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About O LEVEL

# PHYSICS
## ALTERNATIVE TO PRACTICAL
## (PAPER 4) (YEARLY)

### About Thinking Process

When solving problems, we first analyse the questions and then gather relevant information until we are able to determine the answers. But for presentation reason, we need to organise, rearrange and then present ONLY the required workings and solutions.

Thinking process reveals the extra but relevant information which is not required as part of the solutions.

| | |
|---|---|
| period | 2000 to 2022 |
| contents | June & November, Paper 4, Worked Solutions |
| form | Yearly |
| compiled for | O Levels |
| special features | Thinking Process |


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**'O' Level Physics Alternative To Practical 5054 (Yearly)**

# CONTENTS

# JUNE 2022

Answer **all** questions.

***Question 1***

A student determines the thickness of the glass in a test-tube.

**(a)** The student uses a ruler and two rectangular wooden blocks to help him measure the external diameter $D$ of the test-tube.

Describe, with the aid of a diagram, how the student determines an accurate value for $D$.

.....

.....

..... [1]

**(b)** The student:

- clamps the test-tube in a stand
- fills a measuring cylinder to the 100 $cm^3$ mark with water
- pours some water from the measuring cylinder into the test-tube.

The arrangement of apparatus is shown in Fig. 1.1. The test-tube containing water is also shown full size in Fig. 1.1.

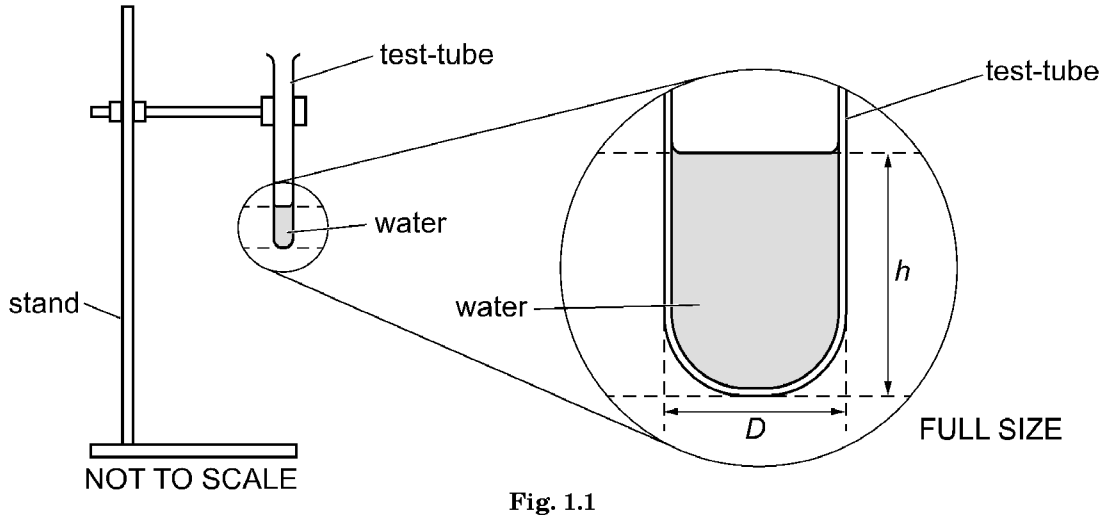



**Fig. 1.1**

Measure the height $h$ of the water in the full size test-tube in Fig. 1.1.

Record $h$ in centimetres to the nearest millimetre in the second row in Table 1.1. [1]

**(c)** Fig. 1.2 shows the volume $V_R$ of water remaining in the measuring cylinder.

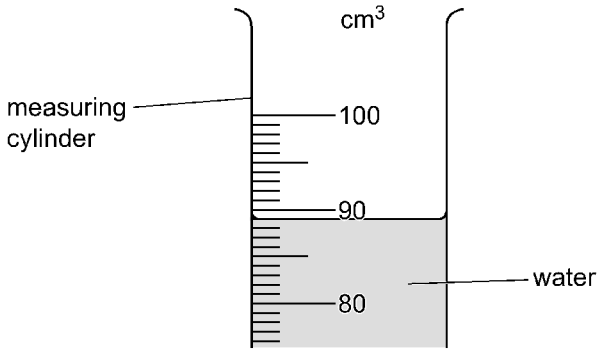



**Fig. 1.2**

**(i)** Record $V_R$ in Table 1.1. [1]

**(ii)** Calculate the volume $V$ of water in the test-tube.
Record your answer in Table 1.1. [1]

**(d)** The student:

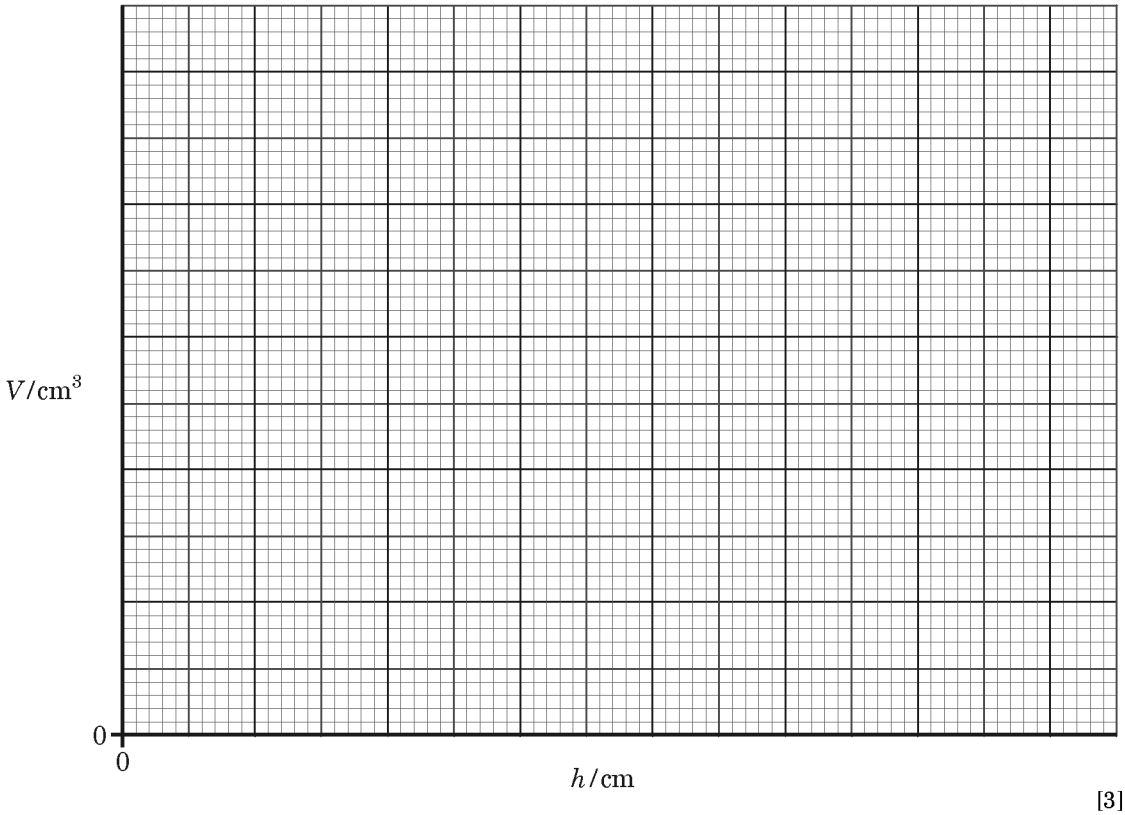
- adds more water from the measuring cylinder into the test-tube
- measures and records the new values of $h$ and $V_R$ in Table 1.1
- repeats the procedure for three more values of $h$ and $V_R$.

The student's results are shown in Table. 1.1.

**Table 1.1**

| $h$ / cm | $V_R$ / cm$^3$ | $V$ / cm$^3$ |
|---|---|---|
| | | |
| 5.6 | 79 | 21 |
| 8.9 | 66 | 34 |
| 12.5 | 54 | 46 |
| 14.2 | 47 | 53 |

On the grid provided, plot a graph of $V$ on the $y$-axis against $h$ on the $x$-axis.
Start both axes from the origin (0, 0).
Draw the best-fit straight line.




[3]

**(e) (i)** Calculate the gradient $m$ of your line. Show all working and indicate on the graph the values you use.

$m$ = ..... [2]

**(ii)** If the test-tube is a perfect cylinder, then the internal diameter $d$ is given by the equation:

$$d = \sqrt{\frac{4m}{\pi}}$$

Use your value of $m$ from **(e)(i)** and the equation to calculate $d$.

$d$ = ..... cm [1]

**(f)** Your value for $d$ is approximate.

**(i)** State **one** difficulty in measuring the height $h$ of the water in the test-tube and suggest how this difficulty can be overcome.

difficulty .....

suggestion .....

.....

[2]

**(ii)** Suggest another reason why your calculated value for $d$ is only approximate.

.....

..... [1]

**(g) (i)** Measure the external diameter $D$ of the full size test-tube in Fig. 1.1.
Record $D$ in centimetres to the nearest millimetre.

$D$ = ..... cm [1]

**(ii)** Use your answers for **(e)(ii)** and **(g)(i)** to calculate the thickness of the glass in the test-tube.

thickness of the glass = ..... cm [1]

*[Total: 15]*

---

***Question 2***

A student investigates the cooling of hot water in a beaker.

The student measures the room temperature before starting the investigation. The room temperature is 24.0 °C.

The student:

- pours 150 $cm^3$ of hot water into a beaker
- places a thermometer into the hot water
- waits for 30 s
- reads the initial temperature of the hot water and starts a stop-watch
- records the temperature $\theta$ of the hot water every 60 s for 300 s.

The student's readings are shown in Table 2.1.

**Table 2.1**

| time $t$ / s | temperature $\theta$ / °C |
|---|---|
| 0 | 89.5 |
| 60 | 83.0 |
| 120 | 77.5 |
| 180 | 73.0 |
| 240 | 69.0 |
| 300 | 66.0 |

**(a)** Suggest why the student waits for 30 s before reading the initial temperature of the hot water.

.....

..... [1]

**(b) (i)** Calculate the average rate of cooling $R_1$ of the hot water during the first 60 s. Use the equation:

$$R_1 = (\theta_0 - \theta_{60})/60$$

where $\theta_0$ is the temperature of the hot water at the start, and $\theta_{60}$ is the temperature of the hot water after 60 s.

$R_1$ = ..... °C / s [1]

**(ii)** Calculate the average rate of cooling $R_2$ of the hot water between $t = 240$ s and $t = 300$ s.

$R_2$ = ..... °C / s [1]

**(c)** Use the values you calculated in part **(b)** to describe how the rate of cooling of the hot water changes as the hot water cools.

.....

..... [1]

**(d)** At the end of the investigation, the student leaves the water in the beaker.

Predict the final temperature of the water 2 hours later.

..... [1]

**(e)** Suggest how the student ensures that the temperature readings are as accurate as possible.

.....

..... [1]

*[Total: 6]*

***Question 3***

Three students, A, B and C, measure the speed of sound in air.

- Students A and B stand at opposite ends of a football pitch.
- Student A strikes two large blocks of wood together.
- Student B starts a stop-watch when she sees the blocks hit each other and stops the stop-watch when she hears the sound.
- The students repeat this procedure twice.
- Student C measures the distance $d$ between students A and B.

The times $t$ recorded are shown.

0.45 s 0.41 s 0.51 s

**(a)** Calculate the average value of $t$. Give your answer to 2 significant figures.

$t$ = ..... s [2]

**(b)** The distance $d$ between students A and B is 119 m.

**(i)** Suggest a device that can be used for measuring this distance.

..... [1]

**(ii)** Calculate a value for $v$, the speed of sound in air. Use the equation:

$$v = \frac{d}{t}$$

$v$ = ..... m/s [1]

**(c)** Suggest **one** reason why the value calculated in **(b)(ii)** for the speed of sound in air is only approximate.

.....

..... [1]

*[Total: 5]*

***Question 4***

A student investigates how the resistance of a filament lamp changes when the current through it is varied.

The student connects the circuit shown in Fig. 4.1.

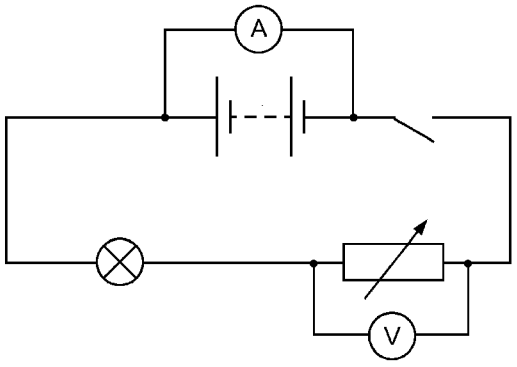



**Fig. 4.1**

**(a)** The student has connected the circuit incorrectly.

In the space below re-draw the circuit with the voltmeter and ammeter connected in the correct positions.

[2]

**(b)** When the switch is closed in the corrected circuit, the student observes that the lamp does not appear to light up. The filament of the lamp is not broken, and the battery is not run down.

**(i)** What observation does the student make to confirm quickly that the filament of the lamp is not broken?

.....

..... [1]

**(ii)** Suggest why the lamp does not appear to light.

.....

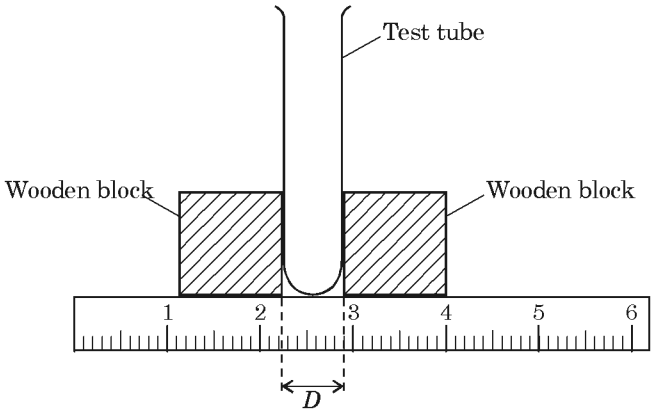
..... [1]

*[Total: 4]*

# SOLUTIONS - JUNE 2022

***Q1 - Solution***

**(a)**

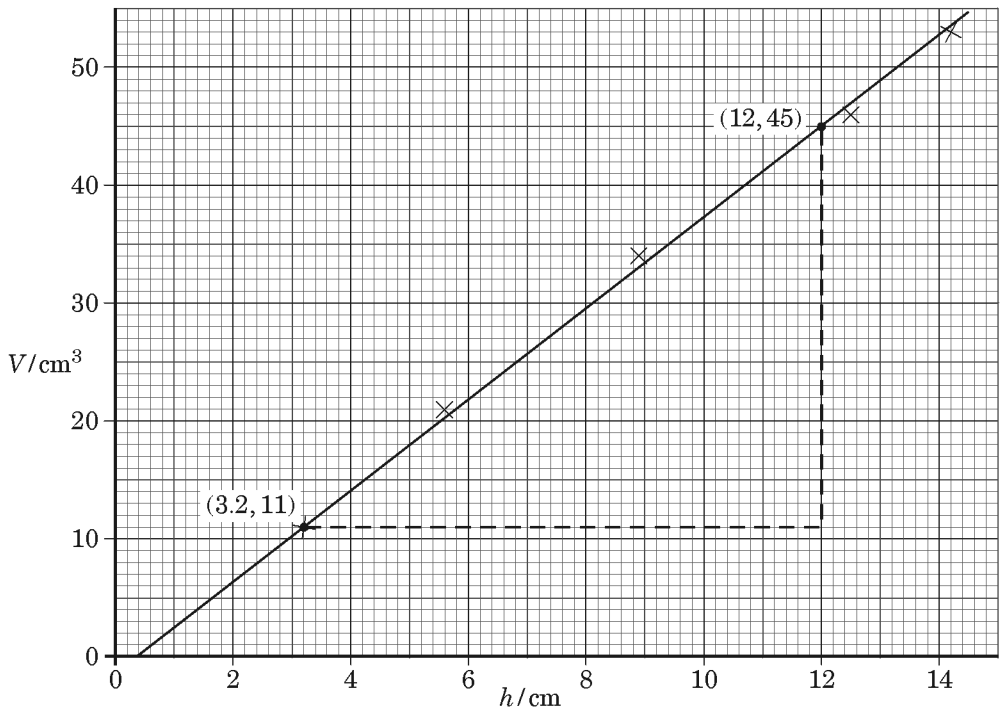



Place the test tube between two wooden blocks as shown in diagram. Measure the distance between two blocks with the help of a ruler. This distance is equal to the external diameter $D$ of the test tube.

**(b) & (c)** Volume $V$ of water in the test-tub = 100 – 89 = 11 $cm^3$

| $h$ / cm | $V_R$ / $cm^3$ | $V$ / $cm^3$ |
|---|---|---|
| **3.2** | **89** | **11** |
| 5.6 | 79 | 21 |
| 8.9 | 66 | 34 |
| 12.5 | 54 | 46 |
| 14.2 | 47 | 53 |

**(d)**



**(e) (i)** Using two points (3.2, 11) and (12, 45) on the graph ,

Gradient, $m = \dfrac{45-11}{12-3.2} = \dfrac{34}{8.8} \approx 3.86$

**(ii)** $d = \sqrt{\dfrac{4m}{\pi}}$

$\Rightarrow \quad d = \sqrt{\dfrac{4(3.86)}{\pi}} \quad \Rightarrow \quad d = 2.22 \text{ cm}$

**(f) (i) Difficulty:** It is difficult to hold the ruler vertical and parallel to the test tube.

**Suggestion:** Clamp the ruler vertically.

***Alternatively:***

**Difficulty:** The clamp does not allow to place the ruler close to the test tube and the test tube has a round bottom, so it is difficult to judge the exact positions of the upper level of water and the bottom of the test-tube on the ruler scale.

**Suggestion:** Hold the ruler vertically and close to the test-tube. Use a set square and align it with the bottom of test-tube. Align the other side of set square with the ruler.

**(ii)** The test tube is not a perfect cylinder. Also the value of $m$ used in the equation is the gradient of the best-fit line. Thus the value of $d$ is an approximate.

**(g) (i)** $D = 2.4$ cm

**(ii)** Thickness of the glass $= \dfrac{2.4 - 2.22}{2} = 0.09$ cm

***Q2 - Solution***

**(a)** To allow the thermometer to adjust its temperature reading to the temperature of the water.

***Alternatively:***

To allow the temperature reading on the thermometer to stop increasing.

**(b) (i)** $R_1 = \dfrac{(\theta_0 - \theta_{60})}{60}$

$\Rightarrow \quad R_1 = \dfrac{(89.5 - 83.0)}{60} = 0.108$ °C/s

**(ii)** $R_2 = \dfrac{\theta_{240} - \theta_{300}}{60}$

$= \dfrac{69.0 - 66.0}{60} = 0.05$ °C/s

**(c)** The Rate of cooling dropped from 0.108 °C/s to 0.05 °C/s. Therefore the rate of cooling decreases.

**(d)** Room Temperature: 24 °C

**(e)** The student avoids the parallex error by reading the thermometer scale at 90° (eye level).

Or,

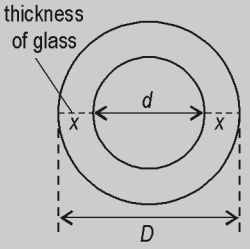
The student uses a digital thermometer.

**COMMENT** on **ANSWER**

❝ **(f) (i)** ***Alternatively:***
Difficulty: It is difficult to stop hand shaking when holding the ruler
Suggestion: Lower the test-tube and place the ruler vertically on the table to measure the height.

**(ii)** ***Alternatively:***
Measuring cylinder reads the volume up to 1 $cm^3$. Also, the height $h$ of the water is an approximation as bottom of test tube is round.

**(g)** **(ii)** Note that $(D - d)$ will give thickness of both sides of the tube, i.e. $(x + x)$. Therefore we divide $(D - d)$ by 2 to get the actual thickness x. ❞




**COMMENT** on **ANSWER**

❝ **(a)** ***Alternatively:***
— To allow thermometer to respond to the temperature of water.

**(e)** ***Alternatively:***
— The student stir the water before taking reading.
— The student makes sure that the thermometer should not touch the beaker.❞

***Q3 - Solution***

**(a)** Average value of $t = \dfrac{0.45 + 0.41 + 0.51}{3}$

$= 0.4566 \approx 0.46$ s

**(b) (i)** Measuring tape, (or laser distance meter, trundle wheel).

**(ii)** $v = \dfrac{d}{t}$

$v = \dfrac{119}{0.46}$

$= 258.69 \approx 258.7$ m/s

**(c)** Time measured is very short. It is effected by human reaction time since it is difficult to start and stop the stopwatch in such a short time.

**COMMENT** on **ANSWER**

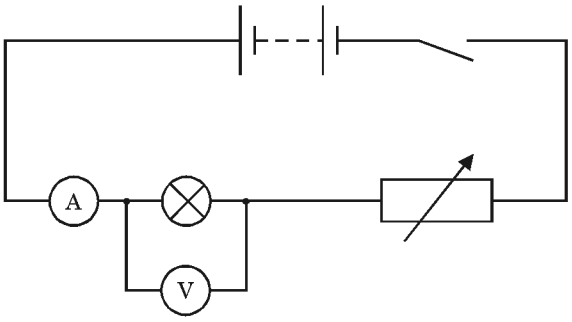
❝ (c) *Alternatively:*

— It is difficult to measure the distance accurately.

— Students A and B did not change positions while repeating the experiment. ❞

***Q4 - Solution***

**(a)**




**(b) (i)** The Ammeter shows some reading which confirms that the filament is not broken.

**(ii)** The current is too low because the resistance of variable resistor is too high.

**COMMENT** on **ANSWER**

❝ (b) (ii) *Alternatively:*

— Lamp rating is higher than the voltage supplied. ❞