PHYSICS

Paper 2

(Principal Subject)

INSTRUCTIONS TO CANDIDATES:

Assume where necessary:

Acceleration due to 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,	*v*	=	$3.40 \times 10^{2} \text{m s}^{-1}$
Electroniccharge,	e	=	$1.60 \times 10^{-19} \text{C}$
Electronic mass,	m_e	=	$9.11 \times 10^{-31} \text{kg}$
Permeability of free space,	μ_o	=	$4\pi \times 10^{-7} \text{H m}^{-1}$
Permittivity of free space,	ε_0	=	$8.85 \times 10^{-12} \text{F m}^{-1}$
The Constant,	$\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9} \text{F}^{-1} \text{m}$

SECTION A

1. (a) (i) State the laws of reflection of light. (2 marks)

(ii) A ray of light from a fixed bulb B is incident on a plane mirror M_1 at 20°. The mirror is then rotated about point O anti-clockwise to position M_2 as shown in figure 1. Taking R_1 and R_2 as the respective reflected rays. Determine the size of angle θ between R_1 and R_2. (3 marks)

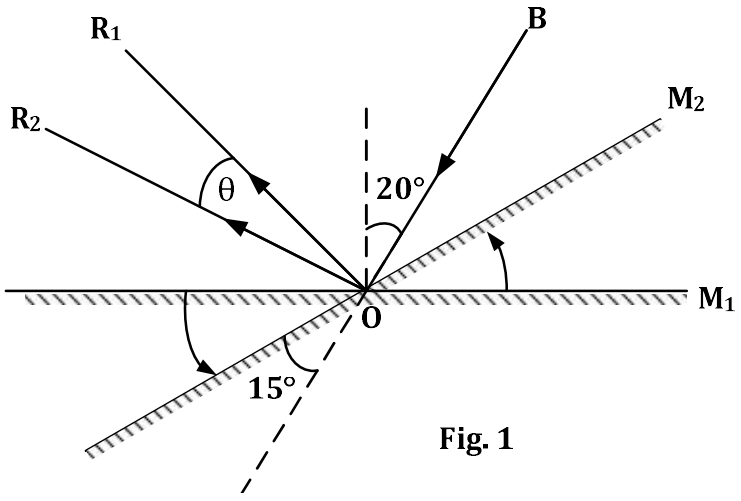

Fig. 1

(b) (i) Define the term centre of curvature of a convex mirror. (1 mark)

(ii) A convex lens L and a convex mirror M are arranged coaxially a distance of 6.0cm apart. A real point object O placed in front of a convex lens of focal length 10.0cm coincides with its own image I by no parallax at a distance of 15.0cm from L.

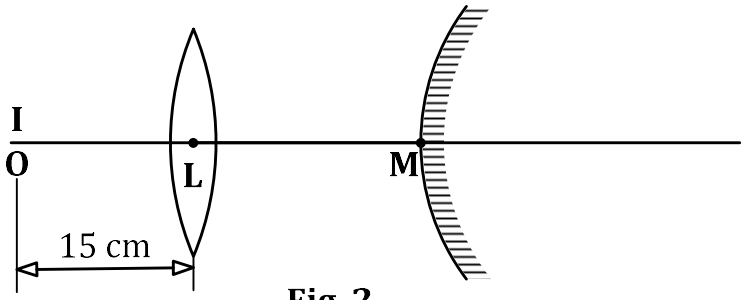

Fig. 2

Determine the focal length of the convex mirror, and draw a ray diagram to illustrate the action. (5 marks)

(c) Describe an experiment to determine the refracting angle of a triangular glass prism using an optical spectrometer. (6 marks)

(d) (i) What is meant by *limiting angle* of a triangular glass prism? (1 mark)

(ii) Calculate the limiting angle of a prism made of glass of refractive index 1.51. (2 marks)

2. (a) (i) Define absolute refractive index of a material. (1 mark)

(ii) Monochromatic light is incident from air into a glass slab of refractive index 1.50 at 48.6°. Given that the thickness of the slab is 9.0cm. Determine the time taken by the light to move across the slab. ($speed\ of\ light\ in\ air = 3.0 \times 10^8 ms^{-1}$). (4 marks)

(b) (i) Describe the structure and action of a compound microscope in normal adjustment. (5 marks)

(ii) A finite object of height 0.2cm is placed 3.0cm in front of the objective lens of focal length 2.5cm. The eyepiece of the microscope having a focal length of 5.0cm produces a magnified virtual image at the near point of the eye. Determine the size of the final image formed. (4 marks)

(c) Explain why a simple hand lens is said to be free chromatic aberration when held very close to the observer's eye for observing objects. (3 marks)

(d) Explain three advantages of reflecting telescopes over refracting telescopes. (3 marks)

SECTION B

3. (a) Distinguish between longitudinal waves and transverse waves. (3 marks)

(b) A progressive wave whose displacement in the x – direction with time is represented by the equation $y_1 = \text{a} \sin 2\pi \left(ft + \frac{x}{\lambda}\right)$ after bouncing off a plane stationary reflecting surface produces another wave of displacement y_2.

(i) State the direction of travel of wave of displacement y_1. (1 mark)

(ii) Write down equation of y_2. (1mark)

(iii) Derive the equation of the resulting standing wave and state its amplitude. (3 marks)

(c) (i) What are beats? (1 mark)

(ii) Explain how beats are produced. (3 marks)

(iii) Describe how you can use the knowledge of beats to determine the frequency of unknown source. (4 marks)

(d) A fine wire of length 0.200m is held between two fixed points and is subjected to a tension of 100N. It's plucked from the middle to set it into vibration. At its 3rd harmonic, it resonates with a tuning force of frequency 256Hz.

Determine the;

(i) Wavelength of the wave profile produced. (2 marks)

(ii) Mass per unit length of the wire used. (2 marks)

4. (a) (i) What is Doppler effect? (1 mark)

(ii) Using well defined symbols, derive an expressive for the apparent frequency of the sound of a car engine heard by an observer moving towards an approaching car travelling on the Same straight road. (4 marks)

(b) (i) Distinguish between unpolarized light and polarized light. (2 marks)

(ii) Describe how polarized light can be used to determine the concentration of sugar solution. (5 marks)

(c) (i) State Huygens's principle. (1 mark)

(ii) UseHuygens's principle to verify one of the laws of reflection of light. (3 marks)

(d) (i) What is interference of light waves? (1 mark)

(ii) State the conditions necessary for the observation of interference fringes in Young's double slit experiment. (3 marks)

SECTION C

5. (a) Define the following terms;

(i) Magnetic field line (1 mark)

(ii) Magnetic variance (1 mark)

(iii) Angle of dip. (1 mark)

(b) Figure 3 shows a straight wire W carrying a current I normal to the plane between two pole pieces of a strong magnet.

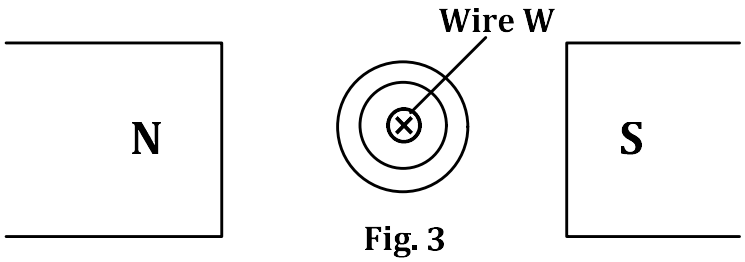

Fig. 3

(i) Complete the diagram to show what happens. (2 marks)

(ii) Explain what will happen to the wire. (3 marks)

(c) Figure 4 shows two parallel wires P and Q of infinite length carrying currents of 30A and 2A respectively and are separated by a distance of 10.0cm apart.

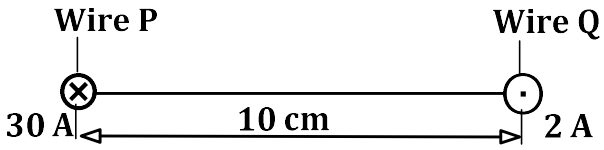

Fig. 4

(i) Determine the resultant magnetic field midway between the wires. (3 marks)

(ii) At what distance from wire Q is the resultant magnetic flux density zero? (3 marks)

(d) Describe an experiment to measure the horizontal component of the earth's magnetic field using a tangent galvanometer. (6 marks)

6. (a) (i) What is electromagnetic induction? (1 mark)

(ii) State the laws of electromagnetic induction. (2 marks)

(b) A window frame of a house standing in the East – West directions is made up of 200 turns of fine copper wire, joined at the end to make a loop. The dimensions of the window are 1.2m by 0.8m. The window is carefully opened about its hinges through an angle of 150° in 1.5seconds. If the resultant earth's magnetic field at the location is 8.0×10^{-4} Tand the angle of dip is 60°,determine the;

(i) Horizontal component of the Earth's magnetic field. (2 marks)

(ii) E.m.f. induced in the coil at the end of the process. (4 marks)

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

(ii) Statetwo applications of eddy currents and two disadvantages of eddy currents. (4 marks)

(d) Describe the structure and mode of operation of an a.c. generator. (6 marks)

7. (a) (i) Define the term *capacitive reactance*. (1 mark)

(ii) A capacitor of capacitance C farads is connected across an a.c source, $V = V_0 \sin 2\pi ft$. Derive an expression for its reactance. (3marks)

(b) Apure inductor of 0.56 μH is used as part of the tuning circuit in a radio receiver. The clearest signal is attained at a frequency of 90.9MHz

(i) Find the value of the most appropriate capacitance desired for the circuit. (3 marks)

(ii) Determine the **rms** value of the current that flows through the inductor when connected across a source of peak voltage 0.27V. (3 marks)

(c) With the aid of one simple circuit diagram, explain the use of a single diode and a capacitor in the rectification process. (5 marks)

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

SECTION D

8. (a) (i) What is meant by *work function* of a material? (1 mark)

(ii) Describe how a conducting sphere can be charged negatively at zero potential. (4 marks)

(b) Figure 5 shows a small sphere of mass 5.10g initially hanging vertically from an insulating thread 12.0cm long.

A uniform electric field of magnitude $1.44 \times 10^{6} NC^{-1}$ applied at 60° to the horizontal displaces the sphere by 6.0cm horizontally.

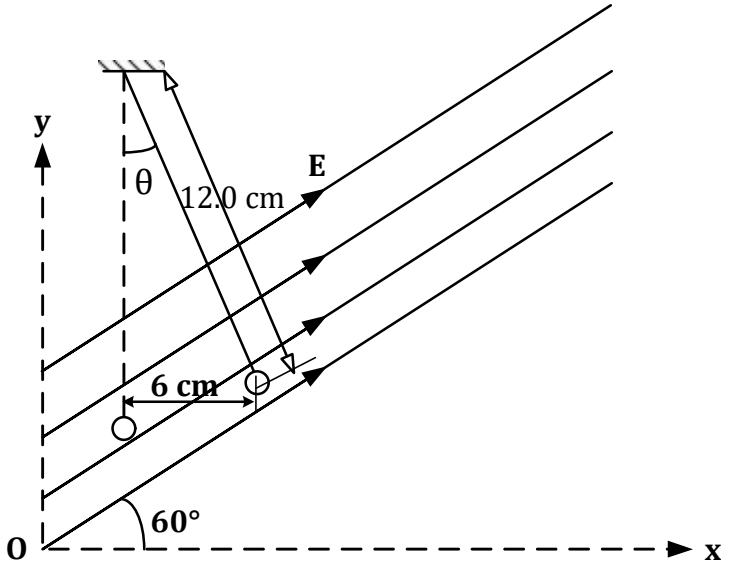

Fig. 5

Determine

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

(ii) Themagnitude of charge on the sphere. (3 marks)

(c) (i) What are equipotential surfaces? (3 marks)

(ii) Sketch electric field patterns due to a positive point charge placed near an earthed metal plate; and show equipotential surfaces of the system. (3 marks)

(d) Explain why the capacitance of a charged parallel plate capacitor increases when dielectric is inserted to fill the space between the plates. (3 marks)

9. (a) (i) State Kirchhoff's laws. (2 marks)

(ii) The circuit in figure 6 shows a network of d.c sources and resistors.

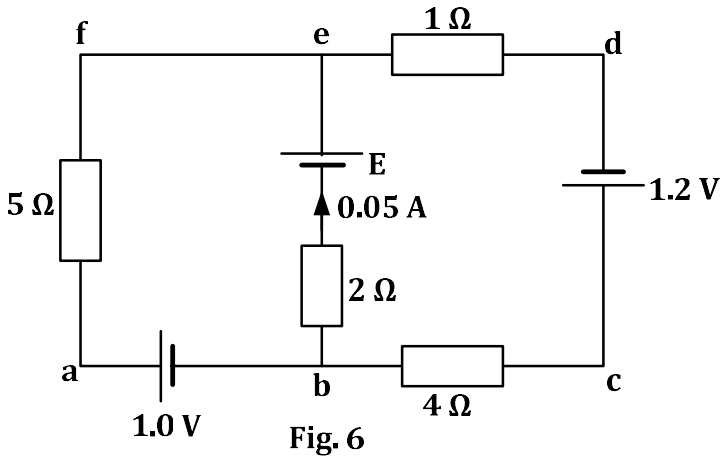

Fig. 6

If a current of 0.05A flows through 2Ω resistor from **b** to **e**, determine the value of E. (4 marks)

(b) (i) Define the term *electrical resistivity* of a material. (1 mark)

(ii) Describe an experiment to measure electrical resistivity of a material inform of a wire using a voltmeter and an ammeter. (6 marks)

(c) (i) Explain the principle of operation of a slide wire potentiometer. (3 marks)

(ii) On top of being accurate, state two other advantages of a slide wire potentiometer over a moving coil voltmeter. (2 marks)

(d) Explain the modifications necessary to use an ordinary slide wire potentiometer for the measurement of thermo electric e.m.f. (2 marks)

10. (a) (i) Define an ohm. (1 mark)

(ii) Derive an expression for the effective resistance of two resistors of resistances R_1 and R_2 arranged in parallel. (4 marks)

(b) Draw a labelled diagram of a Wheatstone bridge and use it to derive the balance condition. (4 marks)

(c) A nickel wire and a 10Ω standard resistor were connected in the gaps of a metre bridge. When the nickel wire was at 0°C a balance point was found 40.0cm from the end of the bridge wire adjacent to the nickel wire. When

it was at 100°C, the balance point occurred at the 50.0cm mark. Calculate the;

(i) temperature of the nickel wire on the resistance scale when the balance point was at 42.0cm from the corresponding end of the wire. (4 marks)

(ii) resistivity of nickel at this temperature, if the length of the wire is 150cm and cross sectional area is $25 \times 10^{-4} cm^2$. (3 marks)

(d) (i) What is an Ohmic conductor? (1 mark)

(ii) Sketch current – voltage characteristic graph of filament lamp and explain the shape. (3 marks)

= END=