Pearson Edexcel

Mark Scheme (Results)

October 2024

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

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

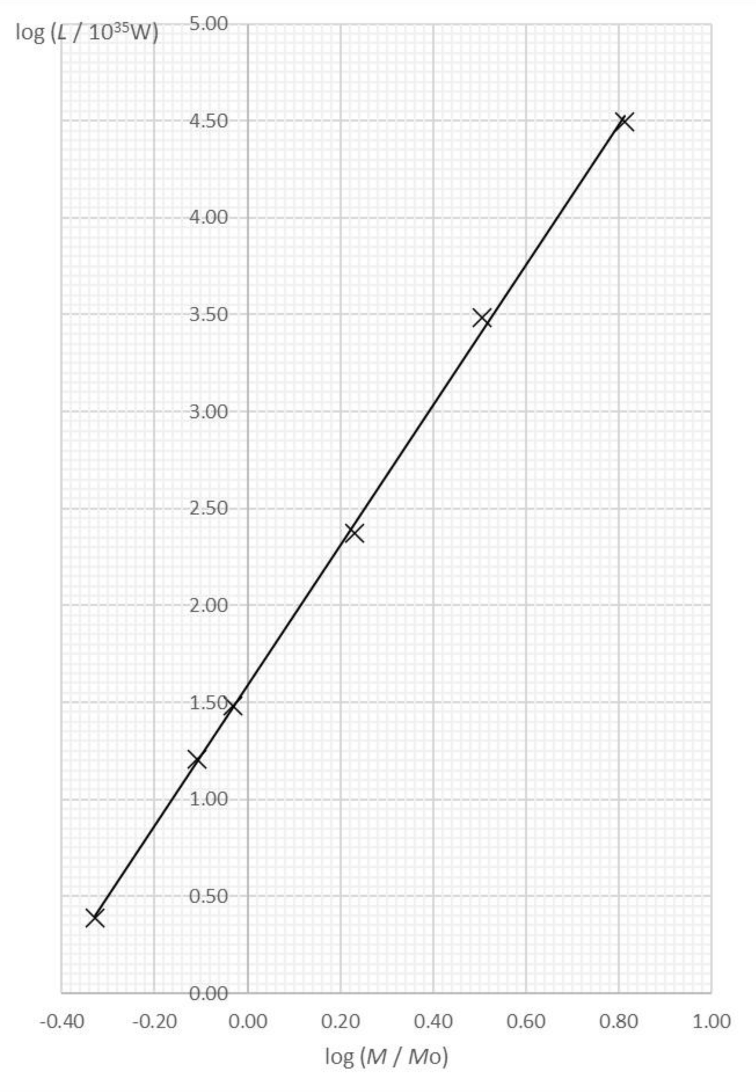
1(c)(ii)	There are not enough sets of data (to draw a graph) **(1)** The range of <u>temperatures</u> is too small **Or** Data is needed below 29.5°C **or** above 50°C **(1)** Ignore references to repeat readings, significant figures and intervals	**2**
	Total for question 1	**9**

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 $5T = \frac{(7.69 + 7.58 + 7.43 + 7.51)\text{ s}}{4} = 7.55$ s Mean $T = \frac{7.55\text{ s}}{5} = 1.51$ 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 $= \frac{(7.69 - 7.43)\text{ s}}{2} = 0.13$ 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



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 **(1)** Uses antilog consistent with log value **(1)** Correct value of $L_{\odot}$ given to 2 or 3 s.f., units W e.c.f. (b)(ii) **(1)** <u>Example of calculation</u> $\log L_{\odot}$ = y-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 **(1)** Correct rearrangement of $L = L_{\odot}\left(\frac{M}{M_{\odot}}\right)^r$ **(1)** Correct value of $L_{\odot}$ given to 2 or 3 s.f., units W e.c.f. (b)(ii) **(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 $\frac{M}{M_{\odot}} = 33$ **(1)** Correct L given to 2 or 3 s.f. with units W e.c.f. (b)(ii) and (b)(iii) **(1)** <u>Example of calculation</u> $L = L_{\odot}\left(\frac{M}{M_{\odot}}\right)^x = 3.72 \times 10^{36}\ \text{W} \times 33^{3.65} = 1.3 \times 10^{42}\ \text{W}$		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) <u>random error</u> MP2 dependent on MP1 Allow 1 mark for "Repeat and calculate a mean to reduce (the effect of) <u>random error</u>" **OR** Check and correct for zero error To eliminate <u>systematic error</u> MP2 dependent on MP1 Allow 1 mark for "Check for zero error to eliminate <u>systematic error</u>"	**(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) <u>Example of calculation</u> $E = \frac{16\pi^2 MD^3}{ab^3T^2} = \frac{16\pi^2 \times 0.4 \text{ kg} \times (0.8 \text{ m})^3}{25.02 \times 10^{-3} \text{ m} \times (6.17 \times 10^{-3} \text{ m})^3 \times (0.62 \text{ s})^2} = 1.43 \times 10^{10}$ Pa	**(1)** **(1)**	**2**

4(b)(iii)	**EITHER** Uses percentage uncertainty in one of *D a, b* **or** *T* Accept fractional uncertainty 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** $2 \times \frac{\Delta T}{T}$ Correct %U given to minimum 2 s.f. Allow inclusion of U in *m* if 1g or 0.5g for uncertainty is used. <u>Example of calculation</u> %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* Calculation of half range shown Correct %U given to minimum 2 s.f. e.c.f. (b)(ii) <u>Example of calculation</u> 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 $E = \frac{0.0685 \times 10^{10} \text{ Pa}}{1.43 \times 10^{10} \text{ Pa}} \times 100 = 4.79\%$	(1) (1) (1) (1) (1) (1)	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**