Pearson Edexcel

Mark Scheme (Results)

October 2022

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

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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 scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the MS has specified specific words that must be present. Such words will be indicated by underlining e.g. '<u>resonance</u>'

1.2 Bold lower case will be used for emphasis e.g. '**and**' when two pieces of information are needed for 1 mark.

1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".

1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.

2.2 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in ePen.

2.4 Occasionally, it may be decided not to insist on a unit e.g the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.

2.5 The mark scheme will indicate if no unit error is to be applied by means of [no ue].

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not be prevent a mark being awarded if the answer given rounds to the answer in the MS.

3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.

3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.

3.4 The use of $g = 10\ m\ s^{-2}$ or $10\ N\ kg^{-1}$ instead of $9.81\ m\ s^{-2}$ or $9.81\ N\ kg^{-1}$ will mean that one mark will not be awarded (but not more than once per clip). Accept $9.8\ m\ s^{-2}$ or $9.8\ N\ kg^{-1}$

3.5 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

4. Calculations

4.1 Bald (i.e. no working shown) correct answers may score full marks.

4.2 Some working is expected for full marks to be scored in a 'show that' question or an extended calculation question.

4.3 If a 'show that' question is worth 2 marks, then both marks will be available for a reverse working. If the question is worth 3 marks then only 2 marks will be available.

4.4 use of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.5 The mark scheme will show a correctly worked answer for illustration only.

5. Quality of Written Expression

5.1 Questions that asses the ability to show a coherent and logically structured answer are marked with an asterisk.

5.2 Marks are awarded for indicative content and for how the answer is structured.

5.3 Linkage between ideas, and fully-sustained reasoning is expected.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

6.4 Points should be plotted to within half a small square.

6.5 Check the two points furthest from the best line.

6.6 For a line mark there must be a thin continuous line which is the best fit line for the candidate's results.

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 × 100 = 0.25% %U for metre rule = 0.05/2 × 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

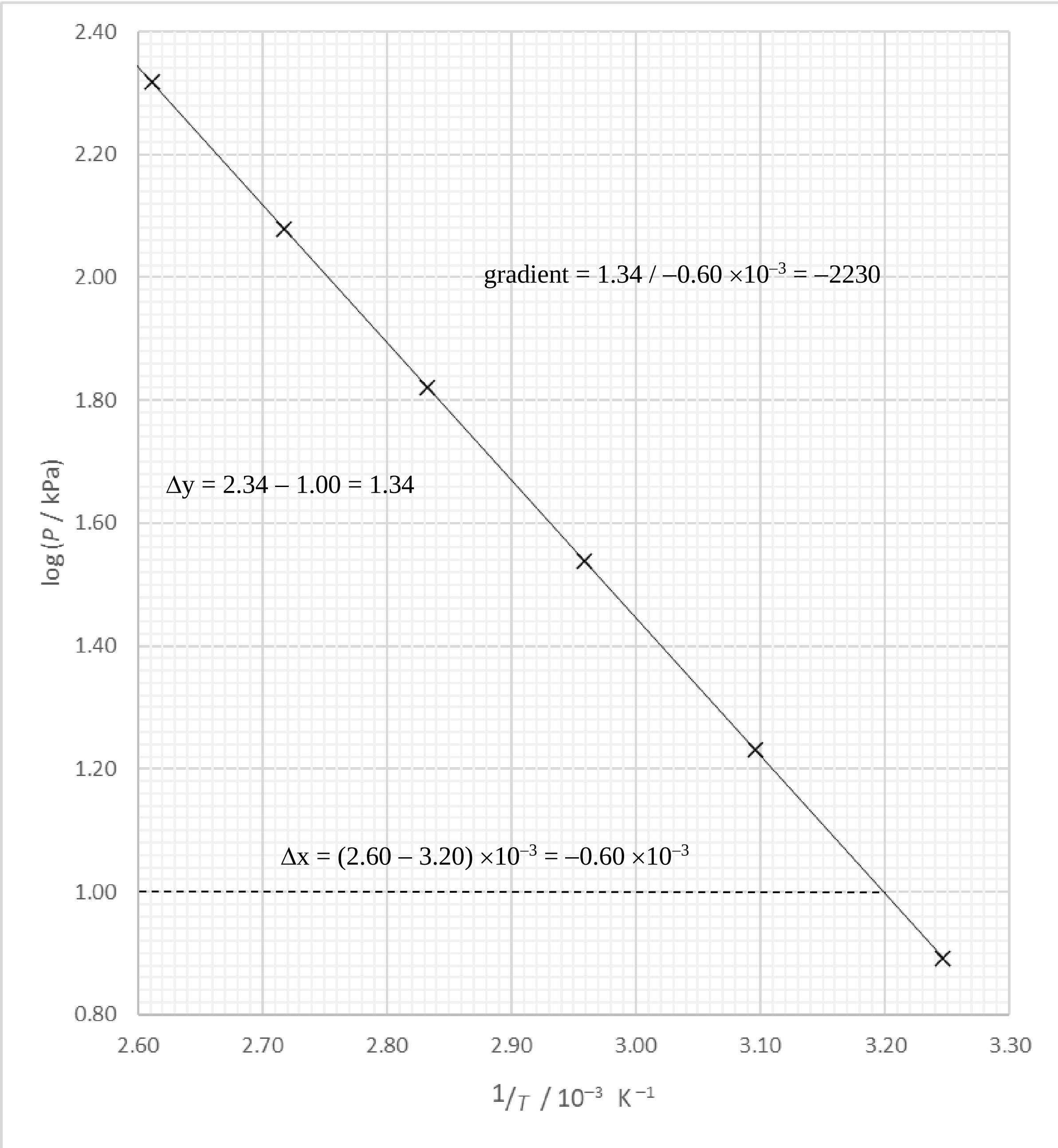
	Total for question 1	10

Question Number	Answer		Mark
2(a)	**Any PAIR from:**	**(1)**	
	$\ln V = \ln V_0 - bt$	**(1)**	2
	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(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)**	2
	MP2 dependent on MP1		

	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 × (– 2.30k) = – 2230 × (–2.30 × 1.38 × 10^{-23} J K^{-1}) = 7.08×10^{-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 / 2.75×10^{-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 <u>random</u> errors **Or** Check **and** correct for zero error (on micrometer screw gauge) To eliminate <u>systematic</u> error MP2 dependent on MP1 [Allow MP2 if MP1 partially correct]	 **(1)** **(1)** **(1)** **(1)**	2
4(a)(ii)	Mean d = <u>0.31</u> (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 <u>Example of calculation</u> 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) <u>Example of calculation</u> $A = \pi \times (0.22\times10^{-3}\text{ m})^2 / 4 = 3.80 \times 10^{-8}\text{ m}^2$ $R = V / I = 4.990\text{ V} / 0.4570\text{ A} = 10.9\ \Omega$ $\rho = RA / L = 10.9\ \Omega \times 3.80 \times 10^{-8}\text{ m}^2 / 0.894\text{ m} = 4.6 \times 10^{-7}$ (Ω m)	**(1)** **(1)** **(1)**	3

<table>
<tr><td>4(b)(ii)</td><td>Use of 2 × %U in d shown [Accept 2 × Δd/d if converted to %U]
Addition of %U for all variables shown
%U = 9.4 (%) [Accept answers that round to 9%]

<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
Calculation of uncertainty in ρ using maximum and minimum ρ
%U = 9.3 (%) [Accept answers that round to 9%]

<u>Example of calculation</u>
$A_{max} = \pi \times (0.23\times10^{-3}\ \text{m})^2 / 4 = 4.15 \times 10^{-8}\ \text{m}^2$
$A_{min} = \pi \times (0.21\times10^{-3}\ \text{m})^2 / 4 = 3.16 \times 10^{-8}\ \text{m}^2$
$R_{max} = V_{max} / I_{min}$ = 4.995 V / 0.4565 A = 10.9 Ω
$R_{min} = V_{min} / I_{max}$ = 4.985 V / 0.4575 A = 10.9 Ω
$\rho_{max} = R_{max} A_{max} / L_{min} = 10.9\ \Omega \times 4.15 \times 10^{-8}\ \text{m}^2 / 0.893\ \text{m}$
$= 5.07 \times 10^{-7}\ (\Omega\ \text{m})$
$\rho_{min} = R_{min} A_{min} / L_{max} = 10.9\ \Omega \times 3.46 \times 10^{-8}\ \text{m}^2 / 0.895\ \text{m}$
$= 4.21 \times 10^{-7}\ (\Omega\ \text{m})$
U in $\rho = (5.07 \times 10^{-7} - 4.21 \times 10^{-7}) / 2 = 0.43 \times 10^{-7}\ (\Omega\ \text{m})$
%U in $\rho = 0.43 \times 10^{-7} / 4.6 \times 10^{-7} \times 100 = 9.34 = 9.3$ %</td><td>(1)
(1)
(1)

(1)
(1)
(1)</td><td>3</td></tr>
<tr><td>4(c)</td><td>Use of an uncertainty of 0.05 Ω in value of R_1 or R_2
Use of U = 2× (U in R_2 + U in R_1) shown
Or
Use of maximum and minimum values shown
%U = 1.8 (%)

<u>Example of calculation</u>
U = 2 × (0.05 + 0.05) = 2× 0.1 = 0.2
%U = (0.2 / 11.4) × 100 = 1.8 %</td><td>(1)

(1)
(1)</td><td>3</td></tr>
</table>

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