HOLY CROSS COLLEGE

Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2018

Question/Answer Booklet

12 PHYSICS

Name SOLUTIONS

Practical Test - Circular Motion

Student Number: In figures | | | | | | | | |

Mark: 54

In words _____

_____

Time allowed for this paper

Reading time before commencing work: five minutes
Working time for paper: sixty minutes

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet
Formulae and Data Booklet

To be provided by the candidate

Standard items: pens, (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

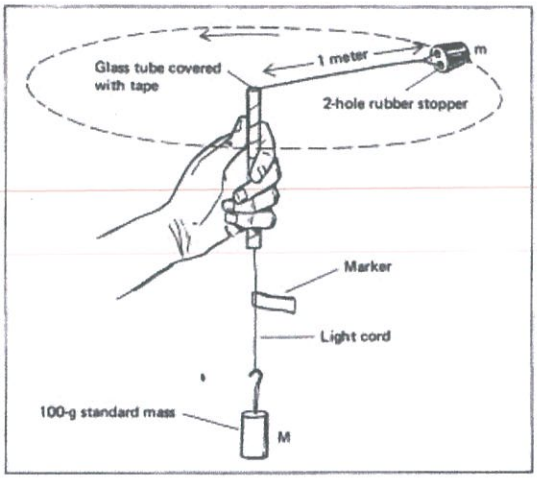
Special items: non-programmable calculators satisfying the conditions set by the School Curriculum and Standards Authority for this course

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

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	0·044
2	0.34	2.61	2.55	0·26	0·068
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

(1) (1) (1) (2) (1) 5 sig. fig. (1)

1. The mass of the rubber stopper was measured as 22.6 g. Write the correct mass in kg. **(1 mark)**

0·0226 kg (1)

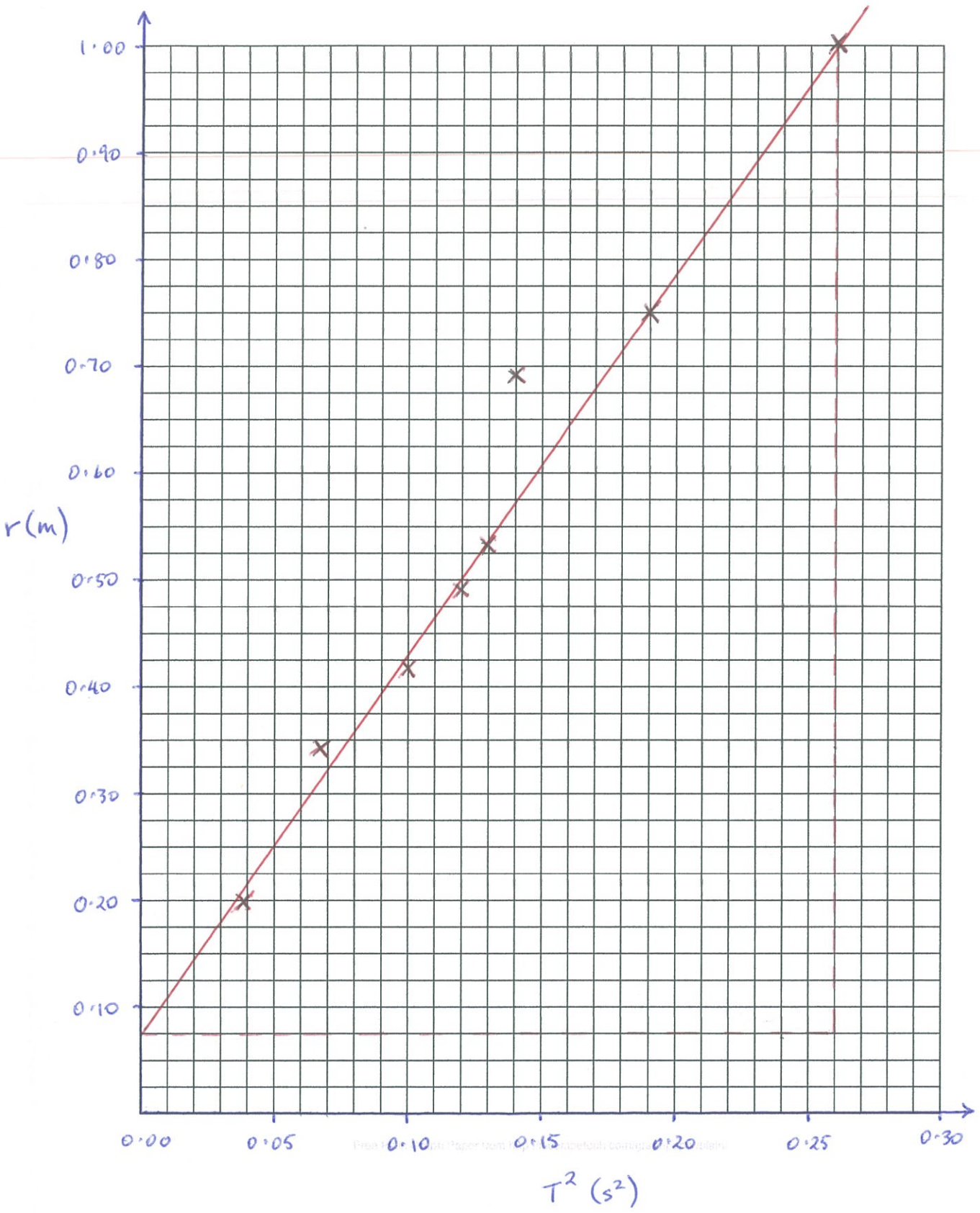
2. Complete table 1, rows 2 to 7, for period and period^2. **(4 marks)**

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)**

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.

   - Show appropriate labels and units. **(2 marks)**
   - Carefully plot the data from table1. **(3 marks)**
   - Sketch the best-fit line for this data. **(2 marks)**

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



Labels + units - 2 marks

Plotting - 3 marks

Line of best fit - 2 marks

5. Calculate the gradient of your graph.

(a) Show the points used on the graph. 2 points - 1 mark **(1 mark)**

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

$$\text{gradient} = \frac{\Delta \uparrow}{\Delta T^2}$$

$$= \frac{1.00 - 0.075}{0.26 - 0.00} \quad (2)$$

$$= 3.6 \text{ ms}^{-2}$$

↑ (1) ↑ (1)

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

$\uparrow = 3.6 T^2$ (3)

[$y = 3.6x^2$ - 1 mark].

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

- $\uparrow$ vs T → gives a curve. (1)
- $\uparrow$ vs T^2 → gives a straight line graph. (1)
- gradient can be used to analyse the relationship. (1)

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

- $r \propto T^2$ (2)
- Graph is a straight line. (1)

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

(3 marks)

$$v = \frac{2\pi r}{T} \quad (1)$$

$$= \frac{2\pi(0.20)}{0.21} \quad (1)$$

$$= \underline{6.0 \text{ ms}^{-1}} \quad (1)$$

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

(3 marks)

$$F_c = \frac{mv^2}{r} \quad (1)$$

$$= \frac{(0.0226)(6.0)^2}{0.20} \quad (1)$$

$$= \underline{4.1 \text{ N}} \quad (1)$$

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

(5 marks)

$$F_w = mg$$

$$= (0.35)(9.8) \quad (1)$$

$$= 3.4 \text{ N} \quad (1)$$

$$\% \text{ difference} = \frac{(4.1 - 3.4)}{3.4} \times \frac{100}{1} \quad (2)$$

$$= \underline{21\%} \quad (1)$$

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

The weight of the brass masses provides the centripetal force.

ie. $F_W = F_c$ (1)

$\Rightarrow mg = \frac{Mv^2}{r}$ (1)

$\Rightarrow mg = \frac{4\pi^2 Mr}{T^2}$ (1)

$\Rightarrow r = \frac{mgT^2}{4\pi^2 M}$ (1)

(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)**

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

$\Rightarrow \text{gradient} = \frac{(0.35)(9.80)}{4\pi^2(0.0226)}$ (1)

$= 3.8 \text{ ms}^{-2}$ (1)

$\%\text{ difference} = \frac{(4.1-3.8)}{3.8} \times \frac{100}{1}$ (1)

$= 7.9\%$ (1)

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

- To reduce the error involved in timing the revolutions.
- To reduce random error.

[Either acceptable – 2 marks]

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

- Cork does not follow a perfectly horizontal circle.
- Value for r is less – introduces an error for F_c.
- Difficult to determine start / stop positions of the orbiting cork.
- Introduces an error for v, and ultimately T.