Name: …………………………………………….. Index no: ……… Class: ……………

NGEE ANN SECONDARY SCHOOL

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PRELIMINARY EXAMINATION

PURE PHYSICS **6091/03**

PAPER 3 **17 August 2021**

1 h 50 min

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A and B

Answer **all** questions.
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 they are made.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

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.

FOR EXAMINER'S USE	
Section A	
Section B	
TOTAL	

Checked by student: ______________________ Date: ___________________

Section A (20 marks)

1 *In this experiment you will measure the time taken to raise the temperature of water by a Bunsen Burner.*

You are provided with:

- A 250 ml beaker,
- a thermometer,
- a 250 ml measuring cylinder,
- a stand, boss and clamp,
- a stopwatch,
- a Bunsen Burner,
- a tripod with wire gauze.

(a) Fig 1.1 has been set up for you.

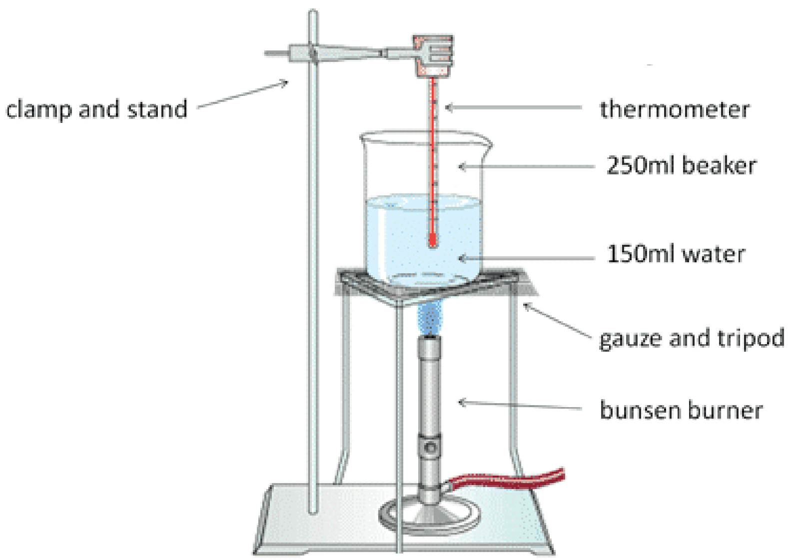

Fig 1.1

Using the measuring cylinder, take 150 ml of water and pour it into the beaker. The density of water is 1.0 g/cm^3. Note that 1.0 ml = 1.0 cm^3, record the mass ***m*** of the water in kilogram.

$\boldsymbol{m}$ = ...

(b) Note the temperature $\boldsymbol{\theta_1}$ of the water.

$\boldsymbol{\theta_1}$ = ... [1]

(c) Using the Bunsen Burner, light up the non-luminous flame (with air-hole fully opened and maximum gas supply). Place it underneath the tripod stand, heat the beaker of water and start your stopwatch. Heat the water for 1 minute. **Wait** for a few minutes and record the **highest steady** temperature $\boldsymbol{\theta_2}$ reached by the water.

$\boldsymbol{\theta_2}$ = ... [1]

(d) The heat energy Q_0 given out by the Bunsen Burner is P.t where P is the power of the Bunsen Burner, t is the duration of heating in seconds. The heat gained by the water is $Q_1 = mc\,\Delta\theta$, where m is the mass of the water in the beaker in kg, c = 4200 JK^{-1}kg^{-1} and $\Delta\theta = \theta_2 - \theta_1$. Q_L is the heat lost to the surrounding.

$$Q_0 = Q_1 + Q_L$$

$$P.t = m.c.\Delta\theta + Q_L$$

Calculate the value of Q_L in terms of P with the correct unit.

Q_L = …………………………….. [2]

(e) Plan

The equation in **(d)** can be re-arranged to the form

$$\boldsymbol{\Delta\theta} = [P/(m.c)].\boldsymbol{t} - [Q_L/(m.c)]$$

Using the same apparatus provided in **Fig 1.1**, plan an experiment to investigate the above relationship. The apparatus provided are not exhaustive, you may include more apparatus in your plan.

Your plan should include
- a list of the quantities that remain constant,
- a description of how you would perform the experiment,
- a suitable table in which to display your measurements and calculated values (you do not need to enter any data into the table),
- a statement of the graph you would plot to test the relationship,
- an explanation of how ***P*** and Q_L are found from the graph,
- state one key source of error in the experiment and how do you overcome it.

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2 *In this experiment, you will determine a value for the density of a piece of modelling clay.*

You have been provided with

- a 30 cm ruler,
- a spring,
- a stand, boss and clamp to support the spring,
- a piece of modelling clay attached to a length of string with a loop at the top of the string,

- an S-hook (paper clip bent into an S),
- a supply of water,
- a 250 cm^3 glass beaker,
- paper towels or cloths to mop up spillages,
- an electronic balance.

(a) Using the electronic balance, record the mass of the modelling clay.

mass = ________________[1]

(b) With the given apparatus, describe how you would *measure* the volume of the modelling clay.

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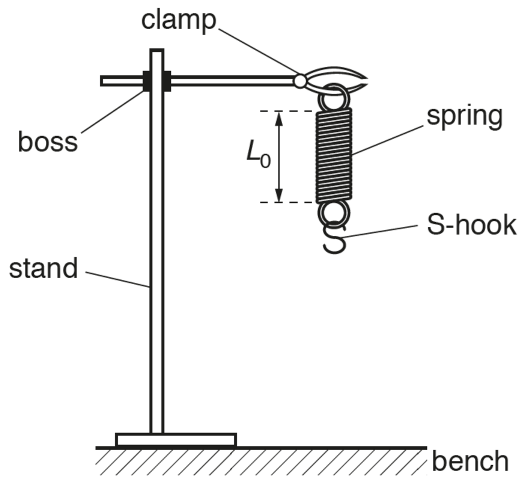
(c) Based on the process described in (b), determine and record the volume of the modelling clay.

volume = ________________[1]

(d) Set up the apparatus as shown in Fig. 2.1.



Suspend the S-hook from the lower end of the spring.

(e) Measure the length L_0 of the coiled part of the spring.

L_0 =________________ [1]

(f) Suspend the modelling clay from the hook using the loop. The modelling clay should not touch the bench. Measure the new height L_1 of the coiled part of the spring.

L_1 =________________________

(g) Calculate the extension e_1 of the spring using $e_1 = L_1 – L_0$.

e_1 =________________ [1]

(h) Place the empty beaker below the suspended modelling clay.

Lower the clamp until the modelling clay is at the base of the beaker and the string becomes completely slack.

Pour water into the beaker until the modelling clay is fully immersed and covered by about 1 cm of water. If the clay starts to float, then lower the clamp further.

Raise the clamp slowly until the modelling clay rises from the bottom of the beaker but is still fully immersed.

Ensure that the modelling clay does not touch the sides of the beaker.

(i) Measure the new length L_2 of the coiled part of the spring.

L_2 = ______________________

(j) Calculate the new extension e_2 using $e_2 = L_2 – L_0$

e_2 = ________________ [1]

(k) The density of water, ρ_W, is 1.0 g/cm^3. Calculate the density ρ of the modelling clay using

$$\rho = \frac{e_1}{e_1 - e_2} \times \rho_W$$

ρ = ________________ [2]

(l) Using the recorded values in (a) and (c), determine the density of the modelling clay.

density = ________________[1]

(m) Suggest why the two values of density in (k) and (l) could be different.

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Section B (20 marks)

3 *In this experiment, you are going to determine the refractive index of water in a beaker.*

You have been provided with

- a 600 ml beaker,
- a piece of rectangular soft board,

- 4 pieces of optical pins,
- a piece of white A4 paper,
- a protractor,
- a 30-cm plastic ruler,
- water.

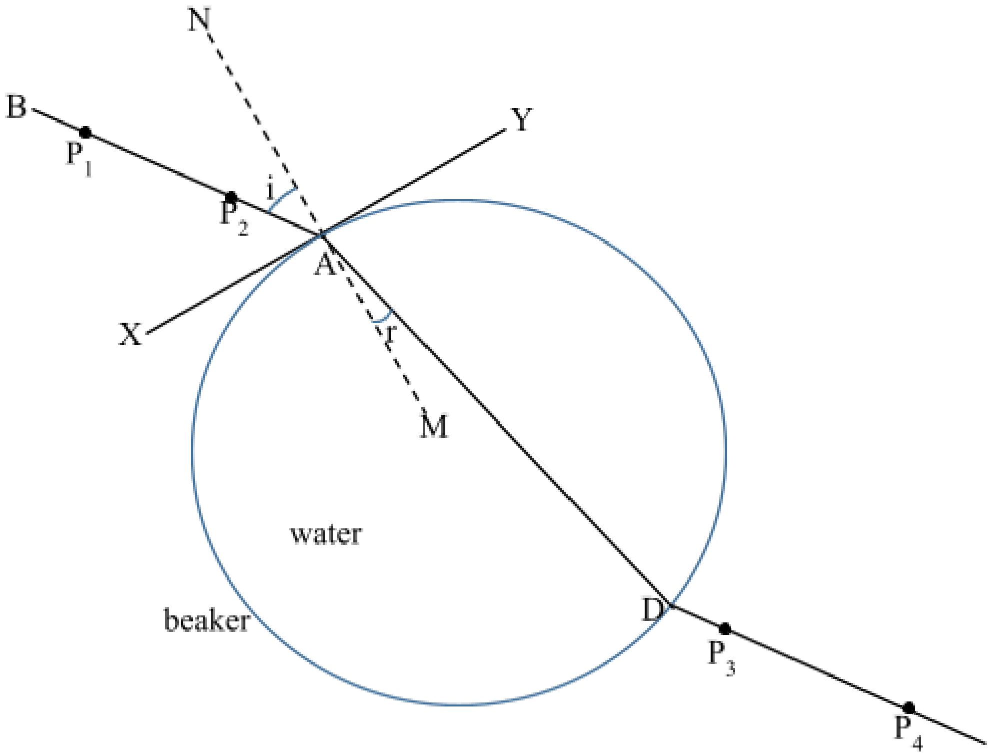

Fig. 3.1 top view of beaker of water

(a) Trace the outline of the base of the beaker on the white A4 paper. Remove the beaker. See Fig 3.1.

(b) Mark a point A, on the circumference of the circle.

(c) Draw the tangent XY of the circle at point A.

(d) Draw a line perpendicular to the tangent XY, and label it NM. NM is the normal to tangent XY at point A.

(e) Using a protractor and a ruler, draw line AB such that the angle XAB is 70°.

(f) Calculate angle of incidence, i, where i = 90° - angle XAB.

(g) Repeat step (e) for angles of XAB = 80°, 90°, 100° and 110°. Label the end of the lines drawn with the angles of incidence, i.

(h) Pour about 300 ml of water into the beaker. Place the beaker of water onto the outline you have drawn in step (a).

(i) Insert 2 optical pins at P_1 and P_2 on line AB. The distance between P_1 and P_2 should be about 3 cm. See Fig. 3.1.

(j) Using only one eye, view the images of pins P_1 and P_2 from the opposite side of the beaker of water. Position your eye such that the image of P_2 covers the image of P_1. With your eye in the same position, insert pins P_3 and P_4 such that they are in line with the images of P_1 and P_2. Mark the positions of P_3 and P_4. Remove pins P_1 and P_2

(k) Repeat step (i) and step (j) for values of i = 10°, 0, -10° and -20°.

(l) Remove the beaker of water, draw the line AD to represent the refracted ray, measure angle MAD, the angle of refraction, r. Note that when angle of incidence, i, is negative, angle of refraction, r, will be negative too.

(m) Record your values of i, r, sin i and sin r in a table. [4]

(n) Using the graph paper in the next page, plot a graph of sin r against sin i. [4]

(o) From your graph, comment on the relationship between sin r and sin i.

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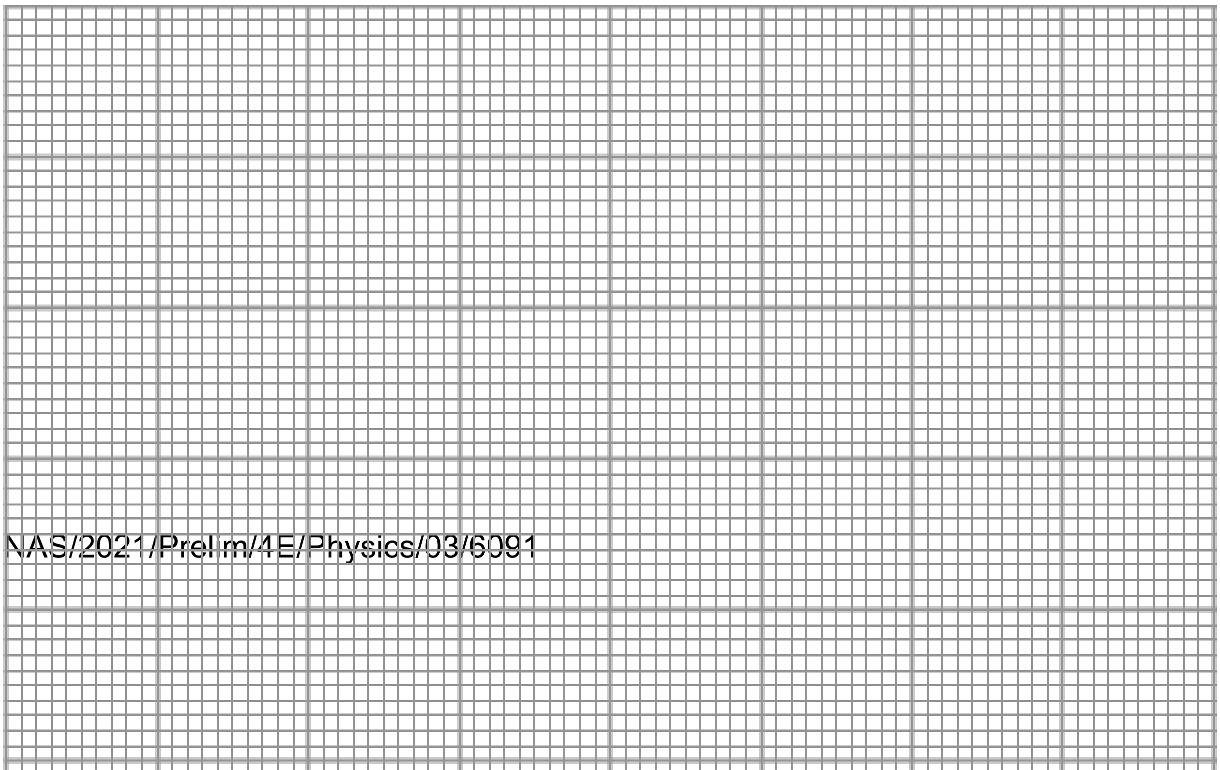
(p) It is suggested that the relationship between i and r is given by the equation

$\eta = \sin i / \sin r$

From your graph, calculate the value of η.

η = ………………………. [2]



(q) It is suggested that η is the refractive index of water in the beaker. State 2 conditions for this statement to be true.

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(r) Identify one key source of error and explain how it affect the calculated **η** in **(p)**.

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……………………...…………………………………………………………[2]

(s) When a letter "R" is placed behind the beaker of water, which is acting as a lens, draw the image of the letter 'R" when viewed from the other side of the beaker of water. State the 2 properties of the image formed.

Object Image

[1]

Property 1 ……………………………………………………………………...[1]

Property 2 ……………………………………………………………………...[1]

(t) Submit your A4-size paper. [2]

-- END OF PAPER –