PHYSICS QUESTIONS

PAPER 2

S.6 Sci

Attempt all questions

SECTION A (Geometrical Optics - Light)

1(a) For a converging mirror define the terms
(i) radius of curvature (1)
(ii) principal focus (1)

(b) With the aid of a ray diagram derive the mirror formula for a convex mirror. (6)

(c) (i) With the aid of a ray diagram, describe the structure and action of a reflecting telescope in normal adjustment. (5)
(ii) State two advantages of a reflecting telescope over a refracting one. (2)

(d) An astronomical telescope with an objective of focal length 84.0 cm and an eyepiece of focal length 8.0 cm. The eyepiece is shifted until the final image is formed at a distance of 64.0 cm from the objective. Find the distance between the two lenses. (5)

2(a) (i) Explain the difference between the terms **magnifying power** and **magnification** as applied to optical instruments. (3)

(ii) State what is meant by **normal adjustment** in the case of an astronomical telescope. (1)

(iii) With the aid of a ray diagram, explain how the two lenses of a telescope form, at infinity, a magnified virtual image of a real distant object. (4)

(b) A telescope has an objective of focal length 80cm and an eyepiece of focal length 2.0cm. It is focused on the moon, whose diameter subtends an angle of 8.0×10^{-3} rad at the objective. The eyepiece is adjusted so as to project a sharp image of the moon onto a screen placed 20cm from the eyepiece lens. Calculate:

(i) the diameter of the intermediate image formed by the objective lens. (3)

(ii) the diameter of the image on the screen. (3)

(iii) the separation of the lenses. (2)

(c) Explain, with the aid of a diagram, the formation of the **eye-ring** in a telescope and state why it is the best position for the eye of the observer. (4)

3(a) (i) What is meant by ***refraction of light***? (1)

(ii) Explain why a pond of clear water appears shallower, than it actually is, to an observer. (3)

(iii) Describe an experiment to determine the refractive index of a liquid using the air-cell method. (6)

(b) A lens forms a sharp image of height h_1 on a fixed screen. As the lens is moved towards the screen another sharp image of height h_2, of the same object, is formed on the screen. If the object position remained the same in both cases, obtain an expression for the height of the object. (4)

(c) A converging lens of focal length 30 cm is placed between an object and a diverging lens of focal length 5 cm. If the object is 6 metres from the converging lens and 6.20 metres from the diverging lens, determine

(i) the position and nature of the image formed. (4)

(ii) the magnification of the image. (2)

4(a) (i) State the conditions for total internal reflection. (2)

(ii) Draw a labeled diagram of a named device to show (without description) an application of total internal reflection. (2)

(b) Explain how a fish in a pond is able to enjoy a 180^o field of view. (3)

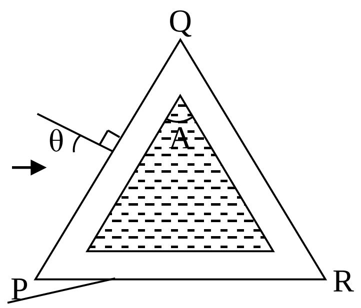
(c) Show that when a ray of light passes through different media separated by plane boundaries

***n sin i* = constant**

where ***n*** is the absolute refractive index of a medium and ***i*** is the angle made by the ray with the normal in the medium. (4)

(d) Describe an experiment to measure the refractive index of glass of rectangular shape, using a pin, by the apparent depth method. (4)

(e) The figure below shows a liquid of refractive index 1.33 enclosed by glass of uniform thickness. A ray of light, incident on face PQ at an angle of incidence, θ, emerges through face QR.



As the angle θ is reduced, suddenly the emergent ray disappears when θ = 16^o.Find the angle A. (5)

SECTION B (Physical Optics – Waves)

1(a) (i) Distinguish between **free** and **damped** oscillations. (2)

(ii) What is a **wave**? (1)

(b) A mechanical wave in a certain medium is represented by the equation

$$\mathbf{y = 0.3\sin 2\pi(35t - 0.4}x\mathbf{)}$$

where all distances are in metres.

(i) State what each of the symbols x and y represents. (2)

(ii) Find the velocity of the wave (3)

(c) (i) What is meant by **resonance** in waves? (1)

(ii) Describe an experiment to determine the velocity of sound in air using the resonance method. (6)

(d) (i) What is a **harmonic** in sound. (1)

(ii) A string of length 0.50 m and mass 5.0 g is stretched between two fixed points. If the tension in the string is 100 N, find the frequency of the second harmonic.

(Velocity of sound along the string = $\sqrt{\left(\frac{\text{Tension}}{\text{Mass per unit length}}\right)}$) (4)

2(a) (i) What is meant by interference of waves? (2)

(ii) State the conditions necessary for the observation of interference pattern. (2)

(iii) Describe how interference can be used to test for the flatness of a surface. (3)

(b) Describe with the aid of a labeled diagram, how the wavelength of monochromatic light is measured using Young's double-slit method. (5)

(c) Two microscope slides are in contact at one end and are separated by a thin piece of paper at the other end. Monochromatic light is directed normally on the wedge.

(i) What type of fringes will be observed? (2)

(ii) Explain what will be observed if a liquid is introduced between the slides.(2)

(d) When monochromatic light of wavelength 5.0×10^{-7}m is incident normally on a transmission grating, the second order diffraction line is observed at an angle of 27^0. How many lines per centimeter does the grating have? (4)

3(a) What is meant by

(i) ***wavelength*** of a wave. (1)

(ii) ***pitch*** of a musical note (1)

(b) (i) A source of sound of frequency f, is moving with velocity u_s away from an observer who is moving with velocity u_o in the same direction. If the velocity of sound is V, derive an expression for the frequency of sound heard by the observer. (5)

(ii) Explain what happens to the pitch of the sound heard by the observer in (b)(i) above when the observer moves faster than the source (2)

(c) (i) A star which emits light of wavelength λ is approaching the earth with velocity v. If the velocity of light is c, write down an expression for the shift in the wavelength of the emitted light. (1)

(ii) Describe how the speed of a star may be measured using the Doppler effect (4)

(d) Two open pipes of lengths 78 cm and 80 cm are found to give a beat frequency of 5 Hz when each is sounding in its fundamental note. If the end errors are 1.7 cm and 1.5 cm respectively, calculate the;

(i) velocity of sound in air (4)

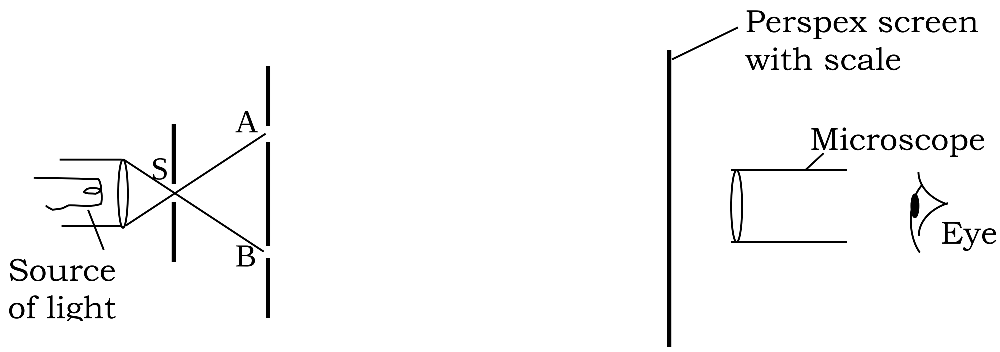
(ii) frequency of each note. (2)

4(a) (i) What evidence does suggest that light is a transverse wave while sound is a longitudinal one? (1)

(ii) What is meant by ***division of wavefronts*** as applied to interference of waves? (2)

(b) Two slits X and Y are separated by a distance s and illuminated with light of wavelength λ. Derive the expression for the separation between successive fringes on a screen placed a distance D from the slit. (5)

(c) A source of light, a slit, S, and a double slit (A and B) are arranged as shown below



(i) Describe what is observed on the screen through the microscope when a white source of light is used. (2)

(ii) Explain what is observed when slit S is gradually widened. (3)

(iii) How would you use the set up above to measure the wavelength of red light? (4)

(d) In Young's double-slit experiment, the 8^{th} bright fringe is formed 6mm away from the centre of the fringe system when the wavelength of light used is 6.3×10^{-7} m. Calculate the distance of the screen from the slits if the separation of the two slits is 0.7 mm. (3)

SECTION C (Magnetism and A.C circuits)

1(a) What is meant by the terms:

(i) Magnetic meridian (1)

(ii) Magnetic declination (1)

(b) Explain what happens to the angle of dip as one moves along the same longitude from the Equator to the North pole. (2)

(c) (i) Write down an expression for the magnetic flux density at the centre of a narrow circular coil of radius r having N turns when a current I is flowing in it. (1)

(ii) Describe an experiment to determine horizontal component of the Earth's magnetic flux density at a certain location. (5)

(d) A circular coil of 4 turns and diameter 14.0 cm carries a current of 0.35A. It is placed at the equator with its plane along the magnetic meridian. Calculate the direction and magnitude of the resultant magnetic flux density at the position if the earth's magnetic flux density at the location is 1.8×10^{-5} T. (4)

(e) (i) What is meant by the term ***magnetic moment*** of a coil? (1)

(ii) Explain why a moving coil galvanometer must have the following:

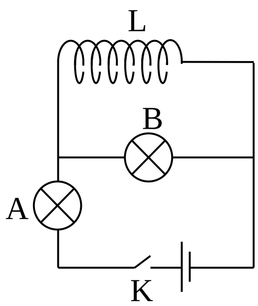
A radial magnetic field,
Fine hair springs,
Large number of turns
A conducting former. (5)

2(a) What is meant by

(i) self- induction (1)

(ii) eddy current (1)

(b) The diagram shows an iron-cored coil, L, of many turns and negligible resistance with identical bulbs, A and B, connected in a circuit



(i) When switch K is closed, at first both bulbs A and B light up, but soon B dims out while A becomes brighter. Explain these observations. (3)

(ii) If now K is opened, state and explain what is observed. (3)

(c) (i) Explain the origin of the back emf in a motor. (2)

(ii) A motor, whose armature resistance is 2Ω, is operated on 240V mains supply. If it runs at 3000 rev min^{-1} when drawing a current of 5 A, at what speed will it run when drawing a current of 15 A? (3)

(d) (i) With the aid of a labeled diagram, describe the mode of action of a simple d.c generator. (5)

(ii) Sketch the output against time of a simple d.c generator. (1)

(iii) State two factors that determine the polarity of the output of a d.c generator. (1)

3 (a) Define the following terms as applied to voltage in alternating current circuits.

(i) ***Root-mean-square value***. (1)

(ii) ***Peak value***. (1)

(b) Derive the relationship between the root mean square value and the peak value of the alternating current. (4)

(c) With the aid of a labeled diagram, describe the mode of operation of a repulsion type moving iron ammeter. (5)

(d) A source of alternating current voltage of ***frequency f*** is connected across the ends of a pure inductor of ***self -inductance L***. Derive an expression for the inductive reactance of the circuit and explain the phase difference between the voltage and the current that flows. (5)

(e) A pure inductor of inductance 2H, is connected in series with a resistor of 500 Ω across a source of e.m.f 240 $V_{(r.m.s)}$, alternating at a frequency of 50 Hz. Calculate the potential difference across the resistor. (4)

4 (a) (i) Give two advantages of alternating current over direct current in power transmission. (2)

(ii) Explain the fact that an alternating current continues to pass through a capacitor whereas direct current cannot. (4)

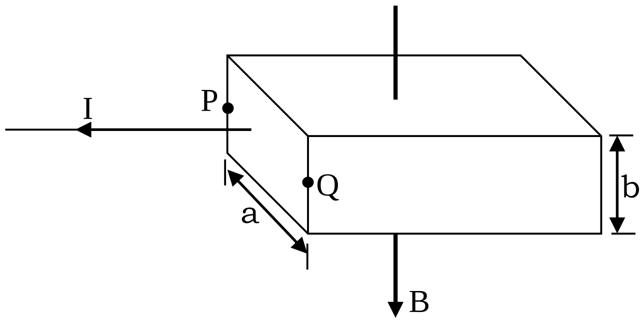
(b) A sinusoidal voltage, $V = V_o \sin 2\pi ft$, is connected across a capacitor of capacitance, C. Derive an expression for the reactance of the capacitor. (4)

(c) With the aid of a labelled diagram describe the structure and action of a hot-wire ammeter. (6)

(d) Power of 60 kW produced at 120 V is to be transmitted over a distance of 2 km through cables of resistance 0.2 $\Omega\ m^{-1}$. Determine the voltage at the output of an ideal transformer needed to transmit the power so that only 6% of it is lost. (4)

5 (a) What is a ***magnetic field***? (1)

(b) A magnetic field of flux density B is applied normally to a metal strip carrying current I as shown in the figure below.



(i) Account for the occurrence of a potential difference between points P and Q, indicating the polarity of this p.d. (3)

(ii) Derive an expression for the electric intensity between P and Q if the drift velocity of the conduction electrons is v. (3)

(c) (i) With the aid of a labeled diagram, describe the mode of action of a simple d.c generator. (5)

(ii) Sketch the output against time of a simple d.c generator. (1)

(iii) Explain how a back e.m.f is developed in a motor. (3)

(d) A square coil of side 10 cm has 100turns. The coil is arranged to rotate at 3000 rev. min^{-1} about a vertical axis perpendicular to the horizontal uniform magnetic field of flux density 0.8 T. The axis of rotation passes through the mid-points of a pair of opposite sides of the coil. Calculate the e.m.f induced in the coil when the plane of the coil makes an angle of 60^o with the field. (4)

6(a) State the laws of electromagnetic induction. (2)

(b) A coil of area A is rotated at a frequency f in a uniform magnetic field of flux density B about an axis which is perpendicular to the field.

(i) Derive an expression for the e.m.f generated. (3)

(ii) Deduce at least four of the factors on which the e.m.f depends. (2)

(iii) State any two factors that reduce the efficiency of an a.c. generator to less than 100% (2)

(c) A rectangular coil of 50 turns is 15.0 cm wide and 30.0 cm long. If it rotates at a uniform rate of 3000 revolutions per minute about an axis parallel to its long side and at right angles to a uniform magnetic field of flux density 0.04T, find the peak value of the emf induced in the coil. (2)

(d) (i) A metallic circular disc of diameter d is in a uniform magnetic field of flux density B and the plane of the disc is perpendicular to the field. If the disc is rotated at a frequency f, derive an expression for the emf developed between its centre and rim. (4)

(ii) Describe an experiment to measure resistance by means of a rotating disc in a magnetic field. (5)

SECTION D (Electricity)

1(a) For a source of electricity, what is meant by

(i) electromotive force (1)

(ii) internal resistance? (1)

(b) (i) State the factors which determine the resistance of a wire of a given material. (2)

(ii) Explain why the resistance of a metal increases when the temperature of the metal is increased.

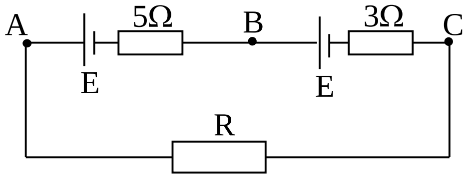
(2)

(iii) Derive an expression for the equivalent resistance of three resistances, R_1, R_2 and R_3 connected in series. (3)

(c) You are provided with about 1 m of a bare constantan wire, an ammeter, a voltmeter, crocodile clips and some connecting wires.

Describe an experiment you would perform, using all but only the items provided, to determine the internal resistance of a cell. Give a diagram of your setup. (5

(d) In the circuit shown below, each source has en e.m.f of 2V and negligible internal resistance.



When a voltmeter is connected between A and B, it reads 0V. Find

(i) the value of the resistance R. (4)

(ii) the reading of the voltmeter when connected between B and C. (2)

2(a) Explain why the terminal p.d falls as the current drawn from a source increases. (3)

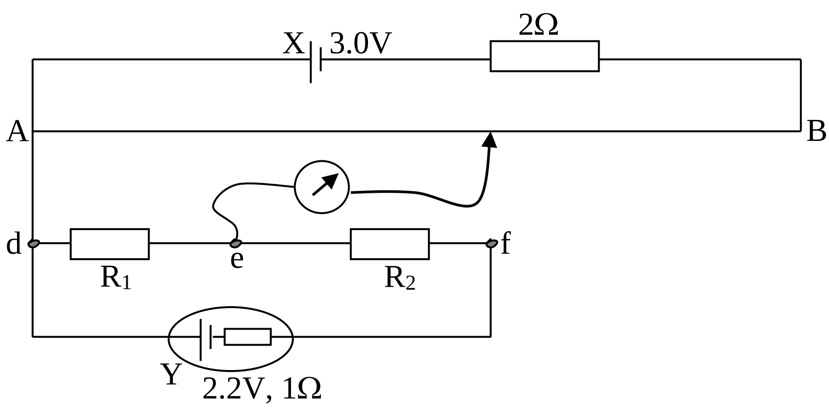
(b) A d.c source of e.m.f 12 V and negligible internal resistance is connected in series with two resistors of 400 Ω and R ohms, respectively. When a voltmeter is connected across the 400 Ω resistor, it reads 4 V while it reads 6 V when connected across the resistor of R ohms. Find the:

(i) resistance of the voltmeter (6)

(ii) value of R (1)

(c) Describe how you would use a slide wire potentiometer to measure the internal resistance of a dry cell. (5)

(d) In the circuit diagram shown below, AB is a slide wire of length 1.0 m and resistance 10 Ω. X is a driver cell of e.m.f 3.0 V and negligible internal resistance. Y is a cell of e.m.f 2.2 V and internal resistance 1.0Ω
When the centre-zero galvanometer is connected in turns to points **e** and **f**, the balance lengths obtained are 45.0 cm and 80.0 cm respectively.
Calculate the:
(i) current flowing through R_1. (3)
(ii) resistances of R_1 and R_2. (2)



3 (a) Define the following terms as applied to a capacitor.

(i) capacitance (1)

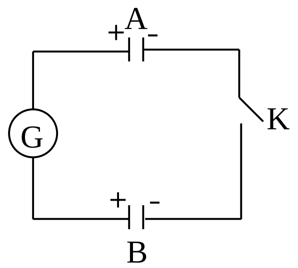
(ii) dielectric strength (1)

(b) Explain the action of a dielectric in a capacitor. (4)

(c) Describe an experiment to show that capacitance is affected by the thickness of the dielectric. (4)

(d) Derive an expression for the energy stored in a capacitor of capacitance C charge to a p.d V. (5)

(e) In the circuit shown below switch K is open, capacitors A and B have respective capacitances of 10μF and 15 μF and are charged to p.ds of 25 V and 20 V respectively.



A ballistic galvanometer G, with sensitivity of 2 divisions per μC joins the positive plates of the capacitors. If K is now closed, what will be the throw on G? (5)

4(a) (i) State Coulomb's law of electrostatics. (1)

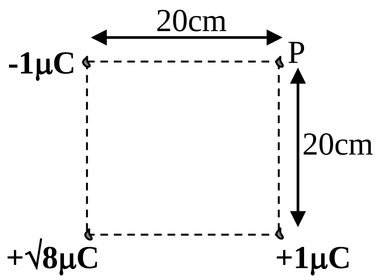
(ii) Define the terms ***electric field intensity*** and ***electric potential at a point***. (2)

(b) (i) Sketch graphs of the variation of electric potential and electric field intensity with distance from the centre of a charged conducting sphere. (2)

(ii) Describe how a conducting body may be positively charged but remains at zero potential. (3)

(iii) Explain how the presence of a neutral conductor near a charged conducting sphere may reduce the potential of the sphere. (3)

(d) Charges of **-1μC**, **+√8μC** and **+1μC** are placed at the corners of a square of side 20 cm as shown below



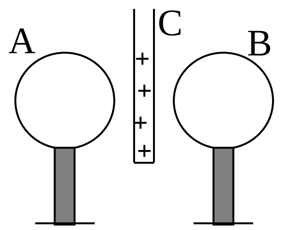
Calculate the:

(i) electric potential at P (4)

(ii) electric field intensity at P (5)

5(a) Explain how objects get charged by rubbing. (3)

(b) The diagram shows two metallic spheres A and B placed apart and each supported on an insulating stand. A positively charged plate C is placed mid-way between them but without touching them.



B is momentarily earthed in the presence of C. Finally C is withdrawn.

(i) Draw the spheres at the end of the operation and show the charge distribution over them. (2)

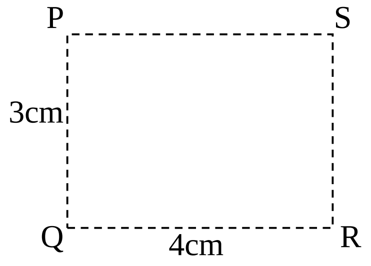
(ii) On the same diagram sketch the electric field pattern in the region of the spheres. (2)

(iii) Explain the change in p.d between the spheres as the spheres are moved further apart. (2)

(c) Describe an experiment to show that excess charge resides outside a hollow conductor.

(5)

(d) Charges of **-3μC**, **+4μC** and **+3μC** are placed at the corners P, Q and R of a rectangular frame PQRS in which PQ = 3 cm and QR = 4 cm as shown in the figure below



If the charges are in vacuum, calculate the magnitude of the electric intensity at S due to the charges. (6)

6(a) Define

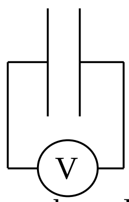
(i) ***capacitance*** (1)

(ii) ***dielectric strength*** (1)

(b) Describe an experiment to show the relationship between capacitor charge and potential difference. (5)

(c) Derive an expression for the equivalent capacitance of three capacitors connected in series. (3)

(d) Two large metal plates, placed parallel to each other and separated by dry air, form a capacitor. The arrangement is given a charge, then isolated and finally an ideal voltmeter is connected across its plates as shown.



Explain what is observed on the voltmeter reading when

(i) an insulating material is inserted in between the plates. (2)

(ii) the separation of the plates is increased. (2)

(e) When two capacitors, C_1 and C_2 are connected in series and the combination connected to a supply V the charge stored by C_1 is 8μC while the p.d. across C_1 is 4V. When the capacitors are connected in parallel to the same supply the total charge stored by the combination is 36μC. Given that $C_1 < C_2$, find;

(i) the capacitances of the capacitors (4)

(ii) the p.d, V, of the supply (2)

END