

Molarity & Dilution

Key formulas**Molarity:** $c = n \div V$ (mol/L) · **Moles:** $n = c \times V$ · **Mass:** $m = n \times M$ **Dilution:** $c_1V_1 = c_2V_2$ (the moles of solute stay the same) · **Volume:** always convert mL to L ($\div 1000$) for $c = n \div V$ Give answers to 3 significant figures. **Molar masses (g/mol):** H 1.01, C 12.01, N 14.01, O 16.00, Na 22.99, S 32.07, Cl 35.45, K 39.10, Cu 63.55**A Molarity from moles and volume**

4 marks

1. 2.00 mol of NaCl is dissolved to make 1.00 L of solution. Find the molarity.

2. 0.500 mol of KCl is dissolved to make 250. mL of solution. Find the molarity.

3. 0.150 mol of HCl is dissolved to make 500. mL of solution. Find the molarity.

4. 0.0250 mol of NaOH is dissolved to make 100. mL of solution. Find the molarity.

B Molarity from mass

6 marks

2 marks each: moles first, then molarity.

5. 11.7 g of NaCl is dissolved to make 200. mL of solution. Find the molarity.

6. 4.00 g of NaOH is dissolved to make 250. mL of solution. Find the molarity.

7. 90.1 g of $C_6H_{12}O_6$ is dissolved to make 1.00 L of solution. Find the molarity.

C Preparing a solution: mass needed

6 marks

8. What mass of NaCl is needed to make 500. mL of a 0.200 mol/L solution?

9. What mass of KNO₃ is needed to make 250. mL of a 0.400 mol/L solution?

10. What mass of CuSO₄ is needed to make 100. mL of a 0.150 mol/L solution?

D Moles and volume from molarity

2 marks

11. How many moles of HCl are in 75.0 mL of a 0.200 mol/L solution?

12. What volume of 0.250 mol/L NaOH contains 0.0500 mol of NaOH?

E Dilution: $c_1V_1 = c_2V_2$

4 marks

13. 50.0 mL of 6.00 mol/L HCl is diluted to 300. mL. What is the new concentration?

14. What volume of 12.0 mol/L HCl is needed to make 500. mL of 0.600 mol/L HCl?

15. How much water must be added to 100. mL of 2.00 mol/L NaCl to make it 0.500 mol/L?

16. 25.0 mL of 0.800 mol/L KCl is diluted to 200. mL. What is the new concentration?

F Ion concentrations

2 marks

17. What is $[\text{Cl}^-]$ in 0.150 mol/L CaCl_2 ?

18. What are $[\text{Na}^+]$ and $[\text{SO}_4^{2-}]$ in 0.200 mol/L Na_2SO_4 ?

G Spot the mistake

2 marks

19. A student finds the molarity of 0.500 mol of NaCl in 250. mL as $0.500 \div 250 = 0.00200$ mol/L. Explain the error and correct it.

20. To make 500. mL of 1.00 mol/L NaCl, a student adds 29.2 g of NaCl to 500. mL of water. Explain the error and correct it.

H Challenge

2 marks

21. 100. mL of 0.200 mol/L NaCl is mixed with 50.0 mL of 0.500 mol/L NaCl. What is the final concentration?

22. $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$. What volume of 0.100 mol/L HCl neutralizes 25.0 mL of 0.200 mol/L NaOH?

Molarity & Dilution **ANSWER KEY****Key formulas****Molarity:** $c = n \div V$ (mol/L) · **Moles:** $n = c \times V$ · **Mass:** $m = n \times M$ **Dilution:** $c_1V_1 = c_2V_2$ (the moles of solute stay the same) · **Volume:** always convert mL to L ($\div 1000$) for $c = n \div V$ Give answers to 3 significant figures. **Molar masses (g/mol):** H 1.01, C 12.01, N 14.01, O 16.00, Na 22.99, S 32.07, Cl 35.45, K 39.10, Cu 63.55**A Molarity from moles and volume**

4 marks

- 2.00 mol of NaCl is dissolved to make 1.00 L of solution. Find the molarity.
 $c = 2.00 \text{ mol} \div 1.00 \text{ L} = 2.00 \text{ mol/L}$
- 0.500 mol of KCl is dissolved to make 250. mL of solution. Find the molarity.
 $c = 0.500 \text{ mol} \div 0.250 \text{ L} = 2.00 \text{ mol/L}$
- 0.150 mol of HCl is dissolved to make 500. mL of solution. Find the molarity.
 $c = 0.150 \text{ mol} \div 0.500 \text{ L} = 0.300 \text{ mol/L}$
- 0.0250 mol of NaOH is dissolved to make 100. mL of solution. Find the molarity.
 $c = 0.0250 \text{ mol} \div 0.100 \text{ L} = 0.250 \text{ mol/L}$

B Molarity from mass

6 marks

2 marks each: moles first, then molarity.

- 11.7 g of NaCl is dissolved to make 200. mL of solution. Find the molarity.
 $n = 11.7 \div 58.44 = 0.200 \text{ mol}; c = 0.200 \div 0.200 \text{ L} = 1.00 \text{ mol/L}$
- 4.00 g of NaOH is dissolved to make 250. mL of solution. Find the molarity.
 $n = 4.00 \div 40.00 = 0.100 \text{ mol}; c = 0.100 \div 0.250 \text{ L} = 0.400 \text{ mol/L}$
- 90.1 g of $\text{C}_6\text{H}_{12}\text{O}_6$ is dissolved to make 1.00 L of solution. Find the molarity.
 $n = 90.1 \div 180.18 = 0.500 \text{ mol}; c = 0.500 \div 1.00 \text{ L} = 0.500 \text{ mol/L}$

C Preparing a solution: mass needed

6 marks

- What mass of NaCl is needed to make 500. mL of a 0.200 mol/L solution?
 $n = 0.200 \times 0.500 \text{ L} = 0.100 \text{ mol}; m = 0.100 \times 58.44 = 5.84 \text{ g}$
- What mass of KNO_3 is needed to make 250. mL of a 0.400 mol/L solution?
 $n = 0.400 \times 0.250 \text{ L} = 0.100 \text{ mol}; m = 0.100 \times 101.11 = 10.1 \text{ g}$
- What mass of CuSO_4 is needed to make 100. mL of a 0.150 mol/L solution?
 $n = 0.150 \times 0.100 \text{ L} = 0.0150 \text{ mol}; m = 0.0150 \times 159.62 = 2.39 \text{ g}$

D Moles and volume from molarity

2 marks

11. How many moles of HCl are in 75.0 mL of a 0.200 mol/L solution?

$$n = 0.200 \times 0.0750 \text{ L} = 0.0150 \text{ mol}$$

12. What volume of 0.250 mol/L NaOH contains 0.0500 mol of NaOH?

$$V = 0.0500 \div 0.250 = 0.200 \text{ L (200 mL)}$$

E Dilution: $c_1V_1 = c_2V_2$

4 marks

13. 50.0 mL of 6.00 mol/L HCl is diluted to 300. mL. What is the new concentration?

$$c_2 = (6.00 \times 50.0) \div 300. = 1.00 \text{ mol/L}$$

14. What volume of 12.0 mol/L HCl is needed to make 500. mL of 0.600 mol/L HCl?

$$V_1 = (0.600 \times 500.) \div 12.0 = 25.0 \text{ mL}$$

15. How much water must be added to 100. mL of 2.00 mol/L NaCl to make it 0.500 mol/L?

$$V_2 = (2.00 \times 100.) \div 0.500 = 400. \text{ mL; water added} = 400. - 100. = 300 \text{ mL}$$

16. 25.0 mL of 0.800 mol/L KCl is diluted to 200. mL. What is the new concentration?

$$c_2 = (0.800 \times 25.0) \div 200. = 0.100 \text{ mol/L}$$

F Ion concentrations

2 marks

17. What is $[\text{Cl}^-]$ in 0.150 mol/L CaCl_2 ?



18. What are $[\text{Na}^+]$ and $[\text{SO}_4^{2-}]$ in 0.200 mol/L Na_2SO_4 ?



G Spot the mistake

2 marks

19. A student finds the molarity of 0.500 mol of NaCl in 250. mL as $0.500 \div 250 = 0.00200 \text{ mol/L}$. Explain the error and correct it.

Volume must be in litres: $250. \text{ mL} = 0.250 \text{ L}$. Correct: $0.500 \div 0.250 = 2.00 \text{ mol/L}$

20. To make 500. mL of 1.00 mol/L NaCl, a student adds 29.2 g of NaCl to 500. mL of water. Explain the error and correct it.

Molarity uses the volume of the *solution*, not the water. Dissolve the NaCl in some water, then add water up to the 500. mL mark in a volumetric flask.

H Challenge

2 marks

21. 100. mL of 0.200 mol/L NaCl is mixed with 50.0 mL of 0.500 mol/L NaCl. What is the final concentration?

$$n = 0.200 \times 0.100 + 0.500 \times 0.0500 = 0.0450 \text{ mol; } V = 0.150 \text{ L; } c = 0.300 \text{ mol/L}$$

22. $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$. What volume of 0.100 mol/L HCl neutralizes 25.0 mL of 0.200 mol/L NaOH?

$$n(\text{NaOH}) = 0.200 \times 0.0250 = 0.00500 \text{ mol} = n(\text{HCl}) \text{ (1 : 1); } V = 0.00500 \div 0.100 = 0.0500 \text{ L} = 50.0 \text{ mL}$$