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QUESTION BANK OF MULTIPLE-CHOICE QUESTIONS 2021-22

CLASS - XII SUBJECT - PHYSICS

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1. A force of 4N is acting between two charges in air. If the space between them is completely filled with glass (relative permittivity = 8), then the new force will be

a) 2N b) 5N c) 0.2N d) 0.5N

2. A charge q is placed at the center of the line joining two equal charges Q. The system of three charges will be in equilibrium if q is equal to

a) –Q/2 b) –Q/4 c) Q/4 d) Q/2

3. Two point charges Q and -3Q are placed some distance apart. If the electric field at the location of Q is **E**, the field at the location of -3Q is

a) E b) -E c) E/3 d) –E/3

4. A soap bubble is given a negative charge, then its radius

a) Decreases b) Increases

c) Remains unchanged d) Nothing can be predicted as information is insufficient

5. Two equally charged identical metal spheres A and B repel each other with a force F. Another identical uncharged sphere C is touched to A and then placed midway between A and B. The net force on C is in the direction

a) F towards A b) F towards B c) 2F towards A d) 2F towards B

6. An electric dipole when placed in a uniform electric field will have minimum potential energy, if the angle between dipole moment and electric field is

a**)** Zero b) π/ 2 c) π d) π/3

7. An electric dipole consists of two opposite charges of magnitude 1μC separated by a distance of 2cm. The dipole is placed in an electric filed 10^{-5} V/m. The maximum torque experienced by the dipole is

a) 10^{-3} Nm b**)** 2 x10^{-13} Nm c) 3 x10^{-3} Nm d) 4x 10^{-3} Nm

8. Electric field lines provide information about

(a) Field strength (b) direction (c) nature of charge (d) all of these

9. There are two charges + 1mc and + 2mc kept at certain separation. The ratio of electro static forces acting on them will be in the ratio of

a) 1 : 2 b) 2 : 1 c) 1 : 1 d) 1 : 4

10. Electric field on the axis of a small electric dipole at a distance r is E_1 rand E_2 at a distance of 2r, on a line of perpendicular bisector. Then, (E_1 / E_2) is

a) 2 b) 4 c) 8 d) 16

Source based questions:

Smallest charge that can exist in nature is the charge of an electron. During friction it is only the transfer of electron which makes the body charged. Hence net charge on a body is an integral multiple of charge of an electron (1.6×10^{-19} C) i.e., $q = \pm ne$
where r= 1, 2, 3, 4 ….
Hence no body can have a charge represented as 1.8e, 2.7e, 2e/5, etc.
Recently, it has been discovered that elementary particles such as protons or neutrons are elemental units called quarks.

11. Which of the following properties is not satisfied by an electric charge?
(a) Total charge conservation.
(b) Quantization of charge.
(c) Two types of charge.
(d) Circular line of force.

12. Which one of the following charges is possible?
(a) 5.8×10^{-18} C
(b) 3.2×10^{-18} C
(c) 4.5×10^{-19} C
(d) 8.6×10^{-19} C

13. If a charge on a body is 1nC, then how many electrons are present on the body?
(a) 6.25×10^{27}
(b) 1.6×10^{19}
(c) 6.25×10^{28}
(d) 6.25×10^{9}

Case study questions:

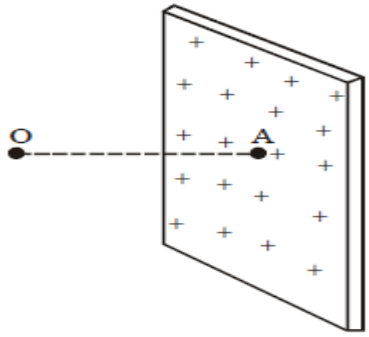
Gauss's law for the electric field describes the static electric field generated by a distribution of electric charges. It states that the electric flux through any closed surface is proportional to the total electric charge enclosed by this surface. By convention, a positive electric charge generates a positive electric field. The law was published posthumously in 1867 as part of a collection of work by the famous German mathematician Carl Friedrich Gauss.

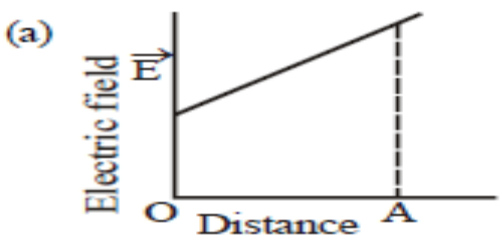
$\oint E.ds = q/\in 0$

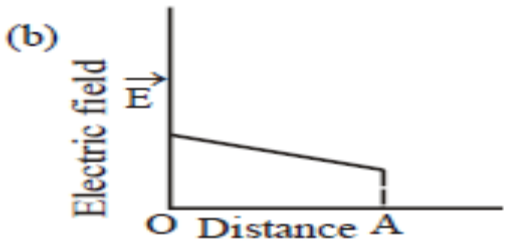
14. Gauss law cannot be used to find which of the following quantity?
a) Electric field intensity
b) Electric flux density
c) Charge
d) Permittivity

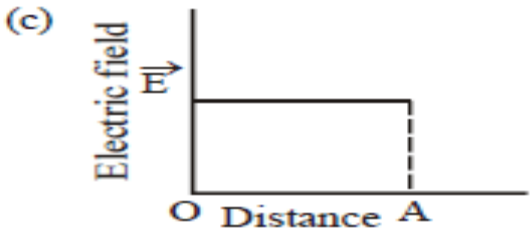
15. Select the correct statements from the following.
I. The electric field due to a charge outside the Gaussian surface contributes zero net flux through the surface.
II. Total flux linked with a closed body, not enclosing any charge will be zero.
III. Total electric flux, if a dipole is enclosed by a surface is zero.
(a) I and II
(b) II and III
(c) I and III
(d) I, II and III

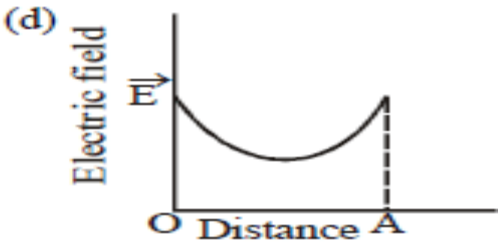
16. Figure shows the part of an infinite plane sheet of charge. Which of the following graphs correctly shows
the behavior of electric field intensity as we move from point O to A.











Case study questions:

17. In Gauss Theorem, Number of electric field lines entering the surface is _____ to the field lines leaving the surface.

A. greater B. less

C. equal D. two times.

18. A plane surface is rotated in a uniform electric field. When is the flux of the electric field through the surface maximum?

a. When the surface is perpendicular to the field
b. When the surface is parallel to the field
c. When the surface is at an angle of 30^0 with the field
d. When the surface is at an angle of 45^0 with the field

19. What is the electric flux through a cube, which encloses an electric dipole?

a) q/ε_0
b) $q/6\varepsilon_0$
c) $q/4\pi\varepsilon_0$
d) Zero

20. A point charge q is placed at a distance a/2 directly above the center of the square of side a. The electric flux through the square is

a. q/ε_0
b. $q/6\varepsilon_0$
c. $q/4\pi\varepsilon_0$
d. $q/2\varepsilon_0$

21. Which of the following statements is not true about Gauss's law?
(a) Gauss's law is true for any closed surface.
(b) The term q on the right side of Gauss's law includes the sum of all charges enclosed by the surface.
(c) Gauss's law is not much useful in calculating electrostatic field when the system has some symmetry.
(d) Gauss's law is based on the inverse square dependence on distance contained in the coulomb's law.

22 . Two unlike charges separated by a distance of 1m attract each other with a force of 0.108N. If the charges are in the ratio 1:3, the weak charge is

a) 2μC b) 4μC c) 6μC d) 5μC

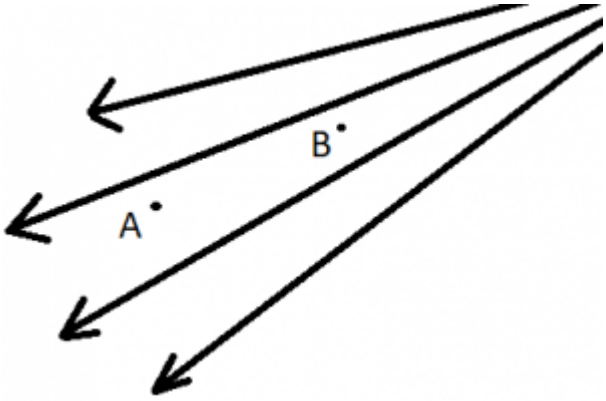
23. if the electric field is given by $(6\mathbf{i} + 3\mathbf{j} + 4\mathbf{k})$ N/c, the flux through a surface of area $20m^2$ in the Y-Z plane is

a) 12 units b) 120 units c) 360 units d) 80 units

24. If the electric flux entering and leaving an enclosed surface respectively is Φ1 and Φ2, the electric charge inside the surface will be
(a) (Φ2 + Φ2) × εo
(b) (Φ2 – Φ2) × εo
(c) (Φ1 + Φ2) × εo
(d) (Φ2 – Φ1) × εo

25. A cylinder of radius R and length L is placed in a uniform electric field E parallel to the axis of the cylinder. The total flux over the curved surface of the cylinder is
(a) zero
(b) πR2E
(c) 2πR2E
(d) E / πR2

26. Consider the lines of force as shown in the figure. Two unit positive charges are kept at points A and B. Which of the following is correct?



a) Charge at A will suffer greater force
b) Charge at B will suffer greater force
c) Force at both points will be same but non-zero
d) Force at both points will be the same

Assertion-Reason Questions:

DIRECTION: Read the two statements Assertion (A) and Reason (R) carefully to mark the correct option out of the options given below:

(a) Assertion and Reason both are correct statements and Reason is correct explanation for Assertion. (b) Assertion and Reason both are correct statements but Reason is not correct explanation for Assertion.

(c) Assertion is correct statement but Reason is wrong statement.

(d) Assertion is wrong statement but Reason is correct statement

27. **Assertion**: No two electric lines of force can intersect each other.
Reason: Tangent at any point of electric line of force gives the direction of electric field.
28. **Assertion**: Coulombs law of force is applicable for point charges at rest.
Reason: Coulombs law is a central force.

29. **Assertion**: Electric charge is quantized.
Reason: Charging is because of transfer of an integral number of protons or electrons.
30. **Assertion:** If there exists coulomb attraction between two bodies, both of them may not be charged.
Reason: In coulomb attraction two bodies are oppositely charged.

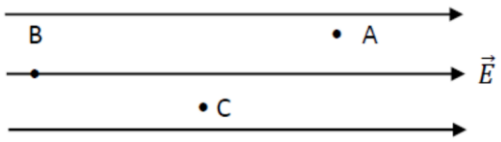
ANSWER KEY

1. d	2.b	3.d	4.b	5.a	6.a	7.b	8.d	9.c	10.c
11.d	12.b	13.d	14.b	15.d	16.c	17.c	18.a	19.d	20.b
21.c	22.a	23.b	24.d	25.a	26.b	27.a	28.b	29.c	30.b

Chapter 2: Electric potential and Capacitance

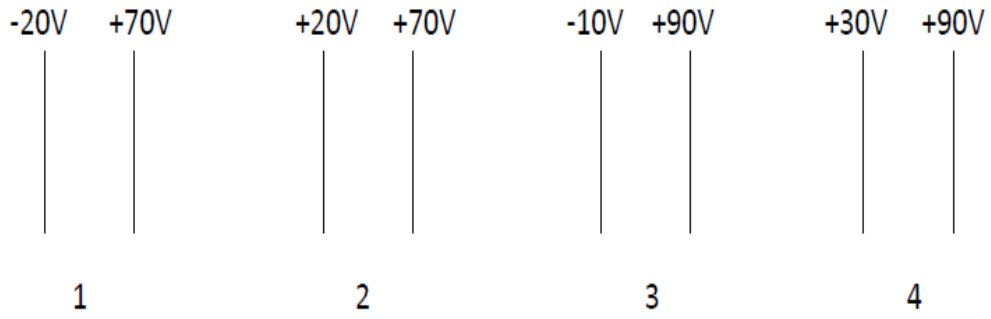
MCQs

1. If an electron is brought towards another electron, the electric potential energy of the system
   A) **increases** B) decreases C) becomes zero D) remains the same
2. Equal charges are given to two spheres of different radii. The potential will:
   A) Be more on bigger sphere
   B) Be more on smaller sphere
   C) Be equal on both the spheres
   D) Depend on the nature of the materials of the spheres
3. A, B & C are three points in a uniform electric field.



   The electric potential is
   A) Maximum at C
   B) Same at all the three points A, B & C
   C) Maximum at A
   D) Maximum at B
4. A charge 'Q' is supplied to a hollow metallic conductor. Which of the following is true?
   A) Electric field inside it is same as on the surface
   B) Electric potential inside is zero
   C) Electric potential inside it is constant
   D) Electric potential on the surface is zero

5. The diagram shows four pairs of large parallel conducting plates. The value of electric potential is given for each plate. Rank the pairs according to the magnitude of the electric field between the plates, least to greatest.



A) 1, 2, 3, 4
B) 4, 3, 2, 1
C) 2, 3, 1, 4
D) 2, 4, 1, 3

Assertion-Reasoning type questions

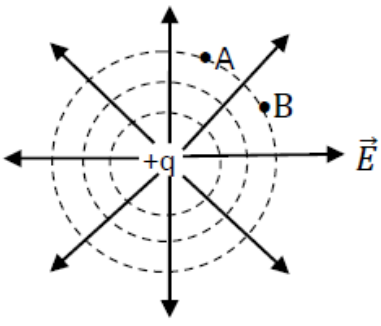
Read the following questions and choose any of the following four responses.

(A) If both Assertion and Reason are true and the Reason is the correct explanation of the Assertion.
(B) If both Assertion and Reason are true and the Reason is not a correct explanation of the Assertion.
(C) If Assertion is true but the Reason is false
(D) If both Assertion and Reason are false

1. **Assertion**: Two adjacent conductors, carrying the same positive charge have no potential difference between them.
   Reason: The potential of a conductor does not depend upon the charge given to it.
2. **Assertion**: One may have zero potential but non-zero electric field at a point in space.
   Reason: Electric potential is a scalar quantity.

Case/Source based questions:

For the various charge systems, we represent equipotential surfaces by curves and line of force by full line curves. Between any two adjacent equipotential surfaces, we assume a constant potential difference. The equipotential surfaces of a single point charge are concentric spherical shells with their centres at the point charge. As the lines of force point



radially outwards, so they are perpendicular to the equipotential surfaces at all points.

Choose the most appropriate alternative for each of the following questions:

1. Identify the wrong statement
   A) Equipotential surface due a single point charge is spherical
   B) Equipotential surface can be constructed for dipoles too
   C) The electric field is normal to the equipotential surface through the point
   D) The work done to move a test charge on the equipotential surface is positive
2. Nature of equipotential surface for a point charge is
   A) Ellipsoid with charge at foci
   B) Sphere with charge at the centre of the sphere
   C) Sphere with charge on the centre of the sphere
   D) Plane with charge on the surface
3. The work done to move a unit charge along an equipotential surface from A to B
   A) Must be defined as $-\int_A^B \vec{E}.\overrightarrow{dl}$
   B) Is zero
   C) Can have a non-zero value
   D) Both (A) & (B) are correct
4. A spherical equipotential surface is not possible
   A) Inside a uniformly charged sphere
   B) Inside a spherical condenser
   C) For a dipole
   D) For a point charge

*****

Answers (Elec. Potential)

MCQs

1) A (work is done against the repulsive force, so PE of the system increases)
2) B ($V \propto \frac{1}{r}$)
3) D (in the direction field, electric potential decreases, therefore $V_B > V_C > V_A$)
4) C
5) D (based on E = V/d, here 'd' is same. Hence, E ∝ V)

Assertion-Reason type

1) D
2) B

Case/Source Based:

1) D
2) B
3) D
4) C

Topic: Capacitors

MCQS

1. A parallel plate capacitor is charged by a battery. Once it is charged battery is removed. Now a dielectric material is inserted between the plates of the capacitor, which of the following does not change?

(a) electric field between the plates

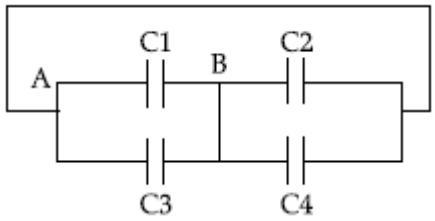
(b) potential difference across the plates

(c) charge on the plates

(d) energy stored in the capacitor.

Ans. (c)

Q2. Four capacitors, each of 2 μF, are connected as shown. What will be the equivalent capacitor across the points A, B?



(A) 0.5 μF

(B) 2 μF

(C) 8 μF

(D) 4 μF

Ans. (C)

Explanation: All the capacitors are connected in parallel. So the equivalent capacitance will be 8 μF.

3. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system

(a) increases by a factor of 4.

(b) decreases by a factor of 2.

(c) remains the same.

(d) increases by a factor of 2

Ans. (b)

Explaination: (b) Using, $V_{net} = V/2$, $U = ½ C_{net}V_{net}^2$

Q4. Two metal spheres are separately charged and then brought in contact, so

(a) total charge on the two spheres is conserved.

(b) total energy of the two spheres is conserved.

(c) Both (a) and (b)

(d) None of the above

Ans. (a)

Explanation: According to the law of conservation of charge, total charge on the two spheres is conserved.

Q5. Two identical capacitors are joined in parallel, charged to a potential V, separated and then connected in series, the positive plate of one is connected to the negative of the other. Which of the following is true?

(*a*) The charges on the free plate connected together are destroyed.

(*b*) The energy stored in this system increases.

(*c*) The potential difference between the free plates is 2V.

(*d*) The potential difference remains constant.

***Ans.* (*c*)**

6. A battery does 200 J of work in charging a capacitor. The energy stored in the capacitor is

(a) 200 J (b) 100 J (c) 50 J (d) 400 J

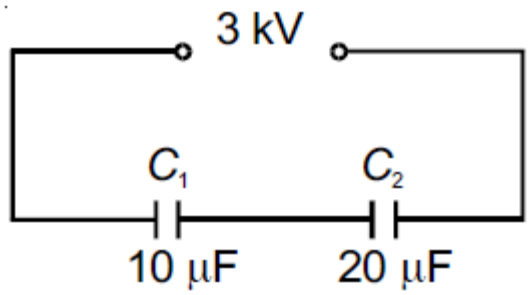
Ans. (b)

$U = ½ C V^2$

$W = C V^2$

U = W / 2 = 100 J (half of work is lost in heat)

7. Capacitors C_1 is 10 μF and C_2 is 20 μF are connected in series across a 3 kV supply, as shown. What is the charge on the capacitor C_1 ?



(a) 45000 μC (b) 20000 μC (c) 15000 μC (d) 10000 μC

Ans.: (B)

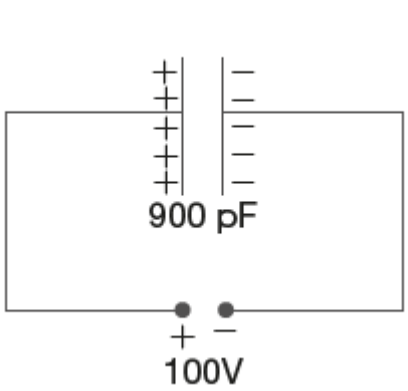
$$\frac{1}{C}=\frac{1}{10}+\frac{1}{20}=\frac{3}{20}$$

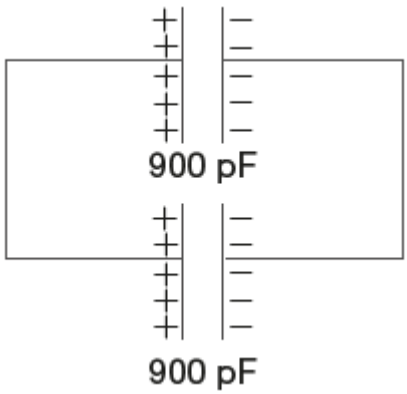
$$C=\frac{20}{3}\mu F$$

$$q=\frac{20}{3}.3000=20000\times10^{-6}$$

$$q = 2 \times 10^{-4}\,C$$

8. The energy stored in the capacitor as shown in Fig. (a) is 4.5×10^{-6} J. If the battery is replaced by another capacitor of 900 pF as shown in Fig. (b), then the total energy of the system is _____





(a) 4.5×10^{-6} J (b) 2.25×10^{-6} J (c) zero (d) 9×10^{-6} J

Ans: (b)

Energy stored in the capacitor in Fig. (a)

$$\frac{1}{2}\frac{Q^2}{C} = 4.5 \times 10^{-6}\ \text{J}$$

If battery in Fig. (a) is replaced by capacitor in Fig. (b),

$$\text{total energy stored} = \frac{1}{2}\left(\frac{1}{2}\frac{Q^2}{C}\right) = \frac{1}{2} \times 4.5 \times 10^{-6}$$

$$= 2.25 \times 10^{-6}\ \text{J}$$

Hence, the correct answer is option (b).

Assertion and Reason Questions

Directions: These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses.

(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(c) If the Assertion is correct but Reason is incorrect.

(d) If both the Assertion and Reason are incorrect.

Q.1. Assertion : If the distance between parallel plates of a capacitor is halved and dielectric having dielectric constant is three inserted between the plates of capacitor, then the capacitance becomes 6 times.

Reason : Capacity of the capacitor does not depend upon the nature of the material.

Ans: C

Q.2. Assertion : Two metal plates having charges Q, –Q face each other at some separation and are dipped into an oil tank. If the oil is pumped out, the electric field between the plates increases.

Reason : Electric field between the plates, $E_{med} = E_{air}/K$

Ans: A

Q3. **Assertion:** Polar molecules have dipole moment.

Reason: In polar molecule, the centres of positive and negative charges coincide even when there is no external field.

Ans: D

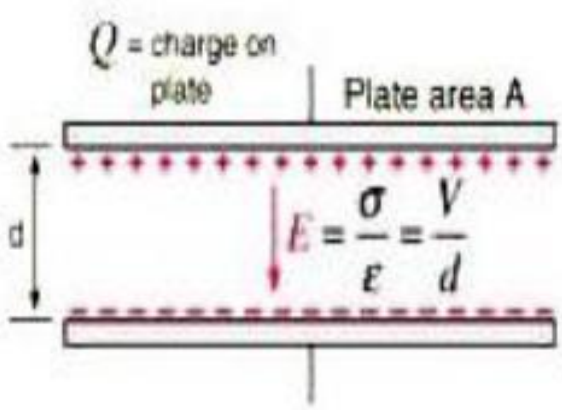
Q4**. Assertion:** A capacitor is a device which stores electric energy in the form of electric field.

Reason: Net charge on the capacitor is always zero.

Ans: B

Case study base question:

Capacitance is the ratio of the change in the electric charge of a system to the corresponding change in its electrical potential. Capacitor consists of two metal plates which are filled with dielectric. When a voltage is applied to these plates an electric current flows charging up one plate with a positive charge with respect to the supply voltage and the other plate with an equal and opposite negative charge. The generalized equation for the charge stored in a capacitor is given by q=CV, where C is the capacitance of the capacitor



1. The capacitance of a capacitor does not depend on

a. Area of plates

b. Separation between the plates

c. Applied potential difference

d. Dielectric constant

2. A parallel plate air capacitor with no dielectric between the plates is connected to the constant voltage source. How would capacitance and charge change if dielectric of dielectric constant K=2 is inserted between the plates. C_0 and Q_0 are the capacitance and charge of the capacitor before the introduction of the dielectric.

a. $C=C_0/2$; $Q=2Q_0$

b. $C=2C_0$; $Q=Q_0/2$

c. $C=C_0/2$; $Q=Q_0/2$

d. $C=2C_0$; $Q=2Q_0$

3. Capacity of a parallel plate condenser can be increased by

(a) increasing the distance between the plates

(b) increasing the thickness of the plates

(c) decreasing the thickness of the plates

(d) decreasing the distance between the plates

4. In a charged capacitor, the energy is stored in

(a) the negative charges

(b) the positive charges

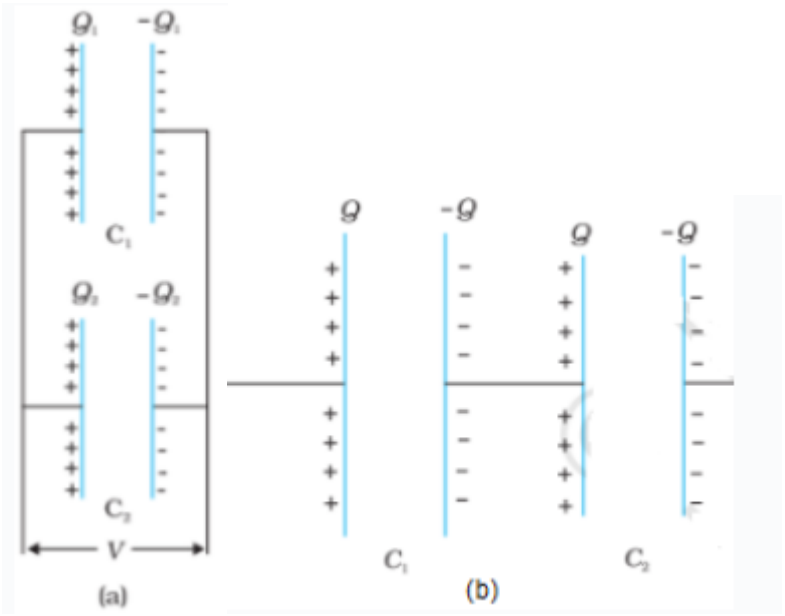
(c) the field between the plates

(d) both (a) and (b)

Ans: 1 – c, 2 – d, 3 – d, 4 – c,

Read the source given below and answer any four out of the following questions:

If two or more capacitors are connected in series, the overall effect is that of a single (equivalent) capacitor having the sum total of the plate spacing of the individual capacitors. If two or more capacitors are connected in parallel, the overall effect is that of a single equivalent capacitor having the sum total of the plate areas of the individual capacitors. (figure (a) shows parallel combination and (b) shows series combination)



1. Capacity can be increased by connecting capacitors in:

   a. parallel

   b. series

   c. both a and b

   d. none of these

2. Three capacitors having a capacitance equal to 2μF, 4μF and 6μF are connected in parallel. Calculate the effective parallel capacitance:

   a. 12/11 μF

   b. .11 μF

   c. 12 μF

   d. 13 μF

3. When capacitors are connected in the series _____ remains same.

   a. voltage

   b. capacitance

   c. charge

   d. resistance

4. Four 10 μF capacitors are connected in series, calculate the equivalent capacitance.

   a. 1.5 μF

   b. 2.5 μF

   c. 3.5 μF

d. 4.5 μF

Answer Key:

1. (a) parallel
2. (c) 12 μF
3. (b) charge
4. (b) 2.5 μF

Chapter 3 - CURRENT ELECTRICITY

MCQ questions

1. path followed by free electrons in conductor, when it is placed in an external electric field is:
   a. Straight line
   b. Circular
   c. Curved path
   d. Elliptical

   Ans. **Option C** Curved path

2. Average thermal speed of electrons in a conductor is:
   a. 3×10^8 m/s
   b. 10-4 m/s
   c. 0 m/s
   d. 10^{-6} m/s

   Ans. **Option C** : 0 m/s as the electrons have random motion in the absence of electric field inside the conductor. Their thermal velocity averaged to be zero.
3. A cell of emf 8V with small finite internal resistance is charged with the help of an external battery. Terminal Potential drop across the cell while charging would be:
   a. Greater than 8 V
   b. Less than 8 V
   c. Zero
   d. Equal to 8 V

   Ans: **Option a** : Greater than 8V while charging terminal drop of a cell is V = E + Ir as r being non zero V will always be more than E(i.e. 8V).

4. When three cells each of emf 3V and internal resistance 1 ohm is connected in series across a resistor. Then, a graph of terminal drop of the combination vs current drawn from it is found to be a straight line. Then Its Y-intercept and slope represents:

a. 9 V and effective internal resistance
b. 3 V and negative of effective internal resistance
c. 3 V and effective internal resistance
d. 9 V and negative of effective internal resistance

Ans: **Option d**: graph of terminal drop vs current is a straight line with negative slope, so Y, intercept represents effective emf of the combination (in series Eeff = E_1+ E_2+ E_3 = 9V) and negative slope gives us effective internal resistance.

5. Name the material that offers less resistance with increase in temperature
   a. Au
   b. Ag
   c. Si
   d. Hg at 4^0C

      Ans: **Option c**: remaining all are metals whose resistivity increase with increase in temperature. Whereas Si is a semiconductor, whose resistivity decreases with increase in temperature.
6. When a resistor x is kept in the left gap and y in the right gap of a meter bridge, balancing length is found to be l cm. what resistance is to be placed in the left gap to have the same balancing length l cm on placing x in the right gap?
   a. X^2/y
   b. X^2y
   c. Y^2x
   d. Y^2/x

      Ans: **Option A**: in the first case x/y = l/(100-l)

      Second case z/x = l/(100-l), on comparing both z = x^2/y
7. The best instrument for accurate measurement of EMF of a cell is-

      (i) Potentiometer

      (ii) metre bridge

      (iii) Voltmeter

      (iv) ammeter and voltmeter

      Ans: **Option a**: Potentio meter, as it draws no current from the cell
8. Name the physical quantity that is conserved in Kirchhoff's loop rule:
   a. Charge
   b. mass
   c. Energy
   d. Momentum

      And: **Option C**. Energy is conserved in Kirchhoff's loop rule. Where as charge is conserved in Kirchhoff's junction rule
9. How does the balancing length of a potentiometer change on increasing the resistance offered by the rheostat that is connected in series with the primary cell.
   a. Increases
   b. Decreases
   c. Remains same
   d. Turns zero

Ans: **Option b**: on increasing the resistance offered by primary resistance, total current in the primary decreases which will decrease the potential drop across the potentiometer wire. So to balance the given potential balancing length will increase.

10. a cell of emf 5V and internal resistance 1 ohm is connected across a heating element of resistance 9 ohm, find the amount of heat lost in one sec is:
    a. 2.25 Watt
    b. 2.25 Joule
    c. 2.5 Watt
    d. 2.5 Joule

    Ans: **Option b**: $H = i^2Rt$ here t= 1 sec, R=9 ohm and I = E/(R+r) = 5/(9+1)=0.5 A
    H= 0.25 x 9 x 1 = 2.25 joule

Q.No. 11 to 16 are assertion and reason questions, which consists of two statements, typed as Assertion and Reason. While answering these questions you are required to choose any one of the following four responses.

A) If both Assertion and Reason are True and the Reason is a correct explanation of Assertion.

B) If both Assertion and the Reason are True but the Reason is not a correct explanation of the Assertion.

C) If Assertion is true but the Reason is False

D) If both Assertion and the Reason are false.

11. Assertion: A domestic electric appliance working on a three pin, will continue working if the thick pin is removed.
    Reason: The thick pin is used only as a safety device.
    a. A b. B c. C d. D
    Ans. **Option A**

12. Assertion: Conductivity of a metal is much higher than that of an electrolyte at room temperature.
    Reason: Free electron density in metals is much lesser than the density of ions in electrolytes and also free electrons have smaller mobility than ions.
    a. A b. B c. C d. D
    Ans. **Option C**
13. Assertion: When Wheatstone bridge is balanced, the current through the cell depends on the resistance of the galvanometer.
    Reason: In balanced condition, current through the galvanometer is very high.
    a. A b. B c. C d. D
    Ans. **Option D**
14. Assertion: Potentiometer is an ideal instrument to measure the potential difference.

Reason: Potential gradient along the potentiometer wire can be made very small.

a. A b. B c. C d. D

Ans. **Option B**

15. Assertion: The value of temperature of coefficient of resistance is positive for metals.
Reason: The value of temperature or coefficient of resistance is negative for insulators.

a. A b. B c. C d. D

Ans. **Option B**

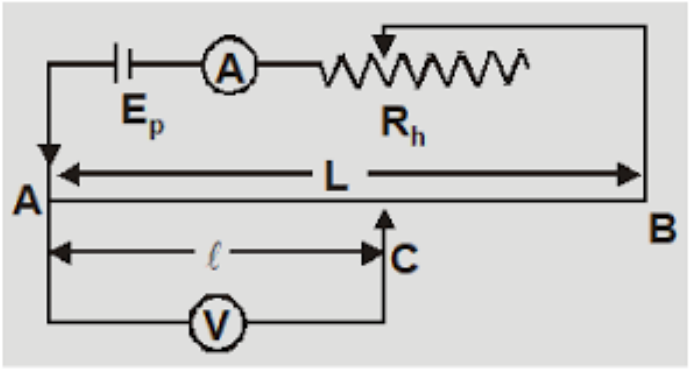
16. Assertion: When identical cells are connected in parallel to an external load, the effective emf increases.
Reason: All the cells will be sending unequal currents to the external load in the same direction.

a. A b. B c. C d. D

Ans. **Option D**

Question 17-20 are case study based and source based questions, in which relevant data will be given in the form of a diagram or paragraph or the principle behind the topic. Based on which 4 MCQs will be asked.

17. **Potentiometer:** A potentiometer is an instrument that measures the terminal potential difference with high accuracy without drawing any current from the unknown source. It is based on the principle that if constant current is passed through a wire of uniform cross-section, then potential difference across any segment of the wire is proportional to its length. Sensitivity of potentiometer inversely depends on its potential gradient. In the below circuit length of AB is 1.00m emf of E_p is 5.0V, resistance offered by AB is 0.08 ohm per cm and Voltmeter reads 2 V with a balancing length of 50 cm.



i) What is the resistance offered by the rheostat in ohm in the above condition is:

a. 1 b. 2 c. 0.5 d. 0.25

Ans: **Option b**. As 50 cm is balancing 2.0V entire wire AB can balance 4.0 V as emf of primary is 5.0V, drop across Rheostat be 1.0V.
Resistance offered by AB is 8ohm so for a drop of 4.0V current through it will be 0.5A.
Now for a current of 0.5A and drop of 1.0V rheostat has to offer 2 ohm of resistance.

ii) On slightly increasing the emf of the primary cell how would the balancing length change?

a. Increases b. decreases c. remains same d. turns zero

Ans. **Option b**. On increasing primary emf, potential gradient will increase which will decrease the balancing length.

iii) If voltmeter is replaced with series combination of two cells of emf E_1 and E_2 ($E_1>E_2$), balancing length is found to be 80cm, when the same cells are connected in opposite new balancing length is found to be 40 cm. the ratio of emf of the two cells(E_1/E_2) is:

a. 1:2 b. 2:1 c. 1:3 d. 3:1

Ans: **Option d**. $E_1+E_2 = k\,80$, $E_1-E_2=k40$, on adding both $E_1=k60$, and $E_2=k20$ => $E_1/E_2 = 3:1$

iv) Sensitivity of a potentiometer can be increased by :

a. Decreasing potential gradient along the wire
b. Increasing potential gradient along the wire
c. Decreasing current through the wire
d. Increasing current through the wire

Ans: **Option a**

18. Electric energy:

Whenever an electric current is passed through a conductor, it becomes hot after some time. The phenomenon of the production of heat in a resistor by the flow of an electric current through it is called heating effect of current or Joule heating. Thus, the electrical energy supplied by the source of emf is converted into heat. In a purely resistive circuit, the energy expended by the source entirely appears as heat. But if the circuit has an active element like a motor, then a part of the energy supplied by the source goes to do useful work and the rest appears as heat.

i) Which of the following statements is not correct?

a. Heat produced in a conductor depends only on its resistance
b. Heat produced in a conductor depends only on current passing through it
c. With increase in time heat produced in a conductor decreases.
d. All of the above

Ans: **Option d**, Aloof the given statements are false

ii) If the coil of a heater is cut to one third, what would happen to heat produced?

a. Tripled
b. Becomes one third
c. Remains same
d. Becomes nine times

Ans: **Option A**. as length becomes one third resistance will also become one third. Heat produced is $H = (v^2/R)t$, as $R' = R/3$ => $H' = 3H$

iii) 60W and 100W are joined in series and connected to the mains. Which bulbs will glow brighter?

a. 60W
b. 100W
c. both bulbs glow brighter

d. none will glow

Ans: **Option A**, H is directly proportional to R where R is inversely proportional to P. So more the power rating less the heat produced in series.

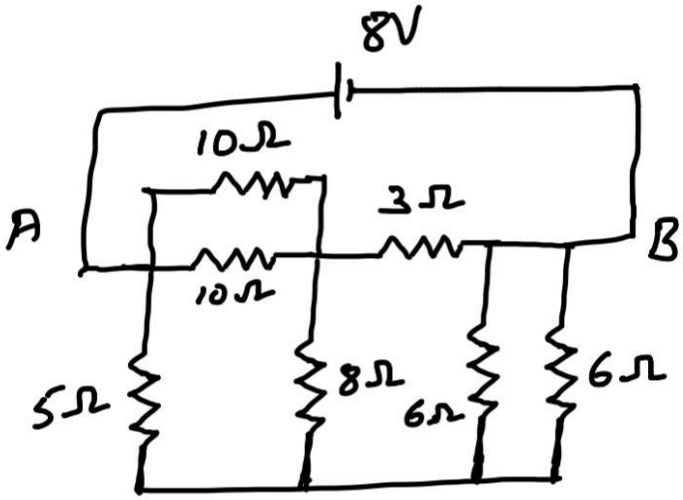
iv) Distance transmission of electrical energy is to be done at

a. High voltages to increase the power dissipated
b. High voltages to decrease the power dissipated
c. Low voltages to decrease the power dissipated
d. Low voltages to increase the power dissipated

Ans: **Option b**, power dissipated in transmission line is $P_c = P^2R/V^2$, here P is the power to be delivered, which remains constant, $P_c \alpha 1/V^2$, more the voltage less the power dissipated.

19. Kirchhoff's laws(Wheatstone bridge):

These are two basic rules that will help us to solve the circuits that can not be resolved as simple series or parallel combinations. These laws deal with currents and voltage drops in a circuit.



i) What is the effective resistance between A and B in the above circuit

a. 4 ohm b. 2 ohm c. 1 ohm d. 2.4 ohm

Ans: **Option a**. above circuit is a balanced wheatstone bridge so the effective resistance turns out to be 4 ohm

ii) What is the total current in the circuit

a. 0 A b. 2 A c. 1 A d. 0.5 A

Ans: **Option b**, as total resistance is 4 ohm and total voltage applied is 8 V from ohm's law total current will be 2 A

iii) Current through 8 ohm resistor is:

a. 0 A b. 2 A c. 1 A d. 0.5 A

Ans: **Option A**, as bridge is balanced no current will flow through 8 Ohm resistor

iv) What will be the drop across 3 Ohm resistor

a. 1 V b. 2V c. 3 V d. 0V

Ans: **Option C**, as current through circuit is 2 A, from symmetry it'll get divided equally about upper and lower branch i.e. 1 A each. As 1 A current in passing through 3 Ohm resistor, drop across it will be 3V

20. Current in a conductor :

Metal's have a large number of free electrons, nearly 10^{28} per cubic metre. In the absence of an electric field, the average terminal speed of the electrons in random motion at room temperature is of the order of 10^5m/s. When a potential difference V is applied across the two ends of a given conductor, the free electrons in the conductor experience a force and are accelerated towards the positive end of the conductor. On their way, they suffer frequent collisions with the ions/atoms of the conductor and lose their gained kinetic energy. After each collision, the free electrons are again accelerated due to electric field, towards the positive end of the conductor and lose their gained kinetic energy in the next collision with the ions/atoms of the conductor. The average speed of the free electrons with which they drift towards the positive end of the conductor under the effect of applied electric fields is called drift speed it can also be expressed in terms of current as v_d=i/neA.

i) Magnitude of drift velocity per unit electric field is;

a. Current density b. current c. resistivity d. mobility

Ans: **Option d**, mobility

ii) The drift speed of the electrons depends on:

a. Dimensions of the conductor
b. Number density of free electrons in the conductor
c. Both a and b
d. Neither a nor b

Ans: **Option C**, v_d = I/neA

iii) We are able to obtain fairly large currents in a conductor because

a. The electron drift speed is usually very large
b. The number density of free electrons is very high and this can compensate for the low values of the electron drift speed and the very small magnitude of the electron charge
c. The number density of free electrons as well as the electron drift speeds are very large and these compensate for very small magnitude of the electron charge
d. The very small magnitude of the electron charge has to be divided by the still smaller product of the number density and drift speed to get the electric current.

Ans: **Option b**.

iv) The number density of free electrons in copper conductor is 8.5 x $10^{28}m^{-3}$, how long does an electron take to drift from one end of a wire 3.0m long to its other end? The area of cross-section of the wire is 2.0 x 10^{-6} m^2 and it is carrying a current of 3.0A.

a. 8.1 x 10^4 s b. 2.7 x 10^4s c. 9 x 10^3 s d. 3 x 10^3 s

Ans: **Option b**, I = neAv_d and v_d=length/t => t=neA(length)/I

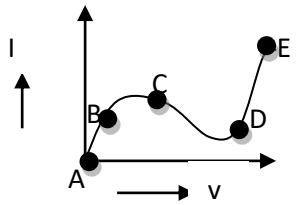
Additional questions:

21. An electric current is passed through a circuit containing two wires of same material, connected in parallel. If the lengths and radii of the wires are in the ratio of 3:2 and 2:3, then the ratio of the current passing through the wire will be

a. 2:3 b. 3:2 c. 8:27 d. 27:8

Ans: optin 3, 8:27 as I inversely depends on R in parallel and R proportional to L/r^2

22. From the graph between current I and voltage V shown below, identify the portion corresponding to negative resistance.



a. AB b. BC c. CD d. DE

Ans: Option C, CD this is the region where current is falling with raise in voltage

23. Two wires of same material have length L and 2L and cross-sectional areas 4A and A respectively. The ratio their specific resistance would be:

a. 1 : 2 b. 8 : 1 c. 1 : 8 d. 1 : 1

Ans: Option d. as both materials being same, specific resistance remains same

24. Two cells of emf's approximately 5V and 10V are to be accurately compared using a potentiometer of length 400m.
    a. The battery that run the potentiometer should have voltage of 8 V
    b. The battery of potentiometer can have a voltage of 15V and R adjusted so that the potential drop across the wire slightly exceeds 10V
    c. The first portion of 50cm of wire itself should have a potential drop of 10V
    d. Potentiometer is usually used for comparing resistance and not voltages.

    Ans: Option B: driving battery emf should always more than the emf of secondary cells

25. A 220V-100W bulb is connected to a source of 180V. the power consumed by it will be nearly :

a. 32 w b. 67 W c. 100 W d. 75 W

Ans: Option b: 67 W, $Pc = V_{ap}^2 P_{actual}/V_{actual}^2 = (180^2 \times 100)/220^2 = 66.9 = 67$ W

Chapter 4: Magnetic effect of electric current

MCQ's

1. Which of the following statements is correct?

(a) A charged particle can be accelerated by a magnetic field.

(b) A charged particle cannot be accelerated by a magnetic field.

(c) The speed of a charged particle can be increased by a uniform magnetic field.

(d) The speed of a charged particle can be increased by a nonuniform magnetic field.

2. A proton moves horizontally towards a vertical conductor carrying a current upwards. It will be deflected
(a) to the left (b) to the right (c) upwards (d) downwards

3.A proton and an Alpha-particle with the same kinetic energy are moving in circular trajectories in a constant magnetic field. If *r*p and *r*a denote respectively the radii of the trajectories of these particles,

(a) $r_p > r_a$ (b) $r_p = r_a$ (c) $r_p < r_a$ (d) $r_p = r_a^2$

4.A circular loop of area $1cm^2$, carrying a current of 10A is placed in a uniform magnetic field of 0.1T perpendicular to the plane of the loop. The force on the loop due to magnetic field is

A) Zero b)10^{-4}N c) 10^{-2}N d) 1 N

5. Two long conductors separated by a distance d carry currents I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its direction is reversed. The distance is also increased to 3d. The new value of the force between them is
A) -2F B)F/3 C)-2F/3 D)-F/3

6. A circular coil of one turn with radius R carrying a current I has a dipole moment M. Now the coil is opened and rewound to have two turns without altering the current. The new dipole moment of the coil is

A) M/2 B) 2M C) M D) 4M

7. In order to float a wire carrying current I with linear mass density μ in the air , the direction and magnitude of magnetic field to be is (Current is passing left to right)

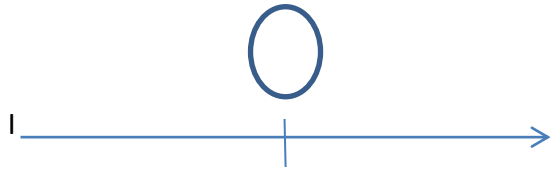
A) μg/I into the plane B) μg/I vertically upward

B) μg/IL into the plane D) μg/I L vertically upward

8.A galvanometer coil has a resistance of 100Ω and the meter shows full scale deflection for a current of 1mA. The shunt resistance required to convert the galvanometer into an ammeter of range 0 to 5A is about

A) 0.01 Ω B) 0.1Ω C) 0.02 Ω D) 0.2 Ω

9.An infinitely long wire carries a current I from left to right direction. A circular coil of radius R is in contact with the wire and carries the same current in clockwise direction. What is the magnitude and direction of net magnetic field intensity at the centre of the coil?



A) $\frac{\mu 0.I}{2R}$ (1- $\frac{1}{\Pi}$) out of the plane of the page

B) $\frac{\mu 0.I}{2R}$ (1- $\frac{1}{\Pi}$) in to the plane of the page

C) $\frac{\mu 0.I}{2R}$ (1+ $\frac{1}{\Pi}$) out of the plane of the page

D) $\frac{\mu 0.I}{2R}$ (1+ $\frac{1}{\Pi}$) out of the plane of the page

10. If we increase the number of turns of the coil of the moving coil galvanometer what happens to the sensitivity?

A)Current sensitivity remains constant but voltage sensitivity changes

B)Current sensitivity increases but voltage sensitivity remains same

C)Both of them increase

D) No change in them

ASSERTION AND REASON TYPE QUESTIONS:

Answer: (A) : Both are correct and reason is correct explanation of assertion.

Answer: (B) : Both are correct but reason is not the correct explanation of assertion.

Answer: (C) : Reason is wrong.

Answer: (D) : Both are wrong.

11. Assertion: If a charged particle is moving in a perpendicular uniform magnetic field then its K E does not change
Reason: Velocity of the charged particle is not changing in the magnetic field

12. Assertion: A linear solenoid carrying a current is an equivalent bar magnet
Reason: The field lines of a solenoid resemble that of a bar magnet

13. Assertion: Magnetic field of an atom is due to both, the orbital motion and spin motion of electrons
Reason: A moving charged particle produces magnetic field

14. Assertion: Two electrons projected in to a uniform magnetic field at right angles with two different velocities complete their circular paths in the same time
Reason: Time period of revolution does not depend on velocity of the charged particle

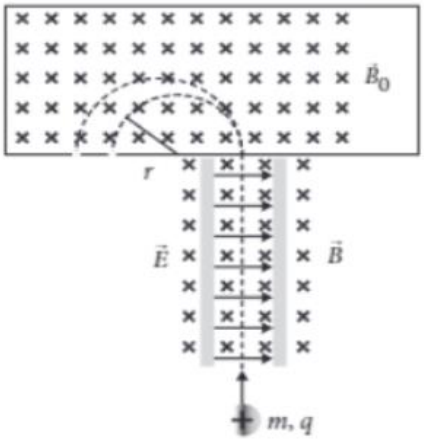
15. Assertion: The magnetic field along the axis of a thick current carrying conductor is zero
Reason: Electric current flows only on the surface of a conductor

SOURCE BASED QUESTIONS:

16. **Mass Spectrometer**

Various methods can be used to measure the mass of an atom. One possibility is through the use of a mass spectrometer. The basic feature of a Banbridge mass spectrometer is illustrated in figure. A particle carrying a charge $+q$ is first sent through a velocity selector and comes out with velocity $v = E/B$.

The applied electric and magnetic fields satisfy the relation $E = vB$ so that the trajectory of the particle is a straight line. Upon entering a region where a second magnetic field $\vec{B}_0$ pointing into the page has been applied, the particle will move in a circular path with radius r and eventually strike the photographic plate.



(i) In mass spectrometer, the ions are sorted out in which of the following ways?

(a) By accelerating them through electric field.
(b) By accelerating them through magnetic field.
(c) By accelerating them through electric and magnetic field.
(d) By applying a high voltage.

(ii) Radius of particle in second magnetic field B_0 is

(a) $\frac{2mv}{qE_0}$ (b) $\frac{mv}{qE_0}$ (c) $\frac{mv}{qB_0}$ (d) $\frac{2mE_0v}{qB_0}$

(iii) Which of the following will trace a circular trajectory with largest radius?

(a) Proton (b) α-particle (c) Electron
(d) A particle with charge twice and mass thrice that of electron.

(iv) Mass of the particle in terms q, B_0, B, r and E is

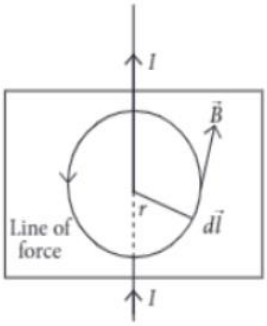
(a) $\frac{qBr}{E}$ (b) $\frac{qB_0Br}{E}$ (c) $\frac{qBr}{EB_0}$ (d) $\frac{qBrE}{B_0}$

(v) The particle comes out of velocity selector along a straight line, because

(a) electric force is less than magnetic force (b) electric force is greater than magnetic force
(c) electric and magnetic force balance each other (d) can't say.

17. **Ampere's Circuital Law**

Ampere's law gives a method to calculate the magnetic field due to given current distribution. According to it, the circulation $\oint \vec{B} \cdot d\vec{l}$ of the resultant magnetic field along a closed plane curve is equal to μ_0 times the total current crossing the area bounded by the closed curve provided the electric field inside the loop remains constant. Ampere's law is more useful under certain symmetrical conditions. Consider one such case of a long Straight wire with circular cross-section (radius R) carrying current I uniformly distributed across this cross-section.



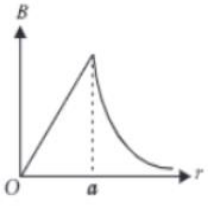
(i) The magnetic field at a radial distance r from the centre of the wire in the region $r > R$, is

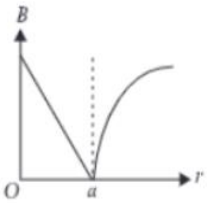
(a) $\frac{\mu_0 I}{2\pi r}$ (b) $\frac{\mu_0 I}{2\pi R}$ (c) $\frac{\mu_0 I R^2}{2\pi r}$ (d) $\frac{\mu_0 I r^2}{2\pi R}$

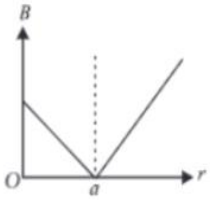
(ii) The magnetic field at a distance r in the region $r < R$ is

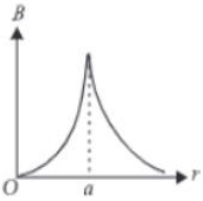
(a) $\frac{\mu_0 I}{2r}$ (b) $\frac{\mu_0 I r^2}{2\pi R^2}$ (c) $\frac{\mu_0 I}{2\pi r}$ (d) $\frac{\mu_0 I r}{2\pi R^2}$

(iii) A long straight wire of a circular cross section (radius a) carries a steady current I and the current I is uniformly distributed across this cross-section. Which of the following plots represents the variation of magnitude of magnetic field B with distance r from the centre of the wire?

(a) 

(b) 

(c) 

(d) 

(iv) A long straight wire of radius R carries a steady current I. The current is uniformly distributed across its cross-section. The ratio of magnetic field at $R/2$ and $2R$ is

(a) $\frac{1}{2}$ (b) 2 (c) $\frac{1}{4}$ (d) 1

(v) A direct current I flows along the length of an infinitely long straight thin walled pipe, then the magnetic field is

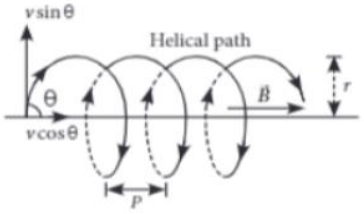
(a) uniform throughout the pipe but not zero (b) zero only along the axis of the pipe

(c) zero at any point inside the pipe

(d) maximum at the centre and minimum at the edges.

18. **Helical Motion**

The path of a charged particle in magnetic field depends upon angle between velocity and magnetic field. If velocity $\vec{v}$ is at angle θ to $\vec{B}$, component of velocity parallel to magnetic field ($v \cos \theta$) remains constant and component of velocity perpendicular to magnetic field ($v \sin\theta$) is responsible for circular motion, thus the charge particle moves in a helical path.



The plane of the circle is perpendicular to the magnetic field and the axis of the helix is parallel to the magnetic field. The charged particle moves along helical path touching the line parallel to the magnetic field passing through the starting point after each rotation.

Radius of circular path is $r = \dfrac{mv \sin\theta}{qB}$

Hence the resultant path of the charged particle will be a helix, with its axis along the direction of $\vec{B}$ as shown in figure.

(i) When a positively charged particle enters into a uniform magnetic field with uniform velocity, its trajectory can be (i) a straight line (ii) a circle (iii) a helix.

(a) (i) only
(b) (i) or (ii)
(c) (i) or (iii)
(d) any one of (i), (ii) and (iii)

(ii) Two charged particles *A* and *B* having the same charge, mass and speed enter into a magnetic field in such a way that the initial path of *A* makes an angle of 30° and that of *B* makes an angle of 90° with the field. Then the trajectory of

(a) *B* will have smaller radius of curvature than that of *A*
(b) both will have the same curvature
(c) *A* will have smaller radius of curvature than that of *B*
(d) both will move along the direction of their original velocities.

(iii) An electron having momentum 2.4×10^{-23} kg m/s enters a region of uniform magnetic field of 0.15 T. The field vector makes an angle of 30° with the initial velocity vector of the electron. The radius of the helical path of the electron in the field shall be

(a) 2 mm
(b) 1 mm
(c) $\dfrac{\sqrt{3}}{2}$ mm
(d) 0.5 mm

(iv) The magnetic field in a certain region of space is given by $\vec{B} = 8.35 \times 10^{-2}\,\hat{i}$ T. A proton is shot into the field with velocity $\vec{v} = (2 \times 10^5\,\hat{i} + 4 \times 10^5\,\hat{j})$ m/s. The proton follows a helical path in the field. The distance moved by proton in the *x*-direction during the period of one revolution in the *yz*-plane will be
(Mass of proton = 1.67×10^{-27} kg)

(a) 0.053 m
(b) 0.136 m
(c) 0.157 m
(d) 0.236 m

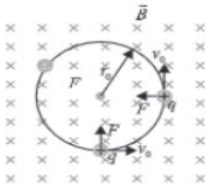
(v) The frequency of revolution of the particle is

(a) $\dfrac{m}{qB}$
(b) $\dfrac{qB}{2\pi m}$
(c) $\dfrac{2\pi R}{v \cos\theta}$
(d) $\dfrac{2\pi R}{v \sin\theta}$

19.

Motion of Charge in Magnetic Field

An electron with speed $v_0 << c$ moves in a circle of radius r_0 in a uniform magnetic field. This electron is able to traverse a circular path as magnetic field is perpendicular to the velocity of the electron. A force acts on the particle perpendicular to both $\vec{v}_0$ and $\vec{B}$. This force continuously deflects the particle sideways without changing its speed and the particle will move along a circle perpendicular to the field. The time required for one revolution of the electron is T_0.



(i) If the speed of the electron is now doubled to $2v_0$. The radius of the circle will change to
(a) $4r_0$ (b) $2r_0$ (c) r_0 (d) $r_0/2$

(ii) If $v_0 = 2v_0$, then the time required for one revolution of the electron will change to
(a) $4T_0$ (b) $2T_0$ (c) T_0 (d) $T_0/2$

(iii) A charged particles is projected in a magnetic field $\vec{B} = (2\hat{i} + 4\hat{j}) \times 10^2$ T. The acceleration of the particle is found to be $\vec{a} = (x\hat{i} + 2\hat{j})$ m s^{-2}. Find the value of x.
(a) 4 m s^{-2} (b) -4 m s^{-2} (c) -2 m s^{-2} (d) 2 m s^{-2}

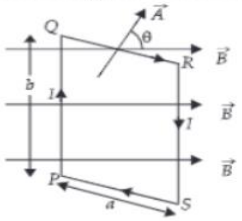
(iv) If the given electron has a velocity not perpendicular to B, then trajectory of the electron is
(a) straight line (b) circular (c) helical (d) zig-zag

(v) If this electron of charge (e) is moving parallel to uniform magnetic field with constant velocity v, the force acting on the electron is
(a) Bev (b) $\frac{Be}{v}$ (c) $\frac{B}{ev}$ (d) zero

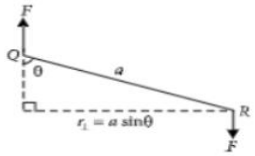
20.

Torque on a Rectangular Loop Placed in Uniform Magnetic Field

When a rectangular loop $PQRS$ of sides 'a' and 'b' carrying current I is placed in uniform magnetic field $\vec{B}$, such that area vector $\vec{A}$ makes an angle θ with direction of magnetic field, then forces on the arms QR and SP of loop are equal, opposite and collinear, thereby perfectly cancel each other, whereas forces on the arms PQ and RS of loop are equal and opposite but not collinear, so they give rise to torque on the loop.



Force on side PQ or RS of loop is $F = IbB \sin 90° = Ib\,B$ and perpendicular distance between two non-collinear forces is $r_\perp = a \sin\theta$



So, torque on the loop, $\tau = IAB \sin\theta$
In vector form torque, $\vec{\tau} = \vec{M} \times \vec{B}$
where $\vec{M} = NI\vec{A}$ is called magnetic dipole moment of current loop and is directed in direction of area vector $\vec{A}$ *i.e.*, normal to the plane of loop.

(i) A circular loop of area 1 cm^2, carrying a current of 10 A is placed in a magnetic field of 0.1 T perpendicular to the plane of the loop. The torque on the loop due to the magnetic field is
(a) zero (b) 10^{-4} N m (c) 10^{-2} N m (d) 1 N m

(ii) Relation between magnetic moment and angular velocity is

(a) $M \propto \omega$ (b) $M \propto \omega^2$ (c) $M \propto \sqrt{\omega}$ (d) none of these

(iii) A current loop in a magnetic field

(a) can be in equilibrium in two orientations, both the equilibrium states are unstable

(b) can be in equilibrium in two orientations, one stable while the other is unstable

(c) experiences a torque whether the field is uniform or non uniform in all orientations

(d) can be in equilibrium in one orientation.

(iv) The magnetic moment of a current I carrying circular coil of radius r and number of turns N varies as

(a) $\frac{1}{r^2}$ (b) $\frac{1}{r}$ (c) r (d) r^2

(v) A rectangular coil carrying current is placed in a non-uniform magnetic field. On that coil the total

(a) force is non-zero (b) force is zero (c) torque is zero (d) none of these

Answer Key

1	A	
2	D	
3	B	
4	A	
5	C	
6	A	
7	B	
8	C	

9	B	
10	B	
11	C	
12	A	
13	A	
14	A	
15	C	

16	I	C
	II	C
	III	B
	IV	B
	V	C
17	I	A
	II	D
	III	A
	IV	B
	V	C

18	I	D
	II	C
	III	D
	IV	C
	V	B
19	I	B
	II	C
	III	B
	IV	C
	V	D

20	I	B
	II	A
	III	C
	IV	D
	V	A

Chapter 5 - Magnetism and Matter

MULTIPLE CHOICE QUESTIONS

1. What is the dimensional formula of magnetic pole strength

a)$[M^0L^{-1}T^0A^1]$ b))$[M^0L^1T^0A^1]$ C))$[M^2L^1T^0A^2]$ D))$[M^0L^2T^0A^1]$

2. A wire of length 2m is bent to form a circular coil of single turn. What is its magnetic moment in Am^2 if the current in the coil is 1A

a) $2/\pi$ $b)3/\pi$ c) $1/\pi$ d) $1/2\ \pi$

3. A circular coil of wire n turns has a radius r and carries a current I . Its magnetic dipole moment is M .

Now the coil is unwound and again rewound into a circular coil of half the initial radius and the

same current is passed through it, then the dipole moment of this new coil is

(a)M/2 **(b)M/4** **(c)M** **(d)2M**

4. A uniform copper wire of length **L** is bent into a circular coil of two turns and a current **i** is passed through it. The coil now behaves like a magnetic dipole of moment

(a) $iL^2/16\pi$ **(b) $iL^2/8\pi$** **(c) $iL^2/4\pi$** **(d) $iL^2/2\pi$**

5. The primary origin of magnetism lies in

(a) atomic current and intrinsic spin of electrons.
(b) polar and non polar nature of molecules.
(c) pauli exclusion principle.
(d) electronegatic nature of materials.

6. The expression for magnetic moment of revolving electron is

a)evr/2 b)(eh/4πm)n **c)(e/2m)L** **d) all the above**

7. The orbital speed of electron orbiting around a nucleus in a circular orbit of radius 50pm is 2.2×10^6m/s.Then the magnetic moment of electron is

a)$8.8\times10^{-24}Am^2$ b) $1.6\times10^{-19}Am^2$ c)$8.8\times10^{-30}Am^2$ d)None of these

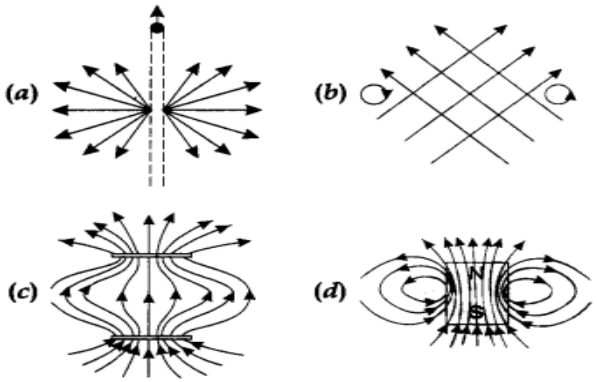
8. A closely wound solenoid of 800 turns and area of cross section $2.5\times10^{-4}m^2$ carries a current of 3.0A. What is its associated magnetic moment?

a)$0.5Am^2$ b) 0.6Am c) 0.5Am d) $0.6Am^2$

9. Magnetic moment for solenoid and corresponding bar magnet is

(a) equal for both (b) more for solenoid
(c) more for bar magnet (d) none of these

10. Point out the correct direction of magnetic field in the given figures.



11. . The earth behaves as a magnet with magnetic field pointing approximately from the geographic

(a) North to South

(b) South to North

(c) East to West

(d) West to East

12. Lines of force, due to earth's horizontal magnetic field, are

(a) elliptical

(b) curved lines

(c) concentric circles

(d) parallel and straight

13. The earth's magnetic field at the equator is approximately 0.4 G. What is the estimated value of the earth's dipole moment **is (The radius of the earth is R=6.4 x10^{24} m)**

(a) 1.05 x10^{23} Am

(b) 1.05 x10^{23} Am^2

(c) 2.05 x10^{23} Am^2

(d) 3.05 x10^{23} Am^2

14. If the angles of dip at two places are 30^0 and 45^0 respectively, then the ratio of horizontal components of earth's magnetic field at the two places will be:

(a) $\sqrt{3} : \sqrt{2}$ (b) $1 : \sqrt{2}$ (c) $1 : \sqrt{3}$ (d) 1 : 2

15. Which of the following statement is not correct about the magnetic field?

(a) Magnetic field lines form a continuous closed curve.

(b) Magnetic field line do not interest each other.

(c) Direction of tangent at any point on the magnetic field line curve gives the direction of magnetic field at that point.

(d) Outside the magnet, magnetic field lines go from South to North pole of the magnet.

16.The magnetic field lines inside a bar magnet:

(a) do not exist

(b) depends on area of cross-section of bar magnet

(c) are from N-pole to S-pole of the magnet

(d) are from S-pole to N-pole of the magnet.

17. The Direction of net magnetic field at any point in the magnetic field is----------

a) Always South to North at all points of the field

b) Always North to South at all points of the field

c) Tangential to the field line at that point

d) Normal to the field line at that point

18. . What is the strength of magnetic field known as _____

a) Magnetic flux

b) Density

c) Intensity of magnetisation.

d) Magnetic flux density

19.The net magnetic flux through any closed surface, kept in a magnetic field is

(a) zero (b) $\mu_0/4\pi$ (c) $4\pi/\mu_0$ (d) $4\mu_0/\pi$

20.At a place the angle of dip is 30°. If the horizontal component of earth's magnetic field is H_E, then the total field intensity will be given by

(a) H_E /2 (b) 2 H_E /√3 (c) H_E / √2 (d) H_E /√3

21.The Earth always have both horizontal and vertical components everywhere.

a)True

b)False

22.When is the angle of dip at a place equal to 45^o?

a) When the vertical and horizontal components of earth's magnetic field are equal

b) When the vertical component is twice the horizontal component of earth's magnetic field

c) When the vertical component is half the horizontal component of earth's magnetic field

d) When either the vertical component or the horizontal components of earth's magnetic field is equal to zero

23.The magnetic field of Earth can be modelled by that of a point dipole placed at the centre of the Earth. The dipole axis makes an angle of 11.3° with the axis of Earth. At Mumbai, 'declination is nearly zero. Then,

(a) the declination varies between 11.3° W to 11.3° E.

(b) the least declination is 0°.
(c) the plane defined by dipole axis and Earth axis passes through Greenwich.
(d) declination averaged over Earth must be always negative.

24.Which of the following is responsible for the earth's magnetic field?

(a) Convective currents in earth's core
(б) Diversive current in earth's core.
(c) Rotational motion of earth.
(d) Translational motion of earth.

25 How many quantities are required to specify the magnetic field of the earth?

a). 1
b). 2
c). 3
d). 4

26.. Which of the following is the definition for magnetic meridian of Earth?
a) Vertical plane passing through the axis of a freely suspended or pivoted magnet
b) Horizontal plane passing through the axis of a freely suspended or pivoted magnet
c) Vertical plane passing through the geographical North Pole and South Pole at a given place
d) Horizontal plane passing through the geographical North Pole and South Pole at a given place

27. Which among the following is denoted by δ?

a) Horizontal component
b) Magnetic meridian
c) Magnetic declination
d) Magnetic inclination

28. A long magnet is cut into two parts such that the ratio of their lengths is 2:1. What is the ratio pole strength of both the section?

a. 1:2
b. 2:1
c. 4:1
d. Equal

29.Which of the following statements is true about magnetic field intensity?

a. Magnetic field intensity is the number of lines of force crossing per unit volume.
b. Magnetic field intensity is the number of lines of force crossing per unit area.
c. Magnetic field intensity is the magnetic induction force acting on a unit magnetic pole.
d. Magnetic field intensity is the magnetic moment per unit volume.

30.. What happens to the magnetic moment if a hole is made at the centre of a bar magnet?

a. Decreases
b. Increases
c. Does Not change
d. None of the above
e. II Assertion and Reasoning type of questions

Directions for assertion & reason questions

These questions consist of two statements each , printed as assertion and reason. while answering these questions you have to choose any one of the following four responses.

(A) if both assertion& reason are true &the reason is a correct explanation of the assertion.
(B) if both assertion& reason are true but the reason is not a correct explanation of the assertion.
(C) if assertion is true but the reason is false.
(D) if assertion is false but reason is true

31 . **Assertion :** When radius of a circular loop carrying current is doubled, its magnetic moment becomes four times.
Reason : Magnetic moment depends on area of the loop.

32. **Assertion :**The magnetic moment (μ) of an electron revolving around the nucleus decreases with increasing principle quantum number (n).
Reason : Magnetic moment of the revolving electron $\mu \propto n$

33. **Assertion :** The magnetic field produced by a current carrying solenoid is independent of its length and cross-sectional area.
Reason : The magnetic field inside the solenoid is uniform.

34. **Assertion :**The ends of a magnet suspended freely point out always along north south direction.
Reason : Earth behaves as a huge magnet.

35. **Assertion :The angle of dip is maximum at the poles of the earth.**
Reason :The magnetic field lines are parallel to the surface of the earth at the poles.

KEY FOR THE QUESTIONS

1. b	2.c	3.a	4.b	5.a
6.d	7.a	8.d	9.a	10.d
11.b	12.d	13.b	14.a	15.d

16.d	17. c	18.d	19.a	20.b
21.b	22.a	23.a	24.a	25.c
26.a	27.d	28.d	29.c	30.c
31.b	32.d	33.b	34.a	35.c

Hints:

2. Length of the wire =2m, when bent becomes circumference (c) of the loop, whose radius is given by :

$r=c/2\pi=(2/2\pi)=(1/\pi)$

Thus, area of loop :-

$A=\pi r^2=\pi(1/\pi)^2=1/\pi\ m^2$

So, the magnetic moment of the loop in,

$M=IA=(1/\pi)Am^2$.

3.

The length of remains same $N_1\pi * r = N_2\pi * r/2$

$N_2 = 2n$

$M = NAI = nI\pi * r^2$

$M_2 = N_2I * \pi * (r/2)^2 = 2n * I\pi * (r^2/4)$

$\frac{M_2}{M} = \frac{1}{2}$

$M_2 = \frac{M}{2}$

4.

Wire is bent into a circular coils of two turns

$l = 2 \times 2\pi r$

$r = \frac{l}{r\pi}$

magnetic dipole moment$= n \times i \times A = n \times i \times \pi r^2 = 2i\left(\frac{l^2}{16\pi^2}\right)\pi = \frac{iL^2}{8\pi}$

7.

Magnetic dipole moment

$$m = iA = \frac{e}{T} \times \pi r^2 = \frac{e}{(2\pi r/v)} \times \pi r^2 = \frac{erv}{2}$$

$$= \frac{1.6 \times 10^{-19} \times 50 \times 10^{-12} \times 2.2 \times 10^{6}}{2}$$

$$= 8.8 \times 10^{-24} Am^2$$

8.

Given: n=800,

A=2.5×$10^{-4}$$m^2$,

I=3.0A

A magnetic field develops along the axis of the solenoid. Therefore current-carrying solenoid acts like a bar magnet.

m=nIA=800×3×2.5×10^{-4}

=0.6Am^2 along the axis of the solenoid.

13.Bequatorial=μ0/4π×M/d^3⇒

Here μ0 is the permeability of free space, M is the dipole moment of the magnet, d is the distance of the point from the equator of the magnet, and

Bequatorials the magnetic field of the magnetic field at the equator of the magnet.

for any point on the equator d=R=6400Km=6400×10^3m

Also, the value of the magnetic field is given as

⇒B=0.4G=0.4×10^{-4},T

On calculation

Earth's dipole moment at the equator will be 1.05×$10^{23}$$Am^2$

14

Correct option is **B** $1:\sqrt{2}$

The horizontal component of earth's magnetic field is given by , $H = R\cos\delta$

where, δ is the angle of dip so $H_1 = R\cos 30^\circ$

and $H_2 = R\cos 45^\circ$

$$\therefore \frac{H_1}{H_2} = \frac{R\cos 30^\circ}{R\cos 45^\circ} = \frac{\sqrt{3}/2}{1/\sqrt{2}} = \frac{\sqrt{3}}{\sqrt{2}}$$

20A

The Horizontal component of magnetic field intensity is given by,

$I\cos\theta = H$

(from the data given from question)

$$I\frac{\sqrt{3}}{2} = B_H$$

$$I = \frac{2B_H}{\sqrt{3}}$$

Chapter 6 - ELCTRO MAGNETIC INDUCTION

1) Lenz's law of electromagnetic induction is as per law of conservation of
   (a) energy.
   (b) angular momentum.
   (c) charge.
   (d) electromotive force.

2) Which of the following statements is not correct?

(a) Whenever the amount of magnetic flux linked with a circuit changes, an emf is induced in circuit.

(b) The induced emf lasts so long as the change in magnetic flux continues.

(c) The direction of induced emf is given by Lenz's law.

(d) Lenz's law is a consequence of the law of conservation of momentum.

3) Which of the following does not use the application of eddy current?

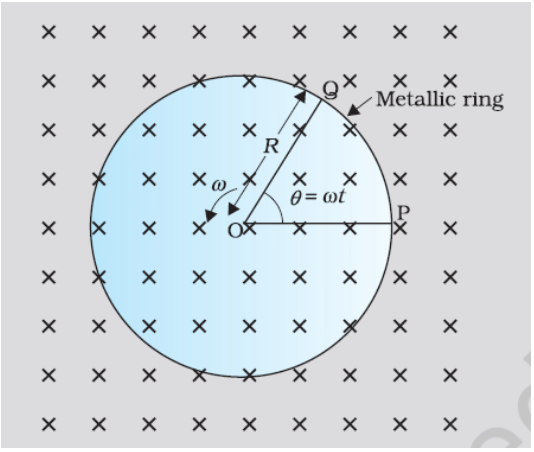
(a) Electric power meters

(b) Induction furnace

(c) LED lights

(d) Magnetic brakes in trains

4) A metallic rod of length ' L' is rotated with a angular frequency of ' ω ' , with one end hinged at the centre and the other end at the circumference of circular metallic ring of radius 'R', about an axis passing through the centre and perpendicular to the plane of the ring as shown in the figure. A constant and uniform magnetic field 'B' parallel to the axis is present everywhere. What is the emf between the centre and the metallic ring?



a) (BωR)/2

b) ($B\omega^2R$)/2

c) ($B\omega R^2$)/2

d) ($B^2\omega R$)/2

5) In the given figure current from A to B in the straight wire is increasing. The direction of the induced current in the loop is

(a) clockwise.

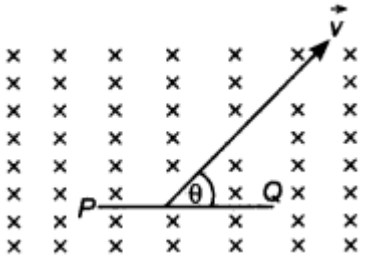
(b) anticlockwise.

(c) straight line.

(d) no induced e.m.f. produced.

6) A rod PQ of length 'L' is moved in uniform magnetic field '**B**' as shown.

If the rod is moving with a velocity 'v' making an angle 'θ' with the magnetic field. What will be the emf induced in it?



a) BLvsinθ
b) BLvcosθ
c) BLv
d) BLvtanθ

7) When current in a coil changes from 5 A to 2 A in 0.1 s, averagevoltage of 50 V is produced. The self-inductance of the coil will be.

(a) 1.67 H (b) 6 H (c) 3 H (d) 0.67 H

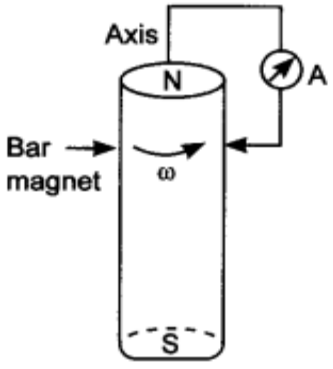
8) The north pole of a long bar magnet was pushed slowly into a short solenoid connected to a galvanometer. The magnet was heldstationary for a few seconds with the north pole in the middle of the solenoid and then withdrawn rapidly. The maximum deflection of the galvanometer was observed when the magnet was

(a) moving towards the solenoid (b) moving into the solenoid
(c) at rest inside the solenoid (d) moving out of the solenoid

9) If number of turns in primary and secondary coils is increased to two times each, the mutual inductance.

(a) becomes 4 times
(b) becomes 2 times
(c) becomes 8 times
(d) remains unchanged

10) A cylindrical bar magnet is rotated about its axis (Figure). A wire is connected from the axis and is made to touch the cylindrical surface through a contact. Then



(a) A direct current flow in the ammeter A.
(b) No current flows through the ammeter A.
(c) An alternating sinusoidal current flow through the ammeter A with a time period T = 2πω
(d) A time varying non-sinusoidal current flows through the ammeter.

11) The polarity of the induced emf is given by
a) Ampere' circuital law
b) Biot- Savart Law
c) Lenz's law
d) Fleming's right-hand rule

12) Which of the following statements is correct?
a) The induced e.m.f is not in the direction opposing the change in magnetic flux so as to
oppose the cause which produces it.
b) The relative motion between the coil and magnet produces change in magnetic flux
c) EMF is induced only if the magnet is moved towards coil.
d) EMF is induced only if the coil is mover towards magnet.

13) SI unit of magnetic flux
a) weber
b) tesla x meter
c) tesla
d) Gauss

14) Flux is a
a) Vector quantity
b) Scalar quantity
c) Phasor
d) negative quantity

15) Which of the following statements is wrong for magnetic flux
a) Magnetic flux can be negative
b) Magnetic flux can be positive
c) Magnetic flux can be zero
d) Magnetic flux is always positive or negative.

Assertion and Reason questions

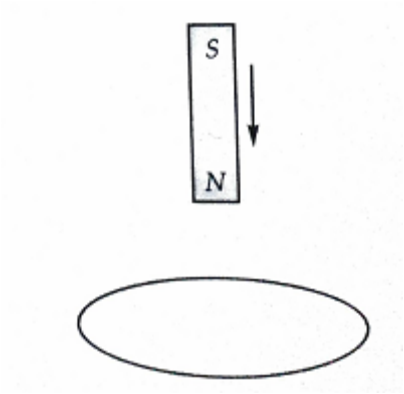
Each question contains Assertion and Reason. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Select the correct choice:

Choices are:

(A) Assertion is True, Reason is True and Reason is a correct explanation for Assertion.
(B) Assertion is True, Reason is True but Reason is **NOT** a correct explanation for Assertion.
(C) Assertion is True, Reason is False.
(D) Assertion isFalse, Reason is False.

16) Assertion: The bar magnet falling vertically along the axis of the horizontal coil

will be having acceleration less than 'g'



Reason: Clock wise current is induced in the coil

17) **Assertion**: The presence of large magnetic flux through a coil maintains a current in the coil, if the circuit is continuous.

Reason: Only a change in magnetic flux will maintain an induced current in the coil.

18) **Assertion**: If a coil is rotated in uniform magnetic field about an axis perpendicular to the field, emf induced in coil is maximum for orientation of coil in which magnetic flux through the coil is zero.

Reason: Work done to rotate the coil will get converted into electrical energy.

19) **Assertion:** Magnetic flux linked to closed surface is zero.

Reason: Direction of induced current due to change of magnetic flux is given by Faraday's Law.

20) **Assertion:** When two coils are wound on each other, the mutual induction between the coils is maximum.

Reason: Mutual induction does not depend on the orientation of the coils.

KEY, CH - 6, E M Induction

Q.NO	Answer	Explanation
1)	(a) energy	Against to the opposing force work is done. The work done by the external agency get converted in to Electrical energy.
2)	(d) Lenz's law is a consequence of the law of conservation of momentum.	Conservation of Angular momentum (I x ω = constant) has nothing to do with Lenz's law
3)	(c) LED lights	Eddy current cannot make an LED glow.
4)	c) $(B\omega R^2)/2$	Simple derivation
5)	(a) clockwise.	According to Lenz's law
6)	a) BLvsinθ	The component of velocity which contribute to the motional emf is v sinθ
7)	a) 1.67 H	e = - $L\frac{dI}{dt}$, By substituting the values of e, dI , dt the value of L can be calculated.
8)	(d) moving out of the solenoid	As the magnet is pulled out with maximum velocity the emf generated is also proportionately more.
9)	(a) becomes 4 times	Mutual Inductance is $\mu_0 n_1 n_2 \pi r^2 l$
10)	(a) a direct current flow in the ammeter A.	As there is no variation of θ the current generated is DC
11)	c) Lenz's law	Lenz's law gives the polarity of induced emf
12)	b)	All other statements are wrong
13)	a) Weber	Wb is the unit of magnetic flux
14)	b) Scalar quantity	Flux is a dot product of **B** and **A**
15)	d)	Flux can be zero even. It is neither positive nor negative
16)	c) Assertion is true but the reason is false.	Due to change of flux, anticlockwise current is induced in the coil. Which opposes the motion of the magnet of the magnet and so a < g
17)	d) Both Assertion and Reason are wrong	If there is no change in the magnetic flux linked with the coil, there is no induced current. The current induced in a coil is directly proportional to the rate of change of magnetic flux linked with the coil
18)	b) Both the statements are individually true	Reason is not relevant for Assertion
19)	c) Assertion is True, but reason is false	Faraday's law doesn't explain the direction of current

20)	c) Assertion is True but reason is false	Mutual induction depends on orientation of coils.

SECTION -A

1) Lenz's law is consequence of the law of conservation of

(a) Charge (b) Momentum

(c) Mass (d) Energy

2) The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in time Δt, Then the total quantity of electric charge Q, which passing during this time through any point of the circuit is given

(a) $Q = \frac{\Delta\phi}{\Delta t}$ (b) $Q = \frac{\Delta\phi}{\Delta t} \times R$

(c) $Q = -\frac{\Delta\phi}{\Delta t} + R$ (d) $Q = \frac{\Delta\phi}{R}$

3) A copper ring is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet while it is passing through the ring is

(a) Equal to that due to gravity

(b) Less than that due to gravity

(c) More than that due to gravity

(d) Depends on the diameter of the ring and the length of the magnet

4) In a coil of area $10\ cm^2$ and 10 turns with a magnetic field directed perpendicular to the plane and is changing at the rate of 10^8 *gauss/second*. The resistance of the coil is 20 *ohm*. The current in the coil will be

(a) 5 *amp* (b) 0.5 *amp*

(c) 0.05 *amp* (d) 5×10^8 *amp*

5) A 10 *metre* wire kept in east-west falling with velocity 5 *m/sec* perpendicular to the field $0.3 \times 10^{-4} Wb/m^2$. The induced e.m.f. across the terminal will be

(a) 0.15 *V* (b) 1.5 *mV*

(c) 1.5 *V* (d) 15.0 *V*

6) A metal rod moves at a constant velocity in a direction perpendicular to its length. A constant uniform magnetic field exists in space in a direction perpendicular to the rod as well as its velocity. Select the correct statement(s) from the following

(a) The entire rod is at the same electric potential

(b) There is an electric field in the rod

(c) The electric potential is highest at the centre of the rod and decreases towards its end
(d)The electric potential is lowest at the centre of the rod and increases towards its end

7) A wheel with ten metallic spokes each 0.50 *m* long is rotated with a speed of 120 *rev/min* in a plane normal to the earth's magnetic field at the place. If the magnitude of the field is 0.4 Gauss, the induced e.m.f. between the axle and the rim of the wheel is equal to

(a) $1.256 \times 10^{-3}\ V$ (b) $6.28 \times 10^{-4}\ V$ (c) $1.256 \times 10^{-4}\ V$ (d) $6.28 \times 10^{-5}\ V$

8) An e.m.f. of 5 *volt* is produced by a self inductance, when the current changes at a steady rate from 3 *A* to 2 *A* in 1 millisecond. The value of self inductance is

(a) Zero (b) 5 *H*
(c) 5000 *H* (d) 5 *mH*

9) A 50 *mH* coil carries a current of 2 *ampere.* The energy stored in joules is
(a) 1 (b) 0.1
(c) 0.05 (d) 0.5

10) The number of turns in the coil of an ac generator is 5000 and the area of the coil is $0.25\ m^2$. The coil is rotated at the rate of 100 *cycles/sec* in a magnetic field of 0.2 W/m^2. The peak value of the emf generated is nearly

(a) 786 *kV* (b) 440 *kV*
(c) 220 *kV* (d) 157.1 *kV*

11) The core of a transformer is laminated to reduce energy losses due to
(a) Eddy currents (b) Hysteresis
(c) Resistance in winding (d) None of these

12) The inductance of a solenoid 0.5 *m* long of cross-sectional area 20 cm^2 and with 500 turns is

(a) 12.5 *mH* (b) 1.25 *mH*
(c) 15.0 *mH* (d) 0.12 *mH*

13) The number of turns of primary and secondary coils of a transformer are 5 and 10 respectively and the mutual inductance of the transformer is 25 *henry*. Now the number of turns in the primary and secondary of the transformer are made 10 and 5 respectively. The mutual inductance of the transformer in *henry* will be

(a) 6.25 (b) 12.5
(c) 25 (d) 50

SECTION –B

DIRECTIONS FOR ASSERTION & REASON QUESTIONS

These questions consist of two statements each , printed as Assertion and Reason. While answering these Questions you are requested to choose any one of the following four responses.

(E) IF BOTH ASSERTION& REASON ARE TRUE &THE REASON IS A CORRECT EXPLANATION OF THE ASSERTION.

(F) IF BOTH ASSERTION& REASON ARE TRUE BUT THE REASON IS NOT A CORRECT EXPLANATION OF THE ASSERTION.

(G) IF ASSERTION IS TRUE BUT THE REASON IS FALSE.

(H) IF ASSERTION IS FALSE BUT REASON IS TRUE

14) Assertion: Whenever magnetic flux linked with the coil changes with respect to time,then an emf is induced in it.

Reason: According to Lenz's law ,the direction of induced current in any coil in such a way that it always opposes the cause by which it is produced.

15) Assertion: A small magnet takes longer time in falling in a hollow metallic tube with out touching the wall.

Reason: There is opposition of motion due to production of eddy currents in a metallic tube.

16) Assertion: On moving a straight wire of copper in a uniform magnetic field cutting the lines of force, an emf is induced between the ends of the wire.

Reason : The Lorentz force acts on the free electrons of copper wire when moved in magnetic field .

17) Assertion: The phenomenon of self induction is helpful in working of a choke coil .

Reason : A choke coil is used for reducing energy loss in the circuit .

18) Assertion: When two coils are wound on each other ,the mutual induction between the coils is maximum .

Reason :Mutual induction does not depend on the orientation of the coils .

KEY AND SOLUTIONS (FOR CHAPTER 6. E.M.I)

SECTION-A

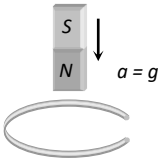
1. (d) The energy of the field increases with the magnitude of the field. Lenz's law infers that there is an opposite field created due to increase or decrease of magnetic flux around a conductor so as to hold the law of conservation of energy.

2. (b) We know that $e = \frac{d\phi}{dt}$

But $e=iR$ and $i = \frac{dq}{dt} \Rightarrow \frac{dq}{dt} R = \frac{d\phi}{dt} \Rightarrow dq = \frac{d\phi}{R}$

3. (b) When the magnet is allowed to fall vertically along the axis of loop with its north pole towards the ring. The upper face of the ring will become north pole in an attempt to oppose the approaching north pole of the magnet. Therefore the acceleration in the magnet is less than *g.*

Note : If coil is broken at any point then induced *emf* will be generated in it but no induced current will flow. In this condition the coil will not oppose the motion of magnet and the magnet will fall freely with acceleration *g*. (*i.e. a = g*)

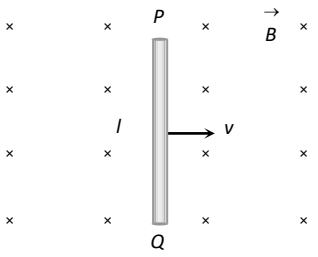


4. (a) $I = \frac{e}{R} = \frac{-N(d\phi/dt)}{R} = \frac{10 \times 10^{8} \times 10^{-4} \times 10^{-4} \times 10}{20}$ = 5 *A*

5. (b) Induced e.m.f. $= Blv = 0.3 \times 10^{-4} \times 10 \times 5$

$= 1.5 \times 10^{-3} V = 1.5\ mV$

6. (b) A motional emf $e = Bvl$ is induced in the rod, or we can say, a potential difference is induced between the two ends of the rod , with *P* at higher potential and *Q* at lower potential. Due to this potential difference, there is an electric field in the rod.



7. (d) $e = Bl^2 \pi\nu = 0.4 \times 10^{-4} \times (0.5)^2 \times (3.14) \times \frac{120}{60}$

$= 6.28 \times 10^{-5} V$

8. (d) $L = \frac{e}{di/dt} = \frac{5}{(3-2)/10^{-3}} = \frac{5}{1} \times 10^{-3} = 5 millihenry$

9. (b) Energy stored $E = \frac{1}{2} Li^2 = \frac{1}{2} \times 50 \times 10^{-3} \times 4 = 0.1\ J$

10. (d) $e_0 = \omega NBA = (2\pi\nu)\, NBA$

$= 2 \times 3.14 \times 1000 \times 5000 \times 0.2 \times 0.25$ = 157 *kV*

11. (a) Circulation of eddy currents is prevented by use of laminated core.

12. (b) S $L = \frac{\mu_0 N^2 A}{l} = \frac{4\pi \times 10^{-7} \times (500)^2 \times 20 \times 10^{-4}}{0.5}$ =1.25*mH*

13. (c) $M = \frac{\mu_0 N_1 N_2 A}{l}$

SECTION-B

14. (B) 15. (A) 16. (A) 17. (B)

18. (C)

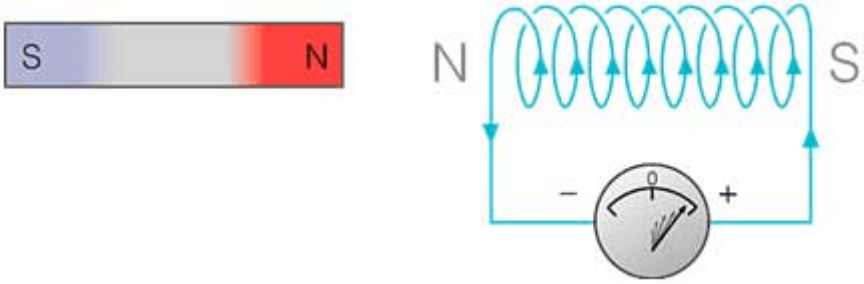
SECTION –C
CASE STUDY QUESTIONS AND ANSWERS
CH 6.EMI

19)

Lenz's law states that ,The induced electromotive force with different polarities induces a current whose magnetic fieldopposes the change in magnetic flux through the loop in order to ensure that original flux is maintained through the loop when current flows in it.

To better understand Lenz's law, let us consider two cases:

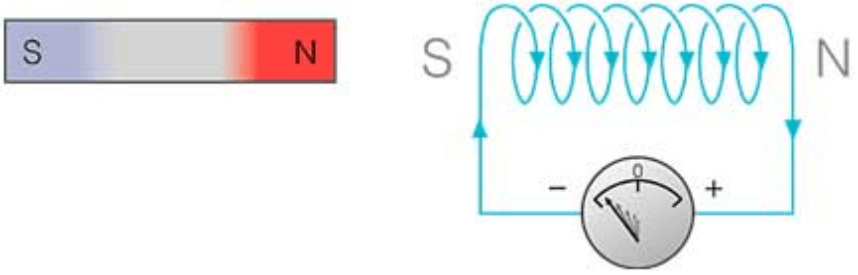
Case 1: When a magnet is moving towards the coil.



When the north pole of the magnet is approaching towards the coil, the magnetic flux linking tothe coil increases. According to Faraday's law of electromagnetic induction, when there is a change in flux, an EMF, and hence current is induced in the coil and this current will create its own magnetic field.

Now according to Lenz's law, this magnetic field created will oppose its own or we can say opposes the increase in flux through the coil and this is possible only if approaching coil side attains north polarity, as we know similar poles repel each other. Once we know the magnetic polarity of the coil side, we can easily determine the direction of the induced current by applyingright hand rule. In this case, the current flows in the anticlockwise direction.

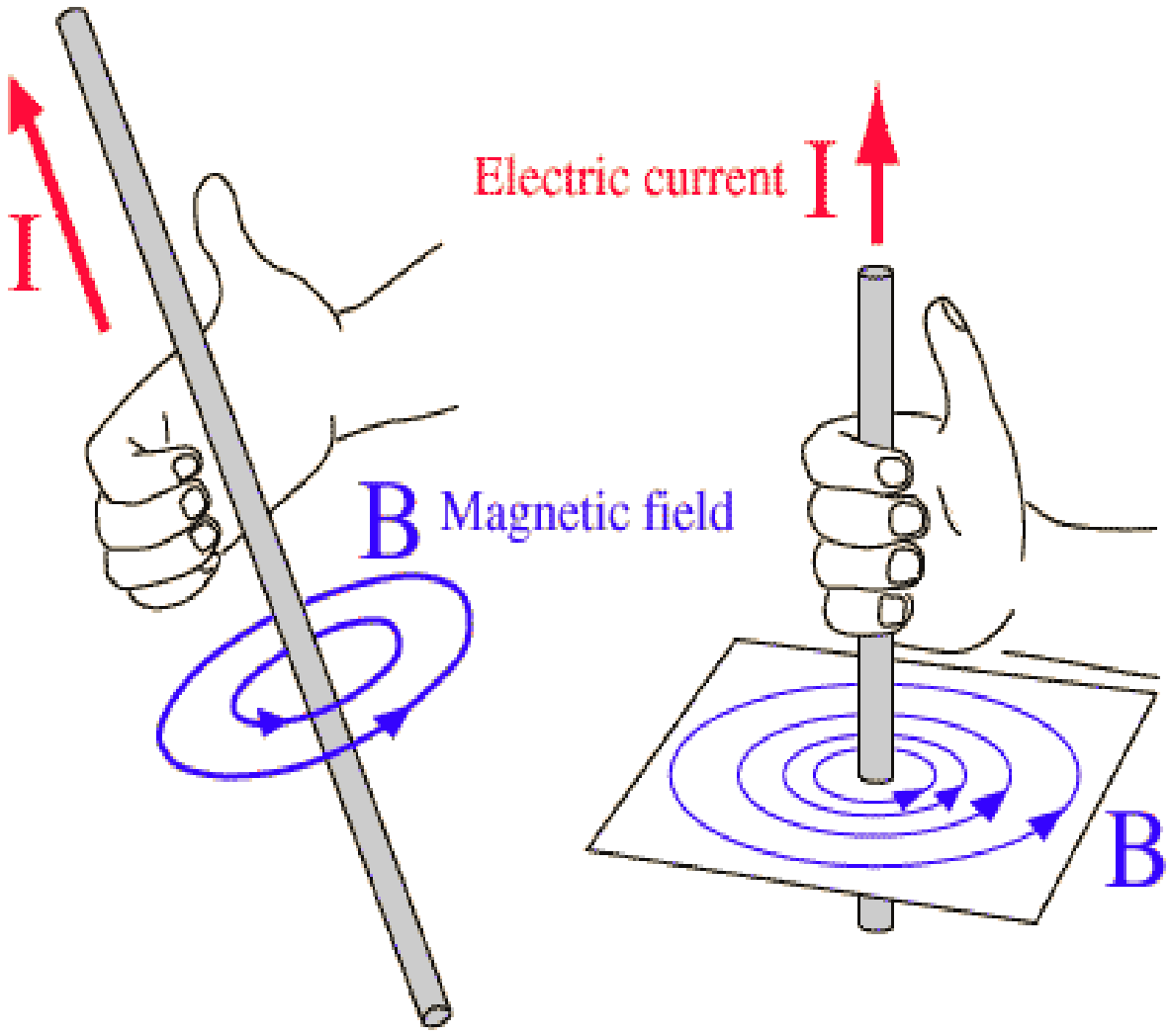
Case 2: When a magnet is moving away from the coil



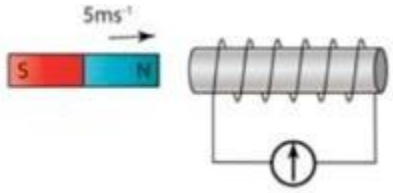
When the north pole of the magnet is moving away from the coil, the magnetic flux linking to the coil decreases. According to Faraday's law of electromagnetic induction, an EMF and hence current is induced in the coil and this current will create its own magnetic field.

Now according to Lenz's law, this magnetic field created will oppose its own or we can say opposes the decrease in flux through the coil and this is possible only if approaching coil side attains south polarity, as we know dissimilar poles attract each other. Once we know the magnetic polarity of the coil side, we can easily determine the direction of the induced current by applying right hand rule. In this case, the current flows in a clockwise direction.

> Note that for finding the directions of magnetic field or current, use the right-hand thumb rule i.e if the fingers of the right hand are placed around the wire so that the thumb points in the direction of current flow, then the curling of fingers will show the direction of the magnetic field produced by the wire.



1. What is the direction of the induced magnetic field?



(a) Left

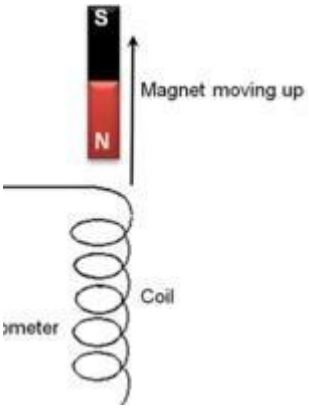
(b) right

(c) up

(d) down

Ans. (a) left

2. What is the direction of the induced magnetic field?



(a) left

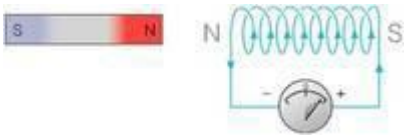
(b) right

(c) up

(d) down

Ans. (d) down

3. In what direction is the magnet moving?



(a) left

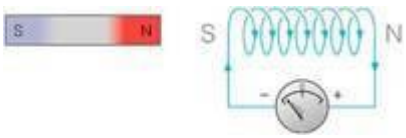
(b) right

(c) up

(d) down

Ans. (b) right

4. In what direction is the magnet moving?



(a) left

(b) right

(c) up

(d) down

Ans. (a) left

5. Which of the following is NOT an application of Lenz's Law

(a)Transformer

(b) AC Generator

(c) DC Motor

(d)A coil transversed by AC current

Ans.(c) DC Motor

20)

According to Faraday's law of electromagnetic induction, there will be an EMF induced in the second winding. If the circuit of this secondary winding is closed, then a current will flow through it. This is the basic working principle of a transformer.

Let us use electrical symbols to help visualize this. The winding which receives electrical power from the source is known as the 'primary winding'. In the diagram below this is the 'First Coil'. The winding which gives the desired output voltage due to mutual induction is commonly known as the 'secondary winding'. This is the 'Second Coil' in the diagram above.

A transformer that increases voltage between the primary to secondary windings is defined as a step-up transformer. Conversely, a transformer that decreases voltage between the primary to secondary windings is defined as a step-down transformer.
Whether the transformer increases or decreases the voltage level depends on the relative number of turns between the primary and secondary side of the transformer.
If there are more turns on the primary coil than the secondary coil than the voltage will decrease (step down).

If there are less turns on the primary coil than the secondary coil than the voltage will increase (step up).

While the diagram of the transformer above is theoretically possible in an ideal transformer – it is not very practical. This is because in the open air only a very tiny portion of the flux produced from the first coil will link with the second coil. So the current that flows through the closed circuit connected to the secondary winding will be extremely small (and difficult to measure). The rate of change of flux linkage depends upon the amount of linked flux with the second winding. So ideally almost all of the flux of primary winding should link to the secondary winding. This is effectively and efficiently done by using a core type transformer. This provides a low reluctance path common to both of the windings.

1. The secondary winding of which of the following transformers is always kept closed?

(a)Current transformer

(b)Voltage transformer

(c)Power transformer

(d)Step down transformer

Ans. (a) Current Transformer

2. If the supply frequency of a transformer increases, the secondary output voltage of thetransformer

(a) Increase
(b)Decrease

(c)Remain the same

(d)Any of the above

Ans.(c) Remain the same

3. The open-circuit test in a transformer is used to measure(a)Copper loss

(b)Winding loss

(c)Total loss

(d)Core loss

Ans.(d) Core loss

4. Lamination of the transformer core is made of

(a)Cast Iron

(b)Silicon Steel

(c)Aluminum

(d)Cast Steel

Ans.(b) Silicon Steel

5. A transformer transform

(a)Current

(b)Voltage & current

(c)Frequency

(d)Voltage

Ans.(b) Voltage & current

21)

Definition: Mutual Inductance between the two coils is defined as the property of the coil due to which it opposes the change of current in the other coil, or you can say in the neighbouring coil. When the current in the neighbouring coil changes, the flux sets up in the coil and becauseof this, changing flux emf is induced in the coil called Mutually Induced emf and the phenomenon is known as Mutual Inductance.

The value of Mutual Inductance (M) depends upon the following factors

1. Number of turns in the secondary or neighboring coil
2. Cross-sectional area
3. Closeness of the two coils

Mutual Coupling In the Magnetic Circuit

When on a magnetic core, two or more than two coils are wound, the coils are said to be mutually coupled. The current, when passed in any of the coils wound around the magnetic core,produces flux which links all the coils together and also the one in which current is passed.
Hence, there will be both self-induced emf and mutual induced emf in each of the coils.
The best example of the mutual inductance is the transformer, which works on the principleof Faraday's Law of Electromagnetic Induction.
Faraday's law of electromagnetic induction states that " the magnitude of voltage is directly proportional to the rate of change of flux." which is explained in the topic Faraday's Law of Electromagnetic Induction.

1. The phenomenon due to which there is an induced current in one coil due to current in a neighbouring coil is?

A. Electromagnetism

B.Susceptance C.Mutual

inductance

D.Steady current

Ans. (c) Mutual Inductance

2. Mutual inductance between two magnetically coupled coils depends on

A. Permeability of the core material
B. Number of turns of the coils
C. Cross sectional area of their common core
D. All of the aboveAns. (D)

3. Which of the following is unit of inductance?

A. Ohm
B. Henry
C. Ampere turns
D. Webers/meter
Ans. (B) Henry

4. Which of the following circuit elements will oppose the change in circuit current?

A. Capacitance
B. Inductance
C. Resistance
D. All of the above
Ans.(B) Inductance

5. If in an iron cored coil the iron core is removed so as to make the air cored coil, the inductance of the coil will be

A. More
B. Less
C. The same
D. None of these
Ans.(B) Less

Chapter 7: ALTERNATING CURRENT CIRCUITS

MCQ's

1. In an ac circuit, *V* and *I* are given by V = 100 sin (100t) Volt, $I = 100 \sin\left(100t + \frac{\pi}{3}\right)$ mA. The power dissipated in the circuit is

(a) 10^4 watt (b) 10 watt (c)2.5 watt (d)5 watt

Ans: c

$P = V_{rms} I_{rms} \cos\theta$

2. An alternating e.m.f. is applied to purely capacitive circuit. The phase relation between e.m.f. and current flowing in the circuit is

(a) e.m.f. is ahead of current by $\pi/2$

(b) Current is ahead of e.m.f. by $\pi/2$

(c) Current lags behind e.m.f. by π

(d) Current is ahead of e.m.f. by π

Ans: b

3. Voltage and current in an ac circuit are given by V = 5 sin ($100\pi t - 30^0$) and I = 4 sin($100\pi t + 30^0$)

(a) Voltage leads the current by 30^o

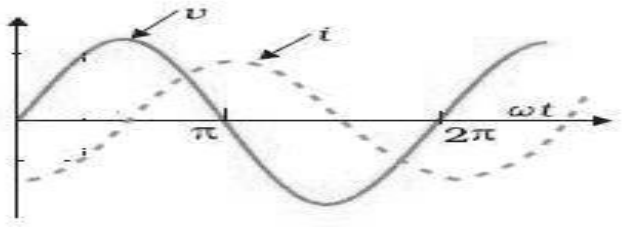
(b) Current leads the voltage by 30^o

(c) Current leads the voltage by 60^o

(d) Voltage leads the current by 60^o

Ans: c

4. The given figure shows the variation of V and I vs ωt for a circuit element connected to A.C mains. Name the circuit element



(a) Resistance

(b) Capacitor

(c) Inductor

Ans: b

Capacitor

5.In a series LCR Series circuit, the voltages across Inductor, capacitor and Resistances are 20V,20V,40V respectively. The phase difference between the supplied voltage and current in the circuit is

(a) 30^0 (b) 60^0 (c) 90^0 (d) 0^0

Ans: d

Since voltage across Inductor and capacitor are same, circuit is in resonance. Phase difference is 0^0

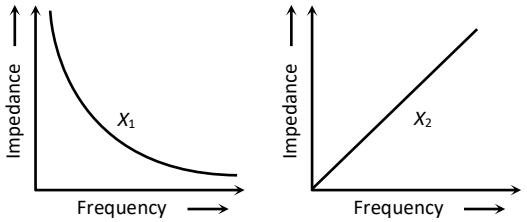
6. If an 8Ω resistance and 6Ω reactance are present in an ac series circuit then the impedance of the circuit will be

(a) 20 *ohm* (b) 5 *ohm* (c) 10 *ohm* (d) $14\sqrt{2}$ *ohm*

Ans: (c)

Ans $Z^2 = R^2 + X^2$

7. The graphs given below depict the dependence of two reactive impedances X_1 and X_2 on the frequency of the alternating e.m.f. applied individually to them. We can then say that



(a) X_1 is an inductor and X_2 is a capacitor

(b) X_1 is a resistor and X_2 is a capacitor

(c) X_1 is a capacitor and X_2 is an inductor

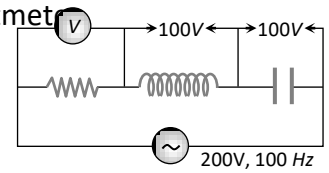
(d) X_1 is an inductor and X_2 is a resistor

Ans: (c)

For capacitor, Capacitative Reactance is inversely proportional to frequency

and For Inductor, Inductive Reactance is directly proportional to frequency

8. In the circuit given below, what will be the reading of the voltmeter



(a)200V (b) 100 V (c) 300V (d) 400V

Ans: (a)

$V^2 = V_R^2 + (V_L - V_c)^2$

9. A capacitor has capacitance C and reactance X, If the capacitance and frequency become double, then reactance will be (a) 4X (b) X/2 (c) X/4 (d) 2x

Ans: (c)

X α (1/fC)

10. A capacitor acts as an infinite resistance for

(a) DC (b) AC (c) Both DC and as well as AC (d) Neither for AC nor DC

Ans: (a)

For DC Frequency is zero

11. High Voltage transmission line is preferred as

(a) its electric appliances are less costly
(b) Thin power cables are required
(c) Idle current is low
(d) Power losses is low
Ans: (d)
Power losses is low

12. In a series LR circuit, $X_L = R$ and power factor of the circuit is P_1 . When capacitor with capacitance C is such that is put in series, the power factor becomes P_2 . The ratio of P_1/P_2 is
(a) 2:1
(b) 1: √2
(c) √2 : 1
(d) 1: 2

Ans: (b)
Hint: Power factor P = R/Z
For LR circuit, $P_1 = 1/\sqrt{2}$
For LCR Series circuit $P_2 = 1$

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true, the reason is the correct explanation of the assertion

(b) If both assertion and reason are true, the reason is the not correct explanation of the assertion

(c) If assertion is true but reason is false

(d) If the assertion and reason both are false

13. Assertion : An inductance and a resistance are connected in series with an ac circuit. In this circuit the current and the potential difference across the resistance lag behind potential difference across the inductance by an angle $\pi/2$.

Reason : In *LR* circuit voltage leads the current by phase angle which depends on the value of inductance and resistance both.

Ans: b

14. Assertion : A capacitor of suitable capacitance can be used in an ac circuit in place of the choke coil.

Reason : A capacitor blocks dc and allows ac only.

Ans: b

15. Assertion : Capacitor serves as a block for dc and offers an easy path to ac.

Reason : Capacitive reactance is inversely proportional to frequency.

Ans: a

16. Assertion : When capacitive reactance is smaller than the inductive reactance in *LCR* current, e.m.f. leads the current .

Reason : The phase angle is the angle between the alternating e.m.f. and alternating current of the circuit.

Ans: b

17. Assertion: Direct current is more dangerous than Alternating current of same value.

Reason: An electrocuted person sticks to direct current line. While alternating current repels the person from the line.

Ans: d

18. Assertion: A transformer can't work on DC supply
Reason -- DC changes neither in magnitude nor in direction
Answer - A

CASE STUDY EXPERIMENT:

According to Faraday's law of electromagnetic induction, there will be an EMF induced in the second winding. If the circuit of this secondary winding is closed, then a current will flow through it. This is the basic working principle of a transformer.
A transformer that increases voltage between the primary to secondary windings is defined as a step-up transformer. Conversely, a transformer that decreases voltage between the primary to secondary windings is defined as a step-down transformer.
Ideal transformer is not very practical. This is because in the open air only a very tiny portion of the flux produced from the first coil will link with the second coil. So the current that flows through the closed circuit connected to the secondary winding will be extremely small (and difficult to measure).
The rate of change of flux linkage depends upon the amount of linked flux with the second winding. So ideally almost all of the flux of primary winding should link to the secondary winding. This is effectively and efficiently done by using a core type transformer. This provides a low reluctance path common to both of the windings.
19. If the supply frequency of a transformer increases, the secondary output voltage of the transformer
(a) Increase (b) Decrease (c) Remains the same (d) any of the above
Ans.(c) Remain the same

20. Which quantity is increased in step-down transformer ?
(a) resistance (b) power (c) current (d) charge
Ans: c

21. The voltage in the secondary coil of a transformer does not depend upon
(a) Frequency of the source (b) Voltage in Primary
(c) Ratio of no. of turns in the two coils (d) Both (b) and (c)
Ans: a

22. The primary winding of transformer has 500 turns whereas its secondary has 5000 turns. The primary is connected to an ac supply of 20 V, 50 Hz. The secondary will have an output of
(a) 200 V, 50 Hz (b) 2 V, 50 Hz (c) 200 V, 500 Hz (d) 2 V, 5 Hz
Ans: (a)

23. The magnitude of the emf induced across the secondary of a transformer does not depend on
(a) the magnitude of the emf applied across the primary
(b) the number of turns in the primary
(c) the number of turns in the secondary
(d) the resistance of the primary and the secondary
Ans: d

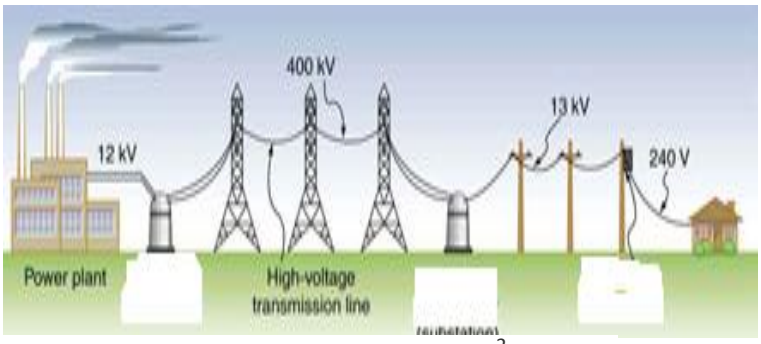
24. Why does stepping voltage reduce power losss?
(a) Since the resistance of the conductor decreases with increase of voltage
(b) Since current decreases with increase of the voltage
(c) Both of the above
(d) None of the above
Ans.(b)

Hint: Power is directly proportional to the current.

25. The physical quantity that remains unchanged in a transformer is

(a) Voltage (b) current (c) Frequency (d) None of these

2. Electrical **power transmission** involves the bulk movement of electrical **energy** from a **generating** site, such as a **power station** or **power plant**, where voltage is stepped up and distributed to electrical substation and from electrical substation where voltage is stepped down and distributed to **consumers** or other substations. The reason electrical power is stepped up to these voltage levels is to make it more efficient by reducing the I^2R losses that take place when power is transmitted. When voltage is stepped up, the current reduces relative to the voltage so that power remains constant, thus reducing these I^2R losses.



26. Name the device which is used to transform voltage from 12kV to 400kV from power plant to substation.

A) AC generator B) Step up Transformer C) Moving coil Galvanometer D) Step down transformer
Ans: B

27. Laminated cores are used in such devices to reduce energy loss due to:
A) Eddy currents B) Flux leakage C) Resistance of the windings D) Hysteresis loss
Ans: A

28. A small town with a power demand of 600 kW at 220 V is situated 20 km away from power plant generating power at 440 V. The resistance of the two wire line carrying power is 0.4 Ω per km. If the

power is transmitted to the substation in the town at 12 kV which the substation steps down to 220 V before supplying to the town, Estimate the line power loss during transmission in the form of heat.

A) 400 kW B) 40 kW C) 600 kW D) 60 kW

Ans: B

(I = P/V = 600000/12000 = 600/12 = 50 A,

Power loss = I^2 R = 50 x 50 x R = 50 x 50 x 0.4 x 40 = 40000 W = 40 kW)

29. High voltage transmission line is preferred as

A) Its appliances are less costly B) Thin power cables are required

C) Idle current is very low D) Power loss is very less

Ans: D

30. Which of the following assumptions are used for deriving the relation:

$$\frac{v_s}{v_p} = \frac{N_s}{N_p}$$

A) The primary resistance and current are small;

B) The same flux links both the primary and the secondary as very little flux escapes from the core

C) The secondary current is small

D) All of the above

Ans: B

MCQ'S IN ALTERNATING CURRENTS

Q 1. A capacitor acts as an infinite resistance for

(a) DC (b) AC

(c) DC as well as AC (d) neither AC nor DC.

Q 2. In an AC circuit current is lagging from the applied voltage then circuit can have

(a) Resistance and inductor

(b) Resistance and capacitor

(c) Both (a) and (b)

(d) None of the above

Q 3. The peak voltage in a 220 V, AC source is

(a) 220 V (b) about 160 V (c) about 310 V (d) 440 V.

Q 4. An AC source is rated 220 V, 50 Hz. The average voltage is calculated in a time interval of 0·01 s. It

(a) must be zero (b) may be zero (c) is never zero (d) is (220/√2)V.

Q 5. The magnetic field energy in an inductor charges form maximum value to minimum value in 5·0 ms when connected to an AC source. The frequency of the source is

(a) 20 Hz (b) 50 Hz (c) 200 Hz (d) 500 Hz.

Q 6. In a series L, R, C, circuit which is connected to a.c. source. When resonance is obtained then net impedance Z will be

(A)Z = R (B) $Z = \omega L - \frac{I}{\omega C}$

(C)Z = ωL (D) $Z = \frac{1}{\omega C}$

Q 7. A series AC circuit has resistance of 4Ω and a reactance of 3Ω. The impedance of the circuit is

(a) 5Ω (b) 7 Ω1 (c) 12/7Ω (d) 7/12Ω

Q 8. Transformers are used

(a) in DC circuits only (b) in AC circuits only

(c) in both DC and AC circuits (d) neither in DC nor in AC circuits

Q 9. An alternating current having peak value 14 A is used to heat a metal wire. To produce the same heating effect, a constant current i can be used where i is

(a) 14 A (b) about 20 A (c) 7 A (d) about 10 A

Q 10. A constant current of 2·8 A exists in a resistor. The rms current is

(a) 2·8 A (b) about 2 A (c) 1·4 A (d) undefined for a directed current.

CASE STUDY QUESTIONS

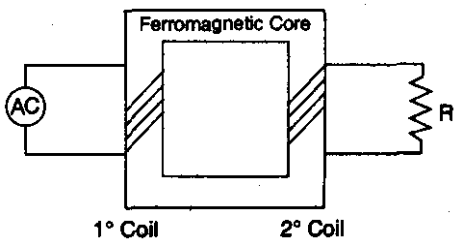
A series LCR circuit containing a resistance of 120 Ω has an angular resonance frequency 4×10^5 rad/sec . At resonance, voltage across resistance and inductance are 60 V and 40 V.

11. Value of inductance is
(A) 100H (B) 200H
(C) 100μH (D) 200μH

12. The value of capacitance is
(A) 32μF (B) 16μF
(C) 1/32μF (D) 1/16μF

13 The value of $X_L - X_C$, when the current lags behind the voltage by 45^0 is
(A) 60Ω (B) 120Ω
(C) 180Ω (D) 240Ω

➲ A physics lab is designed to study the transfer of electrical energy from one circuit to another by means of a magnetic field using simple transformers. Each transformer has two coils of wire electrically insulated from each other but wound around a common core of ferromagnetic material. The two wires are close together but do not touch each other.



➲ The primary (1°) coil is connected to a source of alternating (AC) current. The secondary (2°) coil is connected to a resistor such as a light bulb. The AC source produces an oscillating voltage and current in the primary coil that produces an oscillating magnetic field in the core material. This in turn induces an oscillating voltage and AC current in the secondary coil.

➲ Students collected the following data comparing the number of turns per coil (N), the voltage (V) and the current (I) in the coils of three transformers.

	Primary Coil			**Secondary Coil**		
	$N_{1°}$	**$V_{1°}$**	**$I_{1°}$**	**$N_{2°}$**	**$V_{2°}$**	**$I_{2°}$**
Transf-ormer 1	100	10 V	10 A	200	20 V	5 A
Transf-ormer 2	100	10 V	10 A	50	5 V	20 A
Transf-ormer 3	200	10 V	10 A	100	5 V	20 A

14. The primary coil of a transformer has 100 turns and is connected to a 120 V AC source. How many turns are in the secondary coil if there's a 2400 V across it?

(a) 5 (b) 50 (c) 200 (d) 2000

15. A transformer with 40 turns in its primary coil is connected to a 120 V AC source. If 20 W of power is supplied to the primary coil, how much power is developed in the secondary coil?

(a) 10 W (b) 20W (c) 80W (d) 160W

16. Which of the following is a correct expression for R, the resistance of the load connected to the secondary coil?

(a) $\left(\frac{V_{1^0}}{I_{1^0}}\right)\left(\frac{N_{2^0}}{N_{1^0}}\right)$ (b) $\left(\frac{V_{1^0}}{I_{1^0}}\right)\left(\frac{N_{2^0}}{N_{1^0}}\right)^2$ (c) $\left(\frac{V_{1^0}}{I_{1^0}}\right)\left(\frac{N_{1^0}}{N_{2^0}}\right)$ (d) $\left(\frac{V_{1^0}}{I_{1^0}}\right)\left(\frac{N_{1^0}}{N_{2^0}}\right)^2$

17. A 12 V battery is used to supply 2.0 mA of current to the 300 turns in the primary coil of a given transformer. What is the current in the secondary coil if N_2 = 150 turns ?

(a) zero (b) 1.0 mA (c) 2.0 mA (d) 4.0 mA

SOURCE STUDY QUESTIONS

An alternating voltage (in volts) varies with time t (in seconds) as V = 200 sin (100 πt) to a series combination of resistance of 10 ohm and inductor of Inductance 5 mH . Then

18. The peak value of the voltage is

(A) 200 V (B) 282.8 V

(C) 141.45 V (D) 100 V

19. The rms value of the voltage is

(A) 200 V (B) 282.8 V

(C) 141.45 V (D) 100 V

20. Inductive reactance in the circuit is

(A) 500π mΩ (B) 500 mΩ

(C) 200π mΩ (D) 500π Ω

Statement answers type questions:

A. Both Assertion and Reason are correct and Reason is the correct explanation for Assertion.

B. Both Assertion and Reason are correct and Reason is not the correct

explanation for Assertion.

C. Assertion is correct but Reason is incorrect.

D. Both Reason and Assertion are incorrect.

21. **Assertion:** If the frequency of alternating current in an ac circuit consisting of an inductance coil is increased then current gets decreased

Reason: The current is inversely proportional to frequency of alternating current.

22. **Assertion:** An alternating current does not show any magnetic effect.

Reason: Alternating current does not vary with time.

23. **Assertion:** In a series LCR circuit, at resonance condition power consumed by circuit is maximum.

Reason: At resonance condition effective resistance of circuit is maximum.

24. **Assertion:** When resistance and inductor are connected in series with A-C source. Voltage lead the current in inductor.

Reason: In series R, L, C circuit when connected by A-C source voltage can lead, or lag in phase with current depends on L and C only.

1	(a)	2	(a)	3	(c)	4	(b)	5	(b)	6	(a)	7	(a)	8	(b)	9	(d)	10	(a)
11	D	12	C	13	B	14	d	15	b	16	b	17	d	18	A	19	C	20	A
21	a	22	d	23	d	24	b												

Sample Question Paper 2021-22
Term 1
Subject: Physics (042)

Time: 90 Minutes Max. Marks 35

General Instructions:

1. The Question Paper contains three sections.

2. Section A has 25 questions. Attempt any 20 questions.

3. Section B has 24 questions. Attempt any20 questions.

4. Section C has 6 questions. Attempt any 5 questions.

5. All questions carry equal marks.

6. There is no negative marking.

SECTION A

This section consists of 25 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable numberof questions are attempted, ONLY first 20 will be considered for evaluation.

Q1.Which of the following is NOT the property of equipotential surface?

(i) They do not cross each other.

(ii) The rate of change of potential with distance on them is zero.

(iii) For a uniform electric field they are concentric spheres.

(iv) They can be imaginary spheres.

Q2. Two point charges +8q and -2q are located at x=0 and x=L respectively. The point on x axis at which net electric field is zero due to these charges is-

(i) 8L

(ii) 4L

(iii) 2 L

(iv) L

Q3. An electric dipole of moment p is placed parallel to the uniform electric field. The amount of work done in rotating the dipole by 90° is-

(i) 2pE

(ii) pE

(iii) pE/2

(iv) Zero

Q4. Three capacitors 2μF, 3μF and 6μF are joined in series with each other. The equivalent capacitance is-

(i) 1/2μF

(ii) 1μF

(iii) 2μF

(iv) 11μF

Q5. Two point charges placed in a medium of dielectric constant 5 are at a distance r between them, experience an electrostatic force 'F'. The electrostatic force between them in vacuum at the same distance r will be-

(i) 5F

(ii) F

(iii) F/2

(iv) F/5

Q6. Which statement is true for Gauss law-

(i) All the charges whether inside or outside the gaussian surface contribute to the electric flux.

(ii) Electric flux depends upon the geometry of the gaussian surface.

(iii) Gauss theorem can be applied to non-uniform electric field.

(iv) The electric field over the gaussian surface remains continuous and uniform at every point.

Q7.A capacitor plates are charged by a battery with 'V' volts. After charging battery is disconnected and a dielectric slab with dielectric constant 'K' is inserted between its plates, the potential across the plates of a capacitor will become

(i) Zero

(ii) V/2

(iii) V/K

(iv) KV

Q8.The best instrument for accurate measurement of EMF of a cell is-

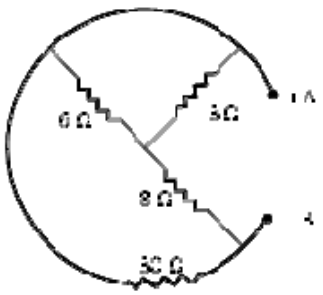
(i) Potentiometer

(ii) metre bridge

(iii) Voltmeter

(iv) ammeter and voltmeter

Q9.An electric current is passed through a circuit containing two wires of same r… the lengths and radii of the wires are in … ratio of the current passing throug…



(i) …

(ii) …

(iii) …

(iv) 27:8

Q10.By increasing the temperature, the specific resistance of a conductor and a semiconductor-

(i) increases for both.

(ii) decreases for both.

(iii) increases for a conductor and decreases for a semiconductor.

(iv) decreases for a conductor and increases for a semiconductor.

Q11.We use alloys for making standard resistors because they have

(i) low temperature coefficient of resistivity and high specific resistance

(ii) high temperature coefficient of resistivity and low specific resistance

(iii) low temperature coefficient of resistivity and low specific resistance

(iv) high temperature coefficient of resistivity and high specific resistance

Q12. A constant voltage is applied between the two ends of a uniform metallic wire, heat 'H' is developed in it. If another wire of the same material, double the radius and twice the length as compared to original wire is used then the heat developed in it will be-

(i) H/2

(ii) H

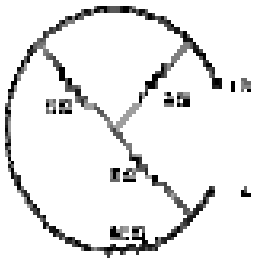
(iii) 2H

(iv) 4H

Q13.If the potential difference V applied across a conductor is increased to 2V with its temperature kept constant, the drift velocity of the free electrons in a conductor will -

(i) remain the same.
(ii) become half of its previous value.
(iii) be double of its initial value.
(iv) become zero.

Q14.The equivalent resistance between A and B is-



(i) 3 ohms

(ii) 5.5 ohms

(iii) 7.5 ohms

(iv) 9.5 ohms

Q15. The SI unit of magnetic field intensity is

(i) AmN^{-1}
(ii) $NA^{-1}m^{-1}$
(iii) $NA^{-2}m^{-2}$
(iv) $NA^{-1}m^{-2}$

Q16.The coil of a moving coil galvanometer is wound over a metal frame in order to

(i) reduce hysteresis
(ii) increase sensitivity
(iii) increase moment of inertia
(iv) provide electromagnetic damping

Q17.Two wires of the same length are shaped into a square of side 'a' and a circle with radius 'r'. If they carry same current, the ratio of their magnetic moment is

(i) $2 : \pi$
(ii) $\pi : 2$
(iii) $\pi : 4$
(iv) $4 : \pi$

Q18. The horizontal component of earth's magnetic field at a place is $\sqrt{3}$ times the vertical component. The angle of dip at that place is

(i) π/6
(ii) π/3
(iii) π/4
(iv) 0

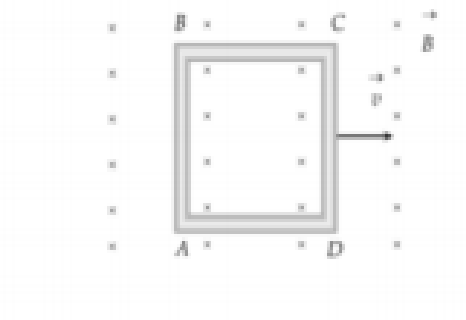
Q19. The small angle between magnetic axis and geographic axis at a place is-

(i) Magnetic meridian
(ii) Geographic meridian
(iii) Magnetic inclination
(iv) Magnetic Declination

Q20.Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon the

(i) rate at which current change in the two coils
(ii) relative position and orientation of the coils
(iii) rate at which voltage induced across two coils
(iv) currents in the two coils

Q21. A conducting square loop of side 'L' and resistance 'R' moves in its plane with the uniform velocity 'v' perpendicular to one of its sides. A magnetic induction 'B' constant in time and space pointing perpendicular and into the plane of the loop exists everywhere as shown in the figure. The current induced in the loop is



(i) BLv/R Clockwise
(ii) BLv/R Anticlockwise
(iii) 2BLv/R Anticlockwise
(iv)Zero

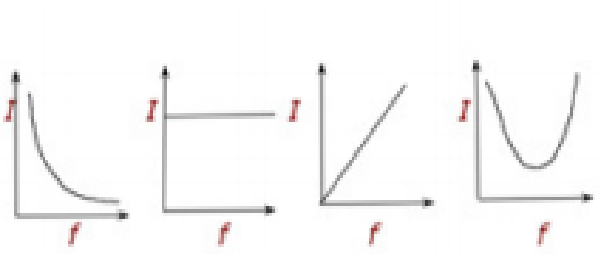
Q22. The magnetic flux linked with the coil (in Weber) is given by theequation –

$\Phi = 5t^2 + 3t + 16$

The induced EMF in the coil at time, t=4 will be-

(i) -27 V
(ii) -43 V
(iii) -108 V
(iv) 210 V

Q23. Which of the following graphs represent the variation of current(I) with frequency (f) in an AC circuit containing a pure capacitor?



(i) (ii) (iii) (iv)

Q24. A 20 volt AC is applied to a circuit consisting of a resistance and a coil with negligible resistance. If the voltage across the resistance is 12 volt, the voltage across the coil is-

(i) 16 V

(ii) 10 V

(iii) 8 V

(iv) 6 V

Q25. The instantaneous values of emf and the current in a series ac circuit are-

E = Eo Sin ωt and I= Io sin(ωt+π/3) respectively, then it is

(i) Necessarily a RL circuit

(ii) Necessarily a RC circuit

(iii)Necessarily a LCR circuit

(iv) Can be RC or LCR circuit

SECTION B

This section consists of 24 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

Q26. A cylinder of radius r and length l is placed in an uniform electric field parallel to the axis of the cylinder. The total flux for the surface of the cylinder is given by-

(i) zero

(ii) πr^2

(iii) $E \pi r^2$

(iv))2 $E\pi r^2$

Q27. Two parallel large thin metal sheets have equal surface densities

26.4×10^{-12} C/m^2 of opposite signs. The electric field between these sheets is-

(i) 1.5N/C

(ii) 1.5×10^{-18} N/C

(iii) 3×10^{-10} N/C

(iv) 3N/C

Q28. Consider an uncharged conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then,

(i) negative and uniformly distributed over the surface of sphere

(ii) positive and uniformly distributed over the surface of sphere

(iii) negative and appears at a point the surface of sphere closest to point charge.

(iv) Zero

Q29. Three Charges 2q, -q and -q lie at vertices of a triangle. The value of E and V at centroid of triangle will be-

(i) E#0 and V#0

(ii) E=0 and V=0

(iii) E#0 and V=0

(iv) E=0 and V#0

Q30. Two parallel plate capacitors X and Y, have the same area of plates and same separation between plates. X has air and Y with dielectric of constant 2 , between its plates. They are connected in series to a battery of 12 V. The ratio of electrostatic energy stored in X and Y is-

(i) 4:1

(ii) 1:4

(iii) 2:1

(iv) 1:2

Q31. Which among the following, is not a cause for power loss in a transformer-

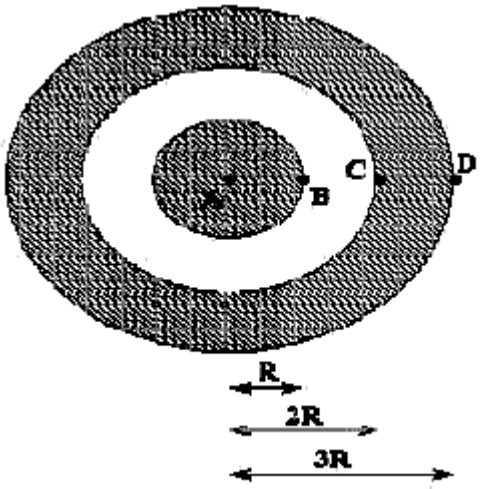
(i) Eddy currents are produced in the soft iron core of a transformer.
(ii) Electric Flux sharing is not properly done in primary and secondary coils.

(iii) Humming sound produed in the tranformers due to magnetostriction.
(iv) Primary coil is made up of a very thick copper wire.

Q32. An alternating voltage source of variable angular frequency 'w' and fixed amplitude 'V' is connected in series with a capacitance C and electric bulb of resistance R(inductance zero). When 'w' is increased-

(i) The bulb glows dimmer.
(ii) The bulb glows brighter.
(iii) Net impedance of the circuit remains unchanged.
(iv) Total impedance of the circuit increases.

Q33. A solid spherical conductor has charge +Q and radius R. It is surrounded by a solid spherical shell with charge -Q, innerradius 2R, and outer radius 3R. Which of the following statements is true?



(i)The electric potential has a maximum magnitude at C and the electric field has a maximum magnitude at A

(ii) The electric potential has a maximum magnitude at D and the electric field has a maximum magnitude at B.

(iii) The electric potential at A is zero and the electric field has a maximum magnitude at D.

(iv). Both the electric potential and electric field achieve a maximum magnitude at B.

Q34. A battery is connected to the conductor of non-uniform cross section area. The quantities or quantity which remains constant is-

(i) electric field only

(ii) drift speed and electric field

(iii)electric field and current

(iv) current only

Q35. Three resistors having values R_1, R_2, and R_3 are connected in series to a battery. Suppose R_1 carries a current of 2.0 A, R_2 has a resistance of 3.0 ohms, and R_3 dissipates 6.0 watts of power. Then the voltage across R_3 is-

(i) 1V

(ii) 2V

(iii) 3V

(iv) 4V

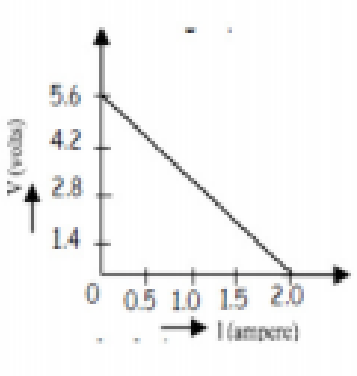
Q36.A straight line plot showing the terminal potential difference (V) of a cell as a function of current (I) drawn from it, is shown in the figure. The internal resistance of the cell would be then-

(i) 2.8 ohms

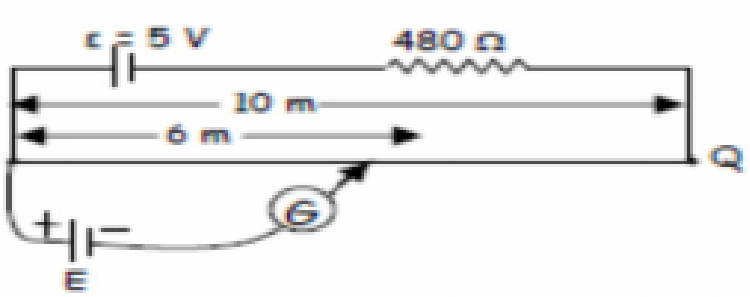
(ii) 1.4 ohms

(iii) 1.2 ohms

(iv) zero



Q37. A 10 m long wire of uniform cross-section and 20 Ω resistance is used in a potentiometer. The wire is connected in series with a battery of 5 V along with an external resistance of 480 Ω. If an unknown emf E is balanced at 6.0 m length of the wire, then the value of unknown emf is-



(i) 1.2 V

(ii) 1.02 V

(iii) 0.2 V

(iv) **0.12 V**

Q38.The current sensitivity of a galvanometer increases by 20%. If its resistance also increases by 25%, the voltage sensitivity will

(i) decrease by 1%

(ii) increased by 5%

(iii) increased by 10%

(iv) decrease by 4%

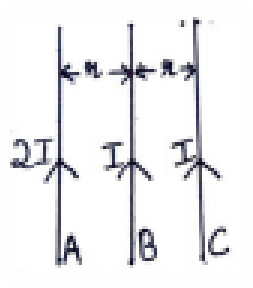
Q39. Three infinitely long parallel straight current carrying wires A, B and C are kept at equal distance from each other as shown in the figure . The wire C experiences net force F .The net force on wire C, when the current in wire A is reversed will be

(i) Zero

(ii) F/2

(iii) F

(iv) 2F



Q40. In a hydrogen atom the electron moves in an orbit of radius 0.5 A° making 10 revolutions per second, the magnetic moment associated with the orbital motion of the electron will be

(i) 2.512×10^{-38} Am^2

(ii) 1.256×10^{-38} Am^2

(iii) 0.628×10^{-38} Am^2

(iv) zero

Q41. An air-cored solenoid with length 30 cm, area of cross-section 25 cm^2 and number of turns 800, carries a current of 2.5 A. The current is suddenly switched off in a brief time of 10^{-3}s. Ignoring the variation in magnetic field near the ends of the solenoid, the average back emf induced across the ends of the open switch in the circuit would be

(i) zero

(ii)3.125 volts

(iii) 6.54 volts

(iv) 16.74 volts

Q42. A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which R = 3 Ω, L = 25.48 mH, and C = 796 μF, then the power dissipated at the resonant condition will be-

(i)39.70 kW

(ii) 26.70 kW

(iii)13.35 kW

(iv)Zero

Q43. A circular loop of radius 0.3cm lies parallel to much bigger circular of radius 20 cm. The centre of the small loop is on the axis of the bigger loop. The distance between their centres is 15 cm. If a current of 2.0 A flows through the smaller loop, then the flux linked with the bigger loop is

(i) 3.3×10^{-11} weber

(ii) 6×10^{-11} weber

(iii) 6.6×10^{-9} weber

(iv) 9.1×10^{-11} weber

Q44.If both the number of turns and core length of an inductor is doubled keeping other factorsconstant, then its self-inductance will be-

(i) Unaffected
(ii) doubled
(iii) halved
(iv) quadrupled

45. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion (A): To increase the range of an ammeter, we must connect a suitable high resistance in series to it.

Reason (R): The ammeter with increased range should have high resistance.

Select the most appropriate answer from the options given below:

(i) Both A and R are true and R is the correct explanation of A

(ii) Both A and R are true but R is not the correct explanation of A.

(iii)A is true but R is false.

(iv) A is false and R is also false.

46. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion (A): An electron has a high potential energy when it is at a location associated with a more negative value of potential, and a low potential energy when at a location associated with a more positive potential.

Reason (R):Electrons move from a region of higher potential to region of lower potential.

Select the most appropriate answer from the options given below:

(i) Both A and R are true and R is the correct explanation of A

(ii) Both A and R are true but R is not the correct explanation of A.

(iii)A is true but R is false.

(iv) A is false and R is also false.

47. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion(A): A magnetic needle free to rotate in a vertical plane, orients itself (with its axis) vertical at the poles of the earth.

Reason (R): At the poles of the earth the horizontal component of earth's magnetic field will be zero.

Select the most appropriate answer from the options given below:

(i) Both A and R are true and R is the correct explanation of A

(ii) Both A and R are true but R is not the correct explanation of A.

(iii)A is true but R is false.

(iv) A is false and R is also false.

48. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion(A): A proton and an electron, with same momenta, enter in a magnetic field in a direction at right angles to the lines of the force. The radius of the paths followed by them will be same.

Reason(R): Electron has less mass than the proton.

Select the most appropriate answer from the options given below:

(i) Both A and R are true and R is the correct explanation of A

(ii) Both A and R are true but R is not the correct explanation of A.

(iii)A is true but R is false.

(iv) A is false and R is also false.

49. Given below are two statements labelled as Assertion (A) and Reason (R)

Assertion (A): On Increasing the current sensitivity of a galvanometer by increasing the number of turns, may not necessarily increase its voltage sensitivity.

Reason(R): The resistance of the coil of the galvanometer increases on increasing the number of turns.

Select the most appropriate answer from the options given below:

(i) Both A and R are true and R is the correct explanation of A

(ii) Both A and R are true but R is not the correct explanation of A.

(iii)A is true but R is false.

(iv) A is false and R is also false.

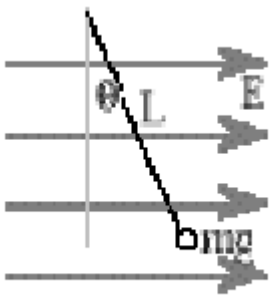
SECTION C

This section consists of 6 multiple choice questions with an overall choice to attempt any 5. In case more than desirable number of questions are attempted, ONLY first 5 will be considered for evaluation.

Q50. A small object with charge q and weight mg is attached to one end of a string of length 'L' attached to a stationary support. The system is placed in a uniform horizontal electric field 'E', as shown in the accompanying figure. In the presence of the field, the string makes a constant angle θ with the vertical. The sign and magnitude of q-

(i) positive with magnitude mg/E

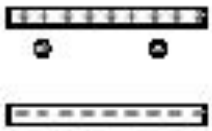
(ii) positive with magnitude (mg/E)tanθ



(iii) negative with magnitude mg/E tanθ

(iv) positive with magnitude E tanθ/mg

Q51. A free electron and a free proton are placed between two oppositely charged parallel plates. Both are closer to the positive plate than the negative plate.



Which of the following statements is true?

I. The force on the proton is greater than the force on the electron.

II. The potential energy of the proton is greater than that of the electron.

III. The potential energy of the proton and the electron is the same.

(i) I only

(ii) II only

(iii) III and I only

(iv)II and I only

Case study :

Read the following paragraph and answers the questions:

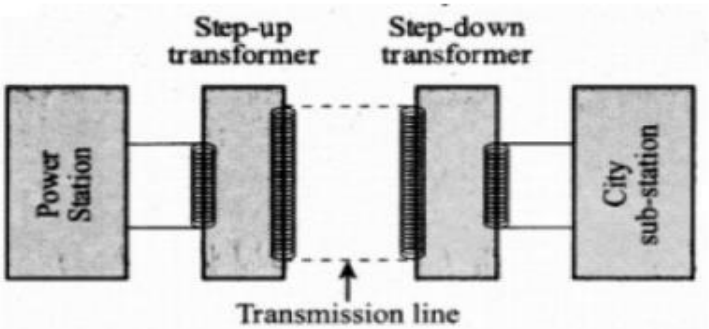


Figure: Long distance power transmissions

The large-scale transmission and distribution of electrical energy over long distances is done with the use of transformers. The voltage output of the generator is stepped-up. It is then transmitted over long distances to an area sub-station near the consumers. There the voltage is stepped down. It is further stepped down at distributing sub-stations and utility poles before a power supply of 240 V reaches our homes.

Q52. Which of the following statement is true?

(i) Energy is created when a transformer steps up the voltage

(ii) A transformer is designed to convert an AC voltage to DC voltage

(iii) Step–up transformer increases the power for transmission

(iv) Step–down transformer decreases the AC voltage

Q53. If the secondary coil has a greater number of turns than the primary,

(i) the voltage is stepped-up (Vs >Vp) and arrangement is called a step-up transformer

(ii) the voltage is stepped-down (Vs <Vp) and arrangement is called a step-down transformer

(iii) the current is stepped-up (Is >Ip) and arrangement is called a step-up transformer

(iv) the current is stepped-down (Is <Ip) and arrangement is called a step-down transformer

Q54. We need to step-up the voltage for power transmission, so that

(i) the current is reduced and consequently, the I^2R loss is cut down

(ii) the voltage is increased , the power losses are also increased

(iii) the power is increased before transmission is done

(iv) the voltage is decreased so V^2/R losses are reduced

Q55. A power transmission line feeds input power at 2300 V to a step down transformer with its primary windings having 4000 turns. The number of turns in the secondary in order to get output power at 230 V are

(i) 4

(ii) 40

(iii) 400

(iv) 4000