Mark Scheme (Results)

October 2022

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

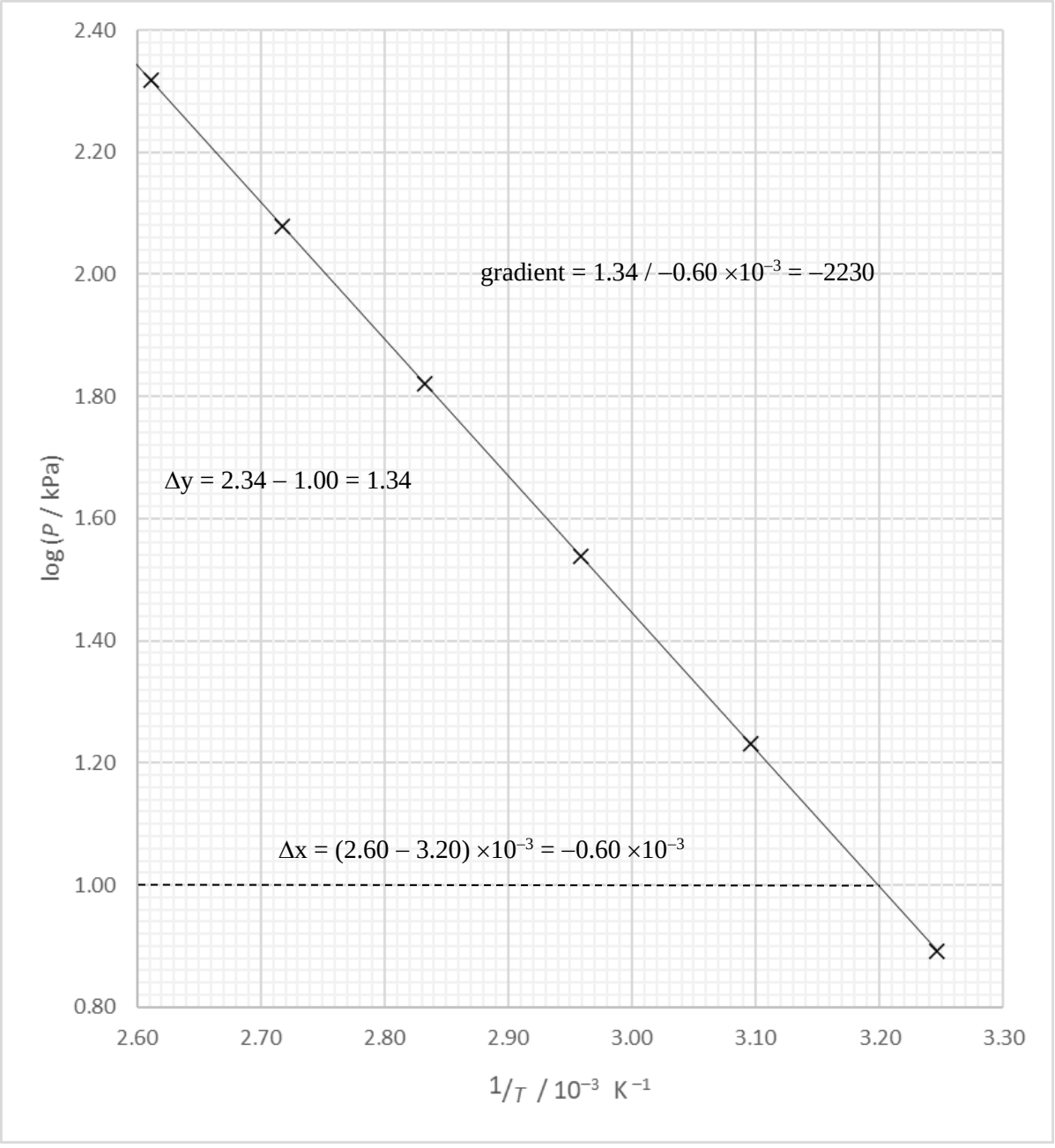
Question Number	Answer	Mark
1(a)	**Any PAIR from:** There could be a short circuit (across the power supply) **(1)** Use insulated wire **(1)** **Or** There is a risk of electrocution (from coil A) [Accept electric shock] **(1)** Use a low p.d. **(1)** **Or** There is a risk of the wire overheating (if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

	Total for question 1	**10**

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

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

P / kPa	T / K	$\frac{1}{T}$ / K^{-1}	log (P / 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)	**Either** Repeat at different orientations (along the wire) **and** calculate a mean To reduce the effect of random errors **Or** Check **and** correct for zero error (on micrometer screw gauge) To eliminate systematic error MP2 dependent on MP1 [Allow MP2 if MP1 partially correct]	**(1)** **(1)** **(1)** **(1)**	**2**
4(a)(ii)	Mean d = 0.31 (mm) Calculation using half range shown **Or** Calculation of furthest from mean shown Uncertainty in d = 0.02 (mm) Decimal places consistent with the calculated mean MP3 dependent on MP2 Example of calculation Mean d = (0.31 + 0.32 + 0.31 + 0.33 + 0.30) / 5 = 1.57 / 5 = 0.314 = 0.31 (mm) Uncertainty = (0.33 – 0.30) / 2 = 0.03 / 2 = 0.015 = 0.02 (mm)	**(1)** **(1)** **(1)**	**3**
4(b)(i)	Use of $A = \pi d^2/4$ **and** $R = V/I$ Use of $R = \rho L/A$ $\rho = 4.6 \times 10^{-7}$ (Ω m) Example of calculation $A = \pi \times (0.22\times10^{-3}\text{ m})^2 / 4 = 3.80 \times 10^{-8}\text{ m}^2$ $R = V / I$ = 4.990 V / 0.4570 A = 10.9 Ω $\rho = RA / L$ = 10.9 Ω × 3.80×10^{-8} m² / 0.894 m = 4.6×10^{-7} (Ω m)	**(1)** **(1)** **(1)**	**3**

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

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