

Chemistry By : Er. Jitendra Gupta sir

Topic: Electrostatic, Potential & Capacitance, Current Electricity, Magnetic effect of Current, Magnetism & Matter, EMI, AC, EM Wave

M.M: 80

Date:

M.T.: 180 Min.

General Instructions-

- ✓ Every Question is Compulsory.
- ✓ Use of Calculator, slide rule, Graph paper & Trigonometric Tables is Not Permitted.

Section-'A' Each Questions-1 Mark

- Electric force between two charged spheres is 18 units. If the distance between the centers of the sphere is tripled, the electric force will be
(a) 2 units (b) 54 units (c) 3 units (d) 6 units
- When a negatively charged, conductor is connected to earth
(a) Electrons flow from the earth to the conductor (b) Protons flow from the conductor to the earth
(c) No charge flow occurs (d) Electrons flow from the conductor to the earth
- A system has two charges $q_A = 2.5 \times 10^{-7} \text{C}$ and $q_B = -2.5 \times 10^{-7} \text{C}$ located at points A (0, 0, -15cm) and B (0, 0, +15cm) respectively. What are the total charge and electric dipole moment of the system?
(a) zero, $8.5 \times 10^{-8} \text{Cm}$ (b) zero, $6.5 \times 10^{-8} \text{Cm}$ (c) zero, $7.5 \times 10^{-8} \text{Cm}$ (d) zero, $5.5 \times 10^{-8} \text{Cm}$
- Two tangent galvanometers having coils of the same radius are connected in series. A current flowing in them produces a deflection of 60° and 45° respectively. The ratio of the number of turns in the coils is:
(a) $\sqrt{3}/1$ (b) $(\sqrt{3}+1)/1$ (c) $(\sqrt{3}+1)/(\sqrt{3}-1)$ (d) $4/3$
- The susceptibility of a magnetic substance is found to depend on temperature and the strength of the magnetizing field. The material is a:
(a) diamagnet (b) superconductor (c) ferromagnet (d) paramagnet
- Assume that a motor in which the coils have a total resistance of 10Ω is supplied by a voltage of 120 V. When the motor is running at its maximum speed, the back emf is 70 V. Current in the coils when the motor is turned on and when it has reached maximum speed are
(a) 16 A, 5 A (b) 14 A, 5 A (c) 12 A, 4 A (d) 12 A, 5 A
- If v_s , v_x and v_m are the speeds of gamma rays, X-rays and microwaves respectively in vacuum, then
(a) $v_s > v_x > v_m$ (b) $v_s = v_x = v_m$ (c) $v_s < v_x < v_m$ (d) $v_s > v_x > v_m$
- The velocity of electromagnetic waves in free space is $3 \times 10^8 \text{ ms}^{-1}$. The frequency of a radio wave of wavelength 150 m is
(a) 45 MHz (b) 2 MHz (c) 2 kHz (d) 20 kHz
- In an electromagnetic wave, the electric and magnetic fields are 100 V/m and 0.265 A/m. The maximum energy flow will be:
(a) 53.0 W/m² (b) 26.5 W/m² (c) 13.2 W/m² (d) 79 W/m²
- A copper ring is held horizontally and a magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet is
(a) more than that due to gravity (b) depends on the diameter of the ring & the length of the magnet
(c) less than that due to gravity (d) equal to that due to gravity

Questions 11 to 17, Assertion_ Reason Type:

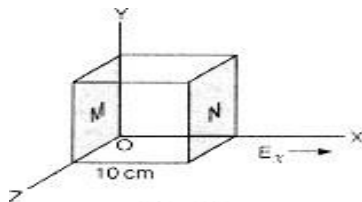
- (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false. (d) A is false but R is true.
- Assertion (A): Electric field is always normal to equipotential surfaces and along the direction of decreasing order of potential.
Reason (R): Negative gradient of electric potential is electric field.
- Assertion (A): Electric field is discontinuous across the surface of a spherical charged shell.
Reason (R): Electric potential is continuous across the surface of a spherical charged shell.
- Assertion (A): Current is a scalar quantity.
Reason (R): Electric current arises due to continuous flow of charged particles or ions.
- Assertion (A): Higher the range of an ammeter, smaller is its resistance.
Reason (R): To increase the range of the ammeter, additional shunt needs to be connected across it.
- Assertion (A): To protect any instrument from external magnetic field, it is put inside an iron body.
Reason (R): Iron is a magnetic substance.
- Assertion (A): The magnetic poles of earth do not coincide with the geographic poles.
Reason (R): The discrepancy between the orientation of a compass & true north-south direction is known as magnetic declination.
- Assertion (A): An induced current has a direction such that the magnetic field due to the current opposes the change in the magnetic flux that induces the current.
Reason (R): Above statement is in accordance with the conservation of energy.

Section-'B' Each Questions-2 Mark

18. At a certain location in Africa, a compass points 12° west of the geographic north. The north tip of the magnetic needle of a dip circle placed in the plane of magnetic meridian points 60° above the horizontal. The horizontal component of the earth's field is measured to be 0.16 G. Specify the direction and magnitude of the earth's field at the location.
19. A bar magnet placed in a uniform magnetic field of strength 0.3T with its axis at 30° to the field, experiences a torque of 0.06 Nm. What is the magnetic moment of the bar magnet?
20. A proton has spin and magnetic moment just like an electron. Why then its effect is neglected in magnetism of materials?
21. Show, by giving a simple example, how EM waves carry energy and momentum.
22. Why sky wave propagation of electromagnetic waves cannot be used for TV transmission? Suggest two methods by which range of TV transmission can be increased.

Section-'C' Each Questions-3 Mark

23. In Fig., the electric field is directed along positive X- direction and given by $E_x = 5A x + 2B$,



where E is in NC^{-1} and x is in meter. A and B are constants with dimensions. Taking $A = 10 \text{ NC}^{-1}\text{m}^{-1}$ and $B = 5 \text{ NC}^{-1}\text{m}^{-1}$, calculate

- (i) the electric flux through the cube. (ii) net charge enclosed within the cube
24. A parallel plate capacitor, each with plate area A and separation d, is charged to a potential difference V. The battery used to charge it is then disconnected. A dielectric slab of thickness d and dielectric constant k is now placed between the plates. What changes, if any, will take place in
- (i) charge on the plates. (ii) electric field intensity between the plates (iii) capacitance of the capacitor.
25. Seven capacitors each of capacitance $2\mu\text{F}$ are connected in a configuration to obtain an effective capacitance $10/11 \mu\text{F}$. Suggest a suitable combination to achieve the desired result.
26. The walls of a closed cubical box of edge 50 cm are made of a material of thickness 1 mm and thermal conductivity $4 \times 10^{-4} \text{ cal s}^{-1} \text{ cm}^{-1} \text{ }^\circ\text{C}^{-1}$. The interior of the box maintained at 100°C above the outside temperature by a heater placed inside the box and connected across a 400 V d.c. source. Calculate the resistance of the heater.
27. i. State the condition under which a charged particle moving with velocity V goes undeflected in a magnetic field B.
ii. An electron, after being accelerated through a potential difference of 10^4 V enters a uniform magnetic field of 0.04 T, perpendicular to its direction of motion. Calculate the radius of curvature of its trajectory.
28. Classify materials 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 the increase of temperature?
29. The current through two inductors of self-inductance 15 mH and 25 mH is increasing with time at the same rate. Draw graphs showing the variation of the
- (i) emf induced with the rate of change of current (ii) energy stored in each inductor with the current flowing through it. Compare the energy stored in the coils, if the powers dissipated in the coils are same.
30. The instantaneous value of an alternating voltage in volts is given by the expression $\epsilon t = 140 \sin 300 t$, where t is in second. What is
- (i) the peak value of the voltage, (ii) its rms value and (iii) frequency of the supply? Take $n = 3, \sqrt{2} = 1.4$

Section-'D' Each Questions-4 Mark

31. Read the text carefully and answer the questions:

A charged particle moving in a magnetic field experiences a force that is proportional to the strength of the magnetic field, the component of the velocity that is perpendicular to the magnetic field and the charge of the particle.

This force is given by $\vec{F} = q(\vec{v} \times \vec{B})$ where q is the electric charge of the particle, v is the instantaneous velocity of the particle, and B is the magnetic field (in tesla). The direction of force is determined by the rules of cross product of two vectors. Force is perpendicular to both velocity and magnetic field. Its direction is given as $\vec{v} \times \vec{B}$ if q is positive and opposite of $\vec{v} \times \vec{B}$ if q is negative.

The force is always perpendicular to both the velocity of the particle and the magnetic field that created it.

Because the magnetic force is always perpendicular to the motion, the magnetic field can do no work on an isolated charge.

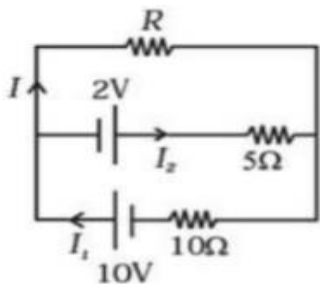
It can only do work indirectly, via the electric field generated by a changing magnetic field.

- (i) When a magnetic field is applied on a stationary electron, it
- (a) moves in the direction of the field (b) remains stationary
(c) moves perpendicular to the direction of the field (d) spins about its own axis
- (ii) A proton is projected with a uniform velocity v along the axis of a current-carrying solenoid, then
- (a) the proton will be accelerated along the axis (b) the proton will continue to move with velocity v along the axis
(c) the proton moves along helical path (d) the proton path will be circular about the axis

- (iii) A charged particle experiences magnetic force in the presence of magnetic field. Which of the following statement is correct?
 (a) The particle is moving and magnetic field is parallel to velocity.
 (b) The particle is stationary and magnetic field is perpendicular.
 (c) The particle is moving and magnetic field is perpendicular to the velocity.
 (d) The particle is stationary and magnetic field is parallel.
- (iv) A charge q moves with a velocity 2 ms^{-1} along x-axis in a uniform magnetic field $\vec{B} = (i + 2j + 3k)T$, then charge will experience a force
 (a) along -z axis (b) in z-y plane (c) along +z axis (d) along -y axis

Section-'E' Each Questions-5 Mark

32. Two cells of voltage 10V and 2V and internal resistances 10Ω and 5Ω respectively, are connected in parallel with the positive end of 10V battery connected to negative pole of 2V battery (Fig). Find the effective voltage and effective resistance of the combination.



33. State Faraday's laws of electromagnetic induction and explain three methods of producing induced emf.
 34. Draw a labelled diagram of Hertz's experiment set up to produce electromagnetic waves. Explain the generation of electromagnetic waves using this setup.
 35. Read the text carefully and answer the questions:

The triboelectric series is a list that ranks materials according to their tendency to gain or lose electrons. The process of electron transfer as a result of two objects coming into contact with one another and then separating is called triboelectric charging. During such an interaction, one of the two objects will always gain electrons (becoming negatively charged) and the other object will lose electrons (becoming positively charged). The relative position of the two objects on the triboelectric series will define which object gains electrons and which object loses electrons.

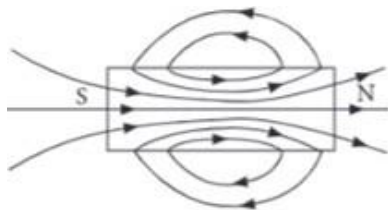
In triboelectric series, materials are ranked from high to low in terms of the tendency for the material to lose electron. If an object high up on this list (Glass, for example) is rubbed with an object low down on the list (Teflon, for example), the glass will lose electrons to the Teflon. The glass will, in this case, become positively charged and the Teflon will become negatively charged. Materials in the middle of the list (steel and wood, for example) are items those do not have a strong tendency to give up or accept electrons.



- (i) Materials in the upper position have _tendency to become positively charged.
 (a) no (b) medium (c) high (d) low
- (ii) Name two materials which do not have a strong tendency to give up or accept electrons.
 (a) Steel, wood (b) Plastic wrap, Teflon (c) Ebonite, Nylon (d) Nylon, cat fur
- (iii) If human hair is rubbed with amber, how those will be charged?
 (a) Hair will be negatively charged, Amber will be positively charged. (b) Both positive
 (c) Hair will be positively charged, Amber will be negatively charged. (d) Both negative
- (iv) Triboelectric charging is the process of electron transfer between two objects
 (a) By contact (b) Without contact (c) By anyone of these (d) By none of these
- (v) The object which loses electron becomes ____charged and the object gains electron becomes ____charged
 (a) positively, positively (b) negatively, positively (c) negatively, negatively (d) positively, negatively

36. Read the text carefully and answer the questions:

By analogy to Gauss's law of electrostatics, we can write Gauss's law of magnetism as $\oint \vec{B} \cdot d\vec{s} = \mu_0 m_{\text{inside}}$ where $\oint \vec{B} \cdot d\vec{s}$ is the magnetic flux and m_{inside} is the net pole strength inside the closed surface. We do not have an isolated magnetic pole in nature. At least none has been found to exist till date. The smallest unit of the source of magnetic field is a magnetic dipole where the net magnetic pole is zero. Hence, the net magnetic pole enclosed by any closed surface is always zero. Correspondingly, the flux of the magnetic field through any closed surface is zero.



(i) Consider the two idealized systems

- (I). a parallel plate capacitor with large plates and small separation and
- (II). a long solenoid of length $L \gg R$, radius of cross-section.

In (i) $\vec{E}$ is ideally treated as a constant between plates and zero outside. In (ii) magnetic field is constant inside the solenoid and zero outside. These idealized assumptions, however, contradict fundamental law as

- (a) case (ii) contradicts $\oint \vec{H} \cdot d\vec{s} = I$
 - (b) case (i) agrees with $\oint \vec{E} \cdot d\vec{s} = 0$
 - (c) case (ii) contradicts Gauss's law for magnetic fields
 - (d) case (i) contradicts Gauss's law for electrostatic fields
- (ii) The net magnetic flux through any closed surface, kept in a magnetic field is
- (a) $4\mu_0 / \pi$
 - (b) $\mu_0 / 4\pi$
 - (c) $4\mu_0 \pi$
 - (d) zero
- (iii) Which of the following is not a consequence of Gauss's law?
- (a) The magnetic poles always exist as unlike pairs of equal strength.
 - (b) Isolated magnetic poles do not exist.
 - (c) There are abundant sources or sinks of the magnetic field inside a closed surface.
 - (d) If several magnetic lines of force enter in a closed surface, then an equal number of lines of force must leave that surface.
- (iv) A closed surface S encloses a magnetic dipole of magnetic moment $2m$. The magnetic flux emerging from the surface is
- (a) $\mu_0 m$
 - (b) $2\mu_0 m$
 - (c) $2m / \mu_0$
 - (d) Zero
- (v) The surface integral of a magnetic field over a surface
- (a) is proportional to mass enclosed
 - (b) equal to its magnetic flux through that surface
 - (c) is proportional to charge enclosed
 - (d) is zero

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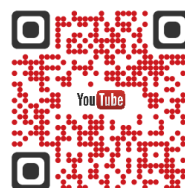
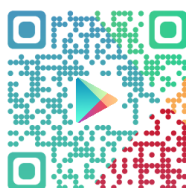
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हमारा विश्वास... हर एक विद्यार्थी है खास !!

You should recognize yourself, you can do a lot, just continuously focus on your target, this is the success mantra.

Er. Jitendra Sir



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