Pearson Edexcel

Mark scheme (Unused)

January 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 schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate.

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. 'resonance'

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 score full marks unless in a 'show that' question.

4.2 If a 'show that' question is worth 2 marks. then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

4.3 **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.

4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

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

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

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 1 mm.

- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

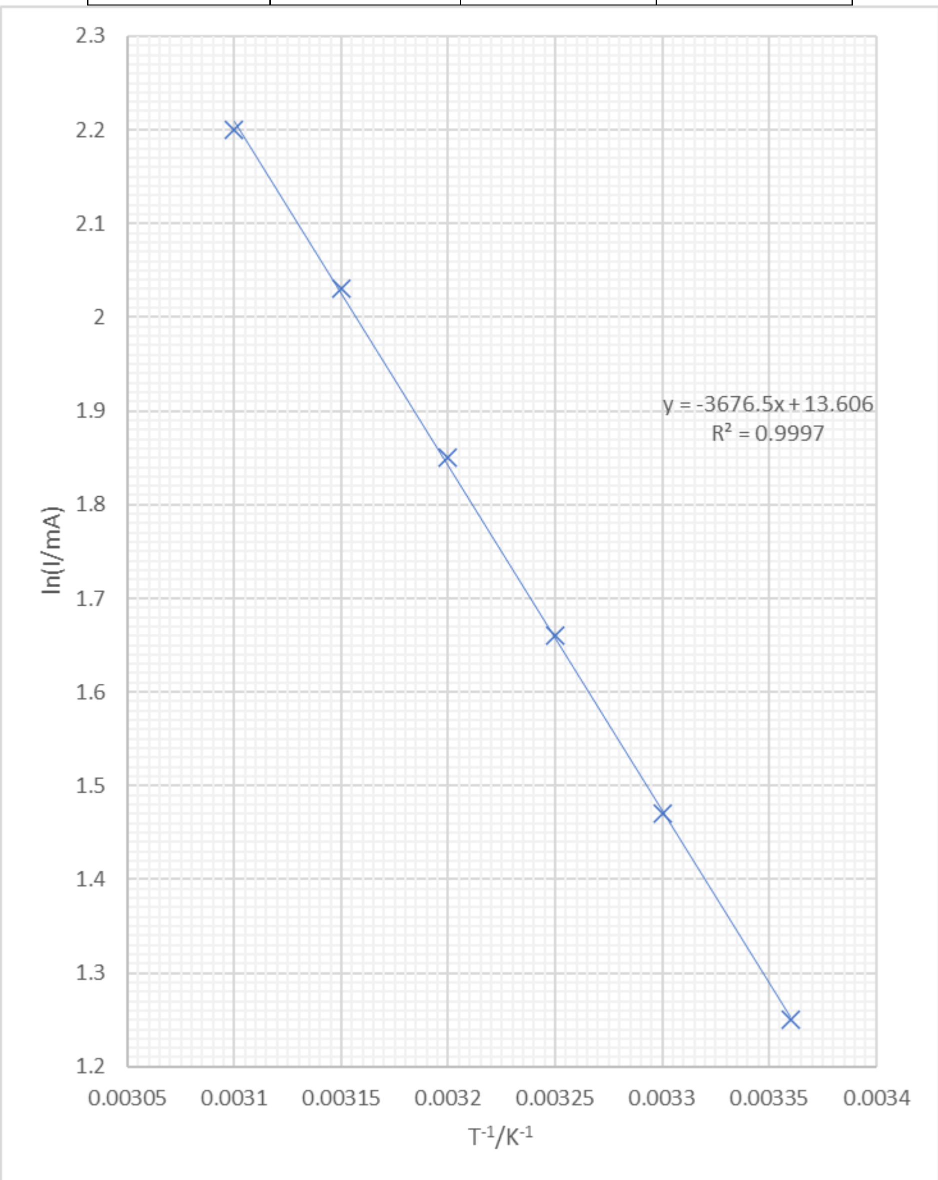
  For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer		Mark
1 (a)(i)	Capacitor Y connected in parallel with X from terminal 2 to below capacitor	(1)	**1**
1 (a)(ii)	Correct symbol for voltmeter connected across X only	(1)	**1**
1 (b)(i)	0.01V	(1)	**1**
1 (b)(ii)	3 significant figures is enough **Or** 2 decimal places is enough [Accept the last digit may fluctuate] [Accept alternative valid answers, e.g. same number of s.f. as p.d. of battery]	(1)	**1**
1 (c)(i)	Three correct values of C_Y All values given to 2 s.f. <u>Example of calculation</u> A: $C_Y = (6.00 - 0.38)/0.38 \times 0.10 = 1.5\ \mu F$ B: $C_Y = (5.97 - 0.72)/0.72 \times 0.22 = 1.6\ \mu F$ C: $C_Y = (5.98 - 1.07)/1.07 \times 0.33 = 1.5\ \mu F$	(1) (1)	**2**
1 (c)(ii)	The range of values is 0.1 μF **Or** Within 10% (allow ecf from ci) Valid conclusion based on results [MP2 dependent]	(1) (1)	**2**
	Total for question		**8**

Question Number	Answer		Mark
2 (a)	Measure the background count (rate)	(1)	
	Measure distance d with a metre rule	(1)	
	Record the count (rate) over a long period of time **Or** Record the count (rate) several times and calculate a mean	(1)	
	Subtract the background count (rate) from each recorded count (rate)	(1)	
	Plot a graph of C against $1/d^2$	(1)	
	Any ONE from:		
	Ensure that the radioactive source is perpendicular to the G-M tube	(1)	
	Repeat for at least 5 values of d	(1)	
	If the graph is a straight line, then the relationship is valid	(1)	**6**
2 (b)	In Arrangement 1, beta radiation could enter the tube through the window	(1)	
	Hence the count rate in Arrangement 1 would not be just due to gamma radiation.	(1)	
	In Arrangement 2 (most) beta radiation would be absorbed by the metal	(1)	
	Hence the count rate in Arrangement 2 would be due to gamma only so would be more suitable	(1)	**4**
	Total for question		**10**

Question Number	Answer	Mark
3 (a)(i)	Any **TWO** from Place the thermometer close to the diode (1) Stir the water (1) Take current reading and temperature reading simultaneously (1)	**2**
3 (a)(ii)	The initial conditions cannot be easily controlled **Or** The temperature of the surroundings cannot be controlled **Or** The temperature of the surroundings may vary (1)	**1**
3 (b)	$\ln I = \ln I_0 - qV/kT$ (1) is in the form $y = c + mx$ with a gradient of $-qV/k$ (1)	**2**
3 (c)(i)	$\ln I$ values correct to 2 d.p. (1) $1/T$ values correct to 3 s.f. (1) Axes labelled: y as $\ln(I$ / mA) and x as T^{-1} / K^{-1}) (1) Most appropriate scales for both axes (1) Plots accurate to ± 1mm (1) Best fit line with even spread of plots (1)	**6**
3 (c)(ii)	Correct calculation of gradient using large triangle shown (1) Value of q positive and in range (1) Value of q given 2 or 3 s.f., unit C (1) <u>Example of calculation</u> *gradient* = *e* =	**3**
	Total for question	**14**

T / K	I / mA	T^{-1} / K^{-1}	ln(I / mA)
298	3.49	0.00336	1.25
303	4.34	0.00330	1.47
308	5.26	0.00325	1.66
313	6.34	0.00319	1.85
318	7.58	0.00314	2.03
323	9.03	0.00310	2.20



T / K	I / mA	T^{-1} / K^{-1}	ln(I / A)
298	3.49	0.00336	–5.66
303	4.34	0.00330	–5.44
308	5.26	0.00325	–5.25
313	6.34	0.00319	–5.06
318	7.58	0.00314	–4.88
323	9.03	0.00310	–4.71

Question Number	Answer		Mark
4 (a)(i)	Place a set square against the vertical edge and aligned with the mark Place the metre rule flat against the tips of the set squares [Accept parallax]	(1) (1)	2
4 (a)(ii)	The uncertainty of a single measurement is half the <u>resolution</u> of the ruler, which is 0.5 mm As there is uncertainty in the readings at both ends, the uncertainty is doubled	(1) (1)	2
4 (b)(i)	**Any PAIR from:** Use a (timing) marker (at the centre of the oscillation) to ensure that the start and end of the oscillation are known accurately **Or** to ensure that a whole oscillation is measured accurately Measure multiple oscillations and divide by the number of oscillations to reduce percentage uncertainty Repeat the measurement and calculate a mean to reduce the effect of <u>random error</u>	 (1) (1) (1) (1) (1) (1)	2
4 (b)(ii)	Calculation of mean value shown Mean value of T = <u>1.04 s</u> Use of half range shown Uncertainty = 0.01 s [dependent MP3, accept 3 d.p.] <u>Example of calculation</u> Mean 20T = (20.93 + 20.69 + 20.77 + 20.85) s / 4 = 83.24 s / 4 = 20.81 s Mean T = 20.81 s/20 = 1.04 s Uncertainty 20T = (20.93 − 20.69) s /2 = 0.12 s Uncertainty T = 0.1 s/20 = 0.006 s	(1) (1) (1) (1)	4
4 (c)(i)	Use of $G = (32\pi M w^2 x) / (3d^4T^2)$ using S.I. units Value of G given to 3 s.f. [e.c.f. (b)(ii)] <u>Example of calculation</u> $G = 32\pi \times 0.115\text{kg} \times 1.000^2\ \text{m}^2 \times 0.615\ \text{m} / 3 \times (2.35 \times 10^{-3}\ \text{m})^4 \times (1.04\ \text{s})^2$ $= 7.11\ \text{kg m}^3 / 9.91 \times 10^{-11}\ \text{m}^4\ \text{s}^2 = 7.18 \times 10^{10}\ \text{N m}^{-2}$	(1) (1)	2
4 (c)(ii)	Use of 2× %U in w **Or** 4× %U in d **Or** 2 × %U in T shown Correct value of %U in G [e.c.f. (c)(i) and (b)(ii), accept 1, 2 or 3 s.f.] <u>Example of calculation</u> %U = (0.001/0.115) × 100 + 2 × (0.001/1.000) × 100 + (0.001/0.615) × 100 +	(1) (1)	2

	+ 4 × (0.03 / 2.35) × 100 + 2 × (0.01/1.04) × 100 = 0.87% + 2 × 0.10% + 0.16% + 4 × 1.28% + 2 × 0.96% = 0.87% + 0.20% + 0.16% + 5.10% + 1.92% = 8.26% ≅ 8.3%		
4 (d)	Correct calculation of upper limit of *G* shown Correct calculation of lower limit for *G* shown Valid conclusion based on comparison of upper limit Valid conclusion based on upper limit <u>Example of calculation</u> Upper limit $G = 42.1 \times 10^9$ N $m^2 \times (1 + 0.06) = 44.6 \times 10^9$ N m^2 Lower limit $G = 42.1 \times 10^9$ N $m^2 \times (1 - 0.06) = 39.6 \times 10^9$ N m^2 Copper falls outside the range so the rod cannot be copper. Both brass and bronze fall inside the range therefore the student cannot determine whether the rod is brass or bronze. **Or** Correct calculation of %D shown for two metals Correct calculation of %D shown for additional metal Valid conclusion based on comparison for two metals Valid conclusion based on comparison for additional metals <u>Example of calculation</u> %D for *G* of brass = (42.1 − 40.0)/40.0 × 100 = 5.3% %D for *G* of bronze = (44.5 − 42.1)/44.5 × 100 = 5.4% %D for *G* of copper = (45.0 − 42.1)/45.0 × 100 = 6.4% The %D of copper is greater than the %U so the rod cannot be copper. The %D for both brass and bronze are less than the %U therefore student cannot determine whether the rod is brass or bronze.	(1) (1) (1) (1) (1) (1) (1) (1)	4
	Total for question		**18**

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