# SCH3U
# Quantities in Chemical Reactions
## (Chapter 5, MHR)

- Sometimes called "Stoichiometry"

- Or, why "**6.02 x10$^{23}$**" is your new favourite number!

- Or, why "**The Mole**" is your new best friend!

1

6.02 x 10²³

The Mole

# The Mole?

- **Definition: Mole**

- **Noun**

    **1.** The molecular weight of a substance expressed in grams; the basic unit of amount of substance adopted under the System International d'Unites.

    **2.** A spy who works against enemy espionage.

    **3.** (Mexican) spicy sauce often containing chocolate.

    **4.** A small congenital pigmented spot on the skin.

    **5.** A protective structure of stone or concrete; extending into the water to prevent a beach from washing away.

    **6.** Small velvety-furred burrowing mammal having fossorial forefeet
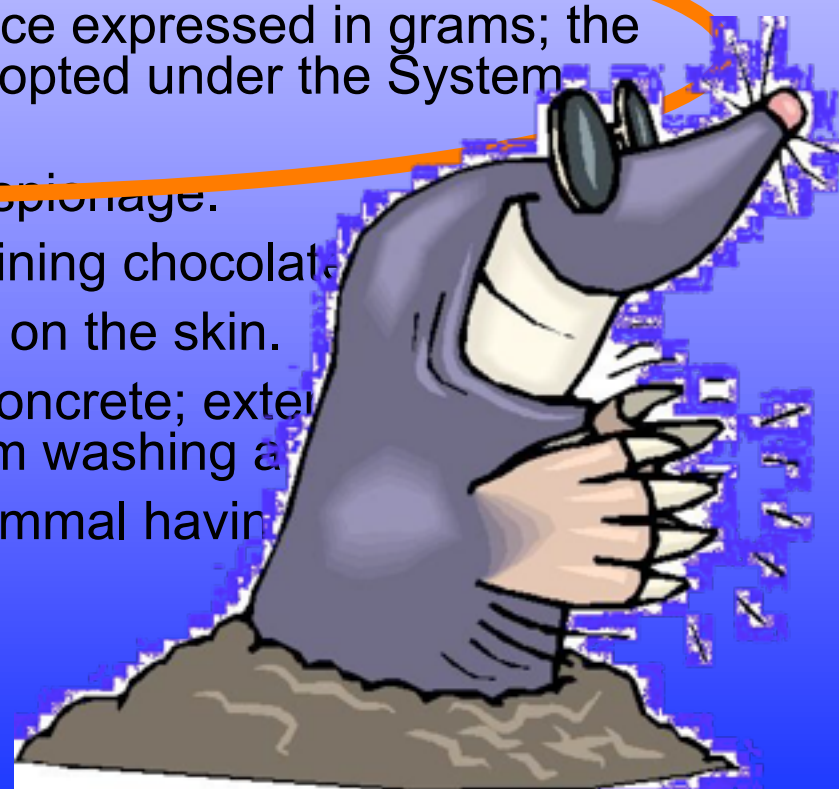
Sunday, January 20, 2013

# Use What You Know!

- How many eggs are in a dozen eggs?
- How many chocolates are in a dozen chocolates?
- How many buses are in a dozen buses?
- How many people are there in a dozen people?

# 12 Twelve!

# What do You Think?

- How much does a dozen weigh?
  - Depends on **what** it is…
- What is the same for every dozen?
  - All have 12 "things"
- What is different for every dozen?
  - They all have different weights

# Avogadro's Number

- Chemists have [given] [a] [nu]mber called **Avogadro's** [...] [i]s like a dozen, but [...] [...] [...] for is **6.02x10²³** [...] and chemists [...] **mole** (not dozen).

- **602 billion** [...] **602,000,00[...]**

# Just How Big is a Mole?

- **Enough soft drink cans to cover the surface of the earth to a depth of over 200 miles.**

- **If you had Avogadro's number of unpopped popcorn kernels, and spread them across the United States of America, the country would be covered in popcorn to a depth of over 9 miles.**

- **If we were able to count atoms at the rate of 10 million per second, it would take about 2 billion years to count the atoms in one mole.**

7

# Learning Check

**Suppose we invented a new collection unit called a rapp. One rapp contains 8 objects.**

**1. How many paper clips in 1 rapp?**

a) 1          b) 4          c) 8

**2. How many oranges in 2.0 rapp?**

a) 4          b) 8          c) 16

**3. How many rapps contain 40 gummy bears?**

a) 5          b) 10          c) 20

# The Mole

- **1 dozen cookies = 12 cookies**
- **1 mole of cookies = 6.02 X $10^{23}$ cookies**

- **1 dozen cars = 12 cars**
- **1 mole of cars = 6.02 X $10^{23}$ cars**

- **1 dozen Al atoms = 12 Al atoms**
- **1 mole of Al atoms = 6.02 X $10^{23}$ atoms**

**Note that the NUMBER is always the same, but the MASS is very different!**

**Mole is abbreviated mol (gee, that's a lot quicker to write, huh?)**

# A Mole of Particles
## Contains 6.02 x 10$^{23}$ particles

1 mole C = 6.02 x 10$^{23}$ C atoms

1 mole H$_2$O = 6.02 x 10$^{23}$ H$_2$O molecules

1 mole NaCl = 6.02 x 10$^{23}$ NaCl "molecules"

(technically, ionics are compounds not molecules so they are called formula units)

6.02 x 10$^{23}$ Na$^+$ ions and

6.02 x 10$^{23}$ Cl$^-$ ions

# Learning Check

## 1. Number of atoms in 0.500 mole of Al
   a)   500 Al atoms
   b)   $6.02 \times 10^{23}$ Al atoms
   c)   $3.01 \times 10^{23}$ Al atoms

## 2. Number of moles of S in $1.8 \times 10^{24}$ S atoms
   a)   1.0 mole S atoms
   b)   3.0 mole S atoms
   c)   $1.1 \times 10^{48}$ mole S atoms

$$N = n \times N_A$$

Number of
Particles/
Atoms/
Molecules

Number of Mole

Avogadro's
number,
$6.02 \times 10^{23}$

12

# Try it!
## p. 230, MHR

$$N = n \times N_A$$

## Practice Problems

11. A Canadian penny contains 0.106 mol of copper. How many atoms of copper are in a Canadian penny?

12. The head of a small pin contains about $8 \times 10^{-3}$ mol of iron. How many iron atoms are in the head of the pin?

13. How many molecules of oxygen gas are in a room that contains $8.5 \times 10^3$ mol of oxygen gas?

14. If a marble countertop contains 849 mol of calcium carbonate, $CaCO_3(s)$, how many formula units of calcium carbonate are in the countertop?

15. A recipe calls for half a teaspoon of salt, which contains $5.23 \times 10^{-2}$ mol of sodium chloride. How many formula units of sodium chloride are needed?

16. A window-cleaning solution contains 3.86 mol of acetic acid, $CH_3COOH(\ell)$. How many molecules of acetic acid are in the solution?

17. A fuel tank used in a barbecue contains $2.0 \times 10^2$ mol of propane, $C_3H_8(g)$. What is the total number of atoms in the tank?

18. Freon™, $CCl_2F_2(g)$, is a refrigerant that is no longer used in car air conditioners because it damages the ozone layer. A sample contains 4.82 mol of Freon™.
    a. How many molecules of Freon™ are in the sample?
    b. How many atoms, in total, are in the sample?

19. Glauber's salt is a common name for sodium sulfate decahydrate, $Na_2SO_4 \cdot 10H_2O(s)$. It is used in the manufacture of detergents. Suppose that a sample of 36.2 mol of sodium sulfate decahydrate is required.
    a. What number of sodium atoms would be in the sample?
    b. What number of water molecules would be in the sample?

20. A sample of sucrose, $C_{12}H_{22}O_{11}(s)$, contains 0.16 mol of oxygen, atoms (O).
    a. What amount in moles of sucrose is in the sample?
    b. How many atoms of carbon are in the sample?

# Try it!
# p. 231, MHR

$$n = N / N_A$$

## Practice Problems

21. A gold coin contains $9.51 \times 10^{22}$ atoms of gold. What amount in moles of gold is in the coin?

22. A patient in a dentist's office is given $1.67 \times 10^{23}$ molecules of dinitrogen monoxide (laughing gas), $N_2O(g)$, during a procedure. What amount in moles of dinitrogen monoxide is the patient given?

23. A sheet of drywall contains $1.2 \times 10^{26}$ formula units of gypsum (calcium sulfate dihydrate), $CaSO_4 \cdot 2H_2O(s)$. What amount in moles of gypsum is in the sheet of drywall?

24. Limewater, a weak solution of calcium hydroxide, $Ca(OH)_2(s)$, is used to detect the presence of carbon dioxide gas. Suppose that you are given a solution that contains $8.7 \times 10^{19}$ formula units of calcium hydroxide. What amount in moles of calcium hydroxide is in the solution?

25. If there are a total of $7.3 \times 10^{29}$ atoms in a sample of glucose, $C_6H_{12}O_6 (s)$, what amount in moles of glucose is in the sample?

26. A sample of aluminum oxide, $Al_2O_3(s)$, contains $8.29 \times 10^{25}$ total atoms. Calculate the amount in moles of aluminum oxide in the sample. **Hint:** This is a two-step problem. Calculate the number of formula units first.

27. Trinitrotoluene, or TNT for short, has the chemical formula $C_7H_5N_3O_6(s)$. If a stick of dynamite is pure TNT and it contains $2.5 \times 10^{25}$ atoms in total, what amount in moles of TNT does it contain?

28. A sample of rubbing alcohol solution contains ethanol, $C_2H_5OH(\ell)$. If the sample contains $1.25 \times 10^{23}$ atoms of hydrogen in the ethanol, what amount in moles of ethanol is in the sample?

29. A cleaning solution contains $7.9 \times 10^{26}$ molecules of ammonia, $NH_3(aq)$. What amount in moles of ammonia is in the solution?

30. A muffin recipe calls for cream of tartar, or potassium hydrogen tartrate, $KHC_4H_4O_6(s)$. The amount of cream of tartar that is required contains $2.56 \times 10^{23}$ atoms of carbon. What amount in moles of potassium hydrogen tartrate is required?