Experiment #4

Due Today

Experiment #4
Exercise B

Double Displacement Reactions

1

1

Stuff you should know

Quantitative

- Always has numbers
- Technique is paramount
- Provide precise data

Qualitative

- Typically "Yes" or "No" answers
- Typically does not require in d

Homer's shirt has four buttons

Homer's buttons are white

2

2

Today's Experiment

Due Today

Experiment #4
Exercise B

- Qualitative
- Goggles
- Waste in fume hood

3

3

3

Chemical Reactions

- Temperature Change
  - It gets HOT – in extremes light is produced
  - It gets COLD
- Phase Change / New Substance Visible
  - Gas is evolved
  - Solid is produced

4

4

4

Law of Conservation of Mass

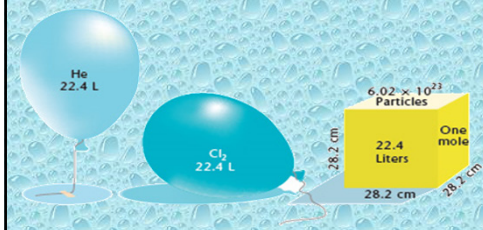
The **Law of Conservation of Mass** indicates that in an ordinary chemical reaction,

- Matter can neither be created nor destroyed and that
- The total mass of products is equal to the total mass of reactants.

5

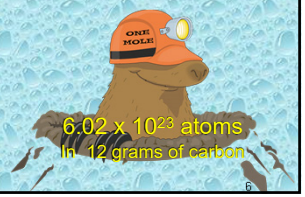
5

THE MOLE



Born: 9 August 1776
Died: 9 July 1856 (aged 79)
Nationality: Italian
Field: Physics

AMEDO AVOGADRO



6

6

Why use Avogrado's Number?

Really Small

Mass of one atom of carbon:

0.000,000,000,000,000,000,000,0199 grams

or 1.99×10^{-23} grams

Mass of one mole of carbon:

12.01 grams

7

7

7

How Big is Avogrado's Number?

- Avogadro's number is the approximate number of milliliters of water in the Pacific Ocean
- One mole of marshmallows would cover the USA to a depth of 6500 miles
- If an Avogadro number of pennies were distributed evenly among each man, woman, and child. They would have enough money to spend a million dollars every hour-day and night-and still have over half of it unspent at death
- It would take over 19 million years to spend Avogadro's number of dollars if the money were spent at the rate of one billion dollars per second.

8

8

8

- Reactants
  - The stuff on the left
  - Order is not important
  - Mass is always conserved
- Products
  - The stuff on the right
  - Order is not important
  - Mass is always conserved
- Arrows
  - Always to the right
  - Sometimes to the left also
  - May have stuff on top

$$A + B \xrightarrow{?} C + D$$

9

9

The Chemical Equation

$$2H_{2(g)} + O_{2(g)} \xrightarrow{\Delta} 2H_2O_{(g)}$$

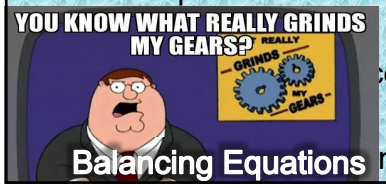
- States of Matter
  - (s) for Solids
  - (l) for Liquids
  - (g) for Gasses
  - (aq) for Items dissolved in Water

10

10

Rules for Balancing Equations

- Leave the lone elements to the last — Fe, Cl_2, Ag etc…
- Typically leave H and O to the last — H_2, O_2
- Keep track of the elements balanced — $MgBr_2$
- …ce, start with new element — ~~$\frac{1}{8}FeCl_2$~~ $8*\frac{1}{8}FeCl_2$ $FeCl_2$



…ns

11

11

Balancing with Polyatomic Atoms

- When possible, use polyatomics!!!

$$Na_3PO_{4(aq)} + MgCl_{2(aq)} \rightarrow$$

$$NaCl_{(aq)} + Mg_3(PO_4)_{2(s)}$$

Nonmetal	Formula of Ion	Name of Ion
Hydrogen	OH^-	Hydroxide
Nitrogen	NH_4^+	Ammonium
	$\mathbf{NO_3^-}$	**Nitrate**
	NO_2^-	Nitrite
Chlorine	ClO_4^-	Perchlorate
	$\mathbf{ClO_3^-}$	**Chlorate**
	ClO_2^-	Chlorite
	ClO^-	Hypochlorite
Carbon	$\mathbf{CO_3^{2-}}$	**Carbonate**
	HCO_3^-	Hydrogen carbonate (or bicarbonate)
	CN^-	Cyanide
	$H_3C_2O_2^-$	Acetate
Sulfur	$\mathbf{SO_4^{2-}}$	**Sulfate**
	HSO_4^-	Hydrogen sulfate (or bisulfate)
	SO_3^{2-}	Sulfite
	HSO_3^-	Hydrogen sulfite (or bisulfite)
Phosphorus	$\mathbf{PO_4^{3-}}$	**Phosphate**
	HPO_4^{2-}	Hydrogen phosphate
	$H_2PO_4^-$	Dihydrogen phosphate
	PO_3^{3-}	Phosphite

12

12

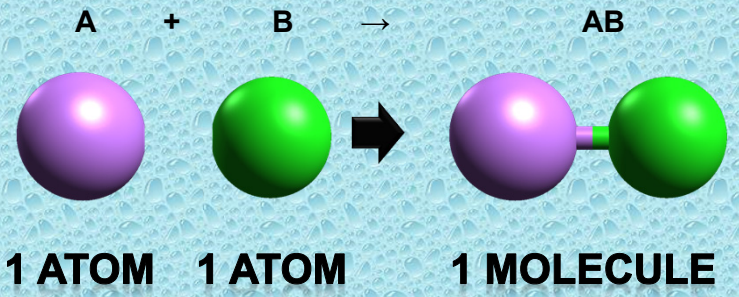
Types of Reactions

- combination reactions
  - $A + B \rightarrow AB$
- decomposition reactions
  - $AB \rightarrow A + B$
- single replacement reactions
  - $AB + C \rightarrow AC + B$
- double replacement reactions
  - $AB + CD \rightarrow AD + CB$
- combustion reactions
  - $C_xH_x + O_2 \rightarrow CO_2 + H_2O + heat$

13

13

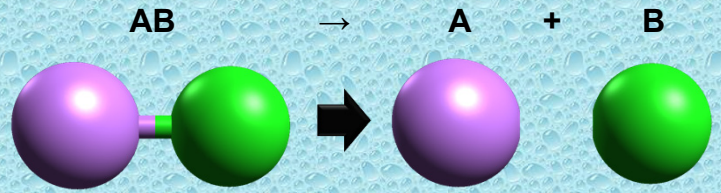
- combination reactions



14

14

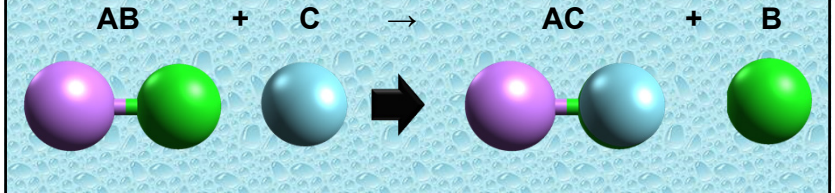
- decomposition reactions



15

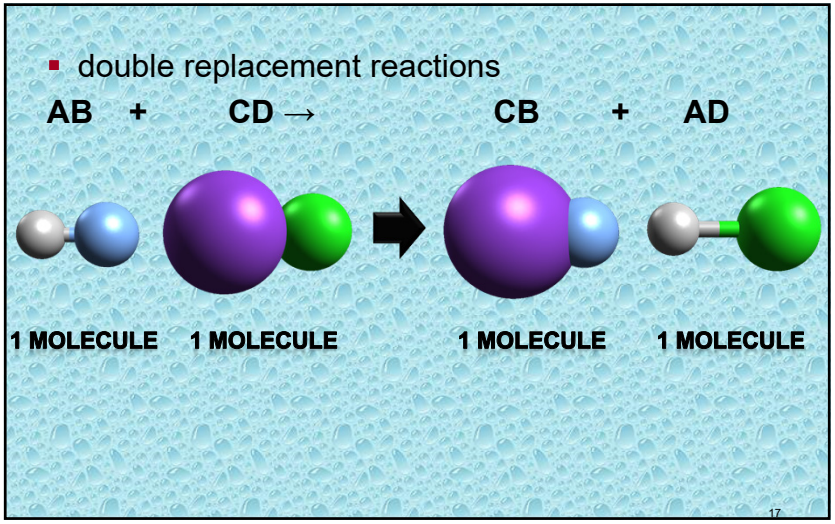
15

- single replacement reactions

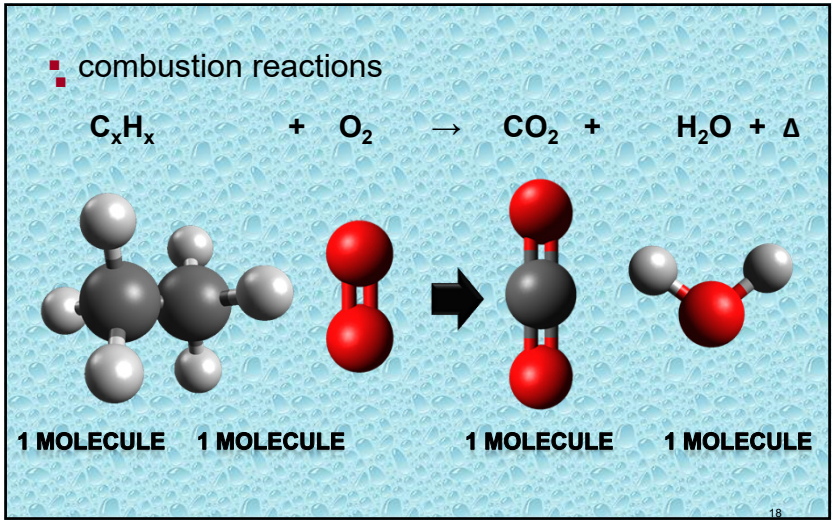


16

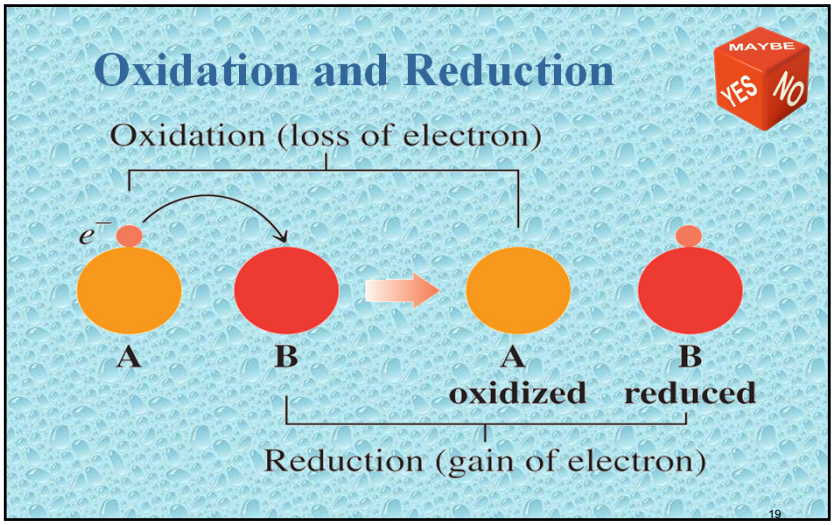
16


double replacement reactions
AB + CD → CB + AD
1 MOLECULE
1 MOLECULE
1 MOLECULE
1 MOLECULE
17

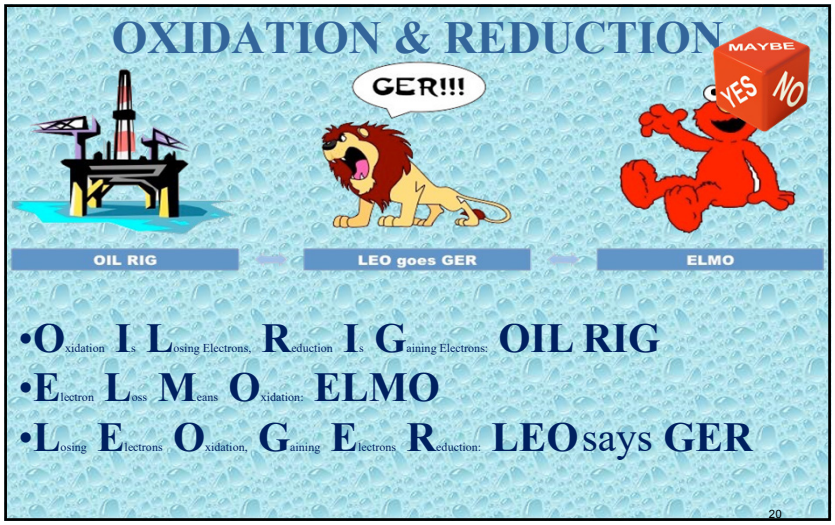
17


combustion reactions
C_xH_x + O_2 → CO_2 + H_2O + Δ
1 MOLECULE
1 MOLECULE
1 MOLECULE
1 MOLECULE
18

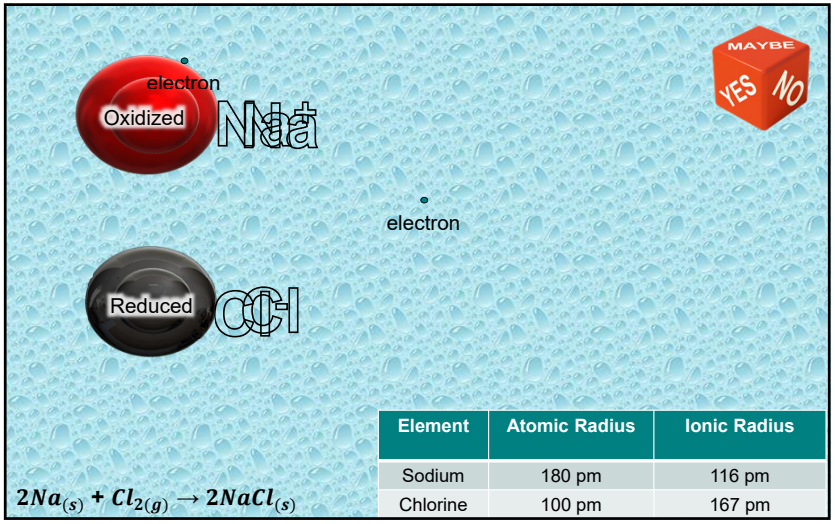
18


Oxidation and Reduction
MAYBE
YES
NO
Oxidation (loss of electron)
e^-
A
B
A
oxidized
B
reduced
Reduction (gain of electron)
19

19

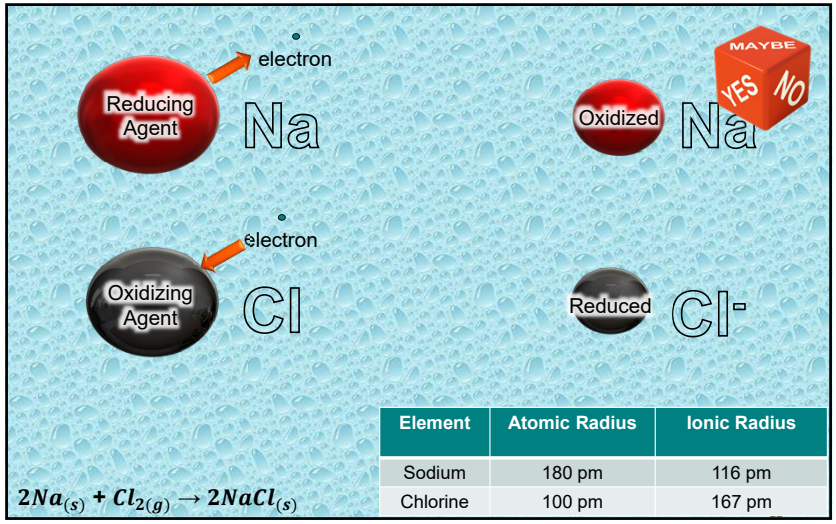

OXIDATION & REDUCTION
MAYBE
YES
NO
GER!!!
OIL RIG
LEO goes GER
ELMO
•Oxidation Is Losing Electrons, Reduction Is Gaining Electrons: OIL RIG
•Electron Loss Means Oxidation: ELMO
•Losing Electrons Oxidation, Gaining Electrons Reduction: LEO says GER
20

20



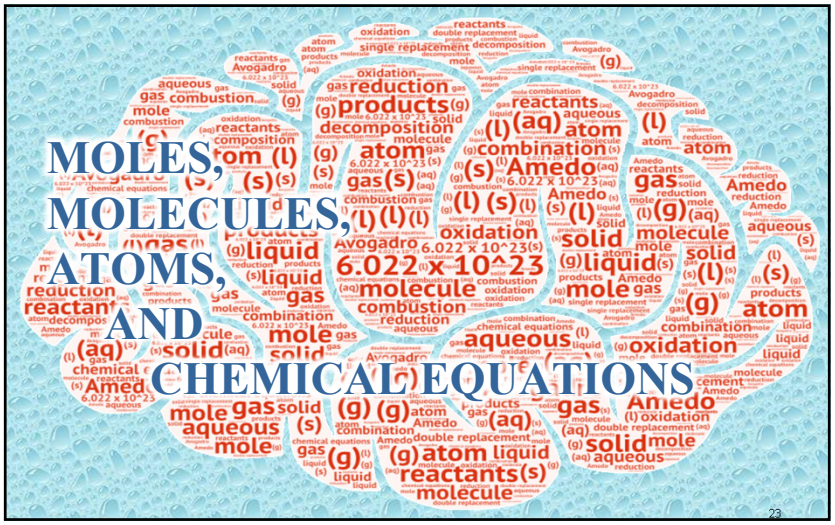
Element	Atomic Radius	Ionic Radius
Sodium	180 pm	116 pm
Chlorine	100 pm	167 pm

21

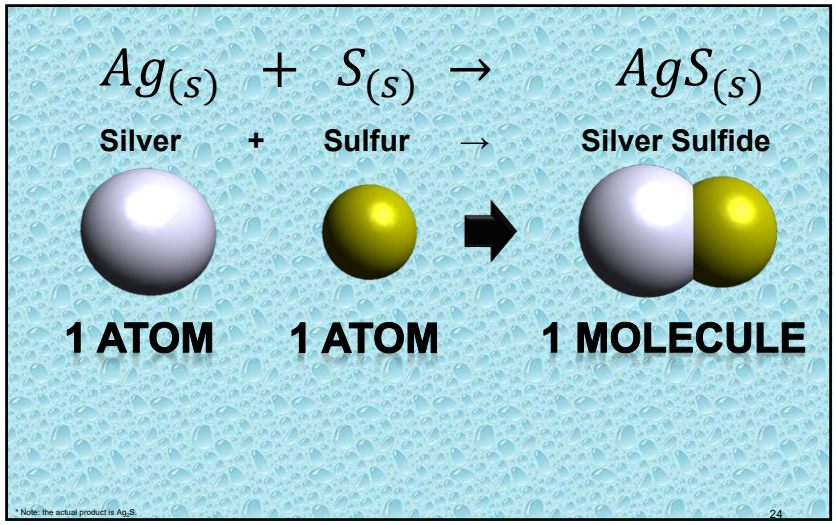


Element	Atomic Radius	Ionic Radius
Sodium	180 pm	116 pm
Chlorine	100 pm	167 pm

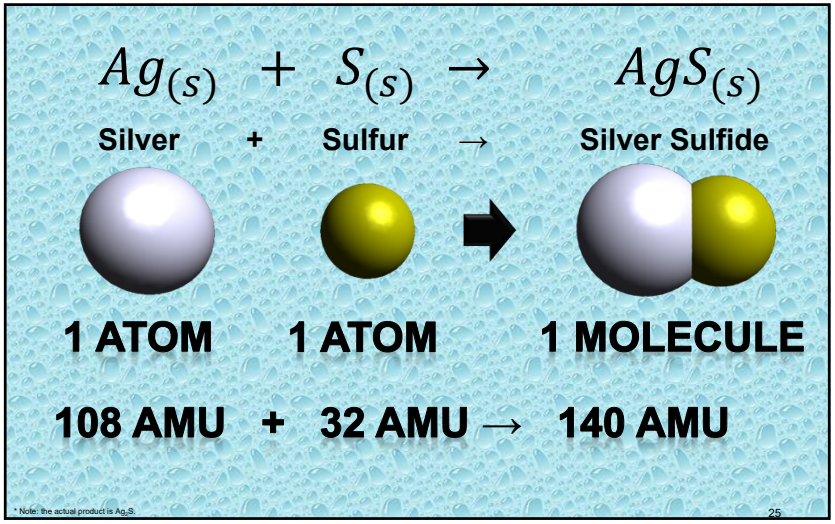
22



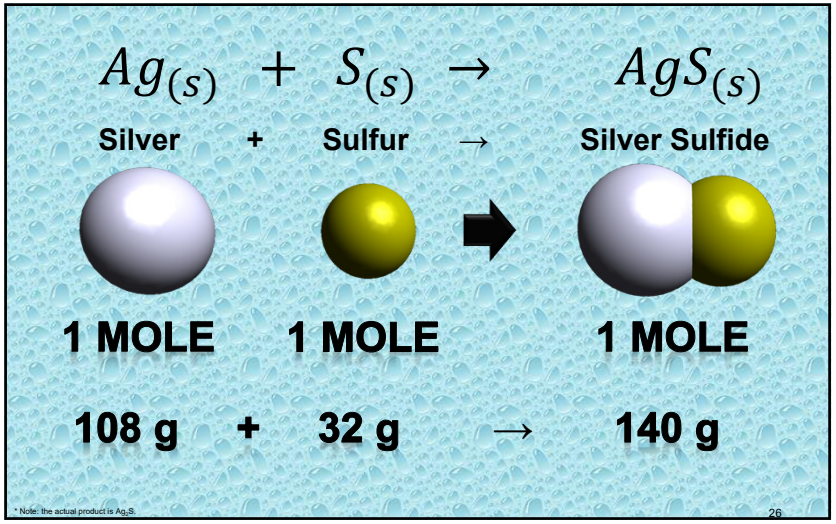
23



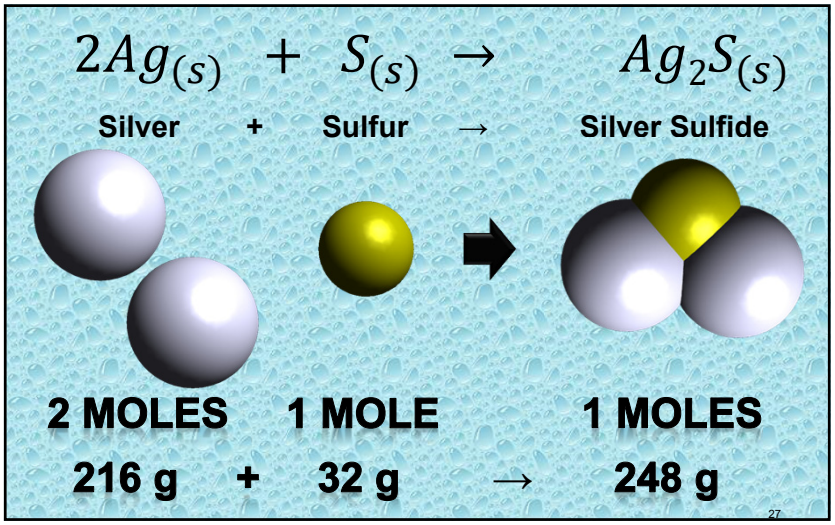
24



25



26



27

Information from a Balanced Equation

	Reactants		Product
Equation	$2Ag(s)$	$+ S(s)$	$\longrightarrow Ag_2S(s)$
Atoms	2 Ag atoms	+ 1 S atom	$\longrightarrow Ag_2S$ formula unit
Moles	2 moles of Ag	+ 1 mole of S	$\longrightarrow$ 1 mole of Ag_2S

28

28

Theoretical, Actual, and Percent Yield

- **Theoretical yield** is the maximum amount of product, which is calculated using the balanced equation.
- **Actual yield** is the amount of product obtained when the reaction takes place.
- **Percent yield** is the ratio of actual yield to theoretical yield.

$$\textbf{Percent yield} = \frac{\textbf{actual yield (g)}}{\textbf{theoritical yield (g)}} \textbf{ x 100\%}$$

29

29

Limiting Reactant

A **limiting reactant** in a chemical reaction is the substance that is used up first and limits the amount of product that can form. The other reactant, called the **excess reactant**, is left over.

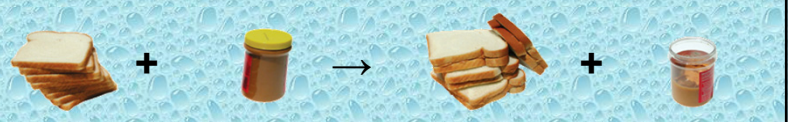
30

30

Example: Limiting Reactant

How many peanut butter sandwiches could be made from 8 slices of bread and 1 jar of peanut butter?

With 8 slices of bread, only 4 sandwiches could be made. The bread is the limiting item.



8 slices of bread + 1 jar of peanut butter make 4 peanut butter sandwiches + peanut butter left over

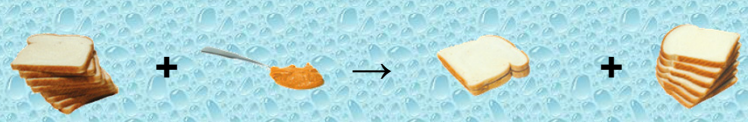
31

31

Example: Limiting Reactant

How many peanut butter sandwiches could be made from 8 slices of bread and 1 tablespoon of peanut butter?

With 1 tablespoon of peanut butter, only 1 sandwich could be made. The peanut butter is the limiting item.



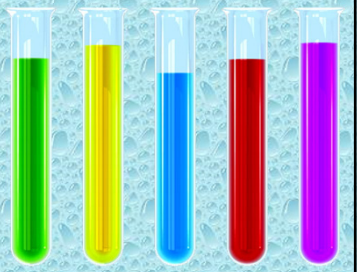
8 slices of bread + 1 tablespoon of peanut butter make 1 peanut butter sandwich + 6 slices of bread left over

32

32

Don't Forget

- **No Contamination**
  - Reagent containers
  - Between samples
- **Goggles**
  - Yes!
  - Always!
- **Reactions are in test tubes**
  - They do not need to be dry
  - Waste goes in the waste containers and not the sink or trash



33