RVHS JC2 Preliminary Examinations Physics Paper 4 Mark Scheme

Question 1

Question	Answer	Marks
1(a)(i)	values of *m* recorded to correct precision with correct units. 2 d.p. in gram range of *m*: 20 g to 30 g	1
(ii)	absolute uncertainty = addition of absolute uncertainty of m_0 and m_1. = $\pm$ 0.02 g percentage uncertainty correctly calculated and given to 1 or 2 s.f.	1
(b)(i)	*p* in the range of 7.0 cm to 9.0 cm with correct precision and unit	1
(ii)	Range of absolute uncertainty Δp : $\pm$ 2 mm to $\pm$ 5 mm percentage uncertainty correctly calculated and given to 1 or 2 s.f.	1

(iii)	**(iv)**
• Difficulty to align bottom edge of cup with the rule • Parallax error when measuring bottom edge of cup	• Attach a light hanging string at the edge as a vertical reference line. • Appropriate method to minimize parallax error (e.g. clamp a grid paper / scaled marking at the side and look perpendicularly at the scale)
• Cup swings / equilibrium is disturbed when taking measurements . • Set square touches edge during measurements; this will sway / move the cup.)	• Use a retort stand to clamp the set square and ruler. Slowly move them into the edge, avoid contact with the hanging cup.
• Difficult to determine edge of cup without marking	• Mark the edge of cup with a marker
Do not accept:	Do not accept:
• imprecise measuring cylinder (*m* is measured accurately using electronic balance)	
• cup not in equilibrium / cup sways, without explanation (e.g. set square touches the dangling cup during measurement)	• switch off the fan / close the window to prevent wind (these are precautions)
	• Clamp the cup. (Cup must be hanging freely)

(c)	Calculations of $\sqrt{p}$ and $\sqrt{m}$ are correct. s.f. of $\sqrt{p}$ and $\sqrt{m}$ follows the s.f. of *p* and *m* respectively.	1
(d)(i)	Points of student plotted correctly.	1
(ii)	BFL evenly distribute points. Anomaly identified and disregarded when drawing BFL	1
(iii)	gradient calculated correctly intercept calculated correctly	1
(iv)	$m = 0$	1
	p calculated correctly from intercept. $p = \text{intercept}^2$	1
(e)(i)	New *p* greater that *p* in **(b)(i)**	1
(ii)	Correct calculation of percentage difference of 2 constants	1
	comparison of percentage difference of constant with percentage uncertainties with correct conclusion	2
(f)	• vary *m* measure θ. or *m* is the independent variable and θ is the dependent variable. • *M* to be kept constant	1
	Valid method to measure θ: either using protractor with parallax error considered. or using correct trigometry with dimensions described and labelled. Valid method to measure *m*: E.g. electronic balance table of measurements with appropriate units: θ in degree or radian; *m* in gram	2
	To find *m* accurately Plot *m* vs θ Range of θ goes <u>beyond 45°</u> Draw a line at $\theta = 45°$, find value of *m* by intersection of lines	1
	To find maximum θ Pour water into cup until it spills (or just about to spill), angle is maximum is θ.	1

	Other comments: • Cup is full ≠ water just about to spill (since cup is tilted, you can't fill up the cup) • Use of $\theta = tan^{-1}\left(\frac{h}{p}\right)$. Draw diagram to illustrate *h* and *p*. *h* and *p* to be measured using metre rule.	

Question 2

Question	Answer	Marks
2(a)	d = 5.79 cm (allow range 5.75 – 5.85 cm) Correct units of cm/mm with appropriate precision, 0.01 cm / 0.1 mm	**1**
2(b)(i)	θ = 54.0 °C Correct units with appropriate precision, 0.5 °C	**1**
2(b)(ii)	ϕ = 6 °C Correct units with appropriate precision, 1 °C $\phi = \theta - \theta_0$ $\Delta\phi = \Delta\theta + \Delta\theta_0 = 0.5 + 0.5 = 1\,^{\circ}\text{C}$ (1 sf)	**1**
2(b)(iii)	absolute uncertainty of ϕ = 1 °C accept 1 to 2 °C Correct units with appropriate precision (1 s.f.)	**1**
2(c)(i)	h = 3.51 cm (allow range 3.30 – 3.70 cm) D = 6.38 cm (allow range 6.20 – 6.50 cm) Correct units of cm/mm with appropriate precision, 0.01 cm / 0.1 mm	**1**

2(c)(ii)	$C = (6.38^3 - 5.79^3) / (6.38 - 5.79) = 111\ cm^2$ Correct calculation, s.f. and units.	**1**
2(d)	$\theta_0 = 60.0\ ^oC$ $\theta = 55.0\ ^oC$ $\phi = 5\ ^oC$ h = 6.48 cm (allow range 6.30 – 6.70 cm) D = 6.85 cm (allow range 6.70 – 7.00 cm) $C = (6.85^3 - 5.79^3) / (6.85 - 5.79) = 120\ cm^2$ Value of ϕ is less than that in (b)(ii). Correct calculation of C. Correct s.f. and units for all values.	**2**
2(e)(i)	Units of Y = K $m^{1.5}$ (or Y = $^oC\ m^{1.5}$) Correct substitutions to determine different values of Y. Calculate the average Y value with correct units.	**1** **1**
2(e)(ii)	Thicker cup affects the accuracy of value of D. Since accuracy of C is dependent on the accuracy of D. Hence the accuracy of value of Y will be affected as well as given in the relationship in (e)(i).	**1**

Question 3

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(b)(i)</td><td>x = 10.0 cm

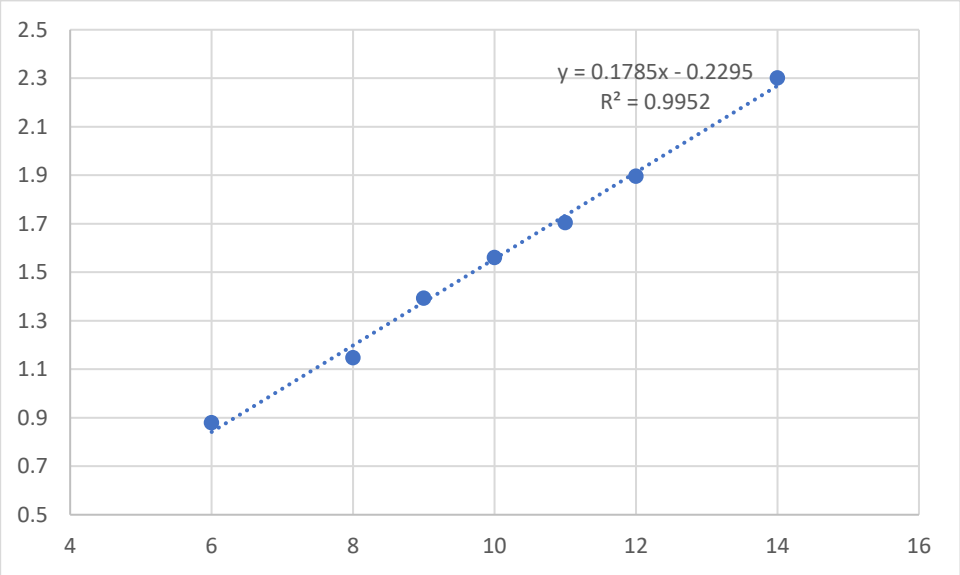
Correct units of cm/mm with appropriate precision, 0.1 cm / 1 mm</td><td>1</td></tr>
<tr><td>3(b)(ii)</td><td>
<table>
<tr><td>n</td><td>x/cm</td><td>t1 / s</td><td>t2 / s</td><td>T / s</td></tr>
<tr><td>20</td><td>10.0</td><td>31.20</td><td>31.23</td><td>1.561</td></tr>
</table>

Correct units of cm/mm with appropriate precision for all values
Show repeated values for t.
Include the number of oscillations in working.</td><td></td></tr>
<tr><td>3(b)(iii)</td><td>
<table>
<tr><td>n</td><td>x/cm</td><td>t1 / s</td><td>t2 / s</td><td>T / s</td></tr>
<tr><td>20</td><td>6.0</td><td>17.56</td><td>17.66</td><td>0.8805</td></tr>
<tr><td>20</td><td>8.0</td><td>22.98</td><td>22.95</td><td>1.148</td></tr>
<tr><td>20</td><td>9.0</td><td>27.74</td><td>27.99</td><td>1.393</td></tr>
<tr><td>20</td><td>10.0</td><td>31.20</td><td>31.23</td><td>1.561</td></tr>
<tr><td>20</td><td>11.0</td><td>33.88</td><td>34.32</td><td>1.705</td></tr>
<tr><td>15</td><td>12.0</td><td>28.20</td><td>28.70</td><td>1.897</td></tr>
<tr><td>15</td><td>14.0</td><td>35.13</td><td>33.94</td><td>2.302</td></tr>
</table>

Tested with values beyond the range stated in question to verify the trend in the experiment.

<u>Data collection</u>
• Award 2 marks, if candidate has successfully collected 6 or more sets of data without assistance/intervention
• Award 1 marks, if candidate has successfully collected 5 sets of data without assistance/intervention
• Award 0 marks, if candidate has successfully collected 4 or fewer sets of data without assistance/intervention

<u>Presentation of data</u>
• All raw data of x and t to the correct precision
• All processed values to follow s.f. of raw data
• All processed values to be calculated correctly
• N column is optional, as long as number of oscillations clearly stated
• Deduct 1 mark if candidate recorded T / s, without any t / s column
• Deduct 1 mark if no repeated readings for t / s
• Deduct 1 mark if t<10s for t / s
• Deduct 1 mark if split table
• Deduct 1 mark for incorrect trend</td><td>4</td></tr>
</table>

Graph	 (Gradient triangle) – larger than half the size of the graph with correct coordinates (do not mark out coordinates). Accept dashed lines (without coordinates) as long as lines are accurately drawn and substitution correctly done in working. Accept labelled coordinates (without dashed lines) Axes labelled with quantity plotted (T against x) and correct unit (allow ECF from table); appropriate scale chosen such that plotted points occupy at least half the graph grid in both *x* and *y* directions Straight line of best fit – judge by scatter of points about the candidate's line. There must be a fair scatter of points either side of the line. All observations must be plotted. Work to an accuracy of half small square. Do not award this mark if pencil markings of points are half smallest-square thick or more.	**3**
3(c)	Linearisation statement – plot a graph of *T* against x, where gradient is P and y-intercept is Q. P = 0.179 m^{-1} s (accept range from 0.12 to 0.25) Q = - 0.230 s Values of P falls within expected range. Show correct read off of coordinates. Calculated correctly values with correct units.	**2**
3(d)	Both magnets will be attracted to each other, making oscillations impossible. The period is too short. Accept any reasonable answers with clear explanations.	**1**

Question 4

Answer	Marks
Labelled diagram of apparatus	
Layout: - Light source, glass sheet and photocell in line.	1
Electrical: - Voltmeter connected to photocell. - Light bulb connected to power source (if variable, no need rheostat) and ammeter in series, with voltmeter in parallel to light bulb.	1
Defining the problem	
- *n* is the independent variable and *V* is the dependent variable or vary *n* and measure *V* - *t* is the independent variable and *V* is the dependent variable or vary *t* and measure *V*	1
- keep distance from light bulb to photocell constant - to be done by either marking out on the lab bench/table or using a metre rule to monitor	1
- keep intensity of light constant. - To use voltage across lamp and current through light bulb to monitor power dissipation	1
Methods to data collection	
- Measure thickness of glass sheet - To use micrometre screw gauge	1
- Take repeated readings of thickness, at different locations and take average	1
- Repeat steps (for at least 1 set of experiment) to collect at least 6 sets of reading	1
Method of analysis	
- For thickness, t, as a constant (control) - Plot a graph of ln V against n - Where gradient = $-\propto t$ and y-intercept = ln V_0 (must match analysis with Definition of Problem) - therefore $\propto = -\frac{gradient}{t}$ Both must be present for credit - For number of sheets, n, as a constant (control) - Plot a graph of ln V against t Where gradient = $-\propto n$ and y-intercept = ln V_0 (must match analysis with Definition of Problem) - therefore $\propto = -\frac{gradient}{n}$	1
Safety / Precautions	Max 1
- Reasoned method to prevent burns from <u>hot</u> light bulb, e.g., use gloves	
- Reasoned method to prevent eye damage from <u>bright/intense</u> source, e.g., shield lamp/dark glasses/do not look at source directly	
Additional details / Accuracy	Max 2
- Take preliminary readings such that appropriate distance/intensity to provide sufficiently large e.m.f. reading	
- Clean sheets of glass before use	
- Constant orientation of light bulb with respect to the sheet-photocell setup	
- Ensure glass sheets are close to each other by binding glass sheets up in a tight stack	
- Apply liquid, that has similar optical density/property to the glass sheets, in between the layers to remove any air gaps	
- Perform experiment in a dark room/shield apparatus from ambient/surrounding light (so that light detected will only be from filament bulb)	
Do not allow vague computer methods	
Total =	12