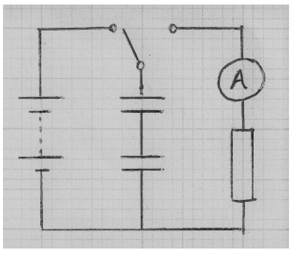
Pearson Edexcel

Mark Scheme (Results)

January 2021

Pearson Edexcel International Advanced Level
In Physics (WPH16)
Paper 1 Practical Skills in Physics II

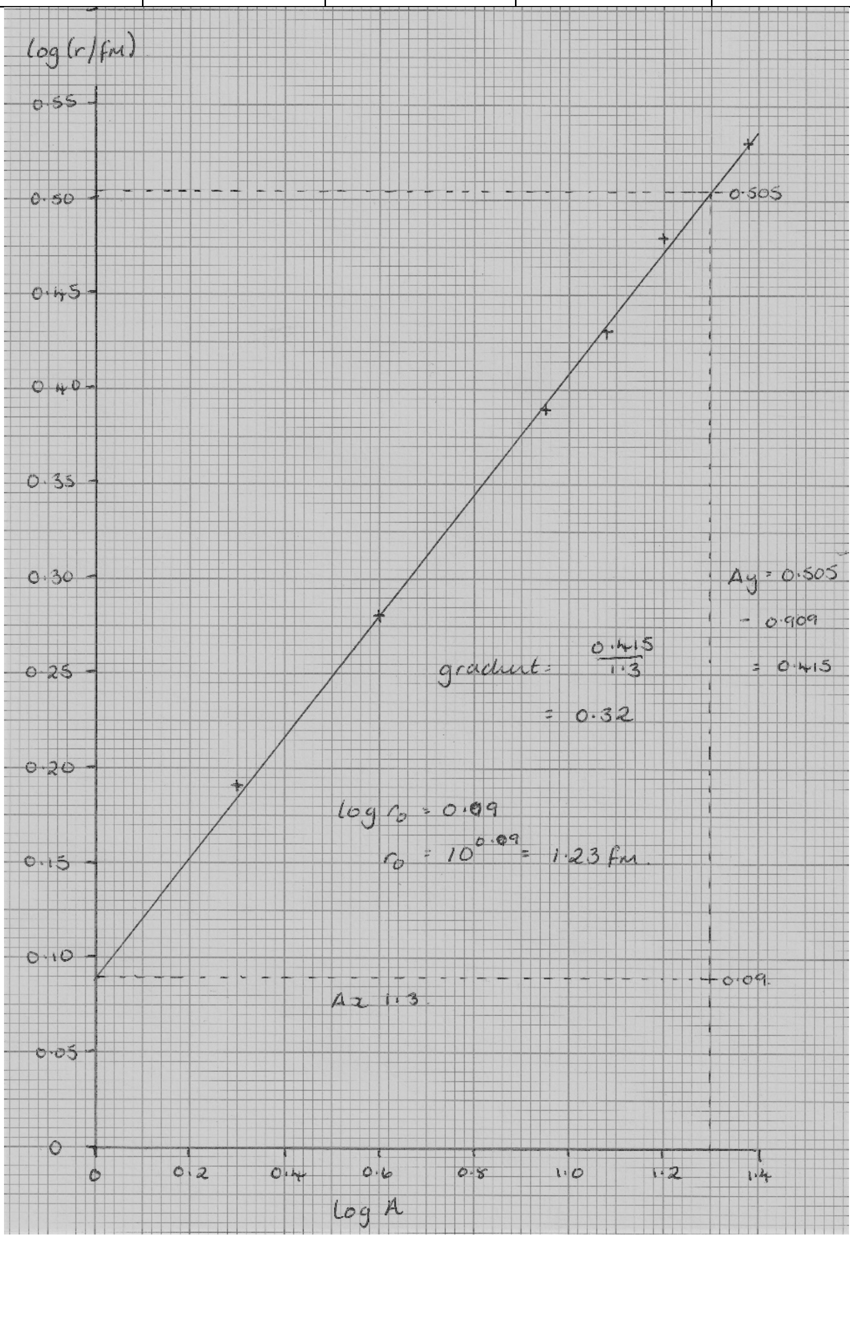
Question number	Answer		Mark
1(a)	Any **THREE** from: Use a timing marker (at the centre of the oscillation) Measure multiple oscillations **and** divide by the number of oscillations Repeat **and** calculate a mean Start timing after several oscillations have completed	(1) (1) (1) (1)	**(3)**
1(b)	Use a metre rule and set square (to ensure metre rule is horizontal) **Or** use a metre rule and spirit level (to ensure metre rule is horizontal) View metre rule perpendicularly (to avoid parallax error) [Accept valid alternative to ensure metre rule is horizontal]	(1) (1)	**(2)**
1(c)	Use of $T = k\sqrt{D}$ **Or** $T^2 = kD$ Three relevant calculations shown [minimum 2 s.f.] Comment consistent with comparing calculations [dependent MP2] [Accept other valid routes] <u>Example of calculation</u> $k = 0.78/\sqrt{0.235} = 1.61$ $k = 0.94/\sqrt{0.335} = 1.62$ $k = 1.09/\sqrt{0.445} = 1.63$ As these values are consistent the prediction is correct.	(1) (1) (1)	**(3)**
			Total mark for Question 1 = 8

Question number	Answer		Mark
2(a)	Capacitors connected in series with a d.c. power supply Circuit to discharge capacitors through resistor **and** ammeter Method of switching between charging and discharging <u>Example of circuit diagram</u> 	(1) (1) (1)	**(3)**
2(b)	Ensure the working p.d. is not exceeded **Or** Ensure the capacitors are fully discharged after the experiment [Accept any other appropriate precaution] [Accept reference to electrolytic capacitors]	(1)	**(1)**
2(c)	<u>Graphical Method</u> Any **SIX** from: 1. Choose the value of resistor to give a reasonable discharge time 2. Measure the resistance of the resistor (using a multimeter) 3. Charge the capacitors to the initial p.d. 4. Ensure that the ammeter and stopwatch are close together **Or** use the laptimer on the stopwatch 5. Start the stopwatch at the same time as changing the switch **Or** (Change the switch) and start the stopwatch at the initial current 6. Record the current (from the ammeter) at times determined using the stopwatch 7. Record measurements over at least one half-life **Or** time constant **Or** Take many measurements <u>Alternative graphs</u> 8. Plot a graph of ln I against t 9. Gradient = $-1/RC$ [dependent on MP8] **Or**	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	

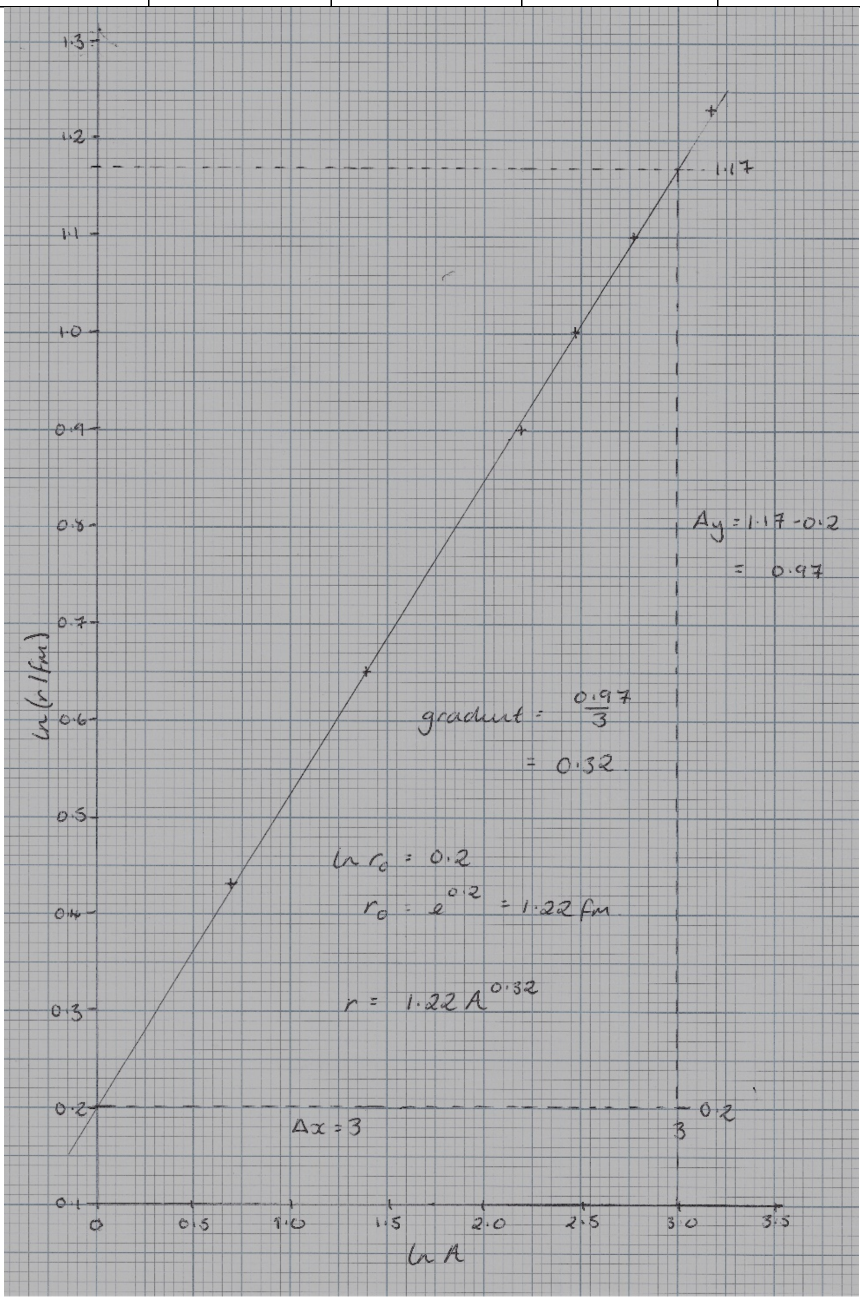
	8. Determine the time for I to halve from a graph of I against t 9. $t_{½} = RC \ln 2$ [dependent on MP8] **Or** 8. Determine the time for I to fall to 37% from a graph of I against t 9. $\tau = RC$ [dependent on MP8] <u>Non-graphical Method</u> Any **SIX** from: 1. Choose the value of resistor to give a reasonable discharge time 2. Measure the resistance of the resistor using a multimeter 3. Charge the capacitors to the initial p.d. 4. Ensure that the ammeter and stopwatch are close together **Or** use the laptimer on the stopwatch 5. Start the stopwatch at the same time as changing the switch **Or** (Change the switch) and start the stopwatch at the initial current 6. Charge to the same initial p.d. each time 7. Obtain minimum of 3 measurements and calculate a mean 8. Record the time taken for the initial current to halve 9. $t_{½} = RC \ln 2$ [dependent on MP8] **Or** 8. Record the time taken for the initial current to reach 37% 9. $\tau = RC$ [dependent on MP8]	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	**(6)**
2(d)	Readings (of current and time) can be taken simultaneously Many readings can be taken in a short time	(1) (1)	**(2)**
			Total mark for Question 2 = 12

Question number	Answer		Mark
3(a)	$\log r = \log r_0 + n \log A$ This in the form of $y = c + mx$ where the gradient is n [MP2 dependent on MP1]	(1) (1)	 **(2)**
3(b)(i)	All $\log r$ values correct to 2 d.p. [accept 3 d.p.] All $\log A$ values correct to 2 d.p. [accept 3 d.p.] Axes labelled: y as $\log(r$ / fm) and x as $\log A$ Most appropriate scales for both axes Plots accurate Best fit line with even spread of plots	(1) (1) (1) (1) (1) (1)	 **(6)**
3(b)(ii)	Correct calculation using large triangle shown Value of n in range 0.30 to 0.34 to 2 or 3 s.f., no unit <u>Example of calculation</u> $n = (0.505 - 0.09)/(1.3 - 0) = 0.415/1.3 = 0.32$	(1) (1)	 **(2)**
3(b)(iii)	Value of y-intercept read from graph shown **Or** Use of coordinates from point on best fit line with gradient to determine $\log r_0$ shown. Value of r_0 consistent with their value of $\log r_0$ States relationship using their values given to 2 or 3 s.f. <u>Example of calculation</u> $\log(r_0/\text{fm}) = 0.09$ $r_0 = 10^{0.09} = 1.23$ (fm) Hence $r = 1.23\ A^{0.32}$ [Accept 1/3 for n]	 (1) (1) (1)	 **(3)**
			Total mark for Question 3 = 13

Isotope	*A*	*r* / fm	log *A*	log (*r* / fm)
H-2	2	1.54	0.30	0.19
He-4	4	1.92	0.60	0.28
Be-9	9	2.47	0.95	0.39
C-12	12	2.72	1.08	0.43
O-16	16	3.00	1.20	0.48
Mg-24	24	3.42	1.38	0.53



Isotope	A	r / fm	ln A	ln (r / fm)
H-2	2	1.54	0.69	0.43
He-4	4	1.92	1.39	0.65
Be-9	9	2.47	2.20	0.90
C-12	12	2.72	2.48	1.00
O-16	16	3.00	2.77	1.10
Mg-24	24	3.42	3.18	1.23



Question number	Answer		Mark
4(a)	The uncertainty is the same for both methods **Or** The resolution of the metre rule is 1mm Student B's measurement will be larger therefore the percentage uncertainty will be smaller **Or** Calculation of percentage uncertainty for both methods using same uncertainty shown Conclusion based on comparison of correct values of percentage uncertainty <u>Example of calculation</u> Student A %U = $\frac{0.1}{10} \times 100\% = 1\%$ Student B %U = $\frac{0.1}{10\pi} \times 100\% = 0.32\%$ Therefore Student B has a smaller percentage uncertainty. [Accept 0.5% and 0.16% if uncertainty of 0.05cm used]	 (1) (1) (1) (1)	(2)
4(b)(i)	Any **TWO** from: Check for zero error to eliminate <u>systematic</u> error Repeat at different places **and** calculate a mean to reduce the effect of <u>random</u> errors Avoid squashing the string to reduce the effect of <u>random</u> errors	 (1) (1) (1)	(2)
4(b)(ii)	mean t = <u>2.10</u> mm Correct uncertainty from calculation of half range shown <u>Example of calculation</u> mean t = (2.15+2.06+2.13+2.08+2.10) mm/5 = 2.104 = 2.10 mm Uncertainty = (2.15−2.06) mm/2 = 0.045 = 0.05 mm	(1) (1)	(2)
4(c)(i)	Use of $C = x - \pi t$ Value of C correct to 3 s.f. [e.c.f (b)(ii)] <u>Example of calculation</u> C = 25.8cm − (π × 0.21 cm) = 25.8 − 0.66 = 25.1 cm	(1) (1)	(2)

4(c)(ii)	Addition of uncertainties shown to minimum 2 s.f. [e.c.f. (b)(ii)] <u>Example of calculation</u> 0.2 cm + 0.005 cm = 0.205 cm	(1)	**(1)**
4(d)	Value of V correct to 3 s.f. [e.c.f. (c)(i)] Use of 2× %U in C and %U in L shown [e.c.f. (c)(i), (c)(ii)] Use of %U to calculate uncertainty in $\frac{C^2L}{4\pi}$ shown Correct uncertainty from addition of final uncertainties <u>Example of calculation</u> $V = (25.1^2 \times 19.9)\ \text{cm}^3/4\pi - 810\ \text{cm}^3 = 998\ \text{cm}^3 - 810\ \text{cm}^3$ $= 188\ \text{cm}^3$ %U in $\frac{C^2L}{4\pi}$ = $(2 \times 0.205\ \text{cm}^3/25.1\ \text{cm}^3)\times100\% + (0.05\ \text{cm}/19.9\ \text{cm})\times100\%$ $= 1.63\% + 0.25\% = 1.88\%$ U in $\frac{C^2L}{4\pi}$ = $(998\ \text{cm}^3 \times 1.88\%) = 18.6 = 19\ \text{cm}^3$ U in $V = (19 + 5)\ \text{cm}^3 = 24\ \text{cm}^3$ **Or** Value of V correct to 3 s.f. [e.c.f. (c)(i)] Use of uncertainties to calculate upper or lower limit of V shown [e.c.f. (c)(ii)] Correct upper or lower limit calculated Uncertainty correct from half range of V <u>Example of calculation</u> $V = (25.1^2 \times 19.9)\ \text{cm}^3/4\pi - 810\ \text{cm}^3 = 998\ \text{cm}^3 - 810\ \text{cm}^3$ $= 188\ \text{cm}^3$ Upper limit of $V = \frac{(25.1+0.2)^2\times(19.90+0.05)}{4\pi} - (810 - 5)$ $= 1016 - 805 = 211\ \text{cm}^3$ $U = 211 - 188 = 23\ \text{cm}^3$	(1) (1) (1) (1) (1) (1) (1) (1)	 **(4)**

4(e)	Calculation of $\rho = \frac{m}{V}$ shown [e.c.f. (d)] Correct calculation of %U in ρ shown [e.c.f. (d)] Calculation of relevant upper and/or lower limit shown Valid conclusion based on comparison [dependent MP3] <u>Example of calculation</u> ρ = 463 g/188 cm^3 = 2.46 (g cm^{-3}) %U = (1/463 × 100) + (24/188 × 100) = 0.2 + 12.8 = 13% Upper limit = 2.46 × 1.13 = 2.78 (g cm^{-3}) Lower limit = 2.46 × (1–0.13) = 2.14 (g cm^{-3}) As both soda glass and borosilicate lie in the range the container may not be safe to heat. **Or** Calculation of $\rho = \frac{m}{V}$ shown [e.c.f. (d)] Correct calculation of %U in ρ shown [e.c.f. (d)] Correct calculation of %D shown for relevant materials Valid conclusion based on comparison [dependent MP3] <u>Example of calculation</u> ρ = 436 g/188 cm^3 = 2.46 (g cm^{-3}) %U = (1/463 × 100) + (24/188 × 100) = 0.2 + 12.8 = 13% Soda glass %D = (2.52–2.46)/2.52 × 100 = 2.38% Borosilicate %D = (2.46–2.23)/2.23 × 100 = 10.3% As both %D are less than the %U we cannot be sure the container is safe to heat. **Or** Use of uncertainties to calculate maximum or minimum ρ shown Correct calculation of upper limit of ρ shown Correct calculation of lower limit of ρ shown Valid conclusion based on comparison of their values	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	**(4)**

	<u>Example of calculation</u> Upper limit of $\rho = \frac{463+1}{188-24} = \frac{464}{164} = 2.83$ (g cm^{-3}) Lower limit of $\rho = \frac{463-1}{188+24} = \frac{462}{212} = 2.18$ (g cm^{-3}) As both soda glass and borosilicate lie in the range the container may not be safe to heat.		
			Total mark for Question 4 = 17