- 2022 Sec 4 Physics PRELIM Paper 3 – Solution

Question	Answer
1a (i)	Measurement to be done using the vernier caliper. 2 d.p in cm for d_1. Accept 3 d.p in m. d_1 = 0.71 cm Range of 0.69 – 0.73 cm accepted
a (ii)	Measurement to be done using the vernier caliper. 2 d.p in cm for d_2 Accept 3 d.p in m. d_2 = 0.72 cm d_{ave} = 0.72 cm Range of 0.69 – 0.73 cm accepted Both answers must be correct to get the 1 mark
a (iii)	Measurement to be done using 50 cm ruler 1 d.p in cm for *l* and *x* Accept 3 d.p in m l = 1.0 cm x = 1.5 cm Accept 0.9 cm – 1.1 cm for l Accept 1.3 cm - 1.7 cm for x
a (iv)	Correct calculation for A. Express value of A to 2 / 3 s.f. A = 2.49 cm^2

<table>
<tr><td>b(ii)</td><td>Value of n to whole number.

n_{rice} = 3 (range of 2 to 7 accepted.)</td></tr>
<tr><td>c</td><td>Correct calculation for μ. Express value of μ to 2 / 3 s.f.

μ_{rice} = 0.803</td></tr>
<tr><td>d</td><td>Value of n should be larger than in b(ii).
n_{sand} = 15

Correct calculation for μ. Express value of μ to 2 / 3 s.f.
μ_{sand} = 4.02</td></tr>
<tr><td>e</td><td>
<table>
<tr><th>limitation</th><th>improvements</th><th>Not accepted</th></tr>
<tr><td>2 readings insufficient for a conclusion</td><td>Take more readings and compare values of</td><td>Repeat/ too few readings</td></tr>
<tr><td>Difficult to keep drop height og 3 cm constant</td><td>Mount a protractor/ marker to makr out height</td><td>Difficult to release strip without a force</td></tr>
<tr><td>Difficult to judge when the mark reaches surface as rice level is uneven</td><td>Measure change of height of pencil/ place a piece of paper on rice around pencil</td><td>Rice spills out during the experiment.</td></tr>
<tr><td>Conical section of pencil not taken into account affecting l</td><td>Use a flat ended rod/ thinner pencil</td><td></td></tr>
</table>
</td></tr>
<tr><td>2ai</td><td>All readings recorded to correct precision of instrument with unit.

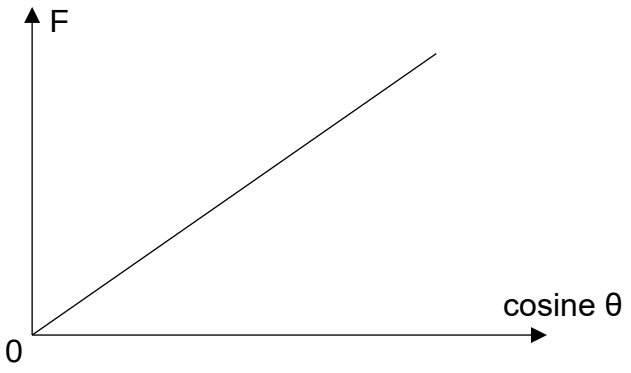
1 dp in cm for l_0
Accept 3 dp in m

Teacher’s value: l_0 = 2.1 cm.</td></tr>
<tr><td>aii</td><td>All readings recorded to correct precision of instrument with correct unit.

1 dp in cm for l_1, , e_0
2 dp in N for F_1

Teacher’s value:
l_1 = 4.1 cm.
e_1 = 2.0 cm
F_1 = 0.60 N</td></tr>
<tr><td>aiii</td><td>k correctly calculated with unit and correct s.f.

Teacher’s value: k = 0.30 N / cm</td></tr>
<tr><td>b(ii)</td><td>l_2 is measured to the correct d.p</td></tr>
</table>

	e_2, correctly calculated with unit and correct s.f. $l_2 > l_1$ $e_2 > e_1$ Teacher's value: l_1 = 7.8 cm e_1 = 5.7 cm
(iii)	F_2 is correctly calculated with unit and correct s.f (least number of sf between k and e_1) F_2 = 1.7 N
(c)	**Proposed Solution** **Independent variable:** angle of inclination, θ **Dependent variables:** e_o or the force required to applied to the object, F **Constant variables:** spring of same spring constant, mass of wooden block and metal masses, frictional co-efficient of the surfaces, surface area of the block in contact with the table, **Description of experiment:** • Set up the experiment as shown in Fig. 2.3. • Raise the spring such that loop of string is now at an angle with the horizontal. • Measure the angle made by the string with the horizontal and adjust the angle to 10º. Record this angle as θ. • Pull the spring until the block just begins to slide on the bench. Record the stretched length of the spring and record this as l. • Using the spring constant and l_0 from the previous experiment, determine the spring force F acting on the block. • Repeat the experiment to obtain at least 4 more values of θ, with a range of at least 30º and its corresponding e_0 and F, using the same number of mass on the wooden block. • Tabulate the results. Include in the table the values of θ, *cos* θ, e_0, l, e and F. θ/ º | *cos* θ | *l*/ cm | e/ cm | F/ N • Plot a graph of force, F against cosine of angle of inclination. If the suggested relationship is correct, the graph with be straight line **passing through the origin.** 

3(b)	*V* and I is measured and recorded to the correct d.p *V* = 1.40 V (precision is 0.05 V) I = 0.10 A (precision is 0.01 A)
c(i)	*R* is calculated correctly and recorded to the correct sf (follow the least number of sf between *V* and I) and correct unit. *R* = 14 Ω
c(ii)	*y* is calculated correctly and recorded to the correct sf (follow the least number of sf between *R* and *L*) and correct unit. *y* = 28 Ω / m

d	Marking Points (Total of 6) Table with quantities *L*, *V, R* and *y,* with correct units. At least 5 sets of reading including the results from (c) Min. range of 0.800 m for *L* (accept at least 0.600 from the students) *L and V are recorded to the correct dp, and R and y and recorded to the correct sf.* R, y and 1/*L* are correctly calculated Correct trend – *V* increases as *L* increase (with I constant)

L / m	V / V	I / A	R / Ω	y / Ω m^{-1}	1/L / m^{-1}
0.000	0.50	0.10	5.0	NA	NA
0.100	0.65	0.10	6.5	65	10.0
0.200	0.85	0.10	8.5	43	5.00
0.300	1.00	0.10	10	33	3.33
0.400	1.20	0.10	12	30	2.50
0.500	1.40	0.10	14	28	2.00
0.600	1.65	0.10	17	28	1.67
0.700	1.80	0.10	18	26	1.43
0.800	2.00	0.10	20	25	1.25
0.900	2.20	0.10	22	24	1.11
1.000	2.40	0.10	24	24	1.00

Note: Column for I / A is not required since I is constant throughout.

e	Marking Points (Total of 4) 1. Axes labelled with units, correct orientation and starting value (no collapsed scale symbol is allowed)
	2. Suitable scale, not based on 3, 6, 7 etc with plotted data occupying at least half the graph paper in both directions.
	3. All points plotted correctly (points must be less than ½ small square from the correct position).
	4. Draw best fit **straight line.**
f(i)	Coordinates of points used to calculate the gradient to be written and the triangle of suitable size to be drawn on the graph. Correct calculation of gradient using the coordinates written on the graph and with correct s.f (accept 2 or 3 sf). Teacher's Value: 4.58
f(ii)	Evidence in using correct method to determine C using the vertical intercept. C is correctly determined and recorded with the correct unit. If determined using calculation, accept 2 or 3 sf. If determined directly from graph, the value will follow precision of the graph (follow dp). Teacher's Value: 19.2
h	From the results, the potential difference across the resistance wire is dependent on the length of resistance wire. Hence, in order to vary this potential difference, lamp should be connected parallel with the resistance wire (i.e replaced voltmeter with the lamp).