S.4 HeLP RESOURCE QUESTIONS
PHYSICS PAPER ONE
Time: 2 Hours 30 Minutes

INSTRUCTIONS TO CANDIDATES:

- *Section **A** is compulsory.*
- *Section **B** has **part I** and **part II**. For each part attempt only one question.*
- *Use none programmable scientific calculators.*
- *All working should be written in the answer booklet provided.*
- In total **five** questions **must** be attempted by the candidate.

SECTION A: WAVES AND LIGHT

Attempt all the three items in this section

Item 1

In a certain music concert that took place at night, a man played a guitar on a floating stage surrounded by disco lights flashing red, blue and green in the middle of the lake. The audience on the boats and shores were wearing white clothes with yellow spots on them. The audience was surprised about the new appearance of the colour of their clothes. The sound waves from the guitar travel through the air with a frequency of $\boldsymbol{440Hz}$. The organizers also projected laser light, that travels through air with a frequency of $\boldsymbol{4.7 \times 10^{8} Hz}$ illuminating waves on the lake surface to aid visibility. On the shores of a lake was a tall storeyed building a distance of $\boldsymbol{x\ metres}$ away from the floating cruise. A lady on the floating boat cruise bearing the floating stage noticed that the guitar sound was heard twice every time the guitar was played. Using a stop watch, she got the time interval between the first and second sound heard to be 2s.

Hint: $Speed\ of\ sound\ in\ air = \boldsymbol{330ms^{-1}}, Speed\ of\ light\ in\ air = \boldsymbol{3.0 \times 10^{8} ms^{-1}}$

Task:

As a physics student;

(a) Help the lady understand why she heard the sound of the guitar twice. And help her know the distance between the lake shore and the boast cruise.

(b) Clearly explain why the colour of the clothes of the audience kept on changing when coloured lights flashed on them.

(c) Why was laser source of light preferred to provide laser light that enhanced visibility in the late hours of the night.

(d) Compare the wave lengths of the sound waves and laser light waves in air medium.

STARS AND GALAXIES, EARTH AND SPACE PHYSICS.

Item 2

At 1:30pm in the dining hall, students were surprised that a live coverage was happening somewhere. Learners watched heavy fog-rains and floods being experienced in a certain outside country on an international T.V live channel. To worsen matters, the floods were happening at night and this risked many natives as many of them were ambushed while asleep. Learners wondered how it would be night and heavily raining in an area yet it was day and the Sun was highly shinning at that time in their school.

Task:

As a physics learner help the learners clear their queries about;

a) Occurrence of the floods in one area yet it was shining in their school at the same time.
b) Why it was night in that outside country yet it was day-time in their area?
c) How T.V signals broadcast from where the floods were happening reached them.

NUCLEAR PROCESSES, ATOMIC MODELS AND DIGITAL ELECTRONICS

Item 3

A certain town experienced an atomic bomb blast, many people were killed in the incidence and others survived with severe injuries, the government advised the survivors to re-locate to other places of the country because this village was not safe for them. The scientist carried out a scientific investigation using detectors of radiations and found out that the environment was still radioactive as shown in the table below.

Time (days)	0	22	42	62	82	102	122	142	162
Count rate (min^{-1})	106	83	66	56	47	36	31	26	15

The scientists recommended that the environment will be safe for use again when

obtained half-life value is less than 60 days and they will need like 1 year (365 days) for the environment to be free from radioactive wastes and materials.

Task: As a student of physics, use your knowledge to:

a) Help the people to know the value of half-life and advise them accordingly.
b) Sensitize the people about the risk associated with radioactive materials and how they should be handled.
c) Help the people to understand the value of number of neutrons of a nuclide Y formed when a radioactive substance X of mass number 208 and atomic number 104 decays by emitting 3 alpha particles, 4 beta particles and gamma rays to form a nuclide Y.

ITEM 4

As a physics student, you are tasked to design a home security light control circuit, the light should be activated by either manually pressing a switch or automatically by a light sensor. The sensor works as follows; when there is sunlight outside, it switches off the light but when there is darkness, it switches on the light. Draw a logic circuit diagram and a truth table for all the possible operations.

ITEM 5

A greenhouse farmer has two sensors in his green house; a temperature sensor and a humidity sensor. The plants in his greenhouse cannot give good yields if the temperatures are above 35^0C or if the humidity is high. He wants an alarm to be sounded if the plants are not having appropriate conditions for giving good yields. Using logic circuits, describe how this can be achieved.

ITEM 6

Scenario:

You are tasked with designing a simple burglar alarm system for a small storage facility. The system uses two types of sensors as inputs and is connected to a single alarm light that turns on when a potential intrusion is detected. The two inputs are:

- **Door Sensor (D):** This sensor is placed on the door and sends a signal (1) if the door is opened and 0 if the door is closed.
- **Motion Sensor (M):** This sensor detects movement within the storage room. It sends a signal (1) when motion is detected and 0 when there is no motion.

The burglar alarm system should activate (turn on the alarm light) only if the following conditions are met:

- **Condition 1:** The door is opened, and there is motion detected inside the room (indicating an unauthorized entry).
- **Condition 2:** There is motion detected inside the room, but the door is closed (indicating someone might be inside without having used the door, possibly breaking in through a window or another unmonitored entry).

Task:

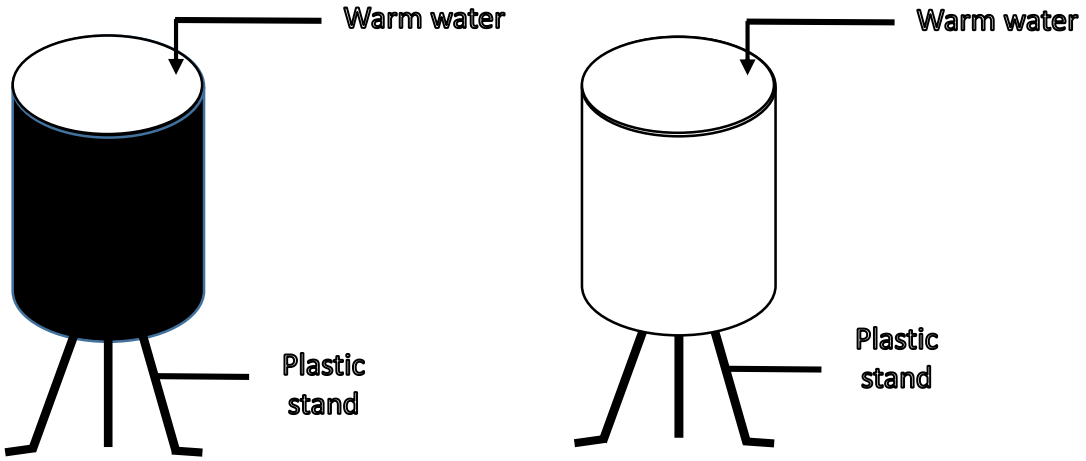
a) Determine the appropriate logic gate configuration to achieve the desired output for the burglar alarm system. Specify which logic gates you would use and how you would connect the inputs (D and M) to these gates to produce the correct output for the alarm light (A).
b) Construct a truth table for the inputs (Door Sensor - D, Motion Sensor - M) and the output (Alarm - A). The truth table should represent all possible combinations of the inputs and the corresponding output state of the alarm light.
c) Provide a clear explanation of why you chose the specific logic gates and how they fulfill the requirements of the burglar alarm system based on the conditions provided.

SECTION B: Select one item from each part

PART 1: HEAT AND MECHANICS

ITEM 7

A certain high way restaurant in one of the towns in Uganda is known to provide warm water to its customers for washing hands during lunch time. On a hot afternoon, An attendant who works in this hotel was given two plastics cylindrical tanks A and B. Tank A has cross-sectional area of $\mathbf{18380}\boldsymbol{cm^2}$ and height of $\mathbf{5.5}\boldsymbol{m}$. While tank B has cross-sectional area of $\mathbf{22200}\boldsymbol{cm^2}$ and height of $\mathbf{4.5}\boldsymbol{m}$ Tank A is painted black while tank B is painted white.



The attendant is supposed to store $\mathbf{10000}\boldsymbol{kg}$ of water in any of the tanks. She is worried about which tank she can use that can accommodate all the available water and which one can keep water warm.
To ensure smartness in the restaurant, each tank is supposed to be supported on plastic stands as shown in the figure.
As a learner of physics;

a) Help to explain to the attendant on;
    i. The tank she would use to store the required amount of water.
    ii. The type of tank that would keep water warm for customers.
b) If one of the tanks was to be used for hand washing and the owner of the restaurant wants to put a tap on it.
    iii. Show him by letter K, the position where the tap can be put.
    iv. Explain to the restaurant owner on the choice of position K.
c) What advice would you give to the restaurant owner on the measures he would ensure for the tank stand to withstand the weight of the tank for a long time.

Item 8

A steel and tube industries company limited was contacted by the school to make a number of new items to restock their kitchen. Among the items on the invoice are; saucepan, strainer, saucepan covers (lids), ladles, cups and plates for students. The school did not specify the type of materials these items should be made of and therefore, the procurement officer of the company contacted their raw materials supplier and the following was supplied following the invoice.

- Plain sheets of copper
- Plain sheets of aluminum
- Melamine resin powder
- Clay
- Wood

For the production team to come up with the items requested by the school, they have to subject these raw materials to either heat or force however these materials behave differently under these two factors.

The cateress prepares milk for students' breakfast. She uses an electric heater which operates on a $\mathbf{4350}\,\boldsymbol{W}$ power supply. Some milk is to be kept so that students can take for their evening tea.

Support knowledge.
Heat capacity of copper is $400\ Jkg^{-1}K^{-1}$
Heat capacity of Milk is $3890\ Jkg^{-1}K^{-1}$
Initial temperature of milk 25^0C
Mass of copper $5\ kg$
Mass of milk $80\ kg$

Task

a) As a physics learner, with reason(s) help the production team to select the raw material suitable for each item to be produced.

b) Determine how long it will take for Milk to reach 100^0C. Assume no heat is lost to the surrounding.

c) With reference to a thermos flask, explain how milk is kept hot.

PART 2: ELECTRICITY AND MAGNETISM

ITEM 9

In a certain place, a house was connected to a **240V** mains voltage supply and the owner wished to connect a TV set rated **75W**, a flat iron rated **600 W,** and **4** bulbs each rated **60W** either in series or parallel connection for lighting purposes. The house owner also bought a Power King extension with a fuse rated **4A**, where he plugged in his TV set and Flat iron. The T.V set is operated for **5** hours per day, the flat iron is operated for 2 hours per day while the bulbs light for 12 hours per day.

Task:

(a) Explain the importance of the fuse in the extension and comment on its effectiveness in the extension whether it would support the T.V and the flat iron when plugged in the extension or not.

(b) Assist the house owner to know in which way to connect his bulbs in the house and explain why?

(c) Suppose all the **4** bulbs were connected in parallel, help the house owner know how much current is delivered through this parallel arrangement if the potential difference across this parallel arrangement is **20V.**

(d) Determine the amount of money required to keep all appliances running for two days, if the cost of each unit is $\boldsymbol{UG\ Sh.680}$

Item 10

Your school organizes a science exhibition in which leaners showcase some of their achievements in science and physics in particular. Your class is tasked to explain some concepts using only the materials available and the circuit given. two solid electrodes (Zinc and copper), an electrolyte (ammonium chloride jelly) and electrical conductor such as wire. You are required to make a cell from the materials given and use it in the circuits in *Figure a* and *Figure b*.

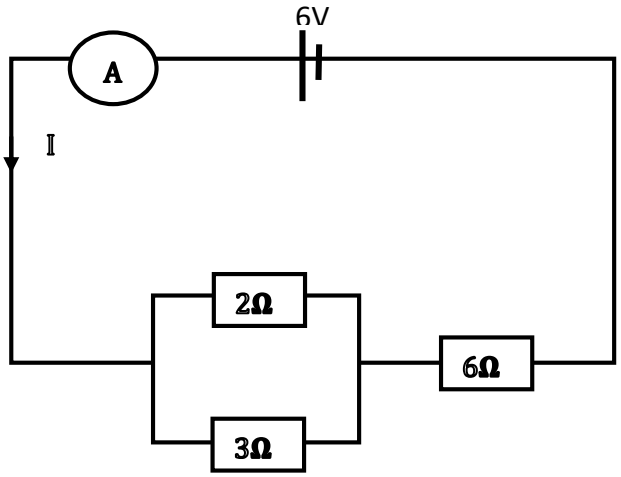


Figure a

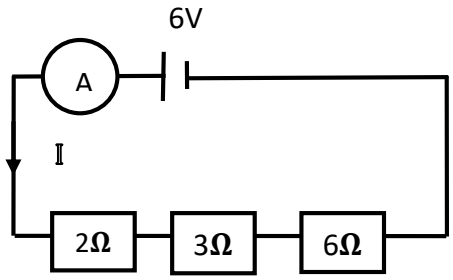


Figure b

Task:

a) Take the team that has visited your stall through the steps of making a simple cell which can be used to supply voltage in the circuits above.
b) By finding the ammeter reading in each circuit, State which of the circuits in $Figure\ a$ and $Figure\ b$ will produce more current.
c) Suppose all the resistors are replaced by identical bulbs (bulbs of the same ratings) and only the bulb in place of the **3Ω** resistor blows out, state which circuit will continue working and give a reason to support your answer.
d) Using the results in 7(b) above, explain why it's advisable to connect bulbs in parallel than in series.

END