Concentration Of A Solution

1 What is the molarity of 2.0 liters of an aqueous solution that contains 0.50 mole of potassium iodide, KI?

(1) 1.0 M (3) 0.25 M

(2) 2.0 M (4) 0.50 M

2 What is the molarity of 0.50 liter of an aqueous solution that contains 0.20 mole of NaOH (gram-formula mass = 40. g/mol)?

(1) 0.10 M (3) 2.5 M

(2) 0.20 M (4) 0.40 M

3 A solution contains 25 grams of KNO_3 dissolved in 200. grams of H_2O. Which numerical setup can be used to calculate the percent by mass of KNO_3 in this solution?

(1) $\frac{25\text{g}}{175\text{g}} \times 100$

(2) $\frac{25\text{g}}{200.\text{g}} \times 100$

(3) $\frac{25\text{g}}{225\text{g}} \times 100$

(4) $\frac{200.\text{g}}{225\text{g}} \times 100$

4 A solution is prepared using 0.125 g of glucose, $C_6H_{12}O_6$, in enough water to make 250. g of total solution. The concentration of this solution, expressed in parts per million, is

(1) 5.00×10^1 ppm (3) 5.00×10^3 ppm

(2) 5.00×10^2 ppm (4) 5.00×10^4 ppm

5 What is the concentration of an aqueous solution that contains 1.5 moles of NaCl in 500. milliliters of this solution?

(1) 0.30 M (3) 3.0 M

(2) 0.75 M (4) 7.5 M

Base your answers to questions 6 on the information below and on your knowledge of chemistry.

In a laboratory investigation, an HCl(aq) solution with a pH value of 2 is used to determine the molarity of a KOH(aq) solution. A 7.5-milliliter sample of the KOH(aq) is exactly neutralized by 15.0 milliliters of the 0.010 M HCl(aq). During this laboratory activity, appropriate safety equipment is used and safety procedures are followed.

6 Show a numerical setup for calculating the molarity of the KOH solution.

Base your answers to questions 7 on the information below and on your knowledge of chemistry.

A bottled water label lists the ions dissolved in the water. The table below lists the mass of some ions dissolved in a 500.-gram sample of the bottled water.

Ions in 500. g of Bottled Water

Ion Formula	Mass (g)
Ca^{2+}	0.040
Mg^{2+}	0.013
Na^{+}	0.0033
SO_4^{2-}	0.0063
HCO_3^{-}	0.180

7 Show a numerical setup for calculating the parts per million of the Na^{+} ions in the 500.-gram sample of the bottled water.

Base your answers to questions 8 on the information below and on your knowledge of chemistry.

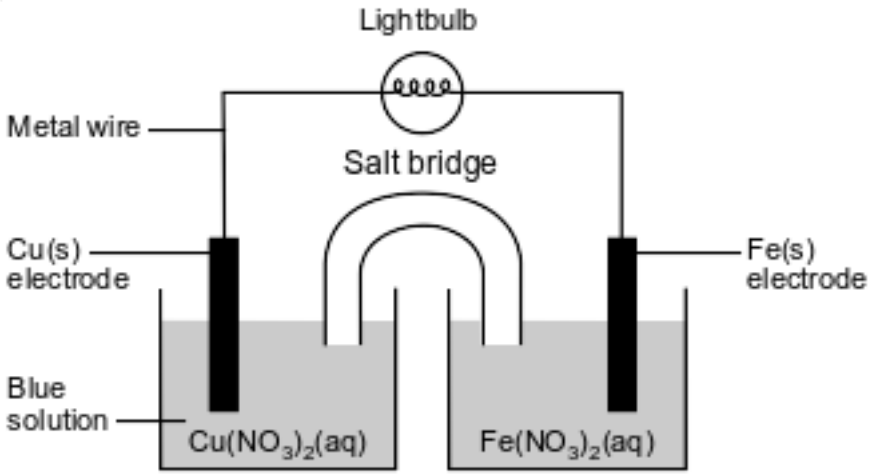
In a laboratory activity, a student titrates a 20.0-milliliter sample of HCl(aq) using 0.025 M NaOH(aq). In one of the titration trials, 17.6 milliliters of the base solution exactly neutralizes the acid sample.

8 Show a numerical setup for calculating the concentration of the hydrochloric acid using the titration data.

Base your answers to questions 9 on the information below and on your knowledge of chemistry.

A student constructs an electrochemical cell. A diagram of the operating cell and the unbalanced ionic equation representing the reaction occurring in the cell are shown below.

The blue color of the solution in the copper half-cell indicates the presence of Cu^{2+} ions. The student observes that the blue color becomes less intense as the cell operates.



$Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s)$

9 State one inference that the student can make about the concentration of the Cu^{2+} ions based on the change in intensity of the color of the $Cu(NO_3)_2(aq)$ solution as the cell operates.

Base your answers to questions 10 on the information below and on your knowledge of chemistry.

In a laboratory activity, each of four different masses of $KNO_3(s)$ is placed in a separate test tube that contains 10.0 grams of H_2O at 25°C.

When each sample is first placed in the water, the temperature of the mixture decreases. The mixture in each test tube is then stirred while it is heated in a hot water bath until all of the $KNO_3(s)$ is dissolved. The contents of each test tube are then cooled to the temperature at which KNO_3 crystals first reappear. The procedure is repeated until the recrystallization temperatures for each mixture are consistent, as shown in the table below.

Data Table for the Laboratory Activity

Mixture	Mass of KNO_3 (g)	Mass of H_2O (g)	Temperature of Recrystallization (°C)
1	4.0	10.0	24
2	5.0	10.0	32
3	7.5	10.0	45
4	10.0	10.0	58

10 Determine the percent by mass concentration of KNO_3 in mixture 2 after heating.

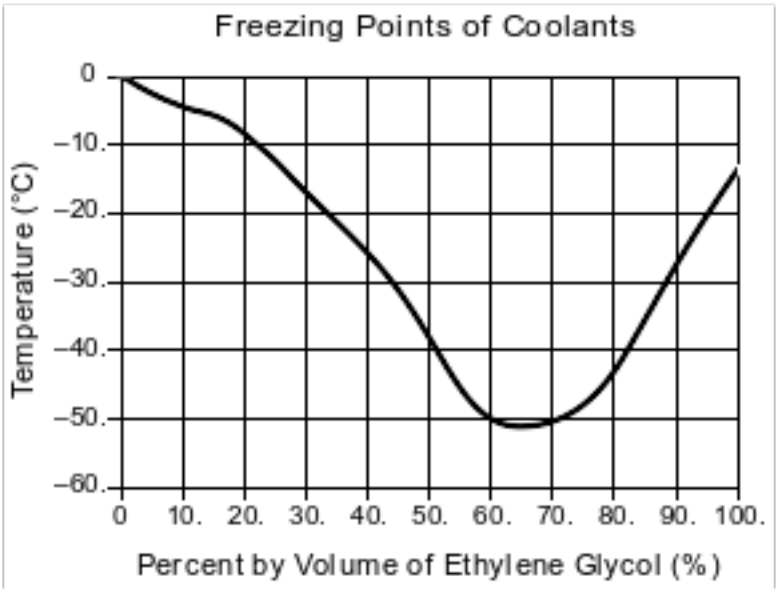
Base your answers to questions 11 on the information below and on your knowledge of chemistry.

A solution is made by dissolving 70.0 grams of $KNO_3(s)$ in 100. grams of water at 50.°C and standard pressure.

11 Show a numerical setup for calculating the percent by mass of KNO_3 in the solution.

Base your answers to questions 12 on the information below and on your knowledge of chemistry.

A solution of ethylene glycol and water can be used as the coolant in an engine-cooling system. The ethylene glycol concentration in a coolant solution is often given as percent by volume. For example, 100. mL of a coolant solution that is 40.% ethylene glycol by volume contains 40. mL of ethylene glycol diluted with enough water to produce a total volume of 100. mL. The graph below shows the freezing point of coolants that have different ethylene glycol concentrations.



12 One engine-cooling system has a volume of 6400 mL. Determine the volume of ethylene glycol in the completely filled engine-cooling system when the concentration of ethylene glycol is 50.% by volume.

Base your answers to questions 13 on the information below and on your knowledge of chemistry.

During a titration, 10.00 mL of acetic acid, $HC_2H_3O_2(aq)$, is completely neutralized by adding 12.50 mL of 0.64 M sodium hydroxide, NaOH(aq).

13 Explain why it is better to use data from multiple trials to determine the molarity of acetic acid, rather than data from a single trial.

Base your answers to questions 14 on the information below and on your knowledge of chemistry.

In an investigation, aqueous solutions are prepared by completely dissolving a different amount of NaCl(s) in each of four beakers containing 100.00 grams of $H_2O(\ell)$ at room temperature. Each solution is heated and the temperature at which boiling occurred is measured. The data are recorded in the table below.

Boiling Point Data for Four NaCl(aq) Solutions

Beaker Number	Mass of $H_2O(\ell)$ (g)	Mass of NaCl(s) Dissolved (g)	Boiling Point of Solution (°C)
1	100.00	8.76	101.5
2	100.00	17.52	103.1
3	100.00	26.28	104.6
4	100.00	35.04	106.1

14 Show a numerical setup for calculating the percent by mass of NaCl in the solution in beaker 4.

Base your answers to questions 15 on the information below and on your knowledge of chemistry.

During the winter months, icy roads pose a threat to motorists and can lead to accidents. A mixture of sand and sodium chloride, NaCl, can be spread on roads to make winter driving safer.

One New York town requires that a mixture of sand and salt used on residential roads should contain 25% or less of NaCl by mass. A 10.0-gram sample of a mixture of sand and NaCl was analyzed and found to contain 3.3 grams of NaCl.

15 Explain, in terms of composition by mass, why the mixture from which the analyzed sample was taken should not be used on residential roads of the town.

Answer Keys

1 3

2 4

3 3

4 2

5 3

6 Allow 1 credit. Acceptable responses include, but are not limited to:

- $\frac{(0.010\ M)(15.0 mL)}{7.5 mL}$

7 Allow 1 credit. Acceptable responses include, but are not limited to:

- $\frac{0.0033 g}{500.\ g} \times 1\,000\,000$

$\frac{0.0033(10^6)}{500}$

$\frac{3300}{500}$

$\frac{0.0033}{500} = \frac{x}{10^6}$

8 Allow 1 credit. Acceptable responses include, but are not limited to:

- $M_A(20.0\ mL) = (0.025\ M)(17.6\ mL)$
- $\frac{(.025)(17.6)}{20}$

9 Allow 1 credit. Acceptable responses include, but are not limited to:

- The concentration of the Cu^{2+} ions decreases.
- There are fewer copper ions in the solution.

10 Allow 1 credit for 33% or any value from 33% to 33.3$\overline{3}$% inclusive.

11 Allow 1 credit. Acceptable responses include, but are not limited to:

- $\frac{70.0 g}{100.\ g + 70.0 g} \times 100$

12 Allow 1 credit. Acceptable responses include, but are not limited to:

13 Allow 1 credit. Acceptable responses include, but are not limited to:

- Multiple trials may improve the precision of results.
- Each trial may involve errors either above or below the acceptable value. Therefore, an average value may be more accurate.
- Results can be shown to be reproducible.
- Multiple trials help cancel random errors.

14 Allow 1 credit. Acceptable responses include, but are not limited to:

- $\frac{35.04\ \text{g}}{100.00\ \text{g} + 35.04\ \text{g}} \times 100$

  $\frac{35}{135} \times 100$

  $\frac{35\ \text{g}\ (100)}{35\ \text{g} + 100\ \text{g}}$

15 Allow 1 credit. Acceptable responses include, but are not limited to:

- The sample is greater than 25% NaCl by mass.
- The ratio by mass of sand to NaCl in the sample is 2 to 1.
- The mass of the salt is too great.