P510/2
PHYSICS
Paper 2
June/July, 2022
2½ hours

MATIGO MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

PHYSICS

Paper 2

INSTRUCTIONS TO CANDIDATES

*Answer **five** questions, including at least **one** from each section, but **not more** than **one** from any of the sections **A** and **B**.*

Where necessary assume the following constants:

Acceleration due to gravity,	g	=	$9.81ms^{-2}$
Speed of light in vacuum,	c	=	$3.0 \times 10^{8}ms^{-1}$
Speed of sound in air	v	=	$340ms^{-1}$
Electronic Charge,	e	=	$1.6 \times 10^{-19}C$
Electronic mass,	m_e	=	$9.1 \times 10^{-31}kg$
Permeability of free space,	μ_0	=	$4.0\pi \times 10^{-7}Hm^{-1}$
Permittivity of free space,	ε_0	=	$8.85 \times 10^{-12}\ Fm^{-1}$
The Constant,	$\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9}F^{-1}m$

SECTION A

I. (a) Define the following terms as applied to lenses.

(i) Focal length (1 mark)

(ii) Focal plane (1 mark)

(b) Describe how you would determine the focal length of a convex lens basing on Newton's lens formula. (5 marks)

(c) A thin Plano - convex lens of focal length 15cm is placed on top of thin layer of liquid poured on a plane mirror as shown in figure 1 below.

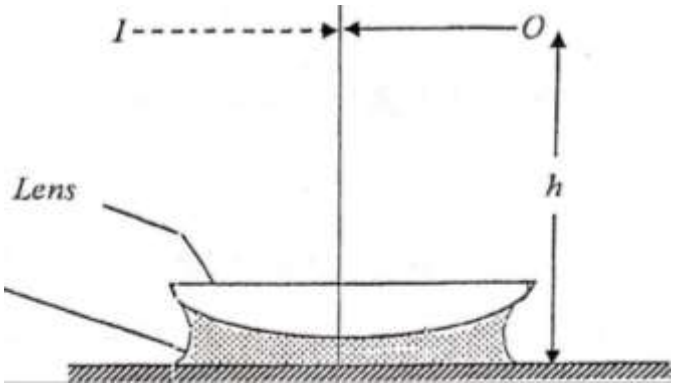


Fig.1

An optical pin O clamped horizontally above the lens coincides with its image by no parallax when it is a distance h above the plane mirror as shown above. If the refractive index of liquid is 1.4 and that of lens material is 1.5, find the value of h. (5 marks)

(d) (i) What is meant by visual angle and magnifying power as applied to optical instruments? (2 marks)

(ii) Derive an expression for magnifying power of a Galilean telescope in normal adjustment. (4 marks)

(e) Explain the significance of a convex mirror in a Cassegrain reflecting telescope. (1mark)

2.(a) What is meant by the following terms?

(i) Monochromatic light. (1 mark)

(ii) Absolute refractive index of a material. (1 mark)

(b) (i) Describe a simple experiment to determine the refractive index of the

liquid using air cell method. (5marks)

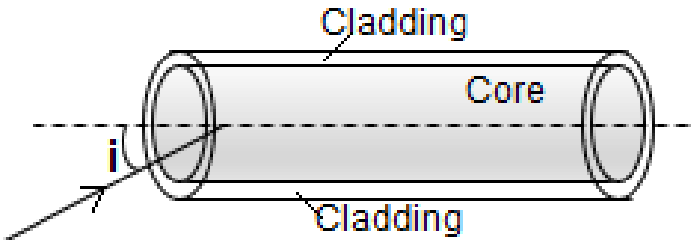
(ii) Why is monochromatic light is used in the experiment (b)(i) above.

(1mark)

(c) (i) Define the terms critical angle and total internal reflection. (2 marks)

(ii) A ray of monochromatic light is incident from air onto the plane surface of the core of an optical fibre at an angle **i** to the axis of the fibre. The core of the fibre has a refractive index of 1.60 while its cladding has a refractive index of 1.50 as shown below. Determine the value of **i** beyond which the ray just gets propagated into the fibre.

(4 marks)



(d) (i) with the aid of a ray diagram, explain the conjugate points as applied to lenses. (2marks)

(ii) An object, O, placed in-front of a converging lens forms a real image, I on the screen. The distance between the object and its real image is, *wh*ile that of the image from the lens is *x.* Derive the expression for the least possible distance between the object and its real image (4marks)

SECTION B

3. (a) Define the terms frequency and amplitude as applied to waves. (2marks)

(b) Figure 3 below shows a progressive wave travelling in the positive x- direction at a speed of $15ms^{-1}$ with a profile shown below. Show that the equation of the wave is given by $y= 3.0\sin 150\pi (t-\frac{x}{15})$ metres.

(4marks)

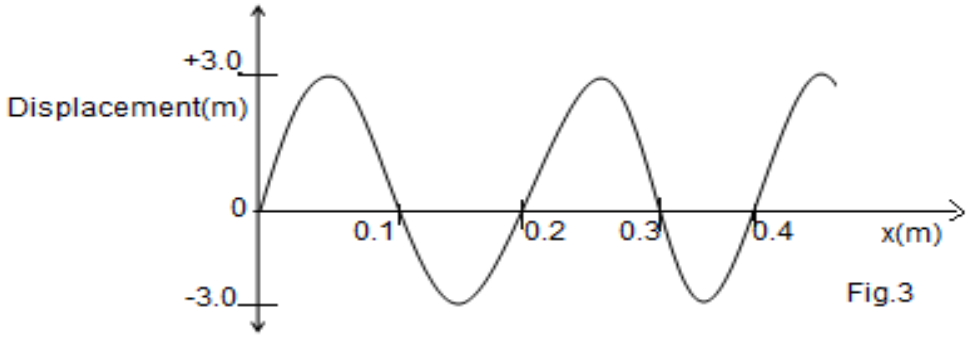


Fig.3

(c) (i) The velocity of propagation of transverse waves along a wire under tension, ***T*** is given by; $V = \sqrt{T/\mu}$ .Verify that this expression is dimensionally correct. (4 marks)

(ii) The fundamental frequency note produced by wire **A** of length 50cm is four times the frequency note produced by another wire **B** of length 1.50 m when each of them is plucked in the middle. Determine the relative mass per unit length of wire B to that of A, when the two wires are subjected to the same tension. (4 marks)

(d) With the aid of a diagram describe an experiment to show how the fundamental frequency varies with tension in a given wire. (6marks)

4. (a) What is meant by the terms path length and interference. (2marks)

(b) (i) Explain how interference fringes are formed in air wedge film between two glass slides when monochromatic light is used. (5marks)

(ii) Describe the appearance of fringes when white light is used. (2marks)

(c) Given that the separation of slits in young's double slit experiment is, a and the distance of the double slits to the screen is Find the expression for the fringe separation when light of wave length λ is used. (5marks)

(d) In young's double slit experiment, light of wave length 4.7×10^{-7}m is used. The separation between the slits is 0.42mm and the distance from the double slits to the screen is 1.4m.

(i) Find the distance between the second dark fringe and the fifth bright fringe. (4marks)

(ii) Explain what is observed when the primary slit is brought closer to the secondary slit. (2marks)

SECTION C

5. (a) (i) Define an ampere (1mark)

(ii) Suppose a similar wire of the same length L, is placed parallel to the first wire, a distance, d from it and also carrying a current I in opposite direction, derive an expression for the magnetic force it experiences. (3marks)

(b) Two thin, straight and parallel wires P and Q each of length 0.5m carrying currents of 2A and 3A respectively in opposite directions are joined by a cotton thread of length 4cm as shown in figure 4, below.

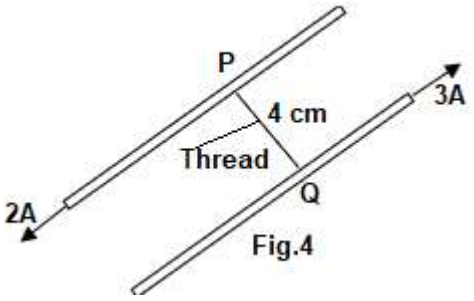


Fig.4

Find the:

(i) tension in the thread. (3marks)

(ii) the magnetic flux density mid-way between the wires. (4marks)

(c) (i) What is an electric motor? (1mark)

(ii) Describe the structure and mode of operation of an electric motor. (5marks)

(d) (i) What are eddy currents? (1 mark)

(ii) Explain how eddy currents are produced in a motor. (2marks)

6. (a) (i) State Lenz's law of electromagnetic induction. (1 mark)

(ii) Describe an experiment to verify Lenz's law. (5 marks)

(b) Figure 4 shows a conducting rod PQ of length 2.0 cm initially resting across smooth parallel conducting copper rails.

A resistance, R, of 4.0 Ω is connected cross the rails to form a complete circuit. When a force, F, is applied, the rod moves and attains a constant velocity of 6.0 m s^{-1} perpendicular to a uniform magnetic field of flux density 1.50 T.

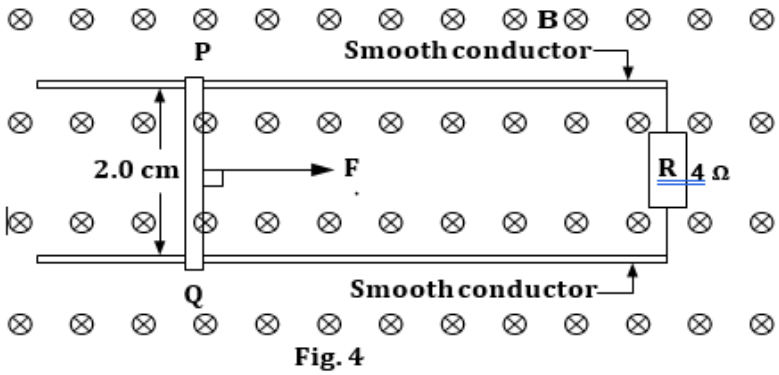


Fig. 4

(i) Explain why the rod moves with a constant velocity. (3marks)

(ii) Calculate the magnitude of the force, F, causing the motion of the metal rod PQ. (3 marks)

(c) (i) State two factors the determine the size of e.m.f induced in an a.c. generator. (2marks)

(ii) Outline the causes of energy losses in the generator in (i) above. (3 marks)

7. (a) (i) Define ***root mean square value*** of alternating current. (1 mark)

(ii) An alternating voltage V = 4.0 sin 100π t is connected across an inductor of self-inductance 0.2 H. Determine the value of the root mean square current flowing through the inductor. (4 marks)

(b) Describe the structure and mode of operation of an attraction type of a moving iron ammeter. (5 marks)

(c) Define; (i) root mean square value of an alternating current, (1 mark)

(ii) capacitive reactance. (1 mark)

(d) A capacitor of capacitance, ***C*** is connected across a source of alternating voltage, $V = Vo\ Sin\ \omega t$.

(i) Find the current which flows in the circuit. (3 marks)

(ii) Sketch using the same axes the voltage across the capacitor and the current which flows in the circuit with time. (2 marks)

(iii) Explain the phase difference between the voltage and current in

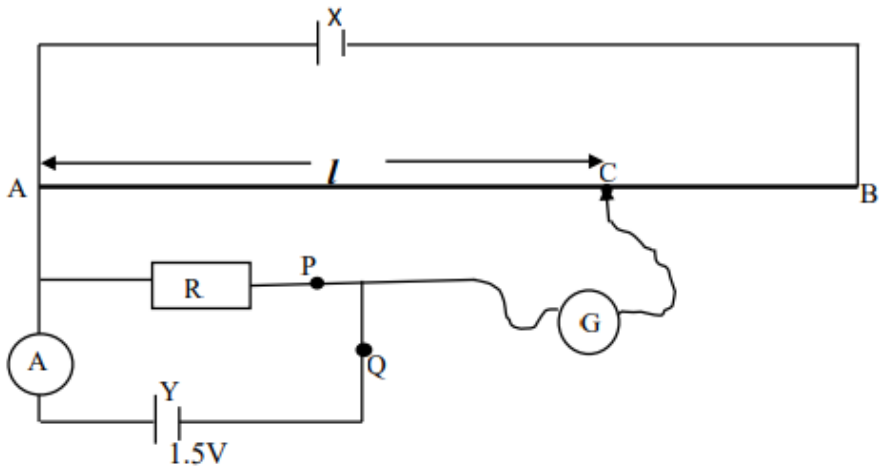
(ii) above. (3marks)

SECTION D

8. (a) (i) Define the terms internal resistance and e.m.f of a cell. (2 marks)

(ii) A battery of emf E and internal resistance, r is connected to a resistor of variable resistance, R. Derive an expression for the maximum power dissipated in the resistor. (4 marks)

(b) A potentiometer is connected to a resistor R, an ammeter A and a source Y of e.m.f 1.5V and internal resistance r as shown in figure 5 below.



The potentiometer wire has resistance of 5Ω and cell X has e.m.f of 2V and negligible internal resistance. When a resistor Rs is connected at P, the balance length l is 70cm and ammeter reads 0.27A. When Rs is connected at Q, the balance length l changes to 60cm. Find the values of r, R and Rs (5 marks)

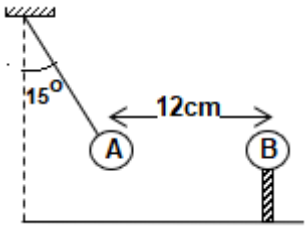
(c) (i) Define temperature coefficient of resistance of a Material. (1 mark)

(ii) Account for the variation of electrical resistance of semi-conductors with temperature. (3 marks)

(d) Describe an experiment to determine the temperature coefficient of resistance of a given wire using a wheat stone bridge. (5marks)

9. (a) (i) State coulomb's law of electrostatics. (1 mark)

(ii) A spherical conductor A of charge +20μC is suspended by a string. An insulated charged sphere B of -30μC placed 12cm from A as shown below:



Determine the mass of conductor A and the tension in the string. (4marks)

(b) Derive the expression for the electric potential at a point a distance, $\boldsymbol{r}$ from an isolated charge of magnitude $\boldsymbol{Q}$ in air. (4 marks)

(c)(i) Distinguish between charging by induction and charging by contact.

(3marks)

(ii)Explain how a lightening conductor protects a house from lightening.

(4 marks)

(d) Describe how the sign of unknown charge on a body can be established

Using a gold leaf electroscope. (4 marks)

10. (a) (i). Define the terms dielectric constant and microfarad. (2 marks)

(ii). Derive an expression for the capacitance of an air capacitor consisting of two parallel opposite circular plates of radius r and a distance t cm apart. (4 marks)

(b) Describe an experiment to determine relative permittivity of a dielectric material. (4 marks)

(c) Two capacitors of a capacitance 2μF and 3μF are joined in series between points A and B.

(i). Find the capacitance that must be placed in parallel with the 2μF capacitor in order to increase the capacitance from A to B by 0.8μF. (4 marks)

(ii). If the p.d between A and B is 12V, calculate the energy stored by the 2μF capacitor. (3 marks)

(d) A capacitor is connected to a d.c supply; explain why capacitance of the capacitor increases when a dielectric is inserted between the capacitor plates. (3 marks)

END