The Mole and Molar Mass

Press Release!

Scientists have, through countless hours of research and experimentation, derived a remarkable new constant: the mole. This number was derived to represent a specific number of particles. Study the exciting, highlighted conclusion in the box below:

1 mole = 6.022×10^{23} particles

It is expected to be the breakthrough discovery that will change life and laws if chemistry and physics, as we know them, forever!

Your Task

As with any new scientific discovery, this one must be exposed to the rigorous testing of the scientific community. Can this constant withstand such scrutiny?

1. Use the periodic table to complete the following calculations.

   1 mole of carbon = 6.022×10^{23} atoms of carbon

   = 12.011 g

   Therefore, one mole of carbon has a mass of 12.011 g/mol.

   1 mole of gold = 6.022×10^{23} atoms of gold

   = 196.97 g

   Therefore, one mole of gold has a mass of 196.97 g/mol.

   1 mole of water = 6.022×10^{23} molecules of water

   = 18.015 g

   Therefore, one mole of water has a mass of 18.015 g/mol.

2. Use your calculations from question 1 to complete the table below. The scientific community – no, the world! – Thanks you. I thank you.

Substance	No. of moles	Mass	No. of Particles
carbon 12.011 g/mol	2 mol	24.022 g	1.2044×10^{24}
	1 mol	12.011 g	6.2×10^{24}
	6.6×10^{-6} mol	7.98×10^{-5} g	4.0×10^{18}
	7.5 mol	90 g	4.5×10^{24}
gold 196.97 g/mol	22 mol	4.3×10^{3} g	1.3×10^{25}
	5 mol	985 g	3.0×10^{24}
	349 mol	6.87×10^{4} g	2.10×10^{26}
	2.2×10^{-11} mol	4.3×10^{-9} g	1.3×10^{13}
water 18.015 g/mol	0.4 mol	7.2 g	2.4×10^{23}
	9.96×10^{-18}	1.79×10^{-16} g	6.0×10^{6}
	1.25×10^{22}	2.24×10^{23} g	7.5×10^{45}
	12 mol	2.2×10^{2} g	7.2×10^{24}

1. How many moles of Na are in 42 g of Na?
2. How many moles of O are in 8.25 g of O?
3. How much does 2.18 mol of Cu weigh?
4. What is the mass of 0.28 mol of iron?
5. How many atoms are in 7.2 mol of chlorine?
6. How many atoms are in 36 g of bromine?
7. How many moles are in 1.0×10^{9} atoms?
8. What is the mass of 1.20×10^{25} atoms of sulfur?
9. How many moles of CO molecules are in 52 g of CO?
10. How many moles of C_2H_6 are in 124 g?
11. How many moles of CCl_4 are there in 56 g?
12. How much does 2.50 mol of H_2SO_4 weigh?
13. How much does 0.25 mol of Fe_2O_3 weigh?
14. How many molecules are there in 52 g of CO?
15. How many formula units are in 22.4 g SnO_2?

16. How many molecules are in 116 g CCl_4?
17. What is the mass of 3.01×10^{23} formula units of Fe_2O_3?
18. What is the mass of 1.2×10^{25} molecules of CO?
19. How many O atoms are in 1.25 mol of SO_2?
20. How many moles of O atoms do you have when you have 1.20×10^{25} N_2O_5 molecules?
21. How many formula units are in 5.33 mol of $CuCl_2$?
22. How many copper atoms are in 5.33 mol of $CuCl_2$?
23. How many moles of Cl atoms are in 5.33 mol of $CuCl_2$?
24. How many moles of $CuCl_2$ contain 1.2×10^{23} atoms of Cl?
25. How many O atoms are in 3.15 mol of SnO_2?
26. How many H atoms are in 17.5 g $(NH_4)_2C_2O_4$?

#1 $? mol = 42g \div 22.990 g/mol = 1.8 mol$

#2 $? mol = 8.25g \div 15.999 g/mol = 5.16 \times 10^{-1} mol$

#3 $? g = 2.18 mol \times 63.546 g/mol = 1.39 \times 10^{2} g$

#4 $? g = 0.28 mol \times 55.845 g/mol = 1.6 \times 10^{1} g$

#5 $? atoms = 7.2 mol \times 6.022 \times 10^{23} molecules/mol \times 2 atoms/molecule = 8.7 \times 10^{24}$

#6 $? atoms = 36g \div 159.808 g/mol \times 6.022 \times 10^{23} molecules/mol \times 2 atoms/molecule = 2.7 \times 10^{23}$

#7 $? mol = 1.0 \times 10^{9} atoms \div 6.022 \times 10^{23} atoms/mol = 1.7 \times 10^{-15} mol$

#8 $? g = 1.20 \times 10^{25} Satoms \div 6.022 \times 10^{23} Satoms/mol \times 32.06 g/mol = 639 g$

#9 $? mol = 52g \div 28.019 g/mol = 1.9 mol$

#10 $? mol = 124g \div 30.079 g/mol = 4.12 mol$

#11 $? mol = 56g \div 153.811 g/mol = 3.6 \times 10^{-1} mol$

#12 $? g = 2.50 mol \times 98.072 g/mol = 245 g$

#13 $? g = 0.25 mol \times 159.687 g/mol = 4.0 \times 10^{1} g$

#14 $? molecules = 52g \div 28.019 g/mol \times 6.022 \times 10^{23} molecules/mol = 1.1 \times 10^{24}$

#15 $? FU = 22.4g \div 150.708 g/mol \times 6.022 \times 10^{23} FU/mol = 8.95 \times 10^{22}$

#16 $? molecules = 116g \div 153.811 g/mol \times 6.022 \times 10^{23} molecules/mol = 4.54 \times 10^{23}$

#17 $? g = 3.01 \times 10^{23} FU \div 6.022 \times 10^{23} FU/mol \times 159.687 g/mol = 79.8 g$

#18 $? g = 1.2 \times 10^{25} molecules \div 6.022 \times 10^{23} molecules/mol \times 28.019 g/mol = 5.6 \times 10^{2} g$

Answers

1. 1.8 mol Na
2. 0.516 mol O
3. 139 g Cu
4. 16 g Fe
5. 8.7×10^{24} Cl atoms
6. 2.7×10^{23} Br atoms
7. 1.7×10^{-15} mol
8. 639 g S
9. 1.9 mol
10. 4.12 mol
11. 0.36 mol
12. 245 g
13. 40. g
14. 1.1×10^{24} molecules
15. 8.95×10^{22} formula units
16. 4.54×10^{23} molecules
17. 79.9 g Fe_2O_3
18. 5.6×10^{2} g CO
19. 1.51×10^{24} O atoms
20. 99.7 mol O
21. 3.21×10^{24} formula units
22. 3.21×10^{24} Cu atoms
23. 10.7 mol of Cl atoms
24. 0.10 mol $CuCl_2$
25. 3.79×10^{24} O atoms
26. 6.79×10^{23} H atoms

#19 ? O atoms = $1.25\,mol \times 6.022 \times 10^{23}\,molecules/mol \times 2\,atoms/molecule = 1.51 \times 10^{24}$ O atoms

#20 ? O mol = $1.20 \times 10^{25}\,molecules \times 5\,O/molecule \div 6.022 \times 10^{23}\,O/mol = 99.6\,mol\ of\ O$

#21 ? FU = $5.33\,mol \times 6.022 \times 10^{23}\,FU/mol = 3.21 \times 10^{24}$ FU

#22 ? Cu atoms = $5.33\,mol \times 6.022 \times 10^{23}\,FU/mol \times 1\,Cu/FU = 3.21 \times 10^{24}$ Cu

#23 ? Cl mol = $5.33\,mol \times 2\,Cl/FU = 10.7\,mol$

#24 ? mol = $1.2 \times 10^{23}\,atoms \div 2\,Cl/FU \div 6.022 \times 10^{23}\,FU/mol = 0.10\,mol$

#25 ? O atoms = $3.15\,mol \times 6.022 \times 10^{23}\,FU/mol \times 2\,atoms/FU = 3.79 \times 10^{24}$ O atoms

#26 ? H atoms = $17.5\,g \div 124.0969\,g/mol \times 6.022 \times 10^{23}\,FU/mol \times 8\,H/FU = 6.79 \times 10^{23}$ H atoms