Q1. What is bond order? Write the formula.

Bond order tells us how many bonds exist between two atoms. Larger bond order means stronger bond and shorter bond length.

Formula:
Bond Order = (Number of bonding electrons – Number of anti-bonding electrons) / 2

Example: In O_2 → (10 – 6)/2 = 2 → bond order = 2

Q2. Why SO_2 is polar molecule but SO_3 is not?

SO_2: Molecule has bent shape, so dipole moments of bonds do not cancel. That makes it polar.

SO_3: Molecule has trigonal planar shape, so dipole moments cancel each other. That makes it non-polar.

Q3. Difference between bonding and anti-bonding molecular orbitals

Bonding Molecular Orbital	Anti-Bonding Molecular Orbital
Formed by constructive overlap of atomic orbitals.	Formed by destructive overlap of atomic orbitals.
Energy is lower than atomic orbitals.	Energy is higher than atomic orbitals.
Provides stability to molecule.	Decreases stability of molecule.

Q4. Why O_2 is paramagnetic and N_2 is diamagnetic?

O_2: Molecular orbital diagram shows 2 unpaired electrons in π* orbitals. So, O_2 is paramagnetic.

N_2: Molecular orbital diagram shows all electrons are paired. So, N_2 is diamagnetic.

Q5. Draw structure of the following on the basis of VSEPR theory:

- **SO_3** → Trigonal planar, bond angle = 120°
- **PCl_5** → Trigonal bipyramidal, bond angles = 90° and 120°

Q6. What is enthalpy and internal energy?

- **Enthalpy (H):** Heat content of system at constant pressure.
- **Internal Energy (U):** Total energy of system (kinetic + potential).

Q7. Difference between endothermic and exothermic reaction

Endothermic Reaction	Exothermic Reaction
Absorbs heat from surroundings.	Releases heat to surroundings.
ΔH is positive.	ΔH is negative.
Example: Photosynthesis.	Example: Combustion of fuel.

Q8. Difference between entropy and Gibbs free energy

Entropy (S)	Gibbs Free Energy (G)
Measure of disorder in a system.	Energy available to do useful work.
Depends only on randomness of particles.	Depends on enthalpy, entropy, and temperature.
Higher entropy means more disorder.	Negative ΔG means spontaneous reaction.

Q9. What is coordinate covalent bond? Give example.

When one atom donates both electrons to form a bond with another atom, it is called coordinate covalent bond.

Example: In NH_4^+, nitrogen donates lone pair to H^+.

Q10. Differentiate between polar and non-polar covalent bond.

Polar Covalent Bond	Non-Polar Covalent Bond
Electrons shared unequally.	Electrons shared equally.
Creates partial positive and negative charges.	No partial charges are created.
Example: H_2O.	Example: Cl_2.

Q11. Predict the bond angle in H_2S. Why is it different from H_2O?

- In **H_2O**, bond angle ≈ 104.5° because of more repulsion due to lone pairs.
- In **H_2S**, bond angle ≈ 92° because S is larger atom and lone pair repulsion is less.

Q12. HCl is stronger acid while HF is weaker acid – justify.

H–Cl bond is weaker, breaks easily, and releases H^+ quickly → strong acid.

H–F bond is strong, does not break easily, releases fewer H^+ ions → weak acid.

Q13. Define the following terms:

- **Enthalpy of combustion:** Heat released when 1 mole of substance burns completely in oxygen.
  Example: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + heat
- **Enthalpy of lattice energy:** Heat released when gaseous ions combine to form 1 mole of ionic solid.
  Example: Na^+ (g) + Cl^- (g) → NaCl (s)

Q14. What is hydration energy? Name the factors affecting it.

Hydration energy is the heat released when 1 mole of gaseous ions dissolve in water and become hydrated.

Factors:

- Size of ion (smaller ion → higher energy)
- Charge of ion (higher charge → higher energy)

Q15. What is Gibbs free energy?

Gibbs free energy is the energy of a system available to do useful work at constant temperature and pressure.

Formula: $\Delta G = \Delta H - T\Delta S$

- If $\Delta G < 0$ → reaction is spontaneous.
- If $\Delta G > 0$ → reaction is non-spontaneous.

Q16. What is entropy? Give example also.

Entropy is the measure of randomness or disorder in a system.

- High entropy → system is more disordered.
- Low entropy → system is more ordered.

Example:

- Ice (solid) → low entropy
- Water (liquid) → medium entropy
- Steam (gas) → high entropy