Devesh Jindal's

The Weavers Institute

TARGET: Class 12th CBSE Boards 2024-25

Physics (Magnetic Effects of Current and Magnetism)

BATCH: 12th **DURATION: 1 HR 30 min** **MAX. MARKS: 35**

Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose

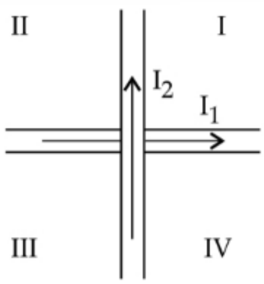
INSTRUCTIONS

Section A *– From question 1 to 6 are MCQs and 7-8 are assertion and reason based of 1 mark each.*
Section B *– Question no. 9-10 are Very Short Answer Type Questions, carrying 2 marks each.*
Answer to each question should not exceed 40 words.
Section C *contains Q.11 to Q.13 are Short Answer Type Questions, carrying 3 marks each.*
Answer to each question should not exceed 60 words
Section D *– Questions no 14 are case based questions with three sub questions and are of 4 marks each.*
Section-E *- Question no. 15-16 are long answer type questions, carrying 5 marks each.*
Answer to each question should not exceed 120 words
There is no overall choice in the question paper. However, an internal choice has been provided in few questions. Only one of the choices in such questions have to be attempted.
You may use the following values of physical constants where ever necessary

i. $c = 3 \times 10^8$ m/s
ii. $m_e = 9.1 \times 10^{-31}$ kg
iii. $e = 1.6 \times 10^{-19}$ C
iv. $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}
v. $h = 6.63 \times 10^{-34}$ Js
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ C^{2}N^{-1}m^{-2}
vii. Avogadro's number = 6.023×10^{23} per gram mole

Section A

1. Two wires carrying current I_1 and I_2 lie, one slightly above the other, in a horizontal plane as shown in figure. The region of vertically upward strongest magnetic field is



(A) I (B) II (C) III (D) IV

2. Two parallel conductors carrying current of 4.0 A and 10.0 A are placed 2.5 cm apart in vacuum. The force per unit length between them is
(A) $6.4 \times 10^{-5}\ N/m$ (B) $6.4 \times 10^{-2}\ N/m$ (C) $4.6 \times 10^{-4}\ N/m$ (D) $3.2 \times 10^{-4}\ N/m$

3. A straight conducting rod of length *l* and mass m is suspended in a horizontal plane by a pair of flexible strings in a magnetic field of magnitude B. To remove the tension in the supporting strings, the magnitude of the current in the wire is
(A) $\frac{mgB}{l}$ (B) $\frac{mgl}{B}$ (C) $\frac{mg}{lB}$ (D) $\frac{lB}{mg}$

4. If the magnetising field on a ferromagnetic material is increased, its permeability
(A) decreases (B) increases
(C) remains unchanged (D) first decrease and then increases

5. Time period of oscillation of a magnetic needle is
(A) $T = \sqrt{\frac{I}{MB}}$ (B) $T = 2\pi\sqrt{\frac{I}{MB}}$ (C) $T = \sqrt{\frac{MB}{I}}$ (D) $T = \pi\sqrt{\frac{MB}{I}}$

6. A circular current loop of magnetic moment M is in an arbitrary orientation in an external magnetic field B. The work done to rotate the loop by 30° about an axis perpendicular to its plane is
(A) MB (B) $\frac{\sqrt{3}\,MB}{2}$ (C) $\frac{MB}{2}$ (D) zero

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

7. Assertion (A): Torque on a coil is maximum when it is suspended radially in a magnetic field.
Reason (R): Torque tends to rotate a coil.

8. Assertion (A) : Ferromagnetic substances become paramagnetic beyond Curie temperature.
Reason (R) : Domains are destroyed at high temperature.

Section B

9. A current of 10 A is passing through a long wire which has semicircular loop of radius 20 cm as shown in the figure. What is the magnetic field produced at the centre of the loop?
Ans $B = 5\pi \times 10^{-6} T$

10. A bar magnet of dipole moment 3 Am^2 rests with its centre on a frictionless pivot. A force F is applied at right angles to the axis of the magnet, 10 cm from the pivot. It is observed that an external magnetic field of 0.25 T is required to hold the magnetic in equilibrium at an angle of 30° with the field. Calculate the value of E. How will the equilibrium be affected if F is withdrawn.

Section C

11. (a) An iron ring of relative permeability μ_r has windings of insulated copper wire of n turns per metre. When the current in the windings is I, find the expression for the magnetic field in the ring.

    (b) The susceptibility of a magnetic material is 0.9853. Identify the type of magnetic material. Draw the modification of the field pattern on keeping a piece of this material in a uniform magnetic field.

12. Two infinitely long straight wires A_1 and A_2 carrying currents I and 2I flowing in the same direction are kept 'd' distance apart. Where should a third straight wire A_3 carrying current 1.5 I be placed between A_1 and A_2 so that it experiences no net force due to A_1 to A_2? Does the net force acting on A_3 depend on the current flowing through it?

13. (a) Derive the expression for the torque acting on a current carrying loop placed in a magnetic field.
    (b) Explain the significance of a radial magnetic field when a current carrying coil is kept in it.

Section D

14. Read the following text and answer any four of the following questions on the basis of the same:

    Super Magnet

    The term super magnet is a broad term and encompasses several families of rare-earth magnets that include seventeen elements in the periodic table; namely scandium, yttrium, and the fifteen lanthanides. These elements can be magnetized, but have curie temperatures below room temperature. This means that in their pure form, their magnetism only appears at low temperatures. However, when they form compounds with transition metals such as iron, nickel, cobalt, etc. Curie temperature rises well above room temperature and they can be used effectively at higher temperature as well. The main advantage they have over conventional magnets is that their greater strength allows for smaller, lighter magnets to be used.

    Super magnets are of two categories:

    (i) **Neodymium magnet:** These are made from an alloy of neodymium, iron, and boron. This material is currently the strongest known type of permanent magnet. It is typically used in the construction of head actuators in computer hard drives and has many electronic applications, such as electric motors, appliances, and magnetic resonance imaging (MRI)

    (ii) Samarium-cobalt magnet: These are made from an alloy of samarium and cobalt. This second-strongest type of rare Earth magnet is also used in electronic motors, turbo-machinery, and because of its high temperature range tolerance may also have many applications for space travel, such as cryogenics and heat resistant machinery.

    Rare-earth magnets are extremely brittle and also vulnerable to corrosion, so they are usually plated or coated to protect them from breaking, chipping, or crumbling into powder. Since, super magnets are about 10 times stronger than ordinary magnets, safe distance should be maintained otherwise these may damage mechanical watch, CRT monitor, pacemaker, credit cards, magnetically stored media, etc.

    These types of magnets are hazardous for health also. The greater force exerted by rare-earth magnets creates hazards that are not seen with other types of magnets. Magnets larger than a few centimetres are strong enough to cause injuries to body part pinched between two magnets or a magnet and a metal surface, even causing broken bones. Neodymium permanent magnets lose their magnetism 5% every 100 years. So, in the truest sense Neodymium magnets may be considered as a permanent magnet.

Q1: Curie point of pure rare Earth elements is

(A) very high
(B) below room temperature
(C) 0 K
(D) varies from element to element

Q2: Neodymium and Samarium are

(A) diamagnetic
(B) paramagnetic
(C) ferromagnetic
(D) not magnetic materials

Q3: Super magnets are about……………. time stronger than ordinary magnets.

(A) 10
(B) 100
(C) 1000
(D) 10000

Q4: To raise the Curie point of rare Earth elements.

(A) They are coated with gold
(B) Compounds are formed with transition metals
(C) they are oxidized.
(D) none of the above.

Section E

15. (a) Show that a current carrying solenoid behaves like a small bar magnet. Obtain the expression for the magnetic field at an external point lying on its axis.

(b) A steady current of 2 A flows through a circular coil having 5 turns of radius 7 cm. The coil lies in X-Y plane with its centre at the origin. Find the magnitude and direction of the magnetic dipole moment of the coil.

16. (a) State Biot-Savart law and express this law in the vector form

(b) Two identical circular coils, P and Q each of radius R, carrying currents 1 A and $\sqrt{3}$ A respectively, are placed concentrically and perpendicular to each other lying in the XY and YZ planes. Find the magnitude and direction of the net magnetic field at the centre of the coils.

OR

(b) Use Biot-Savart law to derive the expression for the magnetic field on the axis of a current carrying circular loop of radius R.

Answer

1. B
2. D
3. C
4. A
5. B
6. D
7. B
8. A
9. B = $5\pi \times 10^{-6} T$
10. Q1: Ans B , Q2: Ans C , Q3: Ans C, Q4: Ans B