ANSWER KEY ➤ Material Science

1. (c)	7. (b)	13. (a)	19. (d)	25. (b)
2. (b)	8. (c)	14. (d)	20. (b)	26. (b)
3. (a)	9. (a)	15. (b)	21. (a)	27. (a)
4. (c)	10. (a)	16. (b)	22. (c)	28. (d)
5. (c)	11. (b)	17. (d)	23. (a)	29. (d)
6. (b)	12. (b)	18. (a)	24. (a)	30. (c)

DETAILED EXPLANATIONS

2. (b)
 (i) Superconductors have zero resistivity.
 (ii) In semiconductors, doping with impurity increases the electrical conductivity.

3. (a)
Permeability of water $\mu_{rw} = 0.99999 < 1$
Permeability of oxygen $\mu_{ro} = 1.00002 > 1$
so, water is diamagnetic material
and oxygen is paramagnetic material. So 1 is right.

4. (c)
Superconductor is diamagnetic so very small negative susceptibility. Ferric chloride is paramagnetic so susceptibility is positive. MnO is Antiferromagnetic follow Curie Weiss law after Neel temperature.

8. **(c)**

Wavelength, $\qquad \lambda(\mu m) = \dfrac{1.24}{E_g(eV)}$

$$\lambda = \dfrac{1.24}{1.43}\,\mu m = 0.867133\,\mu m = 8671.33\,\text{Å}$$

Which is in infrared region.

12. **(b)**

Manganese ferrite is a 1 : 1 mixture of manganese oxide and iron oxide.

14. **(d)**

Iron can exist in solid state in two or more lattice forms depending on the conditions of temperature and pressure. This is allotropy. Fe is also an example of magnetic anisotropic material in which magnetic properties depend on the direction in which they are measured.

15. **(b)**

$$\text{Dielectric loss is given by} = \dfrac{E^2 f\,\varepsilon_r \tan\delta}{1.8 \times 10^{12}}\ \text{W/cm}^3$$

For this specimen the heat loss will be

$$= \dfrac{50^2 \times 10^6 \times 100 \times 4 \times 0.001}{1.8 \times 10^{12}} = 0.55\ \text{mW/cm}^3$$

16. **(b)**

$$D = 4\,P = 4\chi_e \varepsilon_0 E$$

but $\qquad D = \varepsilon_r \varepsilon_0 E = (\chi_e + 1)\varepsilon_0 E$

comparing above expression and taking $\chi_e = \varepsilon_r - 1$

$$4(\varepsilon_r - 1)\varepsilon_0 E = \varepsilon_0 \varepsilon_r E$$
$$4(\varepsilon_r - 1) = \varepsilon_r \Rightarrow 3\varepsilon_r = 4$$

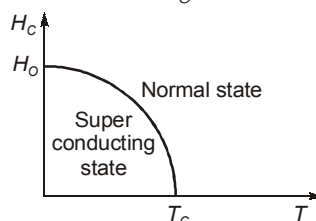$\therefore \qquad\qquad \varepsilon_r = \dfrac{4}{3}$

17. **(d)**

The material for the core in a power transformer must have high permeability and high saturation magnetization.

19. **(d)**

In superconductors, the critical field H_C varies with temperature according to the parabolic law

$$H_C = H_o\left[1 - \left(\dfrac{T}{T_C}\right)^2\right]$$

where H_o is the critical field at absolute zero and T_C is the transition temperature.

Critical Magnetic field of superconductor as a function of temperature.

21. **(a)**

$$B = \mu_0(H + M)$$
$$B = 0 = \mu_0(H + M)$$
$$H = -M$$

$$x_m = \frac{H}{M} = -1$$

$\Rightarrow$ Therefore, super conductors show perfect diamagnetism.

22. **(c)**

For ideal quartz crystal $\quad R = 0,$

$$X = -\frac{1}{\omega C_P} \times \left(\frac{\omega^2 - \omega_s^2}{\omega - \omega_P^2} \right)$$

29. **(d)**

Resistivity of ferrites is very much higher than that of ferromagnetic materials.

30. **(c)**

Alnico has high hysteresis loss.

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