Name: ________________________________ (     )          Class: Sec 4 / (     )

南华中学

# NAN HUA HIGH SCHOOL

## PRELIMINARY EXAMINATIONS 2024

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|---|---|---|
| **Subject** | **:** | **Physics** |
| **Paper** | **:** | **6091/3** |
| **Level** | **:** | **Secondary Four** |
| **Date** | **:** | **7 August 2024** |
| **Duration** | **:** | **1 hour 50 minutes** |

**INSTRUCTIONS TO CANDIDATES**

Write your name, class and register number in the spaces at the top of this page and on any separate answer paper used.

Answer **all** questions.

All of your answers should be written in this Question Paper: scrap paper must **not** be used. Graph paper is provided in this Question Paper. Additional sheets of graph paper should be used only if necessary to do so.

You will be allowed to work with the apparatus for a maximum of 55 minutes for each section.

You are expected to record all your observations as soon as these observations are made.
An account of the method of carrying out the experiment is **not** required.
The use of approved scientific calculator is expected, where appropriate.

At the end of the examination, fasten all your work securely together. The number of marks is given in brackets [ ] at the end of each question or part question.

| **Shift** |
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| |
| **Laboratory** |
| |

| **For Examiner's Use** | |
|---|---|
| **1** | |
| **2** | |
| **3** | |
| **Total** | |

**Section A**

**1** *In this experiment, you will determine the speed of a wave on the surface of water.*

You are provided with:

- a digital calipers,
- a plate,
- a dropper,
- a stopwatch,
- a 30 cm ruler,
- a beaker,
- paper towels to clean up any spillages.

**(a)** Fill the plate with water to the level marked (black line) on the side of the plate.

**(b)** Fig 1.1 shows a wavefront moving outwards from the centre of a plate filled with water. The wavefront is produced by one drop of water from the dropper.

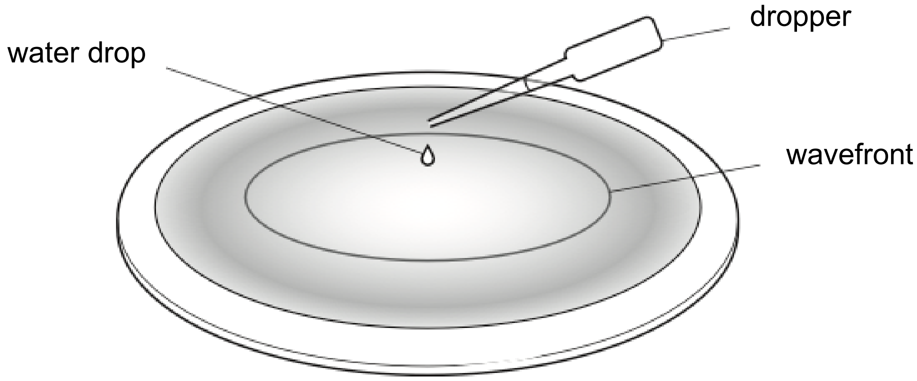


**Fig. 1.1**

**(i)** Using a digital calipers, measure the depth of the water, *d*, at the centre of the plate.

*d* = ____________________ [1]

Put 1.0 $cm^3$ of water into the dropper.

Using the dropper, let one drop of water fall into the centre of the plate.

Observe a wavefront travel to the edge of the plate, reflect back to the centre, and then travel back out again. The wavefront will move in and out several times.

**(ii)** Take measurements to determine an accurate time *t* for the wavefront to travel once from the centre of the plate and back to the centre.

*t* = ____________________ [2]

**(iii)** Using your answer to (a)(ii), calculate the speed of the wavefront using the equation shown.

$$speed = \frac{\text{distance}}{time}$$

You will need to make and record an additional measurement of the diameter of the water surface.

*speed* = ______________________ [2]

**(b)** The approximate speed of waves in shallow water can be given by

$$v_{shallow} = \sqrt{\alpha d}$$

where $d$ is the depth of the water, and $\alpha$ is a constant.

Plan an experiment using the above relationship to determine the constant $\alpha$ using a graphical method.

Your plan should include

- the quantities that you should keep constant,
- a detailed description of how you would perform the experiment,
- a statement of the graph that you would plot to test the relationship,
- a sketch of the graph that you would obtain if the suggested relationship is correct,
- an explanation of how you would obtain a value of the constant $\alpha$ from your graph.

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[5]

[Total: 10]

**2** *In this experiment you will investigate the indentation made by a glass ball in the surface of some modelling clay.*

You are provided with:

- a glass ball,
- two 100 g masses,
- a small lump of adhesive putty,
- a half-metre rule,
- a set square.

**(a)** **(i)** Describe briefly how to use the apparatus in Fig. 2.1 to determine the diameter of the glass ball.

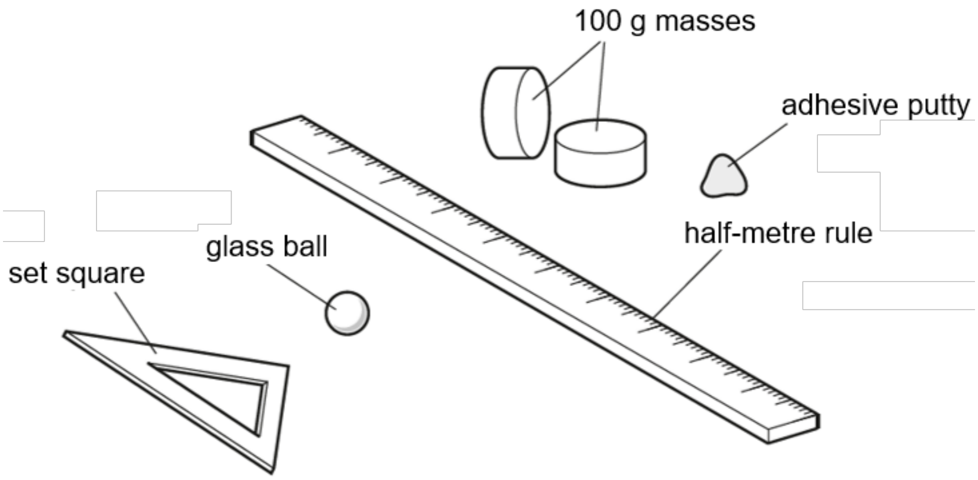


**Fig. 2.1**

Draw a labelled diagram of the arranged apparatus to help your explanation.

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**(ii)** Measure and record the diameter *D* of the glass ball.

*D* = .............................. [1]

**(b)** You are also provided with:

- a stand, boss and clamp,
- a wooden strip (metre-rule),
- a piece of modelling clay,
- a loop of string,
- a mass-hanger,
- a 30 cm ruler.

The supervisor has clamped the wooden strip. Ensure that the clamp is able to rotate freely in the boss.

Place the glass ball and the modelling clay between the centre of the wooden strip and the bench as shown in Fig. 2.2.

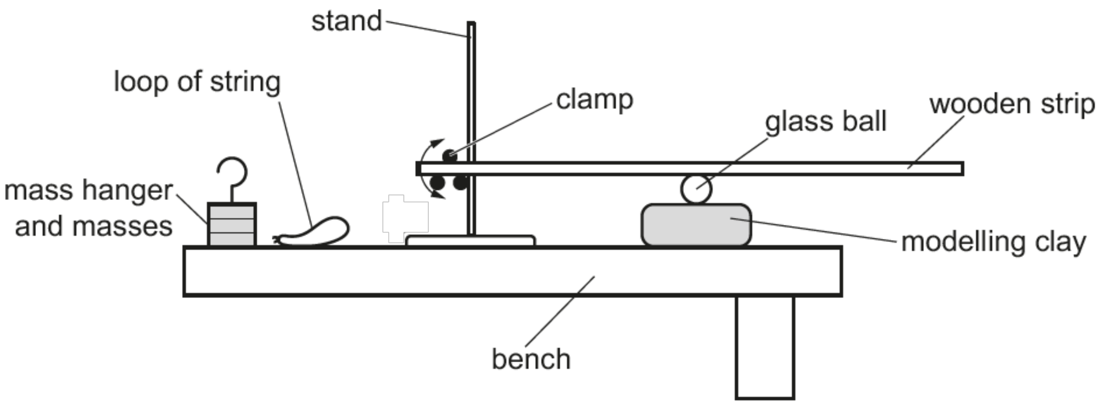


**Fig. 2.2**

Put the two 100 g masses onto the mass hanger.

The combined weight of the mass hanger and both 100 g masses is 3.0 N.

Place the mass hanger and masses directly above the glass ball for about one minute.

Remove the mass hanger and masses.

Raise the wooden strip and remove the ball from the modelling clay.

Observe a small circle where the ball has been pressed into the surface of the clay. This is an indentation.

**(i)** Measure and record the diameter $d_1$ of the indentation.

$d_1$ = ____________________ [1]

**(ii)** The area of a circle can be calculated using the equation shown.

$$A = \frac{\pi d^2}{4}$$

where $A$ is the area and $d$ is the diameter of the circle.

Calculate the area $A_1$ of the indentation with diameter $d_1$.

$A_1$ = ____________________ [1]

**(c)** **(i)** Flip over the modelling clay. Replace the ball on the modelling clay under the wooden strip.

Lower the strip so that it rests on top of the glass ball.

Using the loop of string, attach the mass hanger and masses near the end of the wooden strip as shown in Fig. 2.3.

Measure and record $x$ and $y$.

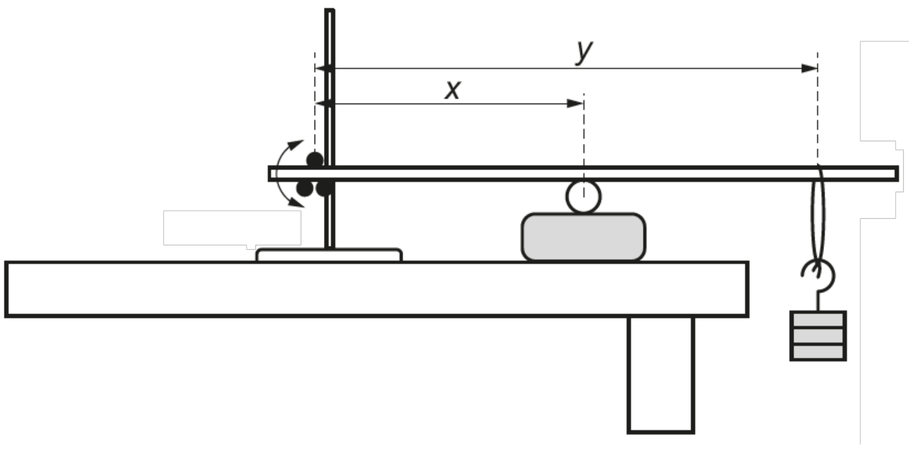


**Fig. 2.3**

$x$ = ____________________

$y$ = ____________________
[1]

**(ii)** Calculate the force $F$ exerted on the modelling clay using the equation shown.

$$F = \frac{3y}{x}$$

Show your working.

$F =$ ____________________ [1]

**(iii)** Measure and record the diameter $d_2$ of the indentation produced by the ball in the clay.

Using the equation in **(b)(ii)**, calculate the area $A_2$ of the circle with diameter $d_2$.

$d_2 =$ ____________________

$A_2 =$ ____________________
[1]

**(d)** Students in another laboratory obtain different values of $A_1$ and $A_2$ using the same arrangement of the apparatus.

Identify two variables that should be controlled to ensure similar values of $A_1$ and $A_2$ when using modelling clay.

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______________________________________________________________________ [2]

[Total: 10]

**Section B**

**3** *In this experiment, you will investigate a thermistor.*

You are provided with:

- a 4.5 V power supply,
- a switch,
- a fixed resistor,
- a thermistor,
- a voltmeter,
- connecting leads,
- a thermometer attached to your bench by a small amount of adhesive putty,
- a stirrer,
- a styrofoam cup,
- a supply of hot water.

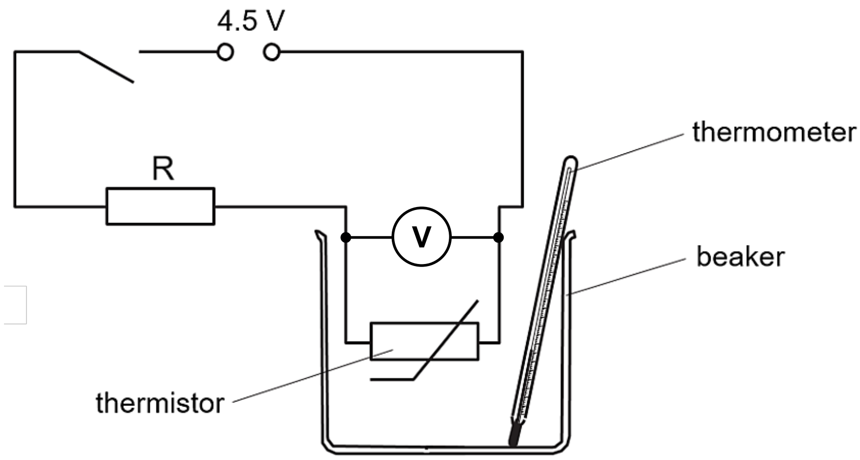


**Fig. 3.1**

**(a)** Set up the circuit shown in Fig. 3.1 without the thermometer.

**(b)** There is a thermometer attached to your bench by a small amount of adhesive putty.

Record the temperature $T_R$ on the thermometer. This is room temperature.

Close the switch.

Record the reading $V_R$ on the voltmeter.

Open the switch.

$T_R$ = ...............................

$V_R$ = ...............................

[1]

**(c)** **(i)** Collect some hot water using the styrofoam cup.

Carefully pour hot water into the beaker until it reaches the 200 $cm^3$ mark.

**The thermistor should be fully immersed in the water.**

Remove the thermometer from the adhesive putty and submerge it in the water.

Close the switch.

Wait about one minute until the reading on the thermometer and voltmeter is steady. Ensure the starting temperature of water is at least 80.0 °C.

Record the new temperature $T_W$ on the thermometer and voltage $V_W$ on the voltmeter.

Open the switch.

$T_W$ = ____________________________

$V_W$ = ____________________________

[1]

**(ii)** Calculate the change in temperature $T_C$ and voltage $V_C$ using the equations shown.

$T_C = T_W - T_R$

$V_C = V_R - V_W$

$T_C$ = ____________________________

$V_C$ = ____________________________

[2]

**(d)** Repeat **(c)** for further values of $T_W$ and $V_W$. For every 0.10 V increase in voltmeter reading, record the reading on the thermometer.

Record your values for $T_W$, $V_W$, $T_C$ and $V_C$ in a suitable table.

Include your values in **(c).** [4]

**(e)** It is suggested that the relationship between $V_C$ and $T_C$ is given by the equation

$$T_C = G\,V_C + Q,$$

where $G$ and $Q$ are constants.

Using the grid provided, plot a graph of $T_C$ against $V_C$. [4]

**(f)** Determine, with appropriate units, the constant $G$ and $Q$.

$G$ = ............................................

$Q$ = ............................................

[3]

**(g)** The body temperature can be measured with a thermistor.

**(i)** Calculate the voltage $V_N$ across the thermistor when temperature is 37.0 °C using the equation shown.

$$V_N = V_R - \left(\frac{37.0 - T_R}{G}\right)$$

$V_N$ = __________________ [1]

**(ii)** A student suggests that if the thermistor is held between a thumb and forefinger for two minutes, the reading on the voltmeter will be the same as the voltage $V_N$ calculated in (g)(i).

Two quantities are considered to be equal, within the limits of experimental accuracy, if their values are within 10 % of each other.

Hold the thermistor between your thumb and forefinger for two minutes, until the voltmeter shows a new steady reading.

Read and record this voltage $V_B$.

State whether your results indicate that $V_N$ and $V_B$ are equal within the limits of experimental accuracy.

Support your statement with a calculation.

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______________________________________________________________________________ [2]

**(iii)** Suggest two ways to improve the procedure in (g)(ii).

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______________________________________________________________________________ [2]

[Total: 20]