

General Instructions

1. There are 33 Questions in all. All Questions are compulsory.
2. This Question paper has five sections.
3. All sections are compulsory.
4. Section – A contains sixteen questions, twelve MCQ and four Assertion – Reasoning based of one mark each, Section – B contains five questions of two marks each. Section – C contains seven questions of three marks each, Section – D contains two case study based questions of four marks each and Section – E contains three long answer questions of five marks each.
5. There is no overall choice. However, an internal choice has been provided in one question in Section – B, one question in Section – C and all three questions in Section – E . You have to attempt only one of the choices in such questions.
6. Use of Calculators is not allowed.

SECTION – A [1 mark each]

Q – 1. An arbitrary Gaussian surface encloses an electric – dipole the total electric flux through this surface will be

- [a] Infinite [b] zero [c] q/ϵ_0 [d] $(q.2l)/ \epsilon_0$

Q – 2 The current flows through in a wire of resistance 5 ohm having a potential difference 7 volt for 20 minutes , the heat produced is

- [a] 1400 Joule [b] 700 Joule [c] 2100 Joule [d] 11760 Joule

Q – 3. When an intrinsic semiconductor is doped with a small amount of trivalent impurity , then

- [a] its resistance increases [b] it becomes a P – type semiconductor
[c] there will be more free electron than Holes [d] Dopant atoms becomes Donor – type atom.

Q – 4. What is the angle between electric – field direction and equi potential surface ?

- [a] 90° [b] 0° [c] 60° [d] 45°

Q – 5. The force on a charge due to a magnetic field becomes maximum

- [a] on a charge which is at rest. [b] which is moving in the direction of magnetic field .
[c] moving in the perpendicular direction. [d] moving in the parallel direction

Q – 6. Based on the V-I characteristics curve of PN junction diode , we can classify diode as

- [a] bilateral device [b] ohmic device [c] Non – ohmic device [d] Passive device

Q – 7. Two charges of equal magnitude and at a distance of 'r' exerts a force ' F 'on each other . if the charges are halved and distance between them is doubled , then the new force acting on each other becomes

- [a] $F / 8$ [b] $F / 4$ [c] $4F$ [d] $F / 16$

Q – 8. The sensitivity of moving coil galvanometer can be increased by decreasing

- [a] Number of turn in turns in coil [b] Intensity of Radial Magnetic – field
[c] Area of coil [d] Restoring force per unit twist of suspension wire

Q – 9. An electron enters in a magnetic field making oblique angle with direction of magnetic field , what will be the nature of path followed?

- [a] Parabola [b] Helix [c] Circle [d] straight line

Q – 10. A battery of emf 10 volt and Internal resistance of 3 ohm is connected to a external resistor. if the current in the circuit is 0.5 Amp , the resistance of resistor will be

- [a] 20 ohm [b] 17 ohm [c] 5 ohm [d] 8.5 ohm

Q – 11. Conductor, semiconductor and insulator having the Forbidden Energy Gap E_1 , E_2 and E_3 respectively. Which one is correct ?

- [a] $E_1 < E_2 < E_3$ [b] $E_1 > E_2 = E_3$ [c] $E_1 = E_2 < E_3$ [d] $E_1 > E_2 > E_3$

Q – 12. A parallel combination of three resistors takes a current of 7.5 Amp from a 30 volt supply. If two resistors are 10 ohm and 12 ohm. What will be the value of third resistor ?

- [a] 3 ohm [b] 15 ohm [c] 20 ohm [d] 4 ohm

In the following questions (from Q No -13 to Q No -16), two statements are given – one labelled Assertion(A) and other Reason (R) . select the correct answer to these questions from the options as given below :

- (a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
(b) If both Assertion and Reason are true and Reason is not the correct explanation of Assertion .
(c) If Assertion is true but Reason is false .
(d) If both assertion and Reason are false.

Q – 13. [Assertion] Electrical conductivity of a semiconductor increases on doping .

[Reason] Doping raises the temperature of semiconductor .

Q – 14. [Assertion] The number of electric lines of forces passing through a given area in a Normal direction is called Electric – flux.

[Reason] Electric flux is a vector quantity.

Q – 15. [Assertion] The poles of a bar magnet can not be separated.

[Reason] Magnetic monopoles do not exist.

Q – 16. [Assertion] Coulomb – Force and Gravitational – Force follows the inverse square law .

[Reason] Both Laws (Force) are same in all respect .

SECTION – B [2 Mark each]

Q – 17. Define Magnetic – lines of force, List its three prominent properties.

Q – 18. An electric motor operates on a 50 volt supply and draws a current of 12 Amp . if this motor gives a mechanical power of 150 watt. Find the percentage efficiency of the Motor ?

Q – 19. Write the definition of S.I. unit of following Physical quantity

[a] Electrical Capacitance [b] Magnetic field Intensity

Q – 20. State Gauss's Theorem of Electrostatics. A positive charge of $17.7\mu\text{C}$ is placed at the centre of a Hollow sphere of radius 0.5 meter. Calculate the Total Electric – flux through sphere also the Electric – Flux density?

Q – 21. A proton and an alpha particle of the same velocity enters in a uniform Magnetic field which is acting perpendicular to their direction of motion. Find the ratio of the radii of the circular paths described by the Alpha particle and proton ?

OR

Two Magnetic poles , one of which is four times stronger than the other , exert a force of 5×10^{-3} kgf on each other when placed at a distance of 10 cm . Find the Pole strength of each pole?

SECTION – C [3 Mark each]

Q – 22. State Ampere's circuital- Law , using it obtain expression for magnetic field inside of a long Solenoid carrying current.

Q – 23. Two cells of e.m.f. of 1.5 volt and 2.0 volt with internal resistance 1 ohm and 2 ohm respectively are connected in parallel so as to send the current in the same direction through an external resistance of 5 ohm.

[a] Draw the circuit diagram .

[b] Using Kirchhoff's laws in drawn circuit Calculate current through each branch of the circuit ?

Q – 24. Draw the circuit diagram for a Full wave rectifier. Explain construction and its working, also draw the input and out put wave form.

Q – 25. Charges of $+5\mu\text{C}$, $+10\mu\text{C}$ and $-10\mu\text{C}$ are placed in air at the corners A,B and C of an equilateral triangle ABC having each side of 5 cm . Determine the resultant Electrostatic force (i.e. magnitude and direction) on the charge at the corner A ?

Q – 26. If three Capacitors C_1 , C_2 and C_3 are connected in series or in Parallel . Mathematically show that total electrostatic energy is additive both in series and in parallel combination of capacitors.

Q – 27. Derive an expression for force per unit length between two infinitely long straight parallel current carrying wires. hence define one Ampere current using derived expression.

Q – 28. Define Magnetic dipole moment, Derive an Expression for magnetic field Intensity along Equatorial line of Magnetic – dipole (i.e. Bar –magnet) .

OR

A current of 1 Amp is flowing in the sides of an equilateral triangle of side 4.5×10^{-2} meter. Find the magnetic – field intensity at the centroid of the triangle ?

SECTION – D [4 MARK] [Case – Study]

Read the paragraph carefully and Answer the questions.

Q – 29. Ritu with her father was coming back home but was caught by a thunderstorm. she found herself frightened by the loud noises of wind ,rain and dramatic lighting she asked her father about the horrible weather and reason behind it . Her father explained her that lighting is a powerful Phenomenon of physics. He further explained during a thunderstorm, warm moist air rises creating updrafts. As water droplets and ice crystal collide within the cloud they become electrically charged. The opposite charges accumulate in different parts of the cloud. The negative charge in the cloud attracts positive charges on the ground. When the electrical potential difference between these regions becomes large the insulating capacity of the air breaks down and sudden discharge of electricity occurs . This discharge is what we see as lighting . The channel of negative charge travels from the cloud towards the ground and a channel of positive charge extends upwards from the ground. The connection between these positive and negative charge create a powerful lighting and heat. It is what we see as lighting. Father explained her that is just one of those beautiful phenomenon of science.

[i] Lightning occurs due to which of the following reasons:

- [a] Thunder [b] Dynamic electricity [c] Static Electricity [d] None of these

[ii] Which of the following is the property of charges ?

- [a] Unlike charges attracts [b] Like charges repel [c] Both a and b [d] None of these

[iii] During a lightning strike, which of the following occurs ?

- [a] Charges flow from the cloud to the ground. [b] Charges neutralized.
[c] Charges remain stationary [d] Charges are created from nothing

[iv] What happens to the electric potential energy of a charge when it moves from a region of high potential to low potential ?

- [a] it increases [b] it decreases [c] it remains the same [d] it becomes zero.

Q – 30. The Total force experienced by a charged Particle moving in a region where both electric and Magnetic field are present is called Lorentz's Force .the electric force acts in the direction of Electric field and is independent of the velocity of the charge where as the Magnetic force depends on the velocity of charge .

Mathematically the total Lorentz's Force experienced by charge due to Both electric field and magnetic field is given by

$$\mathbf{F_L = F_E + F_M}$$

$$\mathbf{F_L = q (E + v \times B)}$$

[where terms having there usual meanings]

[i] Total Lorentz force on Neutron moving in crossed Electric and Magnetic field will be

- [a] $q E$ [b] Zero [c] $q v B$ [d] None of these

[ii] Direction of Magnetic force on a charged particle given by

- [a] Ampere's circuital Law [b] Fleming's Left Hand Rule [c] Junction Rule [d] None of these

[iii] Electric force on charge is

[a] dependent on Magnetic force

[b] Independent of the velocity

[c] dependent on Magnetic field Intensity

[d] Independent on Electric field intensity

[iv] The Electrostatic force [F_E] and Magnetic force [F_M] acting on a charge particle 'q' moving with velocity can be written as

[a] $F_E = q \mathbf{v} \cdot \mathbf{E}$ and $F_M = q (\mathbf{B} \cdot \mathbf{v})$

[b] $F_E = q E$ and $F_M = q (\mathbf{B} \times \mathbf{v})$

[c] $F_E = q E$ and $F_M = q (\mathbf{v} \times \mathbf{B})$

[d] $F_E = q E$ and $F_M = q (\mathbf{B} \times \mathbf{v})$

SECTION – E [5 Marks each]

Q – 31. [a] what do you mean by Electric – dipole. Derive an Expression for Electric potential at a point along axial – line of an Electric – dipole.

[b] Two point charge + q and + 4q are separated by a distance of 6a. Find the point on the line joining the two charges where the electric – field is zero.

OR

[a] What do you mean by Depletion layer across PN junction diode ,Explain how Depletion layer affected during Forward and Reverse biased using crystal - diagram .

[b] Draw the labeled Energy band diagram for Intrinsic - semi conductor, P – type semi conductor and N – type semi – conductor at/above room temperature .

Q – 32. [a] Describe the construction and working of a moving coil galvanometer using a labeled diagram. Mathematically show that current flowing through it is directly proportional to produce deflection.

[b] A galvanometer with a coil of resistance 12 ohm shows full scale deflection for a current 2.5 mA, How will you convert the galvanometer into

[i] An Ammeter of range 0 to 7.5 Amp.

[ii] A voltmeter of range 0 to 10 volt.

OR

[a] Apply Biot – Savart's Law to derive the expression for Magnetic – field Intensity due to current carrying circular loop at a point on the axis of the loop.

[b] Two identical circular loop P and Q each of radius R and carrying current I are kept in perpendicular planes such that they have a common centre as shown in the figure . Find the magnitude and direction of the net magnetic field at the common centre of the two loops ?

Q – 33. [a] Define the term drift velocity and relaxation - time , Derive the expression for resistivity of material in terms of electron density and relaxation – time.

[b] Find the specific resistance of a conductor in which current density of 2.5 Amp / m^2 is found to exist , when an electric field of 15 volt/meter is applied on it ?

OR

[a] Using Kirchhoff 's Laws derive condition for Balanced wheat stone Bridge with labeled circuit diagram.

[b] In the given circuit diagram , A meter bridge is shown in its balanced condition ,the meter bridge wire has a resistance of 1 ohm/cm.

[i] Calculate the value of the unknown resistance X ?

[ii] Find the current drawn from Battery ?