



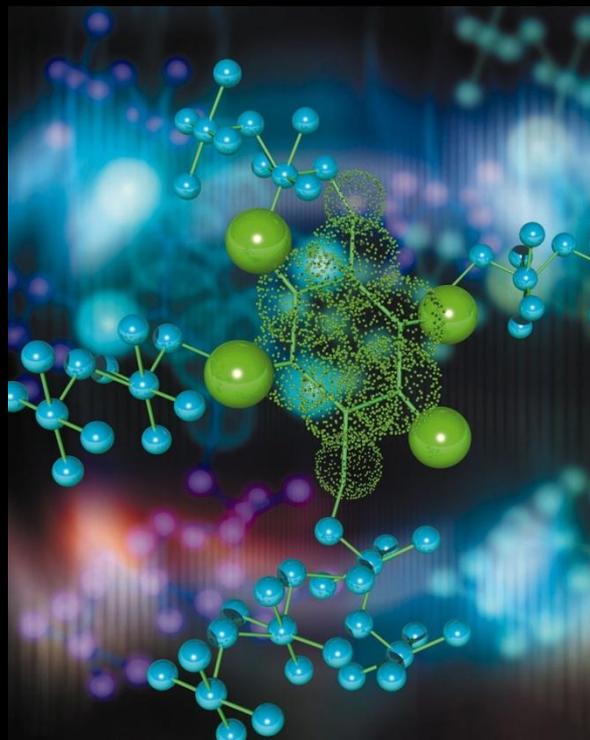
The Mole



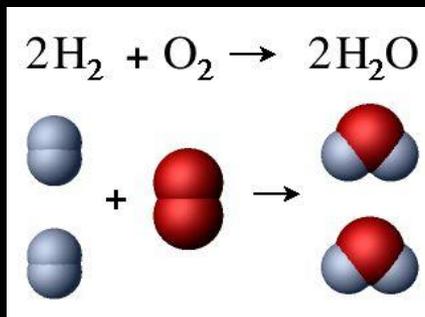


Molecules Are Too Small To See

We must “deduce” number of molecules involved in reactions



Reactions occur at the particulate level:



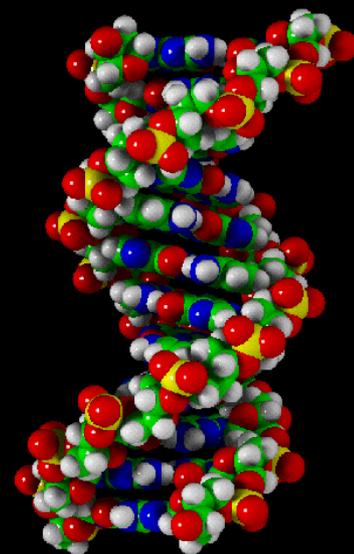
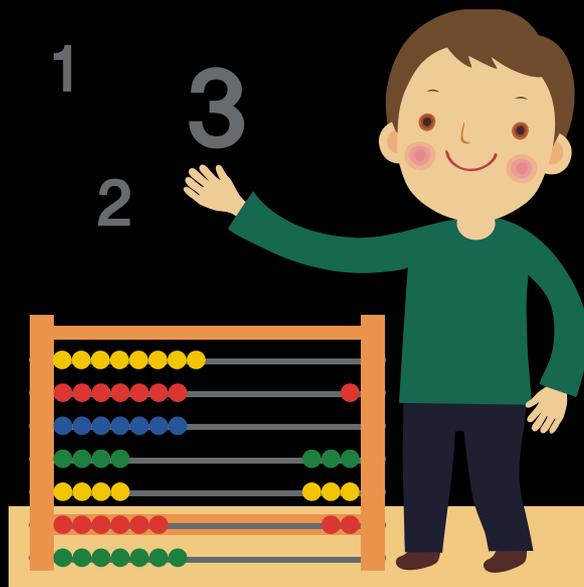
Molecules “collide” to form new products
(Collision Theory)



Need way to determine number of reacting atoms



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



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



Each Element Has A Different Atomic Mass

Periodic Table

1	1/IA																18/VIIIA															
1	1 H 1.008																	2 He 4.003														
2	2/IIA																		13/IIIA		14/IVA		15/VA		16/VIA		17/VIIA					
2	3 Li 6.941	4 Be 9.012																	5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18								
3	3/IIIB		4/IVB		5/VB		6/VIB		7/VIIB		VIII		11/IB		12/IIB		13/IIIA		14/IVA		15/VA		16/VIA		17/VIIA							
3	11 Na 22.99	12 Mg 24.30	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														
4	19 K 39.10	20 Ca 40.08	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														
5	37 Rb 85.47	38 Sr 87.62	72 La-Lu 178.5	73 Hf 180.9	74 Ta 183.8	75 W 186.2	76 Re 190.2	77 Os 192.2	78 Ir 195.1	79 Pt 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po 210.0	85 At 210.0	86 Rn 222.0															
6	55 Cs 132.9	56 Ba 137.3	87 Fr 223.0	88 Ra 226.0	104 Ac-Lr	105 Db	106 Jl	107 Rf	108 Bh	109 Hn	110 Mt	111 Uun	112 Uuq	113 Uub	114 Uuq	115 Uup	116 Uuq	117 Uuq	118 Uuo													
7																																

← s → ← d → ← p →

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
89 Ac 227.0	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 249.1	98 Cf 252.1	99 Es 252.1	100 Fm 257.1	101 Md 258.1	102 No 259.1	103 Lr 262.1

← f →



Each Element or Compound Mole Has Different Mass

12.01 g C

1.008 g H

2.016 g H₂

32.00 g O₂

18.02 g H₂O

58.44 g NaCl

159.7 g Fe₂O₃

108.0 g N₂O₅

~68,000 g Hemoglobin

= Avogadro's number of atoms or molecules



The Mole

A Mole always contains same number of particulates (formula units)

But

Since each element /compound has a different mass,

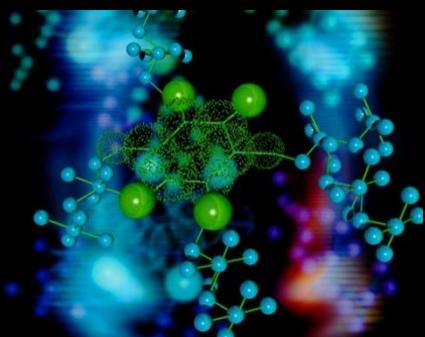
Equal # atoms (a mole) of different elements have a different mass



1																		18																		
1	Metalloids																Metals	He	atomic number																	
1	Alkali Earth Metals																Halogens	4	Element																	
3	Transition Metals																Noble Gases	10	symbol																	
4	Non Metals																Transactinides	20.2	atomic weight																	
11	Alkali Metals																Lanthanides	18																		
12	Actinides																																			
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Mole Map



Atomic Units



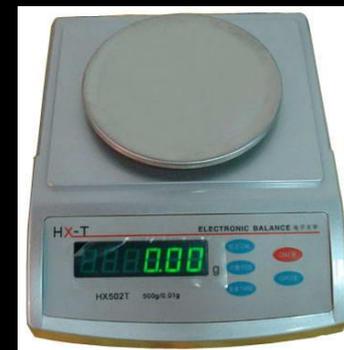
Avagadro's
 6.02×10^{23} fu
mole



Moles



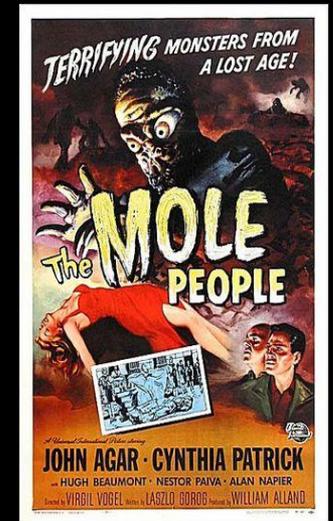
Molar Mass
g / mole



Grams

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

Let's Study the Mole, People





The Mole Lab



Today's Lab



Work In Pairs

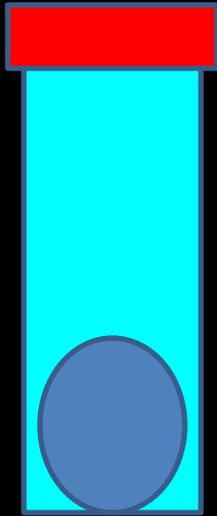
See Video on The Mole

Identify Unknown Elements

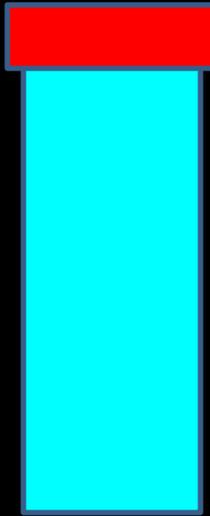
Determine Moles and Formula Units for Ionic Compounds

Determine Moles and Molecules for Molecular Compound

Weighing By Difference



**Container
Plus
Sample
Weight**



**Container
Weight**



**Sample
Weight**

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

Moles and Formula Units



Weigh each vial

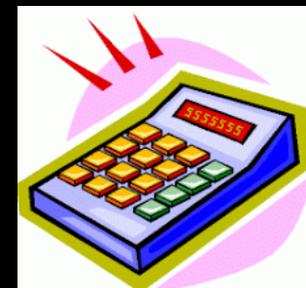
Mass of sample vial – mass written on vial = mass sample

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

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

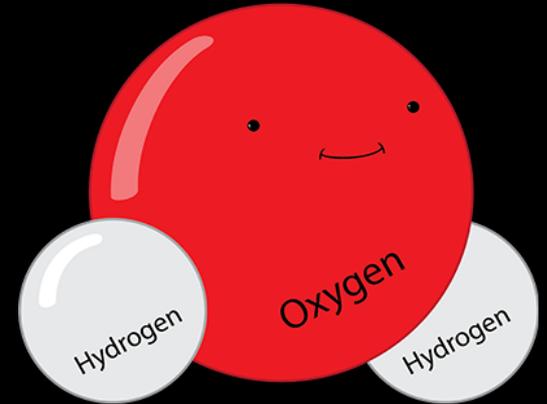
Measure mass

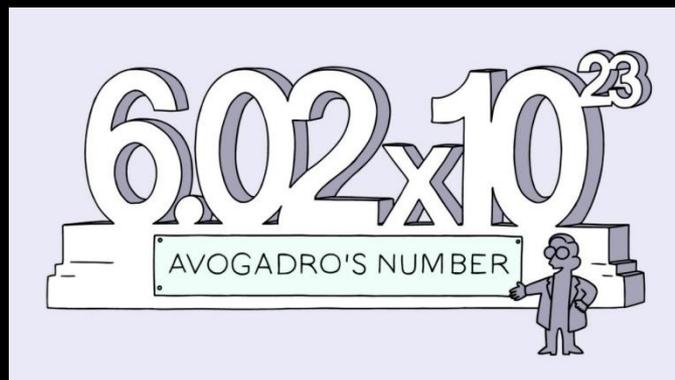
Determine moles of the sample (grams / mole)

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

Identify Number of Formula Units (Molecules)

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





Results

Fill in tables with calculated values

Conclusion

Questions

Proper units and sig figs



Let's Boldly Go Explore Today's Lab



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NAUTILUS MESH: LARRY L. KEATHLEY
RENDER AND POSTWORK: CHRIS S. DISTON 2006

LPT