RIVER VALLEY HIGH SCHOOL
JC2 PRELIMINARY EXAMINATIONS

H2 PHYSICS 9749
PAPER 4

23 AUG 2022

2 HRS 30 MIN

CANDIDATE NAME										
CENTRE NUMBER	S					**INDEX NUMBER**				
CLASS	2	1	J							

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.
Write your name, class and index number above.

Candidates answer on the Question Paper.
The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Give details of the practical shift and laboratory where appropriate in the boxes provided.

Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

SHIFT
LABORATORY

FOR EXAMINERS' USE	
1	**/ 10**
2	**/ 11**
3	**/ 22**
4	**/ 12**
TOTAL	**/ 55**

This document consists of **19** printed pages and **1** blank page.

1 This experiment is investigating the current in a circuit.

Set up the circuit as shown in Fig. 1.1.

The resistor r is used to model the effect of internal resistance in the two batteries. E is the sum of the electromotive force (e.m.f.) of the two batteries.

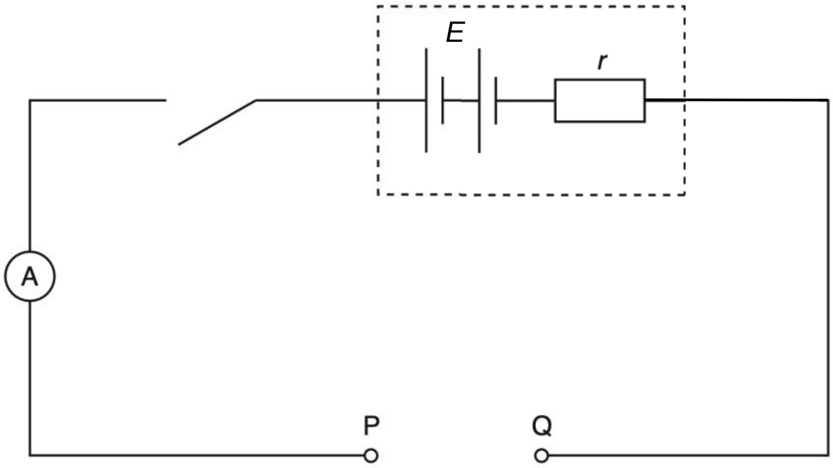

Fig. 1.1

Resistors, each of resistance R, are connected in parallel between P and Q. The current I is measured. The experiment is repeated for different numbers n of resistors between P and Q.

It is suggested that I and n are related by the equation

$$E = I\left(\frac{R}{n} + r\right)$$

(a) **(i)** Measure the current I for n = 2 and n = 3. Record your measurements in Fig. 1.2.

n	I / mA	$\frac{1}{n}$	$\frac{1}{I}$ / A^{-1}
2			
3			
4	70.4		
5	81.6		
6	87.2		
7	95.6		

Fig. 1.2

[1]

(ii) The values of current for n = 4 to n = 7 are given in Fig. 1.2.

Calculate and record the values of $\frac{1}{n}$ and $\frac{1}{I}$ / A^{-1} in Fig. 1.2.

[1]

(iii) The absolute uncertainty of the measurement of I can be taken to be $\pm$ 2 mA.

For your values of I when n = 3, determine the percentage uncertainty of $\frac{1}{I}$.

percentage uncertainty = ………………………… [2]

(b) When $\frac{1}{I}$ is plotted against $\frac{1}{n}$, determine expressions for the gradient and the *y*-intercept.

gradient = ...

y-intercept = ... [1]

(c) **(i)** Plot a graph of $\frac{1}{I}$ on the *y*-axis against $\frac{1}{n}$ on the *x*-axis on Fig. 1.3.

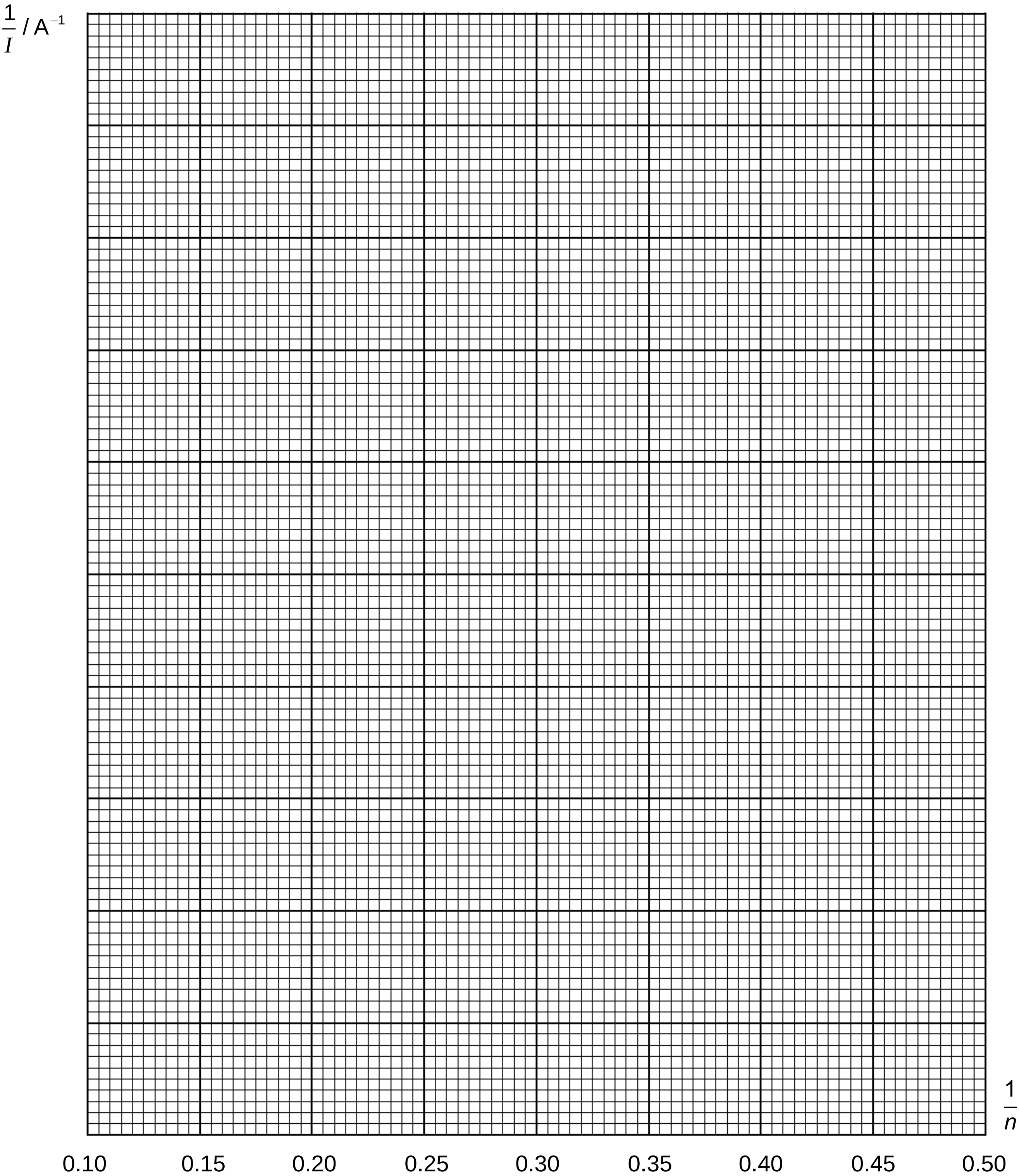

Fig. 1.3

[1]

(ii) Determine values for the gradient and the *y*-intercept.

gradient = ...

y-intercept = ... [2]

(iii) Use your answer in **(b)** and **(c)(ii)** to determine the ratio of $\frac{R}{r}$.

$\frac{R}{r}$ = ... [1]

(iv) Over time, the internal resistance *r* of the batteries may increase.

On Fig. 1.3, draw and label line Z to illustrate what would happen if internal resistance of the batteries increases with their e.m.f. remaining constant.

[1]

[Total: 10]

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2 In this experiment, you will investigate the equilibrium of a metre rule.

(a) You have been provided with a metre rule with a string attached to it.

Set up the apparatus as shown in Fig. 2.1.

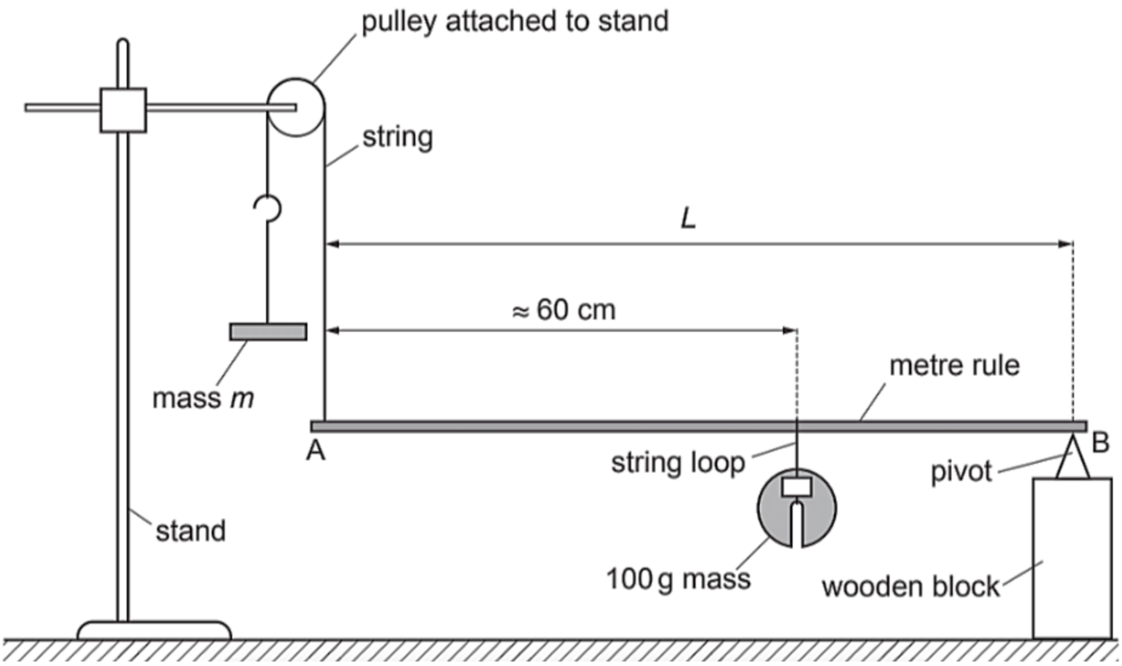

Fig. 2.1

Add masses to the mass hanger so that mass *m* is 80 g.

Adjust the pivot so that it is 5 mm from end B of the rule. The distance between the string at end A and the pivot is *L*.

Measure and record *L*

L = ………………………… [1]

(b) Adjust the string loop supporting the 100 g mass so that it is approximately 60 cm from end A.

Hold the rule at end A so that the rule is approximately horizontal.

Adjust the position of the string loop to find the position where end A is just about to move **upwards** when the rule is released. The distance between the string at end A and the string loop is y_1 as shown in Fig. 2.2.

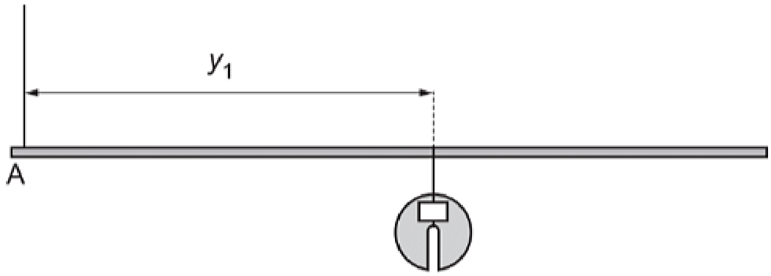

Fig. 2.2

Measure and record y_1.

y_1 = ...

Adjust the position of the string loop to find the position where end A is just about to move **downwards** when the rule is released. The distance between the string at end A and the string loop is y_2

Measure and record y_2.

y_2 = ...

Calculate y where

$$y = \frac{y_1 + y_2}{2}$$

y = ... [1]

(c) Increase m by adding the other masses. Measure the new values of y_1 and y_2.

Repeat until you have five sets of values of m, y_1 and y_2.

Record your results in a table. Include values of y in your table.

[4]

(d) **(i)** Plot a graph of y on the y-axis against m on the x-axis.

(ii) Draw the straight line of best fit..

(iii) Determine the gradient and y-intercept of this line.

gradient = …………………………

y-intercept = ………………………… [5]

[Total: 11]

3 A designer for playground is exploring a new type of ride that is suitable for two users of similar masses.

In this experiment, you will investigate the model for such a ride.

(a) **(i)** Using the short wire, make a sharp bend at its centre so that the angle θ between the straight part of the wire is about 60° as shown in Fig. 3.1.

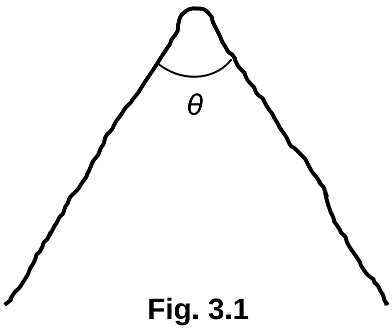

Fig. 3.1

(ii) Measure and record the diameter d of the short wire as shown in Fig. 3.1.

d = ... [1]

(iii) Measure and record the angle θ.

θ = ... [1]

(iv) Estimate the percentage uncertainty in this measurement of θ. Show your working clearly.

percentage uncertainty in θ = ... [1]

(v) Calculate $\sin^2\left(\dfrac{\theta}{2}\right)$.

$\sin^2\left(\dfrac{\theta}{2}\right)$ = ... [1]

(b) Set up the apparatus as shown in Fig. 3.2.

Secure the wooden rod to the boss of the retort stand. The top of the spring passes through the wooden rod. The sharp bend of the wire is resting at the bottom of the spring. **Secure the masses on the ends of the wire with sufficient tapes.**

Each mass represents a child on the ride.

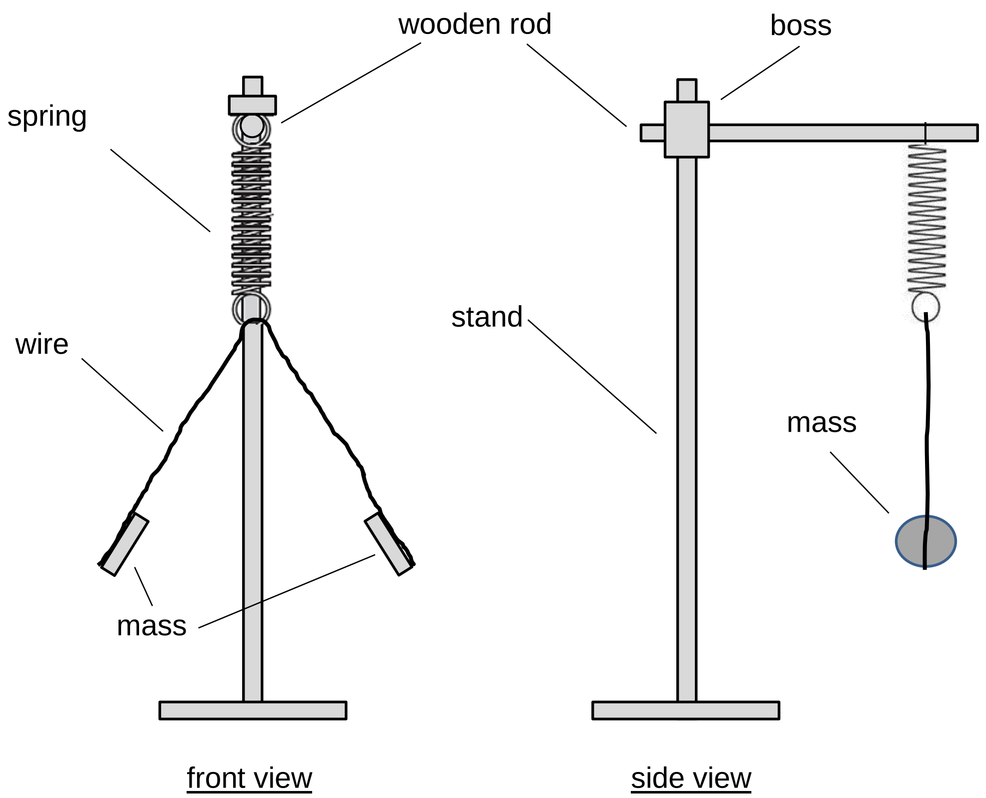

Fig. 3.2

(i) The extension e of the spring is the length of the spring when the wire with masses is loaded at the bottom of the spring minus the unstretched length of the spring.

Determine e and estimate the percentage uncertainty in your value of e.

e = ...

percentage uncertainty in e = ... [2]

(ii) Move one of the masses so that the wire turns through approximately 180° about vertical axis. Release the mass.

The wire will oscillate about a vertical axis as shown in Fig. 3.3.

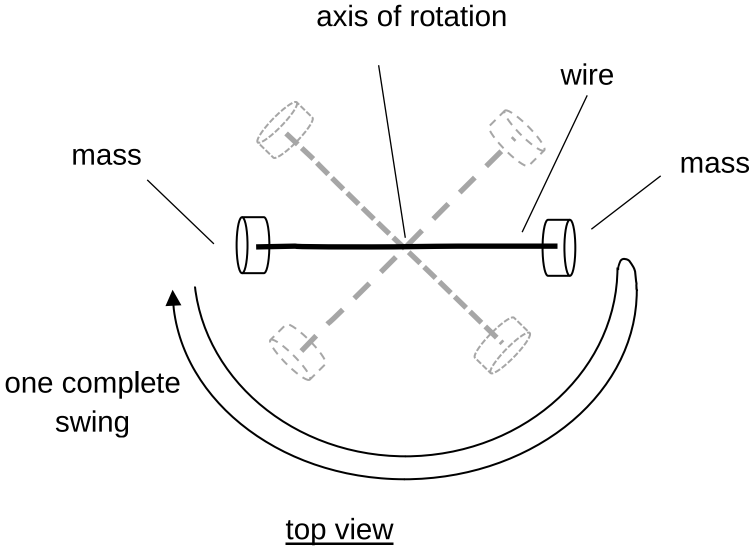

Fig. 3.3

(iii) Determine the time t for the wire to make 5 complete swings.

t = ………………………… [1]

(c) Bend the wire such that θ = 30°. The arms of the wire must remain straight.

Repeat **(a)(iii)**, **(a)(v)** and **(b)(iii)**.

θ = …………………………

$\sin^2\left(\frac{\theta}{2}\right)$ = …………………………

t = ………………………… [2]

(d) It is suggested that the quantities t and θ are related by the equation

$$t^2 = p + ke\sin^2\left(\frac{\theta}{2}\right)$$

where k is a constant and p = 20 s^2.

(i) Use your values from **(a)(v)**, **(b)(i)**, **(b)(iii)** and **(c)** to determine two values of k. Give your values of k to an appropriate number of significant figures.

first value of k = …………………………

second value of k = ………………………… [2]

(ii) State whether the results of your experiment support the suggested relationship in **(d)**.

Justify your conclusion by referring to your values in **(a)(iv)** and **(b)(i)**.

……………………………………………………………………………………...…

……………………………………………………………………………………...…

…………………………………………………………………………………… [1]

(iii) It is suggested that the masses attached to the wire affects the values of t.

Suggest one other factor that may affect the value of t.

……………………………………………………………………………………...…

…………………………………………………………………………………… [1]

(e) Plan an investigation to determine whether the time *t* is directly proportional to the masses attached to the end of the metal wire.

Your account should include:

- your experimental procedure
- control of variables
- how your results can be analysed to reach the conclusion.
- why you might have difficulties using masses with very small values and very large values.

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…………………………………………………………………………………………………

……………………………………………………………………………………………… [5]

(f) **(i)** **Replace the short metal wire with a long metal wire** and set up the apparatus in Fig. 3.2. The angle θ between the straight parts of the wire is about 60°.

Lift up the mass at one end and release it so that it performs small oscillations in a vertical plane as shown in Fig. 3.4.

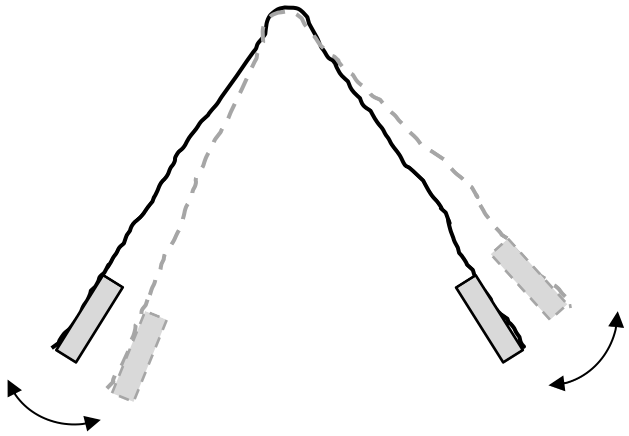

Fig. 3.4

Determine the period T with and without masses at the end of the wire.

Tabulate your results.

[3]

(ii) Suggest a reason for the trend observed in your results in **(f)(i)**.

…………………………………………………………………………………………...…

…………………………………………………………………………………… [1]

[Total: 22]

4 When a thin capillary tube of radius r is inserted vertically into a liquid of density ρ, the liquid rises into the tube a distance h above the liquid level as shown in Fig. 4.1.

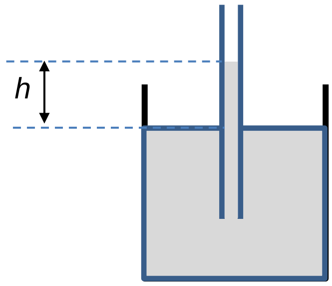

Fig. 4.1

It is suggested that h is related to r and ρ by the relationship

$$h = k\, r^{p} \rho^{q}$$

where k, p and q are constants.

You are given a number of capillary tubes of different dimensions.

Plan a laboratory experiment to test the relationship between h, r and ρ.
Explain how your results could be used to determine values of p and q.

You should draw a diagram showing the arrangement of your equipment. In your account you should pay particular attention to:

- the equipment you would use
- the procedure to be followed
- how the density of the liquid can be varied and measured
- the control of variables
- any precautions that should be taken to improve the accuracy and safety of the experiment.

[Total: 12]

End of Paper