

EXERCISE SOLUTIONS

CLASS 9 · CHEMISTRY

Chapter 3

Chemical Bonding

Complete Textbook Exercise — Solved



10 MCQs

6 Short Answers

6 Constructed Response

6 Descriptive

2 Investigative

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A**Tick the Correct Answer**

Question 1 of 10

1 When molten copper and molten zinc are mixed together, they give rise to a new substance called brass. Predict what type of bond is formed between copper and zinc.

☐ (A) Coordinate covalent bond

☐ (B) Ionic bond

☒ (C) **Metallic bond**



☐ (D) Covalent bond

EXPLANATION

Brass is an alloy composed of two metals, copper and zinc. Metals bond together through a “sea of delocalized electrons,” which is characteristic of a metallic bond. The positive metal ions are held together by these freely moving electrons.

2 Which element is capable of forming all the three types of bonds; covalent, coordinate covalent and ionic?

A Carbon ✓

B Oxygen

C Magnesium

D Silicon

EXPLANATION

Carbon is uniquely versatile. It forms covalent bonds by sharing electrons (e.g., CH_4), coordinate covalent bonds by accepting or donating lone pairs (e.g., in CO or metal carbonyls), and ionic bonds in certain compounds like carbides (e.g., Al_4C_3) where it exists as a carbide ion.

3 Why is H_2O a liquid while H_2S is a gas?

- ☐ A Because in water, the atomic size of oxygen is smaller than that of sulphur
- ☒ B **Because water is a polar compound and there exists strong forces of attraction between its molecules** ✓
- ☐ C Because H_2O molecule is lighter than H_2S
- ☐ D Because water can easily freeze into ice

EXPLANATION

Oxygen has a high electronegativity, making the O-H bond highly polar. This results in strong hydrogen bonding between water molecules, which requires a large amount of energy to break. Sulfur is less electronegative, so H_2S only has weak dipole-dipole interactions, requiring very little energy to separate the molecules, making it a gas at room temperature.

4 Which of the following bonds is expected to be the weakest?

(A) C - C

(B) Cl - Cl

(C) O - O

(D) F - F



EXPLANATION

The F-F bond is anomalously weak. This is because fluorine atoms are very small and have a high electron density. The lone pairs of electrons on the two bonded fluorine atoms are very close together and repel each other strongly, weakening the bond.

5 Which form of carbon is used as a lubricant?

(A) Coal

(B) Diamond

(C) Graphite ✓

(D) Charcoal

EXPLANATION

Graphite has a layered structure where carbon atoms within a layer are strongly bonded, but the layers are held together by weak van der Waals forces. This allows the layers to easily slide over one another, making graphite an excellent dry lubricant.

6 Keeping in view the intermolecular forces of attraction, indicate which compound has the highest boiling point.

A H_2O



B H_2S

C HF

D NH_3

EXPLANATION

Among the given options, H_2O has the highest boiling point because it forms extensive hydrogen bonds. An oxygen atom has two lone pairs and can form hydrogen bonds with two hydrogen atoms of neighboring molecules, creating a strong 3D network. HF and NH_3 also form hydrogen bonds but to a lesser extent.

7 Which metal has the lowest melting point?

(A) Li

(B) Na

(C) K

(D) Rb

**EXPLANATION**

Melting points decrease down Group 1 (alkali metals) as atomic size increases. The valence electron is further from the nucleus, resulting in a weaker metallic bond. Rb (Rubidium) is the largest atom among the given options and thus has the weakest metallic bond and lowest melting point.

8 Which ionic compound has the highest melting point?

A NaCl ✓

B KCl

C LiCl

D RbCl

EXPLANATION

NaCl has strong ionic bonds and a high lattice energy. While LiCl has smaller ions, it exhibits significant covalent character due to the high polarizing power of the small Li^+ ion (Fajan's rules), which lowers its melting point compared to NaCl. KCl and RbCl have larger cations, lower lattice energies, and thus lower melting points.

9 Which compound contains both covalent and ionic bonds?

(A) MgCl_2

(B) NH_4Cl ✓

(C) CaO

(D) PCl_3

EXPLANATION

NH_4Cl consists of ammonium ions (NH_4^+) and chloride ions (Cl^-). The bond between NH_4^+ and Cl^- is ionic. However, within the ammonium ion itself, the bonds between Nitrogen and Hydrogen are covalent (and coordinate covalent).

10 Which among the following has a double covalent bond?

(A) Ethane

(B) Methane

(C) Ethylene ✓

(D) Acetylene

EXPLANATION

Ethylene (C_2H_4) has a carbon-carbon double bond ($\text{C}=\text{C}$). Ethane has a single bond, acetylene has a triple bond, and methane has only single C-H bonds.

B**Short Answer Questions****6 Questions**

1 What type of elements lose their outer electron easily and what type of elements gain electron easily.

ANSWER

Metals lose their outer electrons easily because they have low ionization energies. Non-metals gain electrons easily because they have high electron affinities.

2 Why do lower molecular mass covalent compounds exist as gases or low boiling liquids.

ANSWER

Lower molecular mass covalent compounds have weak intermolecular forces of attraction (London dispersion forces or weak dipole-dipole interactions). Because these forces are weak, only a small amount of thermal energy is required to overcome them, allowing these compounds to exist as gases or low-boiling liquids at room temperature.

3 Give one example of an element which exists as a crystalline solid and it has covalent bonds between its atoms.

ANSWER

Carbon (Diamond) or Silicon. Diamond exists as a giant covalent network solid where each carbon atom is covalently bonded to four other carbon atoms.

4 Which property of metals makes them malleable and ductile?

ANSWER

The metallic bond is responsible for malleability and ductility. In a metallic bond, positive ions are surrounded by a sea of delocalized electrons. When a force is applied, the layers of positive ions can slide over each other without breaking the metallic bond, allowing the metal to be shaped.

5 Is coordinate covalent bond a strong bond?**ANSWER**

Yes, a coordinate covalent bond is as strong as a normal covalent bond. Once formed, it is indistinguishable from a regular covalent bond because it also involves the mutual sharing of an electron pair. The only difference is that both electrons in the shared pair originally came from one atom.

6 Write down dot and cross formula of HNO_3 .**ANSWER**

Nitrogen is the central atom. It forms a double bond (sharing 4 electrons) with one Oxygen atom. It forms a single bond with a second Oxygen atom, which is also bonded to a Hydrogen atom (O-H). Finally, Nitrogen forms a coordinate covalent bond with a third Oxygen atom, accepting a lone pair of electrons from this Oxygen atom.



Constructed Response Questions

6 Questions

1 Why HF is a liquid while HCl is a gas?

ANSWER

Fluorine is highly electronegative, creating a very polar H-F bond. This polarity leads to strong hydrogen bonding between HF molecules, which requires significant energy to break. Chlorine is less electronegative, so HCl molecules only experience weaker dipole-dipole forces. Therefore, HF is a liquid at room temperature while HCl is a gas.

2 Why covalent compounds are generally not soluble in water?

ANSWER

Water is a highly polar solvent, while covalent compounds are generally non-polar. According to the principle “like dissolves like,” polar solvents dissolve polar solutes and non-polar solvents dissolve non-polar solutes. Non-polar covalent compounds cannot form favourable interactions with polar water molecules to break the strong hydrogen bonds between water molecules, making them generally insoluble.

3 How do metals conduct heat?**ANSWER**

Metals conduct heat through their delocalized (free) electrons. When a metal is heated at one end, the free electrons in that region gain kinetic energy. These energetic electrons move rapidly throughout the metal lattice and collide with other electrons and positive ions, transferring thermal energy from the hot region to the cooler regions.

4 How many oxides does nitrogen form. Write down the formulae of oxides.**ANSWER**

Nitrogen forms several oxides in different oxidation states:

- Nitrous oxide (N_2O)
- Nitric oxide (NO)
- Dinitrogen trioxide (N_2O_3)
- Nitrogen dioxide (NO_2)
- Dinitrogen tetroxide (N_2O_4)
- Dinitrogen pentoxide (N_2O_5)

5 What will happen if NaBr is treated with AgNO₃ in water?**ANSWER**

A double displacement reaction will occur. When aqueous solutions of sodium bromide (NaBr) and silver nitrate (AgNO₃) are mixed, a pale yellow precipitate of silver bromide (AgBr) is formed, along with sodium nitrate (NaNO₃) remaining in solution.

Equation: $\text{NaBr (aq)} + \text{AgNO}_3 \text{ (aq)} \rightarrow \text{AgBr (s)} \downarrow + \text{NaNO}_3 \text{ (aq)}$

6 Why does iodine exist as a solid while Cl₂ exists as a gas?**ANSWER**

Iodine (I₂) molecules are much larger and heavier than chlorine (Cl₂) molecules. Because of iodine's larger electron cloud, it has significantly stronger London dispersion forces between its molecules. These strong forces hold the iodine molecules tightly together in a solid lattice at room temperature. Cl₂ molecules are smaller with weaker dispersion forces, allowing them to exist as a gas.

D

Descriptive Questions

6 Questions

1 Explain the formation of an ionic bond and a covalent bond.

ANSWER

Ionic Bond: Formed by the complete transfer of one or more valence electrons from a metal atom (which becomes a positive ion) to a non-metal atom (which becomes a negative ion). The resulting oppositely charged ions attract each other electrostatically. Example: Na loses an electron to Cl to form Na^+ and Cl^- .

Covalent Bond: Formed by the mutual sharing of valence electron pairs between two non-metal atoms to achieve stable noble gas configurations. Example: Two hydrogen atoms share their single electrons to form an H_2 molecule.

2 How do ions arrange themselves to form NaCl crystal.

ANSWER

Sodium and chloride ions arrange themselves in a highly ordered 3D structure called a crystal lattice. NaCl forms a face-centred cubic (FCC) lattice. Each Na^+ ion is surrounded by six Cl^- ions, and each Cl^- ion is surrounded by six Na^+ ions. This arrangement maximizes the attractive forces between opposite charges and minimizes the repulsive forces between like charges.

3 Explain the properties of metals keeping in view the nature of metallic bond.

ANSWER

Metallic bonds consist of positive metal ions immersed in a sea of delocalized valence electrons.

- **Conductivity:** Free electrons move freely and carry current or heat.
- **Malleability/Ductility:** The non-directional nature of the bond lets layers of ions slide past each other without breaking.
- **Luster:** Free electrons absorb and re-emit light, giving metals a shiny appearance.
- **High MP/BP:** The strength of the metallic bond determines melting and boiling points; stronger bonds need more energy to break.

4 Compare the properties of ionic and covalent compounds.

ANSWER

Ionic Compounds: High melting/boiling points due to strong electrostatic forces. Soluble in water. Conduct electricity in molten or aqueous states (free ions). Hard and brittle crystalline solids.

Covalent Compounds: Low melting/boiling points due to weak intermolecular forces. Generally insoluble in water (unless polar). Poor conductors of electricity in any state (no free ions). Often exist as gases, liquids, or soft solids.

5 How will you explain the electrical conductivity of graphite crystals?

ANSWER

In a graphite crystal, each carbon atom is covalently bonded to three other carbon atoms in a hexagonal layered structure. This leaves one valence electron per carbon atom unpaired and free to move. These delocalized electrons move freely parallel to the layers, allowing graphite to conduct electricity (conductivity is lower perpendicular to the layers).

6 Why are metals usually hard and heavy?

ANSWER

Metals are heavy because they generally have high atomic masses and densely packed atoms in their crystal lattice. They are hard because of the strong metallic bonds holding the atoms together. The strength of this bond depends on the number of delocalized electrons and the charge/size of the metal cation, making transition metals particularly hard and dense.

E

Investigative Questions**2 Questions**

1 The formula of AlCl_3 in vapour phase is Al_2Cl_6 which means it exists as a dimer. Explain the bonding between its two molecules.

ANSWER

In an AlCl_3 molecule, the central aluminium atom has only 6 valence electrons, so it has an incomplete octet. To achieve a stable octet, two AlCl_3 molecules combine. One chlorine atom from each AlCl_3 molecule acts as a bridge, donating a lone pair of electrons to the aluminium atom of the other molecule, forming a coordinate covalent bond. This results in a dimer (Al_2Cl_6) where aluminium atoms achieve an octet and chlorine atoms bridge the two units.

2 Explain the structure of sand (SiO_2).

ANSWER

Sand (SiO_2) exists as a giant covalent network solid (macromolecule). Each silicon atom is covalently bonded to four oxygen atoms in a tetrahedral arrangement, and each oxygen atom is bonded to two silicon atoms. This continuous 3D network of strong Si-O covalent bonds extends throughout the crystal. Because these strong covalent bonds must be broken to melt it, SiO_2 has a very high melting point and is extremely hard.



Exercise Complete

Chapter 3 · Chemical Bonding

Every question from this chapter's exercise has been solved with clear, examiner-style explanations — built for CSS & PMS aspirants who want concept clarity, not just answers.

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