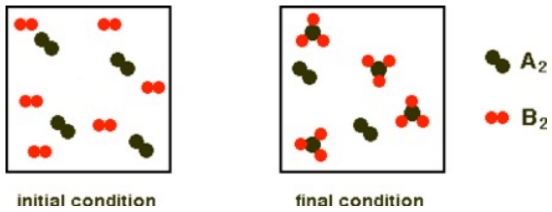
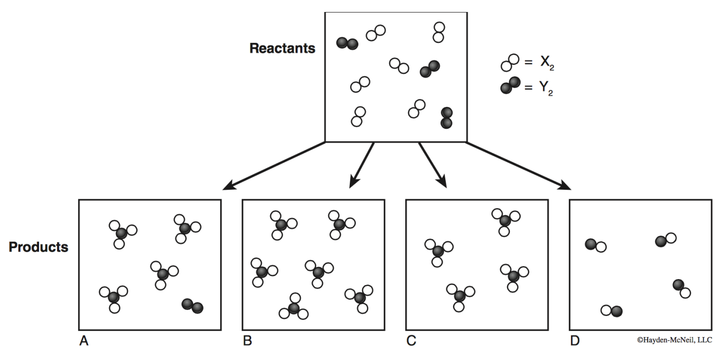
STOICHIOMETRY ACROSS THE CURRICULUM

Scenario 1:
Write the balanced chemical equation for this reaction.



Scenario 2:
Which box best represents the products for this reaction? Explain.



The concept of limiting reactant is often challenging for our students. The use of stoichiometry tables can make solving problems fun and take the mystery out of even the most difficult ones! Begin with limiting reactant problems and go from there. There will be no question about when to do what if you have everything in place. If the problem says “excess” just fill in the word “lots” and you that the other reactant is the limiting reactant. This process really provides a “picture” of the entire reaction.

RICE Method for stoichiometry

R = balanced chemical **equation**
I = initial number of **moles** (may have to convert before beginning – be sure to show this work)
C = change –what reactants according to the **coefficient ratios**
E = ending **moles**
***** convert to whatever is needed*****

Scenario 3:

$$CH_{4(g)} + 2O_{2(g)} \text{-->} CO_{2(g)} + 2H_2O_{(l)}$$

Consider mixing 1.50 mol of methane with 1.80 mol of oxygen. Assume there is no carbon dioxide or water present in the initial mixture.

Which of the following ICE Tables (I or II) make sense assuming the initial amounts above and that the reaction goes to completion.

Table I:

	REACTANTS	REACTANTS		PRODUCTS	PRODUCTS
Equation	CH_4	$2O_2$	--->	CO_2	$2H_2O$
Initial Amount	1.50 mol	1.80 mol		0 mol	0 mol
Change Amount	-1.50 mol	-3.00 mol		+1.50 mol	+3.00 mol
Final Amount	0 mol	-1.20 mol		+1.50 mol	+3.00 mol

Table II:

	REACTANTS	REACTANTS		PRODUCTS	PRODUCTS
Equation	CH_4	$2O_2$	--->	CO_2	$2H_2O$
Initial Amount	1.50 mol	1.80 mol		0 mol	0 mol
Change Amount	-0.90 mol	-1.80 mol		+0.90 mol	+1.80 mol
Final Amount	+0.60 mol	0 mol		+0.90 mol	+1.80 mol

Scenario 4:

ICE tables with reactions –

$$2\ SO_2(g) + 1O_2(g) \rightarrow 2\ SO_3(g)$$

Calculate the number of moles of SO_3 formed when:
2.0 moles of SO_2 are mixed with 5.0 moles of O_2 and allowed to react.

From the problem we can complete the Initial row.

	$2SO_{2(g)}$	$+ O_{2(g)}$	→	$2SO_{3(g)}$
Initial	**2.0 mol**	**5.00 mol**		**0**
Change				
Ending				

AP Retired 2008B-3

A 0.150 g sample of solid lead(II) nitrate is added to 125 mL of 0.100M sodium iodide solution. Assume no change in volume of the solution. The chemical reaction that takes place is represented by the following equation.

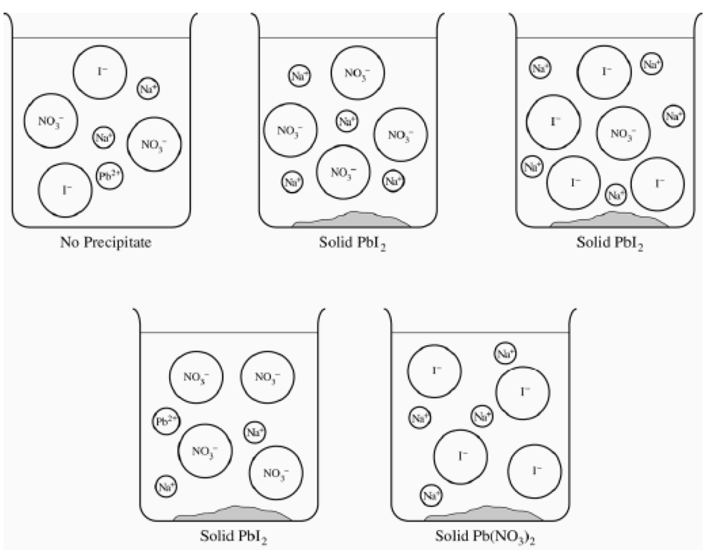
$$Pb(NO_3)_2(s) + 2\ NaI(aq) \rightarrow PbI_2(s) + 2\ NaNO_3(aq)$$

Complete the RICE table:

Reaction	$Pb(NO_3)_2(s)$	+ 2 NaI(aq)	→	$PbI_2(s)$	2 $NaNO_3(aq)$
Initial moles					
Change					
Ending moles					

Now, let's look at the actual free response question --

a) List an appropriate observation that provides evidence of a chemical reaction between the two compounds.
b) Calculate the moles of each reactant.
c) Identify the limiting reactant. Show calculations to support your identification.
d) Calculate the molar concentration of NO_3^{-1} (aq) in the mixture after the reaction is complete.
e) Circle the diagram below that represents the results after the mixture reacts as completely as possible. Explain the reasoning used in making your choice.

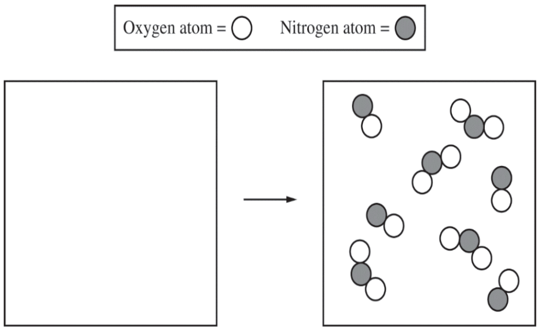


AP Retired 2018-2:

$$2\,NO(g) + O_2(g) \rightarrow 2\,NO_2(g)$$

2. A student investigates the reactions of nitrogen oxides. One of the reactions in the investigation requires an equimolar mixture of $NO(g)$ and $NO_2(g)$, which the student produces by using the reaction represented above.

   (a) The particle-level representation of the equimolar mixture of $NO(g)$ and $NO_2(g)$ in the flask at the completion of the reaction between $NO(g)$ and $O_2(g)$ is shown below in the box on the right. In the box below on the left, draw the particle-level representation of the reactant mixture of $NO(g)$ and $O_2(g)$ that would yield the product mixture shown in the box on the right. In your drawing, represent oxygen atoms and nitrogen atoms as indicated below.



Reactant Mixture　　　　Product Mixture

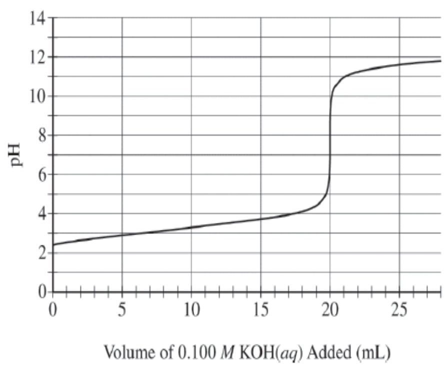
Complete the RICE table:

Reaction			→	
Initial moles				
Change				
Ending moles				

To produce an aqueous solution of HNO_2, the student bubbles $N_2O_3(g)$ into distilled water. Assume that the reaction goes to completion and that HNO_2 is the only species produced. To determine the concentration of $HNO_2(aq)$ in the resulting solution, the student titrates a 100. mL sample of the solution with 0.100 M KOH(aq). The neutralization reaction is represented below.

$$HNO_2(aq) + OH^-(aq) \rightarrow NO_2^-(aq) + H_2O(l)$$

The following titration curve shows the change in pH of the solution during the titration.



(e) Use the titration curve and the information above to

   (i) determine the initial concentration of the $HNO_2(aq)$ solution

Complete the RICE table

Reaction			→		
Initial moles					
Change					
Ending moles					

AP Retired 2018-3:

$$5\ Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$$

Complete the RICE table:

Reaction	5 Fe^{2+}(aq)	MnO_4^-(aq)	8 H^+(aq)	→	5 Fe^{3+}(aq)	Mn^{2+}(aq)	4 H_2O(l)
Initial Moles			?				
Change							
Ending Moles			?				(usually ignore since this conc. is so great)

(d) Write the balanced equation for the half-reaction for the oxidation of Fe^{2+}(*aq*) to Fe^{3+}(*aq*).

(e) The student titrates a 10.0 mL sample of the Fe^{2+}(*aq*) solution. Calculate the [Fe^{2+}] in the solution if it takes 17.48 mL of added 0.0350 *M* $KMnO_4$ (*aq*) to reach the equivalence point of the titration.

AP Retired 2017-3:

Nitrogen monoxide, NO(*g*), can undergo further reactions to produce acids such as HNO_2, a weak acid with a K_a of 4.0×10^{-4} and a pK_a of 3.40.

(c) A student is asked to make a buffer solution with a pH of 3.40 by using 0.100 *M* HNO_2(*aq*) and 0.100 *M* NaOH(*aq*).

(i) Explain why the addition of 0.100 *M* NaOH(*aq*) to 0.100 *M* HNO_2(*aq*) can result in the formation of a buffer solution. Include the net ionic equation for the reaction that occurs when the student adds the NaOH(*aq*) to the HNO_2(*aq*).

(ii) Determine the volume, in mL, of 0.100 *M* NaOH(*aq*) the student should add to 100. mL of 0.100 *M* HNO_2(*aq*) to make a buffer solution with a pH of 3.40. Justify your answer.