



The Mole



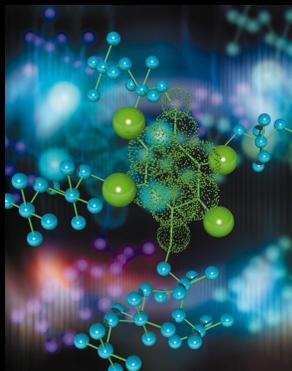
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Molecules Are Too Small To See

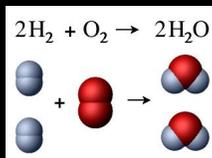
We must “deduce” number of molecules involved in reactions



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Reactions occur at the particulate level:



Molecules “collide” to form new products
(Collision Theory)



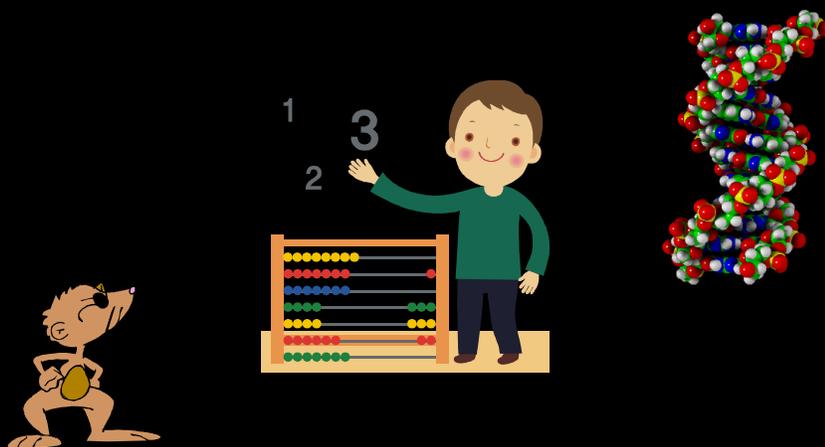
Need way to determine number of reacting atoms



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The Mole is a Chemist's Way of Counting Atoms & Molecules



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The Mole

Mole always contains the same number of formula units:
 6.02×10^{23} (Avogadro's Number)



- 1 mol element = 6.02×10^{23} atoms
- 1 mol diatomic element = 6.02×10^{23} molecules
- 1 mol molecular compound = 6.02×10^{23} molecules
- 1 mol ionic compound = 6.02×10^{23} formula units

So, the "per" expressions:

- 1 mol = 6.02×10^{23} atoms
- 1 mol = 6.02×10^{23} molecules
- 1 mol = 6.02×10^{23} formula units



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Each Element Has A Different Atomic Mass

Periodic Table

1 1/A 1 H 1.008																	18/VIIIA 2 He 4.003
3 Li 6.941	4 Be 9.012											13/IIIA 5 B 10.81	14/IVA 6 C 12.01	15/VA 7 N 14.01	16/VIA 8 O 16.00	17/VIIA 9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	← VIII →										13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.05	18 Ar 39.96
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 146.9	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0	
87 Fr 223.0	88 Ra 226.0	89 Ac Lr	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu 239.1	95 Am 241.1	96 Cm 244.1	97 Bk 247.1	98 Cf 251.1	99 Es 252.1	100 Fm 257.1	101 Md 258.1	102 No 259.1	103 Lr 262.1	

← s → ← d → ← p →

Lanthanides: 57-71

Actinides: 89-103

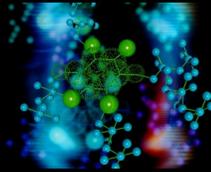
← f →



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Mole Map



Atomic Units

Avagadro's
 6.02×10^{23} fu
mole



Moles

Molar Mass
g / mole



Grams

Avogadro's Number: From Memory
Molar Mass: Calculated from Periodic Table
Let the Units Drive the Solution!

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Let's Study the Mole, People



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The Mole Lab



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Today's Lab

Work In Pairs

See Video on The Mole

Identify Unknown Elements

Determine Moles and Formula Units for Ionic Compounds

Determine Moles and Molecules for Molecular Compound



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Element Identification



Select 3 Element Vials (with different colored dots)

Each vial marked with:

Label (Letter of the Unknown)

Weight of empty vial and cap

Weigh each vial

Mass of unknown vial – mass written on vial = mass unknown

Determine Atomic Mass of the unknown (grams / mole)

mass (grams) unknown / 0.100 mole = unknown atomic mass

Identify Unknown Element

Find element on the periodic table with unknown's atomic mass

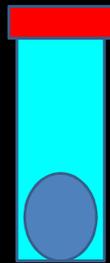


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Periodic Table of the Elements

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Weighing By Difference



Container
Plus
Sample
Weight



Container
Weight



Sample
Weight

Technique gives best weight of sample
(no mechanical loss while weighing)

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Moles and Formula Units

Weigh each vial

Mass of sample vial – mass written on vial = mass sample

Determine moles of the sample (grams / mole)

$$\text{mass (grams)} \times \frac{1 \text{ mole}}{\text{formula mass (g)}} = \# \text{ Moles}$$

Identify Number of Formula Units

$$\# \text{ moles} \times \frac{6.02 \times 10^{23} \text{ formula units}}{\text{mole}} = \# \text{ Formula Units}$$



Each group determines both NaCl and KNO₃

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Moles and Number of molecules

Measure mass of 40.0 mL of deionized water

Tare balance with 50 mL grad cylinder; fill to 40.0 mL

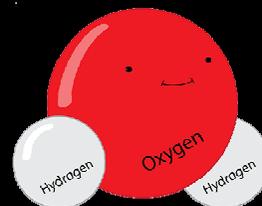
Measure mass

Determine moles of the sample (grams / mole)

$$\text{mass (grams)} \times \frac{1 \text{ mole}}{\text{molecular mass (g)}} = \# \text{ Moles sample}$$

Identify Number of Formula Units (Molecules)

$$\# \text{ moles} \times \frac{6.02 \times 10^{23} \text{ molecules}}{\text{mole}} = \# \text{ Molecules in sample}$$



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Results

Fill in tables with calculated values

Conclusion

Questions

Proper units and sig figs



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Let's Boldly Go Explore Today's Lab



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