WORKSHEET SPLIT 2

12th Standard

Date : 07-Dec-22

Reg.No. : | | | | | | |

Physics

Exam Time : 02:00:00 Hrs **Total Marks : 100**

75 x 2 = 150

1) A 12pF capacitor is connected to a 50V battery. How much electrostatic energy is stored in the capacitor?

2) In a Van de Graff type generator, a spherical metal shell is to be a$15 \times 10^6 V$electrode.The dielectric strength of the gas surrounding the electrode is $5 \times 10^7 Vm^{-1}$ .What is the minimum radius of the spherical shell required? (You will learn from this exercise why one cannot build an electrostatic generator using a very small shell which requires a small charge to acquire a high potential)

3) A small sphere of radiusr_1 and charge $q_1$is enclosed by a spherical shell of radius $r_2$and chargeq_2.Show that ifq_1 is positive, charge will necessarily flow from the sphere to the shell(when the two are connected by a wire) no matter what the chargeq_2 on shell is.

4) Describe schematically the equipotential surfaces corresponding to
(i) a constant electric field in the Z-direction,
(ii) a field that uniformly increases in magnitude but remains in a constant (say Z) direction and
(iii) a single positive charge at the origin.
(d) a uniform grid consisting of long equally spaced parallel charged wires in a plane.

5) Two charges 2 μC and –2 μC are placed at points A and B 6 cm apart.
(a) Identify an equipotential surface of the system.
(b) What is the direction of the electric field at every point on this surface?

6) What conclusion can you draw from the following observations on a resistor made of alloy manganin:

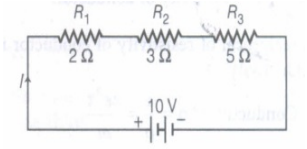
Current (in A)	Voltage (in V)	Current (in A)	Voltage(in V)
0.2	3.94	3.0	59.2
0.4	7.87	4.0	78.2
0.6	11.8	5.0	98.6
0.8	15.7	6.0	118.5
1.0	19.7	7.0	138.2
2.0	39.4	8.0	158.0

7) The storage battery of a car has an emf of 12 V. If the internal resistance of the battery is 0.4Ω, what is the maximum current that can be drawn from the battery?

8) (a) In the electron drift speed is estimated to be only a few mm s^{-1} for currents in the range of a few amperes? How then is current established almost the instant a circuit is closed?
(b) The electron drift arises due to the force experienced by electrons in the electric field inside the conductor. But force should cause acceleration. Why then do the electrons acquire a steady average drift speed?
(c) If the electron drift speed is so small, and the electron's charge is small, how can we still obtain large amounts of current in a conductor?
(d) When electrons drift in a metal from lower to higher potential, does it mean that all the 'free' electrons of the metal are moving in the same direction?
(e) Are the paths of electrons straight lines between successive collisions (with the positive ions of the metal) in the
(i) absence of electric field,
(ii) presence of electric field?

9) The resistance of the platinum wire of a platinum resistance thermometer at the ice point is 5 Ω and at steam point is 5.23 Ω. When the thermometer is inserted in a hot bath, the resistance of the platinum wire is 5.795 Ω. Calculate the temperature of the bath.

10) In the figure given below, the three resistors with resistances 2 Ω, 3 Ω and 5 Ω respectively, are connected in series with 10 V battery. Calculate the equivalent resistance and current that passes through each resistor in the given network.



11) What physical quantity is the same for x-rays of wavelength 10^{-10}m. the red light of wavelength 6800 $\dot{A}$ and radio waves of wavelength 500 m?

12) The magnetic field in a plane electromagnetic wave is given by By = 2×10^{-7} sin (0.5 x10^3x + 1.5 x 10^{11}t) T.
(a) What is the wavelength and frequency of the wave?
(b) Write an expression for the electric field.

13) A charged particle oscillates about its mean equilibrium position with a frequency of 10^9 Hz. What is the frequency of the electromagnetic waves produced by the oscillator?

14) In an unbiased p-n junction, holes diffuse from the region to n-region attract because
(a) free electrons in the n-region attract them.
(b) they move across the junction by the potential difference

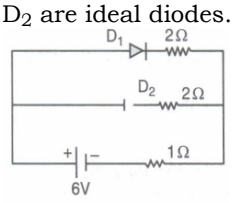
(c) hole concentration in p-region is more as compared to n-region
(d) All the above.

15) Name the $p-n$ junction diode which emit spontaneous radiation when forward biased. How do we choose the semiconductor, to be used in those diodes, if the emitted radiations is to be in the visible region?

16) Suppose a pure Si crystal has 5×10^{28} atmos m^{-3}. It is doped by ppm concentration of pentavalent As. Calculate the number of electrons and holes. Given that $n_i = 1.5 \times 10^{16} m^3$

17) Can we take one slab of p-type semiconductor and physically join it to another n-type semiconductor to get p-n junction?

18) For the circuit shown here, find the current flowing through the 1Ω resistor. Assume that the two diodes D_1 and D_2 are ideal diodes.

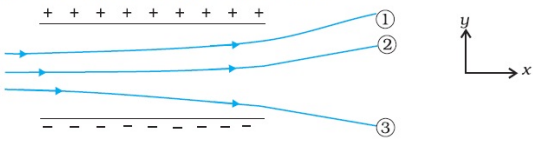


19) How much positive and negative charge is there in a cup of water?

20) (a) Explain the meaning of the statement 'electric charge of a body is quantised'.
(b) Why can one ignore quantisation of electric charge when dealing with macroscopic i.e., large scale charges?

21) (a) An electrostatic field line is a continuous curve. That is, a field line cannot have sudden breaks. Why not?
(b) Explain why two field lines never cross each other at any point?

22) The Figure shows tracks of three charged particles in a uniform electrostatic field. Give the signs of the three charges. Which particle has the highest charge to mass ratio?



23) What is the net flux of the uniform electric field through a cube of side 20 cm oriented so that its faces are parallel to the coordinate planes

24) What is the magnitude of the equatorial and axial fields due to a bar magnet of length 5.0 cm at a distance of 50 cm from its mid-point? The magnetic moment of the bar magnet is 0.40 A m^2, the same as in.

25) In the magnetic meridian of a certain place, the horizontal component of the earth's magnetic field is 0.26G and the dip angle is 60°. What is the magnetic field of the earth at this location?

26) A short bar magnet placed with its axis at 30° with a uniform external magnetic field of 0.25 T experiences a torque of magnitude equal to 4.5 x 10^{-2} J. What is the magnitude of magnetic moment of the magnet?

27) If the solenoid in is free to turn about the vertical direction and a uniform horizontal magnetic field of 0.25 T is applied, what is the magnitude of torque on the solenoid when its axis makes an angle of 30° with the direction of applied field?

28) A pure inductor of 25.0 mH is connected to a source of 220 V. Find the inductive reactance and rms current in the circuit if the frequency of the source is 50 Hz.

29) A lamp is connected in series with a capacitor. Predict your observations for dc and ac connections. What happens in each case if the capacitance of the capacitor is reduced?

30) At an airport, a person is made to walk through the doorway of a metal detector, for security reasons. If she/he is carrying anything made of metal, the metal detector emits a sound. On what principle does this detector work?

31) Keeping the source frequency equal to the resonating frequency of the series LCR circuit, if the three elements, L, C and R are arranged in parallel, show that the total current in the parallel LCR circuit is minimum at this frequency. Obtain the current rms value in each branch of the circuit for the elements and source specified in for this frequency.

32) Given the mass of iron nucleus as 55.85u and A=56, find the nuclear density?

33) Calculate the energy equivalent of 1 g of substance.

34) Tritium has a half-life of 12.5 y undergoing beta decay.What fraction of a sample of pure tritium will remain undecayed after 25 y.

35) Obtain approximately the ratio of the nuclear radii of the gold isotope and the $^{197}_{79}\mathrm{Au}$ silver isotope $^{107}_{47}\mathrm{Ag}$.

36) A proton is moved in a uniform electric field of $1.7 \times 10^{-4} N/C$ between two points A and B separated by a distance of 0.1m.

(i) What is the potential difference between the points?
(ii) How much work is done in the above process?

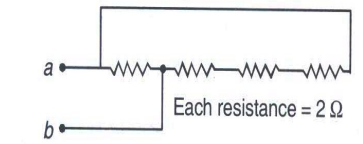
37) Why do we obtain a neutral point in the space between two like charges ?

38) what is the direction of field intensity at a point
(i) on axial line of dipole and
(ii) on equatorial line of dipole ?

39) (i) Obtain an expression for the energy stored per unit volume in a charged parallel plate capacitor.
(ii) The electric field inside a parallel plate capacitor is E. Find the amount of work done in moving a charge q over a closed rectangular loop abcda.

40) Write two properties of equipotential surfaces. Depict equipotential surfaces due to an isolated point charge. Why do the equipotential surfaces get closer as the distance between the equipotential surface and the source charge decreases?

41) Calculate R_{ab} in the following circuit:



42) A conductor of length L is connected to a dc source of emf ϵ. If this conductor is replaced by another conductor of the same material and same area of cross-section but of length 3 L, how will the draft velocity change?

43) What is the unit of potential gradient? If the potential gradient along the potentiometer wire be decreased, will the zero-deflection position be obtained at longer length or shorter length?

44) An ammeter of resistance 0.80Ω can measure current up to 1.0A.
(i) What must be the value of shunt resistance to enable the ammeter to measure current up to 5.0 A ?
(ii) What is the combined resistance of the ammeter and the shunt?

45) A low voltage supply from which one needs high currents must have very low internal resistance. Why?

46) The following table gives the wavelength of some constituents of the electromagnetic spectrum

S.No	Wavelength range
1	1 mm to 700 mm
2	0.1m to 1 mm
3	400 mm to 1 mm
4	< 10 power 3 mm

Select the wavelength range and name the (associated) electromagnetic waves that are used in
(i) Radar system for aircraft navigation
(ii) Earth satellites to observe growth of crops.

47) A capacitor of capacitance, C is being vharged by connecting it across a DC sourse along with an ammeter.Will the ammeter show a momentry deflection during the process of chargings?If so,how would you explain this momentry deflection and the resulting continuity of current in the circuit?Write the expression for the current inside the capacitor?

48) (i) Arrange the following electromagnetic waves in the descending order of their wavelengths
(a) Microwaves
(b) Infrared rays
(c) Ultraviolet radiation
(d) γ-rays
(ii) Write one use each of any two of them

49) How are infrared rays produced? Write their two important uses.

50) Experimental observations have shown that X-rays:
(a) travel in vacuum with a speed of 3×10^8 ms^{-1}.

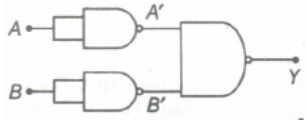
(b) exhibit the phenomenon of diffraction and can be polarized.
What conclusion can be drawn about the nature of X-rays from each of then observations?

51) Zener diode has higher dopant density as compared to ordinary $p-n$ junction diode. How does if effect
(i) the width of depletion layer and
(ii) the junction field?

52) A student wants to use two p-n junction diodes to convert alternating current into direct current. Draw the labelled circuit diagram she would use and explain how it works.

53) (i) Why are Si and GaAs preferred materials for fabrication in solar cells?
(ii) Draw V-I characteristic of solar cell and mention its significance.

54) In the circuit shown in the figure, identify the equivalent gate of the circuit and make its truth table.



55) Explain how a solar cell is fabricated.

56) In filling the gasoline tank of an aeroplane, the metal nozzle of hose from the gasoline truck is always carefully connected to the metal body of the aeroplane by a wire, before the nozzle is inserted in the tank. Explain, why?

57) Aballoon gets negatively charged by rubbing ceilings of a wall. Does this mean that the wall is positively charged? Why does the balloon eventually fall?

58) An uncharged metallic ball is suspended in the region between two vertical metal plates. If the two plates are charged, one positively and one negatively, then describe the motion of the ball after it is brought into contact with one of the plates.

59) Two identical metallic spherical shells A and B having charges + 4 Q and - 10Q are kept a certain distance apart. A third identical uncharged sphere C is first placed in contact with sphere A and then with sphere B, then spheres A and B are brought in contact and then separated. Find the charge on the spheres A and B

60) An oil drop of mass m and charge - q is to be held stationary in the gravitational field of the earth. What is the magnitude and direction of the electrostatic field required for this purpose?

61) A bar magnet when suspended horizontally and perpendicular to the earth's magnetic field experiences a torque of 3×10^{-4} N-m. What is the magnetic moment of the magnet? Horizontal component of earth's magnetic field at that place is 0.4×10^{-4} T.

62) Suppose we want to verify the analogy between electrostatic and magneto static by an explicit experiment. Consider the motion of
(i) electric dipole p in an electrostatic field E and
(ii) magnetic dipole M in a magnetic field B.
Write down a set of conditions on E, B,p, M, so that the two motions are verified to be identical. (Assume identical initial conditions).

63) The horizontal component of the earth's magnetic field at a place is $\sqrt{3}$ times its vertical component here. Find the value of the angle of dip at that place. What is the ratio of the horizontal component to the total magnetic field of the earth at that place?

64) A short bar magnet with its North pole facing North forms a neutral point at A in the horizontal plane. If the magnet is rotated by 90° in the horizontal plane, what is the net magnetic induction at P ?

65) Define the terms magnetic inclination and horizontal component of Earth 's magnetic field at a place. Establish the relationship between the two with the help of a diagram.

66) What is the basic difference in the design of an a.c. generator and d.c. generator?

67) An electric lamp having a coil of negligible inductance connected in series with a capacitor and an AC source is glowing with certian brightness. How does the brightness of the lamp change on reducing the (i) capacitance, and (ii) the frequency? Justify your answer.

68) Write the expression for the impedance offered by the series combination of resistor, inductor and capacitor connected to an AC source of voltage V = V_0 sin . Show on a graph the variation of the voltage and the current with ' ωt in the circuit.

69) A 44 mH inductor is connected to 220 V, 50 Hz AC supply. Determine the rms value of the current in the circuit. What is the net power absorbed over a complete cycle? Explain.

70) State the underlying principle of a transformer. How is the large scale transmission of electric energy over long distance done with the use of transformers?

71) Show that Bohr's second postulate "The electron revolves around the nucleus only in certain fixed orbits without radiating energy" can be explained on the basis of de-Broglie hypothesis of wave nature of electron.

72) Write symbolically the nuclear β^+ decay process of ${}_6C^{11}$. Is the decayed product X an isotope or isobar of ${}_6C^{11}$? Given the mass values of $({}_6C^{11})$
11.011434 u and m(X) = 11.009305 u. Estimate the Q value in the process.

73) Write nuclear equations for
a) The α-decay of $^{226}Ra_{88}$
b) The β^- -decay of $^{32}P_{15}$
c) The β^+ decay of $^{32}P_{15}$

74) Distinguish between nuclear fission and fusion. Show how in both these processes energy is released? Calculate the energy release in MeV in the deuterium-tritium fusion reaction.
${}_1^2\mathrm{H} + {}_1^3\mathrm{H} \longrightarrow {}_2^4\mathrm{He} + n$
Using the data,

$m\left(\begin{matrix}2\\1\end{matrix}\mathrm{H}\right) = 2.014102\mathrm{u}, m\left({}^{3}_{1}\mathrm{H}\right) = 3.016049\mathrm{u}$

$m\left(\begin{matrix}4\\2\end{matrix}\mathrm{He}\right) = 4.002603\mathrm{u}, \quad m_n = 1.008665\mathrm{u}$

$1\mathrm{u} = 931.5\frac{\mathrm{MeV}}{c^2}$

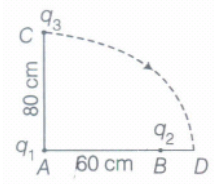
75) (a) Write the β-decay of tritium in symbolic form.
(b) Why is it experimentally found difficult to detect neutrinos in this process?

40 x 3 = 120

76) Compare the properties of electric charge and mass which are not similar.

77) Calculate the voltage required to balance an oil drop carrying 10 electrons, when located between plates of a capacitor, which are 5 mm apart. Given mass of drop $= 3 \times 10^{-16} kg$ charge on electron = $1.6 \times 10^{-19} C \; and \; g = 9.8 m/s^2$

78) Two charges q_1 = +2 x 10^{-8} C and q_2 = -0.4 x 10^{-8} C are placed 60 cm about, as shown in the figure. A third charge q_3 = 0.2 x 10^{-8} C is moved along the arc of a circle of radius 80 cm from C to D. Compute the percentage change in the energy of the system.



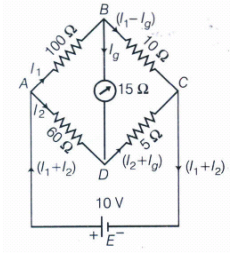
79) An electric dipole is kept in a uniform electric field. Derive an expression for the net torque acting on it and write its direction. State the conditions under which the dipole is in (i) stable equilibrium (ii) unstable equilibrium.

80) What should be the charge on a sphere of radius 4 cm, so that when it is brought in contact with another sphere of radius 2 cm carrying charge of 10 μC, there is no transfer of charge from one sphere to other?

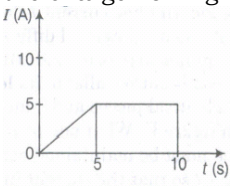
81) The number density of electrons in copper is 8.5 x 10^{28} m^{-3}. Find the current flowing through a copper wire of length 0.2 m, area of cross-section 1 mm^2, when connected to a battery of 4 V. Given that electron mobility = 4.5 x 10^{-6} $m^2V^{-1}s^{-1}$ and charge on electron is 1.6 x 10^{-19} C.

82) A potential difference of 3 V is applied across a conductor through which 5 A of current is flowing. Determine the resistance of the conductor.

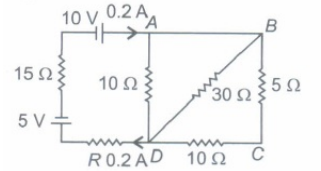
83) The Wheatstone bridge circuit have the resistances in various arms as shown in figure. Calculate the current through the galvanometer.



84) (i) Deduce the relation between current I flowing through a conductor and drift velocity v_d of the electrons.
(ii) Figure shows a plot of current I flowing through the cross-section of a wire versus the time t. Use the plot to find the charge flowing in t_2 see through the wire.



85) Calculate the value of the resistance R in the circuit shown in the figure so that the current in the circuit is 0.2 A. What would be the potential difference between points A and D?



86) In a plane em wave, the electric field oscillates sinusoidally at a frequency of 2.0×10^{10} Hz and amplitude 48 V m^{-1}.
(a) What is the wavelength of a wave ?
(b) What is the amplitude of the oscillating magnetic field ?
(c) Show that the average energy density of the B field. [c=3 × 10^8 ms^{-1}]

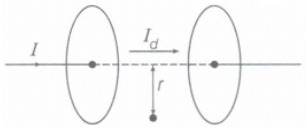
87) Two solenoids A and B spaced close to eachother and sharing the same cylindrical axis have 400 and 700 turns respectively. A current of 3.5 A in coil A produced an average flux of $300\mu\, T - m^2$ through each turns of A and a flux of $90\mu\, T - m^2$ through each turns of B Calculate.
(a) mutual inductance of two solenoids.

(b) the self inductance of A.
What emf is induced in B when the current in A increases at the rate of 0.5 A/s?

88) A plane e.m.wave travelling in vacuum along Z-direction, what can you say about the direction of its electric and magnetic field vectors? If the frequency of the wave to 30 MHz. What is its wavelength?

89) A point source of e.m. radiation has an average power output of 800 W
(a) Find the maximum value of electric field at a distance 3.5 m from the source
(b) What will be the maximum value of the magnetic field?
(c) What will be the energy density at a density 3.5 m from the source?

90) Show that the magnetic field B at a point in between the plates of a parallel plate capacitor during charging is $\frac{\mu_0 \varepsilon_0 r}{2} \cdot \frac{dE}{dt}$ (symbols having usual meaning).



91) What happens during regulation action of a Zener diode?
(a) The current and voltage across the Zener remains fixed.
(b) The current through the series resistance (Rs.) changes.
(c) The Zener resistance is constant.
(d) The resistance offered by the Zener changes.

92) The electrical conductivity of a semiconductor increases when electromagnetic radiation of wavelength short than 2480 nm is incident on it. Find the band gap of the semiconductor. Given $h = 6.63 \times 10^{-34} Js$ and $1\ eV = 1.6 \times 10^{-19}$

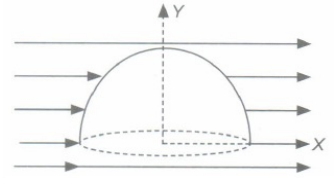
93) In a photo diode the conductivity increases when the material is exposed to light. It is found that the conductivity changes only if the wavelength of incident light is lees than 500 nm. What is the band gap? Use
$h = 6.6 \times 10^{-34}\ Js\ ;\ c = 3 \times 10^{8}\ ms^{-1}$

94) A transisitor has a current gain of 50.If the collector resistance 5 kΩand the input resistance is 1kΩ .Calculate the output voltage if input voltage is 0.01 V.

95) Let A,B and C be any three logic variables,prove the following Boolean identity.
$A\,.\,\overline{B} = + \,.\,\overline{A}\,.\,B = y\ A.B.C + A.\ .\overline{B}\,.C + A.B.\ .\overline{C} = A.(B + C)$

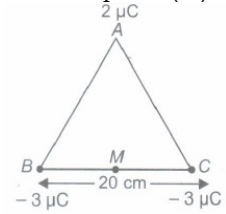
96) Auniform electric field is given as E = $100\hat{i}$ N/C forx > Oand E =$100\hat{i}$ N/C for x< 0. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the X-axis, so that one face is at x = +10 cm and other is at x = -10 cm.
(i) What is the net outward flux through each flat face?
(ii) What is the flux through the side of cylinder? '
(iii) What is the net outward flux through the cylinder?
(iv) What is the net charge inside the cylinder.

97) A hemispherical surface lies as shown in an uniform electric field region. Find the net electric flux through the curved surface if electric field is



(a) along x-axis, and
(b) along y-axis.

98) Three point charges of +2 μC, -3 μC and -3 μC are kept at the vertices A, B and C respectively of an equilateral triangle of side 20 cm as shown in the figure. What should be the sign and magnitude of the charge to be placed at the mid-point (M) of side BC so that the charge at A remains in equilibrium?

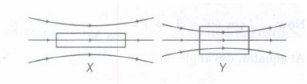


99) An electron moves a distance of 6.0 cm when accelerated from rest by an electric field of strength 2 x 10^4 NC^{-1} Calculate the time of travel.

100) Two identical point charges Q are kept at a distance r from each other. A third point charge is placed on the line joining the above two charges such that all the three charges are in equilibrium. What is the magnitude, sign and position of the third charge?

101) A bar magnet of magnetic moment 6 J/T is aligned at 60° with a uniform external magnetic field of 0.44 T. Calculate (a) the work done in turning the magnet to align its magnetic moment
(i) normal to the magnetic field,
(ii) opposite to the magnetic field, and (b) the torque on the magnet in the final orientation in case (ii).

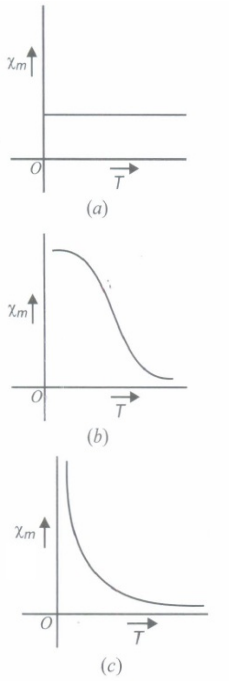
102) When two materials are placed in an external magnetic field, the behaviour of magnetic field lines is as shown in the figure. Identify the magnetic nature of each of these two materials.



103) Draw a plot showing the variation of intensity of magnetisation with the applied magnetic field intensity for bismuth. Under what condition does a diamagnetic material exhibit perfect conductivity and perfect diamagnetism?

104) What are hard and soft magnetic materials? Give one example of each.

105) Three curves are shown in the figures. Indicate what magnetic substance they represent.



106) The ratio of the number of turns in primary and secondary coil of a step up transformer is 1:200. It is connected to a.c. mains of 220 volt. Calculate the voltage developed in the secondary. Determine the maximum current in secondary coil, when a current of 2 ampere flows through the primary.

107) A coil of inductance 0.5 H and resistance $100\ \Omega$ is connected to 200 V, 50 Hz a.c. supply. Find the maximum current in the coil Also, find the time lag between the maximum voltage and maximum current.

108) A $100\ \mu F$ capacitor is charged to a potential of 50 V. The battery is then disconnected and a coil of inductance 10 mH is connected to it. Calculate maximum current in the coil and frequency of LC oscillations.

109) A series LCR circuit with R = 20, L = 1.5H and C = 35μF is connected to a variable frequency 200V a.c. supply power transferred to the circuit in one complete cycle?

110) The current flowing through an inductor of self inductance L is continuously increasing. Plot a graph showing the variation of
(i) Magnetic flux versus the current
(ii) Induced emf versus dI/dt
(iii) Magnetic potential energy stored versus the current.

111) There is a stream of neutrons with a kinetic energy of 0.0327 eV. If the half life of neutrons is 700 seconds, what fraction of neutrons will decay before they travel a distance of 10 m? Given mass of neutron $= 1.675 \times 10^{-27} kg.$

112) Write symbolically the process expressing the β^+ decay of $^{22}_{11}Na$ .Also write the basic nuclear process underlying this decay.

113) Obtain the approximate value of the radius of a nucleus $_{92}$ U^{238} . Take, R_0 is 1.2 x 10^{-15} m.

114) Calculate and compare the energy released by
(i) fusion of 1kg of hydrogen deep with in sun and
(ii) the fission of 1kg of ^{235}U in a fission reactor.

115) Calculate the energy released if ^{238}U an α-particle.
Given: atomic mass of ^{238}U = 238.0508 u, atomic mass of ^{234}Th = 234.04363 u, atomic mass of alpha particle = 4.00260 u and 1 u = 931 MeV/C^2

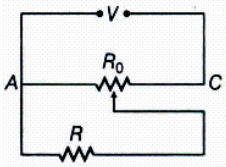
32 x 5 = 160

116) Two tiny spheres carrying charges $1.5\mu C$ and $2.5\mu C$ are located 30 cm apart. Find the potential and electric field:
(a) at the mid-point of the line joining the two charges,and
(b) at a point 10 cm from this mid-point in a plane normal to the line and passing through the mid-point.

117) A spherical capacitor has an inner sphere of radius 12 cm and an outer sphere of radius 13 cm. The outer sphere is earthed and the inner sphere is given a charge of 2.5 μC. The space between the concentric spheres is filled with a liquid of dielectric constant 32.
(a) Determine the capacitance of the capacitor.
(b) What is the potential of the inner sphere?
(c) Compare the capacitance of this capacitor with that of an isolated sphere of radius 12 cm. Explain why the latter is much smaller.

118) A resistance of R Ω draws current from a potentiometer as shown in the figure. The potentiometer has a total resistance R_0 Ω. A voltage V is supplied to the potentiometer. Derive an expression for the voltage across R, when the

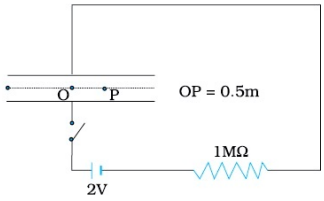
sliding contact is in the middle of the potentiometer.



119) The earth's surface has a negative surface charge density of 10^{-9} Cm^{-2}. The potential difference of 400 kV between the top of the atmosphere and the surface results (due to the low conductivity of the lower atmosphere) in a current of only 1800 A over the entire globe. If there were no mechanism of sustaining atmospheric electric field, how much time (roughly) would be required to neutralise the earth's surface? (This never happens in practice because there is a mechanism to replenish electric charges, namely the continual thunderstorms and lightning in different parts of the globe). (Radius of earth = 6.37 x 106 m.)

120) About 5% of the power of a 100 W light bulb is converted to visible radiation. What is the average intensity of visible radiation.
(a) At a distance of 1 m from the bulb
(b) At a distance of 10 m?
Assume that the radiation is emitted isotropically and neglect reflection.

121) A parallel plate capacitor with circular plates of radius 1 m has a capacitance of 1 nF. At t = 0, it is connected for charging in series with a resistor R = 1 MΩ across a 2V battery. Calculate the magnetic field at a point P, halfway between the centre and the periphery of the plates, after t = 10^{-3} s. (The charge on the capacitor at time t is q (t) = CV [1 – exp (–t/τ)], where the time constant τ is equal to CR



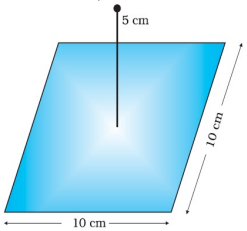
122) For a common emitter transistor amplifier, the audio signal voltage across the collector resistance of 2 k Ω is 2 V.Suppose the current amplification factor of the transistor is 100, find the input signal voltage and base current,if the base resistance is 1 k Ω

123) A p-n photodiode is fabricated from a semiconductor with band gap of 2.8 eV. Can it detect a wavelength of 6000 nm?

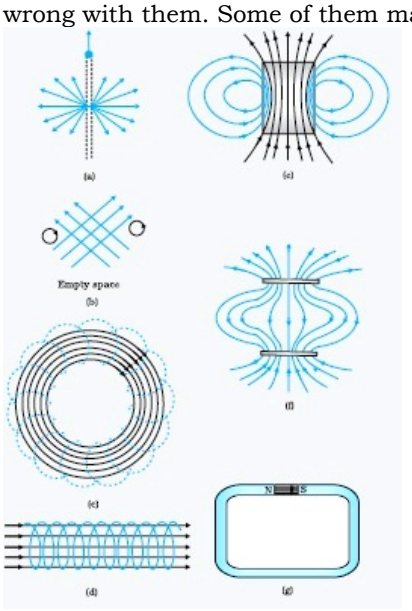
124) Two point charges q_A = 3 μC and q_B = –3 μC are located 20 cm apart in vacuum.
(a) What is the electric field at the midpoint O of the line AB joining the two charges?
(b) If a negative test charge of magnitude 1.5 x 10^{-9} C is placed at this point, what is the force experienced by the test charge?

125) A point charge +10 μC is a distance 5 cm directly above the centre of a square of side 10 cm, as shown in Fig What is the magnitude of the electric flux through the square? (Hint: Think of the square as one face of a cube with

edge 10 cm.)



126) Many of the diagrams given in Fig. show magnetic field lines (thick lines in the figure) wrongly. Point out what is wrong with them. Some of them may describe electrostatic field lines correctly Point out which ones.



127) (a) Magnetic field lines show the direction (at every point) along which a small magnetised needle aligns (at the point). Do the magnetic field lines also represent the lines of force on a moving charged particle at every point?
(b) Magnetic field lines can be entirely confined within the core of a toroid, but not within a straight solenoid. Why?
(c) If magnetic monopoles existed, how would the Gauss's law of magnetism be modified?
(d) Does a bar magnet exert a torque on itself due to its own field? Does one element of a current-carrying wire exert a force on another element of the same wire?
(e) Magnetic field arises due to charges in motion. Can a system have magnetic moments even though its net charge is zero?

128) (a) For circuits used for transporting electric power, a low power factor implies large power loss in transmission. Explain.
(b) Power factor can often be improved by the use of a capacitor of appropriate capacitance in the circuit. Explain.

129) An LC circuit contains a 20 mH inductor and a 50 μF capacitor with an initial charge of 10 mC. The resistance of the circuit is negligible.
Let the instant the circuit is closed be t = 0.
(a) What is the total energy stored initially? Is it conserved during LC oscillations?
(b) What is the natural frequency of the circuit?
(c) At what time is the energy stored
(i) completely electrical (i.e., stored in the capacitor)?
(ii) completely magnetic (i.e., stored in the inductor)?
(d) At what times is the total energy shared equally between the inductor and the capacitor?
(e) If a resistor is inserted in the circuit, how much energy is eventually dissipated as heat?

130) The radionuclide ^{11}C decays according to
$^{11}_{6}\mathrm{C} \rightarrow {}^{11}_{5}\mathrm{B} + e^{+} + v: \quad T_{1/2} = 20.3\ \mathrm{min}$
The maximum energy of the emitted positron is 0.960 MeV. Given the mass values:
$m\left({}^{11}_{6}\mathrm{C}\right) = 11.011434\mathrm{u}$ and $m\left({}^{11}_{6}\mathrm{B}\right) = 11.009305\mathrm{u}$,
calculate Q and compare it with the maximum energy of the positron emitted.

131) A source contains two phosphorous radio nuclides $^{22}_{15}\mathrm{P}\ (T_{1/2} = 14.3\ \mathrm{d})$ and $^{33}_{15}\mathrm{P}\ (T_{1/2} = 25.3\ \mathrm{d})$.Initially, 10% of the decays come from $^{33}_{15}\mathrm{P}$.How long one must wait until 90% do so?

132) The thickness of air layer between two coatings of a spherical capacitor is 2 cm. The capacitor has same capacitance as the sphere of 1.2m diameter. Find the radii of its surfaces.

133) On our return from an excursion trip in our school,I noticed a bird sitting on a high voltage electric wire. I curiously noticed the bird and found to my surprise that the bird flew off after some time without any electrical shock. This incident made me think of another incident that took place near my house last week where, a boy, who climbed to take a kite, got severe jolt of electric current. I immediately approached my school physics teacher for an explanation. My teacher explained the effect of electrical current which I told my mother that evening.
(a) What are the values associated with the above incident?

(b) What would be the explanation given by the physics teacher?

134) (a) State Ohm's law.
(b) Define resistance. Give its SI unit.

135) When 14 cells in series, are connected to the ends of a resistance of 82.6 Ω, then the current is found to be 0.25A. When same cells after being connected in parallel are joined to the ends of a resistance of 0.053 Ω, then the current is 25A. Calculate the internal resistance and the emf of each cell.

136) A parallel plate capacitor made of circular plates each of radius R=5.0 cm has a capacitance C=96 pF. The capacitor is connected to a 220 V a.c supply with (argular) frequency of 300 rad s^{-1} .

137) Calculate the peak values of electric and magnetic fields produced by the radiation coming from a 100 watt bulb at a distance of 3 m. Assume that the efficiency of the bulb is 2.5% and it is a point source?

138) The current in the forward bias is known to be more (~mA) than the current in the reverse bias (~μA), then why photodiodes is to operate in reverse bias. Rajiv did not know its cause. So he requested his friend Sanjiv for its answer. Sanjiv explained him that in case of n-type semiconductor, the majority carrier (electron) density n is considerably larger than the minority hole density p, i.e., n > > p. On illumination, if the excess electrons and holes generated be Δn and Δp respectively, then

$n' = n + \Delta n \quad and \quad p' = p + \Delta p$

Here $\Delta n = \Delta p \quad and \quad n >> p$.Hence the fractional change $\frac{\Delta n}{n}$ would be much less than $\frac{\Delta p}{p}$.

In general, we can state that the fractional change due to the photo-effects on the minority carrier dominated reverse bias current is more easily measurable than the fractional change in the forward bias current. So, photodiodes are preferably used in the reverse bias condition for measuring light intensity.
(a) What values are noticed in Sanjiv ?
(b) For a CE transistor amplifier, the audio signal voltage across the collector resistance of 2 kΩ is 2 V. Current amplification factor of the transistor is 100. Find the input signal voltage and the base current, if its resistance is 1kΩ.

139) (a) State briefly the processes involved in the formation of p-n junction explaining clearly how the depletion region is formed.
(b) Using the necessary circuit diagrams, show how the V-I characteristics of a p-n junction are obtained in
(i) Forward biasing
(ii) Reverse biasing
How are these characteristics made use of in rectification?

140) A point charge causes an electric flux - 3 x 10^{-14} N -m^2 /C to pass through a spherical Gaussian surface.
(i) Calculatethe value of the point charge.
(ii) If the radius of the Gaussian surface is doubled, how much flux would pass through the surface?

141) (a) State Gauss's law. Use it to deduce the expression for the electric field due to a uniformly charged thin spherical shell at points (i) inside and (ii) outside the shell.
(b) Two identical metallic spheres A and B having charges +4 Q and -10Q are kept a certain distance apart. A third identical uncharged sphere C is first placed in contact with sphere A and then with sphere B. Spheres A and B are then brought in contact and then separated. Find the charges on the spheres A and B.

142) (i) A bar magnet of magnetic moment M is aligned parallel to the direction of a uniform magnetic field B. What is the work done, to turn the magnets, so as to align its magnetic moment
(a) opposite to field direction and
(b) normal to field direction?
(ii) Steel is preferred for making permanent magnets, whereas soft iron is preferred for making electromagnets. Give one reason.

143) A solenoid having 5000 turns/m carries a current of 2A. An aluminium ring at temperature 300K inside the solenoid provides the core.
(a) If the magnetisation I is 2 x 10^{-2} A/m, find the susceptibility of aluminium at 300 K.
(b) If temperature of the aluminium ring is 320 K, what will be the magnetisation?

144) A town situated 20km away from a power plant generating power at 440 V requires 600 kW of electric power at 200V. The resistance of town gets power from the line through a 3000-220V step down transformer at a substation in the town. Find line power from the line through a 3000-220V step down transformer at a substation in the town. Find line power losses in the form of heat. How much power must the plant supply assuming that there is negligible power loss due to leakage?

145) A device X is connected across an AC source of voltage V = V_0 sin ωt. The current through X is given as

$I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$

(a) Identify the device X and write the expression for its reactance.
(b) Draw graphs showing variation of voltage and current with time over one cycle of AC, for X.
(c) How does the reactance of the device X vary with frequency of the AC? Show this variation graphically.
(d) Draw the phasor diagram for the device X.

146) If 200 MeV energy is released in the fission of a single nucleus of $_{92}U^{235}$, how many fissions must occur per second to produce a power of 1kW?

147) Obtain the binding energy of the nuclei $^{26}_{56}\mathrm{Fe}$ and $^{209}_{83}\mathrm{Bi}$ in units of MeV from the following data:

m ($^{26}_{56}\mathrm{Fe}$) = 55.934939 u

m ($^{209}_{83}\mathrm{Bi}$) = 208.980388 u