



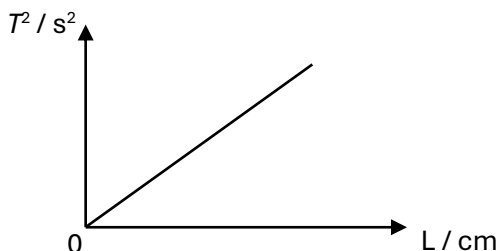
BEATTY SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2026
SECONDARY FOUR EXPRESS / G3
Pure Physics 6091
Mark Scheme Paper 3

Section A

1	(b)	$T_H = 83.5\text{ }^{\circ}\text{C}$			[1]	MMO Accept: $65.0\text{ }^{\circ}\text{C} \leq T_H \leq 100.0\text{ }^{\circ}\text{C}$ Reject: precision error eg. $80\text{ }^{\circ}\text{C}$
	(c)		beaker with 200 cm^3 of water	beaker with 100 cm^3 of water	[1]	PDO Range: t starts at 0 with 30 s intervals
		t / s	$T / ^{\circ}\text{C}$	$T / ^{\circ}\text{C}$	[1]	Trend: column shows decrease in T with time
		0	83.5	80.5		
		30	82.0	78.5		
		60	80.5	76.5		
		90	79.5	75.0		
		120	78.5	73.0		
		150	77.0	71.5		
		180	75.5	70.0		
	(d)				[1]	MMO Trend: change in temperature in 2 nd column (100 cm^3 water) is greater than in 1 st column (200 cm^3 water).
	(e)	A smaller volume of water has a greater rate of cooling. Average drop in temperature in the 1 st column is $8.0\text{ }^{\circ}\text{C}$ whereas it is $10.5\text{ }^{\circ}\text{C}$ in the 2 nd column.			[1]	ACE
	(f)				[1]	ACE Accuracy: r_1 reported to 2 s.f. Unit: correctly shown
	(i)	$r_1 = (80.5 - 75.0) / 90$ $= 0.061\text{ }^{\circ}\text{C/s}$			[1]	
	(f)				[1]	MMO Accuracy: r_2 reported is less than r_1
	(ii)	$r_2 = (75.0 - 70.0) / 90$ $= 0.056\text{ }^{\circ}\text{C/s}$			[1]	

	(g)	Both volumes of water need not have the same starting temperatures, but similar initial temperatures. From (f) , any volume of water will undergo a decrease in the rate of cooling with time. If the initial temperatures are far apart, the rate of cooling is no longer affected by volume of water only.	[1] [1]	ACE Need to recognise that the variable cooling rate makes it challenging to conduct a fair test as the cooling rate is affected by both the volume of water and the temperature at which the water is initially relative to ambient temperature.
--	------------	--	------------------------------	--

2	(a) (i)	Use the half-metre rule to measure 20.0 cm from one end of the wire and bend it at the mark. Measure the remaining length of the wire and divide it into two halves, bending the wire at the middle. Form the triangle, ensuring that $L = 20.0$ cm.	[1]	MMO Instrument used must be identified. Procedure should be sensible.
	(a) (ii)	$L = 20.2$ cm	[1]	MMO Accept: $19.5 \text{ cm} \leq L \leq 20.5 \text{ cm}$
	(a) (v)	$T = (16.4 + 16.8) / 20$ $= 0.8 \text{ s}$	[1]	MMO Accept: $0.7 \text{ s} \leq T \leq 0.9 \text{ s}$
	(a) (vi)	$T^2 = 0.7 \text{ s}^2$	[1]	ACE Accuracy: adhere to the same precision as raw data Unit: correctly shown
	(b)	Independent variable: length of wire, L Dependent variable: square of period, T^2 Constants: material of wire, mass of blu-tack, angle of release, shape of triangle, number of oscillations. <u>Steps</u> 1. Use a half-metre rule to measure $L = 20.0$ cm from one end of a wire and bend it at the mark. 2. Measure the remaining length of the wire and bend it at the middle to form a triangle with roughly three equal sides. Ensure that $L = 20.0$ cm. 3. Use the blu-tack provided to ensure that the two ends of the wire are together to form a triangle. 4. Set up the apparatus as shown on Fig. 2.2. 5. Gently displace the wire and measure the time taken for 20	[1] [1]	Planning At least two constants correctly indicated. Steps should clearly indicate how L is obtained and that the three sides are equal in length.

	oscillations. Obtain the period T by dividing the time taken by 20. 6. Square the period T to obtain T^2. 7. By using other wires of identical material but of different lengths, repeat steps 1 to 6 for five other values of L. 8. Record the values of L, T, and T^2 into a table as shown. <table><tr><th>L / cm</th><th>T / s</th><th>T^2 / s^2</th></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table> 9. Plot a graph of T^2 / s^2 against L / cm. 10. The expected graph should be a straight line with a positive gradient that begins at the origin as shown. 	L / cm	T / s	T^2 / s^2																			[1] The plan should make explicit how other wires of identical material are used to obtain other values of length L (independent variable). [1] Table is shown with headers divided by appropriate units. Independent variable (L) on the leftmost column. [1] Statement must be in the form of independent variable against dependent variable. [1] Graph sketched shows the vertical and horizontal axes clearly and correctly labelled. Graph must be shown to be directly proportional.
L / cm	T / s	T^2 / s^2																					

3	(a) (i)	$V = 4.65 \text{ V}$	[1]	MMO Accept: $4.50 \text{ V} \leq V \leq 4.80 \text{ V}$ Reject: precision error
	(a) (ii)	Using the measuring cylinder, measure 100 cm^3 of deionised water, and pour the water into the beaker. Repeat three more times, until the total volume in the beaker is 400 cm^3 .	[1]	MMO Description must indicate use of measuring cylinder, which must be repeated.
	(b) (i)	$C = 1.0 / 400$ $= 2.5 \times 10^{-3} \text{ g/cm}^3$	[1]	ACE Working must be shown Accuracy: 2 s.f. Unit: correctly shown
	(b) (ii)	$I = 0.07 \text{ A}$	[1]	MMO Reject: precision error
	(b) (iii)	$R = 4.65 / 0.07$ $= 66 \Omega$	[1]	ACE Accuracy: 2 s.f. Unit: correctly shown

	(b) (iv)	E.m.f. of the dry cells will decrease if the switch is left closed, reducing the accuracy of the resistance R over time. OR Electrolysis of the salt solution will happen that will affect the concentration C of the salt solution.	[1]	ACE Accept any other sensible responses.																								
	(b) (v)	Ensure that the needle and the reflection of the needle are aligned when reading the values on the ammeter to avoid parallax error. OR Ensure that all the salt is fully dissolved before taking the ammeter reading. OR Ensure that the two wires coiled around the two wooden rods do not touch each other.	[1]	ACE Accept any other sensible responses.																								
	(c)	<table><tr><th>$C \times 10^{-3} / \text{g/dm}^3$</th><th>I / A</th><th>R / Ω</th></tr><tr><td>2.5</td><td>0.07</td><td>66</td></tr><tr><td>5.0</td><td>0.10</td><td>47</td></tr><tr><td>7.5</td><td>0.13</td><td>36</td></tr><tr><td>10</td><td>0.14</td><td>33</td></tr><tr><td>13</td><td>0.16</td><td>29</td></tr><tr><td>15</td><td>0.17</td><td>27</td></tr><tr><td>18</td><td>0.18</td><td>26</td></tr></table>	$C \times 10^{-3} / \text{g/dm}^3$	I / A	R / Ω	2.5	0.07	66	5.0	0.10	47	7.5	0.13	36	10	0.14	33	13	0.16	29	15	0.17	27	18	0.18	26	[1] [1] [1] [1]	PDO Precision: 2 s.f. in C, I and R Range: must have 7 data points Calculation: all values of R correctly calculated Trend: R decreases as C increases
$C \times 10^{-3} / \text{g/dm}^3$	I / A	R / Ω																										
2.5	0.07	66																										
5.0	0.10	47																										
7.5	0.13	36																										
10	0.14	33																										
13	0.16	29																										
15	0.17	27																										
18	0.18	26																										
	(d)	Refer to graph drawn on the grid.	[1] [1] [1] [1]	PDO Axes: Vertical axis labelled R / Ω Horizontal axis labelled $C \times 10^{-3} / \text{g/cm}^3$ Scale: Scale must not be odd, resulting in a graph that is at least 50% of the grid vertically and horizontally Line of best fit: Line drawn must clearly be a best fit line that is a smooth curve. Plotting of points: All 8 points are correctly plotted																								

	(e) (i)	$G = (23.5 - 43.5) / (0.015 - 0.0036)$ $= - 1800$	[1] PDO Tangent is drawn accurately at $C = 0.010 \text{ g/cm}^3$ and is at least 4 large squares in size. [1] Gradient is unitless, negative and rounded off to 2 s.f.
	(e) (ii)	As concentration of the salt increases, the decrease in resistance of the solution decreases. Since ions are already present to conduct current in the solution, any addition of ions does not proportionally increase the solution's conductivity.	[1] ACE Answer needs to demonstrate that there is diminishing increase in conductivity with more salt added to solution.
	(f)	Using a small measuring cylinder to repeatedly obtain up to the required volume of 400 cm^3 of deionised water is inaccurate as it leaves behind droplets that cling to the sides of the measuring cylinder with every transfer of water into the beaker, thus the volume of water is likely to be less than 400 cm^3. A measuring cylinder with a larger capacity should have been used to obtain a more accurate value of R. OR It is difficult to establish that all the salt has fully dissolved after stirring. This may cause the concentration C to be lower than calculated, resulting in an inaccurate value of R. Instead of adding solid salt incrementally into the beaker, use salt solutions of known concentrations to ensure that the salt solution is accurate. OR Each time the switch is closed, electrolysis occurs, thus affecting the concentration of the salt solution C. To overcome this, a fresh sample of salt solution and wires that are coiled around the wooden rods should be used instead of reusing the same beaker of salt solution.	ACE [1] The source of error should be significant and clearly identified. [1] Improvement proposed should directly address the source of error highlighted. Accept any other sensible responses.

