

## 2 | THE CHEMICAL FOUNDATION OF LIFE

### REVIEW QUESTIONS

1 What are atoms that vary in the number of neutrons found in their nuclei called?

- A Ions
- B Isotopes
- C Isobars
- D Neutral atoms

**Solution** The solution is (B). Isotopes are atoms that have the same number of protons but differ in the number of neutrons.

2 Potassium has an atomic number of 19. What is its electron configuration?

- A Shells 1 and 2 are full, and shell 3 has nine electrons.
- B Shells 1, 2, and 3 are full, and shell 4 has three electrons.
- C Shells 1, 2, and 3 are full, and shell 4 has one electron.
- D Shells 1, 2, and 3 are full, and no other electrons are present.

**Solution** The solution is (C). Shells 1, 2, and 3 are full, as they hold a total of 18 electrons, and shell 4 has the remaining one electron and is unfilled.

3 Which type of bond exemplifies a weak chemical bond?

- A Covalent bond
- B Hydrogen bond
- C Ionic bond
- D Nonpolar covalent bond

**Solution** The solution is (B). A hydrogen bond forms between hydrogen and an electronegative atom. It is weak because electrons are not shared as they are in a covalent bond nor are they transferred to form opposite, attracting charges, as they are in ionic bonds. Instead, hydrogen has a slight positive charge when covalently bonded to a more electronegative atom, because that atom draws the hydrogen's electron away from it, causing it to become attracted to nearby electronegative atoms with unpaired electrons.

4 Which statement is false?

- A Electrons are unequally shared in polar covalent bonds.
- B Electrons are equally shared in nonpolar covalent bonds.

- C Hydrogen bonds are weak bonds based on electrostatic forces.
- D Ionic bonds are generally stronger than covalent bonds.

**Solution** The solution is (D). Ionic bonds are generally stronger than covalent bonds.

5 If xenon has an atomic number of 54 and a mass number of 108, how many neutrons does it have?

- A 27
- B 54
- C 100
- D 108

**Solution** The solution is (B). The number of neutrons can be calculated by subtracting the element's atomic number from its mass number. When you subtract 54 from 108, the number of neutrons is 54.

6 What forms ionic bonds?

- A Atoms that share electrons equally
- B Atoms that share electrons unequally
- C Ions with similar charges
- D Ions with opposite charges

**Solution** The solution is (D). Ions with similar charges will not likely come together to form ionic bonds; they must be oppositely charged.

7 Based on the information provided, which of the following statements is correct?

| Element | Electronegativity |
|---------|-------------------|
| N       | 3.04              |
| H       | 2.20              |
| Cl      | 3.16              |
| O       | 3.44              |
| Li      | 0.98              |
| F       | 3.98              |

- A In  $\text{NH}_2$ , the nitrogen atom acquires a partial positive charge and the hydrogen atoms acquire a partial negative charge.
- B In  $\text{H}_2\text{O}$ , the hydrogen atoms acquire a partial negative charge, and the oxygen atom acquires a partial positive charge.

- C In aqueous HCl, the hydrogen atom acquires a partial positive charge, and the chlorine atom acquires a partial negative charge.
- D In LiF, the lithium atom acquires a positive charge, and the fluorine atom acquires a negative charge.

**Solution** The solution is (C). In HCl(aq), the hydrogen atom acquires a partial positive charge, and the chlorine atom acquires a partial negative charge.

**8** Which statement is NOT true?

- A Water is polar.
- B Water can stabilize the temperature of nearby air.
- C Water is essential for life.
- D Water is the most abundant molecule in Earth's atmosphere.

**Solution** The solution is (D). Water is the most abundant molecule in Earth's atmosphere.

**9** Why do hydrogen and oxygen form polar covalent bonds within water molecules?

- A Hydrogen is more electronegative than oxygen, generating a partial negative charge near the hydrogen atoms.
- B Hydrogen is more electronegative than oxygen, generating a partial positive charge near the hydrogen atoms.
- C Oxygen is more electronegative than hydrogen, generating a partial negative charge near the oxygen atom.
- D Oxygen is more electronegative than hydrogen, generating a partial positive charge near the oxygen atom.

**Solution** The solution is (C). The oxygen atom nucleus is more attractive to the electrons of a hydrogen atom than the hydrogen nucleus is to the oxygen's electrons. Therefore, the hydrogen atom acquires a partial positive charge while the oxygen atom acquires a partial negative charge.

**10** What happens to the pH of a solution when acids are added?

- A The pH of the solution decreases.
- B The pH of the solution increases.
- C The pH of the solution increases and then decreases.
- D The pH of the solution stays the same.

**Solution** The solution is (A). An acid is a substance that increases the  $H^+$  ion concentration of the solution by dissociating its  $H^+$  atoms. Thus, the pH of the solution decreases on addition of a hydrogen atom.

**11** Which statement is true?

- A** Acids and bases cannot mix together.
- B** Acids and bases can neutralize each other.
- C** Acids, not bases, can change the pH of a solution.
- D** Acids donate hydroxide ions ( $\text{OH}^-$ ); bases donate hydrogen ions ( $\text{H}^+$ ).

**Solution** The solution is (B). Acids add  $\text{H}^+$  ions in a solution, while bases add  $\text{OH}^-$  ions to a solution. These ions neutralize each other by forming water molecules.

**12** What is water's property of adhesion?

- A** The force that allows surface water molecules to escape and vaporize
- B** The attraction between water molecules and other molecules
- C** The intermolecular force between water molecules
- D** The force that keeps particles dispersed in water

**Solution** The solution is (B). Adhesion is the tendency of different particles to cling to one another. It is sometimes a strong adhesive force, such as when water is exposed to charged surfaces.

**13** In a solution, what kind of molecule binds up excess hydrogen ions?

- A** Acid
- B** Base
- C** Donator
- D** Isotope

**Solution** The solution is (B). Bases bind excess  $\text{H}^+$  ions in solution, resulting in a neutral solution. For example, the addition of  $\text{OH}^-$  to  $\text{H}^+$  produces water.

**14** What is the maximum number of atoms or molecules a single carbon molecule can bond with?

- A** 4
- B** 1
- C** 6
- D** 2

**Solution** The solution is (A). The carbon atom has four electrons in its valence shell. Therefore, bonding four more electrons will complete its octet, allowing it to attain a stable configuration. A carbon molecule can therefore bond with a maximum of four other atoms.

15 Which statement is true?

- A Molecules with the formulas  $\text{CH}_3\text{CH}_2\text{OH}$  and  $\text{C}_3\text{H}_6\text{O}_2$  could be structural isomers.
- B Molecules must have a single bond to be cis-trans isomers.
- C To be enantiomers, a molecule must have at least three different atoms or groups connected to a central carbon.
- D To be enantiomers, a molecule must have at least four different atoms or groups connected to a central carbon.

**Solution** The solution is (D). To be enantiomers, a molecule must have at least four different atoms or groups connected to a central carbon.

16 What is NOT a functional group that can bond with carbon?

- A Carbonyl
- B Hydroxyl
- C Phosphate
- D Sodium

**Solution** The solution is (D). Sodium is not a functional group; it is an element. Thus, it does not bond with carbon as a functional group.

17 Which functional group is NOT polar?

- A Carbonyl
- B Hydroxyl
- C Methyl
- D Sulfhydryl

**Solution** The solution is (C). Methyl groups are nonpolar because carbon and hydrogen have similar electronegativity. This means the covalent bond between carbon and hydrogen has electrons that are equally shared by the carbon and hydrogen. Therefore, it is a nonpolar molecule.

18 What are enantiomers?

- A Hydrocarbons consisting of closed rings of carbon atoms
- B Isomers with similar bonding patterns differing in the placement of atoms along a double covalent bond
- C Molecules that share the same chemical bonds but are mirror images of each other
- D Molecules with the same chemical formula that differ in the placement of their chemical bonds

**Solution** The solution is (C). Enantiomers are molecules that share the same chemical bonds but are mirror images of each other.