SECTION A

ITEM ONE:

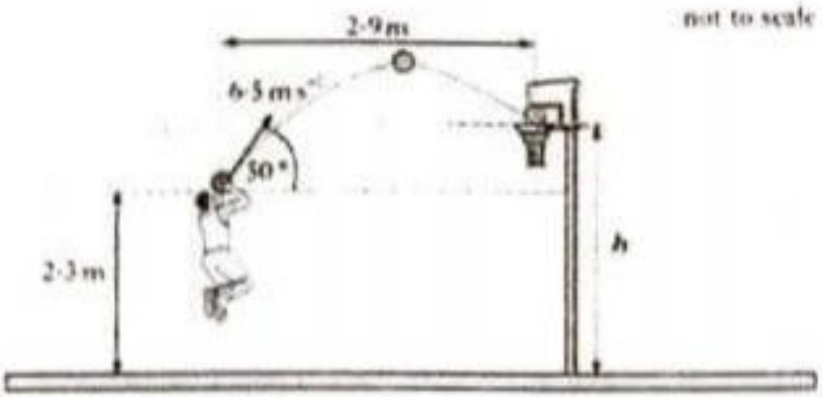
a) Baguma is a traffic officer investigating a bus accident. It was discovered that the Bus was moving at $20ms^{-1}$ when the driver suddenly applied brakes to avoid hitting a boy 50m aw bringing the Bus to a stop in 4s. A passenger inside the Bus hit his head against the metal i front getting injured in the process and is threatening to sue the Driver. The Driver insists t the passenger was at fault for not wearing a Seatbelt.

(i) Determine whether the boy was hit by the bus or not.

(ii) Explain briefly how wearing a seatbelt would have prevented the passenger from injuring himself.

(iii) Discuss how Newton's first law of motion applies in the above case.

b) During a basketball training session, a Basketball player throws a ball with an initial veloci of $6.5ms^{-1}$ at an angle of 50^{o} to the horizontal. The ball is 2.3m above the ground when released and travels a horizontal distance of 2.9m to reach the top of the Basket. The coacl says he will be satisfied if time taken by the ball to reach the basket does not exceed 0.5s.



(i) Is the coach satisfied with the player's state?

(ii) Determine the height h of the top of the Basket above the ground.

(iii) Apart from more practice, how can the player ensure that the ball takes a shorter time to la in the Basket?

ITEM TWO:

Mary operates a shop on a certain street in town. She is interested in putting up a signpost to advertise her business but lacks enough funds. She consults her friend who is studying structural engineering. Her friend advised her as follows; she could use a uniform beam of mass 6kg and 3m in length. The beam is to be hinged to the wall at a point, say A and held horizontally by a rope attached to the other end B of the beam and joined to the wall at a point X 4m vertically above A. The structure is safe if the tension in the string does not exceed 40N and the reaction at the wall exceeds 25N.

On a certain rainy day while Mary is walking along a busy highway, she feels pulled towards a heavy truck passing by her at a high speed. As she is trying to make sense of it, a heavy wind blows over her umbrella at a speed of $120ms^{-1}$ while the air below the Umbrella is at $80ms^{-1}$ and it flies away.

Hint:
Take the surface area of the Umbrella as $4.0 \times 10cm^2$.

a) Help Mary to visualize how the advertising sign post would appear including all the possible forces acting.

b)

(i) What is meant by a uniform beam?

(ii) Determine whether the proposed structure will be safe.

How would Mary determine and ascertain that the mass of the uniform beam is indeed 6kg before it is used, if she has no weighing scale to use.

Explain to Mary why she felt pulled towards the speeding truck.

Determine the magnitude of the force that caused Mary's Umbrella to be blown away.

ITEM THREE:

(a) Imagine you are on a small sailboat in the Atlantic Ocean, several miles from any landmass. Sun is shining, but there are no land marks to help you determine your position and the Su altitude.

TASK:

(i) What instrument would be used to determine the sun's altitude.
(ii) Explain how the instrument named performs its function.
(iii) Derive the principal of working of the instrument named.

(b)A school carpenter fixed a dressing mirror in one of the dormitories in a school. Irean the talle girl among all who reside in that dormitory complained of not being able to see the whole o herself in the mirror while all others could comfortabley see themselves. The carpenter has been advised to change the size of the mirror. Irean is 1.8m tall and her eyes are 10cm below the top of her head.

TASK.

As a physics student,

(i) Advise the capenter on the appropriate type of the mirror to use.
(ii) Help the capenter to know the minimum height of the mirror to fix for Irean to see her full image.
(iii) Help the carpenter to know how close must the lower edge of the mirror be from the floor.

ITEM FOUR:

In order to regulate 'room' temperatures,different materials with different thermal conductivies are used. Some times windows are made with an air layer enclosed between glass planes. In one such window, two thick glass planes each of thickness 30mm are seperated by an air gap 10mm thick. During a heat wave, it was recorded that the room temperature was $20°C$ while the temperature outside was 42°C. The room could be kept comfortable if the rate of heat flo per square meter of the window does not exceed $45Wm^{-2}$.

A boy playing outside the house got a bottle of water from the refridgerator that was initially at about $5°C$ and after 10 minutes, the water was found to have warmed to about $15°C$. He wondered whether the global warming his teacher was talking about was indeed happening.

HINT:

Thermal conductivity of air = $0.03wm^{-1}K^{-1}$

Thermal conductivity of glass= $0.8wm^{-1}K^{-1}$

Specific heat capacity of water=$4200Jkg^{-1}K^{-1}$

TASK:

a)

(i) What do you understand by the term thermal conductivity, and briefly discuss its relevance in poor and good conductors.

(ii) Discuss an experimental set up showing how the thermal conductivity of a poor conductor can be determined including the precautions to be taken.

b) Determine whether the room will be comfortable or not.

c) Given that the solar power incident on a unit area of earth is $1400Wm^{-2}$ and the area of t bottle on which the solar radiation falls normally is $40cm^2$, find the mass of water in the assuming the bottle absorbs 60% of the radiation incident on it. **Hint**; heat capacity of the bottle is $20JK^{-1}$

d) Briefly explain green house effect and its relation to global warming.

SECTION C

ITEM FIVE:

A S5 class presented electrostatics experiments expo to the entire school. During the expo, Alice combed her hair and used the comb to pick up small paper pieces. Alice explained to the audience that the comb acquires charge during combing. During the same expo, Patience stood on a wooden stool and held on the dome (hollow metal sphere) of a Van de Graaff generator with both her hands, the dome is of 2m diameter and holds a charge of $+5.0\mu C$. Her hair stood like spikes on her head. These observations amused the audience and had many un answered questions.

TASK:

As a physics student,

a)

(i) Explain how the comb acquired charge when Alice was combing.

(ii) How can Alice test experimentally and know the type of charge acquired by the comb.

(iii) Explain how the comb is able to attract paper pieces.

b)

(i) Explain how a Van de Graaff generator works and how it is able to make Patience's hair stand like spikes on her head.

(ii) Find the electric potential and electric field intensity at the surface of the Van de Graaff generator dome.

(iii) Explain what would happen if Patience was standing bare footed directedly on the ground rather than standing on a wooden box.

ITEM SIX:

Supercapacitors can store large amounts of energy and are efficient for renewable energy storage. Capacitors that use dielectrics of high dielectric constant are preferred.

A supercapacitor bank to store energy for intermittent solar power system is to be designed. Only 0.1F capacitors are available and a total of capacitance of 0.5F is needed. This energy bank when fully charged, has a maximum voltage of 12.8V.

TASK:

a) What is meant by terms dielectric and dielectric constant.

b) Explain the effect of dielectric on capacitance of a charged capacitor.

c)

(i) How many 0.1F capacitors are needed to make the energy bank and how would they be connected.

(ii) Find the charge stored by the energy bank.

(iii) Derive an expression for the energy that is stored by a capacitor, hence determine the energy stored by the supercapacitor energy bank.

d) Describe how capacitance of a capacitor can be determined using a vibrating reed circuit.

END