CONCENTRATION EXERCISES:

Name: SOLUTIONS

-MUST SHOW ALL WORK AND ALL FORMULAS-

1) Concentration in Grams Per Liter (g/L) $= \frac{\text{Mass of solute(g)}}{\text{Volume of solution(L)}}$ $\quad C = \frac{m}{V}$

2) Percent Concentration (% m/V) $= \frac{\text{Mass of Solute}}{\text{Volume Solution}} \times 100$ $\quad \frac{g}{mL}$

2) Percent Concentration (% V/V) $= \frac{\text{Volume of Solute}}{\text{Volume Solution}} \times 100$ $\quad \frac{mL}{mL}$ *or* $\frac{L}{L}$

2) Percent Concentration (% m/m) $= \frac{\text{Mass of Solute}}{\text{Mass Solution}} \times 100$ $\quad \frac{g}{g}$ *or* $\frac{kg}{kg}$

3) Molar Concentration (mol/L) (Molarity) $= \frac{\text{\# of moles of solute}}{\text{Volume of solution (L)}}$ $\quad C = \frac{n}{V}$

4) Parts Per Million Concentration : (PPM) $\quad 1ppm = \frac{1\text{ mg}}{1\text{ kg}}$ OR $1ppm = \frac{1\text{ mg}}{1\text{ L}}$

1) Convert the following:

a) 20mL = 0.02 L

b) 2.2kg = 2200 g

c) 125L = 125 000 mL

d) 100mg = 0.1 g

e) 0.4g = 400 mg

f) 40g = 0.04 kg

g) 0.6 mL = 0.0006 L

h) 425mg = 0.425 g

i) 1250g = 1.25 kg

2) What amount of salt would be needed to prepare a 600mL salt water solution with a concentration of 10g/L ?

$C = \frac{m}{V}$ $\quad 10 = \frac{m}{0.6}$ $\quad \boxed{m = 6g}$

3) What volume of solution would be needed if 25g of solute was dissolved to produce a 7g/L solution?

$C = \frac{m}{V}$ $\quad 7 = \frac{25}{V}$ $\quad \boxed{V = 3.57L}$

4) You prepared 3 solutions in the laboratory. The following table gives information about each of the solutions.

Solution	Mass of Solute	Volume of solution
1	2.0 g	0.1 L
2	0.6 kg → 600g	3.0 L
3	0.2 g	2.0 mL → 0.002 L

Arrange these solutions in increasing order of their concentration (from least concentrated to most)
(hint: standardize the units)

① $C = \frac{m}{V}$ $C = \frac{2}{0.1} = 20 g/L$

② $C = \frac{m}{V}$ $C = \frac{600}{3} = 200 g/L$

③ $C = \frac{m}{V}$ $C = \frac{0.2}{0.002} = 100 g/L$

1, 3, 2

5) What volume of solution would you prepare if you dissolved 20g of solute and made a 5g/L solution?

$C = \frac{m}{V}$ $5 = \frac{20}{V}$ $V = 4 L$

6) A beaker contains 15g of sugar dissolved in a 1 liter aqueous solution.

a) What is the concentration of this solution?

$C = \frac{m}{V}$ $C = \frac{15 g}{1 L}$ $C = 15 g/L$

b) What would happen to the concentration if we added 450ml of water

$C = \frac{m}{V}$ $C = \frac{15 g}{1.450 L}$ $C = 10.34 g/L$

c) What would the concentration be if we then add 5 more grams of sugar to solution b)

$C = \frac{m}{V}$ $C = \frac{(15+5) g}{1.450 L}$ $C = \frac{20 g}{1.450 L}$ $C = 13.8 g/L$

d) Would the solution prepared in c) have a larger or smaller concentration than original solution a)

Smaller

Use the following table to: answer question 7:

Group I	Group II
Solution A 5g/L	Saline solution of 5g/L
Solution B 30g/L	Sugar-water solution 3g/100mL
Solution C 40g/L	Alcohol solution of 4g/100mL
Solution D 0.5g/L	Indicator solution 250 mg/500mL

7) a) Classify the solutions in group I in increasing order of concentration.

D, A, B, C

b) Classify the solutions in group II in increasing order of concentration. *(think!)*

A → 5g/L

B: $\frac{3g}{100mL} \rightarrow \frac{3g}{0.1L} \rightarrow 30g/L$

C: $\frac{4g}{100mL} \rightarrow \frac{4g}{0.1L} \rightarrow 40g/L$

D: $\frac{250mg}{500mL} \rightarrow \frac{0.25g}{0.5L} \rightarrow 0.5g/L$

} D, A, B, C

c) Why is it more difficult to classify the solutions in group II than those in group I, even if they are the same.

Diffrent units → Must standardize units

8) Transform the following concentrations into percent mass/volume (% m/v) and arrange them in increasing order

a) 5 g/100ml → $\frac{5g}{100mL} \times 100 = 5\%\ (m/v)$

b) 500 g/L → $\frac{500g}{1000mL} \times 100 = 50\%\ (m/v)$

c) 5 mg/ml → $\frac{0.005g}{1\ mL} \times 100 = 0.5\%\ (m/v)$

d) 0.005 g/ml → $\frac{0.005g}{1mL} \times 100 = 0.5\%\ (m/v)$

} D+C, A, B

9) What is the % concentration if 580g of "Brand X" solute was dissolved in enough water to form a 2.4kg of solution ?

$\%\ (m/m) = \frac{\text{mass solute}}{\text{mass solution}} \times 100$ $\quad \frac{580g}{2400g} \times 100$ $\quad = 24.2\%\ m/m$

10) You find a full 3L container marked 28% (m/V) NaCl solution. What quantity of salt is found in this container ?

$\%(m/v) = \frac{\text{mass solute}}{\text{Vol solution}} \times 100$ $\quad 28 = \frac{m}{3000} \times 100$ $\quad \frac{28(3000)}{100} = m$ $\quad \boxed{m = 840g}$

11) Calculate the %concentration of a solution in which 180mL of solute are mixed with 333mL of solvent.

(recall: solute + solvent = solution)

$\%(v/v) = \frac{\text{Vol solute}}{\text{Vol solution}} \times 100$ $\quad \frac{180mL}{(180+333)mL} \times 100 = \frac{180 \times 100}{513}$ $\quad \boxed{= 35.1\%(v/v)}$

12) How much water is present in a 35% mass solution if its total mass of the solution is 400g ?

$\%(m/m) = \frac{\text{mass solute}}{\text{mass solution (solute + solvent)}} \times 100$

① $35 = \frac{m}{400} \times 100$ $\quad \frac{35(400)}{100} = m$ $\quad m = 140g$ (solute)

② Solution = solute + solvent

$400 = 140 + \text{solvent}$ $\quad \boxed{\text{solvent } (H_2O) = 260g}$

13) A bottle of mineral water contains 149 mg/L of calcium. How many **ppm** does this represent?

$\frac{149mg}{L} = \boxed{149ppm}$ $\quad ppm = \frac{mg}{L}$

14) A 700g soil sample is contaminated with 3.2g of a pollutant. What is the concentration of the pollutant in **ppm**.

$3.2g \rightarrow 3200mg$

$700g \rightarrow 0.7Kg$

$\frac{3200mg}{0.7Kg} = \boxed{4571ppm}$

15) A sample of soil, contaminated with Lead (Pb), has a concentration of 5 ppm. What mass of Lead would be found in a 500g sample of the same soil?

$5ppm = \frac{5mg}{Kg}$ $\quad 5 = \frac{x\ mg}{0.5\ Kg}$

$500g = 0.5Kg$ $\quad \boxed{x = 2.5mg}$

16) What is the concentration in ppm of 'chlorine ' in a swimming pool if 150g of chlorine are dissolved in 55000L of water.

↳ 150 000 mg

$\frac{150\,000\ mg}{55\,000\ L} = \boxed{2.73ppm}$

17) The concentration of Calcium in a source of drinking water is measured to be 35ppm. Express this concentration in mg/L and g/L

$35ppm = \boxed{\frac{35\ mg}{L}} = \boxed{\frac{0.035g}{L}}$

18) The maximum concentration of lead (Pb) which is considered safe in drinking water is 0.01ppm. You receive a 250mL sample of tap water which contains 0.05 mg of lead. Is this sample safe to drink ?

$\frac{0.05mg}{0.25\ L} = \boxed{0.2\ ppm}$ → Not safe

19) A farmer must spray his field with pesticide. He plans on mixing 220g of the insecticide into 5000kg of water. What is the concentration of the pesticide in parts per million. ↳ 220 000mg

$\frac{220000mg}{5000\ kg} = \boxed{44ppm}$

20) Find the concentration of a solution that contains 4 moles of substance in 2000ml so solution.

$C = \frac{n}{V}$ $C = \frac{4moles}{2L} = \boxed{2mol/L}$

21) What is the Molarity (molar concentration) of a solution containing 63g of Mg_3N_2 dissolved in water to form a 0.75L solution?

① $M_{Mg_3N_2} = 100.9\ g/mol$

② $n = \frac{m}{M}$

$n = \frac{63}{100.9}$

$n = 0.624 moles$

③ $C = \frac{n}{V}$

$C = \frac{0.624\ mol}{0.75L}$

$\boxed{C = 0.833\ mol/L}$

22) What is the volume of solution whose concentration is 0.2mol/L if it contains 49g of H_2SO_4 ?

① $M_{H_2SO_4} = 98g/mol$

② $n = \frac{m}{M}$

$n = \frac{49}{98}$

$n = 0.5 moles$

③ $C = \frac{n}{V}$

$0.2 = \frac{0.5}{V}$

$V = \frac{0.5}{0.2} = \boxed{2.5L}$

23) If you need 4L of 0.2mol/L of sodium chloride solution. What mass of sodium chloride do you use?

① M_{NaCl} = 58.5g/mol

② $C = \frac{n}{V}$

$0.2 = \frac{n}{4}$

$n = 0.8$ moles

③ $n = \frac{m}{M}$

$0.8 = \frac{m}{58.5}$

$0.8(58.5) = m$

$m = 46.8\,g$

24) What is the Molarity (molar concentration) of a solution containing 100g of Na_2SO_4 contained in 1600ml of solution?

① $M_{Na_2SO_4}$: = 142 g/mol

② $n = \frac{m}{M}$

$n = \frac{100}{142}$

$n = 0.704$ moles

③ $C = \frac{n}{V}$

$C = \frac{0.704 \text{ moles}}{1.6\ L}$

$C = 0.44$ mol/L

25) Suppose you want to make as large a volume of 6.0mol/L sodium nitrate as possible. You have 1.5kg of this substance. What volume of solution can you make? ↳1500g

① $M_{NaNO_3} = 85$ g/mol

② $n = \frac{m}{M}$

$n = \frac{1500}{85}$

$n = 17.64$ moles

③ $C = \frac{n}{V}$

$6 = \frac{17.64}{V}$

$V = 2.94\,L$

26) You are to prepare 300mL of an aqueous solution of sodium hydroxide, NaOH, that will have a concentration of 0.8mol/L. What mass of NaOH do you need? *(circle correct answer)*

a) 0.24g b) 6.0g **c) 9.6g** d) 32g

① M_{NaOH} = 40g/mole

② $C = \frac{n}{V}$

$0.8 = \frac{n}{0.3}$

$n = 0.24$ moles

③ $n = \frac{m}{M}$

$0.24 = \frac{m}{40}$

$m = 9.6\,g$

27) What is the volume of solution with a concentration of 0.5 mol/L containing 25g of $KHCO_3$?

① M_{KHCO_3} = 100.1 g/mol

② $n = \frac{m}{M}$

$n = \frac{25}{100.1}$

$n = 0.25$ moles

③ $C = \frac{n}{V}$

$0.5 = \frac{0.25}{V}$

$V = \frac{0.25}{0.5}$

$V = 0.5\,L$

28) How many grams of $AgNO_3$ are contained in a 50mL solution whose concentration is 1.3mol/L solution?

→ 0.05L

① $M_{AgNO_3} = 169.87\ g/mol$

② $C = \frac{n}{V}$

$1.3 = \frac{n}{0.05}$

$n = 0.065$ moles

③ $n = \frac{m}{M}$

$0.065 = \frac{m}{169.87}$

$m = 11.04g$

29) You want to prepare 300ml of a 30g/L aqueous solution of potassium chloride, KCl. What mass of solute will you need?

$C = \frac{m}{V}$

$30 = \frac{m}{0.3}$

$m = 9g$

30) The table below shows the salinity of four different bodies of water:

Body of Water	Salinity
Baltic Sea	7000ppm
Black Sea	18g/L
Dead Sea	27.5% (m/V)
Mediterranean Sea	39g/L

Compare the given salinities and list the bodies of water in ascending order.

Baltic: $7000ppm = \frac{7000mg}{1L} = \frac{7g}{L}$

Dead: $27.5\%_{(m/v)} = \frac{27.5g}{100mL} = \frac{27.5g}{0.1L} = \frac{275g}{L}$

Answer: Baltic, Black, Medi, Dead

Black: 18 g/L Med: 39 g/L

31) Since the industrial revolution of 1780 large quantities of acid rain were widespread in the environment. As a result, soil, plants and aquatic animals have been negatively affected. The two main culprits in acid rain are nitrous oxide (N_2O) and sulfur dioxide (SO_2).

During the working hours, it has been observed that the quantity of nitrous oxide (N_2O) in 5L of air is 6.82×10^{-5} mol.

Calculate the concentration of Nitrous oxide in ppm.

① $M_{N_2O} = 44\ g/mol$

② $n = \frac{m}{M}$

$6.82 \times 10^{-5} = \frac{m}{44}$

$m = 0.003g$

③ $0.003g = 3mg$

④ $ppm = \frac{mg}{L}$

$\frac{3mg}{5L} = 0.6ppm$

32) Three lakes are being measured for possible toxicity by substance 'X'. In order to be considered safe to swim in these lakes must have a concentration of substance 'X' which is not greater than 0.75ppm.

The following data was collected: (Put in ppm)

Lake	Concentration of 'X'
A	0.0012 g/L
B	0.008 mg/mL
C	0.55 mg/L

A: $\frac{0.0012\,g}{1\,L} = \frac{1.2\,mg}{1\,L} = \boxed{1.2\,ppm}$

Which lakes, if any, are dangerous to swim in ?

B: $\frac{0.08\,mg}{1\,mL} = \frac{0.008\,mg}{0.001\,L} = \boxed{8\,ppm}$

→ Lakes A + B are dangerouse

C: $\frac{0.55\,mg}{1\,L} = \boxed{0.55\,ppm}$

33) The sodium concentration in a bottle of mineral water is 0.005% (m/V).
What is sodium concentration in ppm ?

(recall: $\frac{mg}{L} = ppm$)

① 0.005% (m/v) = 0.005 g → 5 mg
100 mL → 0.1 L

② $\frac{5\,mg}{0.1\,L} = \boxed{50\,ppm}$

34) High concentrations of nitrates (NO_3^-), in drinking water can be dangerous to human health. The safe level for nitrates in drinking water is generally considered to be 45ppm.

Susan has just purchased a home by the country side. Her home is next to several large farms.

Susan wonder if the concentration of nitrates in her drinking water is safe to consume. Susan decides to test her drinking water at a local lab. The results indicate that in 2L of her water there is 0.001 moles of NO_3^- .

What is the concentration of nitrates of Susan's water in ppm ? Is it safe ?

① M_{NO_3} = 62 g/mol

② $n = \frac{m}{M}$

$0.001 = \frac{m}{62}$

$m = 0.062\,g$

③ 0.062 g ↓ 62 mg

③ $ppm = \frac{mg}{L}$

$\frac{62\,mg}{2\,L}$

$= \boxed{31\,ppm}$

35) Given the following information, make the necessary conversions into concentration:

a) 16g & 4000mL

$C = \frac{m}{V}$

$C = \frac{16g}{4L}$

$C = 4g/L$

$ppm = \frac{mg}{L}$

$\frac{4g}{1L} = \frac{4000mg}{L}$

$= 4000ppm$

$\%\ (m/v)$

$\frac{4g}{1L} =$

$\frac{4g}{1000mL} \times 100$

$= 0.4\%$

g/mL = 4g/L

ppm = 4000 ppm

% (m/v) = 0.4%

b) 0.005g & 2.2L

$C = \frac{m}{V}$

$C = \frac{0.005g}{2.2L}$

$C = 0.0023g/L$

$ppm = \frac{mg}{L}$

$\frac{0.0023g}{1L} = \frac{2.3mg}{1L}$

$= 2.3ppm$

$\%\ (m/v)$

$\frac{0.0023g}{L} =$

$\frac{0.0023g \times 100}{1000mL}$

$= 0.00023\%$

g/mL = 0.0023 g/L

ppm = 2.3 ppm

% (m/v) = 0.00023% (m/v)

c) 2mg & 80mL

$\frac{2mg}{80mL} \rightarrow \frac{0.002g}{0.08L}$

$\downarrow$

$0.025g/L$

$ppm = \frac{mg}{L}$

$\frac{2mg}{80mL} \rightarrow \frac{2mg}{0.08L}$

$= 25ppm$

$\%\ (m/v)$

$\frac{2mg}{80mL} =$

$\frac{0.002g \times 100}{80mL}$

$= 0.0025\%$

g/mL = 0.025 g/L

ppm = 25 ppm

% (m/v) = 0.0025% (m/v)

36) Fill in the missing information by converting to the units indicated:

15 % m/v	225g/L	67.5 % m/v	34.5g/L	75g / 2000mL	3.5 % m/v
$\frac{15g}{100mL} = \frac{15g}{0.1L}$	$\frac{225g}{1000mL} \times 100$	$\frac{67.5g}{100mL} = \frac{67.5g}{0.1L}$	$\frac{34.5g}{1000mL} \times 100$	$\frac{75g}{2000mL} \times 100$	$\frac{3.5g}{100mL} = \frac{3500mg}{0.1L}$
150 g/L	22.5 % m/v	675 g/L	3.45 % m/v	3.75 % m/v	35 000 ppm

Solutions:

1. a) 0.02L b)2200g c)125000mL
   d) 0.1g e)400mg f)0.04kg
   g) 0.0006L h)0.425g i)1.25kg
2. 6g
3. 3.57L
4. 1,3,2
5. 4L
6. a) 15g/L b) 10.34g/L
   c) 13.79g/L d) smaller
7. a) D,A,B,C b) D,A,B,C
   c) Standardize units
8. D(0.5%),C(0.5%),A(5%),B(50%)
9. 24.2% (m/m)
10. 840g
11. 35.1% (v/v)
12. 260g
13. 149ppm
14. 4571ppm
15. 2.5mg
16. 2.73ppm
17. 35mg/L , 0.035g/L
18. 0.2ppm
19. 44ppm
20. 2mol/L
21. 0.833mol/L
22. 2.5L
23. 46.8g
24. 0.44mol/L
25. 2.94L
26. 9.6g
27. 0.5L
28. 11.04g
29. 9g
30. Baltic(7g/L),Black(18g/L),Med(39g/L),Dead(275g/L)
31. 0.6ppm
32. A: 1.2ppm, B: 8ppm, C: 0.55ppm Lake A+B are Dangerous
33. 50ppm
34. 31ppm
35. a) 4g/mL , 4000ppm , 0.4%(m/v)
    b) 0.0023g/L , 2.3ppm , 0.00023%(m/v)
    c) 0.025g/L , 25ppm , 0.0025%(m/v)
36. 150g/L , 22.5% m/v , 675g/L , 3.45% m/v , 3.75% m/v , 35000ppm