

School	Candidate's Name (PLEASE PRINT)
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Paper mark /47:

Technique mark /3:



WINCHESTER
COLLEGE

Election

2022

Science

PRACTICAL SECTION

Time allowed: 45 minutes

*You will be given **three minutes** to read the paper and check you have the correct equipment. You should not write anything during this time.*

*This is **not** included in your 45 minutes.*

Maximum marks = 47

+ 3 marks awarded by your invigilator for good experimental technique.

Write all your answers in the spaces on this question paper.

You may use a calculator.

A pencil and ruler are required for diagrams and graphs.

Instructions for the Practical

This practical is an investigation of how the sinking time of metal cups varies with the diameter of holes drilled in the base of the cups.

You will be assessed on your knowledge of principles of Physics, and good general experimental science technique.

First, check you have the following apparatus:

- A set of 8 metal cups. Hole diameters are printed on them: (2.0 mm, 2.5 mm, 3.0 mm, 3.5 mm, 4.0 mm, 4.5 mm, 5.0 mm and 'unknown')
- Two metal washers (metal discs with large holes)
- A drip tray (please keep your equipment within this)
- 1 x 600 ml beaker with 400 ml of water
- Paper towels
- A stopwatch
- Spare calculators are available on request
- Pencil & ruler



1 Select the cup with a **3.0 mm hole**. *Don't touch the washers yet*. Hold the cup upright between finger and thumb, so the hole just touches the level of water in the beaker. Release the cup and carefully watch how it sinks.

(a) Describe what happens and comment on the stability of the cup as it fills with water.

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[2]

(b) Remove the cup from the beaker and use a paper towel to remove the excess water (it doesn't have to be perfectly dry). Now add the two washers to the bottom of the cup. Repeat the cup sinking process. Record any key differences about the way the cup sinks.

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[2]

(c) Explain, using principles of Physics, the effect of adding the washers.

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[3]

2 Swap to the cup with the **2.0 mm hole**. Repeat the steps described in Q1(b), but also use a stopwatch to record the time between releasing the cup and it completely sinking. Perform the experiment **twice** for this cup. **Record the sinking times for the 2.0 mm hole in the table on page 6.**

After taking readings for the 2.0 mm hole, answer the following questions:

(a) What is the advantage of repeating the reading?

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[1]

(b) Carefully describe what happens during the sinking process using a sequence of simple labelled diagrams in the space below:

[3]

- (c) Complete Columns 2 and 3 of the table below by determining **two** sinking times for the other cups.

[8]

- (d) If your two repeats have a **significant** difference between them, take a third reading and record it in Column 4.

Note: if your results are all reasonably close, you do not need to add any data to Column 4.

[1]

- (e) Calculate the **average sinking time** for each hole diameter in Column 5. Write these values to an appropriate number of significant figures.

Note: if in part (d) you chose to take an additional reading, you should calculate your average using the two closest results.

[2]

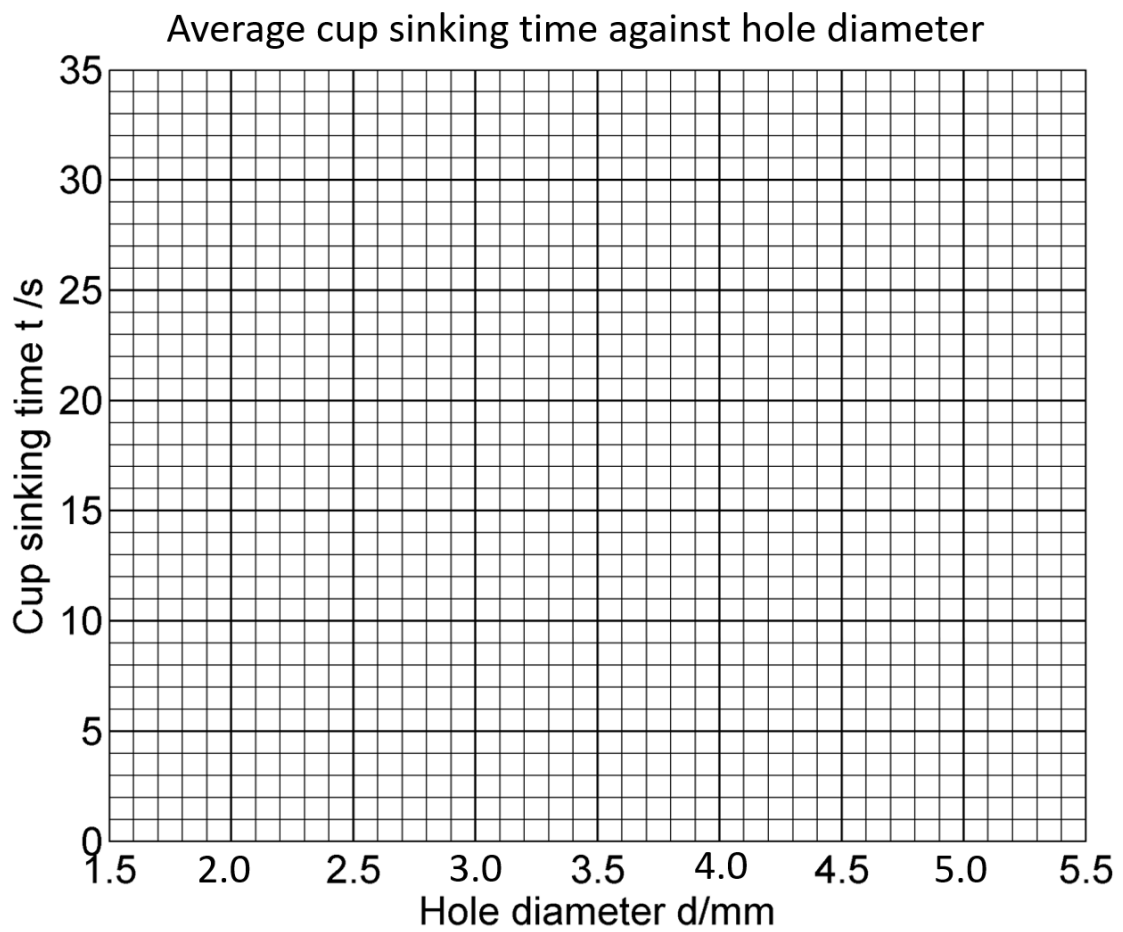
Column 1	Column 2	Column 3	Column 4	Column 5
Hole diameter /mm	Sinking time /s READING 1	Sinking time /s READING 2	Sinking time /s ADDITIONAL READING	Average sinking time /s
2.0				
2.5				
3.0				
3.5				
4.0				
4.5				
5.0				
Unknown				

- 3 (a) Use the axis below to plot a graph of average sinking time against hole diameter. *Don't include the 'Unknown' hole results.*

[2]

- (b) Add a line of best fit to your graph.

[2]



4 Archimedes' principle states:

the upward buoyant force that is exerted on a body immersed in a fluid, whether fully or partially, is equal to the weight of the fluid that the body displaces.

(a) As the cup sinks the water level inside the cup is always lower than the water level outside the cup. Use Archimedes' principle to explain why this is the case.

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[2]

(b) The total volume of steel in one cup and two washers is 5.0 cm^3 . The density of the steel used to make both the cups and the washers is 7.85 g/cm^3 . Show that the **weight** of one steel cup containing two steel washers is about 0.4 N .

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[3]

- (c) The density of water is 1.0 g/cm^3 . The cups have a capacity of 72 cm^3 . Explain why a cup (without a hole in it) containing two washers would float with just over 50% of its volume below the surface. *You may assume the thickness of the cup walls is negligible.*

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[3]

5 It is suggested that in this experiment the sinking time is directly proportional to $\frac{1}{d^2}$, where d is the diameter of the hole in the cup.

(a) Complete the table below. Use the average sinking times you calculated in 2(e).

Hole diameter d /mm	$\frac{1}{d^2}$ / mm ⁻²	Average sinking time t /s
2.0	0.25	
2.5	0.16	
3.0	0.11	
3.5	0.08	
4.0		
4.5		
5.0	0.04	

[2]

(b) Describe the shape you would expect of a graph of t against $\frac{1}{d^2}$.

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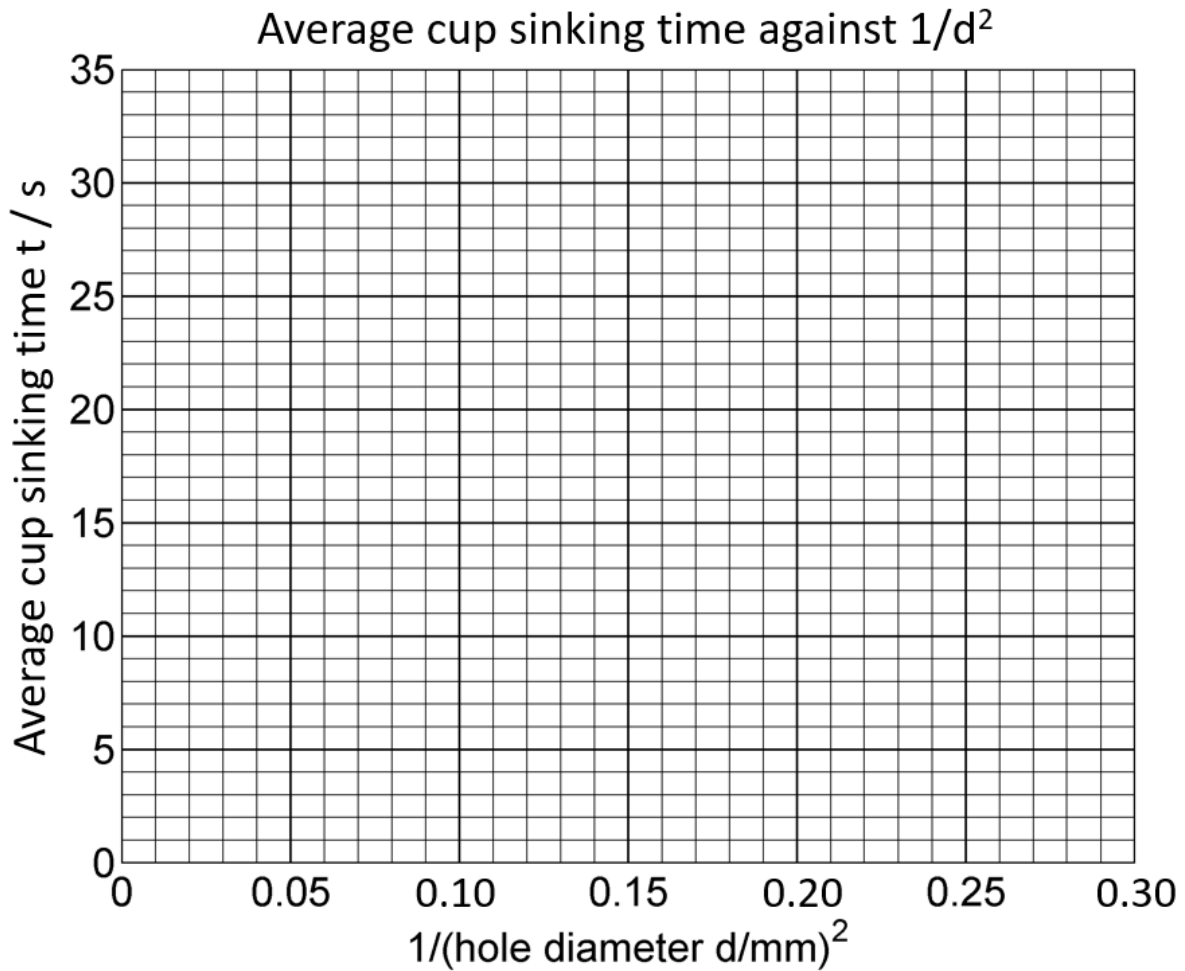
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[2]

- (c) Use the graph paper below to plot sinking time t against $\frac{1}{d^2}$. [2]
- (d) Draw a straight line of best fit to the data. [1]



- (e) Calculate the **gradient** of the straight line of best fit. Show your working.

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Gradient = [2]

(f) Hence write an equation for the sinking time t in terms of hole diameter d .

[2]

(g) Use the graph, or the equation, to calculate the diameter of the 'Unknown' hole (in mm).

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[2]

End of Practical Paper