P510/2

PHYSICS

PAPER 2

2 ½ Hours

June/July 2022

UACE RESOURCEFUL MOCK EXAMINATIONS

PHYSICS

PAPER 2

2 hours 30 minutes

INSTRUCTIONS TO THE CANDIDATES:

Attempt only **five** questions from all the **four** sections A, B, C and D with atleast **one** question from each section but not more than one from A and B. Do not answer two questions from either section A or section B, and not more than two questions from sections C and D.

Where necessary assume the following constants;

Acceleration due gravity, g	=	9.81m s^{-2}
Speed of light in vacuum, c	=	$3.0 \times 10^{8} \text{ m s}^{-1}$
Speed of sound in air	=	340 m s^{-1}
Charge on an electron, e	=	$1.6 \times 10^{-19} \text{C}$
Electron mass	=	$9.1 \times 10^{-31} \text{kg}$
Permeability of free space, μ_o	=	$4\pi \times 10^{-7} \text{H m}^{-1}$
Permittivity of free space, ε_o	=	$8.85 \times 10^{-12} \text{ F m}^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9} \text{F}^{-1} \text{m}$

SECTION A

1. (a) (i) Distinguish between reflection and refraction of light. [2 marks]

(ii) Show that the radius of curvature is related to the focal length according by the expression **r =2f** for a concave mirror. [3 marks]

(b) Describe an experiment used to determine the focal length of a convex mirror using a plane mirror. [4 marks]

(c) Figure.1 below shows a pentaprism as used in the viewfinder of some cameras. Light enters face AB and leaves face BC as shown. The faces AE, ED and DC are silvered and the refractive index of glass is 1.52.

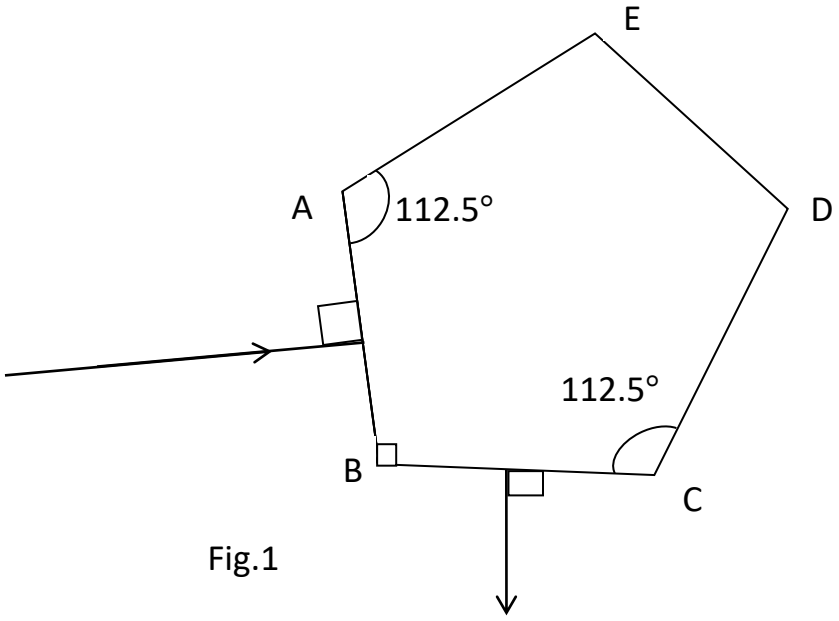


Fig.1

(i) Redraw the diagram and show the path of the incident ray from face AB to face CD. [2 marks]

(ii) State why you have drawn the ray in this direction. [1 mark]

(iii) Explain, with the aid of calculation, why the face CD needs to be silvered if the ray shown is not to be refracted at face CD. [4 marks]

(c) (i) Explain carefully why the apparent depth of water in a tank changes with the position of the observer. [3 marks]

(ii) A microscope is focused on a scratch on the bottom of a beaker. Turpentine is poured into the beaker to a depth of 4 cm, and it is found necessary to raise the microscope through a vertical distance of 1.28 cm to bring the scratch again to focus. Find the refractive index of the turpentine. [4 marks]

2 (a) Define the following terms as applied to concave lenses

(i) focal length [1 mark]

(ii) radii of curvature [1 mark]

(b) (i) Draw a ray diagram showing the formation of a finite image for a finite object placed along the principal axis of a diverging lens. [1 mark]

(ii) Derive an expression that relates the object distance **(u)**, image distance **(v)** and focal length **(f)** of a concave lens using the diagram in b (i) above [3 marks]

(c) (i) What is meant by normal adjustment as applied to microscopes? [1 mark]

(ii) Describe with aid of a ray diagram, the working of a compound microscope in normal adjustment. [4 marks]

(d) A converging lens L_1 of focal length 1.50cm is placed 29.0cm in front of another converging lens L_2 of focal length 6.25cm. An object of height 0.1m is placed 1.60cm away from the first lens on the side remote from the second lens and at right angles to the principal axis of the two lenses.

(i) Draw a ray diagram to show the formation of the final image by the lens system [2 marks]

(ii) Determine the position and size of the final image of the object [4 marks]

(e) Explain why there is a reduction in the intensity of the image formed of a point object placed in front of a thick plane mirror. [3 marks]

SECTION B

3. (a) (i) With the aid of suitable sketch diagrams, distinguish between free and damped oscillations. [3 marks]

(ii) State one application of damping. [1 mark]

(b) Distinguish between interference and diffraction of light [2 marks]

(c) With the aid of suitable sketches, explain the following;

(i) Division of wave front [3 marks]

(ii) Division of amplitude [2 marks]

(d) In young's two slits experiment;

(i) State the conditions necessary for an interference fringes to be visible and explain why these conditions are necessary. [2 marks]

(ii) Monochromatic light of wavelength 5.67×10^{-7}m is incident on two slits of separation 4.5×10^{-4}m. Calculate the fringe separation on a screen placed 150cm from the slit. [3 marks]

(e) (i) Define resonance. [1 mark]

(ii) State two uses and one hazard of resonance. [3 marks]

4. (a) (i) What is meant by interference of waves? [1 mark]

(ii) Describe an experiment to demonstrate interference of sound waves. [5 marks]

(b) (i) Define the terms wavelength, frequency and amplitude of a wave. [3 marks]

(ii) Derive the relationship between velocity, wavelength and frequency of a wave. [3 marks]

(c) The displacement of a particle in a plane progressive wave is given by the equation $y = 4 \sin [2\pi (50\, t - \frac{25}{17}x)]$, where x and y are in millimeters and t in seconds.

(i) Write the equation of the stationary wave which would give rise to a stationary wave if superimposed on the one above. [1 mark]

(ii) Find the equation of the stationary wave and hence determine its amplitude of vibration. [4 marks]

(d) Explain why sound from a distant source is heard more clearly at night than during noon on a shinny day. [3 marks]

SECTION C

5. (a) (i) Define the terms *magnetic field* and *magnetic flux density*. [2 marks]

(ii) Sketch the magnetic field pattern due to two parallel straight wires carrying currents I_1 and I_2 in the same direction in air. [3 marks]

(b) (i) Write down the expression for magnetic flux density at the centre of a plane circular coil of N turns, radius R, and carrying a current I in a vacuum. [1 mark]

(ii) A short wire forming part of a current balance of length 2.0 cm is at the centre of a coil of radius 5.0 cm of 40 turns each carrying a current of 8.0 A. Calculate the magnetic force experienced by the wire if a current through it is 3.0 A. [4 marks]

(c) Explain with the aid of a sketch diagram and relevant equations why a large voltage builds up across opposite faces of a conductor when a current is passed through it. Derive the expression for this voltage. [6 marks]

(d) A solenoid of length 25 cm, with an iron core, is wound with 100 turns of wire and a current of 2A is passed through it. If the magnetic flux density produced at the centre of the core is 2.5 T, calculate the relative permeability of the core. [4 marks]

6. (a) (i) Define the terms *reactance* and *impedance* as applied to a.c. [2 marks]

(ii) An alternating current $I = I_o \sin t$ is passed through a coil of self inductance L. Derive an expression for the reactance of the coil. [4 marks]

(b) Describe the structure and mode of operation of a hot wire ammeter. [5 marks]

(c) An iron cored coil of inductance 0.2 H and resistance 20 Ω is connected in series with a capacitor of 60 μF. Find the;

(i) magnitude of the current flowing through them when connected to a 200 V, 50 Hz ac supply. [4 marks]

(ii) heat energy dissipated in the circuit in 8minutes. [2 marks]

(d) Explain why the resistor and coil in the circuit in (d) warm up while the capacitor remains cold. [3 marks]

7. (a) (i) State the laws of electromagnetic induction. [2 marks]

(ii) Describe a simple experiment to verify Faraday's law. [6 marks]

(b) Derive an expression for the e.m.f induced in a coil rotated in a uniform magnetic field. [3 marks]

(c) A rectangular coil of 100 turns and area $2.0 \times 10^{-2}\,m^2$ lies in a uniform magnetic field of flux density $3.0 \times 10^{-3}\,T$ with its plane initially normal to the magnetic field. The coil rotates uniformly at 100 revolutions per second about an axis perpendicular to the magnetic field.

Calculate:

(i) the amplitude of the e.m.f induced. [2 marks]

(ii) the e.m.f induced when the plane of the coil makes 60° with the magnetic field. [3 marks]

(d) (i) What are Eddy currents? [1 marks]

(ii) Explain the role of Eddy currents in electromagnetic brakes. [3 marks]

SECTION D

8. (a) Define dielectric constant of a capacitor and state its unit. [2 marks]

(b) (i) What is meant by Capacitance of a capacitor? [1 mark]

(ii) Describe how you would compare two capacitances using a reed switch. [4 marks]

(b) A parallel plate charged air capacitor having plates of effective area A and of distance d, between the plates, has a dielectric of relative permittivity ε_r and thickness ⅓d, placed in contact with the entire inner length of one plate. Show that the effective capacitance of the new capacitor is $\left[\frac{3A\,\varepsilon_o\,\varepsilon_r}{d(1+2\varepsilon_r)}\right]$ where ε_0 is permittivity of air.

[4 marks]

(c) A parallel – plate capacitor consists of two plates 3.5 cm apart with a piece of glass 2 cm thick filling part of the space between them. When the glass is removed the plates' separation has to be reduced to 2 cm in order to restore the capacitance to its original value.

(i) Explain why the observation above happens. [3 marks]

(ii) Calculate the relative permittivity of the glass. [3 marks]

(d) Calculate the capacitance of the Earth, if its radius to be 6.4×10^6 m. [3 marks]

9. (a) State Kirchhoff's laws of electrical networks. [2 marks]

(b) In the diagram below, resistors of 10Ω and 8Ω are connected in series with d.c. power supplies of 10V and 12V respectively.

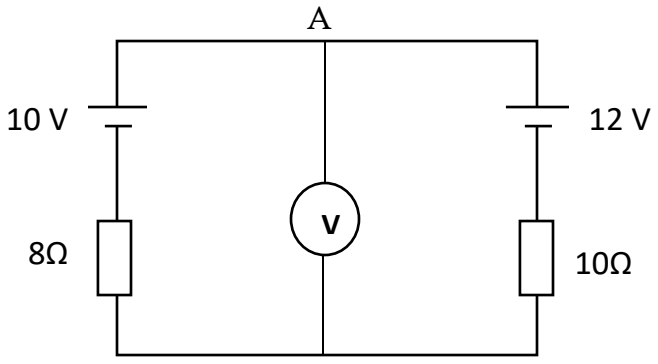


Fig.2

Calculate the;

(i) P.d across AB. [3 marks]

(ii) Power dissipated in the 8Ω resistor. [2 marks]

(c) (i) Define electrical resistivity and state its unit. [2 marks]

(ii) Describe with the aid of a circuit diagram an experiment to determine the electrical resistivity of a given wire using a meter bridge. [6 marks]

(iii) Explain why the bridge is not suitable for comparing very low or very high resistances. [3 marks]

(e) State two applications of super conductors. [2 marks]

10. (a)(i) State coulomb law of electrostatics. [1 mark]

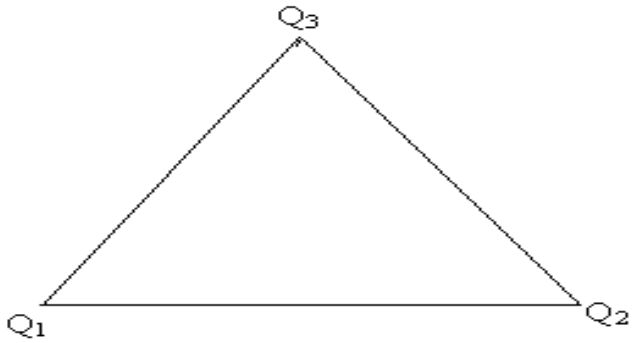
(ii) Explain how the capacitance of a conductor is affected by bringing uncharged conductor in its neighborhood**.** [3 marks]

(b)With a suitable diagram, explain electrostatics. [3 marks]

(c) Describe an experiment to show that there is high concentration of charge at sharp point [5 marks]

(d) Define electric potential energy and electric field intensity. [2 marks]

(e) Charges Q_1, Q2 and Q_3 of magnitude 2 μ C, -3 μ C and 5 μ C respectively are situated the corners of an equilateral triangle of side 20cm as shown in the fig. below.



Calculate; (i) the net force on Q_3 [3 marks]

(ii)the potential energy Q_3 [3 marks]

- **END** -