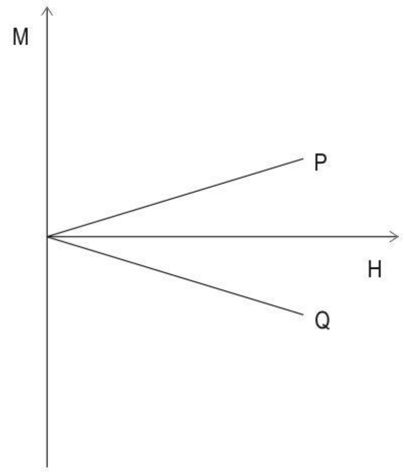
Magnetism and Matter

Q.No	Question	Marks
	Multiple Choice Question	
Q.74	Two statements are given below. One is labelled Assertion (A) and the other is labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements A and R. Assertion(A): Paramagnetic substances are weakly attracted to magnets. Reason(R): The individual atoms of a paramagnetic substance do NOT possess a permanent magnetic dipole moment. A. Both assertion and reason are true and reason is the correct explanation for assertion. B. Both assertion and reason are true but reason is not the correct explanation of assertion. C. Assertion is true but reason is false. D. Both assertion and reason are false.	1
Q.75	The graph below represents the variation of intensity of magnetisation (M) with magnetic field strength (H) for substances P and Q.  Which of the two substances is most likely to be attracted when taken near a magnet? A. Only P B. Only Q C. Both P and Q D. Neither P nor Q	1

Q.76	Assertion: Monopoles exist only as electric charges, not in magnetism. Reason: Gauss law states that the net magnetic or electric flux through any closed surface is always zero. Select the correct option. A. Both A and R are true and R is the correct explanation of A B. Both A and R are true and but R is NOT the correct explanation of A C. A is true but R is false D. A is false and R is also false	1
Free Response Questions/Subjective Questions		
Q.77	Read the following information. Each of the orbiting electrons in an atom contributes towards the orbital magnetic moment. In a diamagnetic material, the resultant magnetic moment of each atom is zero. When exposed to an external magnetic field, the diamagnetic substance experiences repulsion. Answer the following: (a) Why are diamagnetic materials repelled when placed in an external field? Give an explanation basis the changes that occur to the orbital magnetic moment of the electrons. (b) In contrast to a diamagnetic material, how does a material with each individual atom having a non-zero magnetic dipole moment but all atoms aligned in random directions, respond to an external magnetic field? What are such materials known as? (c) In the material identified in (b) what is the effect of fall in temperature and rise in applied magnetic field intensity? (d) What does the value $\mu_r = 0$ signify in a magnetic material? Find χ of such material. What are such materials known as?	4
Q.78	Earth's magnetic field is assumed to be due to a small magnetic dipole located at its core. Considering the distance of either of the poles from the centre of the Earth to be about 6400 km and the measure of the Earth's magnetic field at the poles as 0.6×10^{-4} T, what is the magnetic dipole moment of the assumed magnetic dipole located at the centre?	2

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.74	C. Assertion is true but reason is false.	1
Q.75	A. Only P	1
Q.76	C. A is true but R is false	1
Q.77	(a) When an external magnetic field B is applied to a diamagnetic material, the electrons with an orbital magnetic moment in the direction same as B, slow down whereas the ones in the direction opposite to B, speed up. The diamagnetic material develops a net non-zero magnetic moment in the direction opposite to the applied B. This results in repulsion. [1 mark for correct explanation] (b) Each atom with a net non-zero magnetic moment aligns parallel to the applied magnetic field B. The material will experience attraction. [0.5 mark for correct explanation] They are known as paramagnetic materials. [0.5 mark for correct identification] (c) With the fall in temperature and rise in the applied magnetic field intensity B, the magnetization intensity M of paramagnetic material increases until all dipole moments are perfectly aligned to B. The material is said to have reached its magnetic saturation. [0.5 mark for correct description] (d) As $\mu_r = 1+ \chi$, if $\mu_r = 0$, it implies $\chi = -1$. If such a material is placed in an external magnetic field, it will repel all the field lines. The net magnetic field inside the material, that, $B = \mu H = \mu_0\mu_r H = 0$. [0.5 mark for correct interpretation] [0.5 mark for correct value of χ] Such materials are known as perfectly diamagnetic materials or superconductors. [0.5 mark for identification of material]	4

Q.78	The magnetic field due to magnetic dipole at the center, aligned along the magnetic meridian (end-on position), $B = \frac{\mu_0}{4\pi}\frac{2m}{R^3}$ for R >> length of earth's dipole [0.5 mark for correct formula & 0.5 mark for the correct identification of the end on-position of the Earth's poles with respect to Earth's magnetic dipole] For R >> length of earth's dipole $0.6 \times 10^{-4} = 10^{-7} \times 2m/(6400 \times 10^3)^3$ $m = \frac{0.6 \times 10^{-4} \times (6400 \times 10^3)^3}{2 \times 10^{-7}} = \frac{0.6 \times 64^3}{2} \times 10^{18}$ $m = 7.8 \times 10^{22}$ Am^2 [1 mark for correct calculation and final result]	2