CLASS XII – PHYSICS (042)
PRACTICE PAPER – CHAPTER 5: MAGNETISM AND MATTER

Academic Session 2026–27

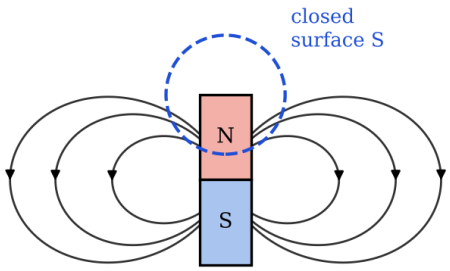
Maximum Marks : 35 **Time Allowed : 1 hour 15 minutes**

General Instructions

(1) There are 18 questions in all. All questions are compulsory.
(2) The question paper has five sections: Section A, B, C, D and E.
(3) Section A (Q.1–9) has seven MCQs and two Assertion–Reasoning questions of 1 mark each. Section B (Q.10–13) has four questions of 2 marks each. Section C (Q.14–16) has three questions of 3 marks each. Section D (Q.17) is one case study based question of 4 marks. Section E (Q.18) is one long answer question of 5 marks.
(4) There is no overall choice. An internal choice is provided in Q.12 (Section B), Q.15 (Section C), Q.17 part (iv) (Section D) and Q.18 (Section E). Attempt only one of the choices in such questions.
(5) Use of calculators is not allowed.
(6) You may use the following values of physical constants wherever necessary: $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}, $\mu_0/4\pi = 10^{-7}$ T m A^{-1}, $\pi = 3.14$.

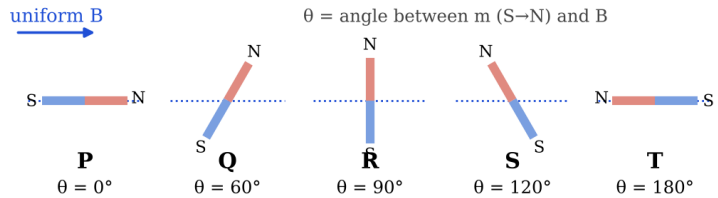
SECTION A (9 × 1 = 9)

1. A bar magnet and a closed surface S (dashed) enclosing its north pole are shown. The net magnetic flux through S is **1**



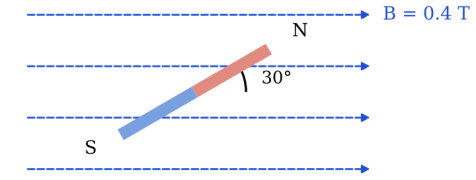
(a) positive, because field lines leave the north pole
(b) negative, because field lines enter the surface
(c) zero
(d) dependent on the size of the surface S

2. A small magnetic needle is held in five different orientations P, Q, R, S and T in a uniform magnetic field, where θ is the angle between its magnetic moment and the field. The orientations in which the needle is in stable and in unstable equilibrium are respectively **1**



(a) P and T
(b) T and P
(c) R and P
(d) P and R

3. A magnetic needle of magnetic moment 0.25 A m^2 lies at 30° to a uniform magnetic field of 0.4 T, as shown. The torque on the needle is **1**



magnetic moment of needle m = 0.25 A m²

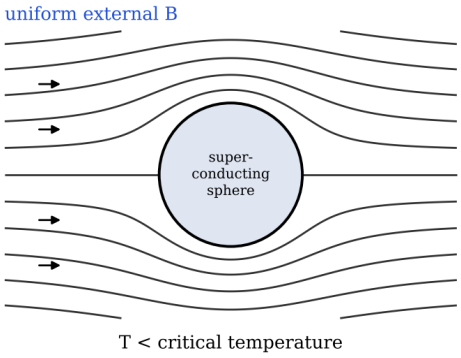
(a) 0.10 N m
(b) 0.05 N m
(c) 0.087 N m
(d) 0.20 N m

4. The magnetic susceptibilities of three materials X, Y and Z at room temperature are given in the table. X, Y and Z are respectively **1**

Material	X	Y	Z
Magnetic susceptibility χ	-2.0×10^{-5}	$+2.0 \times 10^{-5}$	$+5.0 \times 10^{3}$

(a) paramagnetic, diamagnetic, ferromagnetic
(b) ferromagnetic, diamagnetic, paramagnetic
(c) diamagnetic, ferromagnetic, paramagnetic
(d) diamagnetic, paramagnetic, ferromagnetic

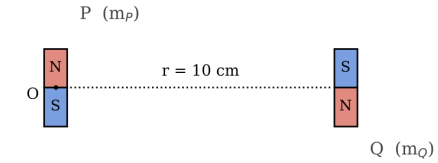
5. A sphere of a material, cooled below a certain temperature, is placed in a uniform magnetic field. The field lines are completely expelled from the sphere as shown. For this material the values of χ and μ_r are respectively **1**



T < critical temperature

(a) 0 and 1
(b) −1 and 0
(c) +1 and 2
(d) −1 and 1

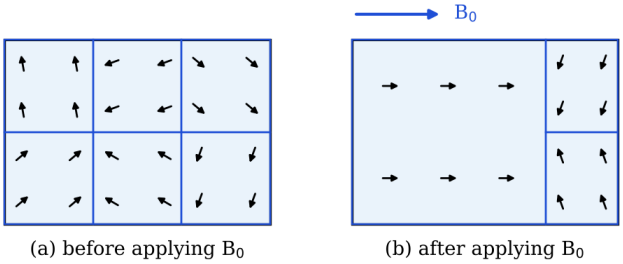
6. A short magnetised needle P has its magnetic moment upward. An identical needle Q is placed at a distance r from P, on the line through P perpendicular to the moment of P, with its moment downward, as shown. The needle Q is in **1**



Q is placed on the line through O perpendicular to m_P

(a) unstable equilibrium
(b) no equilibrium, a torque acts on it
(c) stable equilibrium
(d) neutral equilibrium

7. A piece of a ferromagnetic material is shown (a) before and (b) after it is placed in an external magnetic field B_0. The change from (a) to (b) is due to the fact that **1**



(a) before applying B_0 (b) after applying B_0

(a) the domains oriented opposite to B_0 grow in size
(b) the domains oriented along B_0 grow in size at the expense of others
(c) each atom loses its magnetic moment
(d) the number of atoms in each domain increases to 10^{11}

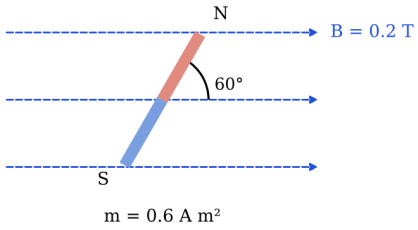
For Questions 8 and 9, a statement of Assertion (A) is followed by a statement of Reason (R). Select the correct answer from the options below.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

8. **Assertion (A):** Cutting a bar magnet into two halves gives an isolated north pole and an isolated south pole. **1**
Reason (R): Magnetic monopoles do not exist; the net magnetic flux through any closed surface is zero.

9. **Assertion (A):** A magnetic needle in a uniform magnetic field experiences a torque but no net force. **1**
Reason (R): The forces on the two poles of the needle are equal in magnitude and opposite in direction, and act along different lines.

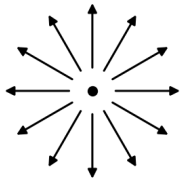
SECTION B (4 × 2 = 8)

10. A bar magnet of magnetic moment 0.6 A m^2 is held at 60° to a uniform magnetic field of 0.2 T, as shown. Find the torque on the magnet and its potential energy in this position (take the potential energy to be zero when the magnet is perpendicular to the field). **2**



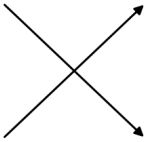
11. Two students draw the diagrams shown as magnetic field lines. State whether each diagram can represent a magnetic field, giving a reason in each case. **2**

lines diverge from a point



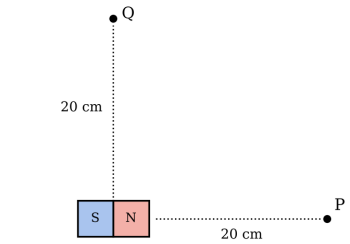
(i)

two lines intersect



(ii)

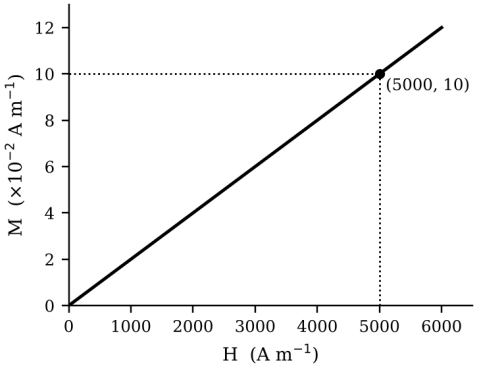
12. **(A)** A short bar magnet of magnetic moment 0.8 A m^2 is shown. Find the magnitude and direction of its magnetic field at the point P (on the axis) and at the point Q (on the equatorial line), each 20 cm from the centre of the magnet. **2**



OR

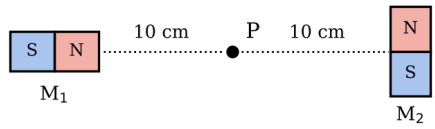
(B) A bar magnet of magnetic moment 0.4 A m^2 is to be replaced by an equivalent solenoid of 200 turns and cross-sectional area 5 cm^2. Find the current the solenoid must carry. Also find the magnetic field on the axis of the magnet at a distance of 25 cm from its centre (take the magnet as short).

13. The graph shows the variation of the magnetisation M of a sample with the magnetising field H. Use it to find the susceptibility and the relative permeability of the material, and state the type of magnetic material it is. **2**



SECTION C (3 × 3 = 9)

14. Two identical short bar magnets M_1 and M_2, each of magnetic moment 2.5 A m^2, are placed with their moments perpendicular to each other as shown. The point P is 10 cm from the centre of each magnet. Find the magnitude of the resultant magnetic field at P and the angle it makes with the line joining P to the centre of M_1. **3**



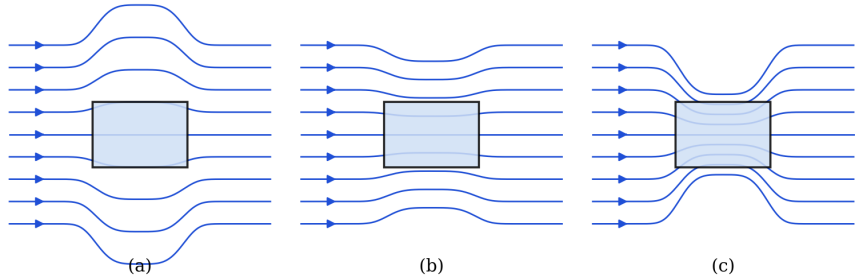
both magnets: m = 2.5 A m², P lies on the axis of M_1 and on the equatorial line of M_2

15. **(A)** Derive an expression for the potential energy of a magnetic dipole of moment **m** placed in a uniform magnetic field **B**. State the orientations of minimum and maximum potential energy and the nature of the equilibrium in each. **3**

OR

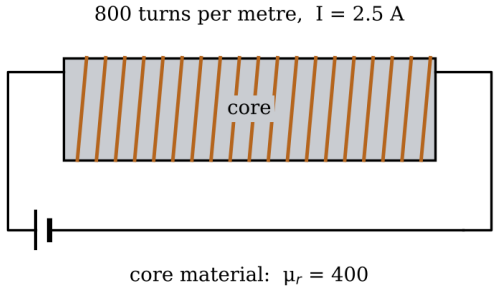
(B) State Gauss's law for magnetism. Explain, with reasons, how it differs from Gauss's law for electrostatics and how it would be modified if magnetic monopoles existed.

16. Three rods (a), (b) and (c), each of a different magnetic material, are placed in a uniform magnetic field. The behaviour of the field lines is shown. For each rod, name the type of magnetic material, state the range of its susceptibility and say how the rod behaves in a non-uniform magnetic field. **3**



SECTION D (1 × 4 = 4)

17. **Case Study.** The core of an electromagnet is a ferromagnetic alloy. A long solenoid has 800 turns per metre and carries a current of 2.5 A. When its interior is filled with the alloy, whose relative permeability is 400, the field inside is greatly enhanced, as shown. The magnetic field B inside the material is the sum of the field B_0 due to the current and the field B_m due to the magnetisation of the core. Answer the following: **4**



(i) The magnetic intensity H inside the solenoid is
(a) 800 A m^{-1} (b) 2000 A m^{-1} (c) 8.0 × 10^5 A m^{-1} (d) 1000 A m^{-1}

(ii) The magnetic susceptibility of the core is
(a) 400 (b) 401 (c) 399 (d) 1

(iii) The magnetic field B inside the core is approximately
(a) 1.0 T (b) 2.0 T (c) 0.5 T (d) 400 T

(iv) The magnetisation M of the core is approximately
(a) 2.0 × 10^3 A m^{-1} (b) 8.0 × 10^5 A m^{-1} (c) 400 A m^{-1} (d) 1.0 × 10^6 A m^{-1}

OR

(iv) The magnetising current I_m (the extra current needed in the same winding, without the core, to produce the same B) is approximately
(a) 2.5 A (b) 400 A (c) 100 A (d) 1000 A

SECTION E (1 × 5 = 5)

18. **(A)** Explain the domain theory of ferromagnetism. Describe what happens to the domains when an external field is applied and removed, and what happens when the sample is heated to a very high temperature. Distinguish between hard and soft ferromagnetic materials. (3) **5**

A paramagnetic sample of relative permeability 1.0002 is placed in a magnetising field H = 4 × 10^3 A m^{-1}. Find its magnetisation M and the magnetic field B inside it. (2)

OR

(B) Derive an expression for the torque on a bar magnet in a uniform magnetic field using the forces on its poles, and hence obtain its potential energy as a function of the angle θ between **m** and **B**. (3)

A bar magnet of magnetic moment 0.4 A m^2 lies along a uniform field of 0.5 T. Find the work done in turning it (i) through 90° and (ii) through 180°, and the torque on it in position (i). (2)

— End of Question Paper —