Pearson Edexcel

Mark Scheme (Results)

January 2024

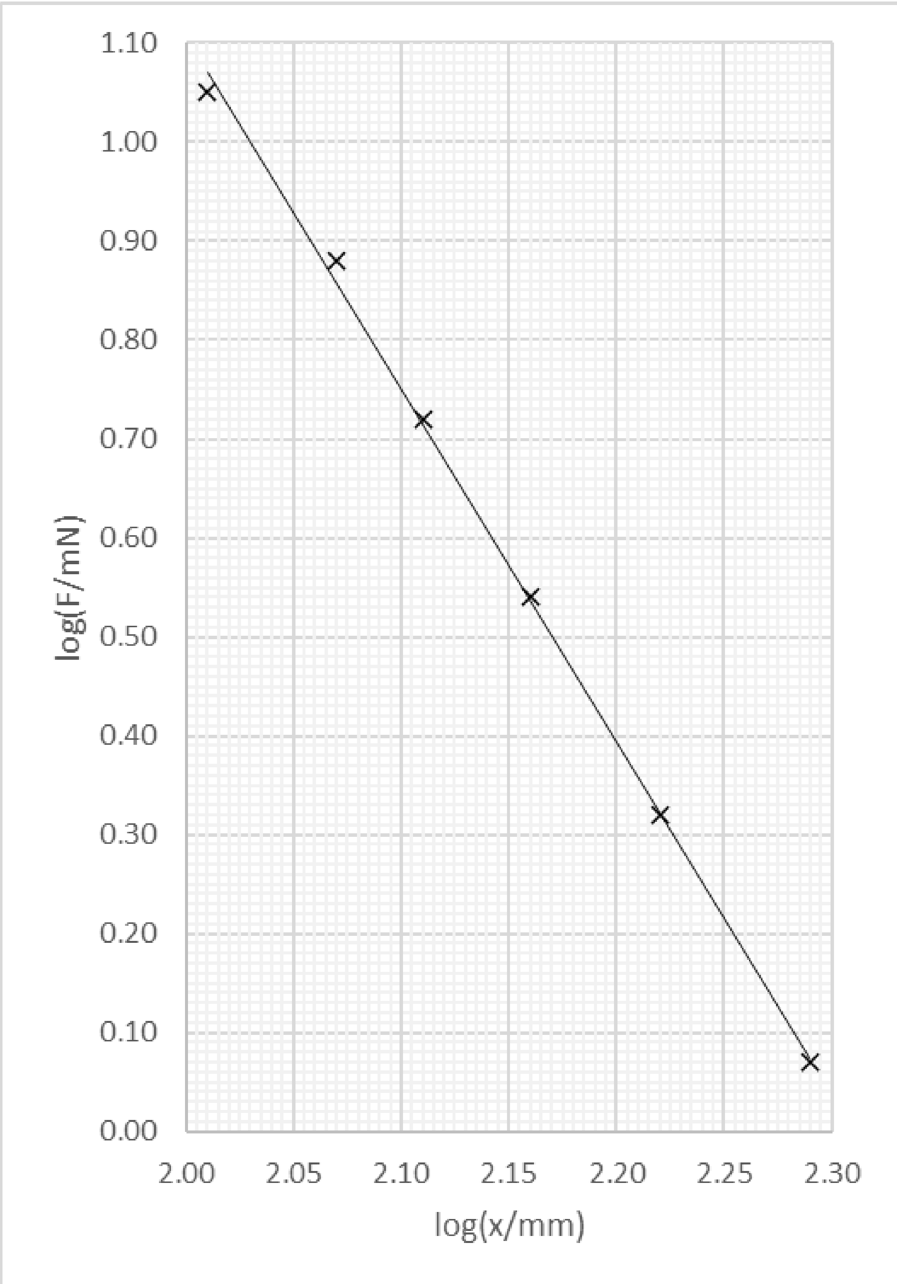
Pearson Edexcel International Advanced Level In Physics (WPH16)
Paper 01: Practical Skills in Physics II

Question Number	Answer		Mark
1(a)	Use a (timing) marker (at the centre of the oscillation)	**(1)**	
	Allow the oscillations to settle before timing	**(1)**	
	Measure multiple oscillations **and** divide by the number of oscillations **Or** Repeat the measurement (of *T*) **and** calculate a mean	**(1)**	**3**
1(b)(i)	f_0 in range 1.50 Hz to 1.54 Hz 3 s.f. only	**(1)**	**1**
1(b)(ii)	Use of $T = \frac{1}{f_0}$	**(1)**	
	Use of $T = 2\pi\sqrt{\frac{m}{k}}$	**(1)**	
	Correct mass given to 2 or 3 s.f. with unit e.c.f. 1(b)(i)	**(1)**	**3**
	<u>Example of calculation</u> $T = \frac{1}{1.52\text{ Hz}} = 0.658\text{ s}$ $m = \frac{kT^2}{4\pi^2} = \frac{30\text{Nm}^{-1} \times (0.658\text{s})^2}{4\pi^2} = 0.329\text{ kg}$		
1(b)(iii)	There are not enough readings around the maximum value **Or** There are not enough readings between 1.4 Hz and 1.6 Hz	**(1)**	
	Therefore the best fit line is uncertain **Or** The position of the peak (of the graph) is uncertain	**(1)**	**2**
1(c)	Data loggers have a high sampling rate	**(1)**	
	So there is less uncertainty in the measurement of amplitude (at each frequency)	**(1)**	**2**
	Total for question 1		**11**

Question Number	Answer	Mark
2(a)	**EITHER** The hot plate **or** glass beaker will be hot **Or** the hot plate **or** glass beaker 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) **(1)** **OR** Thermometer may break (when moving beaker) **(1)** So remove the thermometer (before moving the beaker) **(1)**	2
2(b)	1. Use a stopwatch (to measure time) **(1)** 2. Record the initial temperature and start the stopwatch (simultaneously) **(1)** 3. Stir the water (before measuring the temperature) **(1)** 4. Record the temperature at (regular) time intervals **Or** Record the time at (regular) temperature intervals **(1)** 5. Record many temperature readings (as the water cools) **Or** Keep recording until temperature similar to temperature of the surroundings **(1)** 6. Plot a graph of $\ln\theta$ against t to check it is a straight line **Or p**lot a graph of $\ln\theta$ against t to check the gradient is constant **(1)**	6
	Total for question 2	**8**

Question Number	Answer	Mark
3(a)	Record position of top of lower magnet and bottom of upper magnet **and** subtract to give x **(1)** Any **TWO** from: Ensure the ruler is close to the bar magnets **(1)** Read perpendicular to the scale **Or** measure the position of the bar magnets using a set square **(1)** Clamp the (30 cm) ruler in position **and** use a set square to ensure the (30 cm) ruler is vertical **(1)**	**3**
3(b)	**EITHER** $\log F = \log k + p \log x$ **(1)** Compares with y = c + mx where p is the gradient (which is constant) **(1)** MP2 dependent on MP1 **OR** $\log F = p \log x + \log k$ **(1)** Compares with y = mx + c where p is the gradient (which is constant) **(1)** MP2 dependent on MP1	**2**
3(c)(i)	Values of log x correct and consistent to 2 d.p. Accept consistent to 3 d.p. **(1)** Values of log F correct and consistent to 2 d.p. Accept consistent to 3 d.p. **(1)** Axes labelled: y as log (F / mN) and x as log (x / mm) **(1)** Sensible scales chosen **(1)** log values plotted accurately **(1)** Best fit line drawn **(1)** Accept ln values	**6**

x / mm	F / mN	log (x / mm)	log (F / mN)
102	11.22	2.01	1.05
117	7.56	2.07	0.88
128	5.25	2.11	0.72
145	3.43	2.16	0.54
166	2.09	2.22	0.32
197	1.18	2.29	0.07



3(c)(ii)	Calculation of gradient using large triangle shown **(1)** Value of gradient in range (–)3.40 to (–)3.80 **(1)** Value of calculated gradient given to 2 or 3 s.f., negative, no unit **(1)** <u>Example of calculation</u> $\text{gradient} = \dfrac{1 - 0.2}{2.03 - 2.255} = \dfrac{0.8}{-0.225} = -3.6$	**3**
3(c)(iii)	States form of inverse square relationship as $F \propto x^{-2}$ **(1)** States gradient (p of log F against log x for inverse square law) should be −2 **and** states calculated gradient p **Or** States relationship from graph $F \propto x^{p}$ with p as calculated gradient **(1)** States valid conclusion **(1)** MP3 dependent on MP1 and MP2	**3**
	Total for question 3	**17**

Question Number	Answer		Mark
4(a)(i)	**EITHER**		
	Repeat at different orientations and calculate a mean	**(1)**	
	To reduce (the effect of) random errors	**(1)**	
	MP2 dependent on MP1		
	OR		
	Check and correct for zero error on the calipers	**(1)**	
	To eliminate systematic error	**(1)**	**2**
	MP2 dependent on MP1		
4(a)(ii)	Calculation of %U shown using half resolution	**(1)**	
	States instrument based on justification using calculation of %U from corresponding resolution	**(1)**	**2**
	Example of calculation		
	$\%U = \frac{0.005\text{mm}}{5\text{mm}} \times 100 = 0.1\%$		
	So use a micrometer screw gauge as the %U is small		

4(b)	**EITHER** Uses %U in u **and** v — Accept fractional uncertainty $= \frac{\Delta u}{u}$ and $\frac{\Delta v}{v}$ Calculation of %U in (u + v) — Accept fractional uncertainty Addition of all %U — Accept fractional uncertainty U = 0.15 (cm) — 2 s.f. only <u>Example of calculation</u> %U in $u = \frac{0.1\text{cm}}{29.6\text{cm}} \times 100 = 0.34\%$ %U in $v = \frac{0.1\text{cm}}{19.2\text{cm}} \times 100 = 0.52\%$ %U in $u + v = \frac{(0.1 + 0.1)\text{cm}}{(29.6 + 19.2)\text{cm}} \times 100 = \frac{0.2\text{cm}}{48.8\text{cm}} \times 100 = 0.41\%$ %U in f = 0.34% + 0.52% + 0.41% = 1.3% U in f = 11.6 × 1.3% = 0.15 (cm) **OR** Uses uncertainties to calculate maximum or minimum f Correct calculation of maximum or minimum f Calculation of half range shown U = 0.15 (cm) — 2 s.f. only <u>Example of calculation</u> maximum $f = \frac{(29.6 + 0.1)\text{cm} \times (19.2 + 0.1)\text{cm}}{(29.6 - 0.1)\text{cm} + (19.2 - 1)\text{cm}} = \frac{(29.7 \times 19.3)\text{cm}^2}{(29.5 + 19.1)\text{cm}} = \frac{573.2\text{cm}^2}{48.6\text{cm}} = 11.8$ (cm) minimum $f = \frac{(29.6 - 0.1)\text{cm} \times (19.2 - 0.1)\text{cm}}{(29.6 + 0.1)\text{cm} + (19.2 + 0.1)\text{cm}} = \frac{(29.5 \times 19.1)\text{cm}^2}{(29.7 + 19.3)\text{cm}} = \frac{563.5\text{cm}^2}{49\text{cm}} = 11.5$ (cm) U in $f = \frac{(11.8 - 11.5)\text{cm}}{2} = 0.15$ (cm)	(1) (1) (1) (1) (1) (1) (1) (1)	4
4(c)(i)	Uses $n = 1 + \frac{d^2}{8tf}$ n = 1.63 — 3 s.f. only <u>Example of calculation</u> $n = 1 + \frac{(5.02\text{cm})^2}{8 \times 0.428\text{cm} \times 11.6\text{cm}} = 1 + \frac{25.2\text{cm}^2}{39.7\text{cm}^2} = 1.63$	(1) (1)	2

4(c)(ii)	**EITHER** Uses 2 × %U in d Accept $2 \times \frac{\Delta d}{d}$ %U in n = 1% Accept 1.1% Allow use of value from (b) <u>Example of calculation</u> %U in $\frac{d^2}{8tf} = (2 \times \frac{0.02\text{cm}}{5.02\text{cm}} + \frac{0.01\text{mm}}{4.28\text{mm}} + \frac{0.2\text{cm}}{11.6\text{cm}}) \times 100$ = 0.797% + 0.234% + 1.72% = 2.8% %U in $n = \frac{(0.63\times0.028)}{1.63} \times 100$ = 1.1% **OR** Correct calculation of maximum or minimum n %U in n = 0.9% Accept 0.92% <u>Example of calculation</u> Maximum $n = 1 + \frac{(5.04\text{cm})^2}{8 \times 0.427\text{cm} \times 11.4\text{cm}} = 1.65$ Minimum $n = 1 + \frac{(5.00\text{cm})^2}{8 \times 0.429\text{cm} \times 11.8\text{cm}} = 1.62$ %U = $\frac{(1.65-1.62)}{2\times1.63} \times 100$ = 0.92%	**(1)** **(1)** **(1)** **(1)**	**2**
4(c)(iii)	**EITHER** Correct value of relevant limit (e.c.f. (c)(i), (c)(ii)) Conclusion based on comparison of relevant limit to n = 1.52 MP2 dependent MP1 <u>Example of calculation</u> lower limit of n = 1.63 × (1 − 0.01) = 1.61 As the lower limit is greater than 1.52 the lens could not be made of crown glass **OR** Correct calculation of %D shown (e.c.f. (c)(i), (c)(ii)) Conclusion based on comparison of %D and %U MP2 dependent MP1	**(1)** **(1)** **(1)** **(1)**	**2**

	<u>Example of calculation</u> $\%D = \frac{1.63 - 1.52}{1.52} \times 100 = 7.2\%$ As % D is greater than the %U then lens could not be made of crown glass	
	Total for question 4	**14**