

Robert Noyce Teacher Scholarship Annual Conference

Washington, DC

June 18-20, 2014

Argument from Evidence in Chemistry

How to use the Science Literacy Cycle¹ to create engaging chemistry lessons that help students explain microscopic phenomena using macroscopic observations.

Presenter:

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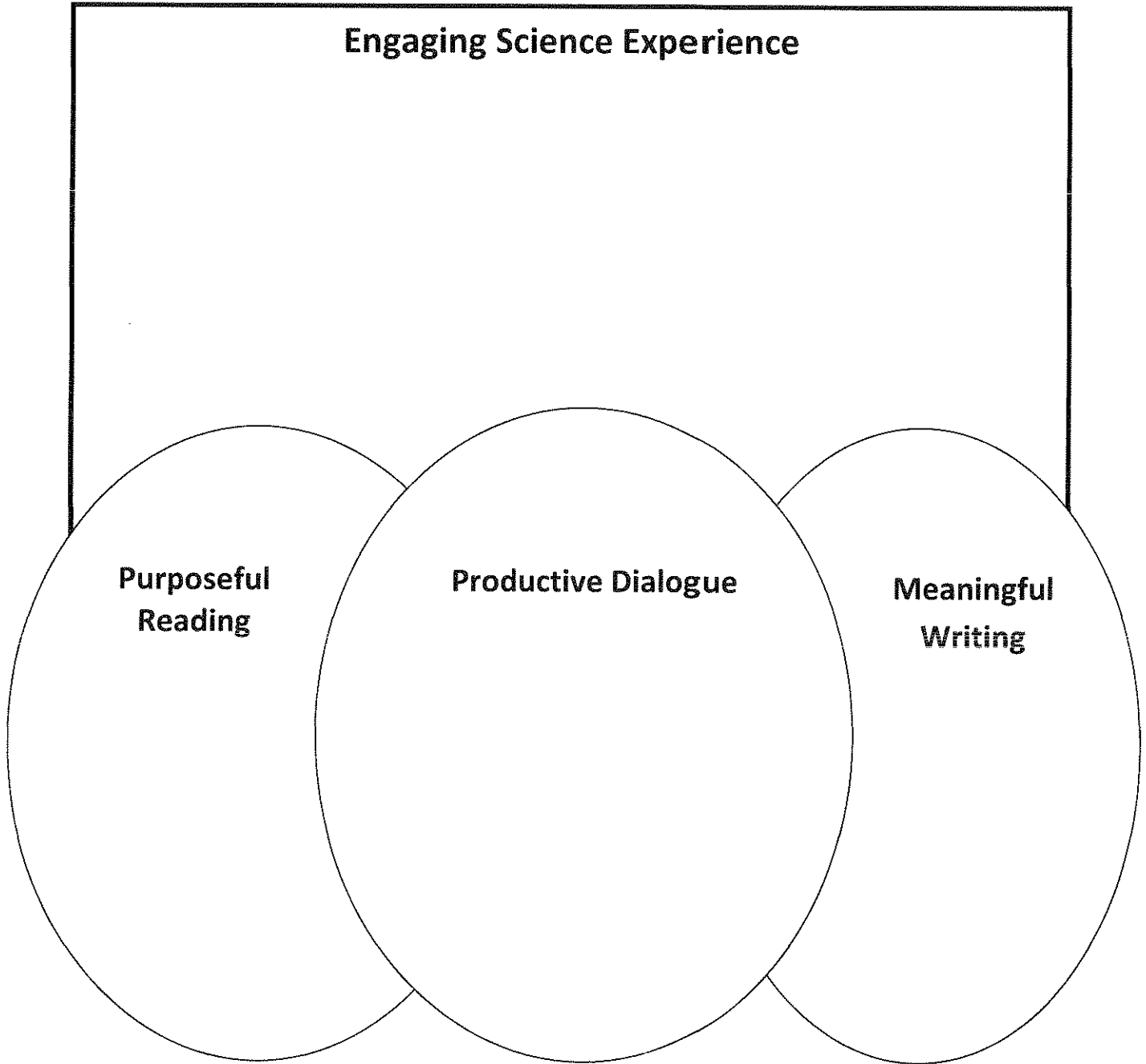
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¹ The Science Literacy Cycle was established by the UC Davis Sacramento Area Science Project.

The Science Literacy Cycle²

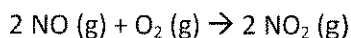


A Science Literacy Cycle Lesson must include: an engaging science activity, purposeful reading, productive dialogue, and meaningful writing. These activities can occur in any order. On the diagram above, number in sequence each part of the cycle as you plan to use them. Write a summary of the strategy that you will use for each part of the lesson cycle.

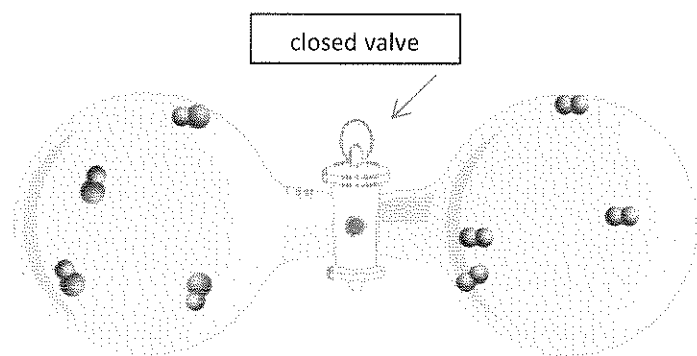
² From the Sacramento Area Science Project website <http://sasp.ucdavis.edu>.

Purposeful Reading Passage – Limiting Reactants

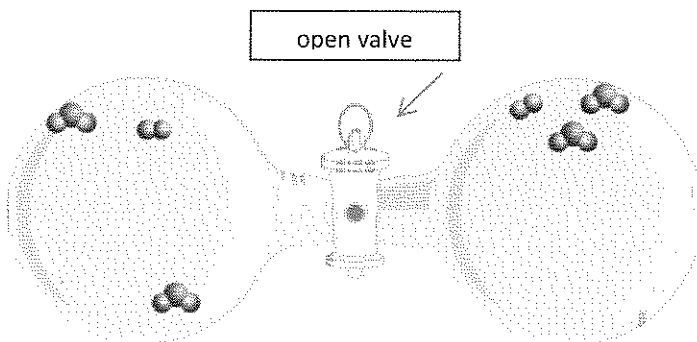
Nitric oxide, NO, is rapidly oxidized in air to form nitrogen dioxide, NO₂, a toxic brown gas that is responsible for much of the brown haze associated with smog. The balanced chemical equation is:



When the reactants are combined in the 2:1 stoichiometric ratio indicated by the balanced equation, they are both completely consumed and turned into the product nitrogen dioxide gas. However, sometimes in real world situations, the reactants are combined in a different ratio, where one reactant will run out before the other is completely used up. The reactant that runs out is called the **limiting reactant** because it limits how much of the product can be formed. The reactant that is left over and not completely used up is called the **excess reactant**.



Consider the diagram³ on the left, showing one possible scenario for the reactants: 4 molecules of NO gas in the left chamber and 4 molecules of O₂ gas in the right. What will happen when the valve is opened and the molecules of gas are allowed to mix and react? Which type of molecule will run out first?



The second diagram shows the result of the reaction. 4 molecules of NO₂ gas were formed and 2 molecules of O₂ gas remain. Which was the limiting reactant? What evidence from the diagram supports that assertion?

By carefully examining the evidence from the reaction, we see that the NO gas has been completely consumed, that there is excess O₂ gas remaining at the end of the reaction, and that there is no way to make any more NO₂ gas (the amount of product formed is limited). Therefore, we can conclude that the NO gas was the limiting reactant.

³ Diagrams from <http://g.web.umkc.edu/gounevt/Animations/Animations211/LimitingReagent.swf>.

Meaningful Writing – Framed Proof Paragraph

Use the frame provided to identify the limiting reactant and justify your choice. Your claim must be supported by three pieces of evidence (observations) and the conclusion that you were able to draw from each observation. Conclude your paragraph with two important facts about limiting reactants.

I know that _____ is the limiting reactant in this mixture

because of my observations. First, _____,

so _____.

Second, _____, so _____

_____.

Third, _____, so _____

_____.

Limiting reactants _____, and

_____.

Example #1

Meaningful Writing – Framed Proof Paragraph

Use the frame provided to identify the limiting reactant and justify your choice. Your claim must be supported by three pieces of evidence (observations) and the conclusion that you were able to draw from each observation. Conclude your paragraph with two important facts about limiting reactants.

I know that copper (II) chloride is the limiting reactant in this mixture

because of my observations. First, the solution is ~~clear~~ clear

so there is no blue copper (II) chloride left

Second, there is some aluminum on the water surface, so aluminum
left over and it is the excess reactant

Third, both of the solid metal are present, but ^{the reaction is not occurring anymore} aluminum

is the excess reactant still present in the mix and copper (II) chloride is the limiting reactant

Limiting reactants ^{is} are the one that limits the amount of product formed, and ^{which ran out}

excess reactant is the one that left over and is not completely used up

in the reaction

Example #2

Meaningful Writing – Framed Proof Paragraph

Use the frame provided to identify the limiting reactant and justify your choice. Your claim must be supported by three pieces of evidence (observations) and the conclusion that you were able to draw from each observation. Conclude your paragraph with two important facts about limiting reactants.

I know that copper (II) chloride is the limiting reactant in this mixture

because of my observations. First, there is aluminum floating at the top of the beaker,
so not all of the aluminum reacted

Second, the water has become completely clear, so all of
the copper (II) chloride has been removed from the beaker

Third, the Copper (II) chloride combined in a ratio of 3:2 with aluminum, so it makes
sense that the copper (II) chloride would run out first

Limiting reactants are substances that become completely used up in chemical reactions, and

Copper (II) chloride is the limiting reactant of this equation

Example #3

Meaningful Writing – Framed Proof Paragraph

Use the frame provided to identify the limiting reactant and justify your choice. Your claim must be supported by three pieces of evidence (observations) and the conclusion that you were able to draw from each observation. Conclude your paragraph with two important facts about limiting reactants.

I know that Copper(II) Chloride (CuCl_2) is the limiting reactant in this mixture because of my observations. First, The solution was no longer blue so all of the Copper(II) Chloride reacted and ran out. Second, The product contained a clear liquid, so we know it resulted in Aluminum chloride, meaning this is not the limiting reactant. Third, the reaction ended with excess Copper, and so, given these products, Aluminum is the excess reactant and Copper(II) Chloride is the limiting reactant. Limiting reactants halt a reaction because they run out, and they are not listed in the product of the reaction.

Example #4

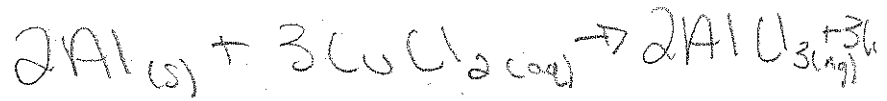
Meaningful Writing – Proof Paragraph

Write a paragraph to identify the limiting reactant and justify your choice. Your claim must be supported by three pieces of evidence (observations) and the conclusion that you were able to draw from each observation. Conclude your paragraph with two important facts about limiting reactants.

The limiting reactant from this reaction is the copper (II) chloride. This is because, when the aluminum was placed in the solution a gas was being released and the solution changed from a $\text{CuCl}_2 \rightarrow \text{AlCl}_3$. The solution was blue before the aluminum was placed in the beaker and turned clear towards the end of the reaction. I know that the copper (II) chloride solution was the limiting reactant because in the end of the reaction, some solid aluminum was left over. The aluminum was the excess reactant. The limiting reactant, the copper (II) chloride was the blue solution and due to the change in color to a clear solution with a solid excess reactant it can be confirmed that the copper (II) chloride was the limiting reactant.

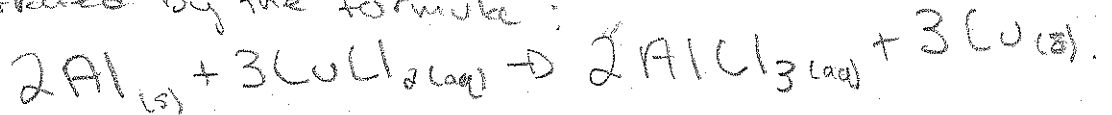
Example #5

Meaningful Writing – Proof Paragraph



Write a paragraph to identify the limiting reactant and justify your choice. Your claim must be supported by three pieces of evidence (observations) and the conclusion that you were able to draw from each observation. Conclude your paragraph with two important facts about limiting reactants.

In reactions the outcome of an experiment is able to show what was the limiting reactant and what was the excess reactant. In the reaction demonstrated by the formula:



We are able to determine both the limiting and excess reactant. In this react the limiting reactant was the copper (II) chloride and the excess was the aluminum. The copper (II) chloride solution ran out first because all of the copper was on the bottom of the beaker and the solution had changed color. The excess reactant was the aluminum because aluminum was still present in the beaker floating ~~at~~ on the top.

Strategies for Engaging Science Lessons

(Explanations of each strategy can be found at <http://sasp.ucdavis.edu>.)

Reading

Common Text Patterns
Paired Reading
Summary Protocol
Really Reading
I read, I thought
Guided Reading
Vocabulary Mnemonic Device
Outside-Inside
K-W-L
Reciprocal Teaching

Science Experiences

Interact with data
Hands-on
Lab Activity
Constructing Explanations
Constructing, Revising or Applying
Mental Models
Problematizing the concept
Anticipatory set
Inquirizing labs
Demonstrations

Writing

Communication Triangle
Proof Paragraph
Proof Essay
Graphic Organizers
Rubrics
Cornell Notes
K-W-L
Challenge Statements
Text Mining

Dialogue

Principles for Participation
Give One, Get One
Quiz, Quiz, Trade
Walkabout Review
A-Z Review
Sign-In Graph
Lines of Communication
Seasonal Partners
Clock Partners
Say Something
Final Word
Talking Sticks
Think-Pair-Share
Dialogue Dots
Paraphrase Passport
Paired Verbal Fluency