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CORPUS CHRISTI COLLEGE
SEQUERE DOMINUM

12 ATAR Physics

Circular Motion Validation

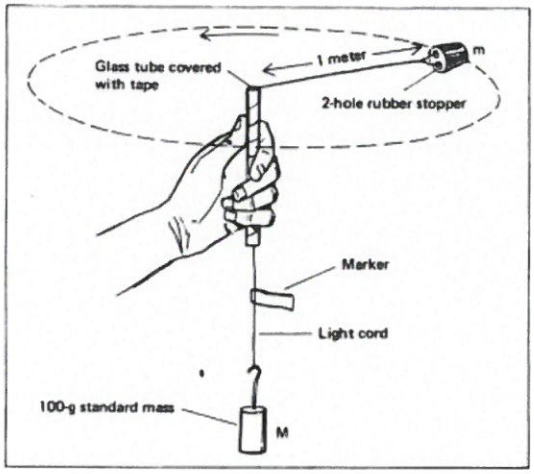
4.0%

Term 4 - 2017

Student name: Soln.

Experimental outline:

When the plastic tube is moved in a small circle above your head, the rubber cork moves around in a horizontal circle at the end of a string that passes through the tube and has a mass hanger with slotted masses suspended from its lower end.



Experimental data:

Table 1

	Radius (m)	Time for 10 revolutions (s)		Period (s)	Period^2 (s^2)
		Trial 1	Trial 2		
1	0.20	2.03	2.25	0.21	0.046
2	0.34	2.61	2.55	0.26	0.07
3	0.42	3.17	3.22	0.32	0.10
4	0.49	3.41	3.59	0.35	0.12
5	0.53	3.54	3.64	0.36	0.13
6	0.69	3.90	3.71	0.38	0.14
7	0.75	4.22	4.39	0.43	0.19
8	1.02	5.09	5.05	0.51	0.26

sf ✓

sf ✓

1. The mass of the rubber stopper was measured as 22.6 grams. Write the correct mass in kg. **(1 mark)** (22.6×10^{-3}) kg (1)

2. Complete table 1, rows 2 to 7, for period and period^2. **(4 marks)** (4)

(AVE) ✓ (÷10) ✓, CORRECT ANS ✓, T^2 UNITS ✓

3. Complete table 1, rows 1 and 8, for period and period^2. Write the values of period^2 using the correct significant figures. **(3 marks)** (3)

CORRECT SF ✓✓, CORRECT ANS ✓

4. Use the data from table 1 to sketch a graph of radius (r) versus period^2 (T^2) on the graph paper provided on the next page.

a) Show appropriate labels and units. (SEE GRAPH) **(2 marks)** (2)

b) Carefully plot the data from table1. (SEE GRAPH) **(3 marks)** (3)

c) Sketch the best-fit line for this data. (SEE GRAPH). **(2 marks)** (2)

5. Calculate the gradient of your graph.

a) Show the points used on the graph. (SEE GRAPH) **(1 mark)** (1)

b) Calculate the gradient of the line including correct units. **(4 marks)** (4)

c) Write the equation of the straight line below. **(3 marks)** (3)

$r = 4.17 T^2$ ✓ ✓

$y = 4.17 x^2$ ✓ (ONE MARK ONLY)

6. Why have we chosen to graph r v's T^2 and not r v's T? **(3 marks)**

- r V'S T^2 GIVES A STRAIGHT LINE. ✓
- r V'S T GIVES A CURVE. ✓
- SIMPLER TO ANALYSE A STRAIGHT LINE MATHEMATICALLY. ✓

(3)

7. What can you say about the relationship between r and T^2? **(3 marks)**

r IS DIRECTLY PROPORTIONAL TO T^2 SINCE THE GRAPH IS A STRAIGHT LINE THROUGH (0,0). ✓

(3)

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8. Calculate the speed of the 2-holed rubber stopper for the first data point of table 1.
(3 marks)

$$V = \frac{2\pi r}{T} = \frac{(6.28)(0.20)}{0.21}$$

$$V = 5.98 \text{ ms}^{-1}.$$

3

9. Calculate the centripetal force (F_c) acting on the 2-holed rubber stopper for the first data point of table 1.
(3 marks)

$$F_c = \frac{mv^2}{r} = \frac{(0.0226)(5.98)^2}{0.2}$$

$$\therefore F_c = 4.1 \text{ N}.$$

3

10. Given that the mass of the slotted masses is 350 grams, compare the value of F_c (above) to that of the weight. Express the comparison value as a percentage difference.
(5 marks)

$$Wt = mg = (0.35)(9.8) = 3.43 \text{ N}.$$

$$\% \text{ DIFF} = \frac{4.1 - 3.43}{3.43} \times 100\%$$

$$= 19.5\%$$

$\therefore$ 19.5% DIFFERENT.

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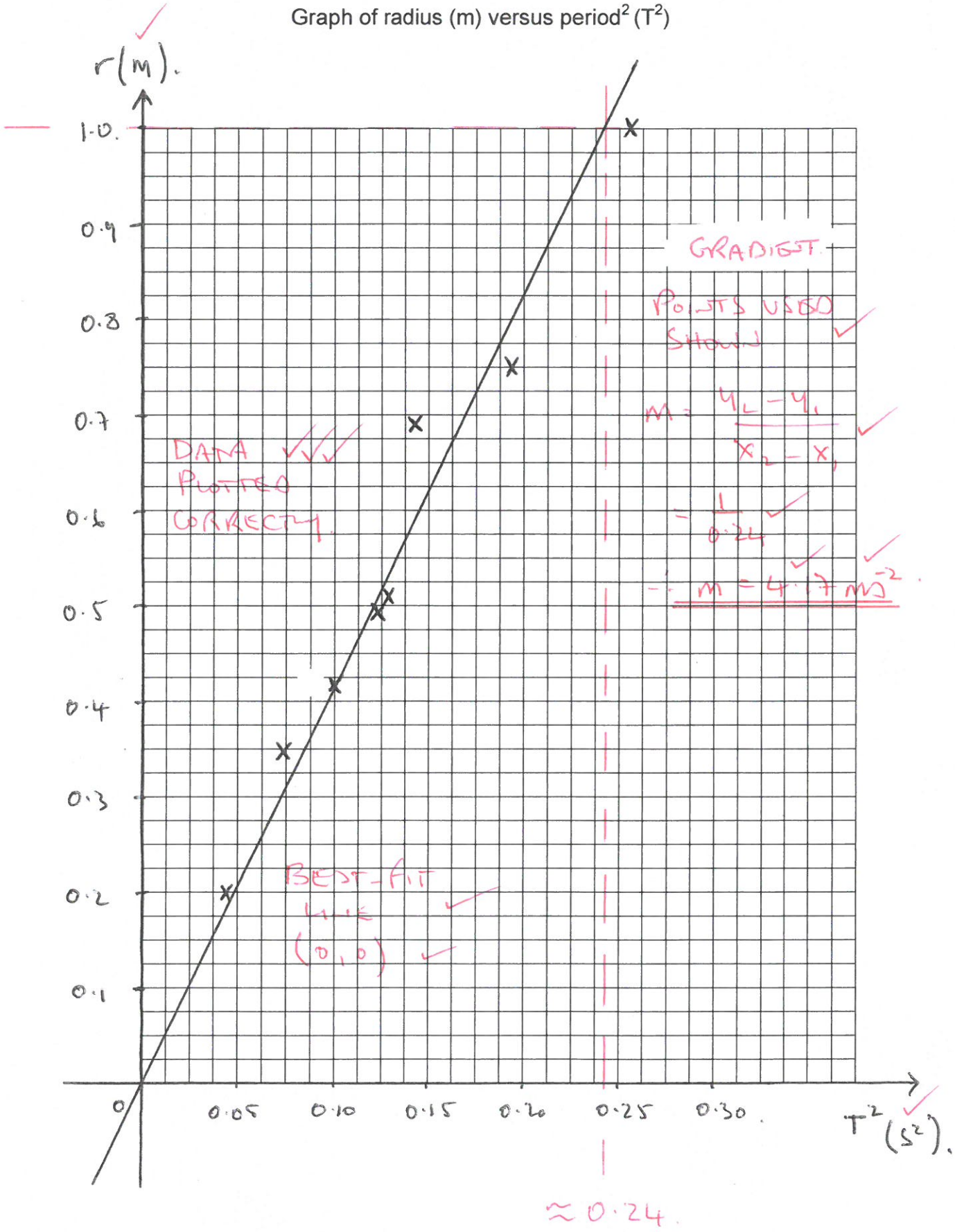
Graph of radius (m) versus period^2 (T^2)



11. The three main formulae used in this experiment are:

$$v = \frac{2\pi r}{T} \qquad F_c = \frac{Mv^2}{r} \qquad F = mg$$

a) Use these to show: **(4 marks)**

$$r = \frac{mg}{4\pi^2 M} T^2$$

Where **M** = mass of stopper and m = slotted masses

$$F_c = \frac{Mv^2}{r} = \frac{M}{r} \times \left(\frac{2\pi r}{T}\right)^2 \checkmark$$

$$= \frac{M 4\pi^2 r^2}{r T^2}$$

$$= \frac{M 4\pi^2 r}{T^2} \checkmark$$

(4)

But this equals mg.

$$\therefore \frac{M 4\pi^2 r}{T^2} = mg \checkmark \quad \text{(NOT SAME m!!)}.$$

$$\therefore r = \frac{mg}{M 4\pi^2} T^2. \checkmark$$

(4)

b) Use the formula shown in 11(a) to calculate a theoretical value for the gradient and use this value to compare with the value calculated in 5(b). Express the difference as percentage value. **(4 marks)**

$$\frac{mg}{M4\pi^2} = \frac{(0.35)(9.8)}{(22.6\times10^{-3})4\pi^2} = 3.85 \checkmark$$

$$\%\ \text{Diff} = \frac{4.17 - 3.85}{3.85} \times 100\% = 8.31\% \checkmark \checkmark$$

(4)

$\therefore$ 8.31% Diff. ✓

12. Briefly explain why 10 revolutions were used. **(2 marks)**

- TO REDUCE THE ERROR OF TIMING THE REVOLUTIONS.

(OR)

- TO REDUCE RANDOM ERROR. ✓✓

(2)

13. List two sources of error that you encountered during this experiment and explain how they affected your results. **(4 marks)**

(1) IT IS DIFFICULT ✓ TO MAINTAIN A HORIZONTAL CIRCLE. THIS CAUSES AN ERROR IN CALCULATION OF F_c. ✓

(2) IT IS DIFFICULT ✓ TO DETERMINE THE START/STOP POSITIONS OF THE REVOLUTION. THIS CAUSES AN ERROR IN CALCULATION OF V & V^2. ✓

(4)

(10)