# Salts Exercise

i. Which of the following salts is soluble in water?

a. Silver chloride ($AgCl$)

b. Lead carbonate ($PbCO_3$)

**c. Sodium nitrate ($NaNO_3$)**

d. Lead chloride ($PbCl_2$)

ii. What type of ions do bases provide for salt formation?

a. Negative ions

**b. Positive ions**

c. Neutral molecules

d. Complex ions

iii. What is the primary reason salts have high melting points?

a. Weak van der Waals forces

**b. Strong electrostatic forces**

c. Hydrogen bonding

d. Covalent bonding

iv. In what state are salts generally good conductors of electricity?

a. Solid

b. Gas

**c. Molten**

d. Powdered

v. Which of the following is a general solubility rule for chlorides?

a. All chlorides are insoluble.

b. All chlorides are soluble.

**c. Chlorides are soluble except lead and silver chlorides.**

d. Chlorides are soluble except sodium and potassium chlorides.

vi. What happens to the ions in a salt when it is dissolved in water?

a. They form a gas.

b. They become fixed in place.

**c. They become mobile.**

d. They form a solid.

vii. Which of the following methods is used to prepare a salt by titration?

a. Acid + Metal

b. Acid + Insoluble Base

c. Acid + Insoluble Carbonate

**d. Acid + Alkali**

viii. Which of these salts is insoluble in water?

a. Potassium carbonate ($K_2CO_3$)

b. Ammonium nitrate ($NH_4NO_3$)

c. Calcium Chloride ($CaCl_2$)

**d. Lead chloride ($PbCl_2$)**

ix. What is formed when an acid reacts with an excess of an insoluble base?

a. Salt and hydrogen

**b. Salt and water**

c. Salt and carbon dioxide

d. Salt and oxygen

x. Which ion is commonly found in soluble nitrates?

a. $NH_4^+$

**b. $NO_3^-$**

c. $Cl^-$

d. $CO_3^{2-}$

**6. Calculate the mass in grams of each of the following samples:**

**Formula:** Mass = moles × molar mass

**(a) 1.2 moles of K**

- Molar mass of K = 39 g/mol
- Mass = 1.2 mol × 39 g/mol = **46.8 g**

**(b) 75 moles of $H_2$**

- Molar mass of $H_2$ = (2 × 1) = 2 g/mol
- Mass = 75 mol × 2 g/mol = **150 g**

**(c) 0.25 moles of steam ($H_2O$)**

- Molar mass of $H_2O$ = (2 × 1) + 16 = 18 g/mol
- Mass = 0.25 mol × 18 g/mol = **4.5 g**

**(d) 1.05 moles of $CuSO_4 \cdot 5H_2O$**

- Molar mass = Cu (63.5) + S (32) + $O_4$ (64) + 5×[$H_2$ (2) + O (16)]
  = 63.5 + 32 + 64 + 5×(18)
  = 159.5 + 90 = 249.5 g/mol
- Mass = 1.05 mol × 249.5 g/mol = **261.975 g**

**(e) 0.15 moles of $H_2SO_4$**

- Molar mass = $H_2$ (2) + S (32) + $O_4$ (64) = 98 g/mol
- Mass = 0.15 mol × 98 g/mol = **14.7 g**
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**7. Calculate the number of molecules present in each of the following samples:**

**Formula:** Number of molecules = moles × Avogadro's number ($6.022 \times 10^{23}$)

**(a) 2.5 moles of carbon dioxide ($CO_2$)**

- Molecules = 2.5 mol × 6.022 × $10^{23}$ molecules/mol = **$1.5055 \times 10^{24}$ molecules**

**(b) 3.4 moles of ammonia ($NH_3$)**

- Molecules = 3.4 mol × 6.022 × $10^{23}$ molecules/mol = **$2.0475 \times 10^{24}$ molecules**

**(c) 1.09 moles of benzene ($C_6H_6$)**

- Molecules = 1.09 mol × 6.022 × $10^{23}$ molecules/mol = **$6.564 \times 10^{23}$ molecules**

**(d) 0.01 moles of acetic acid ($CH_3COOH$)**

- Molecules = 0.01 mol × 6.022 × $10^{23}$ molecules/mol = **$6.022 \times 10^{21}$ molecules**
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**8. Decide whether or not each of the following is an example of an empirical formula:**

- **Empirical Formula:** The simplest whole-number ratio of atoms of each element in a compound.

**(a) $Al_2Cl_3$**

- Ratio is 2:3. It is the simplest whole-number ratio. **Yes.**

**(b) $Hg_2Cl_2$**

- Ratio is 2:2, which can be simplified to 1:1. The empirical formula should be HgCl. **No.**

**(c) NaCl**

- Ratio is 1:1. It is the simplest whole-number ratio. **Yes.**

**(d) $C_7H_5O$**

- Ratio is 7:5:1. It cannot be simplified further. **Yes.**
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**9. TNT contains 7 C-atoms, 5 H-atoms, 3 N-atoms and 6 O-atoms. Write its empirical formula.**

- The ratio of C:H:N:O is 7:5:3:6.
- This ratio cannot be simplified further as 7,5,3,6 have no common divisor.
- Empirical Formula: **$C_7H_5N_3O_6$**
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**10. A molecule contains four phosphorus atoms and ten oxygen atoms. Write the empirical formula. Also determine the molar mass.**

- The ratio of P:O is 4:10, which can be simplified by dividing by 2.
- Simplified ratio is 2:5.
- Empirical Formula: **$P_2O_5$**
- Molar Mass = (2 × 31) + (5 × 16) = 62 + 80 = **142 g/mol**
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**11. Calculate the molar masses and write the empirical formulas.**

**(a) Indigo ($C_{16}H_{10}N_2O_2$)**

- Molar Mass = (16 × 12) + (10 × 1) + (2 × 14) + (2 × 16) = 192 + 10 + 28 + 32 = **262 g/mol**
- Empirical Formula: The ratio 16:10:2:2 can be simplified by dividing by 2. **$C_8H_5NO$**

**(b) Indoxyl ($C_8H_7ON$)**

- Molar Mass = (8 × 12) + (7 × 1) + 16 + 14 = 96 + 7 + 16 + 14 = **133 g/mol**
- Empirical Formula: The ratio 8:7:1:1 cannot be simplified. **$C_8H_7NO$**

**12. Identify the substance that has a formula mass of 133.5 amu.**

- **(a) $MgCl_2$**: 24 + (2 × 35.5) = 95 amu
- **(b) $S_2Cl_2$**: (2 × 32) + (2 × 35.5) = 64 + 71 = 135 amu
- **(c) $BCl_3$**: 11 + (3 × 35.5) = 11 + 106.5 = 117.5 amu
- **(d) $AlCl_3$**: 27 + (3 × 35.5) = 27 + 106.5 = 133.5 amu
- **Answer: (d) $AlCl_3$**

**13. Calculate the number of atoms in each of the following samples:**

**(a) 3.4 moles of nitrogen atoms**

- Number of atoms = moles × Avogadro's number
- Atoms = 3.4 mol × 6.022 × $10^{23}$ atoms/mol = **$2.047 \times 10^{24}$ atoms**

**(b) 23g of Na**

- Moles of Na = mass / molar mass = 23 g / 23 g/mol = 1 mole
- Atoms = 1 mol × 6.022 × $10^{23}$ atoms/mol = **$6.022 \times 10^{23}$ atoms**

**(c) 5g of H atoms**

- Moles of H = mass / molar mass = 5 g / 1 g/mol = 5 moles
- Atoms = 5 mol × 6.022 × $10^{23}$ atoms/mol = **$3.011 \times 10^{24}$ atoms**

**14. Calculate the mass of the following:**

**Formula:** Mass = (Number of particles / Avogadro's number) × Molar Mass

**(a) $3.24 \times 10^{18}$ atoms of iron (Fe)**

- Moles of Fe = $(3.24 \times 10^{18}) / (6.022 \times 10^{23}) = 5.38 \times 10^{-6}$ mol
- Molar mass of Fe = 56 g/mol
- Mass = $5.38 \times 10^{-6}$ mol × 56 g/mol = **$3.01 \times 10^{-4}$ g**

**(b) $2 \times 10^{19}$ molecules of nitrogen gas ($N_2$)**

- Moles of $N_2$ = $(2 \times 10^{19}) / (6.022 \times 10^{23}) = 3.32 \times 10^{-5}$ mol
- Molar mass of $N_2$ = 28 g/mol
- Mass = $3.32 \times 10^{-5}$ mol × 28 g/mol = **$9.30 \times 10^{-4}$ g**

**(c) $1 \times 10^{20}$ molecules of water ($H_2O$)**

- Moles of $H_2O$ = $(1 \times 10^{20}) / (6.022 \times 10^{23}) = 1.66 \times 10^{-4}$ mol
- Molar mass of $H_2O$ = 18 g/mol
- Mass = $1.66 \times 10^{-4}$ mol × 18 g/mol = **$2.99 \times 10^{-3}$ g**

**(d) $3 \times 10^{8}$ atoms of Al**

- Moles of Al = $(3 \times 10^{8}) / (6.022 \times 10^{23}) = 4.98 \times 10^{-16}$ mol
- Molar mass of Al = 27 g/mol
- Mass = $4.98 \times 10^{-16}$ mol × 27 g/mol = **$1.35 \times 10^{-14}$ g**

**15. Balance the following chemical equations**

**(a) $Na(s) + H_2O(l) \rightarrow NaOH(aq) + H_2(g)$**

- **$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$**

**(b) $NH_3(g) \rightarrow N_2(g) + H_2(g)$**

- **$2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$**

**16. Potassium is a Group 1 element...**

**(a) Predict the formula of potassium oxide and potassium nitride.**

- Potassium Oxide: K is +1, O is -2. Formula is **$K_2O$**.
- Potassium Nitride: K is +1, Nitride ion is $N^{3-}$. Formula is **$K_3N$**.

**(b) Show that $1.28 \times 10^{-2}$ mole of K were added to the water.**

- Mass of K = 0.5 g
- Molar mass of K = 39 g/mol
- Moles of K = mass / molar mass = 0.5 g / 39 g/mol = **0.0128 mol** or **$1.28 \times 10^{-2}$ mol**

**(c) Balance the chemical equation.**

- **$2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$**

**(d) Transform the balanced chemical eqauation into an ionic equation.**

- First, write all soluble strong electrolytes as ions: $2K(s) + 2H_2O(l) \rightarrow 2K^+(aq) + 2OH^-(aq) + H_2(g)$
- Cancel spectator ions (there are none to cancel in this case).
- The ionic equation is: **$2K(s) + 2H_2O(l) \rightarrow 2K^+(aq) + 2OH^-(aq) + H_2(g)$**

**(e) Calculate the number of atoms present in the sample of K.**

- Moles of K = $1.28 \times 10^{-2}$ mol
- Number of atoms = moles × Avogadro's number
- Atoms = ($1.28 \times 10^{-2}$ mol) × ($6.022 \times 10^{23}$ atoms/mol) = **$7.71 \times 10^{21}$ atoms**

**(f) Predict the period number of potassium in the periodic table.**

- Potassium (K) has an atomic number of 19.
- Electronic configuration: 2, 8, 8, 1. It has 4 electron shells.
- Therefore, it is in **Period 4**.