Class – IX (Science)

Chapter – Atomic Foundations of Matter

Back Exercise Solution

1. **A particular element (A) has one electron in its third shell. There is another element (B) with six electrons in its second shell.**
   (i) How many electrons does A tend to give or take to become stable?
   (ii) What kind of ion would it form?
   (iii) How many electrons does B tend to give or take to become stable?
   (iv) What kind of ion would it form?
   (v) If A and B were to combine, what kind of bond would be formed?
   (vi) What would be the formula of the compound thus formed?

Solution:

(i) Element A has one electron in its third shell, so it will lose 1 electron to become stable.
(ii) It will form a positive ion (cation), A^+.
(iii) Element B has six electrons in its outer shell, so it will gain 2 electrons to complete its octet.
(iv) It will form a negative ion (anion), B^{2-}.
(v) Since electrons are transferred from A to B, an ionic bond will be formed.
(vi) The formula of the compound formed will be A_2B.

2. An element X has six electrons in its outer shell and forms a diatomic molecule.
(i) Why would that be so?
(ii) What kind of bond would it form?
(iii) Draw the structure of the molecule it would form.
(iv) A certain other element Y has two electrons in its second shell. Draw the structure of the molecule that X would form with Y.

Solution:

(i) X has six valence electrons and needs two more electrons to complete its octet.
Therefore, two atoms of X share electrons and form a diatomic molecule.
(ii) It forms a covalent bond.
(iii) Structure of X_2 molecule:
:X :: X:
(Each atom shares two electrons forming a double covalent bond.)

(iv) Y has two electrons in its second shell, so Y is helium (He), which is chemically inert.
Therefore, X will not normally form a compound with Y.

3. You want to design a new ionic compound, where the total positive charge is 6+ and the total negative charge is 6–. Which of the following combinations gives the correct number of ions?
(i) 2 Al^{3+} and 3 Cl^{-}
(ii) 3 Mg^{2+} and 1 PO_4^{3-}
(iii) 2 Fe^{3+} and 3 O^{2-}
(iv) 3 Ca^{2+} and 2 SO_4^{2-}

Solution:

Correct combinations are:
(i) 2 Al^{3+} and 3 Cl^{-} → Total positive charge = +6, total negative charge = −3 ❌
(ii) 3 Mg^{2+} and 1 PO_4^{3-} → +6 and −3 ❌
(iii) 2 Fe^{3+} and 3 O^{2-} → +6 and −6 ✅
(iv) 3 Ca^{2+} and 2 SO_4^{2-} → +6 and −4 ❌

4. Choose the correct statement(s) and correct the false statement(s).
(i) Elements are made up of molecules and compounds are made up of atoms.
(ii) The molecule of a compound is always made up of two or more atoms of the same kind.
(iii) One molecule of nitrogen gas contains three nitrogen atoms.
(iv) Water is made of two hydrogen atoms, covalently bonded with one oxygen atom.

Solution:

(i) False. Elements are made up of atoms, and compounds are made up of molecules or ions.
(ii) False. A compound contains atoms of different elements.
(iii) False. One molecule of nitrogen gas (N_2) contains two nitrogen atoms.
(iv) True. Water consists of two hydrogen atoms covalently bonded to one oxygen atom.

5. Write the chemical formulae for the following compounds.
(i) Aluminium nitrate
(ii) Calcium oxide
(iii) Ferric oxide

Solution:

(i) Aluminium nitrate → $Al(NO_3)_3$
(ii) Calcium oxide → CaO
(iii) Ferric oxide → Fe_2O_3

6. Write the formulae of the compounds formed from the following pairs of ions.
(i) Ca^{2+} and Br^-
(ii) Al^{3+} and CO_3^{2-}
(iii) K^+ and SO_4^{2-}
(iv) NH_4^+ and Cl^-

Solution:

(i) Ca^{2+} and $Br^- \rightarrow CaBr_2$
(ii) Al^{3+} and $CO_3^{2-} \rightarrow Al_2(CO_3)_3$
(iii) K^+ and $SO_4^{2-} \rightarrow K_2SO_4$
(iv) NH_4^+ and $Cl^- \rightarrow NH_4Cl$

7. Which of the following, in Fig. 9.18, correctly represents Cl^- ion (Atomic number of chlorine = 17).

(a) (b) (c) (d)

Fig. 8.17

Solution:

Chlorine has atomic number 17.
Electronic configuration of Cl atom = 2, 8, 7.
Cl^- ion gains one electron → configuration becomes 2, 8, 8.
Hence, the correct figure is the one showing 18 electrons arranged as 2, 8, 8.

8. Determine the formula unit mass of the following substances.
(i) Ammonium nitrate (NH_4NO_3), used as a nitrogen fertiliser.
(ii) Phosphoric acid (H_3PO_4), used to make phosphate fertilisers and detergents.
(iii) Sodium hydrogencarbonate ($NaHCO_3$), used to relieve acidity and helps in digestion.

Solution:

(i) NH_4NO_3
= (2 × 14) + (4 × 1) + (3 × 16)
= 28 + 4 + 48
= 80 u

(ii) H_3PO_4
= (3 × 1) + 31 + (4 × 16)
= 3 + 31 + 64

= 98 u

(iii) $NaHCO_3$
= 23 + 1 + 12 + (3 × 16)
= 23 + 1 + 12 + 48
= 84 u

9. Write the formulae for the compounds formed by the reaction of:
(i) Magnesium and nitrogen
(ii) Lithium and nitrogen
(iii) Sodium and sulfur
(iv) Aluminium and oxygen

Solution:

(i) Magnesium + Nitrogen → Mg_3N_2
(ii) Lithium + Nitrogen → Li_3N
(iii) Sodium + Sulfur → Na_2S
(iv) Aluminium + Oxygen → Al_2O_3

10. Complete the Table 9.3 by writing the formulae of the compounds formed by the cations on the left and the anions at the top. $LiNO_3$ is given as an example.

Table 9.3

	NO_3^-	SO_4^{2-}	PO_4^{3-}
NH_4^+			
Li^+	$LiNO_3$		
Al^{3+}			
Cu^{2+}			

Solution:

Formulas formed are:

$NH_4^+ + NO_3^- \rightarrow NH_4NO_3$
$NH_4^+ + SO_4^{2-} \rightarrow (NH_4)_2SO_4$
$NH_4^+ + PO_4^{3-} \rightarrow (NH_4)_3PO_4$

$Li^+ + NO_3^- \rightarrow LiNO_3$
$Li^+ + SO_4^{2-} \rightarrow Li_2SO_4$

$Li^+ + PO_4^{3-} \rightarrow Li_3PO_4$

$Al^{3+} + NO_3^- \rightarrow Al(NO_3)_3$
$Al^{3+} + SO_4^{2-} \rightarrow Al_2(SO_4)_3$
$Al^{3+} + PO_4^{3-} \rightarrow AlPO_4$

$Cu^{2+} + NO_3^- \rightarrow Cu(NO_3)_2$
$Cu^{2+} + SO_4^{2-} \rightarrow CuSO_4$
$Cu^{2+} + PO_4^{3-} \rightarrow Cu_3(PO_4)_2$

11. 5.3 g of sodium carbonate react with 6.0 g of acetic acid to produce 2.2 g of carbon dioxide, 0.9 g of water, and 8.2 g of sodium acetate. Verify whether the law of conservation of mass is valid.

Solution:

Mass of reactants:
= 5.3 g + 6.0 g
= 11.3 g

Mass of products:
= 2.2 g + 0.9 g + 8.2 g
= 11.3 g

Since total mass of reactants equals total mass of products, the law of conservation of mass is verified.

12. If a species has 11 protons, 12 neutrons and 10 electrons then
(i) what is its atomic number and mass number?
(ii) is it neutral, a cation or an anion? Explain.
(iii) write its electronic configuration.
(iv) name the species.

Solution:

(i) Atomic number = Number of protons = 11
Mass number = Protons + Neutrons = 11 + 12 = 23

(ii) Since electrons = 10 and protons = 11, it has one extra positive charge.
Therefore, it is a cation.

(iii) Electronic configuration = 2, 8

(iv) The species is Na^+ (sodium ion).

13. Two elements, A and B, have the following configurations:
A: 2, 8, 5 B: 2, 8, 7
(i) Which element is more reactive?
(ii) Will A and B form ionic or covalent bonds when they combine? Explain using electron transfer or sharing.
(iii) Predict the formula of the compound they would form.

Solution:

A = 2, 8, 5
B = 2, 8, 7

(i) B is more reactive because it needs only one electron to complete its octet.

(ii) A and B will form a covalent bond because both are non-metals and will share electrons.

(iii) A shares three electrons with three B atoms.
Hence, the formula formed will be AB_3.

14. Assertion (A): Copper conducts electricity in the molten state but not in the solid state.
Reason (R): Copper and sulfate ions are fixed in the lattice in molten state, while in solid state they can move freely.
Choose the correct option:
(i) Both A and R are true, and R is the correct explanation of A.
(ii) Both A and R are true, but R is not the correct explanation of A.
(iii) A is true, but R is false.
(iv) A is false, but R is true.

Solution:

Assertion (A): True.
Reason (R): False.

In the solid state, ions are fixed and cannot move freely, so electricity is not conducted.
In the molten state, ions become free to move and conduct electricity.

Hence, the correct option is:
(iii) A is true, but R is false.

15. The species ^{27}Al, ^{80}Br and $^{201}Hg^{2+}$ have 13, 35 and 80 protons, respectively. How many electrons and neutrons do they have?

Solution:

For ^{27}Al:
Protons = 13
Electrons = 13
Neutrons = 27 − 13 = 14

For ^{80}Br:
Protons = 35
Electrons = 35
Neutrons = 80 − 35 = 45

For $^{201}Hg^{2+}$:
Protons = 80
Electrons = 80 − 2 = 78
Neutrons = 201 − 80 = 121