Mark Scheme (Results)

Summer 2018

Pearson Edexcel
International Advanced Level
in Physics (WPH06)
Paper 01 Experimental Physics

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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. '<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 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. Graphs

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

5.2 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.

5.3 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.

5.4 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.

5.5 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)	Resolution of micrometer is 0.01 mm/ 0.001 mm The percentage uncertainty 2% / 0.2% which is small. (% U consistent with resolution stated)	(1) (1)	**2**
1(a)(ii)	Check for zero error **Or** avoid squashing wire (using ratchet) Takes multiple readings at different orientations/along wire **and** calculate a mean.	(1) (1)	**2**
1(a)(iii)	1.1 % (allow 1 or 3 sig figs) <u>Example of calculation</u> $\%U = \frac{0.003 \text{ mm}}{0.275 \text{ mm}} \times 100\% = 1.1\ \%$	(1)	**1**
1(b)(i)	Use of $R = \frac{\rho l}{A}$ 4.81×10^{-7} Ωm (3 sig figs only) <u>Example of calculation</u> $\rho = \frac{6.48\ \Omega \times \pi \times \left(\frac{0.275 \times 10^{-3} \text{ m}}{2}\right)^2}{0.8 \text{ m}} = 4.81 \times 10^{-7}\ \Omega\text{m}$	(1) (1)	**2**
1(b)(ii)	Calculation of %U in R and l shown Doubles %U in diameter shown (ecf 1(a)(iii)) 2.8 % (allow ecf 1(a)(iii), 1 sf) <u>Example of calculation</u> $\%U \text{ in } R = \frac{0.03\Omega}{6.48\Omega} \times 100\% = 0.46\ \%$ $\%U \text{ in } l = \frac{0.001 \text{ m}}{0.8 \text{ m}} \times 100\% = 0.13\ \%$ $\%U = 0.46 + 0.13 + 2 \times 1.1 = 2.8\ \%$	(1) (1) (1)	**3**

1(c)	Use %U to calculation upper and/or lower limits shown (allow ecf from 1(b)(i) and 1(b)(ii)) Suitable comment comparing value from table with correct calculated limit Identifies correct metal consistent with data <u>Example of comment</u> Upper limit is 4.81×10^{-7} Ωm × 1.028 = 4.94×10^{-7} Ωm Value for constantan falls in this range so metal is constantan. **Or** Calculation of %D shown (allow ecf 1(b)(i)) Suitable comment comparing %U with correct value of %D (allow ecf 1(b)(ii) Identifies correct consistent with data <u>Example of comment</u> $\% \text{ D} = \frac{(4.9-4.81)\times 10^{-7}}{4.9\times 10^{-7}} \times 100\% = 1.8\ \%$ This is less than the %U of 2.8% so the metal is constantan.	(1) (1) (1) (1) (1) (1)	3
	Total for Question 1		**13**

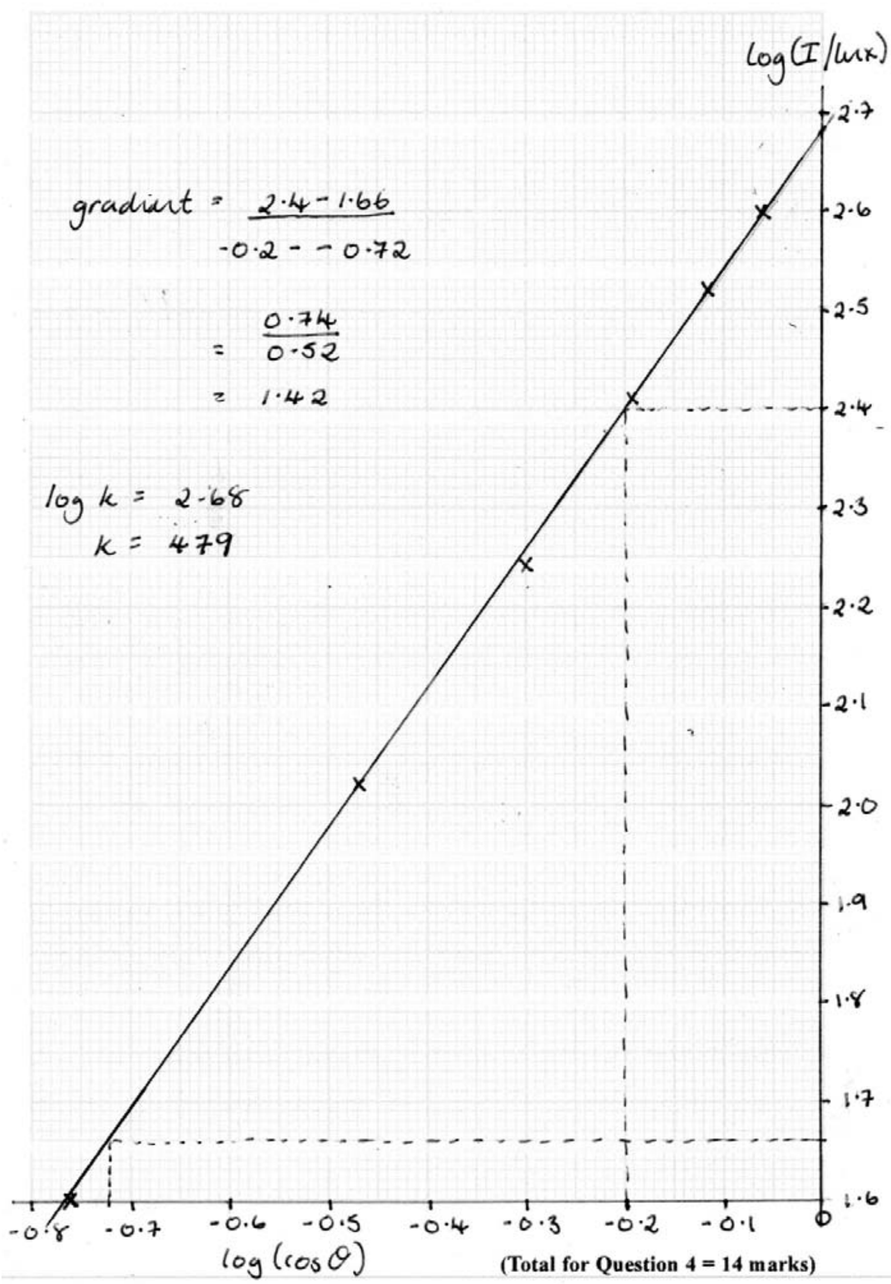
Question Number	Answer: Note part b is to be marked holistically		Mark
2(a)	Use of $f = 1/T$ with $T = 150$ (ms) $f =$ 6.67 (Hz) **(**dependent on correct unit conversion shown) <u>Example of calculation</u> $f = \dfrac{1}{150 \times 10^{-3}\ \mathrm{s}} = 6.67\ \mathrm{Hz}$	(1) (1)	**2**
2(b)	(i) *any additional components required* Ammeter **and** voltmeter. (ii) *the measurements to be taken* Potential difference **and** current (At corresponding) time periods (measured from the oscilloscope) **Or** frequencies from a meter/signal generator (iii) *how the measurements will be used* Calculate a value for Z using V and I Calculate values of Z^2 Calculate f^2 (iv) *a sketch of expected graph* Shows graph of Z^2 against f^2 as straight line with positive y-intercept (may be labelled K^2).	(1) (1) (1) (1) (1) (1) (1)	**7**
	Total for Question 2		**9**

Question Number	Answer		Mark
3(a)	Use of large triangle shown 0.30 (Pa m^3) (accept 3.0×10^{-4} kPa m^3 with unit, accept 3 sig figs, no u.e.) <u>Example of calculation</u> Gradient = $\frac{210 \times 10^3 - 0}{7.0 \times 10^5 - 0} = 0.30$	(1) (1)	**2**
3(b)	Use of $pV = NkT$ Number of molecules = 7.3×10^{19} (Allow ecf from 3(a), no unit, accept 3 sig figs) <u>Example of calculation</u> $N = \frac{0.30}{1.38 \times 10^{-23} \times 298} = 7.3 \times 10^{19}$	(1) (1)	**2**
	Total for Question 3		**4**

Question Number	Answer		Mark
4(a)(i)	Light intensity varies with distance (as an inverse square law) e.g. As distance increases, light intensity decreases **Or** (So that) the intensity of light at the meter/measured remains constant	(1) (1)	**1**
4(a)(ii)	Background light	(1)	**1**
4(b)(i)	log(*I*) =*n*log(cosθ) + log(*k*) is in the form $y = mx + c$ Where gradient = *n* (which is constant)	(1) (1)	**2**
4(b)(ii)	log *I* values correct to 3 or 4 sig figs (Accept ln for log) log(cosθ) values correct to 3 or 4 sig figs (Accept ln for log) Axes labelled – *y* as log(*I*/lux) and *x* as log cosθ (or ln equivalent) Suitable scales Plots accurate to ± 1mm Line of best fit extending to y-axis	(1) (1) (1) (1) (1) (1)	**6**
4(b)(iii)	Correct calculation of gradient shown using large triangle Correct *n* based on line drawn to 2 or 3 sig figs with no unit **Or** Correct calculation of *n* from value of intercept **and** point from line over half way shown Correct *n* to 2 or 3 sig figs, positive with no unit	(1) (1) (1) (1)	**2**
4(b)(iv)	Use of *y*-intercept to determine log(*k*) shown Correct *k* to 2 or 3 sig figs, positive, no unit **Or** Correct calculation using pair of values from best fit line and value of *n* shown (e.c.f from (b)(iii)) Correct *k* to 2 or 3 sig figs, positive, no unit <u>Example of calculation</u> Log(*k*) = log(*I*) – *n* log(cosθ) = 2.4 + (1.4 × −0.2) = 2.68 $k = 10^{2.68} = 479$	(1) (1) (1) (1)	**2**
	Total for Question 4		**14**

Log Values (3 sf, 4 sf)

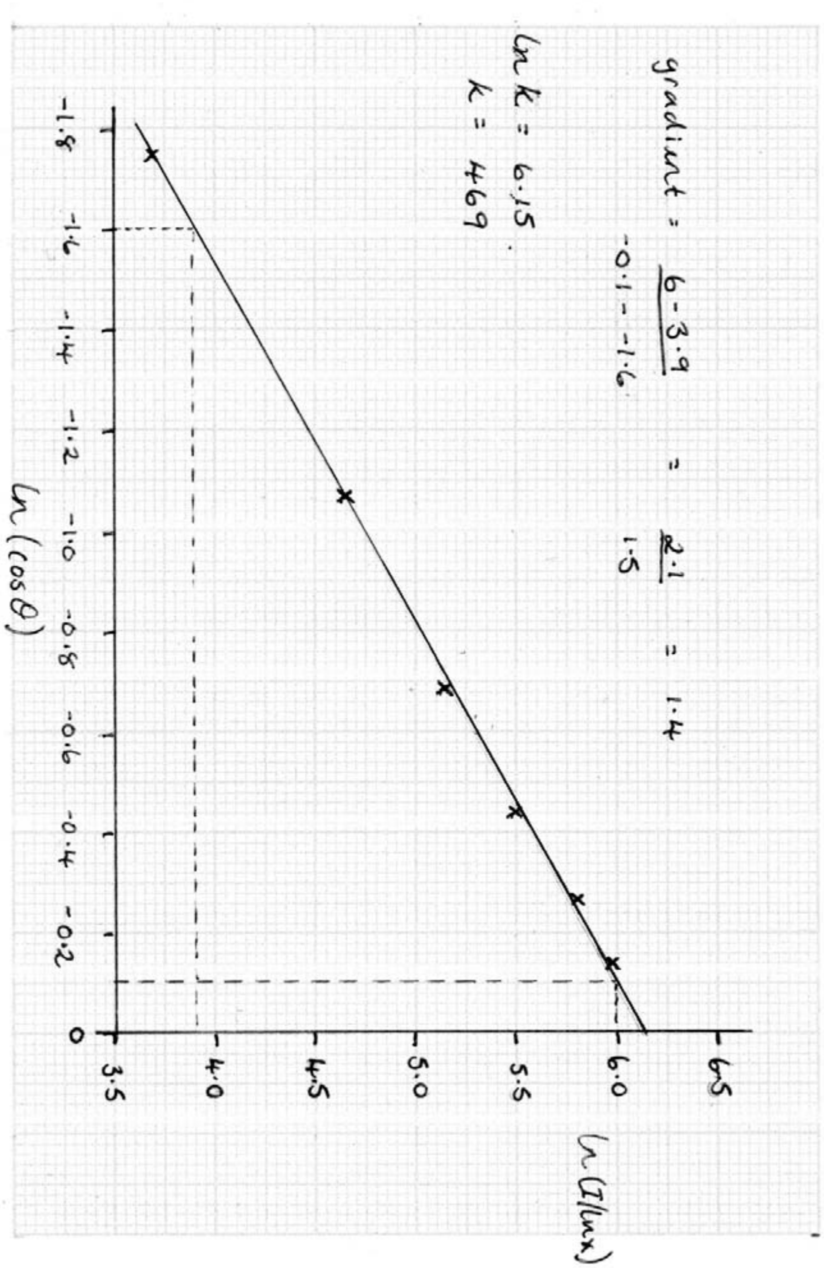
θ / °	I / lux	cosθ	Log(I / lux)	Log (cosθ)	Log(I / lux)	Log (cosθ)
30	398	0.866	2.60	−0.0625	2.600	−0.06248
40	330	0.766	2.52	−0.116	2.519	−0.1158
50	256	0.643	2.41	−0.192	2.408	−0.1918
60	172	0.500	2.24	−0.301	2.236	−0.3010
70	105	0.342	2.02	−0.466	2.021	−0.4660
80	40	0.174	1.60	−0.759	1.602	−0.7595



(Total for Question 4 = 14 marks)

Ln Values (3 sf, 4 sf)

θ / °	I / lux	cosθ	Ln(I / lux)	Ln (cosθ)	Ln(I / lux)	Ln (cosθ)
30	398	0.866	5.99	−0.144	5.986	−0.1439
40	330	0.766	5.80	−0.267	5.799	−0.2666
50	256	0.643	5.55	−0.442	5.545	−0.4416
60	172	0.500	5.15	−0.693	5.147	−0.6931
70	105	0.342	4.65	−1.07	4.653	−1.073
80	40	0.174	3.69	−1.75	3.689	−1.749



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