Mark Scheme for 2024 SAJC Prelims P4 Q1 (A-lev Pract in 2023)

No	Marking Point	Score
(a)	€ Recorded *R* as labelled, ie 68 Ω (as per question) € Recorded I as shown on display, ie to nearest 0.1 mA € Accuracy: range of I : 110.0– 130.0 mA € Recorded repeat measurements of *y* to nearest mm (ie to 1 mm, 0.1 cm or 0.001 m) € Recorded average value of *y* to same dp as its raw readings (ie to nearest mm)	/1
(b)	Tabulation € At least 5 sets of readings of *R &* repeated y.	/1
	Column Headings inTable € Each column heading must have a quantity and a unit: eg *R* /Ω, *y/cm, R/y.*	/1
	Precision of Recording For Raw Data: € Recorded all *R* to nearest Ω (as labelled) € Recorded all *y* to nearest mm € Recorded all I to *nearest 0.1 mA (if recorded)* For Calculated Data: (eg for R/y, IR, 1/R, 1/y) □ Correct no. of sf (which takes into account *consistency* within a given column)	/1
(c)	Graph: Scale, Size & Axes € Sensible scales, ie no awkward scales (eg 3 units into 10 small squares) € Plotted pts occupy at least ½ the graph grid in both x & y directions € Axes labelled with the quantity & unit € Successive scale markings: not more than 20 small squares apart.	/1
	Plotting of Points € ALL observations in table must be plotted € Accurate to within half a small square. € Thickness of plots (ie the crosses, ‘x’) δ half a small square	/1

	Best fit line & Anomaly € Straight line drawn with approx. equal number of points on either side of line (anomalous point not considered). € Line must not be kinked/disjointed or thicker than half a small square € Anomalous plot clearly indicated (eg by a circle or labelled "anomaly".) € Maximum number of anomalous plot allowed: 1	/1
	Correct Trend: (Not awarded for Inappropriate graph) Appropriate graph using data where as R increases, y decreases.	/1
	Determination of Gradient (Not awarded for Inappropriate graph) € Gradient coordinates clearly indicated on graph and in working (accurately recorded) € Precision of gradient coordinates: either to 3 sf or to ½ a small square € Hypotenuse of triangle > half length of line drawn € No obscurity of the 2 points used for gradient calculation. {Hence triangle must not be drawn too near a data plot.} € Precision of gradient: either to 3 sf, or, same number of sf as the coordinate with the least number of sf, or 1 more. € Value of F: calculated correctly to 3 sf. (Accept 4 sf)	/1
	Units of the unknown constants □ F: A Ω, or V (Accept mA ∧) □ Q: Ω m^{-1} (Accept ∧ cm^{-1})	/1
	Determination of y-intercept (Not awarded for Inappropriate graph) € y-intercept calculated using a point on the line {not from the table} & value of gradient. € Value of Q: a POSITIVE value, 3 s.f. (Accept 4 sf) Or, € Reading off the y-intercept if x-axis starts from zero (ie no false origin) € Value of Q: a POSITIVE value, precision to ½ small square	/1
	Linearisation of Equation (Not awarded for Inappropriate graph) For graph of *R/y* against *R:* € Stated explicitly: *QI/F* = gradient € Stated explicitly: - *Q* = y-intercept	/1

(d)	€ Recorded repeat measurements (using micrometer) of *d* & its average to nearest 0.01 mm € Accuracy: acceptable range of *d : 0.17 – 0.19 mm*	/1
	Determination of *p* € Determined *p* correctly with given units.	/1

	Total	**/14**

Mark scheme for 2024 SAJC Prelims P4 Q2 (A-lev Pract in 2023)

No	Marking Point	Score
(a)(i)	Measurement and Observation € Recorded *θ* to the nearest º € Accuracy of *θ:* within range 58 to 62º (“ approx. 60^0 “) □ Recorded repeated values of θ.	/1
(a)(ii)	Measurement and Observation € Recorded n to the nearest integer.	/1
	€ Repeated measurements of *n.* € Accuracy: *n* between 7-11	/1
(b)	Determination of *k* € Determined *k* correctly (k = n/tanθ) {Allow ecf} € Number of sf: either 2 or 3 (since θ has 2 sf & n is considered to be error-free)	/1 /1
(c)	Tabulation of 2 more values of θ (including the 1st set), n & k • Recorded both *θ* to the nearest º, { No need to repeat for θ} • Recorded repeated readings of *n* to the nearest integer. • No mark awarded if not tabulated.	/1
	Range of θ € The 2 *θ*s use should be at least 10º difference with 60º and one above 60º and one below 60º.	/1
(d)	€ If *θ* = 90º, both pendulums would have the same length and thus same period. They would then remain in phase indefinitely/would always be in phase/would never go out of phase.	/1
	Total	**8**

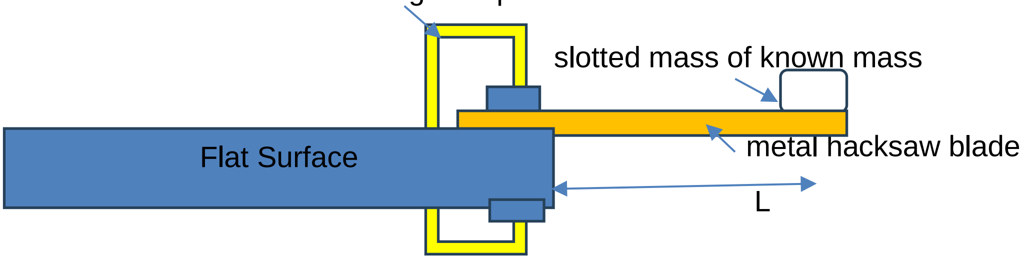
Mark scheme for 2024 SAJC Prelims P4 Q3 (A-lev Pract in 2023)

<table>
<tr><th>No</th><th>Marking Point</th><th>Score</th></tr>
<tr><td>(a)(i)</td><td>Measurement and Observation
€ Recorded at least 2 values each of h and L to nearest mm
€ Recorded average value of h and L to same dp as their raw readings (ie to nearest mm)
€ Accuracy: range of h : 72.0 – 77.0 cm
□ h + L = betw 97.0 – 99 .0cm { NOT = 100 .0 cm }</td><td>/1</td></tr>
<tr><td>(a)(ii)</td><td>€ Calculated h/L correctly.
€ Number of sf for h/L: same number or 1 more sf than the raw data (either h or L,) with the smaller number of sf. {Hence, 3 or 4 sf)</td><td>/1</td></tr>
<tr><td>(a)(iii)</td><td>□ Estimated percentage uncertainty of h/L correctly by adding percentage uncertainty of h (using ⊗h = 3 - 5 mm) and percentage uncertainty of L (using ⊗L = 6 - 8 mm).
□ ⊗L must be > ⊗h { as former has additional uncertainty due to position of it cg }
□ Recorded percentage uncertainty to 1 or 2 sf.</td><td>/1
/1</td></tr>
<tr><td>(b)</td><td>€ Tabulate 5 sets {since only 5 masses provided} of readings, with column headings m, repeated h, repeated L , h/L & correct units.
<table>
<tr><th>m / g</th><th>h1 /cm</th><th>h2 /cm</th><th>L1 /cm</th><th>L2 /cm</th><th>h/L</th></tr>
<tr><td>100</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>200</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>300</td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td><td>/1</td></tr>
</table>

	<table><tr><td>400</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>500</td><td></td><td></td><td></td><td></td><td></td></tr></table>	
	Precision of Recording: For Raw Data, ie for *m, h* and *L:* € Recorded *m* to nearest 100 g (as labelled), *h* to nearest mm and *L to nearest mm* For Calculated Data, ie for h/L □ Correct no. of sf (which takes into account *consistency* within a given column)	/1
(c)(i)	€ Best fit straight line drawn with 5 sets of readings.	/1
(c)(ii)	€ Calculated X correctly (where X = 2/gradient, for graph of h/L vs m	/1
(d)	€ Recorded X to nearest 0.01 g; Accuracy:range betw 80.00 – 130.00 g € Calculated correctly $\frac{\lvert X_1 - X_2 \rvert}{X_2}$ x 100% (X_1 from expt in (c), X_2 measured in (d)) € (Used the percentage uncertainty of (a) (iii) as the criterion.) Concluded that value in (a)(iii) does not explain the difference if $\frac{\lvert X_1 - X_2 \rvert}{X_2}$ x 100% > percentage uncertainty of (a)(iii), or, concluded that value in (a)(iii) does explain the difference if $\frac{\lvert X_1 - X_2 \rvert}{X_2}$ x 100% < percentage uncertainty of (a)(iii).	/1
(e)(i)	Measurement and Observation € Recorded *a* to nearest mm. (range: not assessed, 2.5 – 12.0 cm) € Recorded M = 0.100 kg or value read fr mass balance to nearest 0.01 g. € Recorded *L* to nearest mm. (range: not assessed 12 - 20 cm) € Recorded *u* to nearest mm (if using metre rule). (range: not assessed, u = 1.2 cm) □ Recorded *t* to nearest 0.01 mm (using micrometer). Accuracy: 0.70 -0.80 mm	/1

	€ Repeat measurements of *a & L.* (u & t: not necessary)	/1
	€ Calculated *Y* correctly with the unit GPa (1 GPa = 10^9 Pa)	/1
	€ Number of sf for Y: same no. or 1 more sf than the raw data (among M, L, u, t & g) with the least number of sf.	/1
(e)(ii)	Significant/Major Sources of Error (Any one) € In the measurement of a, uncertainty arises as the reference horizontal axis is imaginary/not well-defined, or, € In the measurement of *a,* uncertainty arises due to the unsteadiness of the hand when holding the rule.	/1
(e)(iii)	Candidates are required to make the correct deduction by comparing *Y* for wood (ie 12 GPa) with the experimental value for the hacksaw blade in (e) (i).)	/1

(f)



€ A diagram similar to Fig.3.2 or a description of a workable set-up. /1

€ Method of measuring length L and mass M:
Use a metre rule &
slotted masses with mass hanger, or a mass balance respectively.

€ Method of determining frequency: /1
Calculate using $f = 1/T$,

€ Method of determining period T:
Calculate $T = t/n$, t = ave oscillation time measured with stopwatch &
n = number of oscillations /1

□ Method of determining Z:
Calculate Z using $Z = M L^3 f^2$, or,
Z= gradient of graph of f^2 vs $1/(ML^3)$

€ Safety precaution: e.g. Place a tray of sand below the setup in case the masses fall off from the blade /1

€ Tabulated 2 sets of results for different values of M & L, with column headings *M, L, t (repeated), n, f and Z & correct units* /1

L/cm	M/g	n	t_1/s	t_2/s	f/s^{-1}	Z/s^{-2} kg m^3
L_1	M_1					
L_2	M_2					

/2

Exemplar of the Written Account:

1. Set up the apparatus as shown.
2. Use a metre rule to measure L & record M, the mass of the slotted mass used.
3. Set the blade into vertical oscillations. Use a stopwatch to measure t, the average time for n number of oscillations.
4. Calculate the period using $T = t/n$.
5. Calculate the frequency $f = 1/T$.
6. Calculate Z by using $Z = M L^3 f^2$.

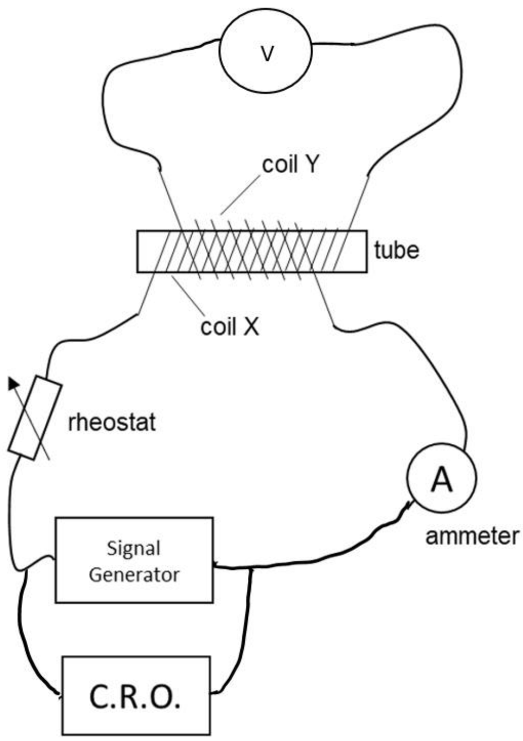
L / m	*M* / kg	*n*	t_1 / s	t_2 / s	*f* / s^{-1}	*Z*/s^{-2} kg m^3

0.256	0.100	35	23.5	23.6	1.48	0.00371
0.155	0.200	45	22.1	22.1	2.04	0.00309

	Total	**22**

Markscheme for Prelim 2024 P4 Q4

V_D **V_{I1}** **V_{I2}**	Dependent Variable: (induced) emf V in coil Y (for both Expts 1 & 2) Independent Variables: • Expt 1: vary f & keep N const. • Expt 2: vary N & keep f const.	1 1
C	Control of Variables: { any 1 } • keep current constant [coil X] throughout both the 2 expts using the rheostat, or, • keep number of turns in coil Y [not coil X] constant	1
	Diagram:	



D	labelled diagram with workable arrangement: signal generator & coil X in series; coil Y wound around coil X	1
P1 **P2**	Expt 1: To det p (keep N const, vary f) Procedure: 1. Connect the circuit as shown in diagram. 2. Connect CRO 1 /voltmeter in parallel across signal generator (can be credited if shown in diagram) 3. Connect CRO 2/voltmeter across coil Y (can be credited if shown in diagram) 4. Use CRO 1 to determine frequency *f* of the current [in coil X]. 5. Measure *V* the induced emf in coil Y using the CRO 2 or AC voltmeter 6. Repeat steps 4 & 5 using different frequencies by varying the frequency of the signal generator to obtain at least 10 sets {NOT:6} of *f* and *V.*	1 1
A1 **P3** **A2**	Analysis: [From $V = k f^{p} N^{q}$, $\lg V = p \lg f + (\lg k + q \lg N)$] Plot a graph of lg V against lg f (Graph 1), ® p = gradient. Expt 2: To det q (keep f const, vary N [in coil X]) Procedure: 1. Connect the circuit as shown in diagram. 2. Record N the number of turns in coil X. 3. Determine *V* the induced emf in coil Y using the CRO. 4. Repeat steps 2 to 3 by winding different number of turns N around coil X to obtain at least 10 sets of *N* and *V.* Analysis: [From $V = k f^{p} N^{q}$, $\lg V = q \lg N + (\lg k + p \lg f)$,] Plot a graph of lg V against lg N (Graph 2), ® q = gradient.	1 1 1
P_S	Safety Precautions: 1. Reference to hot coils – switch off when not in use/use gloves/do not touch coils. Must refer to “hot coils”.	1
P1	Good Features/Details { any 1 } 1. Use insulated wire for coils 2. Increase current in coil X slowly by adjusting the rheostat to obtain preliminary readings to ensure induced emf in coil Y is sufficiently large to be recorded on CRO	1

	3. Use large current in coil X or, large number of coils in coil X (to increase emf V) 4. Use iron core to increase induced emf 5. Details regarding determination of emf using CRO: e.g. Peak Voltage = height × Y-sensitivity, 6. Detail regarding determining frequency from CRO: determine period & then $f = 1/T$, where Period = width of 1 cycle × time-base setting.		
	Total	**11**	