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| | **INDIAN SCHOOL AL WADI AL KABIR** | |
| **Class: XII** | **DEPARTMENT OF SCIENCE -2023-24**<br>**SUBJECT: PHYSICS** | DATE OF COMPLETION:<br>**5.09.2023** |
| WORKSHEET NO:5WITH ANSWERS | **TOPIC: MAGNETISM AND MATTER** | **A4 FILE FORMAT** |
| **CLASS & SEC:** | **NAME OF THE STUDENT:** | **ROLL NO.** |

**MCQ QUESTIONS (1 MARK)**

1. Which among the following materials display higher magnetic susceptibility?

a. Ferromagnetic material
b. Paramagnetic material
c. Diamagnetic material
d. None of these options

**Answer**: (a) Ferromagnetic material

2. In a permanent magnet at room temperature
(a) magnetic moment of each molecule is zero.
(b) the individual molecules have non-zero magnetic moment which are all perfectly aligned.
(c) domains are partially aligned.
(d) domains are all perfectly aligned.

HINTS; (c) At room temperature, the permanent magnet retains ferromagnetic property for a long period of time.

3. A long solenoid has 1000 turns per metre and carries a current of 1 A. It has a soft iron core of $\mu_r$ = 1000. The core is heated beyond the Curie temperature, $T_c$.
(a) The H field in the solenoid is (nearly) unchanged but the B field decreases drastically.
(b) The H and B fields in the solenoid are nearly unchanged.
(c) The magnetisation in the core reverses direction.
(d) The magnetisation in the core does not diminishes.

HINTS; (a) At normal temperature, a solenoid behaves as a ferromagnetic substance and at the temperature beyond the Curie temperature, it behaves as a paramagnetic substance.

4. The SI unit of magnetic flux is

a. Dyne
b. Tesla
c. Weber
d. Ohm

**Answer**: (c) Weber

5. A magnetic needle is kept in a non-uniform magnetic field. It experiences

(a) a torque but not a force. (b) neither a force nor a torque.

(c) a force and a torque. (d) a force but not a torque.

HINTS;(c) As magnetic needle experiences both torque and force in a non-uniform magnetic field, because unequal and non-linear forces are exerted on its poles.

6. Three needles $N_1$ $N_2$ and $N_3$ are made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. A magnet, when brought close to them, will
(a) attract $N_1$ strongly, but repel $N_2$ and $N_3$ weakly.
(b) attract all three of them.
(c) attract $N_1$ and $N_2$ strongly but repel $N_3$.
(d) attract $N_1$ strongly, $N_2$ weakly and repel $N_3$ weakly.

ANS; d

7. Curie temperature is the temperature above which
(a) a ferromagnetic material becomes paramagnetic.
(b) a ferromagnetic material becomes diamagnetic.
(c) a paramagnetic material becomes diamagnetic.
(d) a paramagnetic material becomes ferromagnetic.

HINTS; (a) A ferromagnetic material becomes paramagnetic above the curie temperature.

8. The material suitable for making electromagnets should have
(a) high retentivity and high coercivity. (b) low retentivity and low coercivity.
(c) high retentivity and low coercivity. (d) low retentivity and high coercivity.

Ans; C

9. What is the formula to find the work done in rotating the dipole in a uniform magnetic field from θ1 to θ2?

a. $W = MB (\cos \theta 1/\cos \theta 2)$
b. $W = MB (\cos \theta 1 + \cos \theta 2)$
c. $W = MB (\cos \theta 1 – \cos \theta 2)$
d. $W = M+B (\cos \theta 1 – \cos \theta 2)$

**Answer:** (c) $W = MB (\cos \theta 1 – \cos \theta 2)$

10. If the magnetising field on a ferromagnetic material is increased, its permeability.
(a) is decreased (b) is increased (c) is unaffected (d) may be increased or decreased.

HINTS; (a), Since, $\mu = B/H \Rightarrow \mu \propto 1/H$

11. A magnetic needle suspended parallel to a magnetic field requires /3 J of work to turn it through 60°. The torque needed to maintain the needle in this position will be

(a) $2\sqrt{3}$ J (b) 3 J
(c) $\sqrt{3}$ J (d) $\frac{3}{2}$ J

HINTS; (b) Since, $W = -MB(\cos\theta_2 - \cos\theta_1)$

$$= -MB(\cos 60° - \cos 0°)$$

$$= \frac{MB}{2} = \sqrt{3}\ \text{J}$$

Also, $\tau = MB \sin 60° = MB\frac{\sqrt{3}}{2}$

$$= \sqrt{3} \times \sqrt{3} = 3\ \text{J}$$

12. The magnetic susceptibility of an ideal diamagnetic substance is
(a) +1 (b) 0 (c) -1 (d) ∞

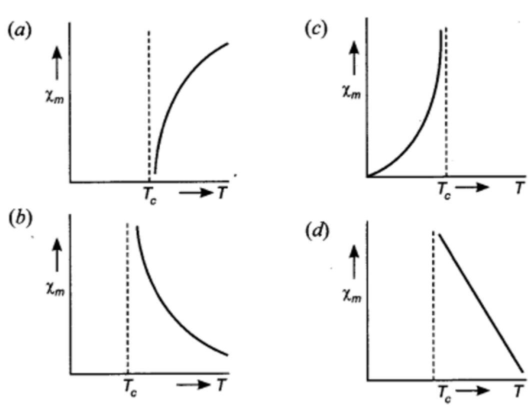
HINTS; (c) Since, for diamagnetic $-1 \le x_m < 0$

13. The best material for the core of a transformer is
(a) stainless steel (b) mild steel (c) hard steel (d) soft iron

Ans; d

14. Domain formation is the necessary feature of
(a) diamagnetism. (b) Para magnetism. (c) ferromagnetism. (d) all of these.
Ans; c

15. The variation of magnetic susceptibility with the temperature of a ferromagnetic material can be plotted as




HINTS; (b) Since susceptibility ($x_m$) of ferromagnetic material decreases with increase in temperature and above curie temperature $T_c$, it becomes paramagnetic.

16. In which type of material the magnetic susceptibility does not depend on temperature?
(a) Diamagnetic (b) Paramagnetic (c) Ferromagnetic (d) Ferrite

Ans; a

17. A diamagnetic material in a non uniform magnetic field moves
(a) perpendicular to the field. (b) from weaker to stronger parts.
(c) from stronger to weaker parts. (d) in random direction.

Ans; c

18. The universal property among all substances is
(a) diamagnetism. (b) paramagnetism. (c) ferromagnetism. (d) all of these.

Ans; a

19. A magnet of dipole moment M is aligned in equilibrium position in a magnetic field of intensity B. The work done to rotate it through an angle 0 with the magnetic field is
(a) MB sin θ (b) MB cos θ (c) MB (1 – cos θ) (d) MB(l – sin θ)

HINTS; (c), At equilibrium position θ = 0,
Work done, W = $\int_0^\theta MB \sin\theta \, d\theta$
= MB (1 – cos θ)

20. A magnet can be completely demagnetized by
(a) breaking the magnet into small pieces. (b) heating it slightly.
(c) dropping it into ice cold water. (d) a reverse field of appropriate strength.

Ans; d

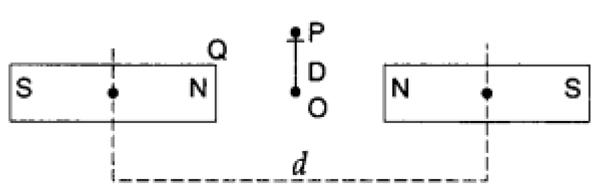
21. Magnetic moment for solenoid and corresponding bar magnet is
(a) equal for both (b) more for solenoid (c) more for bar magnet (d) none of these

Ans; a

22. Which of the following is correct about magnetic monopole?
(a) Magnetic monopole exist.
(b) Magnetic monopole does not exist.
(c) Magnetic monopole have constant value of monopole momentum.
(d) The monopole momentum increases due to increase at its distance from the field

Ans; b

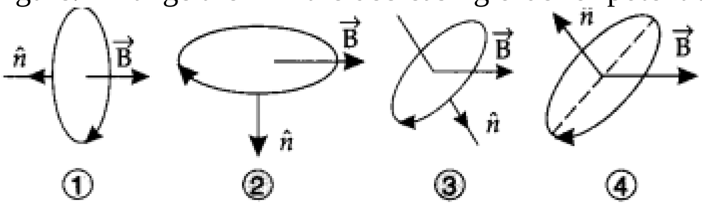
23. Two identical bar magnets are fixed with their centers at a distance d apart. A stationary charge Q is placed at P in between the gap of the two magnets at a distance D from the centre O as shown in the figure. The force on the charge Q is



(a) zero
(b) directed along OP
(c) directed along PO
(d) directed perpendicular to the plane of paper

Ans; a

24. A current carrying loop is placed in a uniform magnetic field in four different orientations as shown in figure. Arrange them in the decreasing order of potential energy.




(a) 4, 2, 3,1
(b) 1, 4, 2, 3
(c) 4, 3, 2,1
(d) 1, 2, 3, 4

Ans; b

$U = -m \cdot B$

$= -mB \cos\theta$

where, m = magnetic dipole moment of the magnet

B = magnetic field

Case I $\theta = 180°$

$\therefore U_1 = -mB \cdot \cos 180°$

$= mB \quad [\because \cos 180° = -1]$

Case II $\theta = 90°$

$U_2 = 0 \quad [\because \cos 90° = 0]$

Case III $\theta$ is acute angle

$\theta \in (0, 90°)$

$\therefore \cos\theta =$ positive

Thus, $U_3 =$ negative

Case IV $\theta$ is obtuse

$\theta \in (90°, 180°)$

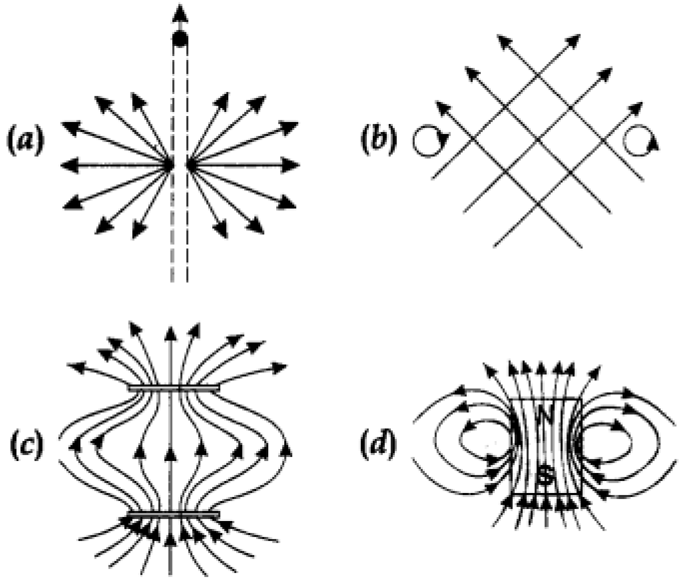
$\therefore \cos\theta \in (0, -1)$

Thus, $U_4 =$ positive

Therefore, decreasing order of PE is

I > IV > II > III

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




Ans; d

SHORT ANSWER QUESTIONS( 2 MARKS)

26. Which orientation of a magnetic dipole in a uniform magnetic field will correspond to its stable equilibrium and unstable equilibrium?

**Answer**
In stable equilibrium, the dipole moment vector and the magnetic field vector are in same direction.In unstable equilibrium, the dipole moment vector and the magnetic field vector are in the opposite direction.

27. Magnetic field arises due to charges in motion. Can a system have magnetic moments even though its net charge is zero?

**Ans.** A system can have a magnetic moment even though its net charge is zero. It is because, the average charge of a system may be zero, but it is not necessary that magnetic moments due to various current loops will also be zero. For example, a neutron has zero charge, but possesses non-zero magnetic moment.

28. If magnetic monopoles existed, how would the Gauss's law of magnetism be modified?

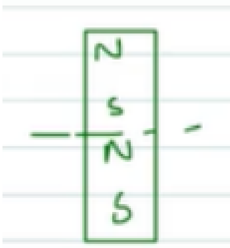
Answer:
Gauss's law of magnetism states that the flux of B through any closed surface is always zero $\oint B.ds = 0$. If the monopole existed, then Gauss's law would have been $\oint B.ds = \mu_0 q_m$ where $q_m$ is magnetic charge (monopole) enclosed by the surface.

29. Does a bar magnet exert a torque on itself due to its own field? Does on element of a current-carrying wire exert a force on another element of the same wire?

**Answer**
No. There is no force or torque on a element due to the field produced by that element itself. But there is a force (or torque) on another element of the same wire.

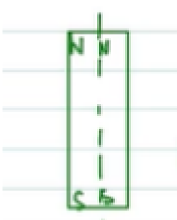
30. A magnetised needle in a uniform magnetic field experiences a torque but no net force. An iron nail near a bar magnet, however, experiences a force of attraction in addition to a torque. Why?

**Answer**:
No force, if the field is uniform. The iron nail experiences a non-uniform field due to the bar magnet. There is induced magnetic moment in the nail, therefore, it experiences both force and torque. The net force is attractive because the induced south pole (say) in the nail is closer to the north pole of magnet than induced north pole.
31. How does the (i) pole strength, and (ii) magnetic moment of each part of a bar magnet change if it is cut into two equal pieces transverse to its length? [HOTS]




**Answer**:
(i) The pole strength does not change.
(ii) The magnetic moment reduces to half as magnetic moments is proportional to length.(Here the length becomes half)
32. What happens if a bar magnet is cut into two pieces: (i) transverse to its length, (ii) along its length?

**Answer**:
In either case, one gets two magnets, each with a north and south pole.
32. How does the (i) pole strength and (ii) magnetic moment of each part of a bar magnet change if it is cut into two equal pieces along its length?



**Answer;**
(i) The pole strength becomes half.
(ii) The magnetic magnet becomes half as pole strength becomes half.
34. Magnetic field lines can be entirely confined ’within the core of a toroid, but not within a straight solenoid. Why?

**Answer**:
According to the Gauss’s law, $\oint \vec{B} \cdot \vec{ds} = 0$, which is true for a as has no ends. But, in case of a solenoid, at

each end the magnetic flux will not be zero, if the magnetic field lines were entirely confined within the solenoid.

35. Two identical looking iron bars A and B are given, one of which is definitely known to be magnetised. (We do not know which one.) How would one ascertain which one? [Use nothing else but the bars A and B.]

**Answer;**

Let, two bars are A and B. Now, bring one end of A near to B, and move it slowly (from one end to the middle). If force experienced by bar A reduces as we move towards middle, then bar B is magnetised, and A is not.

If A experiences repulsion, then both the bars are magnetised.

36. A magnetic needle, free to rotate in a vertical plane, orients itself vertically at a certain place on the Earth. What are the values of (i) horizontal component of earth's magnetic field, and (ii) angle of dip at this placed?

37. Which of the following substances are paramagnetic?

Bi, Al, Cu, Ca, Pb and Ni

**Answer**: Al and Ca.

38. Which of the following substances are diamagnetic?

Bi, Al, Na, Cu, Ca and Ni

Answer: Bi and Cu.

39. The susceptibility of a magnetic material is $-4.2 \times 10^{-6}$. Name the type of magnetic material it represents.

Answer: Diamagnetic.

ASSERTION REASONING QUESTIONS

Here two statements are given

one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

a) If both Assertion and Reason are true and Reason is correct explanation of

Assertion.

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

c) If Assertion is true but Reason is false.

d) If both Assertion and Reason are false.

1) ASSERTION: For making permanent magnets, steel is preferred over soft iron.

REASON: As Retentivity of steel is smaller.

Ans. B

**Solution :**

Steel is preferred over soft iron for making permanent magnets, because Coercivity of steel is larger.

2) ASSERTION: Basic difference between an electric line and magnetic line of force is that former is discontinuous and the latter is continuous or endless.
REASON: No electric lines of forces exist inside a charged body but magnetic lines do exist inside a magnet.

**Correct Answer:** A

**Solution :**

In case of the electric field of an electric dipole, the electric lines of force originate from positive charge and end at negative charge. Since isolated magnetic lines are closed continuous loops extending throughout the body of the magnet.

3) ASSERTION: Magnetic moment of an atom is due to both, the orbital motion and spin motion of every electron.
REASON: A charged particle produces a magnetic field.

Correct Answer: C

Solution :

In an atom, electrons revolve around the nucleus and as such the circular orbits of electrons may be considered as the small current loops. In addition to orbital motion, an electron has got spin motion also. So the total magnetic moment of electron is the vector sum of its magnetic moments due to orbital and spin motion.
4) ASSERTION: Gauss theorem is not applicable in magnetism.
Correct Answer: A

Solution :
If both assertion and reason are true and reason is the correct explanation of assertion.
5) ASSERTION: Torque experience by the bar magnet is maximum when field is applied perpendicular to magnetic moment.
REASON: Torque on a bar magnet depends on the angle between applied magnetic field and magnetic dipole moment.
Correct Answer: A
Solution :
The torque on a bar magnet is given by $\tau = MB\sin\theta$ Where M = magnetic dipole moment, B = uniform magnetic field. When $\theta = 90^\circ$ then magnitude of the torque is maximum.

CASE STUDY BASED QUESTIONS
I)

## Magnetisation and Magnetic Intensity

When the atomic dipoles are aligned partially or fully, there is a net magnetic moment in the direction of the field in any small volume of the material. The actual magnetic field inside material placed in magnetic field is the sum of the applied magnetic field and the magnetic field due to magnetisation. This field is called magnetic intensity ($H$).

$$H = \frac{B}{\mu_0} - M$$

where $M$ is the magnetisation of the material, $\mu_0$ is the permittivity of vacuum and $B$ is the total magnetic field. The measure that tells us how a magnetic material responds to an external field is given by a dimensionless quantity is appropriately called the magnetic susceptibility : for a certain class of magnetic materials, intensity of magnetisation is directly proportional to the magnetic intensity.

**(i)** Magnetization of a sample is

(a) volume of sample per unit magnetic moment
(b) net magnetic moment per unit volume
(c) ratio of magnetic moment and pole strength
(d) ratio of pole strength to magnetic moment.

**(ii)** Identify the wrongly matched quantity and unit pair.

(a) Pole strength – A m
(b) Magnetic susceptibility – dimensionless number
(c) Intensity of magnetisation – $A\ m^{-1}$
(d) Magnetic permeability – Henry m

**(iii)** A bar magnet has length 3 cm, cross-sectional area 2 $cm^2$ and magnetic moment 3 A $m^2$. The intensity of magnetisation of bar magnet is

(a) $2 \times 10^5$ A/m
(b) $3 \times 10^5$ A/m
(c) $4 \times 10^5$ A/m
(d) $5 \times 10^5$ A/m

**(iv)** A solenoid has core of a material with relative permeability 500 and its windings carry a current of 1 A. The number of turns of the solenoid is 500 per metre. The magnetization of the material is nearly

(a) $2.5 \times 10^3\ A\ m^{-1}$
(b) $2.5 \times 10^5\ A\ m^{-1}$
(c) $2.0 \times 10^3\ A\ m^{-1}$
(d) $2.0 \times 10^5\ A\ m^{-1}$

**(v)** The relative permeability of iron is 6000. Its magnetic susceptibility is

(a) 5999
(b) 6001
(c) $6000 \times 10^{-7}$
(d) $6000 \times 10^{7}$

ANS.

(i) (b)

(ii) (d): Magnetic permeability - Henry $m^{-1}$.

(iii) (d): Given, $l = 3$ cm, $A = 2$ cm$^2$, $M = 3$ A m$^2$

Intensity of magnetisation $= \frac{M}{lA} = \frac{3}{3\times10^{-2}\times2\times10^{-4}}$

$= \frac{1}{2\times10^{-6}} = 0.5\times10^6 = 5\times10^5$ A/m

(iv) (b): Here, $n = 500$ turns/m

$I = 1$ A, $\mu_r = 500$

Magnetic intensity, $H = nI = 500\ m^{-1}\times 1\ A = 500\ A\ m^{-1}$

As $\mu_r = 1 + \chi$ or $\chi = (\mu_r - 1)$

Magnetisation, $M = \chi H$

$= (\mu_r - 1)\,H = (500 - 1)\times 500\ A\ m^{-1}$

$= 2.495\times10^5\ A\ m^{-1} \approx 2.5\times10^5\ A\ m^{-1}$

(v) (a): Relative permeability of iron, $\mu_r = 6000$

Magnetic susceptibility $\chi_m = \mu_r - 1 = 5999$.

**BOARD QUESTIONS**

1. The relative permeability of a substance X is slightly less than unity and that of substance Y is slightly more than unity, then

(a) X is paramagnetic and Y is ferromagnetic

(b) X is diamagnetic and Y is ferromagnetic

(c) X and Y both are paramagnetic

(d) X is diamagnetic and Y is paramagnetic

ANS. d