CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN SECONDARY EDUCATION CERTIFICATE®
EXAMINATION

05 JUNE 2023 (a.m.)

R2301238020

FILL IN ALL THE INFORMATION REQUESTED CLEARLY IN CAPITAL LETTERS.

TEST CODE | 0 | 1 | 2 | 3 | 8 | 0 | 2 | 0 |

SUBJECT PHYSICS – Paper 02

PROFICIENCY GENERAL

REGISTRATION NUMBER

SCHOOL/CENTRE NUMBER						

NAME OF SCHOOL/CENTRE

CANDIDATE'S FULL NAME (FIRST, MIDDLE, LAST)

DATE OF BIRTH

SIGNATURE _____

744

A002

SECTION A

Answer ALL questions.

1. Figure 1 shows the setup for an experiment to determine the specific heat capacity of 300 g of a liquid using an electrical heater. The heater has a power rating of 105 W.

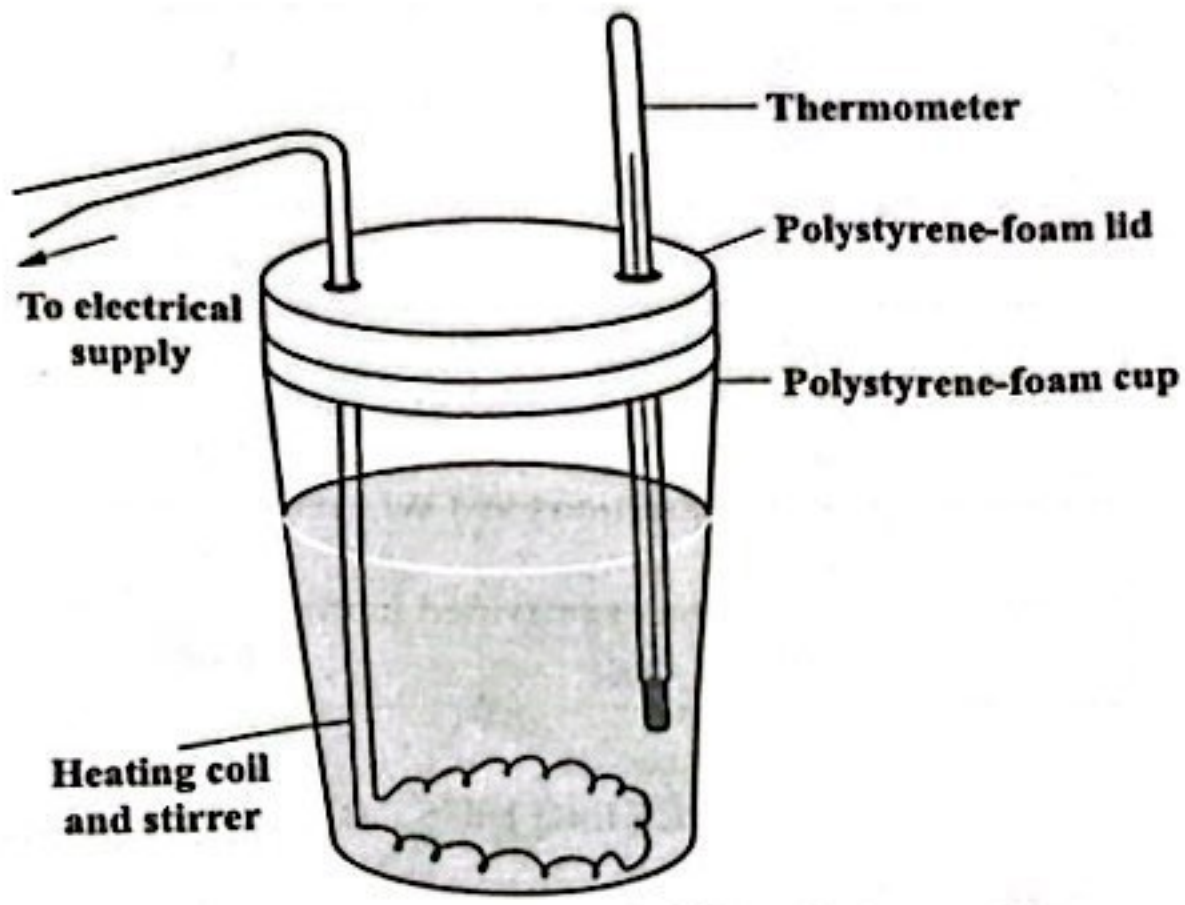

Figure 1. Experiment to determine the specific heat capacity of a liquid

Temperature and time data for the liquid in the polystyrene-foam cup are shown in Table 1.

TABLE 1: TEMPERATURE, θ, AND CORRESPONDING TIME, *t*

Temperature θ / °C	Time t /seconds
25.3	0
30.5	60
34.9	120
41.2	180
46.4	240
51.5	300
56.8	360

(a) Define the term 'specific heat capacity'.

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(3 marks)

(b) Assuming that all of the electrical energy produced by the heater is transferred to the liquid, and that

P is the electrical power of the heater
t is the time duration of the experiment
m is the mass of the liquid
c is the specific heat capacity
$\Delta\theta$ is the increase in temperature of the liquid,

deduce the formula which represents the heat energy transferred from the heater to the liquid.

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(1 mark)

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(c) Using the grid provided **on page 7**, plot a graph of temperature, θ, versus time, t.

(8 marks)

(d) Calculate the gradient, G, of the graph.

(5 marks)

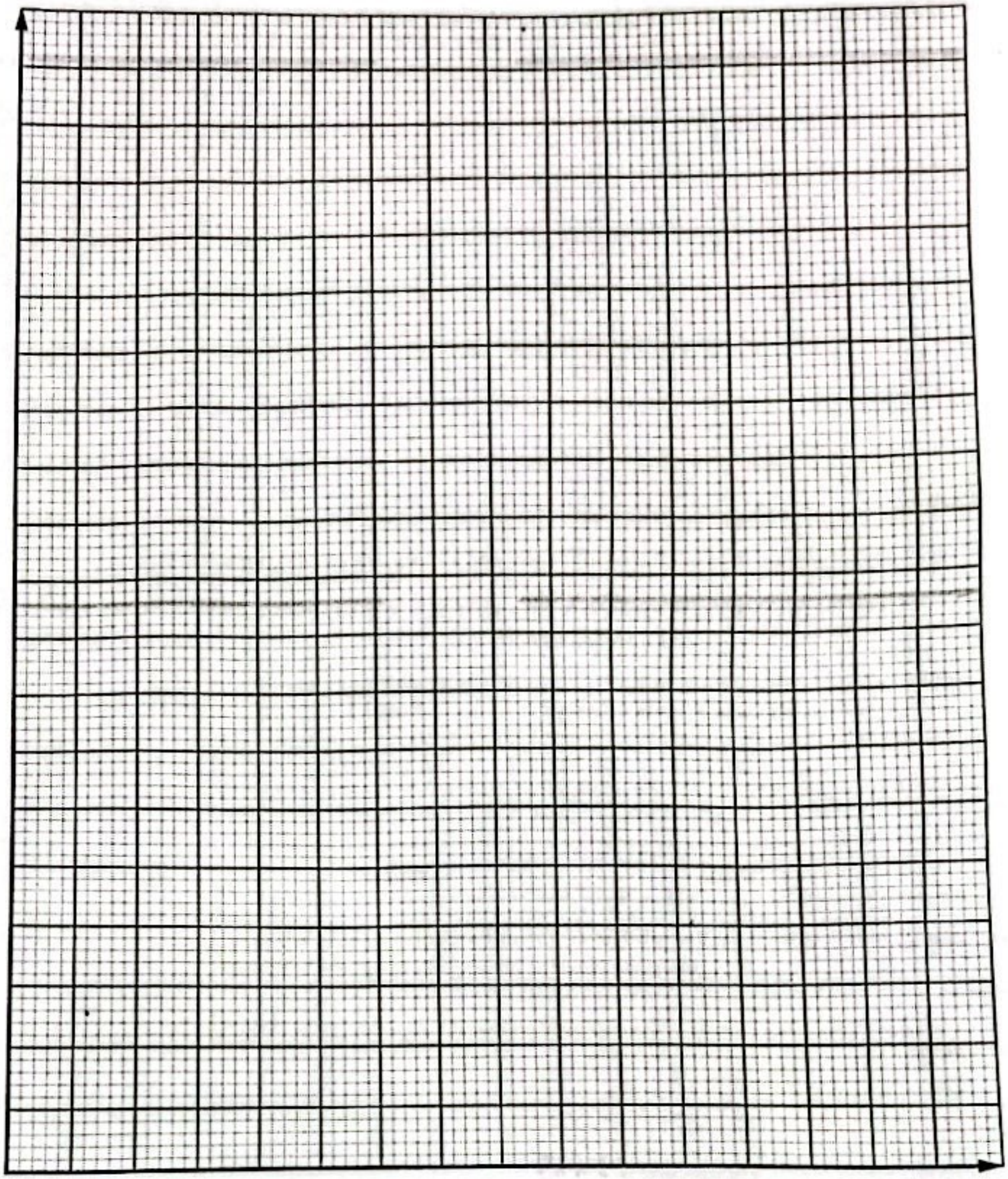

Figure 2. Graph of Temperature, θ versus time, t

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(e) (i) Given that $G = P/mc$, calculate the specific heat capacity, c, of the liquid. Express your answer in S.I. units, to one significant figure.

(6 marks)

(ii) Table 2 shows the specific heat capacities for three commonly used liquids.

TABLE 2: LIQUID AND CORRESPONDING SPECIFIC HEAT CAPACITIES

Liquid	Specific Heat Capacity (J/kg/ °C)
Cooking oil	1700
Milk	3900
Paraffin	2100

Using the answer calculated in (e) (i) and the information in Table 2, state the liquid that was most likely used in the experiment.

Liquid .....

(1 mark)

(f) State ONE precaution that the class should take in performing this experiment.

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(1 mark)

Total 25 marks

2. Figure 3 shows a wind turbine used in some Caribbean countries as an alternative energy source.

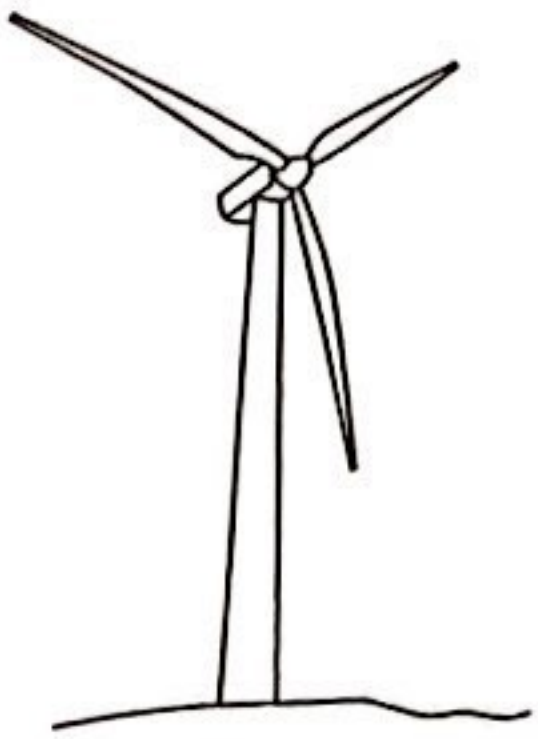

Figure 3. Diagram of a wind turbine

(a) Describe how a wind turbine produces electrical energy.

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(3 marks)

(b) State TWO advantages and TWO disadvantages of using wind turbines in some Caribbean countries.

Advantages

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Disadvantages

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(4 marks)

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(c) If the mass of the air that passes through the circular area swept out by the turbine blades every second is 8.5 kg and its kinetic energy during this time is 2500 J, calculate

(i) the speed of the air

(3 marks)

(ii) the input power of the air

(2 marks)

GO ON TO THE NEXT PAGE

(iii) the efficiency of the wind turbine, given that the output power of the generator is 1350 W.

(3 marks)

Total 15 marks

3. (a) State TWO properties of electromagnetic waves.

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(2 marks)

(b) Figure 4 shows a cup and string telephone.

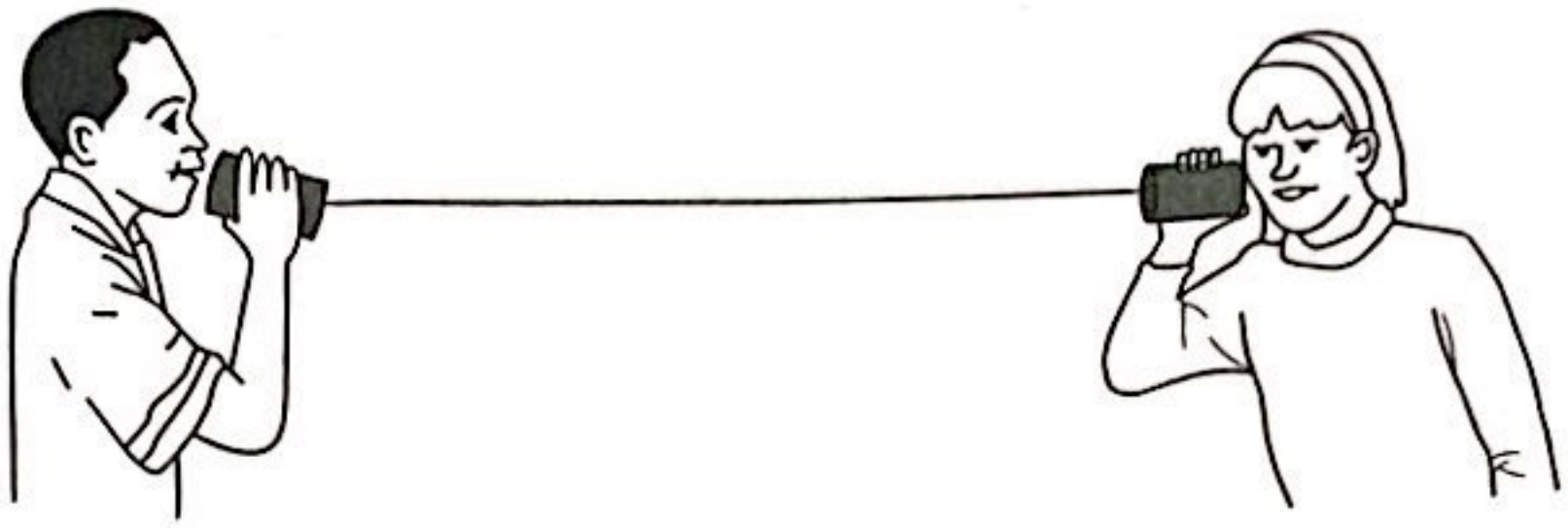

Figure 4. Diagram of a cup and string telephone

(i) Describe how the cup and string telephone works.

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(3 marks)

(ii) Calculate the wavelength of the sound produced by the cup and string telephone, given that the frequency of sound waves in air is 11 000 Hz and the speed of sound in air is 330 m/s.

(3 marks)

(c) Figure 5 shows a coin, at position O, in an empty container. An observer is unable to see the coin based on the position of his eye.

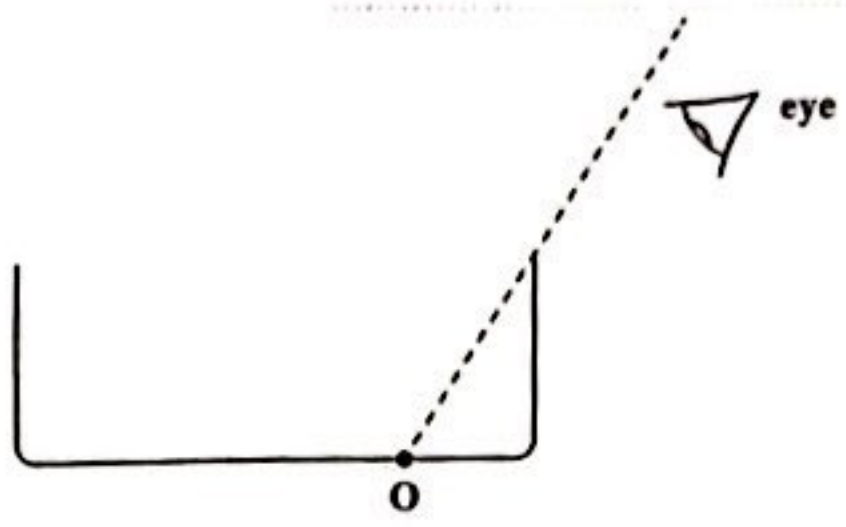

Figure 5. A coin in an empty container

(i) Describe how the observer can see the coin when the container is filled with water.

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(2 marks)

(ii) The refractive index of water is defined as the ratio of the speed of light in air to the speed of light in water.

Calculate the speed of light in water, given that the speed of light in air is 3×10^8 m/s and the refractive index of water is 1.3.

(2 marks)

(iii) Calculate the critical angle of water.

(3 marks)

Total 15 marks

SECTION B

Answer ALL questions.

4. **(a)** **(i)** Draw a labelled diagram of the structure of a thermocouple thermometer.

(3 marks)

(ii) The thermocouple thermometer is used to measure the temperature of the blue part of the flame of a small candle. State THREE reasons why a thermocouple thermometer is suitable for this application.

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(3 marks)

(b) Figure 6 shows a fixed mass of gas which is trapped in a cylinder by a piston.

The gas is at atmospheric pressure 1.0×10^5 Pa. The volume of the trapped gas is 1.9×10^{-4} m^3 and the initial temperature is 27 °C. An electrical heater is used to increase the temperature of the trapped gas to a final temperature of 627 °C.

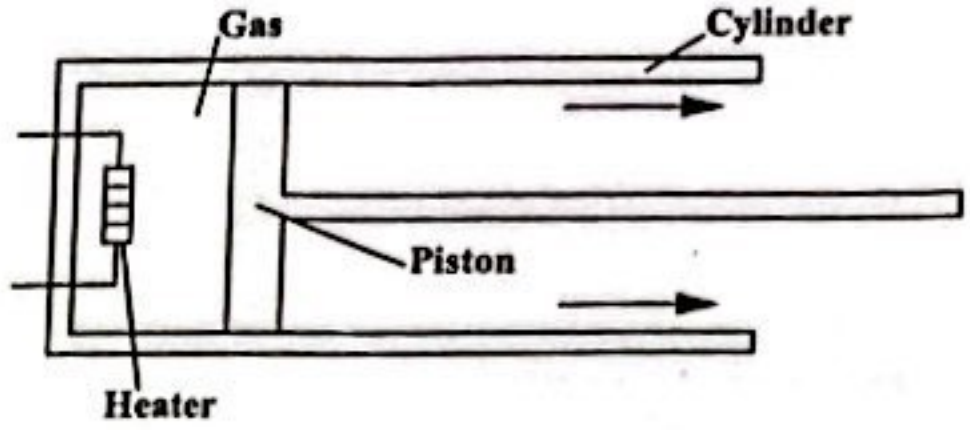

Figure 6. Diagram of fixed mass of gas trapped in a cylinder by a piston

(i) Use the kinetic theory to explain how the gas exerts pressure on the piston.

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(3 marks)

(ii) Calculate the final volume of the gas, given that the final pressure is 1.8×10^5 Pa.

(6 marks)

Total 15 marks

5. (a) (i) State the name of the logic gate represented by the symbol shown in Figure 7.

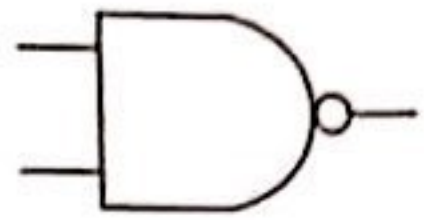

Figure 7. Logic gate

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(1 mark)

(ii) State the name of the logic gate using the truth table shown in the table below.

Input	Output
0	1
1	0

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(1 mark)

(iii) Figure 8 is a digital circuit consisting of a combination of basic logic gates.

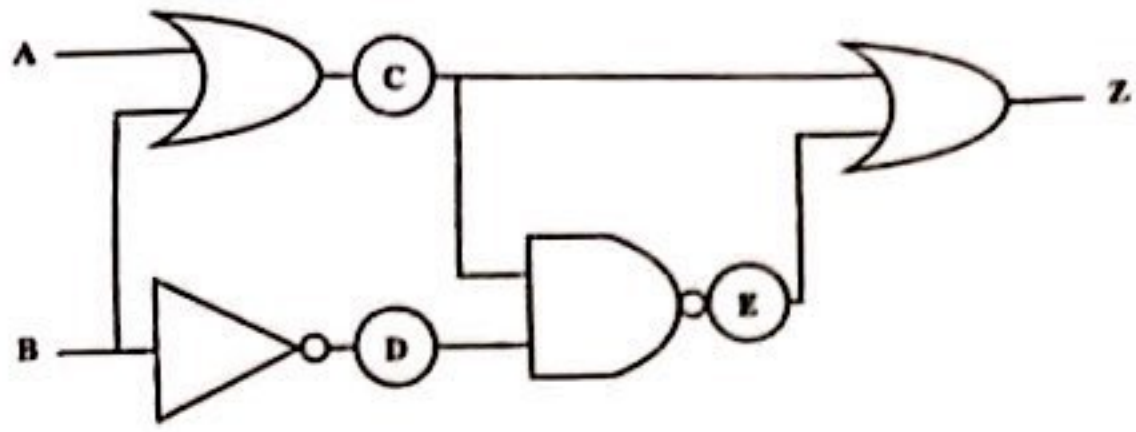

Figure 8. Digital circuit of basic logic gates

Complete the truth table below for the circuit in Figure 8.

INPUTS		C	D	E	OUTPUT Z
A	B				

(6 marks)

(b) Figure 9 shows an arrangement for making an electromagnet.

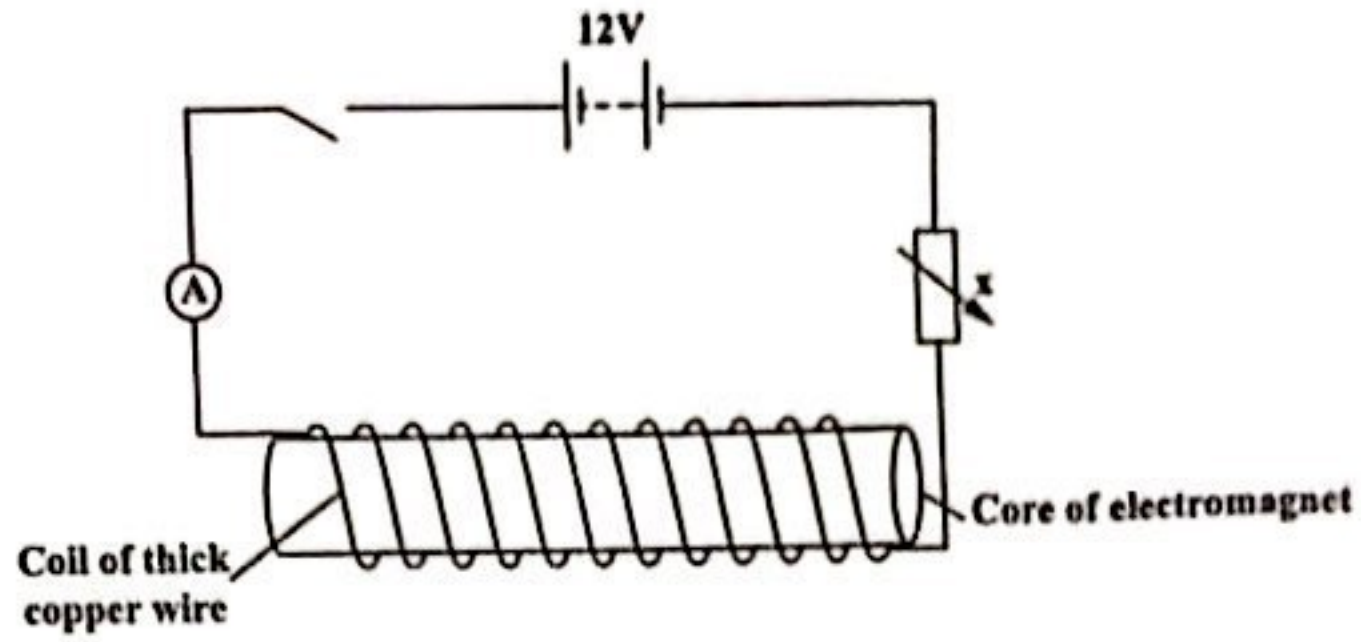

Figure 9. An electromagnet

(i) State a material which is suitable for the core of an electromagnet.

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(1 mark)

(ii) List TWO factors which would cause an increase in the strength of an electromagnet.

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(2 marks)

(iii) State how component X can be used to increase the strength of an electromagnet.

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(1 mark)

(iv) When the switch is closed, the reading on the ammeter is 1.5 A. Calculate the resistance of the circuit.

(3 marks)

Total 15 marks

6. Figure 10 shows a vacuum tube with a radioactive source which emits α-particles, β-particles and γ-rays through an electric field.

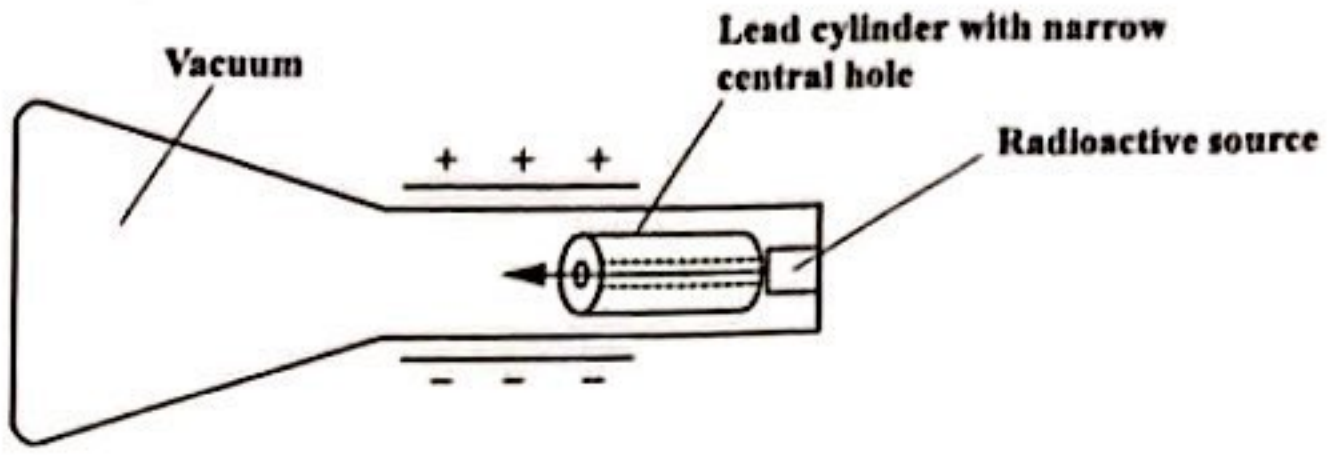

Figure 10. Vacuum tube with a radioactive source emitting radiation which passes through an electric field

(a) Describe the paths of the α-particles, β-particles and γ-rays as they pass through the electric field. State a reason for EACH answer.

(i) α-particles

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(2 marks)

(ii) β-particles

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(2 marks)

(iii) γ-rays

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(2 marks)

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(b) The equation below represents one nuclear fission reaction utilized in power plants.

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3\,^{1}_{0}n + \gamma$$

With masses given as $^{235}_{92}U = 3.902 \times 10^{-25}$ kg

$^{1}_{0}n = 1.675 \times 10^{-27}$ kg

$^{141}_{56}Ba = 2.289 \times 10^{-27}$ kg

$^{92}_{36}Kr = 1.575 \times 10^{-27}$ kg,

calculate

(i) the total mass of the particles (left-hand side) and products (right-hand side)

Particles

Products

(4 marks)

(ii) the mass difference

(2 marks)

(iii) the energy released in the nuclear reaction given that the speed of light is $c = 3.0 \times 10^8\ ms^{-1}$.

(3 marks)

Total 15 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.