Balancing Chemical Equations

Standard of Learning

CH.3 b, c, e; CH.4b
The student will demonstrate a proficiency in identifying and writing chemical equations and quantifying them.

Essential Question(s)

- How are chemical equations balanced?
- How does the mole relate the coefficients in a chemical equation?

Unit: Chemical Reactions and Nomenclature
Lesson: Balancing Chemical Equations
Time Frame: 120 minutes (1.5 blocks)

PWCS Standards Based Planning Process

Standards: ***What will students know and be able to do?***

Essential Understanding

- Chemical reactions change the physical and chemical properties of substances. Balanced chemical equations are used to represent reactants and products found in reactions, due to the Law of the Conservation of Matter (Mass).

- The coefficients in a balanced chemical equation are used to write mole ratios for the substances found in the equation.

Essential Skill –

- Given an unbalanced equation/reaction, balance the equation using the inspection method.

- Demonstrate the balancing of equations and using the coefficient relationships with respect to moles of materials involved.

Assessment: ***How will the student and I know when he/she is successful?***

- **Before Lesson (Pre-Assessment) –** This lesson will follow lessons on formula writing and naming. Assessment results on these lessons should allow teacher to assess whether or not students are prepared to move on to balancing. The teacher will start with an introductory activity that provides an analogy of balancing equations by using the production of a bicycle. If the teacher has the resources, actual pieces of a bicycle could be brought in to add another element to this activity. The teacher should assist students with completing this activity. Sometimes analogy-based activities can be difficult for some students.
- **During Lesson (Formative) –** Students will start with very basic balancing equations and will build to more difficult and challenging problems. Student work must be graded for accuracy to assure mastery. This is a task that many students tend to grasp easily, however many get caught up on simple mistakes. It is important for the teacher to reinforce the fact that students should keep close track of the numbers of atoms in a compound and how each number changes when a coefficient is added. Most mistakes involve a mis-calculation or overlooking how a specific element was changed with the addition of a coefficient. The teacher should be constantly watching out for these mistakes.
- **After Lesson (Summative) –** There is a balancing quiz included for assessing student understanding of this topic. Students will need to be able to demonstrate that they can independently and effectively balance equations. Balancing will also carry through the remainder of the unit to a final unit assessment.

Task Analysis: ***What knowledge, skills and level of understanding do students need to be successful with this lesson?***

- **Pre-Assessment Data:** There is a lot of prior knowledge that will need to be accessed for this unit.
  - Students should be able to name a compound when given the formula.
  - Students should be able to write a formula when given the name of a compound.
  - Students should have a good understanding of the Law of Conservation of Matter.
  - Students should be able to identify the 7 diatomic molecules; H, O, N, Cl, Br, I, F
  - Students should be able to identify and write all of their polyatomic ions.
- **Important Vocabulary (Literacy) –**
  Chemical equation (previous)
  Coefficient
  Subscript (previous)
  Balanced equation
  Law of Conservation of Matter (Previous)
  Diatomic (previous)
- **Skill Development and Differentiation–**
  - *Balancing Chemical Equations #1* - The charts in the beginning are intended to help students focus on each individual atom and help them to keep track of how the number of atoms changes with a coefficient. As students move through the handout the problems get progressively more difficult and provide less assistance.
  - *Balancing Equations With Candy* – This activity provides a good hands on experience for students. It explores building an equation from a written formula as well as an image. It could easily be edited with more images for students who need them. For more advanced students this activity could be extended by asking them to create a few of their own equations and balance them.
  - *J-Lab Balancing Practice* – This activity is great for many levels. If students are working independently or in small groups the difficulty level can be chosen per computer. There are three levels of difficulty available, students who are progressing faster can go for the more advanced categories, while students who are struggling can choose the level of less difficulty. The teacher can also change the number of problems each student is responsible for, which will allow struggling students to feel more successful being able to finish 5 problems in the time someone else can finish 20 problems.

Instruction Using Inquiry Model: ***What learning experiences will facilitate student success?***

Framing the Learning:

1. **Engage –** Begin the lesson with the *Intro to Balancing Equations* handout. This provides an interesting analogy to the Law of Conservation of Matter. Students will need to apply prior knowledge of the Law of Conservation of Matter as well as writing formulas.

Learning Experiences:

2. Explore – The two activities included in this lesson are *Balancing Equations With Candy* and *J-Lab Balancing Practice.* These two activities focus on balancing with coefficients.

- *Balancing Equations With Candy* **–** This activity provides a hands-on approach to balancing. The teacher must make sure the students understand the purpose of the candy and what a coefficient does to a molecular formula.
- *J-Lab Balancing Practice* – This activity is a paperless way to practice balancing. It can be completed as a class, in groups or individually. The teacher can adjust to each student's progress by choosing different levels of difficulty. It is important for the teacher to make sure students are actually working out the problems instead of just choosing answers until they are correct. Teachers could have students print out their results at the end of the activity, this gives a reading of how many tries it took to get the answer correct. The activity is positive because it makes the students keep trying. They are not allowed to move on until the problem is correct.

3. Explain – A PowerPoint presentation is included in the lesson to provide instruction to students. Teachers should stress the importance of carefully counting the atoms and keeping track of how the amounts change as the coefficients change. This is where the tables in the notes and handouts become helpful. It gives students guidance on balancing and keeping track of changes.

4. Elaborate – The progress of each individual class will determine the amount of elaboration needed in the lesson. There are two worksheets included in this lesson. One of the handouts is much more lengthy and provides much more scaffolding for students.

- If students are moving quickly, they may not need as much work with the charts on the first part of worksheet #1, and can move on to the more difficult and less assisted portions.
- Struggling students could also participate in group activities for balancing. Equations could be written on large poster boards with coefficient numbers cut out on squares of paper. Students can physically add and take away coefficients until the equation is balanced.
- If there are students that are struggling more than others, they can continue to use charts for assistance with balancing.
- Classes that are moving faster could move into balancing oxidation/reduction reactions and participate in related labs.

5. Evaluate – There is a balancing quiz included for this lesson. A good understanding of balancing is vital to future lessons. This information will also be included in a culumative unit test. The teacher can format this quiz in any fashion, fill in the blank, short answer or multiple choice.

PWCS Standards Based Planning Process (continued)

Resources:

- *Intro to Balancing Equations* Handout
- PowerPoint Presentation titled *Balancing Equations*
- *Balancing Equations With Candy* Activity –copies of handouts, M&M's, mini marshmallows, Hershey kisses, licorice, blank paper, printed +/= signs.
- *J-Lab Bonding Practice* Activity – A) Computer Lab *OR* B) Lap-Top Cart *OR* C) Teacher Computer with Projector.
- *Balancing Chemical Equations #1* Handout
- *Balancing Chemical Equations #2* Handout
- *Balancing Quiz*

Reflection: ***Based on data, how do I refine the learning experiences and/or the assessment?***

- **Analysis of Data –** This lesson is vital to the next unit of stoichiometry. If students cannot balance equations they will not understand the molar relationship between coefficients in order to successfully complete a stoichiometry problem. Mastery will need to occur now as well as carry out in assessments of future lessons.
- **Immediate Implications –** Remediation will need to occur immediately with teacher assistance if mastery is not shown. As it was stated before, there are many simple mistakes in this unit. It is important for the teacher to stress the importance of taking your time and double checking work to make sure it is correct.
- **Future Planning –** This lesson was produced to simplify the subject of balancing equations with attributes that promote scaffolding according to student needs. It is important that students understand all equations need to be balanced before anything else can be done with them, this will become very important in the next unit, stoichiometry. This is a relatively simple concept that needs to be continuously re-assessed to make sure students remember the task at hand.

CH.3 b, c, e; CH.4b The student will demonstrate a proficiency in identifying and writing chemical equations and quantifying them.

Name: _____

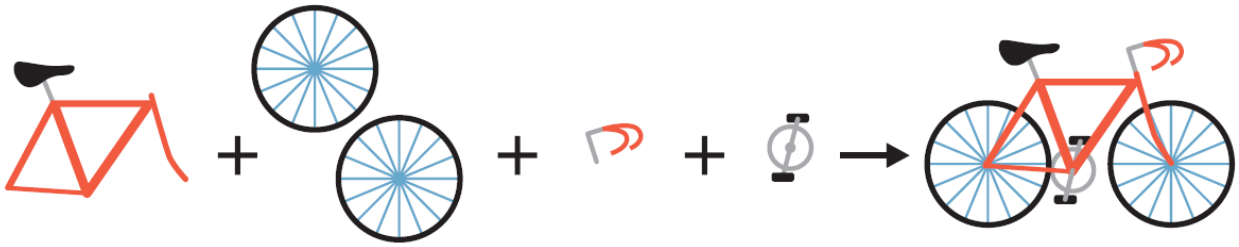
Class Period: _____ Date: _____

ENGAGE PHASE

Intro to Balancing Equations

1. What does the Law of Conservation of Matter state?

2. Write an equation to make the bicycle below. You will need to make symbols to represent the parts.



3. Does the equation you wrote follow the Law of Conservation of Matter? If not what could you do to fix that?

4. Write a ratio for bike frames to wheels. What does this tell you?

CH.3 b, c, e; CH.4b The student will demonstrate a proficiency in identifying and writing chemical equations and quantifying them.

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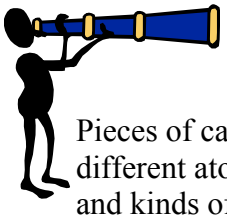
EXPLORE PHASE



Balancing Equations With Candy

Pieces of candy will be used to represent atoms in chemical equations. Different colors will represent different atoms. Conservation of atoms in a chemical equation will be shown by having the same number and kinds of atoms on each side of the equation. One lab partner will use his/her candy to simulate the reactant (left) side of the equation, and the other partner will use his/her candy to simulate the product (right) side.

Materials (per person):

- Candy (see kinds and amounts in table on next page)
- Clean paper napkin
- Small square of paper with = printed on it (1 per group)
- Clean piece of copier paper
- Small square of paper with + printed on it (2 per group)

Procedure

1. Obtain a Fun Size bag of M&M's, plus the specified number of pieces of other candy shown in the table below. If your bag of M&M's does not have enough green, blue or yellow M&M's, get them from the reserve stockpile. The numbers shown below are the minimum for you to be able to do the equation balancing. You may eat the brown, red and orange M&M's whenever you wish, but save all the green, blue and yellow ones until the activity is finished. Once the activity is over, you may eat any of your remaining candy.

ELEMENT	COLOR	CANDY	QUANTITY
H	white	miniature marshmallows	6
Cl	green	M&M's	4
O	red	Red Vine pieces (red)	7
N	blue	M&M's	3
C	black	Red Vine pieces (black)	3
Na	yellow	M&M's	2
Fe	silver	Hershey's Kisses	2

2. For equations (A) - (E) below, complete the following steps:
   a. Try to balance the equation.
   b. One of the two lab partners should use his/her pieces of candy to simulate the left side of the balanced equation on a piece of copier paper, and the other person should simulate the right side on a separate piece of paper. Use the small pieces of paper with + or = as appropriate. Make sure that there are the same number of pieces of each kind and color on each side of the equation.
   c. When you and your lab partner have completed an equation, have your instructor check the balanced equation and the candy arrangement to verify that everything is correct.

(A) ___ Na + ___ Cl_2 = ___ NaCl

(B) ___ Na + ___ H_2O = ___ NaOH + ___ H_2

(C) ___ CO + ___ NO = ___ CO_2 + ___ N_2

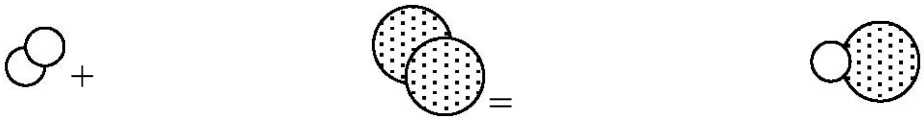
(D) ___ Fe_2O_3 + ___ CO = ___ Fe + ___ CO_2

(E) ___ C + ___ Fe_2O_3 = ___ CO + ___ Fe

3. The drawings for equations (F) - (J) below represent **unbalanced** chemical equations. For these equations, first use the drawings and the key provided to write the **unbalanced** equation, and then follow the same procedure for balancing and simulating with candy that you used for equations (A) - (E) above.

KEY: 

HYDROGEN CHLORINE OXYGEN NITROGEN CARBON

(F) 

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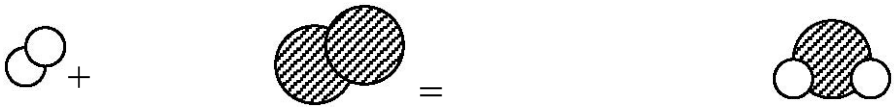
(G) 

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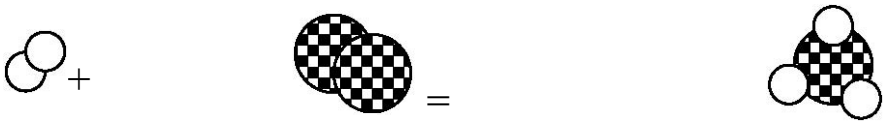
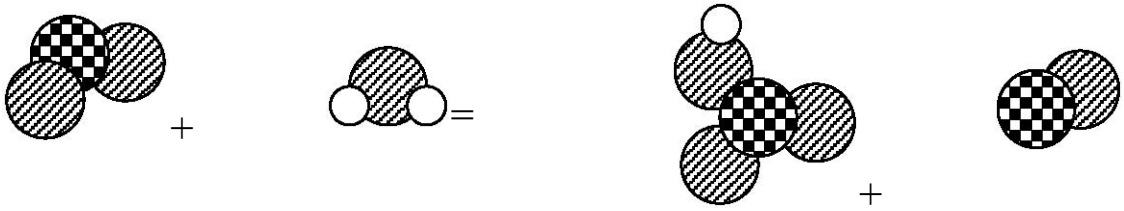
(H) 

_____

(I) 

_____

(J) 

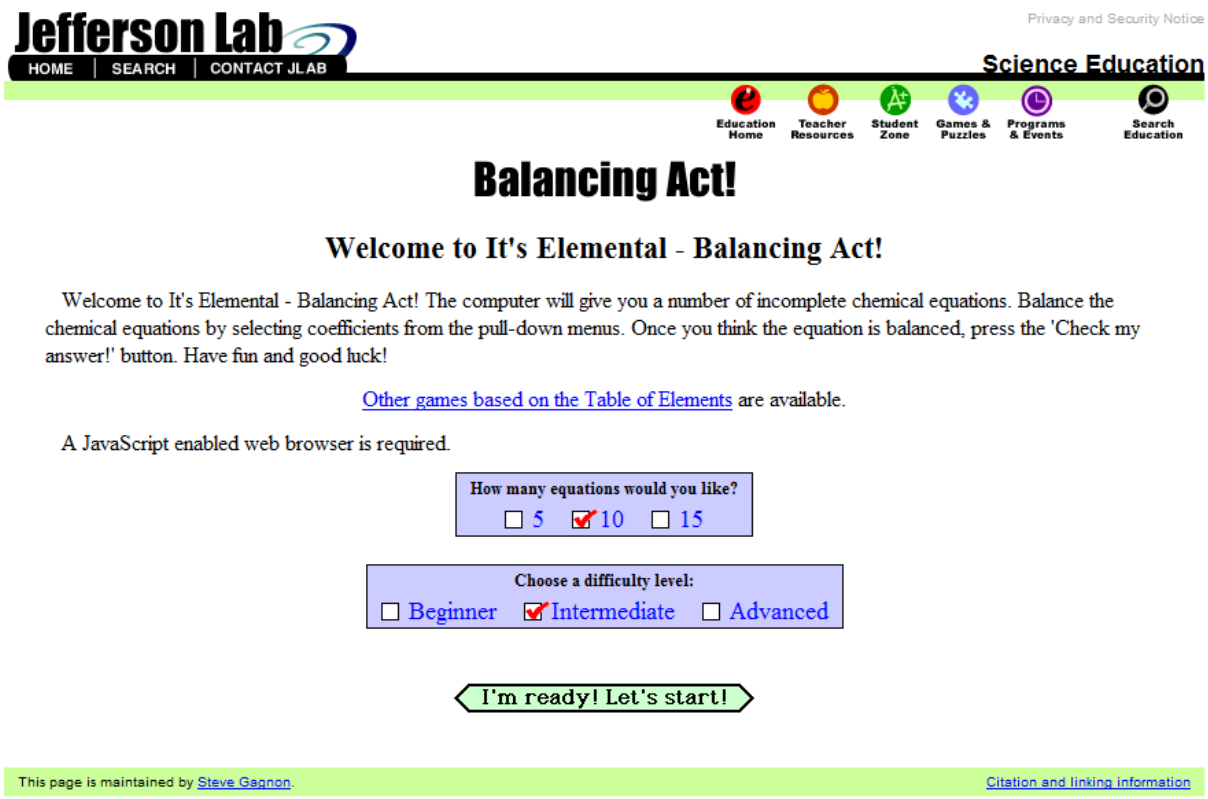
_____

Cut out signs below so that each sign is on its own small square of paper. Each group requires one = sign and two + signs.

J-Lab Balancing Practice

Source: Jefferson Lab

Title: Balancing Act http://education.jlab.org/elementbalancing/index.html



Summary: This website allows the teacher to utilize interactive practice problems for balancing. These can be done as a class with the J-Lab projected on the board. This could also be done in small groups or individually on lap-tops or in a computer lab. The number of problems and difficulty level can be chosen based on individual student or class.

CH.3 b, c, e; CH.4b The student will demonstrate a proficiency in identifying and writing chemical equations and quantifying them.

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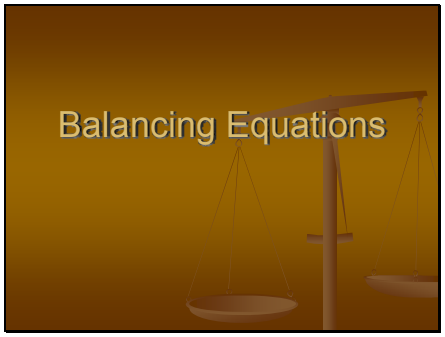
EXPLAIN PHASE

PowerPoing Presentation

See attached file for electronic file for editing and projecting.

Slide 1



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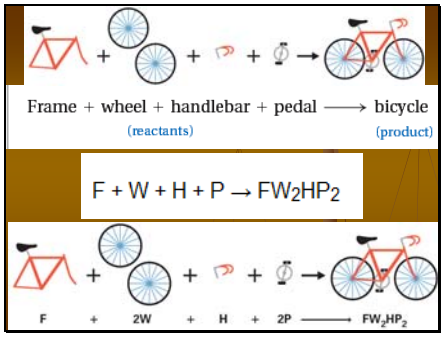
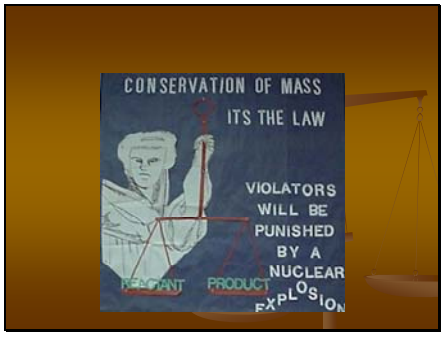


This goes along with the "intro" assignment. Use the bicycle analogy to help students see how the equations need to be balanced. Walk them through each step.

Slide 3



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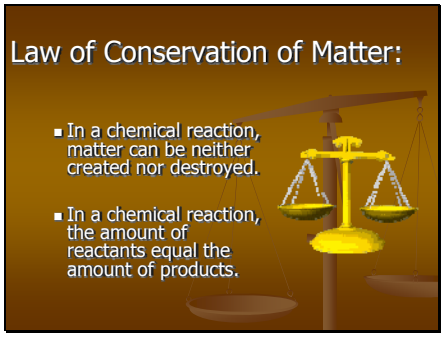

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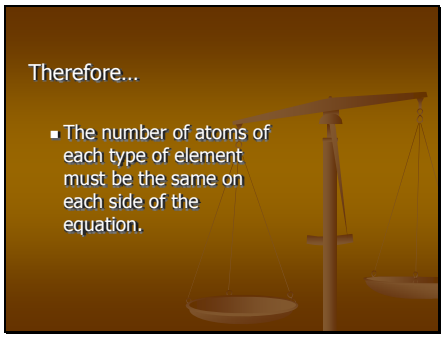

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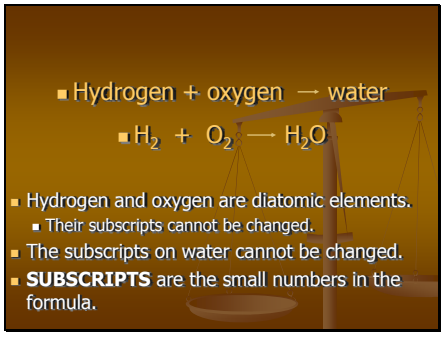
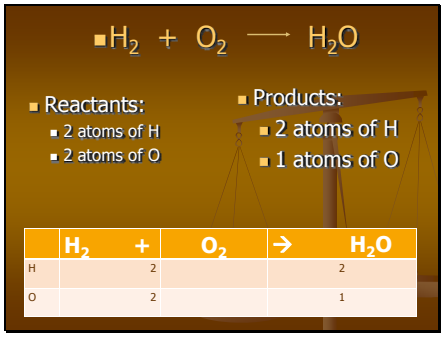


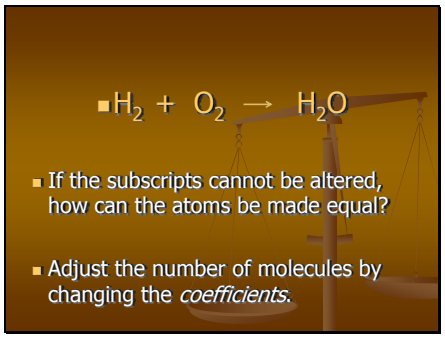
Ask students WHY the subscripts cannot be changed. Remind them that if they change the subscripts they no longer have the same reaction.

Slide 7



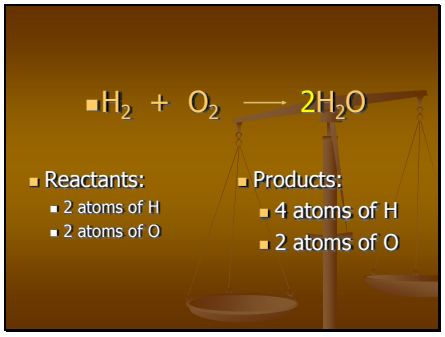
Ask a student to tell you how many atoms of each are present. Then ask if this is obeying the law of conservation of matter. Have them set up the tables presented in the handout to help.

Slide 8



Discuss with students the fact that the coefficients are the number of moles of that molecule. Remind students that they have heard the term coefficient in math. This is the number in FRONT of the molecule and it distributes to all of the atoms in the molecule.

Slide 9



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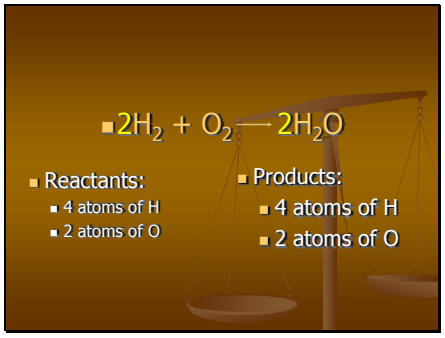

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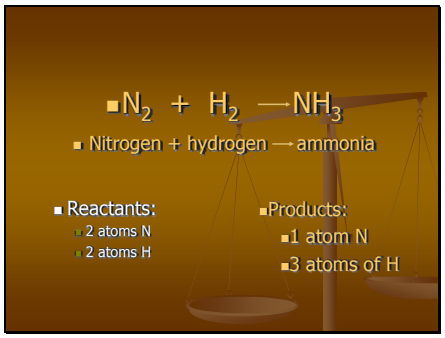

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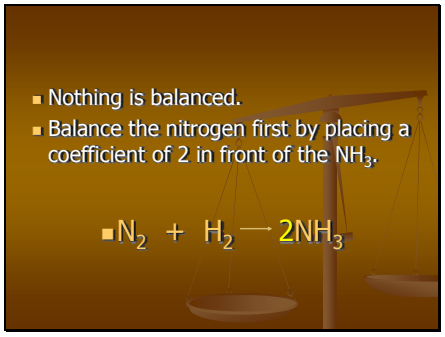

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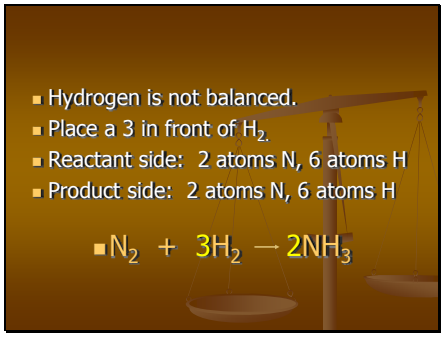

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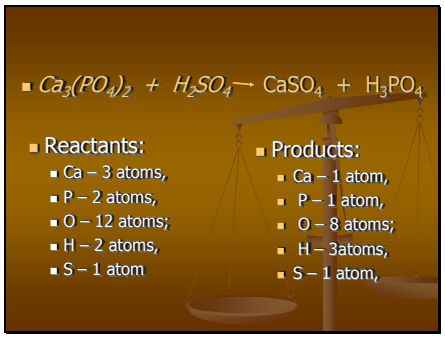

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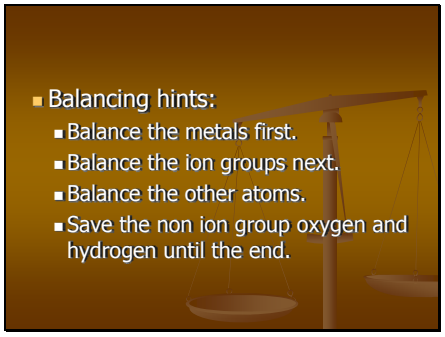

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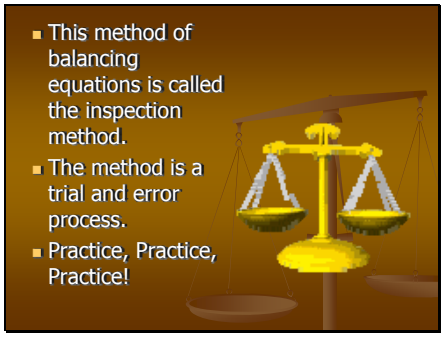

CH.3 b, c, e; CH.4b The student will demonstrate a proficiency in identifying and writing chemical equations and quantifying them.

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ELABORATE PHASE

Balancing Chemical Equations #1

Balance the following equations below using the tables provided.

1) ____ N_2 + ____ H_2 → ____ NH_3

	N_2 + *H_2*	→	*NH_3*
N			
H			

2) ____ $KClO_3$ → ____ KCl + ____ O_2

	$KClO_3$	→	*KCl* + *O_2*
K			
Cl			
O			

3) ____ $NaCl$ + ____ F_2 → ____ NaF + ____ Cl_2

	$NaCl$ + *F_2*	→	*NaF* + *Cl_2*
Na			
Cl			
F			

4) ____ H_2 + ____ O_2 → ____ H_2O

	H_2 + *O_2*	→	*H_2O*
H			
O			

5) ____ $Pb(OH)_2$ + ____ HCl → ____ H_2O + ____ $PbCl_2$

	$Pb(OH)_2$ + *HCl*	→	*H_2O* + *$PbCl_2$*
Pb			
O			
H			
Cl			

6) ____ $AlBr_3$ + ____ K_2SO_4 → ____ KBr + ____ $Al_2(SO_4)_3$

	$AlBr_3$ + *K_2SO_4*	→	*KBr* + *$Al_2(SO_4)_3$*
Al			
Br			
K			
SO_4			

7) ____ CH_4 + ____ O_2 → ____ CO_2 + ____ H_2O

	CH_4 + O_2	→	CO_2 + H_2O
C			
H			
O			

8) ____ C_3H_8 + ____ O_2 → ____ CO_2 + ____ H_2O

	C_3H_8 + *O_2*	→	*CO_2* + *H_2O*
C			
H			
O			

Balance the following equations. Use a separate sheet of paper to draw the tables for assistance.

9) ____ C_8H_{18} + ____ O_2 → ____ CO_2 + ____ H_2O

10) ____ $FeCl_3$ + ____ NaOH → ____ $Fe(OH)_3$ + ____NaCl

11) ____ P + ____O_2 → ____P_2O_5

12) ____ Na + ____ H_2O → ____ NaOH + ____H_2

13) ____ Ag_2O → ____ Ag + ____O_2

14) ____ S_8 + ____O_2 → ____ SO_3

15) ____ CO_2 + ____ H_2O → ____ $C_6H_{12}O_6$ + ____O_2

16) ____ K + ____ MgBr → ____ KBr + ____ Mg

17) ____ HCl + ____ $CaCO_3$ → ____ $CaCl_2$ + ____H_2O + ____ CO_2

18) ____ HNO_3 + ____ $NaHCO_3$ → ____ $NaNO_3$ + ____ H_2O + ____ CO_2

19) ____ H_2O + ____ O_2 → ____ H_2O_2

20) ____ NaBr + ____ CaF_2 → ____ NaF + ____ $CaBr_2$

21) ____ H_2SO_4 + ____ $NaNO_2$ → ____ HNO_2 + ____ Na_2SO_4

For the problems below, write the chemical equation and then balance. Use a separate sheet of paper to draw tables for assistance.

22) Zinc and lead (II) nitrate react to form zinc nitrate and lead.

_____

23) Aluminum bromide and chlorine gas react to form aluminum chloride and bromine gas.

_____

24) Sodium phosphate and calcium chloride react to form calcium phosphate and sodium chloride.

_____

25) Potassium metal and chlorine gas combine to form potassium chloride.

_____

26) Aluminum and hydrochloric acid react to form aluminum chloride and hydrogen gas.

_____

27) Calcium hydroxide and phosphoric acid react to form calcium phosphate and water.

_____

28) Copper and sulfuric acid react to form copper (II) sulfate and water and sulfur dioxide.

_____

29) Hydrogen gas and nitrogen monoxide react to form water and nitrogen gas.

_____

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Class Period: _____ Date: _____

Balancing Chemical Equations #2

1. Define the law of conservation of mass.

2. According to the law of conservation of mass, explain why the following equation is incorrect:
   $HCl + NaOH \rightarrow NaCl$

3. How can you tell when an equation is balanced?

4. $2Al + 3H_2O \rightarrow 2Al_2O_3 + 3H_2$
   Use the equation above to answer the following questions:

   a. Is the 2 in 2Al a coefficient or a subscript?

   b. What is the subscript in the water molecule?

   c. How would changing a coefficient differ from changing the subscript?

   d. Why do we balance Al as 2Al and not Al_2?

   e. What do the 3and 2 represent in $3H_2$? How many hydrogen atoms are present?

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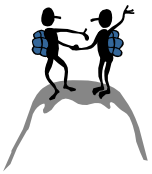

EVALUATE PHASE

Balancing Quiz

Balance the following equations:

1. ____ $KClO_3$ → ____ KCl + ____ O_2

2. ____ $Pb(OH)_2$ + ____ HCl → ____ H_2O + ____ $PbCl_2$

3. ____ $FeCl_3$ + ____ NaOH → ____ $Fe(OH)_3$ + ____NaCl

Write the equation and balance:

4. Calcium Hydroxide + Phosphoric Acid → Calcium Phosphate + Water

5. Hydrogen gas + Nitrogen monoxide → Water + Nitrogen gas.

6. What is the correct coefficient on NaCl?

   $\underline{3}FeCl_2 + \underline{2}Na_3PO_4 \rightarrow \underline{1}Fe_3(PO_4)_2$ + ___ NaCl

   a. 1
   b. 3
   c. 4
   d. 6

7. What is the correct coefficient on H_2O?

   $3CuO$ + ___NH_3 → $3Cu$ + ___H_2O + ___N_2

   a. 1
   b. 2
   c. 3
   d. 4