Topic 2: Solutions

Multiple Choice

1. Listed below are several different concentrations of solutions of coffee :
   1. 25.0 g/250.0 ml
   2. 60.0 g/800.0 ml
   3. 45.0 g/675.0 ml
   4. 75.0 g/825.0 ml

   List the concentrations in increasing order.

   A) 1, 2, 3 and 4 B) 3, 2, 4 and 1 C) 3, 4, 2 and 1 D) 2, 3, 4 and

Answer: B

2. In order to prepare a solution with a concentration of 24 g/L, you use 6 g of solute. What will be the volume of your solution?

   A) 0.25 L B) 4 L C) 144 L D) 250 L

Answer: A

3. A pharmacist wants to prepare 500 mL of an antibiotic solution. The concentration of the solution must be 6% M/V. What mass of the antibiotic must she use?

   A) 1.2 g B) 3 g C) 6 g D) 30 g

Answer: D

4. In the laboratory, you are asked to prepare a solution with a concentration of 50 g/L. You are given 4.0 g of a powdered solute and distilled water. What volume of solution will you obtain?

   A) 8 mL B) 12.5 mL C) 80 mL D) 200 mL

Answer: C

5. Drinking water usually contains calcium carbonate ($CaCO_3$). Water is said to be 'hard' starting at a $CaCO_3$ concentration of 200 ppm. In this case, the water should be treated with a softener to reduce its calcium carbonate concentration. Four samples of water were analyzed. The calcium carbonate concentration of each sample is given below.

   1) Sample 1: C = 0.4 g/L
   2) Sample 2: C = 300 g/1 000 L
   3) Sample 3: C = 10 mg/L
   4) Sample 4: C = 0.005% (m/v)

   Which of these samples need to be treated to reduce the hardness of the water?

   A) Samples 1 and 2
   B) Samples 1 and 3
   C) Samples 2 and 4
   D) Samples 3 and 4

Answer: A

6. The following table provides information about the air quality in two cities on a day in June 2014.

City	Ozone
X	0.09 g/500 000 mL
Y	0.011 mg/L

The maximum ozone concentration standard is 0.15 ppm. Which of the following statements is true/?

A) Only city X meets the standard
B) Only city Y meets the standard
C) Both cities meet the standard
D) Neither city meets the standard

Answer: B

7. City regulations state that municipal swimming pools must be closed when the concentration of free available residual chlorine in the water is less than 0.3 ppm or greater than 5 ppm.

The table below lists the concentrations of free available residual chlorine in water samples taken from four swimming pools.

Table I - Concentration of Free Available Residual Chlorine in the Water From Four Swimming Pools

Swimming pool	Concentration of free available residual chlorine
1	0.00002% (m/V)
2	0.0004% (m/V)
3	0.0004 g/L
4	0.0058 g/L

Which of these pools has water that complies with these regulations?

A) Pools 1 and 3 B) Pools 1 and 4 C) Pools 2 and 3 D) Pools 2 and 4

Answer: B

Short Answer

8. Measurements in atmospheric concentrations of various substances show that the amount of CO_2 and other pollutants has increased significantly in the past 260 years, since the beginning of the Industrial Revolution.

Table 1 – Changes in atmospheric pollutant concentrations

Substance	Formula	Concentration before 1750	Concentration in 2010
carbon dioxide	(CO_2)	287 ppm	389 ppm
nitrous oxide	(N_2O)	0.270 mg/L	0.314 mg/L
methane	(CH_4)	0.109 g/L	0.449 g/L

Determine which of the pollutants in Table 1 has shown the greatest increase in concentration in the past 260 years. Justify your answer with the appropriate calculations.

Answer:

Substance	Formula	Concentration before 1750	Concentration in 2010
carbon dioxide	(CO_2)	287 ppm	389 ppm
nitrous oxide	(N_2O)	0.270 PPM	0.314 PPM
methane	(CH_4)	0.109 g/L = 109 PPM	0.449 g/L = 449 PPM

carbon dioxide change	102 PPM
nitrous oxide change	0.044 PPM
Methane change	340 PPM

Methane has the biggest increase.

9. In the laboratory, a student prepared four solutions of sodium chloride (NaCl). In the table below, she recorded the quantities related to each solution.

Solution	Quantity of solute (g)	Volume of the solution (L)
1	10	2
2	2	0.5
3	15	1.75
4	1	0.1

Which of these solutions is the most concentrated?

Answer:

Solution	
1	10 g/ 2 L = X/1 L = **5 g**
2	2 g / 0.5 L = X/ 1L = **4 g**
3	15 g/ 1.75 L = X/1L **= 8.6 g**
4	1 g/ 0.1 L = X/ 1L **= 10 g**

Solution 4 is most concentrated

10. Mia wants to get her drinking water from an artesian well on her property. To make sure that this water is drinkable, she must have a laboratory analyze it. Canadian standards state that the maximum permitted amount of boron in drinking water is 5 ppm. A lab analyzed a sample of 250 mL of water from Mia's well. This sample contained 0.1 mg of boron. Can Mia drink the water? Justify your answer.

Answer: 0.1 mg = 0.0001 g (must convert mg to g by dividing by 1000)

0.0001 g/250 mL = X/1 000 000 mL **= 4 ppm**
Mia's drinking water is to standard because it has less than 5 ppm of boron

11. To reduce tooth decay, some cities add fluoride to their drinking water. An employee in charge of drinking water fluoridation in a big city dissolved 48 g of fluoride in 50 000 L of water. What is the fluoride concentration of the water in ppm?

Answer: you must convert the L to mL by multiplying by a 1000

48g/ 50 000 000 mL = X/ 1 000 000 mL= **0.96 ppm**

12. You are getting an aquarium ready for different types of fish.

For each form of nitrogen in aquarium water, you did Internet research to find the lethal concentration that will kill the fish.

Table 1: Lethal concentrations that will kill the fish

Form of Nitrogen	Molecular Formula	Lethal Concentration
ammonia/ammonium	NH_3 / NH_4 +	0.02 mg/L
nitrite	NO2 -	0.3 mg/L
nitrate	NO3 -	0.04 g/L

To ensure that your fish survive, you decide to test the water in the aquarium, using the three (3) tests that are commercially available.

Table 2: Test results for each form of nitrogen

Available Test	Form of Nitrogen	Molecular Formula	Concentration in the Aquarium
Test 1	ammonia/ammonium	NH_3 / NH_4 +	0 ppm
Test 2	nitrite	NO_2 -	0.15 ppm
Test 3	nitrate	NO_3 -	45 ppm

Are your fish in danger of dying? Justify your answer, taking into account each form of nitrogen.

Answer: Convert all to PPM

Form of Nitrogen	Lethal Concentration	Concentration in the Aquarium	Danger?
ammonia/ammonium	0.02 ppm	0 ppm	No, concentration less than 0.2 ppm
nitrite	0.3 ppm	0.15 ppm	No, concentration less than 0.3 ppm
nitrate	40 ppm	45 ppm	Yes, concentration higher than 40 ppm

13. Sabrina must prepare 100mL of a salt solution with a concentration of 20g/L.After having calculated the mass of salt required to prepare the solution, Sabrina prepares the solution.
Choose the correct operations, in order, that she must perform to prepare the solution:
A) She weighs the solute.
B) She measures 100 ml of distilled water.
C) She adds 50 ml of the distilled water to the flask.
D) She stirs the mixture to dissolve the solute.
E) She places the solute in a flask.
F) She adds distilled water to the flask, up to the 100 ml mark.

Answer: A- E – B – C- D – F

14. Chlorine is found in the form of chloride in drinking water. Tests show that a sample of 250 mL of drinking water contains 0.02 mg of chlorine. In ppm, what is the concentration of chloride in this sample of drinking water?

Answer: 0.00002/250 = X/1 000000 = **0.08 ppm**

15. A company sells 255 mL bottles of sparkling water. The concentration of calcium in the water in each bottle of sparkling water is 200 ppm. What is the mass of calcium in each bottle of sparkling water?

Answer: 200 g /1 000 000 mL = X/255 mL = 0.051 ppm