Magnetochemistry - Multiple Choice Questions & Answer

1. The branch of chemistry that deals with the magnetic properties of materials is called:
a) Electrochemistry
b) Thermochemistry
c) Magnetochemistry
d) Photochemistry

2. The fundamental source of magnetism in materials is due to:
a) The gravitational force between atoms
b) The motion of electric charges
c) The nuclear forces within the atom
d) The heat energy of the substance

3. The magnetic moment of an electron is primarily due to its:
a) Mass and charge
b) Orbital motion and spin
c) Size and volume
d) Charge and volume

4. A substance that is weakly repelled by a magnetic field is classified as:
a) Ferromagnetic
b) Paramagnetic
c) Diamagnetic
d) Antiferromagnetic

5. Paramagnetism is commonly observed in substances that have:
a) All electrons paired
b) A permanent dipole moment
c) Unpaired electrons
d) A symmetrical electron distribution

6. The magnetic susceptibility (χ) for a diamagnetic substance is:
a) Positive and large
b) Positive and small
c) Negative and small
d) Negative and large

7. Which of the following ions is expected to be diamagnetic?
a) Fe^{3+} (Atomic number of Fe = 26)
b) Cu^{2+} (Atomic number of Cu = 29)
c) Zn^{2+} (Atomic number of Zn = 30) ((Explanation: Zn^{2+} has a d^{10} configuration,

meaning all electrons are paired.)
d) Mn^{2+} (Atomic number of Mn = 25)

8. The effective magnetic moment (μ_eff) for a transition metal ion is calculated using the formula:
a) μ_eff = √[n(n+1)]
b) μ_eff = √[4S(S+1)] ((This is the spin-only formula. Option d is for rare-earth elements where spin-orbit coupling is significant.)
c) μ_eff = √[4S(S+1) + L(L+1)]
d) μ_eff = g√[J(J+1)]

9. For a high-spin d^5 metal ion (e.g., Fe^{3+} or Mn^{2+}), the spin-only magnetic moment in Bohr Magnetons (B.M.) is:
a) 1.73 B.M.
b) 2.83 B.M.
c) 3.87 B.M.
d) 5.92 B.M. (Explanation: For d^5 high-spin, n=5 unpaired electrons. μ_eff = √[5(5+2)] = √35 ≈ 5.92 B.M.)

10. What is the spin-only magnetic moment (in B.M.) for a Ni^{2+} (d^8) ion?
a) 0.0 B.M.
b) 1.73 B.M.
c) 2.83 B.M. (Explanation: Ni^{2+} is d^8. For an octahedral complex, it's typically high-spin with 2 unpaired electrons. μ_eff = √[2(2+2)] = √8 ≈ 2.83 B.M.)
d) 3.87 B.M.

11. The Gouy balance is used to measure:
a) Electrical conductivity
b) Magnetic susceptibility
c) Viscosity
d) Refractive index

12. Ferromagnetic materials, like iron, are characterized by:
a) Random alignment of magnetic moments
b) No permanent magnetic moment
c) Alignment of magnetic moments in the same direction
d) Alignment of magnetic moments in opposite directions, canceling out

13. In an antiferromagnetic material, the magnetic moments of adjacent atoms:
a) Align parallel to each other
b) Align antiparallel to each other and are equal in magnitude
c) Are randomly oriented
d) Are all zero

14. The constant "g" in the magnetic moment formula is called the:
a) Gravitational constant
b) Gyromagnetic ratio or Landé g-factor
c) Gaussian constant
d) Ground state constant

15. The Curie Law states that the magnetic susceptibility (χ) of a paramagnetic substance is:
a) Directly proportional to the absolute temperature (T)
b) Inversely proportional to the absolute temperature (T) (χ = C / T, where C is the Curie constant)
c) Independent of temperature
d) Directly proportional to the square of the temperature (T^2)