SECTION A

1 (a) (i) State the **laws of reflection of light** (02 marks)

(ii) Describe with the aid of a diagram an experiment to demonstrate the principle of reversibility of light using a plane mirror. (04 marks)

(b) A plane mirror is placed 15 cm infront of a convex mirror so that it covers about half of the convex mirror surface. A pin placed 30 cm infront of the plane mirror gives an image which coincides with that of the pin in the convex mirror. Find the focal length of the convex mirror. (04 marks)

(c) (i) Define **refractive index of a medium.** (01 mark)

(ii) Derive an expression for the deviation of light caused by a thin prism of refracting angle, A and refractive index, n of the material of the prism. (04 marks)

(d) Monochromatic light propagating in air is incident on one face of an equilateral prism of refractive index 1.50. Find the angle of incidence if the prism produces maximum deviation. (03 marks)

(e) Briefly explain why an observer sees a spectrum of colours through rain drops when it is raining on a sunny day. (02 marks)

2. (a) Define the following as applied to a convex lens;

(i) **Principal focus.** (01 mark)

(ii) **Centre of curvature.** (01 mark)

(b) Derive an expression for the focal length of a convex lens in terms of the radii of curvature of its surfaces and its refractive index. (05 marks)

(c) Describe an experiment to determine the focal length of a concave lens using convex lens and a plane mirror. (04 marks)

(d) (i) Define **angular magnification** of an optical instrument. (01 mark)

(ii) A compound microscope has an objective of focal length 4.0 cm and an object is placed 5.0 cm from the objective lens. The final virtual image is formed in the plane of the object and 30 cm from the eye piece. Find the focal length of the eye piece lens. (04 marks)

(e) Describe with the aid of a labeled diagram, the structure and operation of a projection lantern. (04 marks)

SECTION B

3. (a) Define the following as applied to waves;
   (i) **Resonance** (01 mark)
   (ii) **Frequency** (01 mark)

   (b) Describe an experiment to investigate the variation of frequency with length of a vibrating wire. (04 marks)

   (c) (i) Explain how stationary waves are formed. (03 marks)
   (ii) A turning fork of frequency 756 Hz is sounded near the open end of a closed pipe of length 32.6 cm. If air in the tube resonates with the tuning fork, determine the mode of vibration and the end correction. (speed of sound in air is 330 ms^{-1}) (04 marks)

   (d) (i) What is meant by **Doppler effect?** (01 mark)
   (ii) An observer standing by the road side hears sound of frequency 600 Hz coming from a horn of an approaching car. When the car passes, the frequency appears to change to 560 Hz. Calculate the speed of the car. (03 marks)
   (iii) Describe how Doppler effect is used in police speed traps. (03 marks)

4. (a) What is meant by the following;
   (i) **Ordinary light.** (01 mark)
   (ii) **Plane polarized light?** (01 mark)

   (b) (i) Describe how plane polarized light can be produced by reflection. (04 marks)
   (ii) The refractive index of a Polaroid is 2.42. Find the polarizing angle of the Polaroid. (02 marks)

   (c) (i) What is a **diffraction grating?** (01 mark)
   (ii) Light of wave length 5.0×10^{-7} m falls on a grating with 600 lines per mm. Determine the highest order of diffraction that can be observed. (04 marks)

   (d) Explain what is meant by an **interference pattern** as applied to light waves. (04 marks)

   (e) Distinguish between **constructive** and **destructive interference.** (03 marks)

Turn Over

SECTION C

5 (a) Define **magnetic field strength** and **magnetic field lines.** (02 marks)

(b) With the aid of a sketch diagram of magnetic field pattern due to two wires carrying currents in opposite directions, explain why the force acts between the wires. (03 marks)

(c) A rectangular coil of a wire of N turns and area, A is suspended at the mid-point of one side of a fibre of tortional constant, k. The plane of the coil is initially set parallel to a horizontal uniform magnetic field of flux density B.

(i) Derive an expression for the angle of rotation of the coil when a current, I flows through it. (04 marks)

(ii) State the modification that would be required to turn the arrangement in (c)(i) into a moving coil galvanometer. (02 marks)

(d)

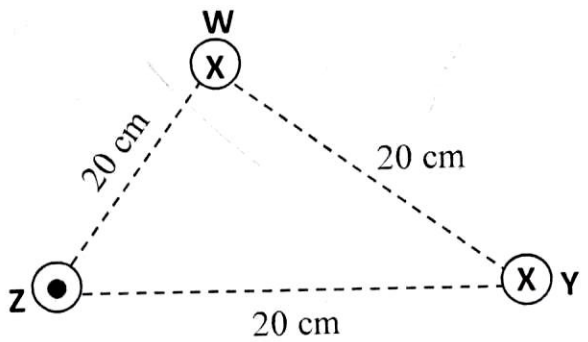


fig. 1

Three conductors W, Y and Z carrying currents 3A, 6A and 8A respectively are arranged as shown in the figure 1 above. Calculate the force experienced by conductor W. (05 marks)

(e) Describe how you would determine the horizontal component of the earth's magnetic flux density using a deflection magnetometer. (04 marks)

6. (a) State the **laws of electromagnetic induction.** (02 marks)

(b) (i) With the aid of a diagram, describe how a simple a.c generator works. (05 marks)

(ii) What are the main energy losses in a practical a.c generator and how are they minimized? (02 marks)

(c) A coil of 200 turns is wound round the middle of a solenoid of 500 turns per meter and radius 9.0 cm. A sinusoidal current $I = 15\sin(120\pi t)$ amperes is passed through the solenoid. Find the amplitude of the induced e.m.f across the terminals of the coil. (04 marks)

(d) (i) What are **eddy currents?** (01 mark)

(ii) Describe an experiment to demonstrate the damping effect of eddy currents. (03 marks)

(e) (i) A motor of armature resistance 0.65 Ω is operated from a 240 V d.c supply. When the motor turns freely without the load, the current in the armature is 8.0 A and the motor makes 500 revolutions per minute. Calculate the back e.m.f. (02 marks)

(ii) When the load is placed on the motor the current increases to 80.0 A. Find the new speed of rotation. (02 marks)

7. (a) Define the **root mean square value of an alternating current.** (01 mark)

(b) With the aid of a diagram, describe the structure and action of a thermo couple meter. (04 marks)

(c) A 6.0μF capacitor is placed across a 240 V (r.m.s) supply.

(i) Calculate the amplitude of the current which flows if the frequency of the a.c is 60 Hz. (04 marks)

(ii) Explain what happens to the value of the current in the circuit if the frequency of the a.c is increased. (02 marks)

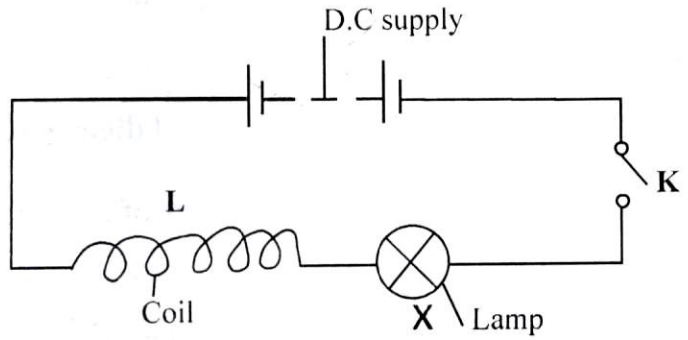
(d) (i) Define the term **impedance.** (01 mark)

(ii) A pure inductor of inductance is 15 mH is connected in series with a resistor of resistance 3 Ω across an a.c mains of frequency 50 Hz. Determine the impedance of the circuit. (03 marks)

(e) (i) What is **inductive reactance?** (01 mark)

(ii) An iron – cored coil having a low resistance and high inductance is connected in series with a filament lamp x. The coil and the lamp are then connected across d.c supply as shown in the figure 2 below;

fig. 2



Explain what is observed when switch K is closed and then opened. (04 marks)

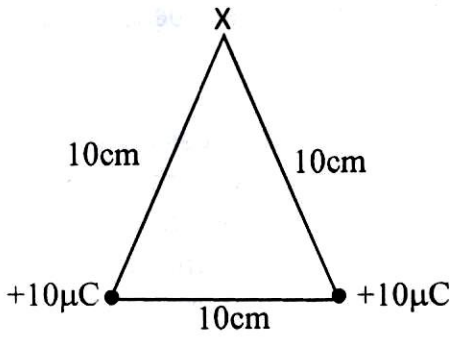
SECTION D

8. (a) (i) Define **electric field intensity** and **electric potential** at a point. (02 marks)

(ii) With the aid of a diagram, explain electrostatic shielding. (03 marks)

(b) Two charges of +10 μC, are placed 10 cm apart as shown in the figure 3 below;

fig. 3



Calculate the:-

(i) Electric field intensity at x. (04 marks)

(ii) Electric potential at x. (03 marks)

(c) Describe an experiment to show that when two dissimilar dielectrics are rubbed together, they acquire equal but opposite charges. (04 marks)

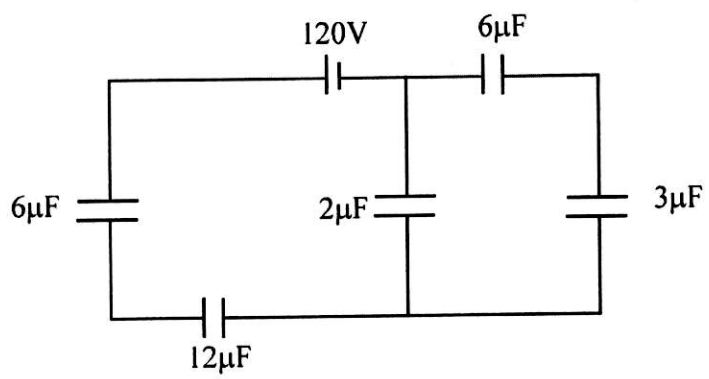
(d) A metal wind mill with sharp points was placed on a pivot on an insulating stand. One of the points was connected to the terminals of a van deGraaf generator and the generator was started. Explain what was observed. (04 marks)

9. (a) (i) Define the terms **capacitance** and **dielectric strength.** (02 marks)

(ii) State two desirable characteristics of a dielectric material. (02 marks)

(b) Describe an experiment to investigate the variation of charge stored in a capacitor and the voltage across it. (05 marks)

fig. 4



(c) The figure 4 above shows a capacitor network connected to a 120 V battery. Find the;

(i) P.d across the 2μF capacitor, (03 marks)

(ii) energy stored in the capacitor net work if the space between the plates of the 3μF capacitor is filled with a dielectric material of dielectric constant 4. (03 marks)

(d) Explain the effect of inserting a sheet of insulating material between the plates of a capacitor connected to a d.c source of Emf, V. (05 marks)

10. (a) (i) Define **e.m.f of a cell.** (01 mark)

(ii) Explain why the e.m.f of a battery left standing in a room for long decreases. (02 marks)

(b) Three identical cells are connected in series with resistors of 4 Ω and 6 Ω. A current of 2.0 A flows in the circuit. When the two resistors are connected in parallel across the three cells in series, the current in the circuit is 3.0 A. Calculate the;

(i) Internal resistance of each cell. (02 marks)

(ii) E.m.f of each cell. (01 mark)

(iii) Power dissipated in the 4 Ω resistor in the parallel connection. (03 marks)

(c) Describe how the resistance of a resistor may be determined using a slide wire potentiometer. (04 marks)

(d) An accumulator of e.m.f 2.0 V is connected across a uniform wire of length 100 cm and resistance 8.0 Ω. A dry cell of e.m.f 1.5 V is connected in series with the galvanometer and across a length, L of the slide wire. The galvanometer shows no deflection when L is 90 cm. Find the internal resistance of the accumulator. (03 marks)

(e) Explain why temperature co-efficient of resistance is positive for metals and negative for semi-conductors. (04 marks)

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