# Module 29:
# General Chemistry
# Instructor Guide – Answer Key

## ☑ Periodic Table Exercise

1. What is the atomic number of an element that contains 11 protons?

**Ans:** Sodium

2. The element Carbon has the atomic number of 6. How many protons does Carbon contain?

**Ans:** 6

3. Indicate the atomic weight of an element that contains 7 protons and 7 neutrons.

**Ans:** 14

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## ☑ Physical and Chemical Changes

*[Review the following statements and mark whether the change is physical or chemical.]*

| | PHYSICAL | CHEMICAL |
|---|---|---|
| 1. Drinking water from ocean water by means of evaporation and condensation | ✓ | |
| 2. Sodium from sodium chloride | | ✓ |
| 3. Pulverizing rock salt | ✓ | |
| 4. Burning wood | | ✓ |
| 5. Dissolving sugar into water | ✓ | |
| 6. Rusting of Iron | | ✓ |
| 7. The evaporation of alcohol | ✓ | |

## Review Exercise

1. Define the term matter and list the three states of matter.

**Ans:** Matter occupies space and has mass. The air that surrounds us, the pencil that we write with and the water that we drink are all examples of matter. The three states of matter are solid, liquid and gas.

2. Differentiate between mass, weight, density and specific gravity.

**Ans:** Mass is the amount of matter present in a given object.

Weight is the mass of an object being acted upon by gravity.

Density is the mass of a substance per unit of volume of the substance.

Specific gravity is the density of a substance compared to the weight of the same volume of water.

3. Explain the difference between a physical and a chemical change in matter.

**Ans:** A physical change in matter is a change in the form of matter but not in its chemical identity. A chemical change in matter is a change in which one or more kinds of matter transform into a new kind of matter.

4. List and define three classes of matter.

**Ans:** Element – a substance that cannot be decomposed into simpler substances by any chemical reaction.

Compound – a substance that is composed of two or more elements that are chemically combined in fixed proportions.

Mixture – a material that can be separated by physical means into two or more substances.

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## Exercise

1. What is the molecular weight of $H_2SO_4$ (sulfuric acid)?

**Ans:** 2 H atoms = 1.0080 + 1.0080 = 2.016
1 S atom = 32.064

4 O atoms = 15.9994 + 15.9994 + 15.9994 + 15.9994 = 63.9976
By adding the three molecular weights together, we get a total molecular weight of 98.0776 for $H_2SO_4$.

2. What is the molecular weight of 2 molecules of $CH_4$ (methane)?

**Ans:** 1 C atom = 12.0112
4 H atoms = 1.0080 + 1.0080 + 1.0080 + 1.0080 = 4.032
By adding the two molecular weights together (12.0012 + 4.032), we get a total molecular weight of 16.0432 for $CH_4$, which is the weight of one molecule of $CH_4$. Since we are asked to calculate the molecular weight of two molecules of CH4, we need to add 16.0432 + 16.0432, which gives us a total molecular weight for the two molecules of 32.0864.

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## Calculations Using Moles

1. Calculate the number of moles in 80 grams of NaOH (sodium hydroxide, or caustic soda).

**Ans:** Step 1: To calculate the molecular weight of NaOH, reference the periodic table to determine the following atomic weights:
1 Na atom = 22.9898
1 O atom = 15.9994
1 H atom = 1.00797
By adding the three molecular weights, we get a total molecular weight of 39.99717 for NaOH.

Step 2: To calculate the number of moles, divide the number of grams of NaOH by the molecular weight of NaOH.

$$\text{Moles} = 80 \text{ grams NaOH} \times \frac{1 \text{ mole NaOH}}{39.99717 \text{ grams}}$$

Moles = 2.0 moles NaOH

2. Calculate the number of moles in 40 grams of $H_2O_2$ (hydrogen peroxide).

**Ans:** Step 1: To calculate the molecular weight of $H_2O_2$, reference the periodic table to determine the following atomic weights:
2 H atoms = 1.0080 + 1.0080 = 2.0160
2 O atoms = 15.9994 + 15.9994 = 31.9988
By adding the two molecular weights, we get a total molecular weight of 34.0040 for $H_2O_2$.

Step 2: To calculate the number of moles, divide the number of grams of $H_2O_2$ by the molecular weight of $H_2O_2$.

$$\text{Moles} = 40 \text{ grams } H_2O_2 \times \frac{1 \text{ mole } H_2O_2}{34.0040 \text{ grams}}$$

Moles = 1.2 moles $H_2O_2$

3. Calculate the number of moles in 79 grams of $KMnO_4$ (potassium permanganate).

**Ans:** Step 1: To calculate the molecular weight of $KMnO_4$, reference the periodic table to determine the following atomic weights:
1 K atom = 39.0983
1 Mn atom = 54.9381
4 O atoms = 15.9994 + 15.9994 + 15.9994 + 15.9994 = 63.9976
By adding the three molecular weights, we get a total molecular weight of 158.0340 for $KMnO_4$.

Step 2: To calculate the number of moles, divide the molecular weight, by the total number of grams.

$$\text{Moles} = 79 \text{ grams } KMnO_4 \times \frac{1 \text{ mole } KMnO_4}{158.0340 \text{ grams}}$$

Moles = 0.5 moles $KMnO_4$

4. Calculate the number of grams in 0.5 mol of HCl (hydrochloric acid).

**Ans:** Step 1: To calculate the molecular weight of HCl, reference the periodic table to determine the following atomic weights:
1 H atom = 1.0080
1 Cl atom = 35.4527
By adding the three molecular weights, we get at total molecular weight of 36.4607 for HCl.

Step 2: To calculate the number of grams, multiply the molecular weight by the total number of moles per molecule.
Grams = (36.4607) (0.5 mol)
Grams = 18.23
or

$$0.5 \text{ mol HCl} \times \frac{36.4607 \text{grams}}{1 \text{ mole HCl}} = 18.23 \text{ grams HCl}$$

5. Calculate the number of grams in 1 mol of $Fe_2(SO_4)_3$ (ferric sulfate).

**Ans:** Step 1: To calculate the molecular weight of $Fe_2(SO_4)_3$, reference the periodic table to determine the following atomic weights:
2 Fe atoms = 55.847+ 55.847 = 111.694
3 x 1 S atoms = 32.066 + 32.066 + 32.066 = 96.198
3 x 4 O atoms = 12 x 15.9994 = 191.992
By adding the three molecular weights, we get at total molecular weight of 399.884 for $Fe_2(SO_4)_3$.

Step 2: To calculate the number of grams, multiply the molecular weight by the total number of moles per molecule.
Grams = (399.884) x (1 mol)
Grams = 399.88
or

1 mol $Fe_2(SO_4)_3$ x $\frac{399.884 \text{grams}}{1 \text{ mole } Fe_2(SO_4)_3}$ = 39.88 grams $Fe_2(SO_4)_3$

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☑ Exercise

1. Calculate the Molarity of 12g of NaOH dissolved in 250 milliliters of deionized water.

**Ans:** Step 1: Convert grams of NaOH to moles.
1 atom of Na = 22.9898
1 atom of O = 15.9994
1 atom of H = 1.0080
39.9972
Moles of NaOH = 12 grams/39.9972 = 0.30 moles

Step 2: Calculate the molarity of the solution
Molarity = 0.30 mol/0.250 L = 1.2 M
Remember that since the definition of Molarity is the number of moles per 1 liter, we need to convert milliliters to liters so that the end result is in mol/Liter, or, M.

2 Calculate the grams of $Na_2S_2O_3$ (Sodium Thiosulfate) necessary to create a 10 ml solution of 0.6 M solution.

**Ans:** Step 1: Convert moles of $Na_2S_2O_3$ to grams.
2 atoms of Na = 2 x 22.9898 = 45.9796
2 atoms of S = 2 x 32.066 = 64.132
3 atoms of O = 3 x 15.9994 = 47.9982
158.1098

Step 2: Molarity = moles of solute/volume (L) of the solution

Remember from earlier that Moles = $\frac{\text{Wt of substance in grams}}{\text{Molecular wt. in grams}}$

So Molarity = $\frac{\frac{\text{Wt of substance in grams}}{\text{Molecular wt. in grams}}}{\text{L}}$

$$0.6 \text{ M} = \frac{\frac{\text{X (wt. of substance g)}}{\text{158.1099 g MW}}}{\text{0.01 L}}$$

Solving the equation for "x" we end up with the following formula:

M x L x MW = x

Step 3: Calculate the number of grams in the solution using the formula from Step 2.
(0.6 M) (0.01 Liters) (158.1098 g/mol) = 0.95 g

3. Calculate the Molarity of a solution of 81.1 grams of $MgCl_2$, Magnesium Chloride, in 1.0 Liter of deionized water.

**Ans:** Step 1: Convert moles of $MgCl_2$ to grams.
1 atoms of Mg = 1 x 24.3050 = 24.3050
2 atoms of Cl = 2 x 35.4527 = 70.9054
95.2104

Moles $MgCl_2$ = $\frac{81.1 \text{ grams}}{95.2104 \text{ g/mol}}$
Moles $MgCl_2$ = 0.85 mol

Step 2: Calculate the molarity of the solution.
Molarity = 0.85 mol/1.0 L = 0.85 M

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Class Exercise:

1. In Which section would you find information concerning the different hazards associated with handling caustic soda?
   - Section 3: Hazards Identification.

2. What are the possible routes of entry?
   - Eye Contact: May cause tissue injury and loss of vision
   - Skin Contact: Corrosive to all tissue
   - Inhalation: concentrated mist May damage respiratory tract
   - Ingestion: Ingestion

3. What information would you look for from the MSDSs, before repairing and metering pump or chemical feed system?

   - Exposure Controls and Protective equipment
   - Handling and Storage
   - First Aid
   - Fire Fighting Measures
   - Physical and chemical properties

3. Where would you find information about storing Sodium Hydroxide? What are the storage recommendations?

- **Section 7 Handling and Storage**

Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry, ventilated area away from sources of heat, moisture and incompatibilities. Always add the caustic to water while stirring; never the reverse. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product. Do not store with aluminum or magnesium. Do not mix with acids or organic materials

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