Unit 17 · Magnetic Properties of Materials

WORKSHEET

Full marks 34

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 34

1 Key words [4]

Write ✓ for a true statement and ✗ for a false one. Correct the false ones. Each carries 0.5 mark.

i. The magnetic intensity H inside a long solenoid is nI, whatever is inside the solenoid. ☐

ii. The intensity of magnetization is the magnetic moment per unit area. ☐

iii. Magnetic susceptibility has no unit. ☐

iv. A paramagnetic substance has a relative permeability slightly less than 1. ☐

v. The susceptibility of a diamagnetic substance does not depend on temperature. ☐

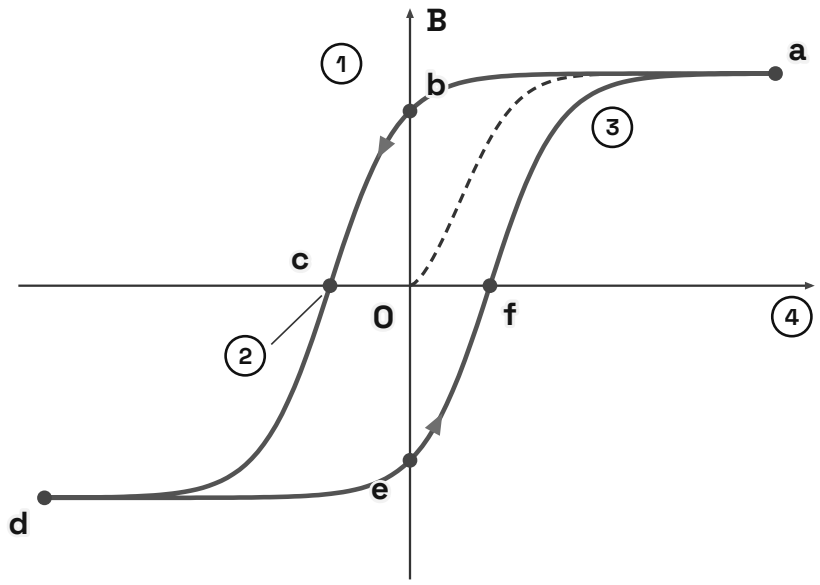
vi. Above its Curie temperature a ferromagnetic substance becomes diamagnetic. ☐

vii. Coercivity is the reverse magnetizing field needed to bring the magnetic induction to zero. ☐

viii. The angle of dip is 90° at the magnetic equator. ☐

2 Label the graph [2]

The graph shows the hysteresis loop of a ferromagnetic material. Write the label that belongs in place of 1 to 4. Each carries 0.5 mark.



1. _____ **2.** _____

3. _____ **4.** _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. The susceptibility of a paramagnetic salt is 1.5×10^{-4} at 300 K. At 450 K it is: [1]

a. 2.25×10^{-4} **b.** 1.0×10^{-4}

c. 1.5×10^{-4} **d.** 0.67×10^{-4}

ii. At a place where the angle of dip is 30°, the Earth's total field is 50 μT. Its horizontal component is about: [1]

a. 25 μT **b.** 43 μT

c. 50 μT **d.** 58 μT

iii. The SI unit of the intensity of magnetization is: [1]

a. T **b.** A m^2

c. A/m **d.** Wb/m

iv. A material for a permanent magnet must above all have: [1]

a. a high permeability **b.** a small hysteresis loop

c. a high coercivity **d.** a negative susceptibility

v. In a weak magnetizing field, an unmagnetized piece of iron becomes magnetized mainly because: [1]

a. new domains are made

b. domains pointing along the field grow at the expense of the others

c. every atom's magnetic moment is reversed

d. the iron becomes hotter than its Curie temperature

4 Short answers [6]

Write short answers to the following questions.

a. A magnet picks up an unmagnetized iron nail. Explain why, using the idea of induced magnetism. [2]

b. A short rod of bismuth and a short rod of aluminium are each hung by a thread between the poles of a strong magnet. How does each settle? Why? [2]

c. Why does a ferromagnetic substance lose its strong magnetism when heated above its Curie temperature? [2]

5 Long answer [4]

Write a long answer to the following question.

Define magnetic permeability and magnetic susceptibility. Starting from $B = \mu_0(H + I)$, show that $\mu_r = 1 + \chi$. What does the result say about the relative permeability of a diamagnetic substance?

6 Numerical problems [10]

Solve the following problems. Show your working. Take $\mu_0 = 4\pi \times 10^{-7}$ T m/A.

a. A solenoid 40 cm long has 240 turns and carries 1.5 A. It is wound on an iron core of relative permeability 800. Find i. the magnetic intensity H, ii. the magnetic induction B in the core, iii. the susceptibility of the iron, and iv. its intensity of magnetization. [4]

Answer:

b. The hysteresis loop of a transformer core has an area of 180 J/m^3. The core's volume is 1500 cm^3, and it is taken round its loop by the 50 Hz mains. Find the power lost as heat by hysteresis, and the energy lost in a day in kWh. [3]

Answer:

c. At a place, the horizontal component of the Earth's field is 30 μT and the vertical component 40 μT. Find the total field and the angle of dip. **[3]**

Answer: _____

7 Think **[3]**

Gadolinium's Curie temperature is about 20 °C. Ramesh finds that a magnet picks up a gadolinium pellet on a cold morning but not in the afternoon sun. Explain, and say what you expect if he warms an iron nail in his hand.

8 Activity: Make a magnet, then spoil it (Activity 17.2) (not marked)

Stroke a steel needle about 30 times with one pole of a bar magnet, always the same way. Test it with pins, then drop it on a hard floor a dozen times and test it again.

	Pins picked up	Its ends near a compass
Before stroking		
After stroking		
After dropping		

Why did the knocks change the needle?