# Year 12 Physics Investigation

# Circular Motion

**Your Name:** Solutions. (NSHS)

**Date:** 2018.

**Score:** _____ /60 _____%

**Aim:** (2 marks) • Study the relationships between the velocity and weight force. concise ✓ achievable ✓
0/ • Show the relationships associated with circular motion.

**Hypotheses:** (4 marks) - Prediction ✓

- Part A - states a prediction relating variables.
  ie: indep - suspended force
  depend - velocity. ✓
- Part B - states a prediction relating variables. ✓
  ie indep - radius of rotation
  depend - velocity ✓

**Variables:**

Part A: (3 marks)

| | |
|---|---|
| Independent | • hanging mass ✓ |
| Dependent | • time for 20 turns ✓ |
| Controlled | • radius ✓<br>• ↓ must have<br>• <br>• <br>• |

Part B: (3 marks)

| | |
|---|---|
| Independent | • radius of rotation - stopper ✓ |
| Dependent | • time for 20 turns ✓ |
| Controlled | • suspended mass. ✓<br>• ↓ must have 4<br>• <br>• <br>• |

**Method:** (6 marks)

Part A:

- Numbered + list (1)
- Logically sequenced (1)
- States that data is recorded in a table. (1)

Part B:

As Above.

**Diagram:** (4 marks)

- Scientific - 2D - (1)
- Caption - (1)
- Labelled - (1)
- Neatness
  ie - ruled - (1).
  - appropriate size

**Results:** (Paste tables and complete calculations here) (2 marks inserted data, 4 marks calculations)

Tables - complete (2 marks)
- neat
- caption eg Table 1 : Part A Variable force with constant radius.

(1) mark each table

Calculations (4 marks)

(2) marks each for part A and part B.

- shows derivation of $v = \frac{2\pi r}{T}$ (Part A)
- " " " $ma_c = \frac{m_s v^2}{R}$ (Part A)
- " " " $v = \frac{2\pi r}{T}$ (Part B)
- " " " $v^2 \propto \frac{1}{r}$ (Part B).

**Graph** (paste pre-prepared graphs here) (10 marks total)

5 → part A
5 → part B.

Marking the graphs.

Part A (2 graphs).

① - Title relates independent and dependent variables.

① - Labelled axis and units.

① - ruled lines for the graph.

② - Correct scaling and neatness

Part B · As above.
(2 graphs)

**Graphs** (paste graphs prepared during in-class assessment here) (10 marks)

**Conclusion:** Summarise the findings of this experiment (3 marks)

Indicates results compared to hypothesis.

- Part A - (1) mark
- Part B - (1) mark.

- Statement of overall findings related to data. - (1)

**Evaluation:** Comment on the accuracy, precision and design of the experiment. (4 marks)

(1) (1) (2)

Precision
~~Accuracy~~ - were the results consistent with each other - grouped?

Accuracy.
~~Precision~~ - were the results close to the theoretical results?

Design - Random errors - unpredictable changes in the experiment.

- Systematic errors - faults associated with measurement devices.

**Evaluation:** Critically analyse the design of this experiment including any modifications you may suggest. (3 marks)

(3) marks - 3 clear random or systematic errors and how to improve / correct them. Clear suggestions.

3 x (1) mark each.

**Questions:** Use the space below and the following page to answer these questions:

1. Calculate the slope of the graph of W against velocity squared (3 marks)
   a. What does this slope represent?
   b. Compare it to the value obtained using the mass of the stopper and the radius of revolution.
2. Does the fact that the string holding the stopper is not exactly horizontal affect the relation between the weight force and the centripetal force? Explain including appropriate equations. (3 marks)
3. Describe the relationship between velocity and radius that was investigated in Part B. (2 marks)
4. In some shopping centres there is a device which collects coins for charity using a funnel-like device. As the coin is inserted it into the funnel near the outer rim so that it rolls. As it does so it falls and begins to move in an inward spiral. What would happen to its velocity and the time for each "orbit" as it progresses? Explain using what you learnt in this investigation. (4 marks) {This has been included to introduce an element of difficulty to separate the more able from less able students. This statement could be removed from the student copy.}

i) a) slope - calculation (1) mark.

what does it represent?

(3) total.

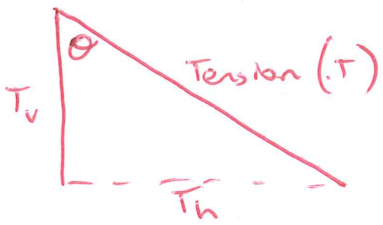
$$m_w g = \frac{m_s v^2}{r_s}$$ — (1)

$$\therefore m_w g \frac{r_s}{m_s} = v^2$$

$$\frac{r_s}{m_s} = \text{slope}.$$

b) compared results to calculated value (1).

2) Calculation needed to justify how $\theta$ affect the tension. (3) marks




Vertical component ($T_v$) equals the weight force. -(1)

$T_v = m_s \times 9.8$

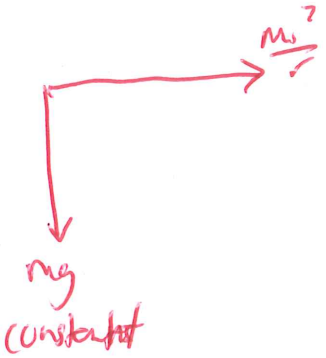
$T_v = \_\_\_\_ N$

$\cos\theta = \frac{T_v}{T}$ -(1)

$\therefore T = \frac{T_v}{\cos\theta} = \frac{m_s 9.8}{\cos\theta}$

As $\theta$ increases $\cos\theta \to 0$ $\therefore$ T increases. -(1)

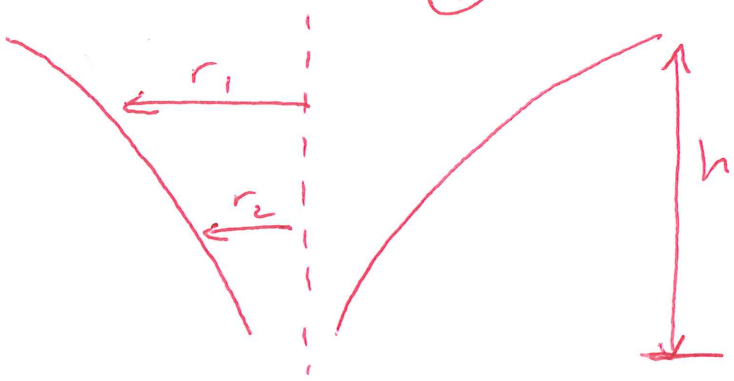
3).




When mg remains constant, so does $\frac{mv^2}{r}$ $\therefore$ as the velocity increases, so does the radius. -(1)

equations + eg to show. -(1)

4) (4) marks.

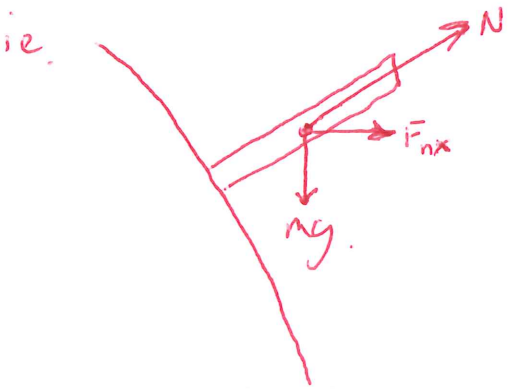



-(1)

As h decreases, so does the r value.

Consider the coin acting on a bank curve. -(1)

ie.




As the coin progresses down the funnel, it loses velocity hence to -(2). maintain a path, it utilises a lower r value - funnel shape.

$$v = \sqrt{r \cdot g \cdot \tan\theta}.$$

Or similar