

PHYSICS TWO SENIOR FIVE
END OF TERM III EXAM 2025

TIME: 2HOURS 15 MINUTES.

Instructions: Attempt any three items.

Where necessary use

Permittivity of free space $\epsilon_0 = 8.85 \times 10^{-12} \text{ Fm}^{-1}$

The constant $\frac{1}{4\pi\epsilon_0} = 9.0 \times 10^9 \text{ m F}^{-1}$

$4\pi\epsilon_0$

Item 1

A group of A' level students investigated how light behaved in different materials. They used a plane mirror, one optical pin, a convex mirror, a glass prism, a meter rule and a plastic fiber for their study.

In one set up, the students were told that with the use of a plane mirror, one optical pin, a convex mirror and a meter rule, it was possible to determine the focal length of the convex mirror if they placed a plane mirror at a distance of 15 cm from the optical pin and at a distance of 10 cm from the convex mirror. In another set up, they passed a narrow monochromatic light ray through a glass prism of refracting angle 60° and found the angle of deviation for which incident and emergent angles are equal to 38° . A student named Anne told them that the information was enough for them to determine refractive index of a prism but she went for short call before explaining to them how possible it was. Finally they observed that light could travel through a bent plastic fibre without escaping. Curious students were, they couldn't explain this observation too.

TASK

As a learner of physics,

- (a) Derive the convex mirror formula.
- (b) Describe how students can determine focal length of the convex mirror using materials provided.

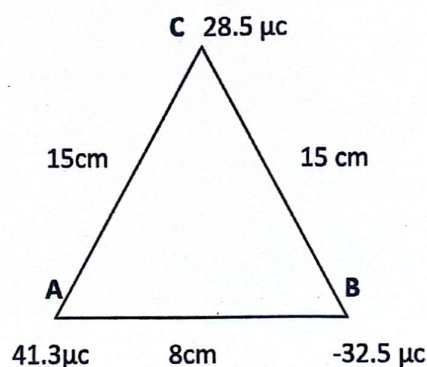
(c) Calculate for them the focal length of the convex mirror and explain to them any one real application of a convex mirror.

(d) Using prism data, help them to obtain the formula they can use to determine the refractive index of the glass prism hence calculate the refractive index for them.

(e) Identify for them the physics concept that enables light to pass through the bent fibre without escaping and with the aid of a clear diagram, explain to them how the light goes through the bent pipe.

Item 2

A business man who imports second hand car and sales them, of recently acquired a garage where the cars can be spray painted so that the cars look good to the customers. Before the garage could start spray painting the cars, the businessman consulted an engineer who told him that during spray painting paint particles repel each other but are attracted to the cars body and wondered if this would not waste the spray paint. The businessman was also told that the body of the car must be earthed during the spray painting. In one of the tests done by the engineer using an electronic microscope it was found that three paint particle from the nozzle of the spray were at one time arranged in a shape of a triangle ABC and carrying charge as shown in the figure below.



Task:

Using your knowledge of electrostatics, help the business man

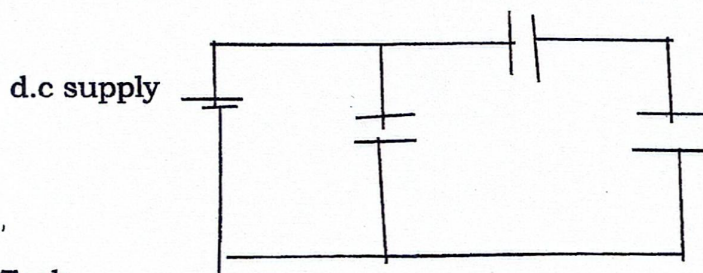
- Understand the law of electrostatics that governs charged particles.
- Know how an electrostatic paint spray works.
- Determine the electrostatic force experienced by the charge at point C.

- d) Calculate the work done to move $-2\mu\text{C}$ from infinity to a point p at the midpoint of the line AB
- e) Understand how the body of car could be charged and yet remains at zero potential.

ITEM 3

A group of S.5 physics students were marking a science project to store charge to always have lights on when power goes off. One of the students said they needed three capacitors and some dielectrics of high dielectric constant to increase on their capacitance and said they should be arranged were to achieve the high capacitance. Some students could not understand him even were not sure on how to arrange them to have the high capacitance.

One of the students drew the circuit shown be that can be used when connecting their capacitors.



Task.

- a). what is meant by the following terms.
 - i) Capacitance
 - ii) Dielectric constant.
- b).explain how a dielectric increases the capacitance of the capacitor.
- c) Explain what would happen if a conductor is inserted between plates of a charged capacitor instead of a dielectric.
- d) Describe how to determine the capacitance of a capacitor using a ballistic galvanometer.
- e) i) mention how the capacitors should be connected to the d.c supply in order to have store more charge.
 - ii) Derive an expression for the effective capacitance of the three capacitors for arrangement mentioned in e i) above

- f) If each of the capacitors had a capacitance of $2\mu\text{c}$ and the e.m.f of the d.c supply is 10V calculate the charge stored by the arrangement suggested in the circuit above.

END