DHS H2 Physics Y6 Prelim Exam 2023 Paper 4 Mark Scheme

<table>
<tr><th>Qn</th><th>Marking Point</th><th>Marks</th></tr>
<tr><td>1(b)(ii)</td><td>I recorded to the nearest 0.1 mA and correct unit.</td><td>1</td></tr>
<tr><td>1(c)</td><td>Quality of raw readings:

3 marks for 8 - 7 sensible readings ($\pm 5\ mA$)
2 marks for 6 - 5 sensible readings ($\pm 5\ mA$)
1 mark for 4 sensible readings ($\pm 5\ mA$)
0 mark for 3 or fewer readings

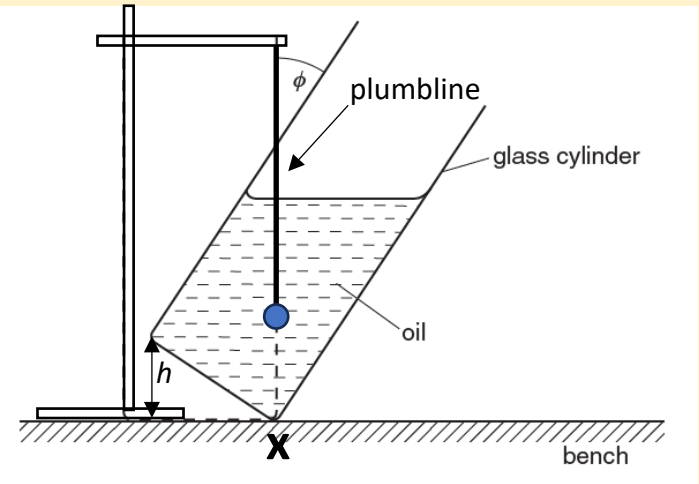
<table>
<tr><th>R / Ω</th><th>I / mA</th><th>P / W</th></tr>
<tr><td>10</td><td>31.8</td><td>0.0101</td></tr>
<tr><td>20</td><td>28.4</td><td>0.0161</td></tr>
<tr><td>33</td><td>24.3</td><td>0.0195</td></tr>
<tr><td>43</td><td>21.7</td><td>0.0202</td></tr>
<tr><td>50</td><td>20.2</td><td>0.0204</td></tr>
<tr><td>60</td><td>18.4</td><td>0.0203</td></tr>
<tr><td>70</td><td>16.8</td><td>0.0198</td></tr>
<tr><td>100</td><td>13.4</td><td>0.0180</td></tr>
</table></td><td>3</td></tr>
<tr><td></td><td>Correct calculation of P, to the correct significant figures (3 s.f.).</td><td>1</td></tr>
<tr><td>1(d)</td><td>All observations must be plotted. Work to an accuracy of half a small square.</td><td>1</td></tr>
<tr><td></td><td>Correct shape (curve).</td><td>1</td></tr>
<tr><td></td><td>Best-fit curve drawn correctly - judge by scatter of points about the line drawn. There must be an even distribution of points on either side of the line. Line must not be kinked.</td><td>1</td></tr>
<tr><td>1(e)</td><td>Value of R with unit read off correctly at maximum value of P.
Acceptable range 40 to 60 Ω.</td><td>1</td></tr>
<tr><td></td><td>TOTAL MARKS FOR Q1:</td><td>9</td></tr>
</table>

Qn	Marking Point	Marks
2(a)(i)	Value of M in the range 10.0 to 11.0 g with unit and to the correct decimal placing (3 d.p.).	**1**
2(a)(ii)	Correct calculation of m dividing M by 25, with unit.	**1**
2(a)(iii)	Justification for significant figures in m linked to the s.f. in M. (5 s.f.).	**1**
2(b)(i)	Value of S in the range 1.0 – 2.0 g with consistent unit.	**1**
2(b)(ii)	Correct calculation of c.	**1**
2(c)(i)	Values of p and q such that $p + q = 25$	**1**
	Evidence of repeated values of p.	**1**
2(c)(ii)	Percentage uncertainty in p based on absolute uncertainty of 1 or 2, recorded to maximum of 2.s.f.	**1**
2(d)	Quality: second value of q less than first value of q.	**1**
2(e)(i)	Two values of k calculated correctly, and unitless.	**1**
2(e)(ii)	Valid comment consistent with calculated values of k, testing against a criterion stated by the candidate. Calculated correctly $\%k_{\text{difference}} = \frac{\Delta k}{k_{ave}} \times 100\%$ (1 Mark) Chose a criterion from the value in 2(c)(ii). (1 Mark) Concluded that results do not support the suggestion if $\%k_{\text{difference}}$ > the criterion chosen. OR Concluded results support the suggestion if $\%k_{\text{difference}} \leq$ the criterion chosen.	**2**
	TOTAL MARKS FOR Q2:	**12**

Qn	Marking Point	Marks
3(b)(i)	Value of l recorded with correct unit to nearest 1 mm. Range of l between 45.0 – 55.0 cm. Evidence of repeated readings.	**1**
3(b)(ii)	Percentage uncertainty based on absolute uncertainty $0.2 \geq \Delta l \geq 0.5$ cm recorded to maximum of 2.s.f.	**1**
3(c)(i)	Value of t recorded with correct unit to 0.1 s. Evidence of repeated readings.	**1**
3(c)(ii)	Percentage uncertainty based on absolute uncertainty $0.2 \geq \Delta t \geq 0.5$ s recorded to maximum of 2.s.f.	**1**
3(d)	Values of l, t recorded to correct d.p. and units.	**1**
	Quality: second value of t is less than value in (c)(i).	**1**
3(e)(i)	Two values of k calculated correctly.	**1**
	Units of k given correctly. ($m^{0.5}\ s^{-1}$)	**1**
3(e)(ii)	Justification for s.f. in k linked to the s.f. in t and l. (least number of s.f. among them.).	**1**
3(e)(iii)	Valid comment consistent with calculated values of k, testing against a criterion stated by the candidate. □ Calculated correctly $\%k_{difference} = \frac{\Delta k}{k_{ave}} \times 100\%$ (1 mark) □ Chose a criterion from the SUM of 3(b)(ii) and 3(c)(ii) (1 mark) □ Concluded that results do not support the suggestion if $\%k_{difference}$ > the criterion chosen. OR Concluded results support the suggestion if $\%k_{difference} \leq$ the criterion chosen.	**2**
3(e)(iv)	Number of times calculated correctly, using 60 / t.	**1**
3(f)	Possible sources of errors: • It is difficult to judge when the pendulums are exactly lined up, affecting t. • It is difficult to judge exactly the centre of the bob, affecting length l. • 2 values of k are not enough to draw a valid conclusion.	**1**
3(g)(i)	All 5 points plotted correctly (to half a small square).	**1**
	Line of best fit drawn correctly (judge by scatter of points about the line drawn. There must be an even distribution of points on either side of the line. Line must not be kinked.	**1**
3(g)(ii)	Gradient calculated correctly.	**1**

3(g)(iii)	Vertical intercept calculated correctly to be non-zero. Correct conclusion: Since the graph **does not pass through the origin**, $\frac{1}{t}$ is not directly proportional to $\frac{1}{\sqrt{L}}$	**1** **1**
3(h)	Diagram correctly drawn and labelled. (single pendulum, clamped to a retort stand which is resting on a table.)	**1**
	Correct procedure with appropriate measuring instruments used: • Measure mass using electronic mass balance. • Measure time taken *t* for *N* oscillations using a stopwatch. • Calculate period *T* using $T = t / N$ (must be stated).	**1**
	Correct control of variable (length of string *L*) with appropriate measuring instrument used (metre rule).	**1**
	Correct analysis: Plot a graph of *T* against *m.* If the relationship is valid, a straight line passing through the origin will be obtained.	**1**
	TOTAL MARKS FOR Q3:	**22**

Question 4 Mark Scheme

	Marking Point	Marks
	Problem Definition A1: identify independent and dependent variables. Dependent variable: ϕ. (or tan ϕ.), maximum angle from vertical before the cylinder topples. Independent variable (for expt 1): m, mass of oil in the cylinder Independent variable (for expt 2): d, diameter of the cylinder A2: identify 1 correct control variable. Possible control variables: density of oil, type of glass cylinder (same shape, material).	**1** **1**
	Labelled Diagram  **X** marks the spot to tilt cylinder B1: labelled diagram drawn.	**1**
	Method of Data Collection B2: identifying 2 experiments required (experiment 1: vary mass, keep diameter constant; experiment 2: vary diameter, keep mass constant) B3: method to determine the different masses of oil in the cylinder, using electronic mass balance. (measure the mass m_0 of the empty cylinder, then pour the oil into the cylinder and measure the total mass m_T. Mass of the oil $m = m_T - m_0$) B4: method to determine the different internal diameters of cylinder, using a vernier calipers. (measure the internal diameter d of the cylinder using the internal (inside) jaws of the vernier calipers) B5: procedure to determine angle properly stated. (Mark a point on bench (**x**) and slowly (gently/gradually) tilt the cylinder of oil until the cylinder is just about to topple. Measure the angle ϕ using a protractor.)	**1** **1** **1** **1**

B6: Feasible details of determining angle ϕ. (either by having a plumbline or using trigonometry by finding *h* (to be labelled clearly). (Measure the angle ϕ using a protractor and a plumbline mounted on a retort stand with the plumbline aligned vertically with the point (**x**) marked on the bench) OR At the point when the cylinder is just about to topple, measure the height of the raised edge of the cylinder, *h*, using a metre rule. The angle ϕ is equal to $\sin^{-1}(h/d)$	**1**
<u>Method of Analysis</u> C1: linearisation of relationship $\ln(\tan\phi) = \ln(k) + p\ln(d) + q\ln(m)$ C2: Expt 1: plot $\ln(\tan\phi)$ against $\ln(m)$, straight line with gradient *q,* y-intercept $\ln(k) + p\ln(d)$ Expt 2: plot $\ln(\tan\phi)$ against $\ln(d)$, straight line with gradient *p,* y-intercept $\ln(k) + q\ln(m)$	**1** **1**
<u>Safety (max 1)</u> D1: Safety correctly identified and explained. Wear gloves to handle the cylinder to prevent skin irritation if the oil spilled onto the hand. OR Place padding (or items with cushioning effects) to prevent glass cylinder from breaking if fallen.	**1**
<u>Additional details: (max 3)</u> E1: Place sandpaper (or any rough material) on the bench to prevent sliding of the cylinder. E2: Measure diameter of cylinder *d* in different directions and take average to reduce random errors. E3: Use of video with slow motion playback to determine ϕ.. E4: take preliminary measurements to establish an approximate angle ϕ. before redoing the experiment by positioning the cylinder near ϕ. for fine-tuning. E5: Use large protractor with higher precision to reduce percentage uncertainty.	**3**
MAXIMUM TOTAL MARKS FOR Q4:	**12**