

## Salts Exercise

- i. Which of the following salts is soluble in water?
  - a. Silver chloride ( $\text{AgCl}$ )
  - b. Lead carbonate ( $\text{PbCO}_3$ )
  - c. Sodium nitrate ( $\text{NaNO}_3$ )**
  - d. Lead chloride ( $\text{PbCl}_2$ )
  
- 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 ( $\text{K}_2\text{CO}_3$ )
- b. Ammonium nitrate ( $\text{NH}_4\text{NO}_3$ )
- c. Calcium Chloride ( $\text{CaCl}_2$ )
- d. Lead chloride ( $\text{PbCl}_2$ )**

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.  $\text{NH}_4^+$
- b.  $\text{NO}_3^-$**
- c.  $\text{Cl}^-$
- d.  $\text{CO}_3^{2-}$

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

**Formula:** Mass = moles  $\times$  molar mass

**(a) 1.2 moles of K**

- Molar mass of K = 39 g/mol
- Mass = 1.2 mol  $\times$  39 g/mol = **46.8 g**

**(b) 75 moles of H<sub>2</sub>**

- Molar mass of H<sub>2</sub> = (2  $\times$  1) = 2 g/mol
- Mass = 75 mol  $\times$  2 g/mol = **150 g**

**(c) 0.25 moles of steam (H<sub>2</sub>O)**

- Molar mass of H<sub>2</sub>O = (2  $\times$  1) + 16 = 18 g/mol
- Mass = 0.25 mol  $\times$  18 g/mol = **4.5 g**

**(d) 1.05 moles of CuSO<sub>4</sub>·5H<sub>2</sub>O**

- Molar mass = Cu (63.5) + S (32) + O<sub>4</sub> (64) + 5 $\times$ [H<sub>2</sub> (2) + O (16)]  
= 63.5 + 32 + 64 + 5 $\times$ (18)  
= 159.5 + 90 = 249.5 g/mol
- Mass = 1.05 mol  $\times$  249.5 g/mol = **261.975 g**

**(e) 0.15 moles of H<sub>2</sub>SO<sub>4</sub>**

- Molar mass = H<sub>2</sub> (2) + S (32) + O<sub>4</sub> (64) = 98 g/mol
- Mass = 0.15 mol  $\times$  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  $\times$  Avogadro's number ( $6.022 \times 10^{23}$ )

**(a) 2.5 moles of carbon dioxide (CO<sub>2</sub>)**

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

**(b) 3.4 moles of ammonia (NH<sub>3</sub>)**

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

**(c) 1.09 moles of benzene (C<sub>6</sub>H<sub>6</sub>)**

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

**(d) 0.01 moles of acetic acid (CH<sub>3</sub>COOH)**

- Molecules =  $0.01 \text{ mol} \times 6.022 \times 10^{23} \text{ molecules/mol} = \mathbf{6.022 \times 10^{21} \text{ molecules}}$
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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<sub>2</sub>Cl<sub>3</sub>**

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

**(b) Hg<sub>2</sub>Cl<sub>2</sub>**

- 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<sub>7</sub>H<sub>5</sub>O**

- 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<sub>7</sub>H<sub>5</sub>N<sub>3</sub>O<sub>6</sub>**
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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<sub>2</sub>O<sub>5</sub>**
- Molar Mass =  $(2 \times 31) + (5 \times 16) = 62 + 80 = \mathbf{142 \text{ g/mol}}$
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**11. Calculate the molar masses and write the empirical formulas.**

**(a) Indigo (C<sub>16</sub>H<sub>10</sub>N<sub>2</sub>O<sub>2</sub>)**

- Molar Mass =  $(16 \times 12) + (10 \times 1) + (2 \times 14) + (2 \times 16) = 192 + 10 + 28 + 32 = \mathbf{262 \text{ g/mol}}$
- Empirical Formula: The ratio 16:10:2:2 can be simplified by dividing by 2. **C<sub>8</sub>H<sub>5</sub>NO**

**(b) Indoxyl ( $\text{C}_8\text{H}_7\text{ON}$ )**

- Molar Mass =  $(8 \times 12) + (7 \times 1) + 16 + 14 = 96 + 7 + 16 + 14 = \mathbf{133 \text{ g/mol}}$
- Empirical Formula: The ratio 8:7:1:1 cannot be simplified.  $\text{C}_8\text{H}_7\text{NO}$

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

- **(a)  $\text{MgCl}_2$ :**  $24 + (2 \times 35.5) = 95 \text{ amu}$
- **(b)  $\text{S}_2\text{Cl}_2$ :**  $(2 \times 32) + (2 \times 35.5) = 64 + 71 = 135 \text{ amu}$
- **(c)  $\text{BCl}_3$ :**  $11 + (3 \times 35.5) = 11 + 106.5 = 117.5 \text{ amu}$
- **(d)  $\text{AlCl}_3$ :**  $27 + (3 \times 35.5) = 27 + 106.5 = 133.5 \text{ amu}$
- **Answer: (d)  $\text{AlCl}_3$**

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

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

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

**(b) 23g of Na**

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

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

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

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

**Formula:** Mass = (Number of particles / Avogadro's number)  $\times$  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  $\times$  56 g/mol =  **$3.01 \times 10^{-4}$  g**

**(b)  $2 \times 10^{19}$  molecules of nitrogen gas (N<sub>2</sub>)**

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

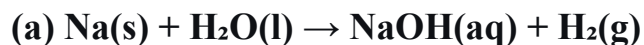
**(c)  $1 \times 10^{20}$  molecules of water (H<sub>2</sub>O)**

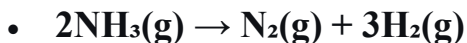
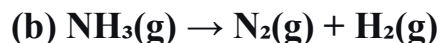
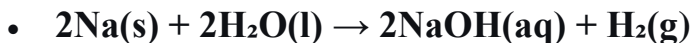
- Moles of H<sub>2</sub>O =  $(1 \times 10^{20}) / (6.022 \times 10^{23}) = 1.66 \times 10^{-4}$  mol
- Molar mass of H<sub>2</sub>O = 18 g/mol
- Mass =  $1.66 \times 10^{-4}$  mol  $\times$  18 g/mol =  **$2.99 \times 10^{-3}$  g**

**(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  $\times$  27 g/mol =  **$1.35 \times 10^{-14}$  g**

#### 15. Balance the following chemical equations





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

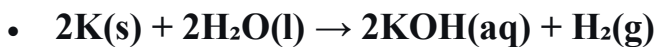
**(a) Predict the formula of potassium oxide and potassium nitride.**

- Potassium Oxide: K is +1, O is -2. Formula is  **$\text{K}_2\text{O}$** .
- Potassium Nitride: K is +1, Nitride ion is  $\text{N}^{3-}$ . Formula is  **$\text{K}_3\text{N}$** .

**(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.**



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

- First, write all soluble strong electrolytes as ions:  $2\text{K(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{K}^+\text{(aq)} + 2\text{OH}^-\text{(aq)} + \text{H}_2\text{(g)}$
- Cancel spectator ions (there are none to cancel in this case).
- The ionic equation is:  $2\text{K(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{K}^+\text{(aq)} + 2\text{OH}^-\text{(aq)} + \text{H}_2\text{(g)}$

**(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  $\times$  Avogadro's number
- Atoms =  $(1.28 \times 10^{-2} \text{ mol}) \times (6.022 \times 10^{23} \text{ atoms/mol}) = \mathbf{7.71 \times 10^{21} \text{ atoms}}$

**(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**.