) either side of (centre) zero (1) (in response to) pole entering and pole leaving (end of coil) (1) (producing) {p.d. / voltage / emf} <u>induced</u> (via changing magnetic field) (1) (producing) an <u>alternating</u> current (1)	 needle vibrates / moves side to side positive and negative accept N / north / S / south for pole do not accept magnet accept current produced / induced accept (induce) an <u>alternating</u> emf / voltage	**(3) AO1.2**

Question number	Answer	Additional guidance	Mark
10(b)	selecting, rearranging and substituting (1) $(V_s = \frac{N_s}{N_p} \times V_p)$ $= \frac{400}{700} \times 230$ selecting, rearranging and substituting (1) $(I_p = \frac{V_s}{V_p} \times I_s)$ $= \frac{131(.429)}{230} \times 1.75$ evaluation (1) 1(.00) (A)	accept correct alternative calculation routes 1 mark for any voltage rounding to 130 V $\frac{130 \times 1.75}{230}$ 0.989 (A) using 130 award full marks for the correct answer without working	**(3) AO2.1**

SSQ NO:	CS NO:	Answer	Mark
10(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. **AO1 strand 1 (6 marks)** • Q is a step-up transformer • step up V causes I to be lower • voltage increases (25 kV to 400 kV) • R is a transmission line / (national) grid /cable • smaller currents in transmission lines • less energy lost though heating those wires • V = I x R • smaller voltage drop across the transmission line • S is a step-down transformer reducing voltage to 230V • ready for use in homes T • detail of transformers – iron core + coils • transformers are not 100% efficient • idea of power as V x I or P = I^2 R	**(6)** **AO1.1**

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which may be inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation 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 Eg - 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 isolated ideas e.g. identifying two of Q, S and R	Possible candidate responses Q and S are transformers R is a wire / cable
Level 2	3–4	Additional guidance more detail about the process of what at least two of Q, R and S do / achieve	Possible candidate responses Q is a step-up transformer - voltage increases R is a high voltage transmission line / cable / part of the National Grid S is a step-down transformer → idea of reducing voltage to 230V
Level 3	5–6	Additional guidance understanding is detailed and fully developed. includes detail about functions and efficiency explanation	Possible candidate responses need for step up and step-down functions via transformers to transfer energy at high voltages (voltage may be specified e.g. 400kV) transformers are not 100% efficient smaller currents in transmission lines so less energy lost though heating those wires: makes system more efficient

Total 12 marks