



# Mark Scheme (Results)

October 2022

Pearson Edexcel International Advanced  
Level in Physics (WPH16)  
Paper 01 Practical Skills in Physics II

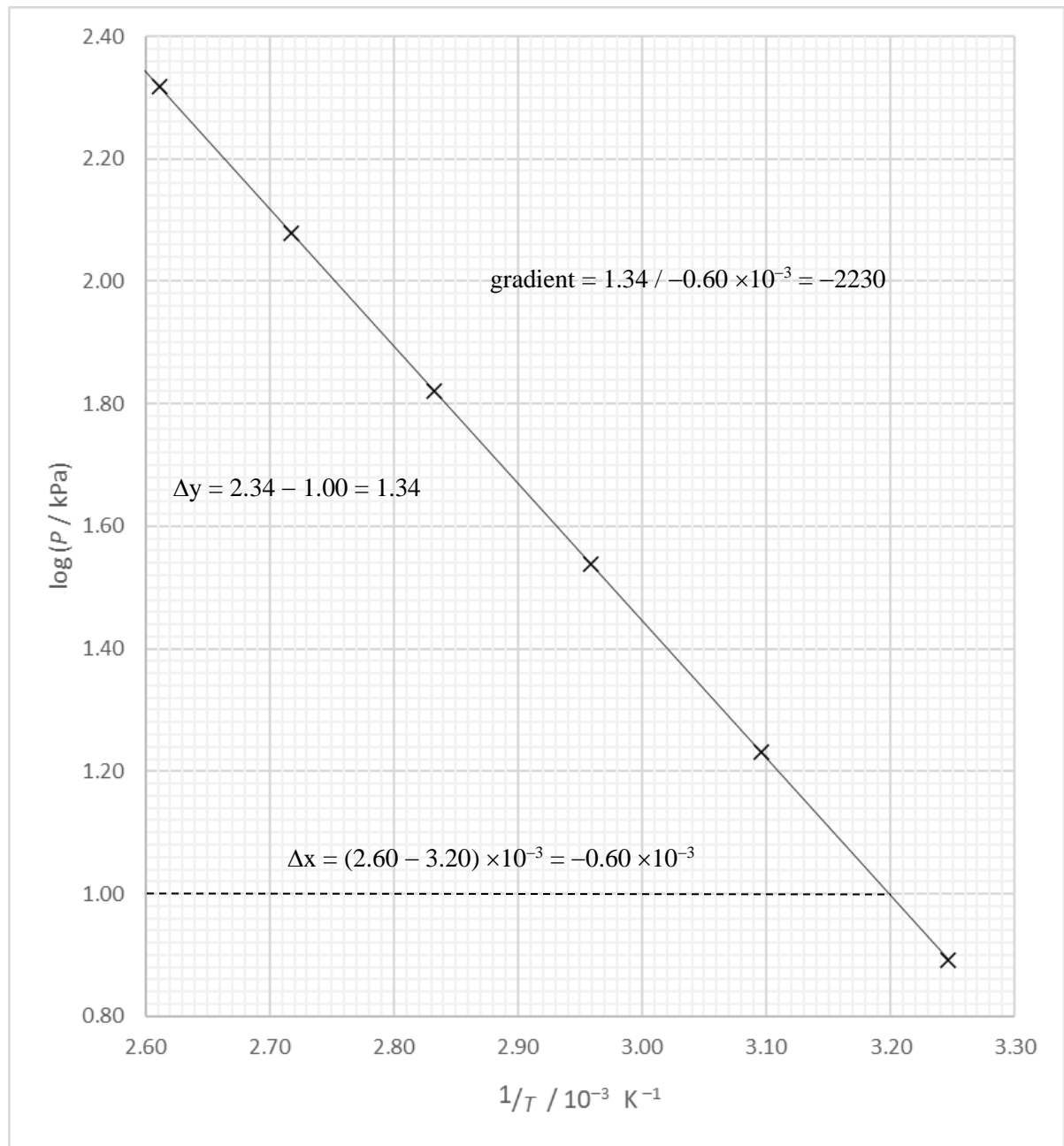
Question Number	Answer	Mark
1(a)	<p><b>Any PAIR from:</b></p> <p>There could be a short circuit (across the power supply) (1)</p> <p>Use insulated wire (1)</p> <p><b>Or</b></p> <p>There is a risk of electrocution (from coil A) [Accept electric shock] (1)</p> <p>Use a low p.d. (1)</p> <p><b>Or</b></p> <p>There is a risk of the wire overheating (if current is too high) (1)</p> <p>Use a low p.d.</p> <p><b>Or</b></p> <p>Use a (limiting) resistor (1)</p>	2
1(b)	<p>Resolution of Vernier calipers is higher (than the metre ruler)</p> <p><b>Or</b></p> <p>Resolution of Vernier calipers is 0.1 mm <b>and</b> resolution of metre rule is 1 mm (1)</p> <p>Use of half resolution to calculate %U <b>Or</b> U in Vernier calipers <b>and</b> ruler (1)</p> <p>Valid comparison of %U <b>Or</b> U (1)</p> <p>MP3 dependent on MP1 or MP2 [Accept converse]</p> <p><u>Example of calculation</u></p> <p>%U for Vernier calipers = <math>0.005/2 \times 100 = 0.25\%</math></p> <p>%U for metre rule = <math>0.05/2 \times 100 = 2.5\%</math></p>	3
1(c)	<p>Measure the amplitude of the trace in divisions</p> <p><b>Or</b></p> <p>Measure the number of divisions between maximum and minimum <b>and</b> divide by two (1)</p> <p>Multiply by 100 mV (per division) (1)</p> <p>Repeat (the amplitude measurement) and calculate a mean (1)</p>	3
1(d)	<p>Any <b>TWO</b> from</p> <p>Inconsistent significant figures <b>Or</b> decimal places (for <math>E</math>) (1)</p> <p>Values of <math>r</math> not given to correct number of decimal places (1)</p> <p>Units of <math>E</math> are incorrect (1)</p> <p>No repeats are shown</p> <p><b>Or</b></p> <p>Not enough readings shown (1)</p>	2

	<b>Total for question 1</b>	<b>10</b>
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Question Number	Answer	Mark
2(a)	<p><b>Any PAIR from:</b> (1)</p> <p><math>\ln V = \ln V_0 - bt</math> (1)</p> <p>Is in the form <math>y = c + mx</math> <b>and</b> the <u>gradient</u> is <math>-b</math> which is constant</p> <p><b>Or</b></p> <p><math>\ln V = -bt + \ln V_0</math></p> <p>Is in the form <math>y = mx + c</math> <b>and</b> the <u>gradient</u> is <math>-b</math> which is constant</p> <p>MP2 dependent on MP1, allow reference to straight line</p>	2
2(b)	<p>Open the tap and start recording time (simultaneously) (1)</p> <p>Record volumes at successive time intervals</p> <p><b>Or</b></p> <p>Record the time taken to fall to specific volumes (1)</p> <p>Read to the bottom of the meniscus (1)</p> <p>Any <b>ONE</b> from:</p> <p>Ensure transparent tube is vertical (1)</p> <p>Use a stopwatch <b>Or</b> lap timer to measure <math>t</math> (1)</p> <p>Keep stopwatch close to the tube (1)</p> <p>Refill to same initial volume <b>and</b> repeat to take a mean (1)</p> <p>Record many measurements of <math>V</math> and <math>t</math> (1)</p> <p>Open the tap to same position each time (1)</p>	4
2(c)	<p><b>Any PAIR from</b></p> <p>It may be difficult to measure <math>V</math> and <math>t</math> simultaneously (1)</p> <p>which will affect <u>random</u> error (1)</p> <p><b>Or</b></p> <p>There is liquid below the scale (1)</p> <p>which will introduce <u>systematic</u> error (1)</p> <p><b>Or</b></p> <p>Air may be trapped in the tap (1)</p> <p>which will affect <u>random</u> error (1)</p> <p>MP2 dependent on MP1</p>	2
	<b>Total for question 2</b>	<b>8</b>

Question Number	Answer	Mark
3(a)(i)	<p>Values of <math>\log P</math> correct to 2 d.p. (1)</p> <p>Values of <math>\frac{1}{T}</math> correct to 5 d.p. (1)</p> <p><b>Or</b></p> <p>Values of <math>\frac{1}{T}</math> correct to 2 d.p. if written in standard form (1)</p> <p>Axes labelled: <math>y</math> as <math>\log (P / \text{kPa})</math> and <math>x</math> as <math>\frac{1}{T} / \text{K}^{-1}</math> (1)</p> <p>Most appropriate scales chosen (1)</p> <p>Values plotted accurately (1)</p> <p>Best fit line drawn (1)</p>	6
3(a)(ii)	<p>Calculation of gradient using large triangle shown (1)</p> <p>Gradient = <math>(- ) 2.2 \times 10^3</math> (1)</p> <p>Gradient given to 2 or 3 s.f. <b>and</b> negative (1)</p> <p><u>Example of calculation</u></p> <p>gradient = <math>(2.34 - 1.00) / (2.60 - 3.20) \times 10^{-3} = 0.34 / -0.60 \times 10^{-3}</math></p> <p>= - 2230</p>	3
3(a)(iii)	<p>Use of gradient = <math>(- ) \frac{X}{2.30k}</math> (1)</p> <p>Correct value of <math>X</math> [e.c.f. (a)(ii)] (1)</p> <p><math>X</math> given to 2 or 3 s.f. (1)</p> <p><u>Example of calculation</u></p> <p><math>X = \text{gradient} \times (-2.30k) = -2230 \times (-2.30 \times 1.38 \times 10^{-23} \text{ J K}^{-1})</math></p> <p>= <math>7.08 \times 10^{-20} \text{ (J)}</math></p>	3
3(b)	<p>Value of <math>\frac{1}{T}</math> interpolated from graph (1)</p> <p>Correct <math>T</math> calculated (1)</p> <p>Conversion of <math>T</math> to <math>^{\circ}\text{C}</math>, given to 2 or 3 s.f. (1)</p> <p><u>Example of calculation</u></p> <p>(<math>\log P = \log (100) = 2</math>)</p> <p><math>\frac{1}{T} = 2.75 \times 10^{-3} \text{ K}^{-1}</math></p> <p><math>T = 1 / 2.75 \times 10^{-3} = 364 \text{ K}</math></p> <p>boiling point = <math>364 - 273 = 91 (^{\circ}\text{C})</math></p>	3
Total for question 3		15

$P / \text{kPa}$	$T / \text{K}$	$\frac{1}{T} / \text{K}^{-1}$	$\log (P / \text{kPa})$
7.8	308	0.00325	0.89
17.0	323	0.00310	1.23
34.6	338	0.00296	1.54
66.1	353	0.00283	1.82
120.1	368	0.00272	2.08
208.1	383	0.00261	2.32



Question Number	Answer	Mark
4(a)(i)	<p><b>Either</b></p> <p>Repeat at different orientations (along the wire) <b>and</b> calculate a mean (1)</p> <p>To reduce the effect of <u>random</u> errors (1)</p> <p><b>Or</b></p> <p>Check <b>and</b> correct for zero error (on micrometer screw gauge) (1)</p> <p>To eliminate <u>systematic</u> error (1)</p> <p>MP2 dependent on MP1</p> <p>[Allow MP2 if MP1 partially correct]</p>	2
4(a)(ii)	<p>Mean <math>d = 0.31</math> (mm) (1)</p> <p>Calculation using half range shown</p> <p><b>Or</b></p> <p>Calculation of furthest from mean shown (1)</p> <p>Uncertainty in <math>d = 0.02</math> (mm)    Decimal places consistent with the calculated mean (1)</p> <p>MP3 dependent on MP2</p> <p><u>Example of calculation</u></p> <p>Mean <math>d = (0.31 + 0.32 + 0.31 + 0.33 + 0.30) / 5 = 1.57 / 5</math>  <math>= 0.314 = 0.31</math> (mm)</p> <p>Uncertainty <math>= (0.33 - 0.30) / 2 = 0.03 / 2 = 0.015 = 0.02</math> (mm)</p>	3
4(b)(i)	<p>Use of <math>A = \pi d^2 / 4</math> <b>and</b> <math>R = V / I</math> (1)</p> <p>Use of <math>R = \rho L / A</math> (1)</p> <p><math>\rho = 4.6 \times 10^{-7}</math> (<math>\Omega</math> m) (1)</p> <p><u>Example of calculation</u></p> <p><math>A = \pi \times (0.22 \times 10^{-3} \text{ m})^2 / 4 = 3.80 \times 10^{-8} \text{ m}^2</math></p> <p><math>R = V / I = 4.990 \text{ V} / 0.4570 \text{ A} = 10.9 \Omega</math></p> <p><math>\rho = RA / L = 10.9 \Omega \times 3.80 \times 10^{-8} \text{ m}^2 / 0.894 \text{ m} = 4.6 \times 10^{-7} (\Omega \text{ m})</math></p>	3

<b>4(b)(ii)</b>	<p>Use of <math>2 \times \%U</math> in <math>d</math> shown [Accept <math>2 \times \Delta d/d</math> if converted to <math>\%U</math>] (1)</p> <p>Addition of <math>\%U</math> for all variables shown (1)</p> <p><math>\%U = 9.4 (\%)</math> [Accept answers that round to 9%] (1)</p> <p><u>Example of calculation</u></p> <p><math>\%U</math> in <math>d = (0.01 / 0.22) \times 100 = 4.55 \%</math></p> <p><math>\%U</math> in <math>V = (0.005 / 4.990) \times 100 = 0.10 \%</math></p> <p><math>\%U</math> in <math>L = (0.1 / 89.4) \times 100 = 0.11 \%</math></p> <p><math>\%U</math> in <math>I = (0.0005 / 0.4570) \times 100 = 0.11 \%</math></p> <p><math>\%U</math> in <math>\rho = (2 \times 4.55) + 0.10 + 0.11 + 0.11 = 9.42 = 9.4\%</math></p> <p><b>Or</b></p> <p>Use of uncertainties to calculate maximum <math>\rho</math></p> <p><b>Or</b> (1)</p> <p>Use of uncertainties to calculate minimum <math>\rho</math> (1)</p> <p>Calculation of uncertainty in <math>\rho</math> using maximum and minimum <math>\rho</math> (1)</p> <p><math>\%U = 9.3 (\%)</math> [Accept answers that round to 9%] (1)</p> <p><u>Example of calculation</u></p> <p><math>A_{\max} = \pi \times (0.23 \times 10^{-3} \text{ m})^2 / 4 = 4.15 \times 10^{-8} \text{ m}^2</math></p> <p><math>A_{\min} = \pi \times (0.21 \times 10^{-3} \text{ m})^2 / 4 = 3.16 \times 10^{-8} \text{ m}^2</math></p> <p><math>R_{\max} = V_{\max} / I_{\min} = 4.995 \text{ V} / 0.4565 \text{ A} = 10.9 \Omega</math></p> <p><math>R_{\min} = V_{\min} / I_{\max} = 4.985 \text{ V} / 0.4575 \text{ A} = 10.9 \Omega</math></p> <p><math>\rho_{\max} = R_{\max} A_{\max} / L_{\min} = 10.9 \Omega \times 4.15 \times 10^{-8} \text{ m}^2 / 0.893 \text{ m}</math>  <math>= 5.07 \times 10^{-7} (\Omega \text{ m})</math></p> <p><math>\rho_{\min} = R_{\min} A_{\min} / L_{\max} = 10.9 \Omega \times 3.46 \times 10^{-8} \text{ m}^2 / 0.895 \text{ m}</math>  <math>= 4.21 \times 10^{-7} (\Omega \text{ m})</math></p> <p><math>U</math> in <math>\rho = (5.07 \times 10^{-7} - 4.21 \times 10^{-7}) / 2 = 0.43 \times 10^{-7} (\Omega \text{ m})</math></p> <p><math>\%U</math> in <math>\rho = 0.43 \times 10^{-7} / 4.6 \times 10^{-7} \times 100 = 9.34 = 9.3 \%</math></p>	<p>3</p>
<b>4(c)</b>	<p>Use of an uncertainty of <math>0.05 \Omega</math> in value of <math>R_1</math> or <math>R_2</math> (1)</p> <p>Use of <math>U = 2 \times (U \text{ in } R_2 + U \text{ in } R_1)</math> shown</p> <p><b>Or</b></p> <p>Use of maximum and minimum values shown (1)</p> <p><math>\%U = 1.8 (\%)</math> (1)</p> <p><u>Example of calculation</u></p> <p><math>U = 2 \times (0.05 + 0.05) = 2 \times 0.1 = 0.2</math></p> <p><math>\%U = (0.2 / 11.4) \times 100 = 1.8 \%</math></p>	<p>3</p>

4(d)	<p>Upper limit of <math>\rho = 5.0 (\times 10^{-7} \Omega \text{ m})</math> (1)</p> <p>Lower limit of <math>R_L = 11.2 (\Omega)</math> (1)</p> <p>Conclusion based on comparison of limits (1)</p> <p>[MP3 dependent MP1 or MP2]</p> <p><u>Example of calculation</u></p> <p>Upper limit <math>\rho = 4.6 \times 10^{-7} \times (1 + 0.09) = 5.0 \times 10^{-7} \Omega \text{ m}</math></p> <p>Lower limit <math>R_L = 11.4 \times (1 - 0.02) = 11.2 \Omega</math></p> <p>Therefore both values fall in the range (confirming metal is constantan).</p> <p><b>Or</b></p> <p>%D for <math>\rho = 6.1\%</math></p> <p>%D for <math>R_L = 1.8\%</math> (1)</p> <p>Conclusion based on comparison of %D and %U (1)</p> <p>[MP3 dependent MP1 or MP2] (1)</p> <p><u>Example of calculation</u></p> <p>%D for <math>\rho = (4.9 - 4.6) / 4.9 \times 100 = 6.1 \%</math></p> <p>%D for <math>R_L = (11.4 - 11.2) / 11.2 \times 100 = 1.8 \%</math></p> <p>Therefore both %D are less than %U (confirming metal is constantan).</p>	3
	Total for question 4	17