

Mole Conversions

The mole road map

Mass (g)

 $\div \text{molar mass} \rightarrow$
 $\leftarrow \times \text{molar mass}$

Moles (mol)

 $\times 6.02 \times 10^{23} \rightarrow$
 $\leftarrow \div 6.02 \times 10^{23}$

Particles

 $n = m / M$ $N = n \times N_A$ ($N_A = 6.02 \times 10^{23}$) · 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, Mg 24.31, Al 26.98, S 32.07, Cl 35.45, K 39.10, Ca 40.08, Fe 55.85, Cu 63.55

A Molar mass

6 marks

- | | | | |
|----------------------------|-------|---------------------------------|-------|
| 1. H_2O | _____ | 2. CO_2 | _____ |
| 3. NaCl | _____ | 4. CaCO_3 | _____ |
| 5. H_2SO_4 | _____ | 6. $\text{Al}_2(\text{SO}_4)_3$ | _____ |

B Mass $\rightarrow$ moles

4 marks

7. Convert 36.0 g of H_2O to moles.

8. Convert 11.0 g of CO_2 to moles.

9. Convert 5.85 g of NaCl to moles.

10. Convert 250. g of CaCO_3 to moles.

C Moles $\rightarrow$ mass

4 marks

11. Find the mass of 3.00 mol of NaCl .

12. Find the mass of 0.500 mol of H_2SO_4 .

13. Find the mass of 2.50 mol of O_2 .

14. Find the mass of 0.0250 mol of CaCO_3 .

D Moles ↔ particles

4 marks

15. How many atoms are in 2.00 mol of iron (Fe)?

16. How many molecules are in 0.250 mol of CO₂?

17. How many moles are in 3.01×10^{23} molecules of H₂O?

18. How many moles are in 9.03×10^{23} atoms of copper (Cu)?

E Two-step conversions

4 marks

19. How many molecules are in 9.01 g of H₂O?

20. How many molecules are in 22.0 g of CO₂?

21. What is the mass of 1.505×10^{23} atoms of iron?

22. How many hydrogen atoms are in 2.00 mol of H₂O?

F Spot the mistake

2 marks

23. To find the mass of 2.00 mol of NaCl, a student calculates $2.00 \div 58.44 = 0.0342$ g. Explain the error and correct it.

24. A student says 1 mol of H₂ has the same mass as 1 mol of O₂. Explain the error and correct it.

G Challenge

2 marks

25. How many oxygen atoms are in 10.0 g of CO₂?

26. Which contains more molecules: 10.0 g of H₂O or 10.0 g of CO₂? Explain.

Mole Conversions

ANSWER KEY**The mole road map****Mass (g)**÷ molar mass →
← × molar mass**Moles (mol)**× 6.02×10^{23} →
← ÷ 6.02×10^{23} **Particles** $n = m / M$ $N = n \times N_A$ ($N_A = 6.02 \times 10^{23}$) · 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, Mg 24.31, Al 26.98, S 32.07, Cl 35.45, K 39.10, Ca 40.08, Fe 55.85, Cu 63.55**A Molar mass**

6 marks

- | | | | |
|-----------------------------------|-------------|--|--------------|
| 1. H ₂ O | 18.02 g/mol | 2. CO ₂ | 44.01 g/mol |
| 3. NaCl | 58.44 g/mol | 4. CaCO ₃ | 100.09 g/mol |
| 5. H ₂ SO ₄ | 98.09 g/mol | 6. Al ₂ (SO ₄) ₃ | 342.17 g/mol |

B Mass → moles

4 marks

7. Convert 36.0 g of H₂O to moles.
 $n = 36.0 \text{ g} \div 18.02 \text{ g/mol} = 2.00 \text{ mol}$
8. Convert 11.0 g of CO₂ to moles.
 $n = 11.0 \text{ g} \div 44.01 \text{ g/mol} = 0.250 \text{ mol}$
9. Convert 5.85 g of NaCl to moles.
 $n = 5.85 \text{ g} \div 58.44 \text{ g/mol} = 0.100 \text{ mol}$
10. Convert 250. g of CaCO₃ to moles.
 $n = 250. \text{ g} \div 100.09 \text{ g/mol} = 2.50 \text{ mol}$

C Moles → mass

4 marks

11. Find the mass of 3.00 mol of NaCl.
 $m = 3.00 \text{ mol} \times 58.44 \text{ g/mol} = 175 \text{ g}$
12. Find the mass of 0.500 mol of H₂SO₄.
 $m = 0.500 \text{ mol} \times 98.09 \text{ g/mol} = 49.0 \text{ g}$
13. Find the mass of 2.50 mol of O₂.
 $m = 2.50 \text{ mol} \times 32.00 \text{ g/mol} = 80.0 \text{ g}$
14. Find the mass of 0.0250 mol of CaCO₃.
 $m = 0.0250 \text{ mol} \times 100.09 \text{ g/mol} = 2.50 \text{ g}$

D Moles ↔ particles

4 marks

15. How many atoms are in 2.00 mol of iron (Fe)?
 $N = 2.00 \times 6.02 \times 10^{23} = 1.20 \times 10^{24}$ atoms
16. How many molecules are in 0.250 mol of CO_2 ?
 $N = 0.250 \times 6.02 \times 10^{23} = 1.51 \times 10^{23}$ molecules
17. How many moles are in 3.01×10^{23} molecules of H_2O ?
 $n = 3.01 \times 10^{23} \div 6.02 \times 10^{23} = 0.500$ mol
18. How many moles are in 9.03×10^{23} atoms of copper (Cu)?
 $n = 9.03 \times 10^{23} \div 6.02 \times 10^{23} = 1.50$ mol

E Two-step conversions

4 marks

19. How many molecules are in 9.01 g of H_2O ?
 $9.01 \div 18.02 = 0.500$ mol; $\times 6.02 \times 10^{23} = 3.01 \times 10^{23}$ molecules
20. How many molecules are in 22.0 g of CO_2 ?
 $22.0 \div 44.01 = 0.500$ mol; $\times 6.02 \times 10^{23} = 3.01 \times 10^{23}$ molecules
21. What is the mass of 1.505×10^{23} atoms of iron?
 $1.505 \times 10^{23} \div 6.02 \times 10^{23} = 0.250$ mol; $\times 55.85 = 14.0$ g
22. How many hydrogen atoms are in 2.00 mol of H_2O ?
 $2.00 \text{ mol} \times 2 \text{ H per molecule} \times 6.02 \times 10^{23} = 2.41 \times 10^{24}$ H atoms

F Spot the mistake

2 marks

23. To find the mass of 2.00 mol of NaCl, a student calculates $2.00 \div 58.44 = 0.0342$ g. Explain the error and correct it.
Mass = moles $\times$ molar mass, not moles $\div$ molar mass. Correct: $2.00 \times 58.44 = 117$ g
24. A student says 1 mol of H_2 has the same mass as 1 mol of O_2 . Explain the error and correct it.
They have the same number of molecules, but different molar masses: 2.02 g vs 32.00 g.

G Challenge

2 marks

25. How many oxygen atoms are in 10.0 g of CO_2 ?
 $10.0 \div 44.01 = 0.227$ mol CO_2 ; $\times 2 \times 6.02 \times 10^{23} = 2.74 \times 10^{23}$ O atoms
26. Which contains more molecules: 10.0 g of H_2O or 10.0 g of CO_2 ? Explain.
 H_2O : 0.555 mol vs 0.227 mol CO_2 . Water has the smaller molar mass, so the same mass contains more moles and more molecules.