

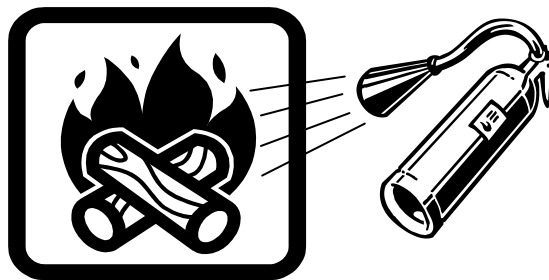
Unit 7: Chemical Equations

Evidence of a chemical reaction:

heat, light, sound, gas emitted, color change, odor

A reaction has occurred if the chemical and physical properties of the reactants and products differ.

For a reaction to occur, particles of reactants must collide, and with sufficient energy → collision theory



activation energy: energy needed to start a reaction

Chemical reactions release or absorb energy.

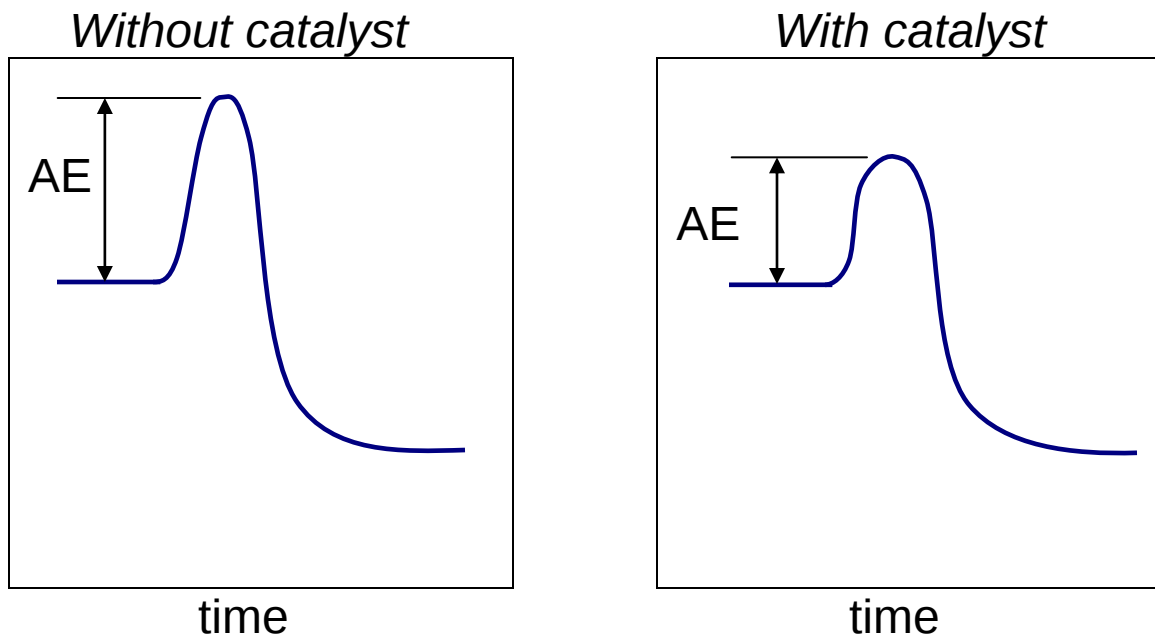
↙
exothermic reactions

(feel “hot”)

↘
endothermic reactions

(feel “cold”)

catalyst: speeds up reaction ^{w/o}/being consumed
...it lowers the activation energy (AE)



Examples:

enzymes catalyze biochemical reactions

catalytic converters convert CO into CO₂

Reaction Conditions and Terminology

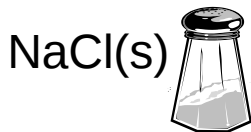
Certain symbols give more info about a reaction.

(s) = solid

(l) = liquid

(g) = gas

(aq) = aqueous (dissolved in H₂O)



NaCl(aq)

More on aqueous...

- “soluble” or “in solution” also indicate that a substance is dissolved in water (usually)
- acids are aqueous solutions

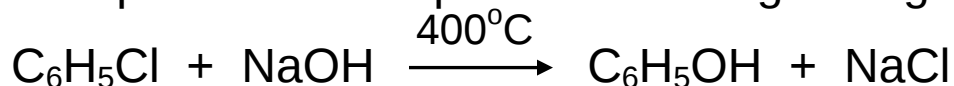
Other symbols...

—————> means “yields” or “produces”

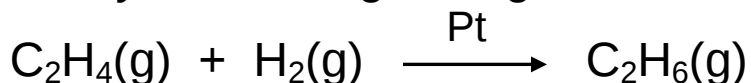
Δ means heat is added to the reaction



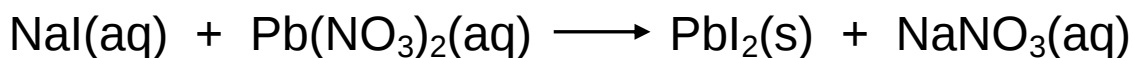
Temp. at which we perform rxn. might be given.



The catalyst used might be given.



precipitate: a solid product that forms in an aqueous solution reaction



Factors that influence the rate of a reaction	To make reaction rate increase...
concentration of reactants	↑
particle size	↓
temperature	↑
mechanical mixing	↑
pressure	↑
catalyst	use one
nature of reactants	N/A

In a reaction: atoms are rearranged

 AND mass } are conserved

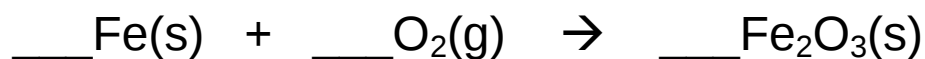
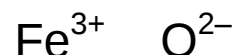
 charge }

 energy }

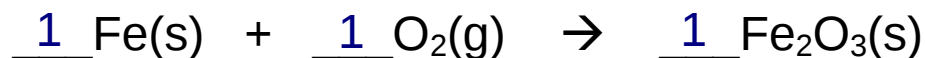
Balancing Chemical Equations

law of conservation of mass	=	same # of atoms of each type on each side of equation
--------------------------------	---	--

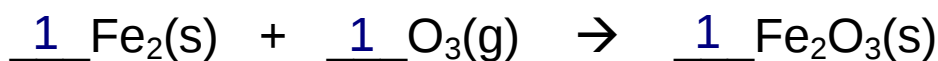
solid iron reacts with oxygen gas to yield solid iron (III) oxide



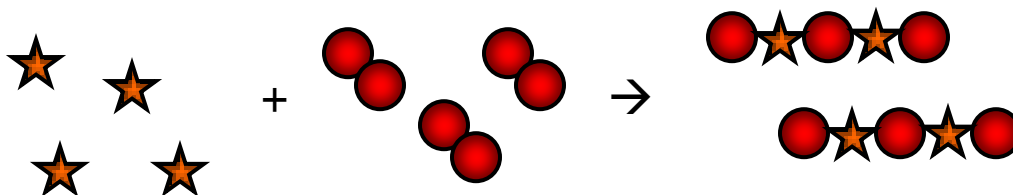
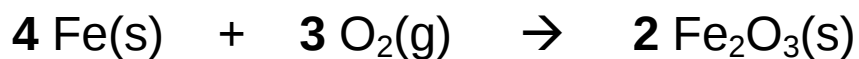
If all coefficients are 1...



If we change subscripts...

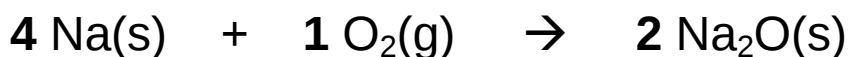
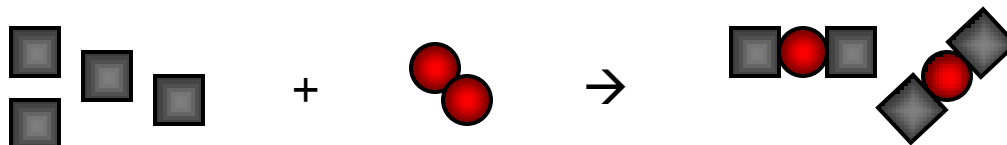
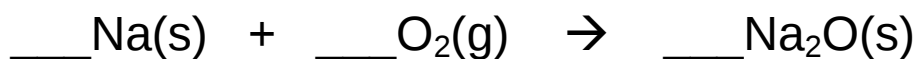
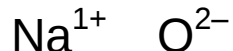


Changing a subscript changes the substance. To balance, only modify coefficients. Right now, superscripts don't enter into our "balancing" picture.



Hint: Start with most complicated substances first and leave simplest substances for last.

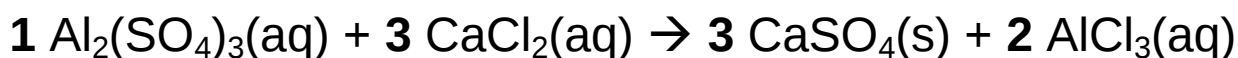
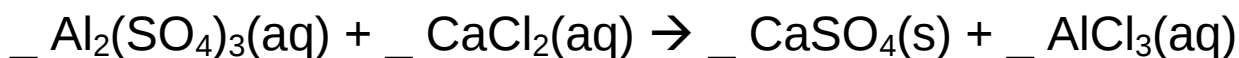
solid sodium reacts ^w/oxygen to form solid sodium oxide



Aqueous aluminum sulfate reacts ^w/aqueous calcium chloride to form a white precipitate of calcium sulfate. The other compound remains in solution.

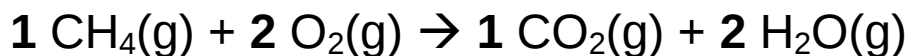
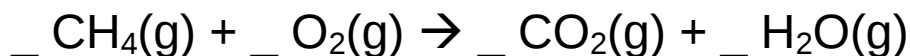


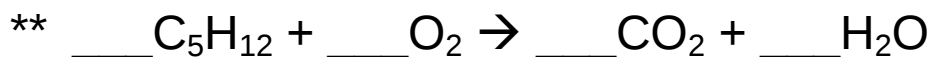
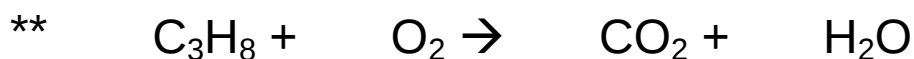
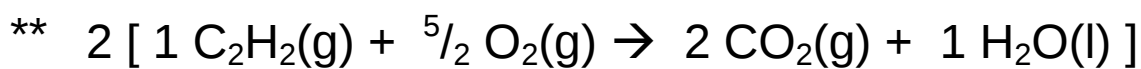
aluminum sulfate + calcium chloride $\longrightarrow$ calcium sulfate + aluminum chloride



Methane gas (CH₄) reacts with oxygen to form carbon dioxide gas and water vapor.

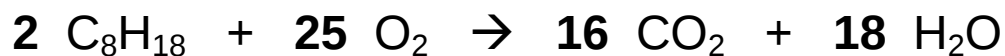
methane + oxygen $\longrightarrow$ carbon dioxide + water





**** complete combustion of a hydrocarbon
yields CO₂ and H₂O**

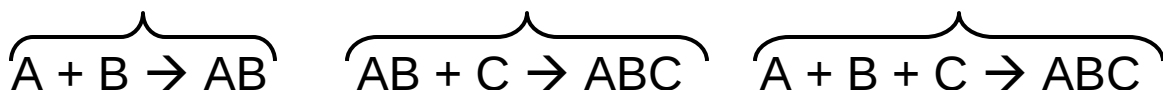
Write equations for combustion of C₇H₁₆ and C₈H₁₈.



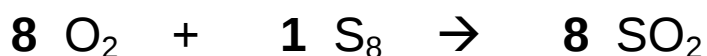
Classifying Reactions

→ four types

synthesis: simpler substances combine to form more complex substances



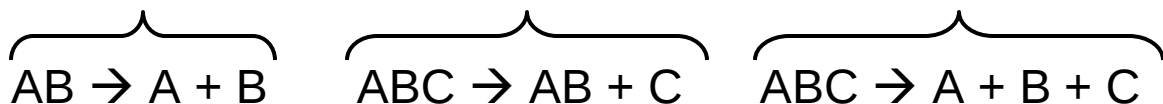
oxygen + rhombic sulfur → sulfur dioxide



sodium + chlorine gas → sodium chloride



decomposition: complex substances are broken down into simpler ones



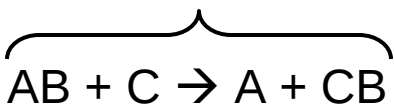
lithium chlorate → lithium chloride + oxygen



water → hydrogen gas + oxygen gas



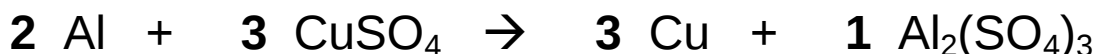
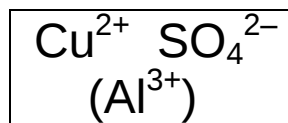
single-replacement: one element replaces another



chlorine + sodium → sodium + bromine
bromide chloride



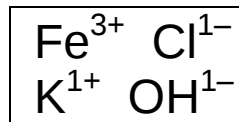
aluminum + copper (II) → ?
sulfate



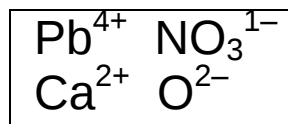
double-replacement:



iron (III) + potassium → ?
chloride hydroxide



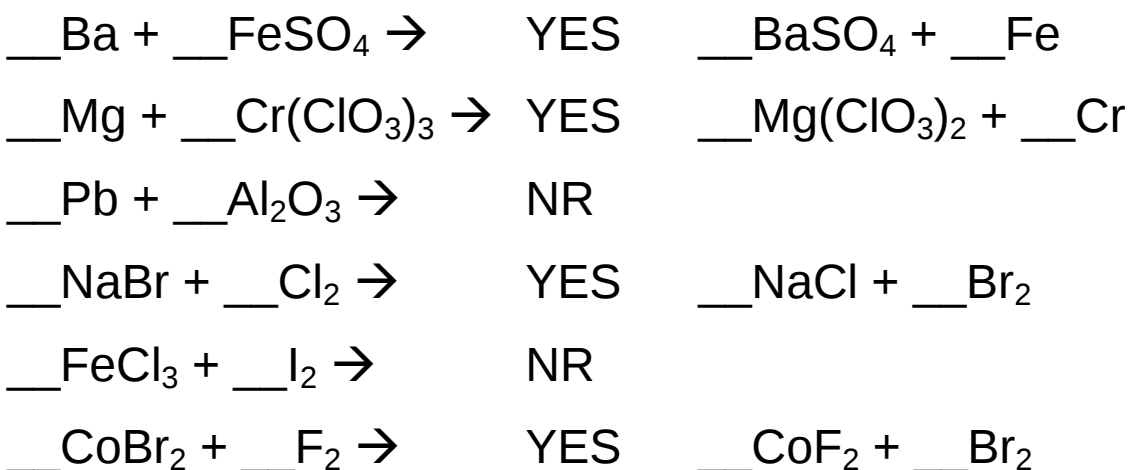
lead (IV) + calcium → ?
nitrate oxide



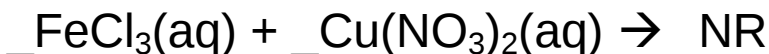
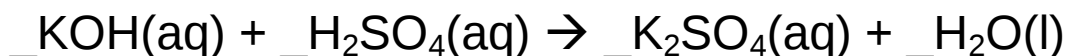
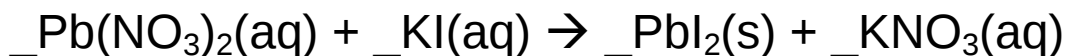
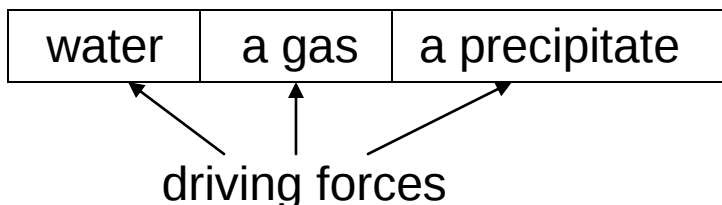
How do we know if a reaction will occur?

For single-replacement reactions, use Activity Series.

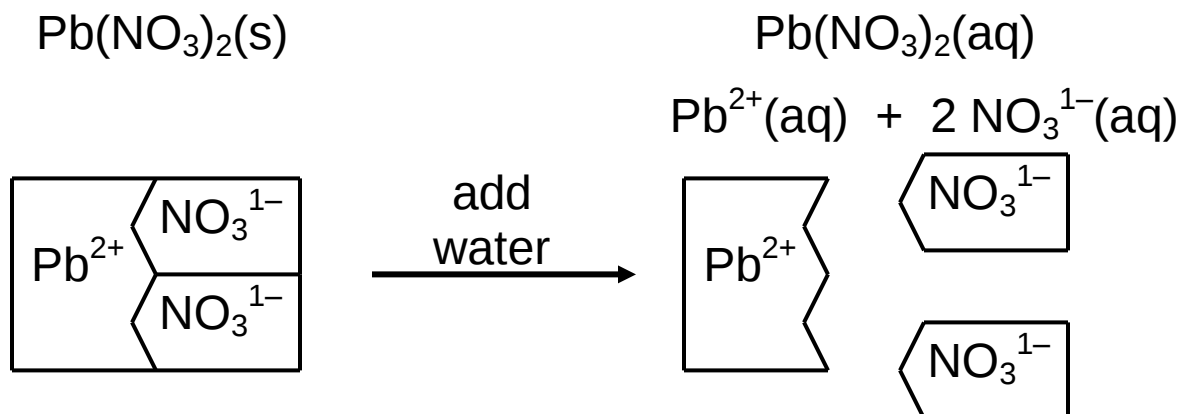
In general, elements above replace elements below.



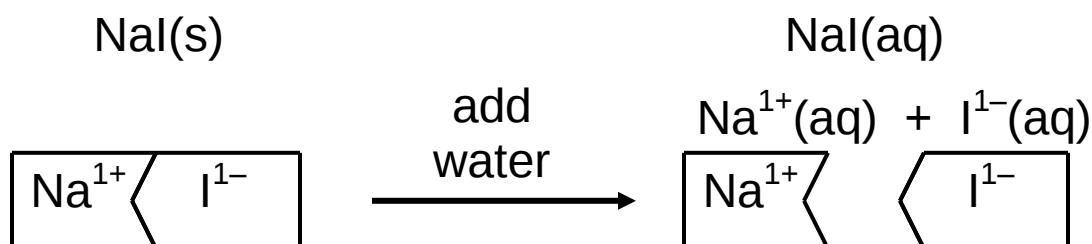
For double-replacement reactions, reaction will occur if any product is:



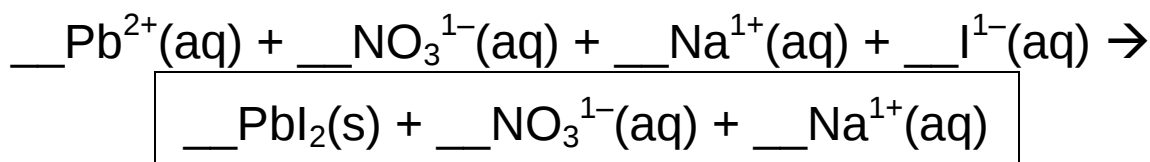
Ions in Aqueous Solution



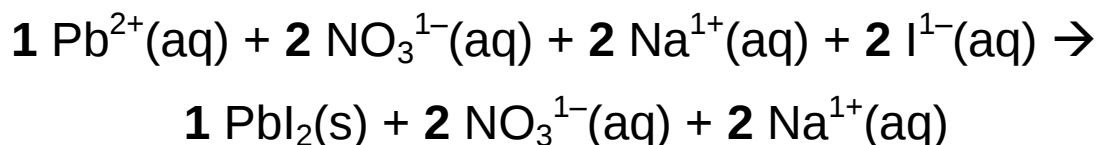
dissociation: “splitting into ions”



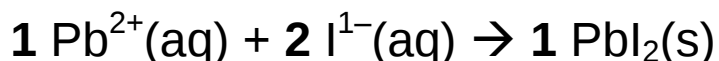
Mix them and get the boxed products...



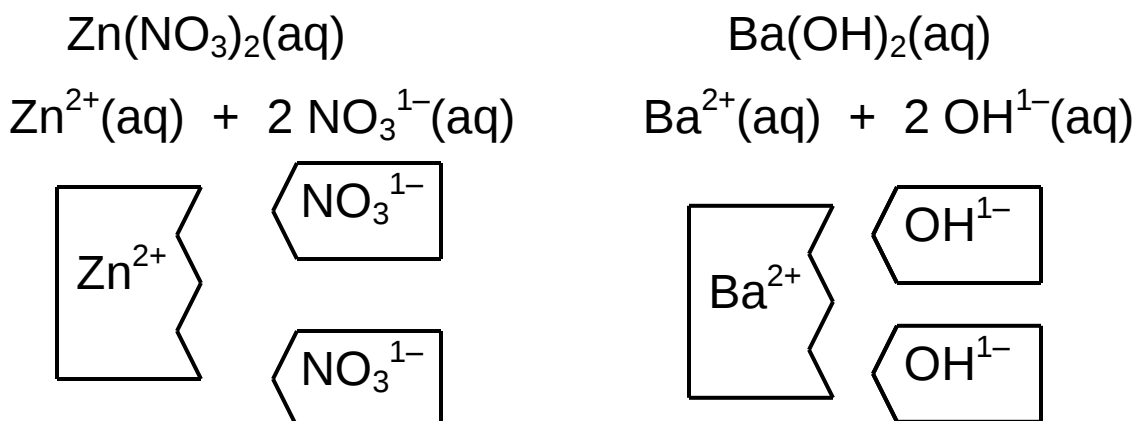
Balance to get overall ionic equation...



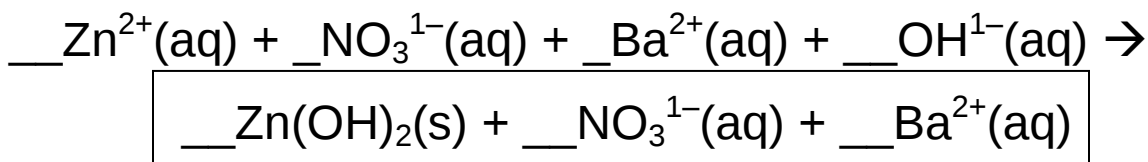
Cancel spectator ions to get net ionic equation...



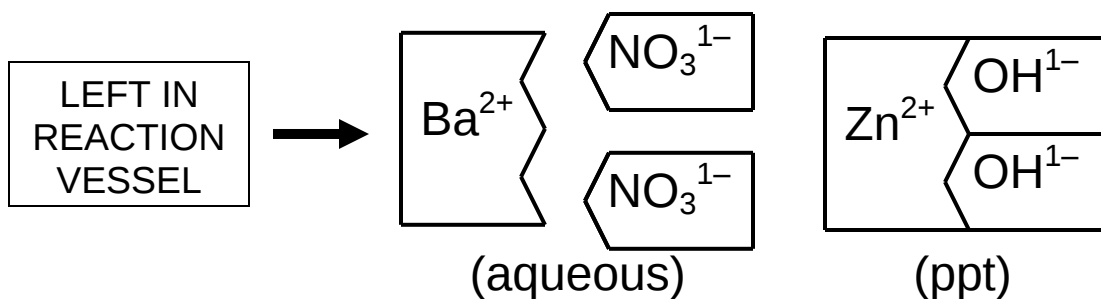
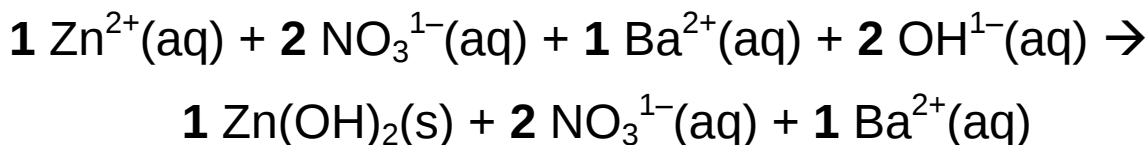
Mix together $\text{Zn}(\text{NO}_3)_2(\text{aq})$ and $\text{Ba}(\text{OH})_2(\text{aq})$:



Mix them and get the boxed products...

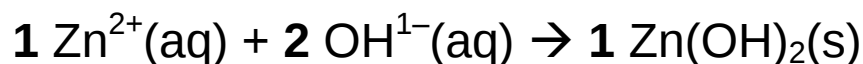


Balance to get overall ionic equation...



SPECTATOR IONS

Cancel spectator ions to get net ionic equation...



Polymers and Monomers

polymer: a large molecule (often a chain) made of many smaller molecules called monomers

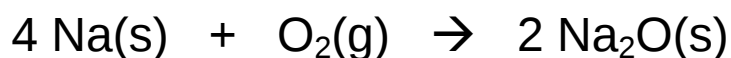
Polymers can be made more rigid if the chains are linked together by way of a cross-linking agent.

Monomer

Polymer

amino acids.....	protein
nucleotides (^w /N-bases A,G,C,T/U)....	nucleic acids
styrene.....	polystyrene
PVA.....	“slime”

Quantitative Relationships in Chemical Equations

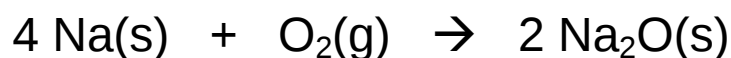


Particles	4 atoms	1 m'cule	2 m'cules
Moles	4 mol	1 mol	2 mol
Grams	4 g	1 g	2 g



****Coefficients of a balanced equation represent # of particles OR # of moles, but NOT # of grams.**

When going from moles of one substance to moles of another, use coefficients from balanced equation.



How many moles oxygen will react with 16.8 moles sodium?

$$X \text{ mol O}_2 = 16.8 \text{ mol Na} \left(\frac{1 \text{ mol O}_2}{4 \text{ mol Na}} \right) = \boxed{4.2 \text{ mol O}_2}$$

How many moles sodium oxide are produced from 87.2 moles sodium?

$$X \text{ mol Na}_2\text{O} = 87.2 \text{ mol Na} \left(\frac{2 \text{ mol Na}_2\text{O}}{4 \text{ mol Na}} \right) = \boxed{43.6 \text{ mol Na}_2\text{O}}$$

How many moles sodium are required to produce 0.736 moles sodium oxide?

$$X \text{ mol Na} = 0.736 \text{ mol Na}_2\text{O} \left(\frac{4 \text{ mol Na}}{2 \text{ mol Na}_2\text{O}} \right) = \boxed{1.47 \text{ mol Na}}$$