GRADED EXERCISE QUESTIONS

LEVEL –1

1. How many electrons will have a total charge of 1 coulomb?
2. Find the electric field intensity due to a charge of 5×10^{-8} C at a point 50 cm from it in vacuum
3. An electric charge of 2 μ c experience an electric force of 3.2×10^{-3} N when kept at a point in vacuum. What is the electric field intensity at that point?
4. An electric dipole consists of two charges of magnitude 1 μ c. They are placed 3 cm apart in a uniform electric field of 100 N C-1 acting at right angles to the axis of dipole. Calculate
    a. dipole moment of electric dipole
    b. electric force acting on either charge
    c. Torque acting on dipole
5. An electric dipole is held at an angle of 30^o with respect to a uniform electric filed of 2×10^4 NC^{-1} experiencing a torque of 18×10^{-25} Nm. Calculate the dipole moment of the dipole
6. Electric potential at a point is 200 Volt. How much work will be down in bringing an α particle from infinity to that point (Charge on an α - particle is 3.2×10^{-19} C)
7. Find the potential at a point 30 cm from a point charge of 2×10^{-8} C in vacuum
8. An electric field at a point due to a point charge is 20 N / C and the electric potential at that point is 10 J / C. Calculate the distance of the point from the charge and also the magnitude of the charge.
9. A Cube of side b has a charge q at each of its eight vertices. Determine the potential and electric field due to these array at the centre of the cube.
10. A uniformly charged conducting sphere of 2.4 m diameter has a surface charge density of 80.0 μ C. m^{-2}. Find (a) The charge on the sphere and (b) total electric flux leaving the surface of sphere.
11. What is the area of the plate of a 2 F parallel plate capacitor with plate separation of 0.5 cm? Why does ordinary capacitor have capacitance of order of microfarads?
12. A 4 μ F capacitor is connected in parallel with a 8 μ F capacitor. The combination is charged at 300 volt. Calculate (i) the total charge on the combination (ii) the total energy stored in the combination
13. The plates of a parallel plate capacitor have an area of 90 cm^2 each and are separated by 2.5 mm. (a) Find the capacitance of capacitor (b) If the capacitor is charged by connecting it to a 400 V supply, how much energy is stored by the capacitor? (c) Calculate the energy stored per unit volume of the capacitor
14. Two parallel plate capacitors of 20 μ F and 30 μ F are charged to 30 V and 20 V respectively. If the plates of these capacitors with same type of charge are connected together. Find
    a. The common potential of the capacitor
    b. Charges on the capacitor at common potential
    c. Loss of energy in the process
15. An infinite line charge producer a field of 9×10^4 N / C at a distance of 2 cm. Calculate the charge density.

ELECTROSTATICS

QUESTIONS FOR PRACTICE

1. oulomb's law in vector form: 1

$$F = \frac{1}{4\pi\in} \frac{q_1 q_2}{r^2} \hat{r}$$

2. In a medium the force of attraction between two point charges, distance d apart is F. What distance apart should these be kept in the same medium so that the force between them become (a) 5 F (b) F ? 5

Ans:- $F \propto \frac{1}{d^2}$

(a) For the force to become 5 F, the separation of must become d root 5

(b) For the force to become F / 5, the separation d must become d / $\sqrt{5}$

3. Sketch the electric lines of force for (a) 5 C (b) 10 C

Less lines of force More lines of Force

4. What is the relation between E_A, E_B & E_C.

$E_A > E_B > E_C$

5. If a point charge +q, is taken first from A to C and then from C to B of a circle drawn with another point charge + q as centre, then along which path more work will be done?

WD will be same, as the distance is same.

6. An uncharged insulated conductor A is brought near a charged insulated conductor B. What happens to charge and potential of B?

Potential decreases but charge remains small as both are insulated.

7. A and B are two conducting spheres of same radius, A being solid and B hollow. Both are charged to the same potential. What will be the relation between the charges on the two spheres?

As charges resides on the surface of the conductors, both the spheres contains same amount of charges.

8. A conductor with a cavity in it is given a charge Q. What will be the total charge on the surface of this conductor if another conductor carrying charge q is placed in the cavity without touching the cavity>

The charges get added up i.e., q + Q is the charge.

9. A capacitor of capacitance c has distance between plate is d. A very thin wire mesh is placed as shown in figure. Calculate new capacitance.

2 MARKS & 3 MARKS

1. A point charge 'q' is placed at O as shown. Is $V_A - V_B$ positive, negative or zero, if 'q' is a (i) positive (ii) negative charge?

O A B

q

2. An electric dipole is free to move in a uniform electric field. Explain its motion when it is placed (1) parallel to the field and (ii) perpendicular to the field (1)

F1 F2 E

+q - q

Either it may be stable or unstable equilibrium. Also, there is no torque or translatory force.
(2)

+q F1

E

F2

- q

The dipole will experience a torque. As EF is uniform, there is no translatory force.

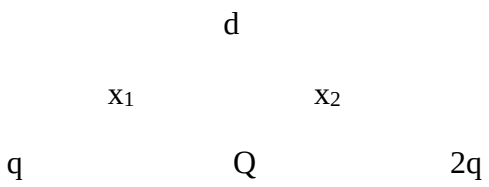
3. Two capacitors of equal capacitance, when connected in series, have a net capacitance of C, and when connected in parallel have a capacitance of C_2. What will be the value of C_1 / C_2.

4.

Find the resultant capacitance

5. A spherical Gaussian surface encloses a charge of 17.7 X 10^{-8} C. (i) Calculate the electric flux passing through the Gaussian Surface. (ii) If the radius of the Gaussian surface is doubled, how much flux would pass through the surface?

6. Two point charges q and 2q are kept at a distance d apart from each other in air. A third charge Q is to be kept along the same line in such a way that the net force acting on q and 2q is zero. Calculate the position of charge Q in terms of q and d.



7. Show that the force on each plate of a parallel plate capacitor has a magnitude equal to (1/2) QE, where Q is the charge on the capacitor and E is the magnitude of EF between the plates. Explain the origin of the factor ½.
8. Calculate capacitance of capacitor as shown below.

9. Derive the expression for 'Energy Density' in a parallel plate capacitor.
10. Derive Energy stored in series combination of capacitors.
11. Derive the Energy stored in parallel combination of capacitors.
12. Discuss the concept of common potential (Sharing of charges) in combination of capacitors.
13. Derive the relation for the loss of energy while sharing of charges when two capacitors are connected in parallel.
14. Derive the relation between Ψe and $\in_r$
15. The diagram shows the arrangement of plates of a parallel plate capacitor. Find the resultant capacitance of this arrangement.

16. What is the equivalent capacitance of the system of parallel plates?

17. What is the equivalent capacitance of the system of plates shown below?

18. Capacitors P, Q and R have each a capacitance C. A battery can charge the capacitor P to a potential difference V. If after charging P, the battery is disconnected from it and the charged capacitor P is connected in following separate instances to Q and R (i) to Q in parallel and (ii) to R in series, then what will be potential difference between the plates of P in the two instances.

More Questions

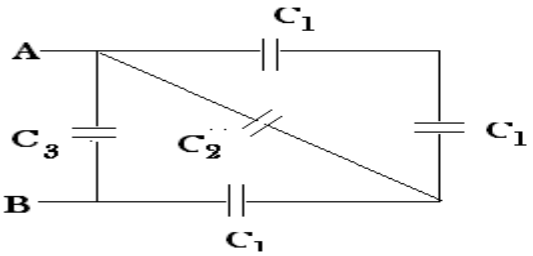
1. State Gauss' theorem. Using it, find the strength of electric field at a distance r from the center of a conducting sphere of radius R carrying charge Q, where (i) $r < R$ and (ii) $r > R$.
2. Define dielectric constant in terms of the capacitance of a capacitor? On what factor does the capacitance of a parallel plate capacitor with dielectric depend?
3. State Gauss' Theorem in electrostatics? Using this theorem define an expression for the field intensity due to an infinite plane sheet of charge density σ C/m^2?

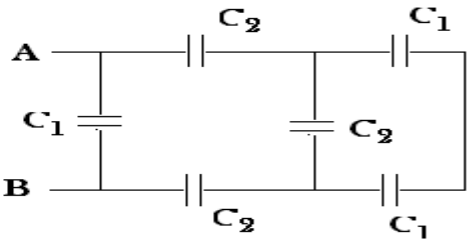
4. Find an expression for the electric field strength at a distant point situated along the equatorial line of an electric dipole.
5. What is equipotential surface? Show that electric field is always perpendicular to the equipotential surface.
6. Define 'electric line of force' and give its two important properties.
7. Derive an expression for the total energy stored in a parallel plate capacitor and related to the electric field.
8. Define "intensity of electric field" at a point. At what points in the electric dipole field intensity is parallel to the line joining the charges.
9. State the principle of quantization of electric charges.
10. Define dipole moment. What is its unit in SI system?
11. Two electric lines never cross each other why?
12. What is the direction and magnitude of the electric field at the midpoint of an electric dipole made of length 2a?
13. Derive the expression for the energy density of a charged parallel plate capacitor.
14. . Show that work done in carrying electric charge on an equipotential surface is zero.
15. A spherical Gaussian surface encloses a charge of 8.85×10^{-10}C.

    (i) Calculate the electric flux passing through the surface.

    (ii) How would the flux change if the radius of the Gaussian surface is doubled and why?

16. Can two equi-potential surfaces intersect each other? Give reasons.
17. A 500 μC charge is at the centre of a square of side 10 cm. Find the work done in moving a charge of 10 μC between two diagonally opposite points on the square.
18. A 12 pF capacitor is connected to a 50V battery. How much electrostatic energy is stored in the capacitor?
19. Define capacitance and write its SI unit.
20. Explain the principle of capacitor
21. Derive an expression for capacitance of a parallel plate capacitor with vacuum as medium between the plates.
22. Derive expression for equivalent capacitance when three C1, C2 and C3 are connected in (i) Series (ii) parallel
23. Calculate equivalent capacitance between A and B in the given fig if $C_1 = 6\mu F$, $C_2 = 3\mu F$ and $C_3 = 2\mu F$.





24. Three capacitors of capacitances 2 pF, 3 pF and 4 pF are connected in parallel.
    (a) What is the total capacitance of the combination?

    (b) Determine the charge on each capacitor if the combination is connected to a 100 V supply.

25. Three capacitors each of capacitance 9 pF are connected in series.

    (a) What is the total capacitance of the combination?

    (b) What is the potential difference across each capacitor if the combination is connected to a 120 V supply?

26. Sketch electric lines of force due to (i) isolated positive change (ie q>0) and (ii) isolated negative charge (ie q<0)
27. Draw equipotential surfaces for an isolated point charge
28. An electric dipole with dipole moment 4×10^{-9} C m is aligned at 30° with the direction of a uniform electric field of magnitude 5×10^{4}N C^{-1}. Calculate the magnitude of the torque acting on the dipole.

LEVEL-2

1 MARK QUESTIONS

01 In a parallel plate capacitor the capacitance increases from 4 μF to 80 μF on introducing a dielectric slab of thickness equal to plate separation. Calculate the dielectric constant of the medium.

02 Force between two point electric charges kept at a distance d apart in air is F. If these charges are kept at the same distance in water, how does the force between them change?

03 In a medium, the force of attraction between two point electric charges, distance d apart, is F. What distance apart should these be kept in the same medium so that the force between them becomes 3F?

04 Name & define the physical quantity whose S I unit is C/V.

05 What is the amount of work done in moving a 100nC charge between two points 5cm apart on an equipotential surface?

2 MARK QUESTIONS

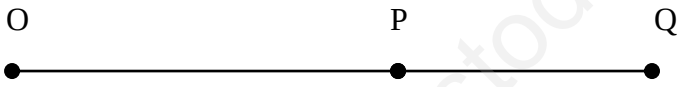
01 At a point in the electric field of a point charge, the intensity of the field is 32 N/C and electric potential is 16 J/C respectively. What is the distance of the point from the point charge? 2

02 Calculate the electric flux through a spherical surface of radius 10 cm enclosing a negative charge of 8.854 μC. What happens to the flux when the radius of the surface is doubled?

03 Two capacitors 6 μF and 2 μF are connected in series with a battery. The voltage across 6 μF capacitor is 2V. Compute the total battery voltage.

04 A parallel plate capacitor with air between the plates has a capacitance of 8 μF. The separation between the plates is now reduced by half and the space between them is filled with a medium of dielectric constant 5. Calculate the value of the capacitance in the second case.

05



A point charge `q' is placed at `O' as shown in the figure. Is V_P - V_Q positive or negative when (i) $q > 0$ and (ii) $q < 0$? Justify your answer.

06 Define electric field intensity. Write its S I unit. Write the magnitude and direction of electric field intensity due to an electric dipole of length 2a at the midpoint of the line joining the two charges.

07 A parallel plate capacitor is to be designed with a voltage rating 1kV using a material of dielectric constant 3 and dielectric strength of about 10^7 Vm^{-1} For safety we would like the field never exceed say, 10% of the dipole strength. What minimum area of the plates is required to have a capacitance of 50pF?

08 A 4 μF capacitor is charged by a 200V supply. The supply is then disconnected and the charged capacitor is connected to another uncharged 2 μF capacitor. How much electrostatic energy of the first capacitor is lost in the process of attaining the steady situation?

09 Two fixed point charges +4e and +e units are separated by a distance `a'. Where should a third positive point charge be placed for it to be in equilibrium?

10 Obtain the energy, in joules and in electron volts, acquired by an electron beam when accelerated through a potential difference of 2000V.

11 An electric dipole is held at an angle θ with a uniform electric field. What is the torque acting on it? Explain what happens to the dipole on being released.

12 What is capacitance? State its SI unit. Define it.

13 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 two charges such that all the three charges are in equilibrium. What is the magnitude, sign and position of the third charge?

14 Draw lines of force to represent a uniform electric field. List the properties of electric field lines.

15 Derive an expression for the work done in rotating an electric dipole through an angle θ in a uniform electric field.

16 The electric field at a point due to a point charge is 20N/C and electric potential at the point is 10J/C. Calculate the distance of the point from the point charge and the magnitude of the charge.

17 Two point electric charges of unknown magnitude and sign are placed at a distance d apart. The electric field intensity is zero at a point, not between the charges but on the line joining them. Write two essential conditions for this to happen.

18 Two point charges `q' and `2q' are kept at a distance `r' from each other in air. A third point charge Q is to be placed on the line joining the two charges such that the net force acting on q and 2q is zero. What is the magnitude, sign and position of the third charge in terms of q and r ?

19 An infinite plane sheet of charge density 10^{-8} Cm^{-2} is held in air. In this situation how far apart are two equipotential surfaces, whose p d is 5V?

20 An electric dipole of length 2cm is placed with its axis making an angle of 60^{o} to a uniform electric field of 10^{5}N/C. If it experiences a torque of $8\sqrt{3}$ Nm, calculate;

a) magnitude of the charge on the dipole

b) potential energy of the dipole.

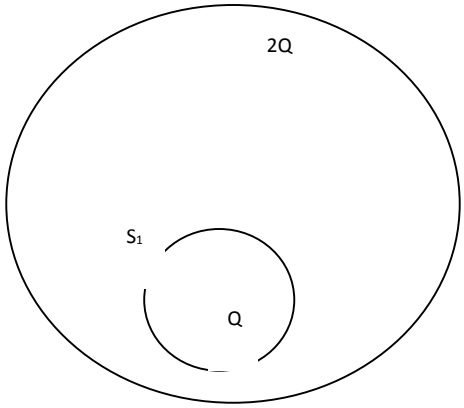
21 What orientation of an electric dipole in a uniform electric field corresponds to its (i)stable and (ii) unstable equilibrium? Explain.

22 Two capacitors 3 μF and 6 μF are charged to potentials 2 V and 5 V respectively. These two charged capacitors are connected in parallel. Find the charge across each of the two capacitors now.

23 S_1 and S_2 are two hollow spheres enclosing charges 2Q and Q respectively as shown in figure

(i) What is the ratio of electric flux through S_1 and S_2

(ii) How will the electric flux through S_2 change if a medium of dielectric constant 5 is introduced in the space inside S_2 in place of air?



24 Two point charges 4 μC and -2 μC are separated by a distance of 1m in air. Calculate at what point on the line joining the two charges is the electric potential zero?

25 Keeping the voltage of the charging source constant, what would be the percentage change in the energy stored in a parallel plate capacitor, if the distance between the plates were to be reduced by 10%?

3 MARK QUESTIONS

26 Derive an expression for the energy stored in a charged parallel plate capacitor. What happens to this energy when the capacitor is made to discharge by connecting the two plates using a conducting wire?

27 An electric dipole of length 8 cm, when placed with its axis making an angle of 60° with a uniform electric field experiences a torque of $8\sqrt{3}$ Nm. Calculate the (i) magnitude of the electric field and (ii) the potential energy of the dipole, if the dipole has charges $\pm$ 4 nC.

28 Two identical plane metallic plates A and B are kept parallel to each other in air, separated by a distance of 1 cm between them. A is given a positive potential of 10 V and the outer surface of B is earthed.

i) What is the magnitude and direction of the uniform electric field between the two plates?

ii) What is the work done in moving a charge of 20 μC from A to B?

29 Derive an equation for the effective capacity of a series combination of three capacitors.

30 Three hollow concentric spheres A, B and C having radii a, b and c respectively (a<b<c) have uniform surface charge densities +σ, -σ and +σ respectively. Compute the electric potential at the surface of the spheres.

31 A point charge of +2 μC is kept fixed at a point O. another point charge of +4 μC is brought from a far off point to a point distant 50cm from O. Calculate the potential energy of the system of the two charges.
Another point charge of +1 μC is brought to a point distant 100 cm from each of the above charges (assumed to be kept fixed). What is the work done in doing so?

32 Derive an expression for the electric field intensity at any point along the perpendicular bisector of an electric dipole.

33 11 A 20 μF capacitor is charged by a 30 V d c supply and then connected across an uncharged 50 μF capacitor. Calculate the final potential difference across the combination and the initial and final energies. How will you account for the difference in energy

34 Use Gauss's theorem to find the electric field at a point near a charged infinitely long thin conducting wire.

35 State Coulomb's law. Write its mathematical form. Define one coulomb.

36 For a parallel plate capacitor prove that the total energy stored is ½ CV^2 and hence derive the expression for its energy density.

37 How does the total energy stored in a parallel plate capacitor with air as the dielectric medium change when a dielectric medium of dielectric constant κ is introduced between the plates?

38 A capacitor is charged from a battery. Assuming that the capacitor is disconnected from the charging battery, explain how;
a) the capacitance, b) p. d. across the plates and c) energy stored in the capacitor change, when a medium of dielectric constant `k' is introduced between the plates.

39 A capacitor is charged from a battery. Assuming that the capacitor remains connected to the charging battery, explain how;
a) the capacitance, b) p. d. across the plates and c) energy stored in the capacitor change, when a medium of dielectric constant `k' is introduced between the plates.

40 Two point charges +4μC and -2 μC are separated by a distance of 1m in air. At what point on the line joining the two charges is the electric potential zero?

41 Two point charges +4μC and -2 μC are separated by a distance of 1m in air. At what point on the line joining the two charges is the electric field zero?

42 A 600 pF capacitor is charged by a 200V supply. It is then disconnected from the supply and is connected to another uncharged 600 pF capacitor. How much electrostatic energy is lost in this process?

43 A point charge of +2 μC is kept fixed at the origin. Another point charge of +4 μC is brought from a far off point to a point distant 50 cm from the origin. Calculate the electrostatic potential energy of this two charge system.
Another charge of+1 μC is brought to a point distant 100 cm from each of these two charges (assumed to be kept fixed). What is the work done?

44 An electric dipole of moment *p* is placed in a uniform electric field of intensity, E. Write the expression for the torque τ experienced by the dipole. Identify two pairs of perpendicular vectors in the expression.
Show diagrammatically, the orientation of the dipole in the field for which the torque is; (i) maximum, (ii) half the maximum value and (iii) zero.

45 A charge Q located at a point r is in equilibrium under the combined electric field of three charges q_1,q_2, q_3. If the charges q_1, q_2 are located at points r_1 and r_2 and respectively, find the direction of the force on Q, due to q_3 in terms of q_1,q_2, r_1, r_2 and r_3

46 Explain the underlying principle of working of a parallel plate capacitor.
If two similar plane plates, each of area A having surface charge densities + σ and – σ are separated by a distance d in air, write the expressions for : i) the electric field at points between the plates ii) potential difference between the plates and iii) the capacitance of the capacitor so formed.

47. When two capacitors are connected in series, the effective capacitance is 2.4μF and when connected in parallel, the effective capacitance is 10μF. Calculate the individual capacitances.

5 MARK QUESTIONS

48 State the theorem which relates the enclosed charge, inside a closed surface, with the electric flux through it. Use this theorem to obtain the electric field due to a uniformly charged thin spherical shell at an (i) outside point (ii) inside point.
An electric charge of 8.85 x 10^{-13} C is placed at the centre of a sphere of radius 1m. What is the total electric flux linked with the sphere? How will the electric flux change if another equal and dissimilar charge is introduced at a distance of
(i) 0.5m from the centre, (ii) 1.5m from the centre?

49 State Gauss's theorem in electrostatics. Using this theorem, derive an expression for the electric field intensity due to a charged metallic spherical shell. Write the special cases. Draw the graph showing the variation of the field with distance from the centre of the conductor.

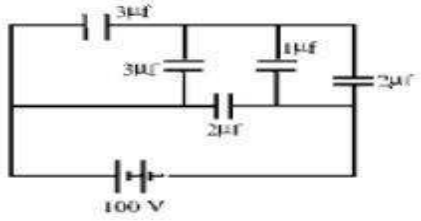
50 Define Capacity. Name the factors on which the capacity of a parallel plate capacitor depends.
Derive the expression for the capacity of a parallel plate capacitor with a dielectric slab between the plates.
A parallel plate capacitor has a capacity of 100 μF with air in between the plates. What happens to the capacity when the plates are introduced in a medium of dielectric constant 80 without changing the plate separation?

51 Explain the effect of introducing a dielectric slab between the plates of a parallel plate capacitor on its capacitance. Derive an expression for its capacitance with a dielectric as the medium between the plates.

52 With the help of a neat labelled diagram explain the principle, construction and working of a Van de Graff Generator.

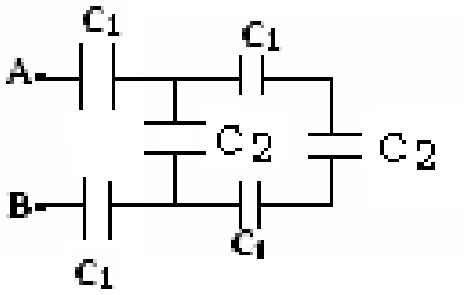
53 Show mathematically that the electric field intensity due to a short dipole at a distance `d' along its axis is twice the intensity at the same distance along the equatorial axis.

54 Obtain an expression for the capacitance of a parallel plate (air)capacitor.
The given figure shows a network of five capacitors connected to a 100V supply. Calculate the total charge and energy stored in the network.

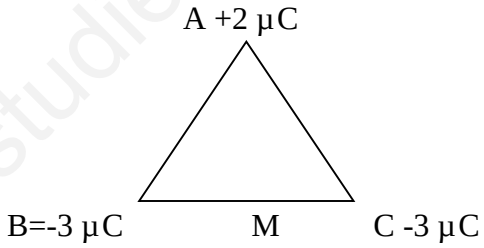


MORE QUESTIONS

1. Draw two equipotential due to a point charge. (ii) What is the amount of work done in moving a 100nC charge between two points 5cm apart on an equipotential surface?
2. If C1 = 3pF and C2 = 2pF, calculate the equivalent capacitance of the given network between points A & B?



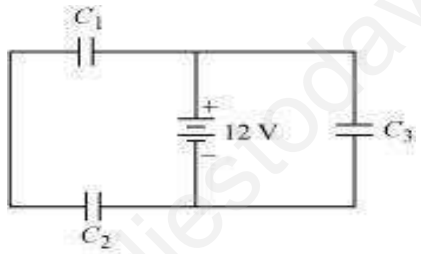
3. An electric dipole is held in uniform electric field.
   (i) Show that net force acting on it is zero.
   (ii) The dipole is aligned parallel to the field. Find the work done in rotating it through 180^0.
4. (a) Using Gauss' law derive the expression for electric field intensity at a point outside a uniformly charged spherical cell.
   (b) Three charges +2μC, -3μC and -3μC are kept at three vertices A, B and C of an equilateral triangle of side 20cm as shown in the figure. Find the charge to be placed at mid point M of BC so that charge at A remains in equilibrium.



5. Define equipotential surfaces and draw the equipotential surfaces for uniformly increasing electric field along +yaxis.
6. State Coulombs law for electrostatics. Two fixed charges +4q and +q are separated by a distance `a`. Where should the third point charge be placed on the line joining two charges so that the third point charge is in equilibrium?
7. Why does the electric field inside a dielectric decrease when it is placed in an external electric field?
8. A parallel plate capacitor with air between the plates has a capacitance of 8 pF. What will be the capacitance if the distance between the plates be reduced by half and the space between them is filled with a substance of dielectric constant K = 6 ?

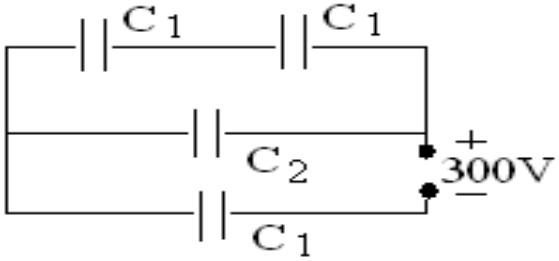
9. Two charges q and -2q are placed at points A and B on a line XY. State whether the points at which (i) E =0 (ii) V=0 will be located (a) to the left of A (b) between A and B? (c) To the right of B? Justify your answer
10. Using Gauss' theorem obtain an expression for the electric field intensity at a distance r from an infinitely long line of charge with uniform linear charge density λ Cm^{-1}
11. An electric dipole of dipole moment p is placed in a uniform electric field E. Write the expression for the potential energy of the dipole in the field. Show diagrammatically the orientation of the dipole in the field for which the potential energy is -
    (i) minimum (ii) maximum (iii) Half the maximum (iv) Zero
12. Sketch the equi -potential surfaces due to a line charge.
13. A parallel plate capacitor of plate area A and separation d is charged to a potential V. The battery is then disconnected and a dielectric slab of thickness d and dielectric constant
    K is inserted in the capacitor. What change if any, will take place in
    (a) Charge on the plates.
    (b) Voltage across the capacitor.
    (c) Electric field between the plates.
    (d) Capacitance of the capacitor.
    (e) Energy stored. Justify your answer in each case.
14. On the basis of Gauss' theorem prove that, for a point outside a charged spherical shell it behaves as a point charge.
15. Draw the graph between electric field strength and distance from the centre of the hollow conducting charged sphere.
16. Two capacitors of capacitances 3μF and 6μF, are charged to potentials of 2V and 5V respectively. These two charged capacitors are connected in series. Find the potential across each of the two capacitors now?
17. P&Q are two conducting spheres of the same radii, P being solid and Q hollow. Both are charged to the same potential. What will be the relation between the charges on the two spheres?
18. What is the angle between the directions of electric field at any point on the 1) axial line 2) equatorial line of the dipole?
19. How does the force between the two charges vary when(a) The system is immersed in a medium. (b) When the distance between them is halved?
20. How does the electric flux, electric field enclosing a given charge vary when the area enclosed by the charge is doubled?
21. Write the expression for electric flux for a uniform (a) Linear charge distribution? (b) Areal charge distribution?
22. Show that at a point where the electric field intensity is zero, electric potential need not be zero.
23. Show diagrammatically the stable and unstable equilibrium of an electric dipole placed in a uniform electric field
24. Derive the expression for the potential due to a dipole. Find the ratio of potential along the equatorial and axial line of a dipole.

25. Derive an expression for the potential energy of a system of two electric charges in an external electric field.
26. Define electric flux. Write its mathematical form. A spherical rubber balloon carries a charge that is uniformly distributed over its surface. As the balloon is blown up and increased in size. How does the total electric flux coming out the surface change? Give reason
27. In a parallel plate capacitor the capacitance increases from 4Mf to 80μF, on introducing a dielectric medium between the plates. What is the dielectric constant of the medium?
28. An electric dipole of length 4 cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $4\sqrt{3}$ Nm. Calculate the magnitude of the electric field if the dipole has charges of ± 8 μC
29. A thin conducting spherical shell of radius R has charge Q spread uniformly over its surface. Draw a graph of electric field $E(r)$ with distance r from the centre of the shell for $0 \leq r \leq \infty$.
30. Three identical capacitors C_1, C_2 and C_3 of capacitance 6 μF each are connected to a 12 V battery as shown.

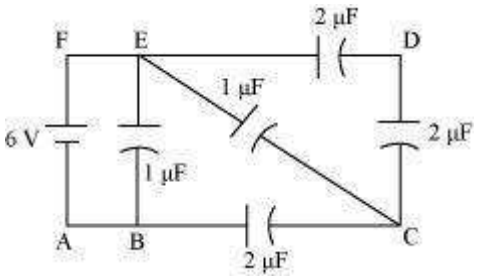


Find (i) charge on each capacitor
(ii) equivalent capacitance of the network

31. A 10 μF capacitor is charged by a 30 V d.c. supply and then connected across an un-charged 50 μF capacitor. Calculate (i) the final potential difference across the combination, and (ii) the initial and final energies. How will you account for the difference in energy?
32. In the given network C_1 =200pF and C_2 = 100pF. Calculate (i) equivalent capacitance of the network and (ii) energy stored in the network of capacitors



33. Find the total energy stored in the capacitors in the given network.



34. The equivalent capacitance of the combination between A and B in the given figure is 4μF.

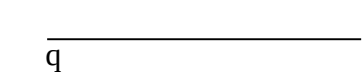
(i) Calculate capacitance of the capacitor C.

(ii) Calculate charge on each capacitor if a 12 V battery is connected across terminals A and B.

(iii) What will be the potential drop across each capacitor?

LEVEL-3

1. An electric dipole of dipole moment 20×10^{-6} Cm is enclosed by a closed surface. What is the net electric flux coming out of the surface?
2. a. Derive the formula for the capacitance of a parallel plate capacitor having a dielectric slab of thickness '**t**' the plates.
   b. A point charge **q** is placed at O as shown in the figure. Is $V_A - V_B$ positive or negative when,



   i) $q > 0$ and ii) $q < 0$

3. Four charges are arranged at corners of a square ABCD of side "d" as shown

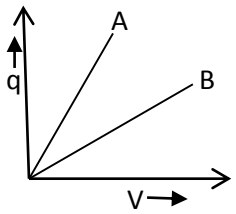
A (+q) B (-q)

q_0

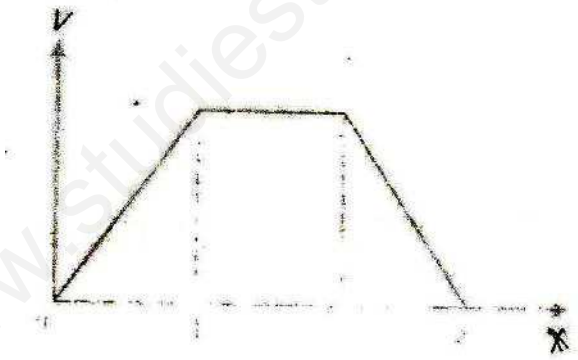
D (-q) C (+q)

Find the work done to put together this arrangement. If a charge q_0 is brought at its centre keeping the four charges at the corners, how much extra work is needed to do this?

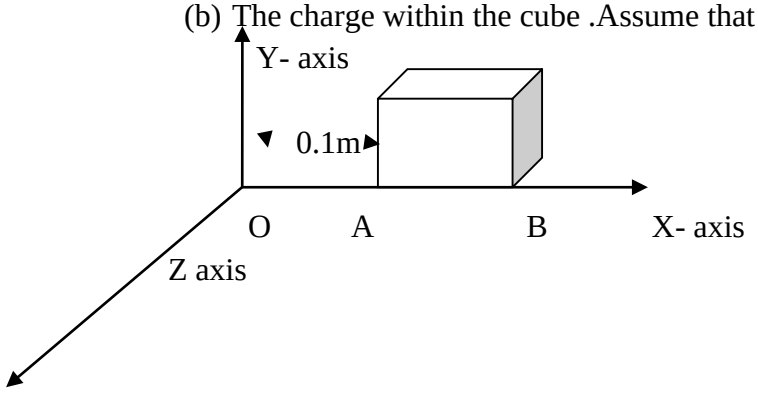
4. The given graph shows the variation of charge q versus potential difference V for capacitance C_1 and C_2. The two capacitors have the same plate separation, but the plate area of C_2 is double that of C_1. Which of the lines in the graph correspond to C_1 and C_2 and why ?



5. Two point charges are placed at a distance r in air exert a force F on each other. At what distance will these charges experience the same force F in a medium of dielectric constant K?
6. Two circular metal plates each of radius 10cm are kept parallel 10 each other at distance of 1mm.
   i) If radius of each plate is increased by factor 2 and their distance of separation decrease to half its initial value, calculate the ratio of capacitance in the two cases?
   ii) Suggest one possible method by which capacitance in the 2nd case can be increased by n times.
7. Define electric potential at a point. Show that electric field at a point is equal to the negative of the potential gradient at that point.



   The electric potential 'V' as a function of distance X is as shown. Construct a corresponding graph of the electric field strength E.
8. The electric field component in figure are Ex = α $x^{1/2}$, E_y=E_z =0; in which α = 800 N/$Cm^{1/2}$.calculate :
   (a) The flux through the cube and
   (b) The charge within the cube .Assume that a = 0.1 m

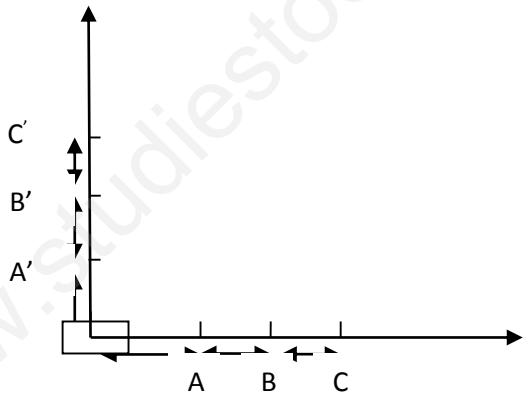


9. What will be the electric field intensity at the center of a uniformly charged circular wire of linear charge density λ?
10. A small metal ball is suspended in a uniform electric field with the help of an insulated thread. If high energy X-rays falls on the ball in which direction will the ball be deflected?
11. Name the physical quantity where the SI unit is Vm, Vm^{-1}. Which of these are vectors?
12. The following data was obtained for the dependence of the magnitude of electric field, with distance, from a reference point 0, within the charge distribution in the shaded region

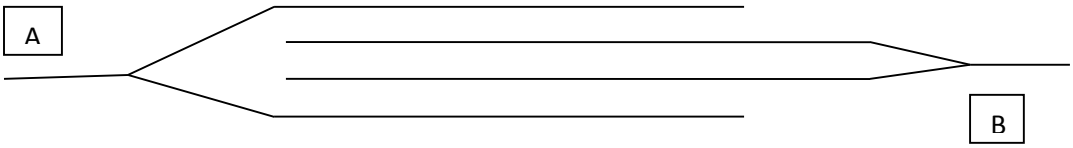
Fixed Point	A	B	C	A'	B'	C'
Magnitude of electric field	E	E/8	E/27	E/2	E/16	E/64

(i) Identify the charge distribution and justify your answer.

(ii) If the potential due to this charge distribution has a value V at the point A, what is its value at point A?

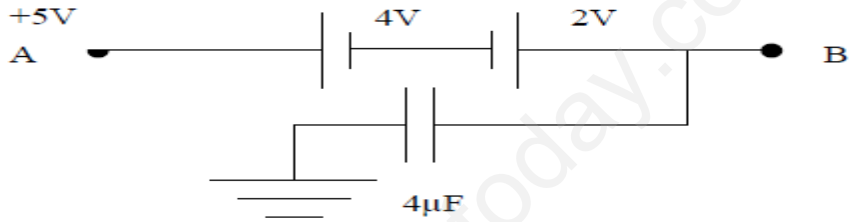


13. Calculate the capacitance between A & B if the area of each plate is A and distance between successive plates is 'd'.



14. Determine the electrostatic potential energy of a system containing 2 charges 7µc and -2 µc separated by a distance of 18cm. How much work is required to separate the two charges infinitely away from each other?

15. An isolated air capacitor of capacitance C_0 is charged to a potential V_0. Now if a dielectric slab of dielectric slab of dielectric constant K is inserted between its plates completely filling the space between the plates, then how do the following change, when the battery is disconnected (i) capacitance (ii) potential difference (iii) energy stored by the capacitor.
16. A conducting stab of thickness 't' is introduced without touching between the plates of a parallel plate capacitor separated by a distance d (t<d). Derive an expression for the capacitance of a capacitor?
17. An air capacitor is given a charge of 2 mC raising its potential to 200 V. If on inserting a dielectric medium, its potential falls to 50 V, what is the dielectric constant of the medium?
18. In a Van de Graaff type generator a spherical metal shell is to be a 15×10^6 V electrode. The dielectric strength of the gas surrounding the electrode is 5×10^7 Vm^{-1}. What is the minimum radius of the spherical shell required?
19. Calculate the p.d across each capacitor in the given fig



20. Is the capacitance of a capacitor proportional to the charge Q ? Sketch a graph to show how the capacitance C of a capacitor varies with the charge given to it.

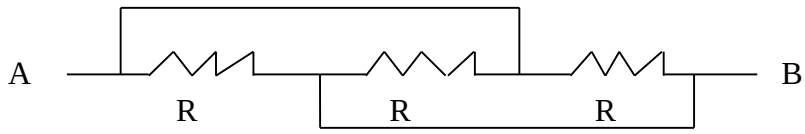
CURRENT ELECTRICITY

LEVEL 1

1) State Ohm's law
2) Define resistance. What are the factors on which the resistance of conductor depend on?
3) What are the factors on which the drift velocity of electrons in a metal depends?
4) Define electrical resistance of a material.
   Defined as the resistance offered by a block of that material of unit length and unit area of cross-section.
5) Name two physical conditions on which the resistivity of a material depends.
6) What is the effect of rise in the temperature on the electrical conductivity of (a) metals (b) Semi conductor (c) Electrolytes?
7) Why is alloy manganin used to make standard resistance?
8) A wire of resistivity ρ is stretched to double of its length . What is new resistivity?
   Remains the same because it is a property of material.
9) Why is a Potentiometer preferred to measure the emf of a cell over a Voltmeter?
   As Potentiometer does not draw any current we prefer potentiometer to measure emf. More over we are taking ready only on null deflection ie. Without drawing current.
10) What is the emf of following battery if the emf of each cell is 2 V

A B

11) Find equivalent resistance?



12) Why is a Voltmeter always connected parallel with a circuit element across which voltage is to be measured?

13) If the length of a wire doubled, what will happen to the drift speed of electrons in the wire?

14) How does the drift velocity of electrons in a metallic conductor vary with increase in temperature?

15) A Carbon resistor is marked in coloured bands of red, black, orange and Silver. What is the resistance tolerance value of the resistor

16) A cell of emf 2V and internal resistance 0.1Ω is connected to a 3.9 Ω external resistance. What will be Pd across the terminals of the cell?

V = E – I r

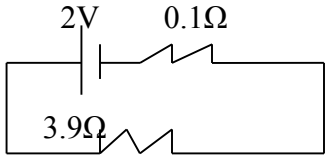
V= 2 – 0.5X0.1

V=2-0.05

$I = \frac{E}{r+R}$

$I = \frac{2}{4} = 0.5$

∴ V = 1.95 Volts



17) Which has greater resistance (i) milliammeter or (ii) ammeter

18) Which has greater resistance (i) millivoltmeter or (ii) Voltmeter?

19) How can we increase the sensitivity of a Potentiometer?

20) What do you mean by end error in a meter bridge?

21) What is the average velocity of free electrons in a conductor in the absence of an external electric field?

22) Under what conditions will the terminal potential Pd of a cell (i) greater (ii) lesser that its emf.

QUESTIONS FOR PRACTICE

1.Derive the relation between Drift Velocity & Current.

2. Derive Ohm's law in terms of material constant or expression for resistivity in terms of material constant.

3. What are non ohmic material.Explain.

4. Explain the Temperature dependence of Resistivity in caser of conductors, insulators and semiconductors .

5. Why are Manganin and Constantan used to prepare standard resistance?

6. Why does Nichrome is preferred to prepare heating element.
7. Explain Meissner Effect:-
8. Obtain the relation for the combination of resistances in Series: -
9.. Obtain the relation for the combination of resistances in parallel: -
10. Write the differences between emf and Terminal potential
11. Write the factors on which the Internal resistance of the cell depends.
12. Derive the relation for the internal resistance of a cell in terms emf and terminal potential difference.
13. Obtain the equivalent emf of cells grouped in series and in parallel.
14. State the Kirchhoff's Laws:
15. Obtain the balanced condition in Wheatstone Bridge:
16. Explain the experimental method for determining the Temperature of the given resistor using Wheatstone bridge.
17. Explain the experimental method for determining the unknown resistance by using metre bridge and hence find its resistivity.
18. State and explain the 'Principle of Potentiometer'.
19. Explain the experimental method for determining Potential difference of a primary cell using potentiometer.
20. Compare the emf's of two primary cells using potentiometer.
21. Explain Joules law of Heating
22. What is Electric Power. Write its S.I units.

LEVEL -3

01 How does the conductivity of a semiconductor depend on temperature? Give reason.

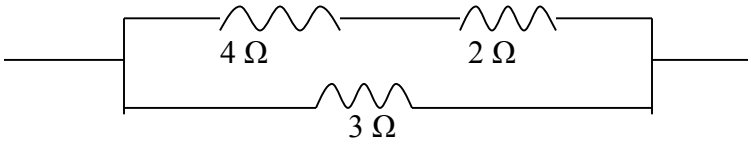
02 Draw a graph representing the variation of resistivity of mercury with temperature at low temperatures.

03 If the temperature of a good conductor increases, how does the relaxation time of electrons in it change?

04 Explain how does the resistivity of a conductor depend upon (i) number density `n' of electrons and (ii) relaxation time `τ'.

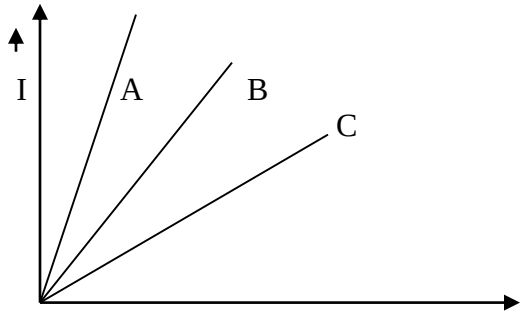
05 Explain with the help of a graph, the variation of conductivity with temperature for a metallic conductor.

06 In a part of the circuit shown in the figure the rate of heat dissipation in the 4 Ω resistor is 100 J/s. calculate the heat dissipated in the 3 Ω resistor in 10 s.



07 A heater coil is rated 100W, 200V. It is cut into two identical parts. Both parts are then connected together in parallel, to the same source of 200V. Calculate the energy liberated per second in the new combination.

08 The V-I graph for two resistors and their series combination are shown in the adjoining figure. Which one of these graph represents the series combination of the other two?



Give reasons for your answer.

9 Draw the circuit diagram of a metre bridge and explain its use to find the resistance of a conductor. State the formula used.

10 Under what condition is the heat produced in an electric circuit is (i) directly proportional and (ii) inversely proportional to resistance of the circuit?

11 Three identical cells of e m f 2V and unknown internal resistance are connected in parallel. This combination is connected to a 5 ohm resistor. If the terminal voltage across the cells is 1.5 V, what is the internal resistance of each cell?

12 State Kirchoff's laws in electric circuits. Use the laws to derive the balancing condition of a Wheatstone's bridge.

13 Are the path of electrons straight lines between two successive collisions in a conductor (with positive ions of the metal) (i) in the absence of electric field and (ii) in the presence of electric field? Establish the relationship between the current flowing through a conductor, the drift velocity of electrons and the number density of free electrons in it. Hence obtain the relation between current density and drift velocity.

14 A storage battery of e m f 8V and internal resistance 1 Ω, is being charged by a 120V d.c. source, using a 15Ω resistor in series in the circuit. Calculate:
(i) the current in the circuit.
(ii) terminal voltage across the battery during charging and
(iii) chemical energy stored in the battery in 5 minutes.

15 Write the principle and theory of a potentiometer.
With a neat circuit diagram explain the use of a potentiometer for comparing the e m f of two primary cells.
Write the advantages of a potentiometer over a voltmeter as a voltage measuring device.

16 State Ohm's law and define the term resistance. What are the factors on which the resistance of a conductor depends?
Define the following: (i) resistivity (ii) one ampere. What are the characteristic features of a fuse wire?
Two metallic wires of same material and same length but different cross sectional areas are joined together (i) in series and (ii) in parallel, to a source of e m f. In which of the two wires will the drift velocity of electron be more and why? Support your answer with proper equations.

17 A heater coil is rated 100W, 200V. It is cut into two identical parts. Both parts are then connected together in parallel, to the same source of 200V. Calculate the energy liberated per second in the new combination.

18 A voltmeter of resistance R_V is connected across a resistor R which is to be measured. An ammeter of resistance R_A is in series with this combination. The arrangement is then connected across a battery and the ratio of the readings in the meters give a value $R^{/}$ for R. Show that R and $R^{/}$ are related as $1/R = 1/R^{/} - 1/R_V$.

19 Two bulbs one of 200W, 220V and the other of 100W, 220V are connected in series and the combination is connected across a 220V supply. With the support of relevant equations and calculations, state which bulb would glow brighter.

20 Two cells of e m f 1.5V and 2V and internal resistance 1ohm and 2ohm respectively are connected in parallel to pass a current in the same direction through an external resistance of 5ohm.
a) Draw a circuit diagram.

b) Using Kirchoff's laws, calculate the current through each branch of the circuit and potential difference across the 5ohm resistor.

21 Establish the relation between current and drift velocity.

22 The potential difference across the terminals of a battery of e m f 12V and internal resistance 2 ohm drops to 10V when it is connected to a resistor. Calculate the value of the resistance.

23 A series battery of lead accumulators of e m f 2V and internal resistance of 0.5 Ω is charged by a 100 V d c supply. What series resistance should be used in the charging circuit in order to limit the current to 8A? Using the required resistor, obtain i) the power supplied by the d. c. source and ii)the power dissipated as heat.

24 Name the two factors on which the resistivity of a given material depends. A carbon resistor has a value of 62 kΩ with a tolerance of 5%. Give the colour code for this resistor.

25 Draw a circuit diagram of a metre bridge to determine the unknown resistance of a resistor. Obtain the balance condition for a metre bridge. Why are the connections between the resistors in a metre bridge made of thick copper strips?

26 Find the shift in the balance point of a metre bridge, when the two resistors in the two gaps, are interchanged. Take the values of the two resistors as R and S.

27 A cell, of e m f 4V and internal resistance 0.5 Ω, is connected across a load of resistance (i) 7.5 Ω and (ii) 11.5 Ω. Calculate (i) the ratio of the differences in the e m f of the cell and the potential drop across the load and (ii) the ratio of the currents in the two cases.

28 A carbon resistor is marked in green, red and orange bands. What is the approximate resistance of the resistor? 1

29 A carbon resistor is marked in red, yellow and orange bands. What is the approximate resistance of the resistor?

30 A carbon resistor is marked in red, green and orange bands. What is the approximate resistance of the resistor?

MAGNETIC EFFECTS OF CIURRENT AND MAGNETISM

LEVEL - I

1. Define the SI unit of current.
2. State Biot- Savart Law.
3. What is the value of Magnetic Permeability of Free space?
4. Name the rule by which the direction of magnetic field of a circular coil is explained and state it also.
5. What is the nature of the magnetic field due to a current flowing in a very long straight thin wire?
6. What is the nature of the magnetic field at the centre of a circular loop carrying current? Draw the diagram of it.
7. Define the unit of magnetic field in terms of magnetic force exerted in a current carrying conductor of length l.
8. The equation $\vec{F} = q(\vec{v} \times \vec{B})$ involves three vectors $\vec{F}$, $\vec{v}$ and $\vec{B}$. What is the angle between $\vec{F}$ and $\vec{v}$, $\vec{F}$ and $\vec{B}$?
9. Does a magnetic field exert a force on a still charge?

10. Does a magnetic field exert a force on an electron moving parallel to the direction of the magnetic field?
11. Derive an expression for magnetic field on a point on the axial line of circular coil.
12. State and prove Ampere's Circuital law.
13. Obtain an expression for the magnetic field due to a solenoid carrying the current.
14. What is the nature of the magnetic field due to a solenoid carrying current?
15. Obtain an expression for the magnetic field due to a toroid carrying the current.
16. What is the nature of the magnetic field due to a toroid carrying current?

17. An electron is not deflected in passing through a certain region of space. Can we be sure that there is no magnetic field in that region?
18. What is the nature of the force between two conductors carrying currents in the opposite direction separated by a distance r?
19. Obtain an expression for torque experienced by a current carrying conductor placed in uniform magnetic field.
20. Explain the principle, construction and working of moving coil galvanometer.
21. Define Current sensitivity and voltage sensitivity.
22. Write the factors on which current sensitivity of galvanometer depends.
23. What is a radial field in Moving coil galvanometer?
24. Equal currents I, I are flowing through two infinitely long parallel wires. What will be the magnetic field at a point midway, when the currents are flowing in the same direction?
25. State two properties of the material of the wire used for suspension of the coil in a moving coil galvanometer.
26. How a galvanometer is connected to (a) ammeter and (b) Voltmeter.
27. If a particle of charge q is projected into a magnetic field with an angle, what is the trajectory of it?
28. Write the limitations of Cyclotron.
29. Explain the principle, construction and working of Cyclotron.
30. An alpha particle and a proton are moving in the plane of the paper in a region where there is uniform magnetic field B directed normal to the plane of paper. If two particles have equal linear momenta, what will be the ratio of the radii of their trajectories in the field?
31. A galvanometer of resistance 15Ω gives a full scale deflection for a current of 2mA. Calculate the shunt resistance needed to convert it into an ammeter of range 0-5A.
32. Derive an expression for Force per unit length due to two straight current carrying wires .Hence define Ampere.
33. Using Biot-Savart law, derive an expression for the Magnetic field due to a current carrying circular loop at its centre.
34. Using Biot-Savart law, derive an expression for the Magnetic field due to a current carrying circular loop at its centre.
35. State Ampere's circuital law. Using it, derive an expression for the magnetic field due to a straight long current carrying wire
36. What is Bohr's magneton? Derive an expression for the magnetic moment associated with a revolving electron.
37. Discuss the construction, working and theory of cyclotron. State its limitations.

38. Explain with the help of a labeled diagram, the underlying principle, construction and working of a moving coil galvanometer .How its sensitivity can be increased. What is the use of radial magnetic field?
39. State the properties of magnetic lines of force.
40. Compare the magnetic field lines of a bar magnet and solenoid.
41. Write three magnetic elements of earth. What is the cause of earth magnetism?
42. State Tangent law.
43. How does angle of dip change from pole to equator.
44. Write the properties of the material used in making (a) an electromagnet (b) soft iron.
45. Define neutral points. Write the positions of the neutral points when North Pole of the magnet is placed along (a) North geographical axis and (b) south geographical axis.
46. An iron bar magnet is heated to 1000°C and then cooled in a magnetic Yield free space. Will it retain magnetism?
47. If toroid uses zinc for its core, will the field in the core be greater or lesser than when the core is empty?
48. Find dip when horizontal and vertical component of magnetic field are equal?
49. What happens when a diamagnetic substance is placed in varying field?
50. Name any three
    (a) Paramagnetic materials
    (b) Ferromagnetic material
    (c) Diamagnetic material

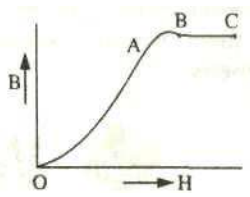
LEVEL-II:

01. Can a magnetic field independent of time change the velocity of a charged particle? What about its K.E.?
02. .How will an electron move in a homogeneous magnetic field if the velocity of the electron at the initial moment is perpendicular to the force lines of the field ?
03. The net charge in a current carrying conductor is zero; even then it experiences force in a magnetic field. Why?
04. An electron is deflected in a given field. How will you detect whether the given field is a uniform magnetic field or a uniform electric field?
05. How will an electron move in a homogeneous magnetic field if the velocity of the electron at the initial moment forms an angle θ with the force lines of the field?
06. In a certain arrangement, a proton does not get deflected while passing through a magnetic field region. State the condition under which it is possible.
07. What is the work done by the magnetic force on a charged particle moving perpendicular to the magnetic field?
08. A wire of length 0.04m carrying a current of 12 A is placed inside a solenoid, making an angle of 30^0 with its axis. The field due to the solenoid is 0.25 T. Find the force on the wire.
09. A circular loop of radius 0.1 m carries a current of 1A and is placed in a uniform magnetic field of 0.5T. The magnetic field is perpendicular to the plane of the loop. What is the force experienced by the loop?
10. A proton, alpha particle and deuteron are moving in circular paths with same kinetic energies in the same magnetic fields. Find the ratio of their radii and time periods.

11. How will the magnetic field intensity at the centre of a circular coil carrying current change if the current through the coil is doubled and the radius of the coil is halved.
12. Two similar bars, made from two different materials P and Q are placed one by one in a non uniform magnetic field. It is observed that (a) the bar P tends to move from the weak to the strong field region. (b) the bar Q tends to move from the strong to the weak field region. What is the nature of the magnetic materials used for making these two bars?
13. An electron travelling west to east enters a chamber having a uniform electrostatic field in north to south direction. Specify the direction in which a uniform magnetic field should be set up to prevent the electron from deflecting from its straight line path.
14. Establish the relation between magnetic permeability and Magnetic susceptibility.
15. Angle of dip at a place is 30degrees. If the vertical component of earth's magnetic field at that place is $0.16\sqrt{3} \times 10^{-4}$T. Calculate the horizontal component.

LEVEL-III

1. An electron beam is moving vertically upwards. If it passes through a magnetic field directed from South to North in a horizontal plane, in what direction will the beam be deflected?
2. A current is set up in a long copper pipe. What is the magnetic field inside the pipe?
3. A wire placed along north south direction carries a current of 5 A from South to North. Find the magnetic field due to a 1 cm piece of wire at a point 200 cm north East from the piece.
4. A circular coil of 200 turns, radius 5 cm carries a current of 2.5 A. It is suspended vertically in a uniform horizontal magnetic field of 0.25 T, with the plane of the coil making an angle of 60^0 with the field lines. Calculate the magnitude of the torque that must be applied on it to prevent it from turning.
5. A long straight conductor PQ , carrying a current of 60 A, is fixed horizontally. Another long conductor XY is kept parallel to PQ at a distance of 4 mm, in air. Conductor XY is free to move and carries a current 'I' . Calculate the magnitude and direction of current 'I' for which the magnetic repulsion just balances the weight of the conductor XY.
6. A Ferromagnetic displaying a hysteresis loop acts as a device for storing memory. Explain how?
7. The hysteresis loop of a soft iron piece has a much smaller area than that of a steel piece. If the materials are given repeated cycles of magnetisation which piece will dissipate greater heat energy?
8. An unmagnetised ferromagnetic substance is magnetised. Given Figure shows the B-H curve. Identify the stage of saturation, reversible region and irreversible region.



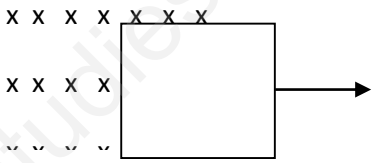
9. Why are electromagnets made of soft iron?
10. Permanent magnets are made of steel while core of a transformer is made of soft iron. Why?
11. Why is large area of hysteresis loop not a disadvantage for steel used for making permanent magnets?
12. Why is diamagnetism independent of temperature?
13. Among steel, soft iron and silicon steel, which is suitable for?Making permanent magnets and why?
14. Establish relationship between magnetic inclination and horizontal component of Earth's magnetic field at a place with the help of a diagram.
15. Suppose you have two bars of identical dimensions, one made of paramagnetic and the other diamagnetic substance. If you place the bars along a uniform magnetic field. Show diagrammatically what modification in the field would take each case?
16. Classify material on the basis of their behavior in a magnetic field . Under which category does iron come? How does the magnetic property of iron change with increase of temperature?
17.

ELECTRO MAGNETIC INDUCTION AND AC

LEVEL -I

1. The instantaneous current from an ac source is I = 5 sin 314 t . What is the rms value of current ?
2. Define self inductance . Write down the expression for it for a long solenoid of length l with number of turns N
3. Distinguish between the terms reactance and impedance of an ac circuit . Prove that an ideal capacitor connected to an ac source does not consume any power
4. The instantaneous emf of an ac source is given by E =300 sin 314 t .What is the rms value of emf ?
5. Prove that an ideal resistance connected to an ac source dissipates power = V_{eff}^2 / R
6. If a rate of change of current 2 A/s induces an emf of 10 mV in a solenoid , what is the self inductance of the solenoid ?
7. What type of materials are used for making permanent magnets ?
8. Prove that an ideal inductor connected to an ac source does not dissipate any power
9. Give the phase difference between the applied ac voltage and the current in an LCR circuit at resonance .
10. Mathematically prove that average value of alternating current over one complete cycle is zero
11. Distinguish between average value and rms value of an alternating current . A 60 V-10 W electric lamp is to be run on 100 V - 60 Hz mains .
    a. calculate the inductance of choke coil required
    b. If a resistor is to be used in place of choke coil to achieve the same result , calculate its value
12. Draw the graph showing the variation of reactance of a)a capacitor , and b) an inductor with the frequency
13. Prove that an ideal inductor does not dissipate power in an ac circuit .

14. A sinusoidal voltage V = 200 sin 314 t is applied to a resistor of 10 Ω resistance . Calculate
    a. rms value of the voltage b) rms value of the current c) power dissipated as heat in watts
15. How does the self inductance of a coil change when
    One) the number of turns in the coil is decreased
    Two) an iron rod is introduced into it ? Justify your answer in each case
16. Why does the acceleration of the magnet falling through a long solenoid decrease ?
17. How are eddy currents produced ?Give two applications of eddy currents
18. What is the power factor of an LCR series circuit at resonance ?
19. A rectangular coil of N turns , area A is held in a uniform magnetic field B . If the coil is rotated at a steady angular speed ω , deduce an expression for the induced emf in the coil at any instant of time
20. Define mutual induction . state two factors on which the mutual inductance between a pair of coils depends
21. Draw the curve showing the variation of inductive reactance and capacitive reactance with applied frequency of an ac source .
22. A capacitor , resistor of 5 Ω , and an inductor of 50 mH are in series with an ac source marked 100 V , 50 Hz . It is found that the voltage is in phase with current . Calculate the capacitance of the capacitor and the impedance of the circuit
23. State Lenz's law . A square loop of wire PQRS is moved at a constant speed from a uniform magnetic field acting normal to the plane of the paper as shown in the figure . State with reason , the direction in which the induced current flows in the loop



24. A 28 turn coil with average diameter of 0.02 m is placed perpendicular to a magnetic field of 8000 T . If the magnetic field changes to 3000 T in 4s , What is the magnitude of the induced emf ?
25. A student connects a long air core coil of manganin wire to a 100 V d.c source and records a current of 1.5A When the same coil is connected across 100 V, 50 Hz a.c source , the current reduces to 1.0 A .
    a. Give reason for this observation b) Calculate the value of the reactance of the coil .
26. Which device will you use to step up a.c voltage . Can we use the same device to step up d.c ?
27. A wheel with 40 metallic spokes each 0.5 m long is rotated with an angular speed of 10 radian/s in a plane normal to the earth's magnetic field . If the magnitude of the field is 0.4×10^{-4} T , calculate the emf induced between the axle and rim of the wheel .
28. Calculate the capacitance of the capacitor , which when connected in series with an inductor of inductance 4 henry will cause the circuit to resonate at 50 Hz
29. Derive an expression for the impedance of the an ac circuit for an inductor and a resistor in series .

30. A 15 μF capacitor has a capacitive reactance of 12 Ω . What is the frequency of the source ? If the frequency of the source is doubled , what will be the capacitive reactance ?

31. Establish the relationship between peak value and rms value of alternating current .

32. A 0.3 H inductor , 60 μF capacitor and a 50 Ω resistor are connected in series with a 120 V , 60 Hz supply Calculate the (i) impedance of the circuit (ii) current flowing in the circuit

33. Prove mathematically that the average value of alternating current over one complete cycle is zero .

34. With the help of a labelled diagram , explain the construction , principle and working of a step down transformer Why is the core laminated

35. When 200 V dc is applied across a coil , a current of 2 a flows through it . When 200 V ac of 50 Hz is applied to the same coil , only 1 A flows . calculate the resistance , the impedance and the inductance of the coil .

36. When a capacitor is added in series to an LR series circuit the alternating current flowing in the circuit increases . Give reason Explain with the help of a labelled diagram , the principle , construction and working of an ac generator .

37. Calculate the current flowing through a solenoid of self inductance 30 mH in which a magnetic flux of 15 mWb is linked .

38. Show that the work done in maintaining a steady current i_0 in an inductor L is $\frac{1}{2} Li_0^2$

39. What is self inductance of a coil , in which magnetic flux of 40 mWb is produced when 2 A current flows through it ?

40. What is meant by resonance in LCR circuit ? State the essential conditions for resonance . A 50 mH inductor, a capacitor of capacitance 20 μF and a 10 ohm resistor are connected in series across 220 V ac source of variable frequency . calculate (i) the resonant frequency of the circuit (ii) current amplitude at resonance and (iii) maximum power dissipation

41. When a current of 3 A flows through a primary coil , a magnetic flux of 30 mWb is linked with the secondary coil . What is the mutual inductance between the pair of coils

42. A coil when connected across a 10 V d.c source draws a current of 2 A . When it is connected across a 10 V - 50 Hz a.c supply , the same coil draws a current of 1 A . Explain why it draws lesser current in the second case . hence determine the self inductance of the coil

43. Name the SI unit of magnetic flux and show that it equals volt -second . Give three possible ways of producing an induced emf in a coil giving an example in each case . A copper loop and an aluminium loop , identical in shape and size , are removed from identical magnetic fields , from identical positions , in equal time intervals .Compare the induced emf and currents produced in the two loops .

44. Explain the nature of variation in magnetic flux as represented by the graph in first case

45. Distinguish between the terms resistance and impedance of an a.c circuit . A capacitor C and a resistor R are connected in series in an a.c circuit . Deduce by drawing phasor diagram , a mathematical expression for the impedance of this circuit . How will this impedance be affected when the frequency of the applied signal is decreased and why ?

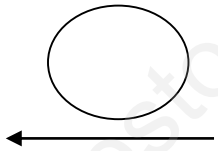
46. An inductor L , a capacitor C and a resistor R are connected in series in an a.c circuit . deduce with the help of a suitable phasor diagram , a mathematical expression for

impedance of this circuit .What is meant by resonance of this circuit ? Prove that this circuit exhibits resonance at a frequency given by $\frac{1}{2\pi\sqrt{LC}}$

47. What is meant by root mean square value or effective value of a.c ? Derive a relation between the it and its peak value .

LEVEL-II

1. Show that Lenz's law is in accordance with the law of conservation of energy
2. A capacitor , a resistor and a 40 mH inductor are connected in series to an ac source of frequency 60 Hz . Calculate the capacitance of the capacitor, if the current is in phase with the voltage
3. Distinguish between reactance and impedance . When a series combination of a coil of inductance L and a resistor of R is connected across a 12 V , 50 Hz supply a current of 0.5 A flows through the circuit . The current differs in phase from the applied voltage by $\pi/3$ radian . Calculate the value of L and R
4. The electric current in a wire in the direction from B to A is decreasing. What is the direction of induced current in the loop kept above the wire as shown in figure ?



5. An ideal inductor is in turn put across 220 V , 50 Hz and 220 V , 100 Hz supplies . Will the current flowing through it in the two cases be the same or different ?
6. When a capacitor is connected in series with a series LR circuit , the alternating current flowing in the circuit increases . Explain why ?
7. An a.c generator has a coil of N turns each of area A , rotating with angular velocity ω in a uniform magnetic field B
   a) What is the maximum emf between its slip rings ?
   b)What is the flux associated with the coil when the emf across it is zero
8. How does the mutual inductance of a pair of coils change when
   a) the distance between the coils is increased b) the number of turns in each coil is increased Justify your answer in each case

9. A capacitor of capacitance 100 μF and a coil of resistance 50 Ω and inductance 0.5 H are connected in series with a 110 V, 50 Hz source . Calculate the rms value of the current in the circuit

10 . A series combination of L = 5.0 H , C = 80 μF and R = 40 Ω is connected across a variable frequency 230 V main source . Calculate

(i)the frequency in radians per second of the source which drives the circuit in resonance

(ii) The impedance of the circuit and the amplitude of the current at resonant frequency

(iii) rms value of potential drop across the inductor at resonant frequency

11. Distinguish between reactance and impedance .
When a series combination of inductance and resistance are connected with a 10 V, 50 Hz ac source , a current of 1 A flows in the circuit . The voltage leads the current by a phase angle of $\pi/3$ radian . Calculate the value of resistance and inductance

12. For an ac circuit , distinguish between resistance and impedance . An iron - cored inductor and a bulb are connected in series to an ac source . Explain with reason , how the brightness of the bulb change in the following situations
a) Iron core is removed from the inductor
b) The number of turns of the inductor is doubled
c) If a capacitor is included in series with the circuit such that $X_C = 2 X_L$

12. An ac circuit having an inductor and a resistor in series draws a power of 560 W from an ac source marked
210 V 60 Hz . If the power factor of the circuit is 0.8 , calculate
(i) the impedance of the circuit (ii) the inductance of the inductor used

13. Which is the best method of reducing current in an ac circuit and why ?

14. Calculate the r.m.s value of the current in an a.c circuit containing a capacitor of 40μF and a resistor of 10 Ω in series . The power supply in the circuit is rated as 230 V , 50 Hz .

15. An alternating current of 1.5 mA and angular frequency 100 rad/sec flows through a 10 kΩ resistor and
a 0.05 μF capacitor in series . Calculate the value r.m.s voltage across the capacitor and the impedance of the circuit .

16. An electric lamp which runs at 80 V d.c , consumes 10 A current . The lamp is connected to a 100 V , 50 Hz a.c source . Calculate the inductance of the choke required .

17. Why does the acceleration of a bar magnet decrease , while falling through a solenoid connected to a closed circuit ?

18. An arc lamp operates at 80 V , 10 A . Suggest a method to use it with a 240 V dc source . calculate the value of the electric component required for this purpose .

19. A series LCR circuit consists of a resistance of 10 Ω , a capacitor of reactance 60 Ω and an inductor coil .

20. The circuit is found to resonate when put across 300 V , 100 Hz supply . calculate
i) the inductance of the coil (ii) current in the circuit at resonance

21. If the speed of rotation of the armature of a generator is increased , how would it affect (i) the maximum emf produced and (ii) the frequency of emf

22. In a series LCR circuit , the voltages across an inductor , capacitor and resistor are 40 V , 20 V and 20 V respectively . What is the total voltage operative across the combination

23. A capacitor , a resistance of 20 Ω and an inductor of 30 mH are connected in series to an ac source 110 V , 60 Hz . calculate the capacitance of the capacitor if the current is in phase with the voltage

24. A rectangular loop of wire KLMN is moved with a velocity 'v' right angles to a uniform magnetic field 'B' as shown in figure .
a) What is the magnitude of current induced in the loop ?
b)Will there be any work done on the loop ? Give reason for your answer

26. An a.c generator has a coil of N turns each of area A , rotating with angular velocity ω in a uniform magnetic field B
    a) What is the maximum emf between its slip rings ?
    b)What is the flux associated with the coil when the emf across it is zero ?

LEVEL - 3

1. The Magnetic Flux through a coil perpendicular to its plane and directed into the paper is varying according to the relation: $\phi = 5t^{2} + 10t+5$ mWeber. Calculate the E.M.F. induced in the loop at t = 5 seconds.
2. A uniform magnetic field B exists in a cylindrical region of radius r = 10 cm. A uniform wire of length 80 cm and resistance R = 4Ω is bent into a square frame and is placed with one side along the diameter of the cylindrical region. If the magnetic field increases at a constant rate of 0.01 T/sec, find current induced in the frame.
3. A long solenoid with 15 turns per cm has a small loop of area 2.0 cm^2 placed inside, normal to the axis of the solenoid. If the current carried by the solenoid changes steadily from 2A to 4A in 0.1 sec, what is the induced voltage in the loop, while the current is changing?
4. (a) A toroidal solenoid with an air core has an average radius of 15 cm, area of cross section 2 cm^2 and 1200 turns. Obtain the self-inductance of the solenoid.
   (b) A second coil of 300 turns is wound closely on the toroid above if current in the primary coil is increased from 0 to 2.0A in 0.05 sec. Obtain E.M.F. induced in the second coil.
5. The network shown below is a part of a complete circuit. What is the potential difference $V_B - V_A$, when the current I is 5A and is decreasing at a rate of 10^{-3} A/s?
6. (a) The peak voltage of an A.C. supply is 300 V. What is its r.m.s. voltage?
   (b) The r.m.s. value of current in an A.C. circuit is 10A. What is its peak current?
7. A coil of inductance 0.5 H and resistance 100 is connected to a 240V, 50Hz A.C. supply.
   a. What is the maximum current in the coil?
   b. What is the time lag between the voltage maximum and the current maximum?
8. A resistor of 12Ω, a capacitor of reactance 14Ω and a pure inductor of inductance 0.1H are joined in series and placed across a 200V, 50 Hz A.C. supply. Calculate (i) current in the circuit, (ii) phase angle between current and voltage. Take $\pi = 3$.
9. 11kW of electric power can be transmitted to distant station at (i)220V or (ii)22000V. Which of the two modes of transmission should be preferred and why?
10. The output voltage of an ideal transformer, connected to a 240V A.C. Mains is 24V. When this transformer is used to light a bulb with a rating 24V - 24W, Calculate the current in the primary coil of the circuit.
11. At a hydroelectric powerplant, the water pressure head is at a height of 300m and the water flow available is $100 m^3/s$. If the turbine generator efficiency is 60%, estimate the electric power available from the plant.
12. A 100μF capacitor in series with a 40 Ω resistance is connected to a 110 v, 60 Hz supply
    (a) What is the maximum current in the circuit?
    (b) What is the time log between current maximum and voltage maximum?
13. A coil of inductance 0.4 mH is connected to a capacitor of capacitance 400pF. To what wavelength is this circuit tuned?
14. A series LCR circuit with L = 0.12 H , C = 480 nF , R = 23Ω is connected to a 230 V variable frequency supply.

a) What is the source frequency for which current amplitude is maximum?
b) What is the source frequency for which avg power absorbed by the circuit is maximum? Obtain the value of this max power.
c) What is the Q factor of the given circuit?

15. A series LCR circuit is connected to an a.c. source of 220V-50HZ.if the readings of voltmeters across resistor, capacitor and inductor are 65V,415V,204V and r=100Ω.calculate
i) current in the circuit
ii) value of L&C
iii) capacitance required to produce resonance with the given inductor L.

16. A resistor of 12 Ω, a capacitor of reactance 14 Ω and an inductor of reactance 30 Ω are joined in series and placed across a 230V-50Hz supply.
Calculate i) current in circuit
ii) phase angle between current and voltage and
iii) power factor

17. An inductor coil stores 32J of magnetic field energy and dissipates energy as heat at the rate of 320W when a current of 4A is passes through it. Find the time constant of the circuit when the coil is joined across an ideal battery.

18. When an alternating voltage of 220 V is applied across a device X , a current of 0.5 A flows through the
circuit and is in phase with the applied voltage . When the same voltage is applied across another device Y , the same current again flows through the circuit but it leads the applied voltage by π/2 radians .
One) name the devices X and Y
Two) calculate the current flowing in the circuit when same voltage is applied across the series combination of X and Y

19. A radio frequency choke is air cored coil whereas an audio frequency choke is iron cored . Give reason.

20. An electric lamp connected in series with a variable capacitor and an ac source is glowing with some brightness . How will the brightness change on increasing the value of capacitance and why?

ELECTRO MAGNETIC WAVES

LEVEL –1

1) State Ampere's Circuital law and give its mathematical form.(2)
2) What is the inconsistency which Maxwell observed in Ampere's Circuital law?(2)
3) What is Displacement current? Explain.(2)
4) Write Maxwell's equations and explain the existence of EM waves.(3)
5) Explain how EM waves are produced?(2)
6) Write the properties of EM waves.(3)
7) Define the term electromagnetic spectrum and mention its components? (2)
8)What are the components of the invisible parts of electromagnetic spectrum?(2)
9) Write wavelength ranges of following electromagnetic radiations
(a) Radio waves (b) micro waves (c) ultraviolet(uv) radiation (d) visible light (e) infrared radiation (f) X – rays and (g) gamma rays. (3)
(10) Mention any one use of the following radiations.
(a) Radio waves (b) micro waves (c) ultraviolet(uv) radiation (d) infrared radiations

(f) X – rays and (g) gamma rays. (3)

11) Write frequency ranges of following electromagnetic radiations

(a) radio waves (b) micro waves (c) ultraviolet(uv) radiation (d) visible light (e) infrared radiation (f) x – rays and (g) gamma rays. (3)

12) Arrange the following em waves in increasing order of their frequency

Gamma rays, UV rays, visible radiation, IR radiation (2)

LEVEL -2

1) Draw the diagram of electromagnetic plane polarized electromagnetic wave travelling in the forward direction and mark the directions of electric and magnetic field vectors and also the direction of propagation of the wave.(3)

2) What is the relation between the magnitudes of electric field and magnetic field in an em wave? Define the term radiation pressure and explain with an example.(3)

3) The amplitude of magnetic field part of a harmonic em wave in vacuum is Bo=510nT.What is the amplitude of electric field part of the wave?

4) Electric field vector is along the X direction and Magnetic field vector is along Y direction .What do you say about the direction of propagation of the wave?(1)

5) Identify the type of em wave associated with the following

a) used to take photograph under foggy conditions b)radiation emitted during welding

c) emitted during radioactive decay (3)

6) Identify the type of e.m wave associated with the following wavelength/frequency ranges.

a) 0.1 to 1m b) 10^{14}Hz c) 1^0 A to 100^0 A (3)

7) Name the em radiation is in electric ovens and mention its other uses.(3)

8) What physical quantity is same for gamma rays of wavelength 10^{-13}m and red light of wavelength $6800A^0$ (1)

9) What are the physical quantities a) that remain constant b) increase and c) decease as one moves from Gamma rays to Radio waves in an em spectrum.(3)

10) What does an em wave consist of? On what factors does the velocity of em wave depend?(3)

11) Why did Maxwell introduce the concept of displacement current? Explain.(2)

12) How does a Microwave oven work? (2)

13) What type of em radiation is used in the following?

a) Resource mapping of the earth b) TV transmission c) Radar systems for aircraft navigation. d) used in water purifiers to kill germs (2)

14) A radio can tune into any station 7.5MHz to 12MHz band.What is the corresponding wavelength band?(2)

15) Scientists predict a 'Nuclear winter 'if there is a global nuclear war which may have a devastating effect on earth.What might be the basis of this prediction? (2)

16) Optical and radio telescopes are built on the ground but X-Ray astronomy is possible only from satellite orbiting the earth.Why?(2)

LEVEL – 3

(1) The electric field of a plane electromagnetic wave in vacuum is represented by Ex=0, Ez=0 and $Ey=0.7\cos[2\prod x10^8(t-x/c)]$ (3)

a) What is the direction of propagation of em wave?

b) Determine the wavelength of the wave.

c) Compute the component of associated magnetic field.

2) A plane em wave is travelling along the X – direction has a wavelength of 3mm .The variation in the electric field occurs in the Y direction with the amplitude of 66V/m .What is the equation for the variation of electric and magnetic fields as a function of x and t. (3)

3) Show that the energy of em wave is equally divided between electric and magnetic fields. (3)

4) An em wave of frequency n=3MHz passes from vacuum into a dielectric medium with permittivity ε=4.What will happen to its frequency and wavelength? (2)

5) What might be the frequency of em wave which is best suited to observe a particle of size $3x10^{-4}$m?(2)

6) Suppose the electric field amplitude of em wave is E_0=150N/C and its frequency n=70MHz.Find the expression for electric and magnetic field vectors. (3)

7) An ammeter is connected with a battery , switch and capacitor .When switch is put on, explain your observations.

OPTICS

LEVEL –1

1. Draw a ray diagram to show the formation of image of an object placed between f and 2f of a thin convex lens. Deduce the relation between the object distance, the image distance and the focal length of the lens under this condition
2. By stating sign conventions and assumptions, derive the relation between u, v and f in case of a concave mirror?Derive an expression for the refractive index of the prism in terms of angle of prism and angle of minimum deviation
3. How does the focal length of the lens change when red light is replaced by blue light?
4. How is a wave front different from a ray? Draw the geometrical shape of the wave fronts when (i) light diverges from a point source (ii) light emerges out of the convex lens when a point source is placed at its focus.
5. Show with a ray diagram, how an image is produced in total reflecting prism?
6. State Huygens's principle.
7. What are coherent sources? Why are coherent sources required to produce interference of light?
8. What is interference of light? Using Young's double slit experiments deduce the conditions for (i) constructive and (ii) destructive interference at a point on the screen.
9. Draw the diagram showing intensity distribution of light on the screen for the interference of light in Young's double slit experiment.
10. Draw labeled ray diagram of compound microscope.
11. Write the expression for magnifying power and resolving power of i) microscope ii) telescope
12. Draw a labeled diagram of telescope when the image is formed at the least distance of distinct vision? Hence derive the expression for its magnifying power?
13. State Brewster law? Using this law prove that, at the polarizing angle of incidence, the reflected and transmitted rays are perpendicular to each other?
14. State any two essential conditions for observing sustained interference of light.
15. Explain the phenomenon of diffraction of light at a single slit, to show the formation of diffraction fringes. Show graphically the variation of the Intensity, with angle, in this single slit diffraction pattern.

16. A convex lens made up of refractive index n_1 is kept in a medium of refractive index n_2. Parallel rays of light are incident on the lens. Complete the path of rays of light emerging from the convex lens if
    (1) $n_1 > n_2$ (2) $n_1 = n_2$ (3) $n_1 < n_2$
17. Give reasons for the following in one word or sentence:
    (a) Sky appears blue during day time as seen from the earth.
    (b) A rainbow is never observed from the surface of moon.
    (c) Sunset and sunrise are abrupt as seen from moon.
18. Derive the expression for the fringe width in young's double slit experiment.
19. How does the fringe width in the interference pattern change, when the Whole apparatus is immersed of refractive index 4/3?
20. State any two differences between interference and diffraction.
21. When a monochromatic light travels from one medium to another, why its wavelength changes but frequency remains the same.
22. Why does bluish colour predominate in a clear sky.
23. No interference pattern is detected when two coherent sources are infinitely close to each other
24. State the essential condition for diffraction of light to take place.
25. What is the shape of wave front on earth for sunlight
26. What type of lens is an air bubble inside water?
27. Define magnifying power of a telescope. Write its expression.
28. What is power of a lens? State its unit.
29. Draw a ray diagrams for the following:
    a. Image formed by concave mirror when the object is placed between centre of curvature and principle focus
    b. Image formed by convex mirror when the object is placed at a distance.
    c. Image formed by convex lens when the object is placed beyond 2F
    d. Image formed by concave lens when the object is placed at certain distance
    e. Lens maker's formula
    f. Image formed by convex spherical refracting surface when the object is placed in rarer medium
    g. Simple microscope – image is formed at least distance of distinct vision
    h. Compound microscope – image is formed at least distance of distinct vision and at infinity
    i. Astronomical telescope - image is formed at least distance of distinct vision and at infinity.
    j. Reflecting telescope
    k. Young's double slit experiment – for fringe width derivation
    l. Interference pattern – for constructive and destructive interference.
    m. Diffraction through a single slit.
    n. Brewster's law
    o. Verification of reflection and refraction of light using Huygen's principle.
    p. Graph on interference – distance, diffraction – angle, law of malus
    q. Refraction through prism and its graph

LEVEL-2

1 Mark Question

1) Give the ratio of velocities of light rays of wavelengths 4000 Å and 8000 Å in vacuum.
2) What is the principle of reversibility of light?
3) Define critical angle for total internal reflections
4) Define power of a lens.
5) Why dose sky appear blue?
6) What should be the position of an object relative to a convex lens so that it behaves like a magnifying lens?
7) For which colour in visible region, the refractive index of glass is maximum?
8) Define refractive index of a medium in terms of wavelength of light.
9) State the factors on which the refractive index of a medium depends.
10) Do the frequency and wavelength change when light passes from a rarer to a denser medium and vice-versa?
11) For the same angle of incidence, the angles of refraction in three different media A,B, and C are 15° , 20° and 30° respectively . In which medium will the velocity of light be minimum?
12) Does critical angle depend on colour of light?
13) What is the value of critical angle for a material of refractive index $\sqrt{2}$?
14) If ${}^{a}n_{g}=3/2$ and ${}^{a}n_{w}=4/3$, then what will be the value of ${}^{w}n_{g}$?
15) What type of a lens is an air-bubble inside water?
16) A convex lens is held in water what change, if any, do you expect in its focal length?
17) A equiconvex lens of focal length 15cm is cut into two equal halves as shown in fig. What is the focal length of each half?
18) Name the factors on which the angle of deviation produced by a prism depends.
19) A lens immersed in a transparent liquid is not visible. Under what condition can it happen?
20) An object is first seen in red light through a simple microscope. In which case is the magnifying power bigger?
21) Write the expression for linear magnification produced by a convex lens and a concave lens.
22) A ray of light is incident normally on the glass slab. What will be the angle of refraction?
23) State the expression for magnifying power of a simple microscope.
24) Can a microscope function as a telescope by inverting it?
25) What is the effect of increasing the diameter of the objective of a telescope on its (i) magnifying power (ii) resolving power?
26) How can we increase the resolving power of a microscope?
27) What is the use of inverting lens in an astronomical telescope?

Short Answer Type Questions

2Marks Each

1. Why does a ray of light having oblique incidence deviate towards the normal as it passes from air to glass? Explain.
2. What is the twinkling effect of a star due to?
3. A microscope is focused on a dot at the bottom of a beaker. Some oil is poured into the beaker to a height of y cm and it is found necessary to raise the microscope through a

vertical distance of x cm to bring the dot again into the focus. Express refractive index of oil in terms of x and y.

4. The Sun near horizon appears flattened at Sunset and Sunrise. Why?
5. Why does the rising Sun appear bigger?
6. Mention two important applications of the optic fibers.
7. A lens whose radii of curvature are different is forming the image of an object placed on its axis. If the lens is reversed, will the position of the image change? Explain.
8. A ray of light after refraction through a concave lens becomes parallel to the principal axis. Explain with a ray diagram when this can happen.
9. A convex lens (n_g=1.5) behave as a converging lens when dipped in water (n_w=1.33) whereas it behaves as a divergent lens when dipped in carbon disulphide (n_e=1.65). Why?

SHORT ANSWER TYPE QUESTIONS

3 Marks Each

1) Define 'critical angle of incidence' .Establish relationship between the critical angle of incidence and speed of light in the two media.
2) What is an optical fibre? On what principle does it work? Explain by drawing a ray diagram how optical fibres transmit signals without any significant absorption.
3) A concave lens made of a material of refractive index n_1 is kept in a medium of refractive index n_2. A parallel beam of light incident on the lens. Complete the path of the rays of light from the concave lens if (a) $n_1 > n_2$ (b) $n_1 = n_2$ (c) $n_1 < n_2$.
4) A ray of light passes through an equilateral glass prism, such that angle of incidence is equal to the angle of emergence. If the angle of emergence is ¾ times the angle of prism. Calculate the refractive index of the glass prism.
5) Draw a ray diagram to show the formation of the image of an object placed between f and 2f of a thin concave lens. Deduce the relation between the object distance, the image distance and the focal length of the lens under this condition.
6) Draw ray diagrams to show how a right angled isosceles prism can be used
   (i) To deviate a ray of light through 90°
   (ii) To deviate a ray of light through 180°
   Also name the instrument in such prisms used.
7) Deduce lens maker's formula for a thin biconvex lens.
8) If a ray of light undergoing refraction through a combination of three media, show that ${}^1n_2 \times {}^2n_3 \times {}^3n_1 = 1$.
9) With the help of a ray diagram, explain the construction and working of a Newtonian reflecting telescope. Write the formula for its magnifying power.
10) A tank is filled with water to a height of 12.5cm. The apparent depth of a needle lying at the bottom of full tank is measured by a microscope to be 9.4cm. What is the refractive index of water? If water is replaced by a liquid of refractive index 1.63 up to the same height, by what distance would the microscope have to be moved to focus the needle again?
11) A converging lens has a focal length of 20cm in air. It is made of a material of refractive index 1.6. If the lens is immersed in a liquid of refractive index 1.3. What will be the new focal length of the lens?

12) Draw a neat and labeled ray diagram of an astronomical telescope when the image is formed at the least distance of distinct vision . State the expression for its magnifying power.

Long-Answer Questions

5 MARKS EACH

1) You are given two convex lenses of focal length 80mm &800mm. Which one will you use as an objective & which one as eye piece for constricting an astronomical telescope? Trace the course of ray through the two lenses to show the formation of images of a distant object in normal adjustment. Derive an expression for the magnifying power of the telescope.
2) Draw a neat & labeled ray diagram showing the formation of image in a compound microscope. Derive an expression for its magnifying power. How can its magnifying power be increased?
   Magnifying power can be increased by taking lenses of small focal length.

WAVE - OPTICS

1) Sound waves are not electromagnetic in nature. What is the evidence?
2) What is plane polarized light?
3) The polarizing angle of a medium is 60^0 what is the refractive index of the medium?
4) What is a Polaroid?
5) The phase difference between two waves reaching a point is $\pi/2$ what is the resultant amplitude if the individual amplitudes are 3mm and 4mm?
6) A young's slit set up is immersed completely in water without any other change. What happens to the fringe width?
7) A plane wave front is incident normally on a convex lens sketch the refracted wave front.
8) What happens to the frequency when light travels from one medium to another?
9) A soap bubble or oil on water shows beautiful colour in sunlight. Why?
10) Give one basic difference between interference and diffraction.
11) When light travels from a rarer to a denser medium it loses some speed. Does the reduction in speed imply a reduction in the energy carried by the light wave?
12) Define wave front
13) When a low flying aircraft passes overhead we sometimes notice slight shakening of the picture on our TV screen. Why?

2 marks Question.

1) What are coherent sources? Can two different bulbs similar in all respects act as coherent sources?
2) State and explain Huygens principle. Name the type of wave front that corresponds to a beam of light (i) coming from a very far off source (ii) diverging radically from a point.
3) Determine the angular separation between central maximum and first order maximum of the diffraction pattern due to single slit of width 0.25 mm when light of wavelength 5890 A^0 is incident on it normally on it.

4) What is meant by polarizing angle (or) Brewster angle?
5) Give two examples of commonly used devise which makes use of polaroids.

3 Marks Question

1) Deduce the law of reflection on the basis of Huygens's principle.
2) Mention the basic condition for-permanent interference of light waves.
3) Derive the expression for fringe width in young's double slit experiment.
4) Derive an expression for the angular width of the central maximum of the diffraction pattern produced by a single slit illuminated with monochromatic light.
5) Define polarizing angle. Derive the relation between polarizing angle and refractive index of the medium.

LEVEL – 3

REFLECTION AT A SPHERICAL SURFACE:

1. If you look into a shiny spoon, you see an inverted image on one side and an upright image on the other side. Why? Could you see upright image on both sides?
2. A moth flies towards a concave mirror. Does its image become larger or smaller as it approaches the mirror's focal point? What kind of image is it? What happens when the moth is at the focal point?

REFRACTION AT A PLANE SURFACE:

3. For the same angle of incidence, the angles of refraction in three media A,B and C are 15^0, $25^0$and 35^0 respectively. In which medium would the velocity of light be minimum?
4. In the H.G.Wells novel, THE INVISIBLE MAN, a person becomes invisible by altering his index of refraction to match that of air. If the invisible man could actually do this, would he be able to see? Explain.
5. The length of a wave in water diminishes μ times, μ being the refractive index of water. Does this mean that a diver cannot see surrounding objects in their natural colours?
6. The covered print is not visible from any of the four sides of a glass cube placed on a book. Explain what happens by a simple diagram. (for air to glass, when $i = 90^0$, $r = 42^0$)

REFRACTION AT SPHERICAL SURFACES AND LENSES:

7. A man wishing to get a picture of a zebra photographed a white donkey after fitting a glass with black streaks on the objective of his camera. What will be on the photograph?
8. Why do the sunglasses (goggles) which have curved surfaces, not have any power?
9. A concave mirror and a convex lens are held in water. What change, if any, do you expect to find in the focal length of either?
10. A virtual image, we always say, cannot be caught on a screen. Yet when we 'see' a virtual image, we are obviously bringing it on to the 'screen' (i.e., the retina) of our eye. Is there a contradiction?
11. A convex lens made of a variety of glass of high dispersive power has a focal length of 15 cm. A parallel beam of white light is incident on one side of the lens and a screen is placed on the other side. Describe the chromatic aberration of the lens i.e, describe the colours on the spot focused on the screen as the screen is moved away from the lens.

OPTICAL INSTRUMENTS:

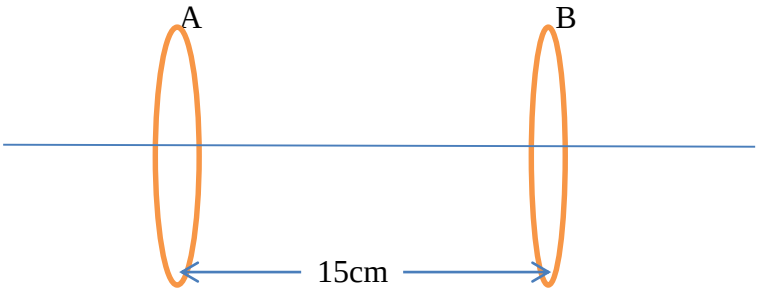
12. What is the minimum distance between two points that you are able to resolve from a distance of 100 m, if you have normal visual acuity? Could you recognize a familiar face 100 m away?
13. The angle subtended at the eye by an object is equal to the angle subtended at the eye by the virtual image produced by a magnifying glass. In what sense then does a magnifying glass provide angular magnification?
14. If your near point distance is N, how close can you stand to a mirror and still be able to focus on your image?
15. Magnifying power of a simple microscope is inversely proportional to the focal length of the lens. What then stops us from using a convex lens of smaller and smaller focal length and achieving greater and greater magnifying power?
16. Four double convex lenses, with the following specifications are available:

lens	Focal length	aperture
A	100 cm	10 cm
B	100 cm	5 cm
C	10 cm	2 cm
D	5 cm	2 cm

Which two of the given four lenses should be selected as the objective and eyepiece to construct an astronomical telescope and why? What will be the magnifying power and normal length of the telescope so constructed?

17. Which of the four lenses (Q.No.16) should be selected as objective and eyepiece of a compound microscope and why? How can the magnifying power of such a microscope be increased?
18. Which of two main considerations are kept in mind while designing the objective of an astronomical telescope?
19. The Mt. Palomar telescope is used to observe Moon, 3.8×10^8 m away. The objective has a focal length of 17 m and the eyepiece has a focal length of 17 cm. find the minimum distance between object points on the moon that are just barely resolved by an eye looking through the telescope. Assume that the resolution is limited by the eye's acuity and that the minimum angle of resolution is 5.0×10^{-4} rad.
20. Two convex lenses A and B of an astronomical telescope having focal length 5 cm and 20 cm respectively, are arranged as shown in fig.

(3m)



(i) Which one of the two lenses you will select to use as the objective lens and why?

(ii) What will be the change in the distance between the lenses to have the telescope in normal adjustment?

(iii) Calculate the magnifying power of the telescope in the normal adjustment position.

21. How does diffraction limit the resolving power of an optical instrument?

WAVE OPTICS:

22. The speed of light in still water is c/μ, where μ is the refractive index of water. What is the speed of light in a stream of water flowing at a steady of speed of 'v' relative to the observer?
23. Fig shows an experimental set up similar to Young's double slit experiment to observe interference of light. Here, $SS_2 - SS_1 = \lambda/4$. Write the condition of (i) constructive (ii) destructive interference at any point P in terms of path difference, $\Delta = S_2P - S_1P$. Does the central fringe observed in the above set lie above or below O? Give reason in support of your answer.

24. White light is used to illuminate two slits in Young's double-slit experiment. The separation between the slits is 'b', and the screen is at a distance d(>>b) from the slits. At a point on the screen directly in front of one of the slits, which wavelengths are missing?
25. Suppose a sheet of glass is placed in front of one of the slits in a Young's double slit experiment. If the thickness of the glass is such that the light reaching the two slits is 180^0 out of phase, how does this affect the interference pattern?
26. You want to check the time while wearing your Polaroid sunglasses. If you hold your forearm horizontally, you can read the time easily. If you hold your forearm vertically, however, so that you are looking at your watch sideways, you notice that the display is black. Explain.
27. The electromagnetic waves we pick up on our radios are typically polarized. In contrast, the indoor light we see every day is typically unpolarised. Explain.
28. Modern day 3-D movies are produced by projecting two different images onto the screen, with polarization directions that are 90^0 relative to one another. Viewers must wear headsets with polarizing filters to experience the 3-D effect. Explain how this works.
29. While you drive through a city or mountain areas, the quality of your radio reception varies sharply from place to place, with stations seeming to fade out and reappear. Could diffraction be a cause of this? Which of the following bands would you expect to be least affected by it:

    (a) 162 MHz (b) (88-108 MHz) (c) (525-1610 KHz)
30. Light from sodium lamp is passed through two Polaroid sheets P_1 and P_2 kept one after the other. Keeping P_1 fixed, P_2 is rotated so that its pass-axis can be at different angles θ with respect to the pass-axis of P_1. An experimentalist records the following data for the intensity of light coming out of P_2 as a function ofθ.

s.no.	θ(angle between the pass-axis of two polaroids)	I (intensity of light coming out of P_2)
1.	0^0	$I_0/2$
2.	30^0	$(3/8)I_0$
3.	45^0	$(1/2\sqrt{2})I_0$
4.	60^0	$I_0/8$
5.	90^0	0

Here I_0= intensity of beam falling on P_1.
One of these observations is not in agreement with the expected theoretical variation of I. Identify the observation and write the correct expression.

DUAL NATURE OF MATTER AND RADIATION

LEVEL -1

1. Write down the relation between wavelength and momentum of a photon.
2. What happens to the wavelength of a photon after it collides with an electron?
3. Write Einstein's photoelectric equation.
4. Define the threshold wavelength for photoelectric effect.
5. What is the stopping potential in photoelectric effect?
6. What is de-Broglie wave length?
7. What is the de-Broglie wavelength of an electron accelerated through a Potential difference of V volts.
8. Show graphically how stopping potential for the given photosensitive surface varies with frequency of incident radiation.
9. If 'h' is Planck's constant, find the momentum of a photon of wavelength $0.01A^0$.
10. State and explain the laws of photoelectric emission.
11. Derive the relation for deBroglie wavelength.
12. Explain the experimental demonstration to explain photo electric effect..Hence explain Stopping potential.
13. What is the momentum of energy 1MeV?
14. How many photons are effective in the emission 1 photoelectron?
15. Draw the graphs showing the variation of photoelectric current with potential for varying intensities and hence explain the effect of intensity of incident radiation on photoelectric current.
16. Plot a graph showing the variation of stopping potential with frequency of incident radiation and hence obtain the Planck's constant.

LEVEL-2

1. If the wavelength of the EM radiation is doubled, what will happen to the energy of the photons.
2. Does the 'stopping potential' in the photoelectric emission depend upon a) the intensity of the incident radiation.
   b) the frequency of the incident radiation

3. An electron is accelerated through a potential difference of 300V.What is its energy in electron volt?
4. What is the rest mass of a photon?
5. What is the momentum p of a photon from UV light of wavelength 332nm.
6. How many electron volt make one Joule.
7. How will the photoelectric current change on decreasing the wavelength of incident radiation for a given photosensitive material.
8. The stopping potential in an experiment on photoelectric effect is 1.5V.What is the maximum kinetic energy of the photoelectrons emitted.
9. It is difficult to eject out an electron from copper than sodium. Which of the two metal has greater work function and has greater threshold wavelength.
10. de-Broglie wavelength associated with an electron accelerated through a potential difference V is λ. What will be its wavelength when the accelerating potential is increased to 4V.
11. .Sketch the graphs showing the variation of stopping potential Vs with frequency of the incident radiations for two photosensitive materials A and B having threshold frequencies $\gamma_0 > \gamma_0'$
    (i)Which of the two metals A or B has higher work function.
    (ii)What information do you get from the slopes of the graph
    (iii)What is the value of intercept of graph A
12. A photon and an electron have the same deBroglie wavelength. Which has greater total energy? Explain.
13. Show that deBroglie hypothesis of matter wave supports the Bohr's concept of stationary orbit.
14. Work function of Sodium is 2.3eV.Does Sodium show Photoelectric emission for orange light(λ=6800 A^0)

LEVEL-3

1. Two beams, one of red light and other of blue light, of the same intensity is incident on a metallic surface to emit photo electrons. Which one of the two beams emit electrons of greater frequency.
   A. Blue emits electrons of greater kinetic energy because its frequency is greater than that of red light.
2. The most probable kinetic energy of thermal neutrons at a temperature of T Kelvin, may be taken as equal to kT, where k is Boltzmann constant. Taking the mass of a neutron and its associated de-Broglie wavelength as m and λ_B respectively, state the dependence of λ_B and m on T.
   A. $\lambda_B = h/p = \left(\frac{h}{\sqrt{2mk}}\right) = \frac{h}{\sqrt{2mkT}}$ $\quad \therefore \lambda_B \alpha \frac{1}{\sqrt{mT}}$
3. The maximum kinetic energy of photoelectrons emitted from a surface, when a photon of energy 6eV fall on it is 4eV.What is the stopping potential in volt for the fastest electrons.
   A. Stopping potential $V_0 = \frac{K_{max}}{e} = \frac{4eV}{e} = 4V$

4. The wavelength λ of a photon and the de- Broglie wavelength of an electron have the same value. Show that the energy of the photon is $\frac{2\lambda mc}{h}$ times the kinetic energy of electron, where m,c, and h have their usual meaning.

A. K.E of electron, $E_k = \frac{1}{2}mv^2 = \frac{\frac{1}{2}m^2v^2}{m} = \frac{\frac{1}{2}h^2}{m\lambda^2}$ $(\therefore \lambda = \frac{h}{mv})$

Energy of a photon $E = \frac{hc}{\lambda}$ $\therefore \frac{E}{E_k} = \frac{\frac{hc}{\lambda}}{\frac{\frac{1}{2}h^2}{m\lambda^2}} = \frac{2\lambda mc}{h}$

$$E = \left(\frac{2\lambda mc}{h}\right) E_k = \frac{2\lambda mc}{h} xK.E\ of\ electron$$

5. An X ray operates at 10KV.What is the ratio of X-ray wavelength to that of de-Broglie wavelength.

A. For X-rays $eV = \frac{hc}{\lambda}$ $0r$ $\lambda = \frac{hc}{eV}$

For de-Broglie wavelength $eV = \frac{1}{2}mv^2$ $or\ mv = \sqrt{2eVm}$

$$\lambda' = \frac{h}{mv} = \frac{h}{\sqrt{2eVm}}$$

$$\frac{\lambda}{\lambda'} = \frac{\left(\frac{hc}{eV}\right)}{\frac{h}{\sqrt{2eVm}}} = \frac{c\sqrt{2m}}{\sqrt{eV}} = \frac{3x10^8\sqrt{2x(9x10^{-31})}}{\sqrt{(1.6x10^{-19})x10^4}} = 10$$

6.If the frequency of the incident light on a metal surface is doubled, will the kinetic energy of the photoelectrons be doubled? Give reasons.

A. $h\nu = E_1 + W_0$ and $2h\nu = E_2 + W_0$

On dividing $2 = \frac{E_2 + W_0}{E_1 + W_0}$

Or $E2 = 2E_1 + W_O$

The kinetic energy of the photoelectrons is increased more than double on doubling the frequency of incident radiation.

7. Show that the wavelength of the EM radiation is equal to the de-Broglie wavelength of its quantum (photon).

A. For a photon $\lambda = \frac{h}{p}$,

For EM radiation of ν frequency and λ' wavelength,

$\lambda' = \frac{c}{\nu}$, momentum, $p = \frac{E}{c} = \frac{h\nu}{c}$ or $p = \frac{hc}{c\lambda'}$,

or $\lambda' = \frac{h}{p} = \lambda$

The wavelength of EM radiation is same as the de-Broglie wavelength of the photon.

8. A particle of a mass M at rest decays into two particles of masses m1 and m2 having nonzero velocities. What is the ratio of the de-Broglie

Wavelengths of the two particles?

A. By conservation of linear momentum

m1v1 +m2v2 =Mx0, or m1v1=-m2v2,

or m1v1=m2v2, or p1=p2 (only magnitude)

or $\frac{\lambda_1}{\lambda_2} = \frac{p_2}{p_1} = 1$

9. The de-Broglie wavelength of a particle of kinetic energy K is λ. What would be the wavelength of the particle, if its kinetic energy were K/4.

A. $\lambda = \frac{h}{\sqrt{2mK}}$, when kinetic energy is K/4,

$$\lambda' = \frac{h}{\sqrt{2m\left(\frac{K}{4}\right)}} = \frac{2h}{\sqrt{2mK}} = 2\lambda$$

10. Xrays of wavelength 0.82 A^0 fall on a metal plate. Find the wavelength associated with photoelectrons emitted. Neglect the work function of the metal. Given $h=6.634*10^{-34}$Js (Ans.0.099 $A^{0)}$

LEVEL - 1

1. Name the experiment which is associated with the discovery of atomic nucleus.
2. What will be the ratio of radii of two nuclei with mass numbers A1 & A2?
3. What is binding energy?
4. Name some important characteristics of nuclear forces.
5. What is the atomic & mass numbers of element 'X'?

$${}_0n^1 + {}_{80}Hg^{198} \longrightarrow X + {}_1H^1$$

6. Define radioactive decay constant.
7. What is half life of a radioactive substance?
8. What is average life of a radioactive substance?
9. How is the half life of a radioactive substance related to its average life?
10. Why do we use neutrons for causing nuclear reactions?
11. Name the SI unit of radioactivity.
12. Plot the graph between the binding energy per nucleon & the mass number . Hence explain nuclear fission & fusion based on this graph.
13. What is radioactivity? Draw the radioactive decay curve.
14. What is the SI unit of decay rate?
15. Establish the relationship between decay constant &half life of a radioactive substance.
16. Explain the origin of spectral lines. Obtain an expression for Rydberg's constant & write its value.
17. Draw energy level diagram for hydrogen atom.
18. State the limitations of the Bohr's theory.
19. Draw a labeled diagram of experimental setup of Rutherford 's alpha particle scattering experiment. Write two important inferences drawn from this experiment.
20. What is the nuclear force? Mention any two important properties of it.
21. If 70% of a given radioactive sample is left un-decayed after 20 days, what is the % of original sample will get decayed in 60 days?
22. 4 nuclei of an element fuse together to form a heavier nucleus .If the process is accompanied by release of energy, which of the two: the parent or the daughter nuclei would have higher binding energy per nucleon. Justify your answer.

LEVEL -2

1.The sequence of stepwise decays of a radioactive nucleus is

$$D \xrightarrow{\alpha} D_1 \xrightarrow{\beta} D_2 \xrightarrow{\alpha} D_3$$

If the nucleon number and atomic number for D2 are 176 and 71 respectively, what are the corresponding values of D and D3 ? Justify your answer in each case.

2. The half life of a radioactive substance is 30 s.Calculate i.)Decay constant. ii.)Time taken by the sample to become one-fourth of its initial value.

3. A neutron is absorbed by a ${}^{6}_{3}Li$ nucleus with the subsequent emission of an alpha particle.
(i) Write the corresponding nuclear reaction.
(ii) Calculate the energy released, in MeV, in this reaction

Given: *mass* ${}^{6}_{3}Li = 6.015126\,u$; *mass*(*neutron*) $= 1.0086654\,u$;

mass (*alpha particle*) $= 4.0026044\,u$ *and mass* (*triton*) $= 3.0100000\,u$.

Take $1\,u = 931\ MeV/c^2$.

4. In the series of radioactive disintegration of ${}^{Z}_{A}X$ first an alpha-particle and then a beta-particle is emitted. What is the atomic number and mass number of the new nucleus formed by these successive disintegrations?

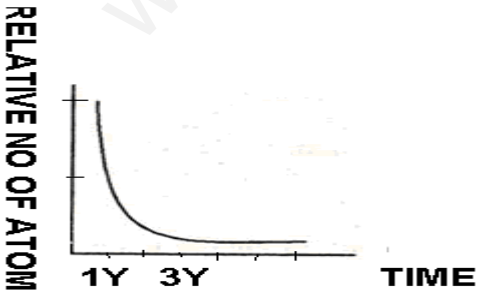
5. A nucleus ${}^{23}_{10}Ne$ undergoes $\beta - decay$ to give the nucleus ${}^{23}_{11}Na$. Write down the $\beta - decay$ equation. Calculate the kinetic energy of the electron emitted, assuming the mass of ${}^{23}_{10}Ne$ as 22.994466 u and that of ${}^{23}_{11}Na$ as 22.989770 u. Rest mass of the electron may be ignored.

6. State the radioactive disintegration law & deduce exponential law from it.

7. Deduce expression for mean life.

LEVEL - 3

1. The graph shows how the activity of a sample of radon-220 changes with time. Use the graph to determine its half-life. Calculate the value of decay constant of radon-220.



2. Thehalf life of a radioactive substance is 4 hours.
a.) In how much time will 7/8th of the material decay? B.)Tritium has a half life of 12.5 years against the beta decay. What fraction of the sample of tritium will remain un-decayed in 25 years?

3. Explain how radioactive nuclei can emit $\beta - particles$ even though atomic nuclei do not contain these particles. Hence explain why the mass number of a radioactive nuclide does not change during $\beta - decay$. Use the basic law of radioactive decay, to show that radioactive nuclei follow an exponential decay law. Hence obtain a formula, for the half-life of a radioactive nuclide, in terms of its disintegration constant.

4.For scattering by an inverse square field (such as that produced by a charged nucleus in Rutherford's model)the relation between the impact parameter 'b' & the scattering angle 'θ' is given by $b=(Ze^2\cot\theta/2) / (2\pi\varepsilon_0 mv^2)$:

a.)What is the scattering angle for b=0?

b.)For a given impact parameter 'b', does the angle of deflection increase or decrease with the increase of energy?

c.)What is the impact parameter at which scattering angle is 90^0 for Z= 79 and initial energy = 10MeV

d.)Why is it that the mass of the nucleus does not enter the formula above, but its charge does?

e.)For a given energy of the projectile, does the scattering angle increase or decrease with the decrease in impact parameter?

5. A muon is a particle that has the same charge as an electron but is 200 times heavier than it. If we had an atom in which the muon revolves around a proton instead of an electron, what would be the magnetic moment of the muon in the ground state of such an atom?
6. In a hydrogen atom, electron moves from second excited state to first excited state then from first excited state to ground state. Find ratio of wavelength obtained.
7. An electron in hydrogen atom makes transition from an excited state of energy 0.85eV to its ground state. Find out energy of photon emitted in this transition.
8. According to the classical electromagnetic theory, calculate the initial frequency of the light emitted by the electron revolving around a proton in hydrogen atom. Given: The velocity of electron moving around a proton in hydrogen atom in an orbit of radius 5.3×10^{-11} m is 2.2×10^{-06} ms^{-1}.
9. In the Rutherford's nuclear model of the atom, the nucleus (radius about 10^{-15}m) is analogous to the sun about which the electron moves in orbit (radius about 10^{-10}m) like the earth orbits around the sun. If the dimensions of the solar system had the same proportion as those of the atoms would the earth be closer to or farther away from the sun than actually it is? The radius of earth's orbit is about 1.5×10^{11}m. The radius of the sun is taken as 7×10^8m.
10. A 10 kg satellite circles earth once every 2h in an orbit having a radius of 8000 km. Assuming that Bohr's angular momentum postulates applies to satellite just as it does to an electron in the hydrogen atom .Find the Quantum number of the orbit of the satellite.

SEMICONDUCTOR DEVICES

LEVEL – 1

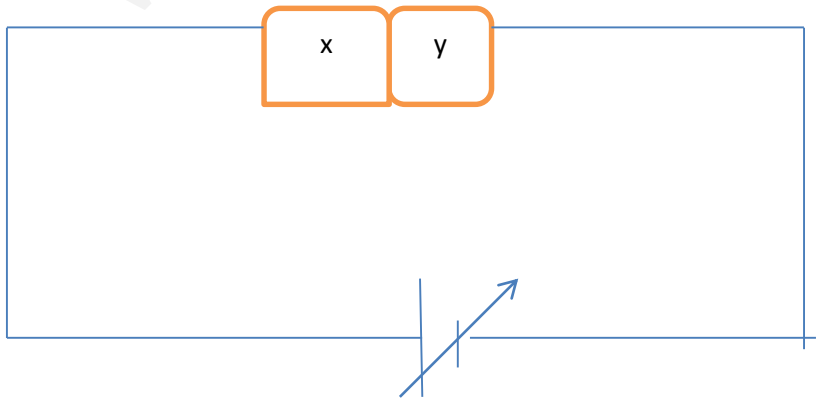
1. What is the net charge on p-type semi conductors?
2. What is the net charge on an n-type semi conductor?
3. Write the full form of LCD?
4. Write the difference between intrinsic and an extrinsic semi conductor? Name the process in which the intrinsic semiconductor can be converted to an extrinsic semi conductor?
5. How n-type semiconductors and p-type semiconductors are formed?

6. Write two important processes in the formation of p-n junction diode?
7. State which factor controls the wave length of an LED?
8. Name the impurity, which when added to pure Si to produce n-type semiconductor
9. How the depletion layer is formed? What is the order of the thickness of it?
10. What do you understand by forward and reverse biasing of a diode.
11. What is the advantage of semiconductors over diode valves? 12) Write the full forms of CRT and LCD?
12. Give two examples for elemental semiconductors
13. Give two examples of compound semiconductors.
14. Draw the schematic diagram for energy band gaps for metals, insulators and semiconductors.
15. Draw the symbols of p-n junction diode.
16. what are photo diodes? Why they are used in reverse biased? What are the applications of it? Draw I-V charecterestic curves for it? 18) explain the fabrication & functioning of LEDs and write the applications and advantages?
17. explain the fabrication & functioning of Solar cells and write the applications and advantages?Why GaAs are considered for the fabrication of solar cells?Why I-V charecterestic curves are drawn in IVquadrants for Solar cells.
18. What are transistors?What are the three elements of transistor?What are the types of transistors?
19. Draw the symbols ,truth tables and realization of OR,AND and NOT gates.
20. what are ICs ? Write the advantages and limitations of ICs.
21. Write the differences between the analogue and digital signals.
22. Which naturally occurring lead compound acts as detector in radio receiver?
23. What are energy bands and how they are formed?
24. How metals act as conductors?
25. At what temperature the conduction band is completely empty inSi.
26. What do you mean by energy band gap?
27. What is the unique property that Semiconductor show and conductors do not show?
28. What is doping?
29. Penta valent dopant is called donor impurity and trivalent dopant is called acceptor dopant .Why?
30. What is the dominating current in Forward bias and in Reverse bias? In forward bias diffusion current is larger than that of drift current and in reverse bias the drift current dominates
31. What are the orders of diffusion and drift current in a p-n junction diode
32. What is breakdown voltage of a p-n junction diode?
33. What property of diode allows it to uses it as rectifier.
34. Why in rectifiers step down transformers are used?
35. Is it compulsory to use Centre-tap transformer in full wave rectifier?
36. What is use of the filters in rectifier circuits?
37. Who was the inventor of ZENER diode
38. What are the criteria for selecting the material for solar cell?
39. How GaAs is better choice than Si for fabricating a solar cell in spite of its higher band gap?
40. Why do not we select PbS whose band gap is 0.4 eV.

41. Why it is enough to draw only one line in input characteristic curves and many in output characteristic curves?
42. Amplifier is not a power generating device. Then how the output is amplified?

LEVEL –2

1. C,Si Ge have the same lattice structures. Why C an insulator but why Si and Ge are intrinsic semi conductors?
2. Draw the schematic diagrams for n-type and p type semiconductor?
3. Can we join p-type and n-type slabs to form p-n junction diode?
4. What do you understand by forward and reverse bias? Draw the diagrams and also draw the model graphs.
5. How the zener diode acts as voltage stabilizer?
6. Describe the action of transistor and draw the input and output charecterstic curves?
7. Explain the active region,cut off region and saturation region with respect to the charecterestic curves of transistor?
8. What is an amplifier?In which region of the transistor is operated as amplifier? Explain the working of npn transistor as an amplifier under common emitter mode? Why npn is prferred over pnp transistor?How in C-E mode the gains are high when compared to C-B mode?derive the expression for current,voltage and power gains. Explain the phase reversal in c-e configuration.
9. which is the universal gate and why it is so called?
10. Can we interchange the emitter and collector in atransistor?
11. Why a transistor can not be used as rectifier?
12. Draw the circuit diagram fo realising the NOT gate?
13. Show that $\alpha = \beta/(1+\beta)$ where $\alpha = Ic/Ie$ and $\beta = Ic/Ib$
14. Derive the expression for the conductivity of p-n junction diode and what is the effect of temperature on the conductivity of p-n junction diode?
15. In half-wave rectification, what is the output frequency if the input frequency is 50 Hz. What is the output frequency of a full-wave rectifier for the same input frequency?
16. Two semiconductor materials X and Y shown in the figure are made by doping germanium crystal with indium and arsenic. The two are joined as shown in fig.



a) Will the junction be forward biased or reverse biased?
b) Sketch V-I graph for this arrangement.

17. Draw the out put wave form for the given input wave form for a NOT gate?

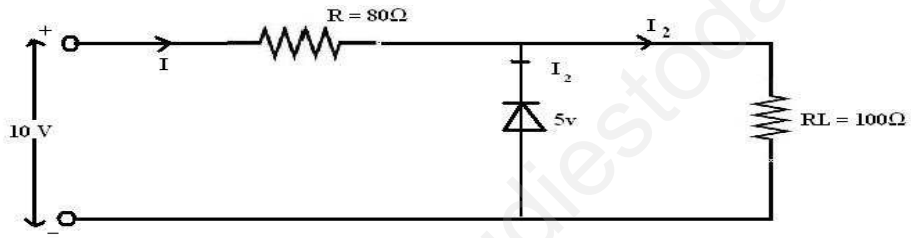
LEVEL -3

Q.1. When the voltage drop across a p-n junction diode is increase from 0.65 v to 0.70 v, the change in the diode current is 5mA. What is the dynamic resistance of the diode?

Ans : Dynamic resistance = change in voltage / change in current

= (0.70- 0.65)/5x10-3
= 0.05/ 5 x 10-3
= 10

Q.2. In the figure shown, find out the current passing through R_L and Zener diode :



Ans : Here, V2 = 5V

Voltage drop across R = Input voltage – V_2

= 10 – 5 = 5v

I_2= 5/100

= $5x10^{-2}$ A

Here, $I = I_2 + I_L$ $I_2 = I - I_L$

= $(6.25-5)\ 10^{-2}$

= 1.25×10^{-2}A.

Q.3. A common emitter transistor has current gain of 100. If emitter current is 8.08 m A, find the base and collector current.

Ans: Here, β = 100 Ie = 8.08 mA β = Ic/Ib We get Ic = $\beta I_B = 100\ I_B$

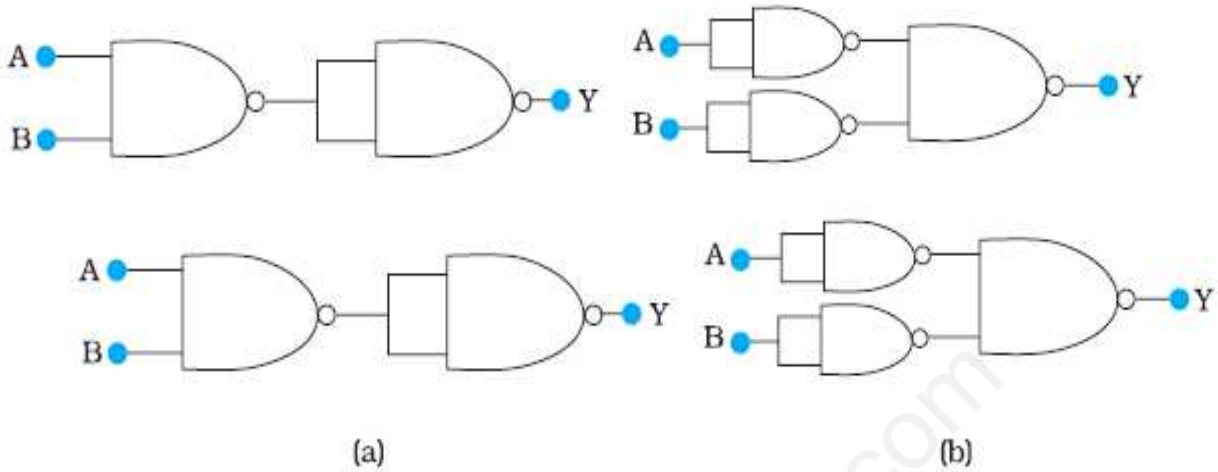
Using, Ie =Ib + Ic

We get Ie = 101 Ib

Or, Ib = Ie/101= 0.08mA

Therefore Ic = 100 x 0.08 = 8mA.

Q4 Write the truth table for the following combination of gates.



reverse biased. Explain?

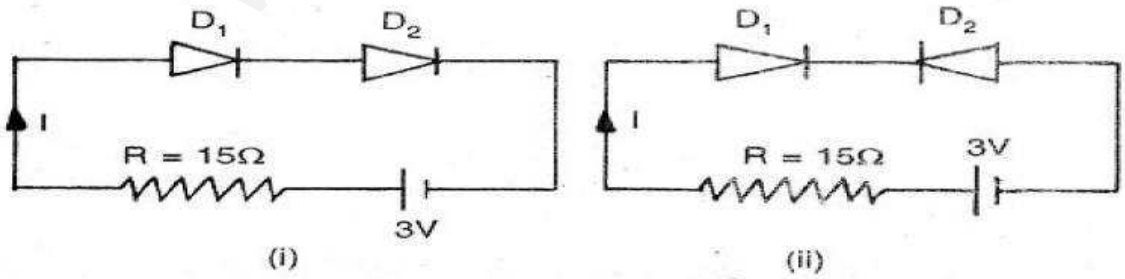
Q7) why silicon devices are preferred to germanium devices?Silicon devices have higher break down voltages than that of germanium diodes (1.5 times)

Q8) In a transistor, reverse bias is very high as compared to the forward bias. Why?In a transistor, charge carriers move from emitter to collector through the base. The reverse bias on collector is made quite high so that it may exert a large attractive force on the charge carriers to enter the collector region. These moving carriers in the collector constitute a collector current.

Q9) The out put of an unregulated d. c power supply needs to be regulated. Name the device that can be used for this purpose and draw the relevant circuit diagram.The device is ZENER diode.Ref 14.22 of NCERT TEXT BOOK.

Q10) Zener diodes have higher dopant densities as compared to ordinary p-n junction diodes. How does it affect the width of the depletion layer and the electric field of the potential barrier?The Depletion region is very thin in the order of micro meter and the electric field is very high $5X10^6$ V/m

Q11) Determine the current through resistance "R" in each circuit. Diodes D1 and D2 are identical and ideal.



Ans: In circuit (i) Both D1 and D2 are forward biased hence both will conduct current and resistance of each diode is "0".Therefore I = 3/15 = 0.2 A

(iii) Diode D1 is forward bias and D2 is reverse bias, therefore resistance of diode D1 is "0" and resistance of D2 is infinite. Hence D1 will conduct and D2 do not conduct. No current flows in the circuit.

Q12) In a transistor the base current is changed by 20μa. This results in a change of 0.02V in base emitter voltage and a change of 2ma in collector current.

(i) Find input resistance,

(ii)Transconductance.

Input resistance = change in voltage/change in current'

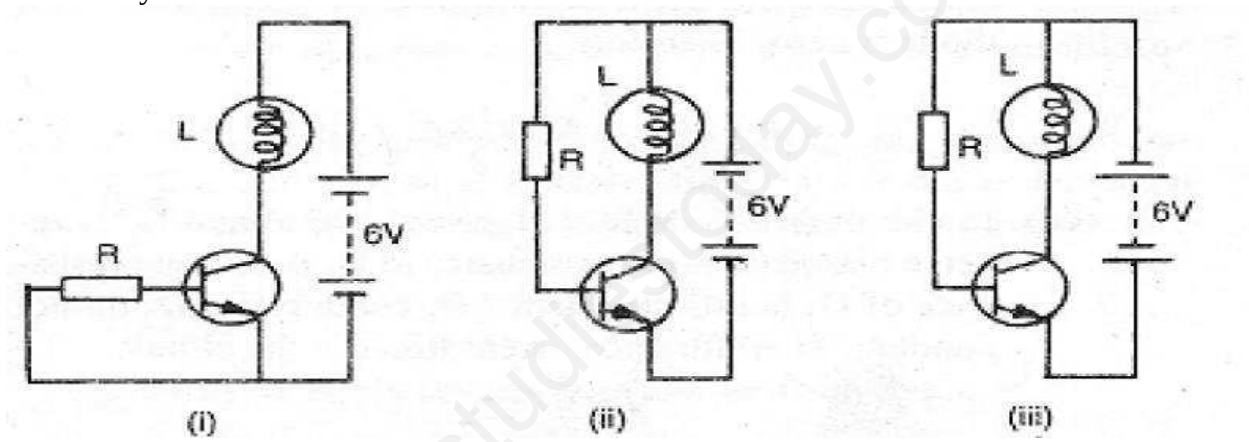
Amplification factor $\mu = r_p X g_m$

Q13) A semiconductor has equal electron and hole concentrations of 6x108/m3. On doping with a certain impurity, the electron concentration increases to 9x1012/ m3. (ii) Calculate the new hole concentrations.

Ans: (i) n-type semiconductor.

(ii) $(n_e)(n_h) = n_i^2 \Rightarrow n_h = 6x108 \text{ x} 6x108 = 4x104 \text{ perm}^2$

Q14) In only one of the circuits given below, the lamp "L" glows. Identify the circuit? Give reason for your answer?



Ans: In fig (i) emitter –base junction has no source of emf. Therefore Ic =0, bulb will not glow.

In fig (ii) emitter – base junction is forward biased; therefore lamp "L" will glow.

(iii) Emitter – base junction is received biased so the bulb will not glow.

Q15)

In half-wave rectification, what is the output frequency if the input frequency is 50 Hz. What is the output frequency of a full-wave rectifier for the same input frequency.

Ans: 100 Hz

Q16) A logic gate is obtained by applying output of OR gate to a not gate .Name the gate so formed .Write the symbol and truth table of it?

NOR gate.

Q17) A p-n photo diode is fabricated from a semiconductor with a band gap of 2.8 eV.Can it detect a wave length of 600 nm.

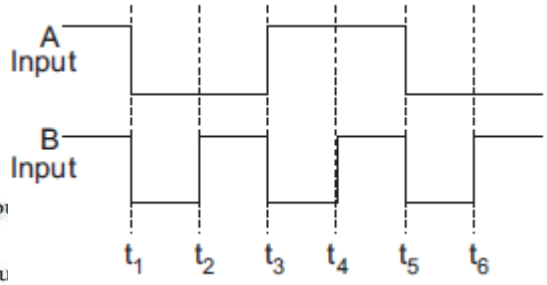
$E = h_\gamma = 2.8$ eV but $_\gamma = c/\lambda$ so we can calculate wave length and tell whether it detects or not.

Q 18) We have valence electrons and conduction electrons in a semi conductor. Do we have also valence holes and conduction holes in a semi conductor?

In a semiconductor the valance band is the highest filled band and then conduction band. For the conduction in a semiconductor electron jumps from the valance band to conduction band and left

a vacancy called hole.However,energy states in conduction band are of higher energy and Pauli's exclusion principle do not allow them to fall back in the valance band.Therfore we do not have holes in conduction band.

Q19) draw the output form for NAND gate for the given input?



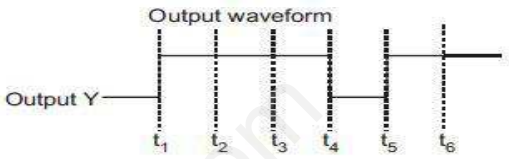
The outpu

i.e., outpu

Accordingly the output waveform $Y = \overline{AB}$ is shown in fig.

i.e., output is zero between intervals 0 to t_1 and t_4 to t_5 and in all other intervals it is '1'.

The output waveform is shown in fig.



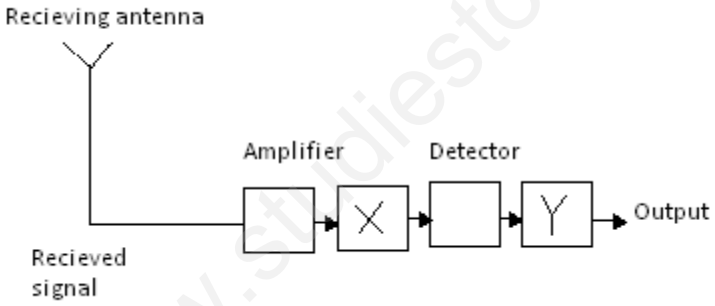
LEVEL – I

1. Give two applications of geostationary satellite?
2. Why is it necessary to use satellite for the long distance T V transmission?
3. Name the process of superimposing signal frequency on the carrier wave.
4. Which wavelengths are reflected by the ionosphere?
5. What is the necessasity for modulation?
6. Define modulation?
7. Name the type of the radio wave of frequency 300 MHz to 3000 MHz?
8. Draw the diagram of AM modulated wave?
9. Write the block diagram of communication system?
10. What are called ground waves?
11. What is meant by demodulation?
12. What is meant by noise?
13. What is a carrier wave?
14. Why ground wave propagation is not suitable for high frequency?
15. What should be the length of dipole antenna for a carrier wave of frequency 6×10^8 Hz?
16. Name the band to which the electromagnetic waves of frequency 120MHz belong.
17. What should be the length of dipole antenna for a carrier wave of frequency 3×10^8 Hz?
18. What is the purpose of modulating a signal in transmission?
19. What is sky wave propagation?
20. What is meant by term 'modulation'? Draw a block diagram of a simple modulator for obtaining an AM signal.

LEVEL-2

1. Name the device which is fitted in the satellite to receive signals from the earth stations?,
2. Why are the transmission signals using ground waves restricted up to a frequency of 1500 kHz?
3. Write the block diagram of detector for AM signal?
4. What is meant by amplification?
5. What is meant by base band signal? Describe briefly with the help of a block diagram the arrangement for the transmission and reception of the message signal.
6. Explain briefly with the help of diagrams, the terms: (i) amplitude modulation, (ii) frequency modulation. Which of these (a) gives better quality transmission, (b) has a larger coverage?
7. What is meant by the term 'modulation'? Explain with the help of a block diagram, how the process of modulation is carried out in radio broadcasts.
8. What is an 'analog signal' and a 'digital signal'?
9. What should be the length of the dipole antenna for a carrier wave of Frequency 3 X $1O^8$ Hz?
10. Explain the types of communication systems according to the mode of the transmission.
11. What is the wavelength of TV station which transmits on 500MHz?
12. Define the term ‘Transducer’ for a communication system.
13. “A Radar using wavelength 5cm and having an antenna disc of a diameter 10m has an angular resolution smaller than 0.01 radian”. Is this statement correct?
14. Why sky waves are not used in the transmission of TV signals?
15. “Greater the height of a TV transmitting antenna, greater is its coverage”. Comment
16. What do you mean by the following? a) ground waves b) sky waves
17. Write four important applications of remote sensing?
18. A carrier wave of 200V amplitude is modulated by a 40V, I kHz sine wave signal. Calculate the modulation factor?
19. Why ground wave propagation is not suitable for high frequency?
20. What do you mean by “base band signals”?
21. What do you mean by noise in communication?
22. What is Modulator?
23. By what percentage will the transmission range of a TV tower be affected when the height of the tower is increased by 21%?
24. Why do we need a higher bandwidth for transmission of music compared to that for commercial telephone communication?
25. Why high frequency carrier waves are employed for transmission of signals?
26. Write two factors justifying the need of modulation for the transmission of a signal?
27. Write the function of 1) transducer 2) repeater in the context of communication system?
28. State the two main reasons explaining the need of modulation for transmission of audio signal?
29. Name any two types of transmission media that are commonly used for transmission of signals. Write the range of frequencies of signals for which these transmission media are used?
30. What is the range of frequencies used in satellite communication? What is common between these waves and light waves?
31. Why is communication using’ line of sight mode’ limited to frequencies above 40 MHz?

32. What does the term LOS communication mean? Name the types of waves that are used for this communication. Which of the two heights of transmitting antenna and height of receiving antenna can effect range over which this mode of communication remains effective?
33. Distinguish between 'Point to point' and 'broad cast' communication modes. Give one example of each?
34. 1) Define Modulation index 2) Why is the amplitude of modulating signal kept less than the amplitude of carrier wave?
35. A carrier wave of peak voltage 12 V is used to transmit a message signal. Calculate the peak voltage of the modulating signal in order to have a modulation index of 75%?
36. On a particular day, the maximum frequency reflected from the ionosphere is 10 MHz. On another day, it was found to decrease to 8 MHz. Calculate the ratio of maximum electron densities of the ionosphere on the two days?
37. What is a digital signal? Explain the function of modem in data communication? Write two advantages of digital communication?
38. Explain the function of a repeater in a communication system?
39. A transmitting antenna at the top of a tower has a height 32 meters and the height of the receiving antenna is 50 meters. What is the maximum distance between them for satisfactory communication in line of sight mode?
40. In the given block diagram of a receiver, identify the boxes labeled as X and Y and write their functions.



41. a) What is space wave propagation? Give two examples of communication system which use space wave mode. b) A TV tower is 80 meter tall. Calculate the maximum distance up to which the signal transmitted from the tower can be received?
42. Which mode of propagation is used by short wave broad cast services having frequency range from a few MHz to 30 MHz? Explain diagrammatically how long distance communication can be achieved by this mode. Why is there an upper limit to frequency of waves used in this mode?
43. What is space wave propagation? Which two communication methods make use of this mode of propagation? If the sum of the heights of transmitting and receiving antenna in line of sight of communication is fixed at H, show that the range is maximum when the two antennas have a height H/2 each.
44. What is ground wave communication? At what factor does the maximum range of propagation in this mode depends?

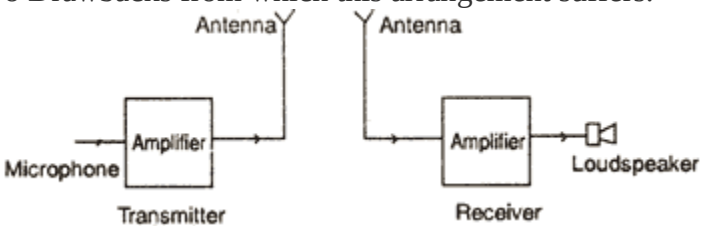
45. Draw schematic diagrams showing the 1) Ground wave 2) Sky wave and 3) Space wave propagation modes for em waves. Write the frequency range for each of the following 1) standard AM broad cast 2) TV 3) Satellite communication.
46. Explain briefly the following terms used in communication system 1) Transducer 2) Repeater 3) Amplification.
47. Write short notes on (a) Internet, (b) Mobile telegraphy and (c) Global positioning system(GPS).

LEVEL-3

1. a) A TV tower has height of 80 meters. Find the radius of the circle within which the transmission can be observed, if the radius of the earth is 6400 km? b) How much population is covered by the TV broad cast if the average population density around the tower is 800 per km^2?
2. A TV tower has a height of 500 meters at a given place. Calculate its coverage range, if the radius of the earth is 6400 km?
3. Which mode of wave propagation is suitable for TV broad cast and satellite communication and why? Draw a suitable diagram depicting this mode of propagation of the wave.
4. Write briefly any two factors which demonstrate the need for modulating a signal. Draw a suitable diagram to show amplitude modulation using a sinusoidal signal as the modulating signal.
5. a) Draw a schematic diagram describing the three modes of propagation of em waves in the atmosphere? Indicate clearly which one of these 1) achieving long distance communication by ionosphere reflection and 2) is used for line of sight (LOS) as well as satellite communication. b) Write an expression for the maximum LOS distance d_m between the two antennas having heights H1 and H2 above the earth's surface.
6. a) The RMS value of carrier voltage is 100 V. After amplitude modulation the RMS value becomes 110 V. Find the modulation index? b) A message signal of 12 kHz and peak voltage 20 V is used to modulate a carrier wave of frequency 12 MHz and peak voltage 30 V. Calculate the 1) modulation index and 2) side band frequencies?
7. What should be the length of the dipole antenna for a carrier wave of Frequency 3 X $1O^8$ Hz?
8. Give reasons for the following:
    a. Long distance radio broadcasts use short-wave bands.
    b. The small ozone layer on top of the stratosphere is crucial for human survival.
    c. Satellites are used for long distance TV transmission. Consider an optical communication system operating at nm. Suppose, only 1% of the optical source frequency is the available channel band-width for optical communication. How many channels can be accommodated for transmit ting
        i. audio-signals requiring a band-width of 8 kHz,
        ii. Video TV signals requiring an approximate band-width of 4.5 MHz? Support your answer with suitable calculations.
9. The height of a T.V. tower at a place is 400 m. Calculate
    a. the maximum range up to which signals can be received from time tower and
    b. Area covered by the transmission. (Radius of the Earth 6400 km) .
10. Why moon cannot be as communication satellite? Give any two reasons.

11. Why sky waves are not used in the transmission of T V signal?

8. A schematic arrangement for transmitting a message signal (20 Hz to 20 kHz) is given below: Give two Drawbacks from which this arrangement suffers.



12. Draw the waveforms for the (i) Input AM wave at A (ii)output, B, of the rectifier and (iii)output signal, C, of the envelope detector.