Making STEM Relevant

Sherry Tharayil

June 30, 2017

Use in the classroom

- Concrete examples to help support the need for performance assessments.
- Real world examples of applications of current chemistry curriculum.
- Better able to link student strengths with possible career opportunities.

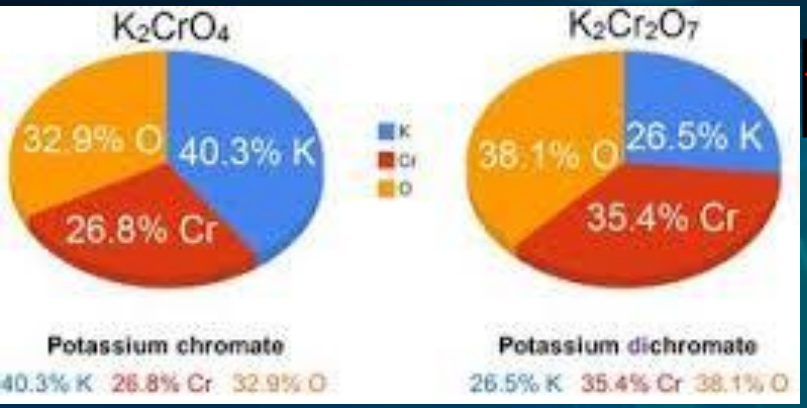
ASIP Local 150

- Primary purpose is to coordinate work and provide continuous training for its members.
- Offers 4 apprenticeship programs
  - Heavy Equipment Operator
  - Heavy Equipment Repair Technician
  - Geothermal/Well Driller
  - Construction Material Inspector (Field Inspector)

Learning connections

STEM applications:

Safety : proper usage of equipment and safety. considerations in a variety of situations.



Percent composition: using measurements to calculate percent composition of materials.

Soft Skills: Punctuality, Work Ethic, making the most of opportunities

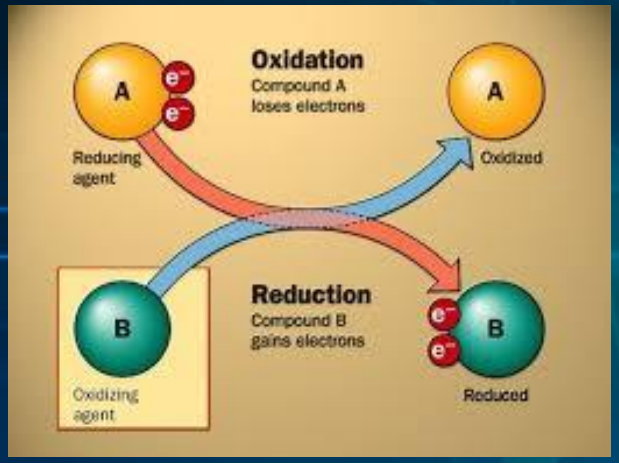
AUX SABLE

- Primary purpose is to separate the various hydrocarbons found in NGL (natural gas liquid)
- Hydrocarbons they sell include ethane, propane, butane and pentane plus

Learning connections

STEM applications:

Separation techniques including distillation and fractionation.

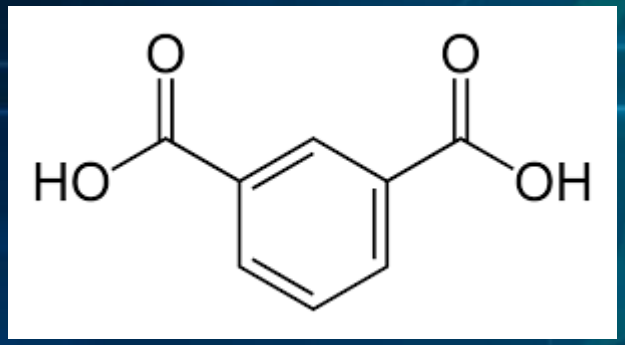


Oxidation reaction of MEROX.

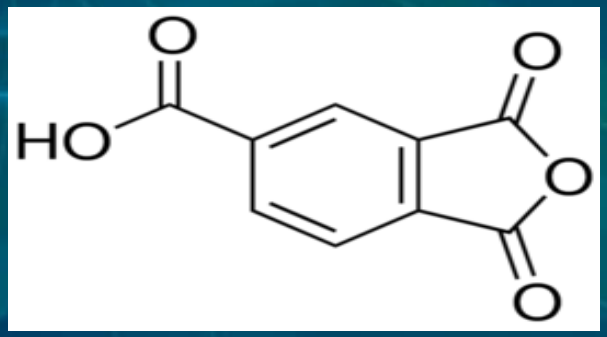
Soft Skills: collaboration, work ethic, community contributor.

FLINT HILLS resources®

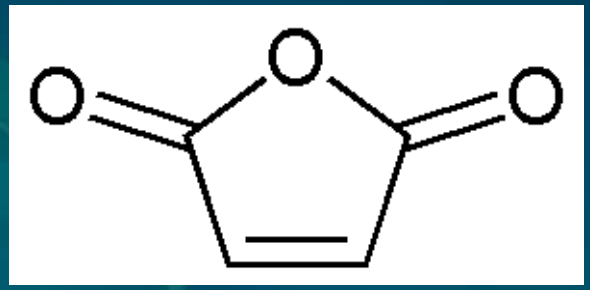
- Primary purpose is to produce *Intermediate chemicals*, which are used to produce paints, wrinkle-resistant clothing, and many other consumer goods.



PIA



TMA

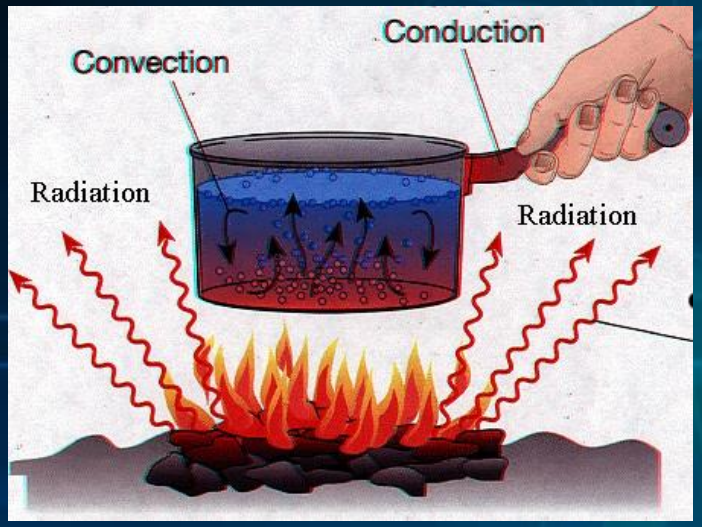


MAN

Learning connections

STEM applications:

Physical properties of matter - melting point.



Heat Transfer between liquids.

Soft Skills: compliance, perseverance, communication.

IOI Loders Croklaan

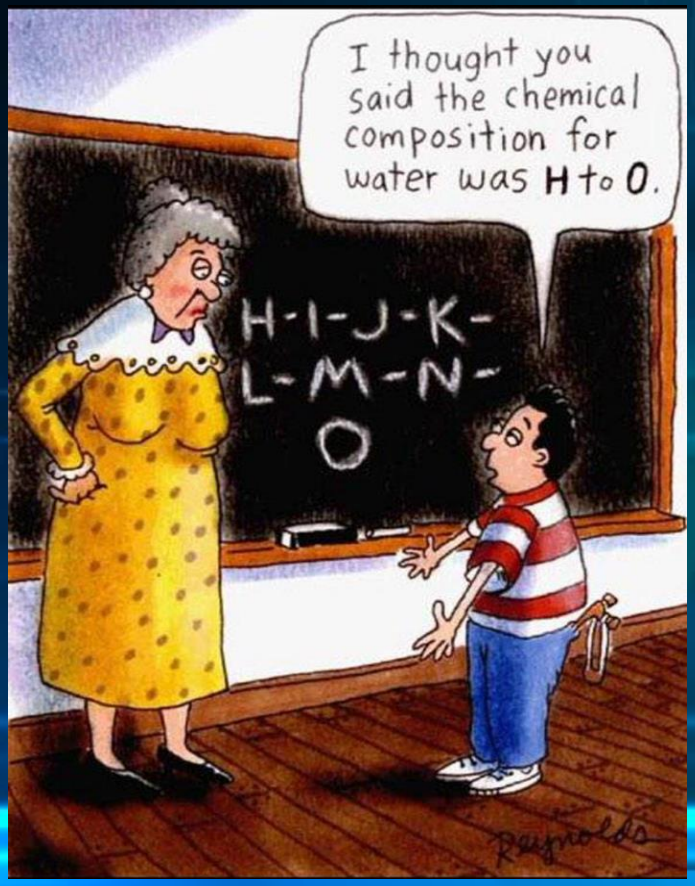
- Primary purpose is to refine palm oil to meet the composition needs of its customers.
- Product is used in a variety of forms and in a variety of products.

Learning connections

STEM applications:

Stoichiometry – mole ratios.

Cooking chemistry!



Chemical composition.

Soft Skills: communication, interpersonal skills

Idea for application

Unit 1 Matter – Percent composition

Intro: Percent composition of an Oreo cookie.

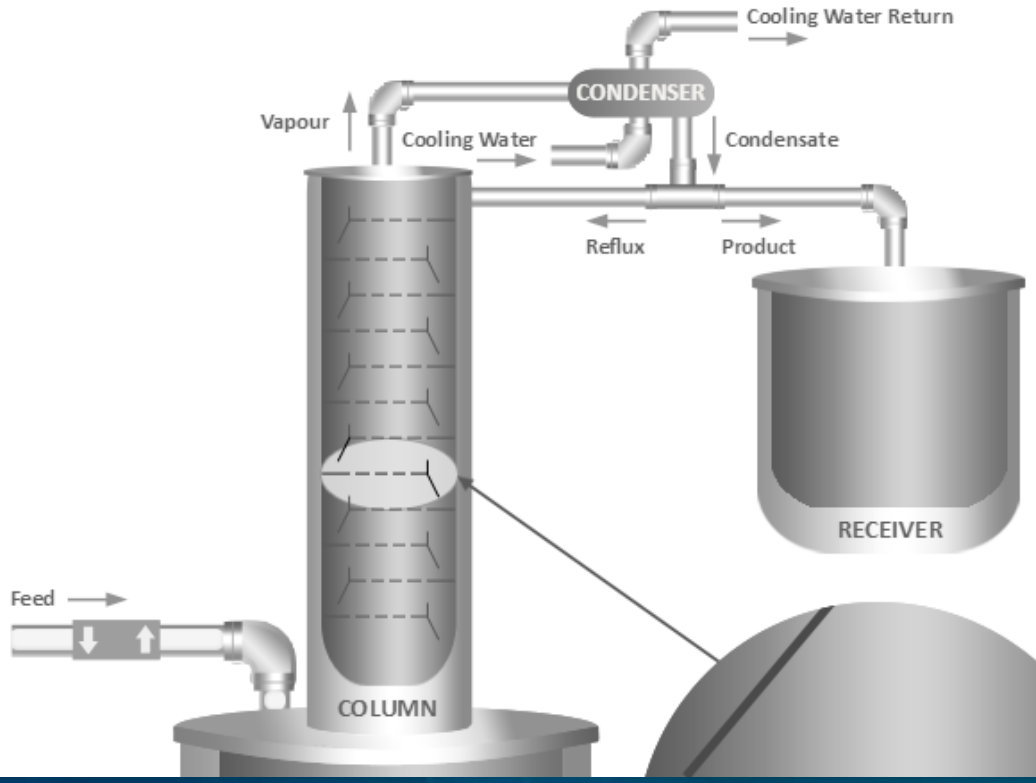
Give each group an Oreo cookie and have them write and execute a procedure on how to find the % cream and % cookie in an Oreo cookie.

Extension – separation techniques have been discussed in this unit – talk about IOI and how they refine their palm oil using fractionation.

Virtual distillation

Distillation Column

Simulation - Easy



Challenge

You need a new asphalt driveway for your house. To make a quality asphalt driveway the slurry used must be within specific parameters.

1. With your team research the percent asphalt that must be in the slurry.
2. With your team write a procedure on how you will test that the slurry you have is in fact within the specified percent.

Once your procedure has been reviewed by a another group and approved by your teacher, obtain an slurry sample from your teacher, carry out your experiment, record your data and provide an evidence based conclusion.

Student Objectives

- Student can design and conduct experiments, as well as to analyze and interpret data.
- Students can use computer based technologies and laboratory skills
- Students can communicate effectively – both written and oral

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4),(HS-PS1-8)
- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

Planning and Carrying Out Investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3)

Using Mathematics and Computational Thinking

Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1),(HS-PS1-2)
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),*(secondary to HS-PS2-6)*
- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

PS1.B: Chemical Reactions

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4),(HS-PS1-5)
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical

Crosscutting Concepts

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1),(HS-PS1-2),(HS-PS1-3),(HS-PS1-5)

Energy and Matter

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8)
- The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7)

One of the most prevalent engineering practices in NGSS is planning and conducting investigations.

Assessment

PENNSTATE

Rubric for Science Experiments

	Score = 4	Score = 3	Score = 2	Score = 1
Experimental design	Design shows student has analyzed the problem and has independently designed and conducted a thoughtful experiment.	Design shows student grasps the basic idea of the scientific process by conducting experiment that controlled obvious variables.	Design shows student grasps basic idea of scientific process but needs some help in controlling obvious variables.	Design shows student can conduct an experiment when given considerable help by the teacher.
Scientific results	Pamphlet explained with convincing clarity the solution to the problem. Information from other sources or other experiments was used in explaining.	Pamphlet showed that student understands the results and knows how to explain them.	Pamphlet showed results of experiment. Conclusions reached were incomplete or were explained only after questioning.	Pamphlet showed results of the experiment. Conclusions drawn were lacking, incomplete, or confused.
Data collection	Data was collected and recorded in an orderly manner that accurately reflects the results of the experiment.	Data was recorded in a manner that probably represents the results of the experiment.	Data was recorded in a disorganized manner or only with teacher assistance.	Data was recorded in an incomplete, haphazard manner or only after considerable teacher assistance.
Verbal expression	Speech presented a clearly defined point of view that can be supported by research. Audience interest was considered as were gestures, voice and eye contact.	Speech was prepared with some instructor help but uses experiment's result. Speech was logical and used gestures, voice and eye contact to clarify meaning.	Speech was given after active instruction. Some consideration was given to gestures, voice and eye contact.	Speech was given only after active instruction.

Reference:

Wiggins, G. (1998). Educative Assessment. San Francisco, CA: Jossey-Bass Publishers.

References

- https://www.asiplocal150.org/Forms/Page.aspx?P=Home
- https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcRN4c_DKddK7axrGaWUSZ16KMBVIewvF6vya1zGaeiAgviVW6rZ
- https://s-media-cache-ak0.pinimg.com/originals/ff/34/18/ff34184ac5b9c1ba66da841b61e7c0a1.jpg
  https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTSa-FXgc_zy3ee0xsbdEe9vRVA-qs-HQu3XTidvjuCeIFl5E7p
- http://photos.prnewswire.com/prnfull/20141103/156294LOGO
- http://www.yourindustrynews.com/upload_images/yourpetrochemicalnews_-_Ethylene_Plant_3.jpg
- https://res.cloudinary.com/crunchbase-production/image/upload/v1397192636/f499b6ddaff4c50739b7bdace350a732.jpg
- http://storage.fortsaskatchewanrecord.com/v1/dynamic_resize/sws_path/suns-prod-images/-577925_ORIGINAL.jpg?quality=80&size=650x&stmp=1345604172541
- https://upload.wikimedia.org/wikipedia/commons/a/a3/Isophthalic-acid-2D-skeletal.png
- http://www.sigmaaldrich.com/content/dam/sigma-aldrich/structure3/057/mfcd00005925.eps/_jcr_content/renditions/mfcd00005925-medium.png
- http://www.g9toengineering.com/resources/heattransfer.jpg
- http://superstaar.org/SuperSTAAR/cache/file/D8DE28C6-29FE-468E-A7C48D83D42762AC.jpg
- http://www.palmtreepassion.com/images/12345473_s.jpg
- http://incrediblethings.com/wp-content/uploads/2013/02/Scientific-Spice-Rack1.jpg