P510/1 PHYSICS

2HOURS: 40MINUTES

UGANDA ADVANCED CERTIFICATE OF EDUCATION

S.6 END OF TERM ONE PHYSICS PAPER ONE

TIME: **2HOURS 40MINUTES**

INSTRUCTIONS:

- ✓ Attempt only **four items not attempting more than one item** in a section.
- ✓ Where necessary, use;

Speed of light in vacuum, c = 3.0 x 10^{8} ms^{-1}

Constant, k = 9.0 x 10^{9} $F^{-1}m$

Permittivity of the free space, ε_0 = 8.85 x 10^{-12} Fm^{-1}

Acceleration due to gravity, g = 9.81 ms^{-2}

SECTION A: MODERN PHYSICS

Item 1 (compulsory)

A physics laboratory uses a photoelectric experiment to investigate electron emission from a metal surface when exposed to different frequencies of light. Students observe that no electrons are emitted when red light is used, but emission occurs when ultraviolet light is used. The experiment is used to model how solar panels and light sensors operate in modern technology.

Given that threshold frequency is f and Planck's constant is h:

Task

(a) Explain the photoelectric effect

(b) State the meaning of threshold frequency.

(c) Explain why red light fails to emit electrons.

(d) Describe how this principle is applied in modern electronic devices.

SECTION B: FORCES AND MECHANICS

(respond to only one item)

Item 2

A transport company is testing a new delivery van designed for urban logistics. The van, when fully loaded, has a mass of 1500 kg. During a controlled test on a straight road, the van accelerates uniformly from rest to 25 m/s over a distance of 200 m. Engineers also measure that engine force remains constant while resistive forces vary slightly due to road surface and air conditions.

TASK

(a) Calculate the acceleration of the van.

(b) Determine the resultant force.

(c) Calculate resistive forces if engine force is 6000 N.

(d) Explain effects of friction and air resistance on vehicle performance.

Item 3

During renovation of a tall community hall, a group of physics students assist the site engineer in checking safety conditions for workers and materials. While inspecting the roof, a worker accidentally tosses a small stone vertically upwards from the roof edge with an initial speed of 15msl. The stone is seen to hit the ground 4.0s later. Concerned about falling objects, the engineer asks the students to analyze the motion so that protective barriers of suitable height can be recommended. Later, the team observes a wooden ladder of length 10.0m and weight 200N leaning against a smooth vertical wall at an angle of 60° to the horizontal. A painter of weight 500N stands at a point one-quarter of the way up from its lower end. The ground at the base is rough. The engineer is unsure whether the ladder is safe and asks the students to justify their conclusions using principles of mechanics(moments)

As the renovation continues, irregular plywood sheets are cut to fit around lighting ducts. The engineer notices that some sheets tip when lifted and asks the students to determine how to locate the centre of gravity before fixing them in position.

Task:

As a student of physics;

reach such high potentials. The operator explained that the large metal sphere on top acted as an equipotential surface. He added that the sphere needed high capacitance to store large amounts of charge, but warned that the electric field intensity around it must not exceed 30,000 volts per centimeter. If it did, the air would break down and a spark would jump out.

They also asked what an equipotential surface was, what the maximum potential of the sphere could be before a breakdown, and what its capacitance would be at that potential.

Later in the demonstration, each student was given a small metal piece to hold. As they moved closer to the Van de Graaff sphere, they felt a pulling force

toward it. The force grew stronger the closer they got, and this puzzled them. Learners wanted to understand the structure and mode of operation of the generator and nature of the spherical surface of the generator.

Task: Address the needs in the above scenarios.

END

temperatures were 15.2°C and 17.4°C respectively. When the flow was increased to 0.232kg/minute, and the rate of heating to 37.8W, the inflow and outflow temperatures are not altered. Find the;

(i) Specific heat capacity of the oil.

(ii) Rate of heat loss in the tube to the surroundings.

(d)Explain why you should carry out the experiment at steady state, and you must carry out two experiments for the workers.

Item 5

In a certain engineering university, a student was conducting a survey to measure the angle of elevation of a bright object in the sky.

However, he was not familiar of the method to employ. The student's supervisor also advised her not to use thick plane mirrors for the survey, but she was not sure of the reason as to why the procedure needed a test to verify the way in which light is reflected before everything commenced.

Available materials:

Two fully silvered thin plane mirrors, one half silvered thin plane mirror, a curved scale, a telescope.

Task:

As a learner of physics, prepare a guide for the researcher to make her understand;

(i) What reflection of light is, and the laws that govern it?

(ii) The reason as to why she was advised not to use thick plane mirrors.

(iii) The device and mode of operation to determine the angle of elevation of the bright image of the sky.

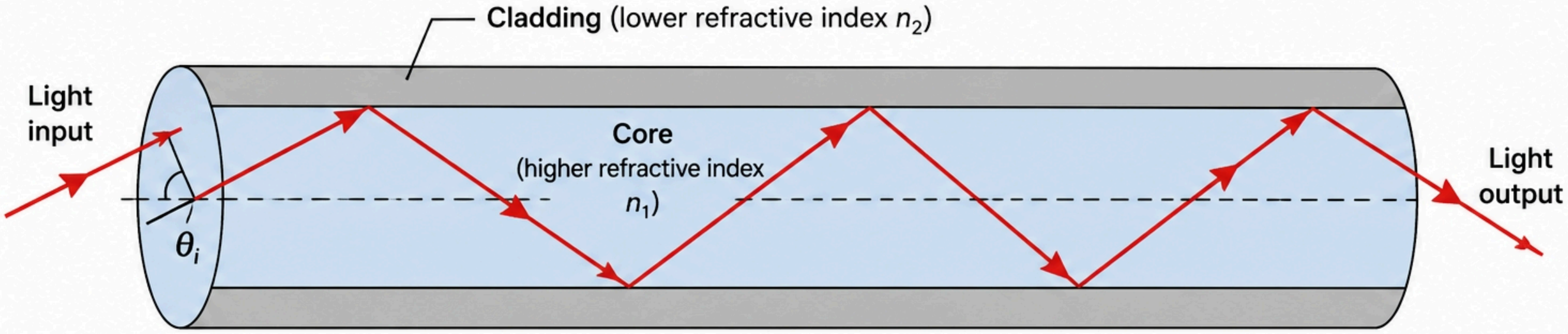
b) During a physics lesson, the teacher tasked members in their respective groups to outline the terms used in wave motion. In their responses, the following terms were mentioned; wavelength, frequency, and speed of the wave.

c) The teacher also told them that motion of a progressive can be analyzed using a general equation given by, $\mathbf{y = 5\sin(100\pi t - 0.4\pi x)}$, where y and x are in metres and t is time

in seconds.

Help your friend to:

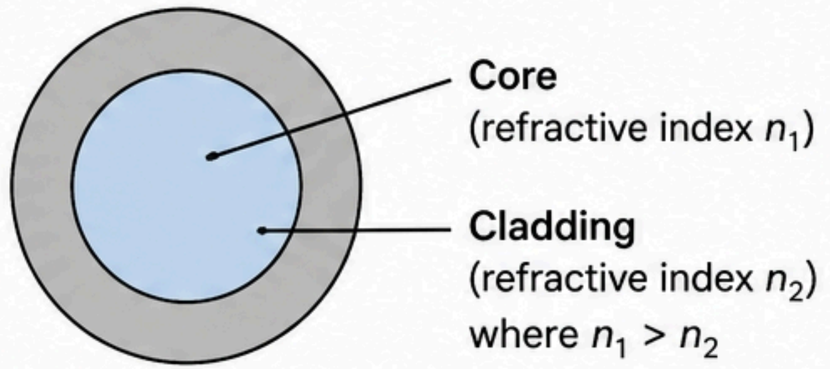
OPTICAL FIBER USING TOTAL INTERNAL REFLECTION



When the angle of incidence (θ_i) at the core–cladding boundary is greater than the critical angle (θ_c), total internal reflection occurs.

The light stays trapped in the core and travels long distances with very little loss.

CROSS–SECTION OF OPTICAL FIBER



KEY POINTS

- Core has higher refractive index (n_1) than cladding (n_2).
- Light entering at suitable angle undergoes total internal reflection.
- Light keeps reflecting and propagates through the fiber.
- Used in telecommunications, internet, medical endoscopy, sensors, etc.

CONDITION FOR TOTAL INTERNAL REFLECTION

$$n_1 > n_2 \text{ and } \theta_i > \theta_c$$

n_1 = refractive index of core

n_2 = refractive index of cladding

θ_c = critical angle