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UGANDA ADVANCED CERTIFICATE OF EDUCATION
NOVEMBER - DECEMBER, 2023

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ITEM 3: LIGHT

At Namanwe Electric Vehicle Manufacturing Plant, lighting system comprises of Head lamps made up of Light Emitting Diodes [LED]. Where as they produce high intensity light, the production of blue and ^{red} light by LED lamps causes glare, a phenomenon that disrupts vision of an incoming motorist. To reduce on this effect and improve on the performance of LED lamps, an achromatic doublet lens consisting of a biconvex lens and a concave lens of the same radius of curvature but of different refractive index cemented together is fixed at the focal point of the reflector in the head lamp. In designing a head lamp used in heavy vehicles, a power of the combined lens in the range 4D - 6D is sufficient to provide high intensity light free of glare. To ensure quality products, confirmatory tests are conducted on the achromatic doublet lens formed before installation to form a complete unit of the lamp. The manager head lamp unit wishes to recruit additional staff offering technical advise and you are selected for this cause. You are provided with a sample of the convex lens and concave lens

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to be used in the head lamps.

TASK: As a Student of Physics at advanced level, help the manager to design and carry out a scientific investigation to determine the quality and suitability of the achromatic doublet lens to be used in car head lamps and advise the manager accordingly.

Apparatus / Material

1 Convex lens $f = 10\text{cm}$ in a holder

1 Concave lens $f = 20\text{cm}$ in a holder

2 Cells in a holder

1 Switch

4 Connecting wires

A screen with wire gauze

A white screen

1 metre rule

1 Plane Mirror

1 Piece of Plasticine or Sellotape

ITEM MECHANICS

An Interior designer uses Marble for Indoor flooring of bathrooms, countertops and Permanent stove tops in the kitchen. The choice of Marble is due to its density, Porosity, hardness and resistance to heat. The walls are painted with a mixture of Paraffin and high quality Paint. The Designer won a tender to design a hotel and ordered for these materials from a known hardware shop and received them. However, during the sizing of the marble to fit the purpose, it was easily breaking and when Paraffin was mixed with Paint, the mixture was not to the standard expected.

This behaviour of the marble and Paraffin were unusual and the designer was prompted to investigate the quality of the materials supplied by the hardware. Research indicates that the density of Marble is in the range $2.05 - 2.5 \text{ g cm}^{-3}$ and its about 36.9% the density of a metallic pendulum bob commonly found in school laboratories; the density of Paraffin is about 0.8 to 0.89 g cm^{-3} at room temperature.

TASK: Using the knowledge of Physics, Help the Designer to design and scientifically investigate the suitability and quality of the Marble and Paraffin supplied to be used in designing the Hotel Interiors.

** Apparatus / Materials

1 Pendulum bob (metallic)

1 Slotted 50g mass

1 Metre rule

1 Wooden block

1 Knife-edge

2 Pieces of knitting thread each about 50cm

2 - Small pieces of wood.

* 500ml beaker with two thirds filled with water

500ml beaker with two thirds filled with Paraffin

1 Vernier caliper