Mark Scheme (Results)

October 2024

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

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October 2024
Question Paper Log Number P78404A
Publications Code WPH16_01_2410_MS

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 placing brackets around the unit.

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not 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 be penalised by one mark (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 **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.

4.2 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.

4.3 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 the 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 are 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)	**EITHER** The beaker will be hot **Or** the beaker **or** hot water will cause burns (if touched) **Or** hot water may spill (onto student) **(1)** Use tongs or insulated gloves (to move the beaker) **(1)** **OR** The hot plate will be hot **Or** the hot plate will cause burns (if touched) **(1)** So turn off the hot plate (when water has boiled) **Or** use insulated gloves (to move the hotplate) **(1)** **OR** There could be a short circuit **(1)** Ensure leads are insulated Do not accept low p.d. **(1)** **OR** Leads (to diode) could pull beaker over **(1)** Support the leads in a clamp **(1)**	2
1(b)	To ensure the potential difference across the diode remains constant **(1)** As the resistance of the diode/circuit may change with temperature **(1)**	2
1(c)(i)	Use of $R = V / I$ **(1)** I in range 5.5×10^{-3}A to 0.060 A **Or** V in range 430 V to 900V **Or** R in range 0.67Ω to 1.4Ω **(1)** Conclusion comparing calculated current with current values in table **Or** Conclusion comparing calculated p.d. with 6V **Or** Conclusion comparing calculated resistance with resistance in circuit **(1)** <u>Example of Calculation</u> $I = \frac{V}{R} = \frac{6\ \text{V}}{1100\ \Omega} = 5.5 \times 10^{-3}$ A	3

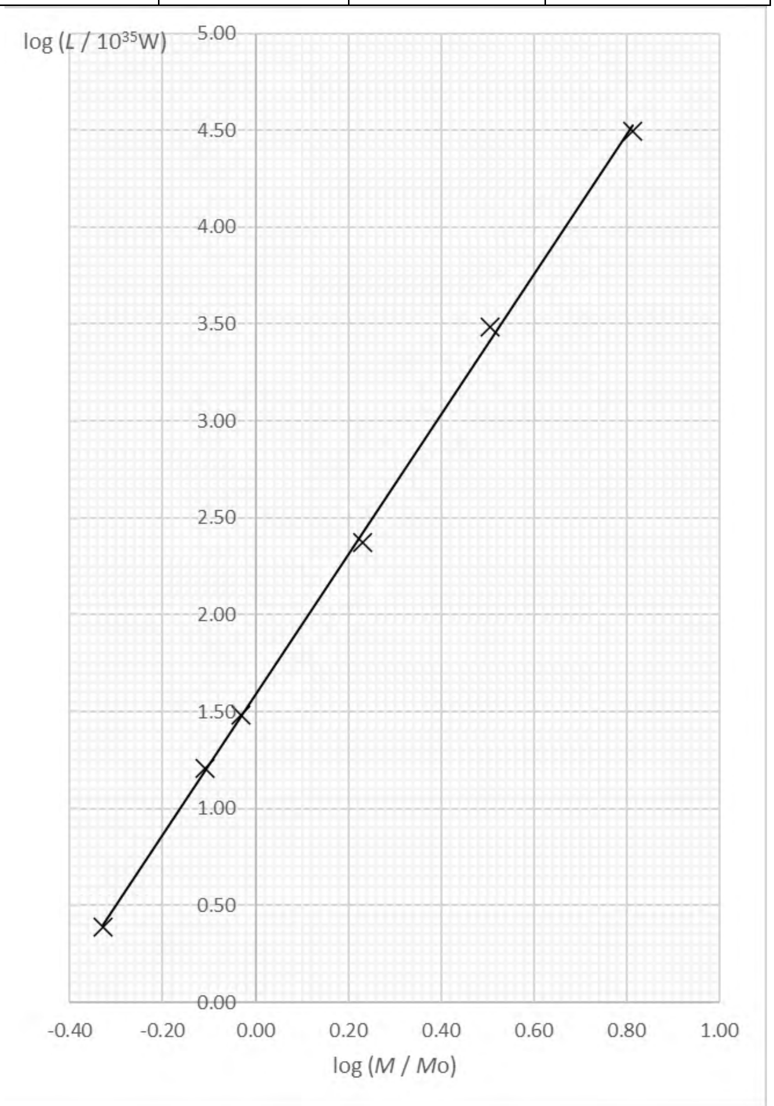
1(c)(ii)	There are not enough sets of data (to draw a graph) **(1)** The range of <u>temperatures</u> is too small **Or** Data is needed below 29.5°C **or** above 50°C **(1)** Ignore references to repeat readings, significant figures and intervals	**2**
	Total for question 1	**9**

Question Number	Answer	Mark
2(a)(i)	Calculation of mean shown **(1)** Mean T = 1.51 s Accept 2 d.p. only **(1)** <u>Example of calculation</u> Mean $5T = \frac{(7.69 + 7.58 + 7.43 + 7.51)\text{ s}}{4} = 7.55\text{ s}$ Mean $T = \frac{7.55\text{ s}}{5} = 1.51\text{ s}$	**2**
2(a)(ii)	Calculation of half range shown **Or** Calculation of furthest from mean shown **(1)** Percentage uncertainty = 1.7% Accept 1 or 2 sig fig, e.c.f (a)(i) **(1)** <u>Example of calculation</u> Half range $= \frac{(7.69 - 7.43)\text{ s}}{2} = 0.13\text{ s}$ Percentage uncertainty $= \frac{0.13\text{ s}}{7.55\text{ s}} \times 100 = 1.7\%$	**2**
2(a)(iii)	Use a (timing) marker (at the centre of the oscillation) **(1)** Allow the oscillations to settle before timing **(1)** Use a small displacement **Or** Ensure displacement is vertical (to avoid movement in other planes) **(1)**	**3**

2(b)	1. Use a metre rule to measure amplitude **(1)** 2. Clamp a metre rule close to the card **Or** Use a set square to ensure metre rule is vertical **Or** View the scale perpendicularly **(1)** 3. Record the amplitude *A* at known value of *n* **(1)** 4. Record at least 5 sets of data (for different values of *n*) **(1)** 5. Plot a graph of ln *A* against *n* **(1)** 6. Read value for *n* when *A* has halved (from the graph) **and** multiply by time period *T* **Or** Calculate the gradient (–λ) and use *n* = ln 2 / (–) gradient **and** multiply by time period *T* **Or** Calculate the gradient (–λ) and calculate *n* from $0.5 = e^{-\lambda n}$ **and** multiply by time period *T* **(1)**	6
	Total for question 2	**13**

Question Number	Answer	Mark
3(a)	**EITHER** $\log L = \log L_\odot + r \log \frac{M}{M_\odot}$ **(1)** Compares to *y* = *c* + *mx* where *r* is the gradient (which is constant) **(1)** MP2 dependent on MP1 **OR** $\log L = r \log \frac{M}{M_\odot} + \log L_\odot$ **(1)** Compares to *y* = *mx* + *c* where *r* is the gradient (which is constant) **(1)** MP2 dependent on MP1	2
3(b)(i)	Values of log *L* correct and consistent to 3 d.p. Accept consistent to 2 d.p. **(1)** Values of $\log \frac{M}{M_\odot}$ correct and consistent to 3 d.p. Accept consistent to 2 d.p. **(1)** Axes labelled: *y* as log (L / 10^{35} W) and *x* as $\log \left(\frac{M}{M_\odot}\right)$ **(1)** Appropriate scales chosen **(1)** log values plotted accurately **(1)** Best fit line drawn **(1)**	6

$\frac{M}{M_\odot}$	L / 10^{35} W	$\log \frac{M}{M_\odot}$	$\log (L / 10^{35}$ W)
6.5	31200	0.813	4.494
3.2	3040	0.505	3.483
1.7	235	0.230	2.371
0.93	30.4	–0.032	1.483
0.78	16.2	–0.108	1.210
0.47	2.43	–0.328	0.386



Question Number	Answer		Mark
3(b)(ii)	Use of large triangle to calculate gradient	(1)	
	Value of r in range 3.50 to 3.70	(1)	
	Value of r given to 2 or 3 s.f., no unit	(1)	3
	<u>Example of calculation</u> $r = \text{gradient} = \frac{4.5 - 1.0}{0.8 - \ -0.16} = \frac{3.5}{0.96} = 3.65$		

3(b)(iii)	**EITHER** Correct y-intercept read from graph **Or** Correct y-intercept using gradient and data point from best fit line Uses antilog consistent with log value Correct value of $L_{\odot}$ given to 2 or 3 s.f., units W e.c.f. (b)(ii) <u>Example of calculation</u> $\log L_{\odot} = y\text{-intercept} = 1.57$ $L_{\odot} = 10^{1.57} = 37.2 \times 10^{35}$ W $= 3.72 \times 10^{36}$ W **OR** Correct data point from best fit line substituted into $L = L_{\odot}\left(\frac{M}{M_{\odot}}\right)^{r}$ with calculated $L_{\odot}$ and r Correct rearrangement of $L = L_{\odot}\left(\frac{M}{M_{\odot}}\right)^{r}$ Correct value of $L_{\odot}$ given to 2 or 3 s.f., units W e.c.f. (b)(ii)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
3(b)(iv)	Uses $L = L_{\odot}\left(\frac{M}{M_{\odot}}\right)^{r}$ with $\frac{M}{M_{\odot}} = 33$ **Or** Uses $\log L = \log L_{\odot} + r \log \frac{M}{M_{\odot}}$ with $\frac{M}{M_{\odot}} = 33$ Correct L given to 2 or 3 s.f. with units W e.c.f. (b)(ii) and (b)(iii) <u>Example of calculation</u> $L = L_{\odot}\left(\frac{M}{M_{\odot}}\right)^{x} = 3.72 \times 10^{36}\ \text{W} \times 33^{3.65} = 1.3 \times 10^{42}\ \text{W}$	**(1)** **(1)**	**2**
	Total for question 3		**16**

Question Number	Answer		Mark
4(a)	**EITHER** Repeat at different places and calculate a mean Do not accept orientation To reduce (the effect of) random error MP2 dependent on MP1 Allow 1 mark for "Repeat and calculate a mean to reduce (the effect of) random error" **OR** Check and correct for zero error To eliminate systematic error MP2 dependent on MP1 Allow 1 mark for "Check for zero error to eliminate systematic error"	**(1)** **(1)** **(1)** **(1)**	**2**
4(b)(i)	(As D increases) value of (20)T will increase Uncertainty in (20)T remains constant so the percentage uncertainty (in 20T) decreases MP3 dependent on MP1 or MP2	**(1)** **(1)** **(1)**	**3**
4(b)(ii)	Substitution into $E = \frac{16\pi^2 MD^3}{ab^3T^2}$ $E = 14.3 \times 10^9$ (Pa) Accept 1.43×10^{10}(Pa) Example of calculation $E = \frac{16\pi^2 MD^3}{ab^3T^2} = \frac{16\pi^2 \times 0.4 \text{ kg} \times (0.8 \text{ m})^3}{25.02 \times 10^{-3} \text{ m} \times (6.17 \times 10^{-3} \text{ m})^3 \times (0.62 \text{ s})^2} = 1.43 \times 10^{10}$ Pa	**(1)** **(1)**	**2**

4(b)(iii)	**EITHER** Uses percentage uncertainty in one of *D a, b* **or** *T* Accept fractional uncertainty **(1)** Uses 3 × %U in *D* **or** 3 × %U in *b* **or** 2 × %U in *T* Accept $3 \times \frac{\Delta D}{D}$ **or** $3 \times \frac{\Delta b}{b}$ **or** $2 \times \frac{\Delta T}{T}$ **(1)** Correct %U given to minimum 2 s.f. **(1)** Allow inclusion of U in *m* if 1g or 0.5g for uncertainty is used. Example of calculation %U in $D = \frac{0.001 \text{ m}}{0.800 \text{ m}} \times 100 = 0.125\%$ %U in $a = \frac{0.05 \text{ mm}}{25.02 \text{ mm}} \times 100 = 0.200\%$ %U in $b = \frac{0.02 \text{ mm}}{6.17 \text{ mm}} \times 100 = 0.324\%$ %U in $T = \frac{0.01 \text{ s}}{0.62 \text{ s}} \times 100 = 1.61\%$ %U in *E* = 3 × %U in *D* + %U in *a* + 3 × %U in *b* + 2× %U in *T* = 3 × 0.125% + 0.200% + 3 × 0.324% + 2 × 1.61% = 0.375% + 0.200% + 0.972% + 3.22% = 4.77% **OR** Use of uncertainties to calculate maximum or minimum *E* **(1)** Calculation of half range shown **(1)** Correct %U given to minimum 2 s.f. e.c.f. (b)(ii) **(1)** Example of calculation Max $E = \frac{16\pi^2 MD^3}{ab^3T^2} = \frac{16\pi^2 \times 0.4 \text{ kg} \times (0.801 \text{ m})^3}{24.97 \times 10^{-3} \text{ m} \times (6.15 \times 10^{-3} \text{ m})^3 \times (0.61 \text{ s})^2} = 1.502 \times 10^{10}$ Pa Min $E = \frac{16\pi^2 MD^3}{ab^3T^2} = \frac{16\pi^2 \times 0.4 \text{ kg} \times (0.799 \text{ m})^3}{25.07 \times 10^{-3} \text{ m} \times (6.19 \times 10^{-3} \text{ m})^3 \times (0.63 \text{ s})^2} = 1.365 \times 10^{10}$ Pa U in $E = \frac{1.502 - 1.365}{2} \times 10^{10} \text{ Pa} = 0.0685 \times 10^{10}$ Pa %U in $E = \frac{0.0685 \times 10^{10} \text{ Pa}}{1.43 \times 10^{10} \text{ Pa}} \times 100 = 4.79\%$		3

4(b)(iv)	**EITHER** Correct value of relevant limit shown e.c.f. (b)(ii), (b)(iii) **(1)** Conclusion based on comparison of relevant limit and accepted value. **(1)** MP2 dependent MP1 <u>Example of calculation</u> Lower limit of $E = 14.3 \times (1 - 0.048) = 13.6$ (GPa) The Young modulus of beech wood is less than the lower limit of E so the metre rule is not made of beech wood Show that values give lower limit 13.3 (GPa) **OR** Calculation of %D shown e.c.f. (b)(ii), (b)(iii) **(1)** Conclusion based on comparison of %D and %U **(1)** MP2 dependent MP1	**2**
	Total for question 4	**12**