JOULIE PBL IMPLEMENTATION GUIDE

DEVELOPED BY THE DEL VALLE HIGH SCHOOL CHEMISTRY TEACHERS

Each day represents approximately a 50 min class period.

This was the first exposure to PBL for most students.

Relevant topics that had already been covered:

- units for temperature
- basic principles of KMT, but it was reviewed here as well
- phase change (in terms of phases of matter, but not the heat associated)
- writing claims/evidence/interpretation statements

Doesn't need to be followed exactly - documents provided are only suggested sequence

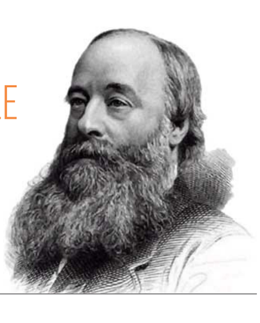
Great to increase student voice and choice and follow a less structured approach

Del Valle teachers found most of what they had previously used in teaching this unit could be reused to teach the content knowledge for the PBL with a few modifications to connect back to the Coffee Joulie.

WEEK 1: HOW IS THE JOULIE SUPPOSED TO WORK?

DAY 1 — BIG IDEA: PROJECT ROLL OUT / LAW OF CONSERVATION OF ENERGY

JAMES JOULE



LEARNING OBJECTIVE

Students will investigate the Law of Conservation of Energy and use this information to evaluate the claims made by the creators of the Coffee Joulie in their pitch on Shark Tank.

ACTIVITIES

Project Roll out

01 PBL Need to Knows

Energy Transformations; System and Surroundings; heat transfer

ASSESSMENTS

01 PBL Daily Summary

TEKS ALIGNMENT

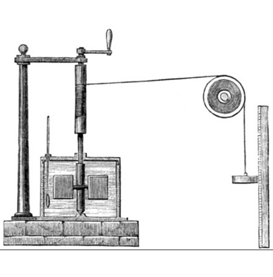
(1) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to: (A) understand energy and its forms, including kinetic, potential, chemical, and thermal energies;

(2) Scientific processes. The student uses scientific methods to solve investigative questions. The student is expected to: (E) plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting equipment and technology, including graphing calculators, computers and probes, sufficient scientific glassware such as beakers, Erlenmeyer flasks, pipettes, graduated cylinders, volumetric flasks, safety goggles, and burettes, electronic balances, and an adequate supply of consumable chemicals;

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to: (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

DAY 2 — BIG IDEA: HEAT VS. TEMPERATURE

JOULE'S APPARATUS



LEARNING OBJECTIVE

Students will model heat transfer using kinetic molecular theory to produce particle drawings.

ACTIVITIES

Student Handout: 02 Heat and Temperature

Demos on Heat and Temperature

Power Point to guide class

ASSESSMENTS

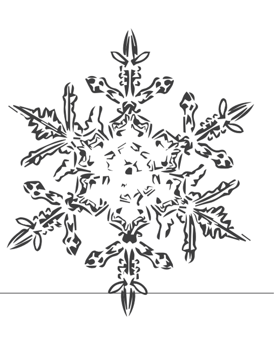
Particle drawings for coffee/air that are done in partners

Need to know written response to the question: How is heat transferred between coffee and the joulie?

TEKS ALIGNMENT

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to: (B) understand the law of conservation of energy and the processes of heat transfer;

DAY 3 — BIG IDEA: PHASE CHANGES



LEARNING OBJECTIVE

Students will describe the movement of heat during a phase change using observations to produce heat diagrams.

ACTIVITY

Student Handout: 03 Phase Changes

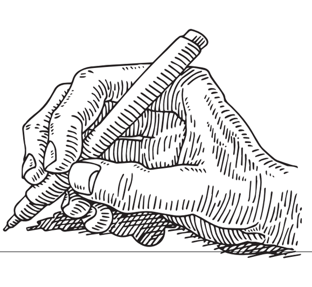
ASSESSMENT

Quick write questions at the end of the student handout provide a formative assessment for the day.

TEKS ALIGNMENT

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to: (B) understand the law of conservation of energy and the processes of heat transfer;

DAY 4 — BIG IDEA: SCIENTIFIC WRITING



LEARNING OBJECTIVE

Students will develop scientific writing skills by following the claim/evidence/interpretation model to make connections between evidence gathered in labs and questions asked about the coffee joulie.

ACTIVITIES

Student Handout: 04 CEI Pre-Writing

Power Point to guide class

ASSESSMENTS

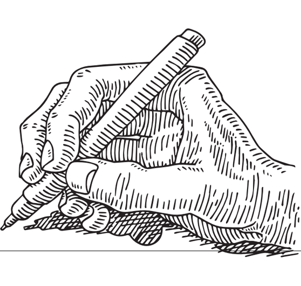
Teacher developed 5 Question Quiz over heat, temperature and phase changes {not included in the Implementation Guide}]

CEI Pre-Writing completed by each student is a great example of a formative assessment.

TEKS ALIGNMENT

(2) Scientific processes. The student uses scientific methods to solve investigative questions. The student is expected to: (I) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphs, journals, summaries, oral reports, and technology based reports

DAY 5 — BIG IDEA: SCIENTIFIC WRITING



LEARNING OBJECTIVE

Students will continue to revise scientific writing using peer review feedback.

ACTIVITIES

Student continue work revising CEI pre-writing based on peer review.

Use CEI pre-writing to write a report (turn the blocks of information into paragraphs).

ASSESSMENTS

Students' reports. [Note this is not the final report, but the first part of the final report.

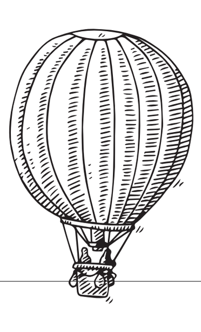
TEKS ALIGNMENT

(2) Scientific processes. The student uses scientific methods to solve investigative questions. The student is expected to: (I) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphs, journals, summaries, oral reports, and technology based reports

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to: (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student

WEEK 2: HOW CAN WE QUANTIFY THE EFFECTIVENESS OF THE JOULIE?

DAY 6 — BIG IDEA: INTRO TO SPECIFIC HEAT



LEARNING OBJECTIVE

Students will be able to define specific heat and explain how this property of matter is connected with daily experiences with heated objects.

ACTIVITIES

Student Handout: 06 Intro to Specific Heat

Specific Heat lab (procedure for students in handout)

ASSESSMENTS

Extension questions and Joulie summary questions at end of student handout provide a formative assessment for the day.

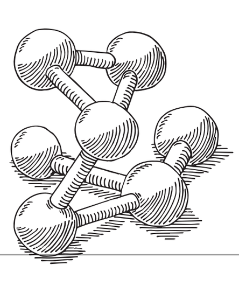
TEKS ALIGNMENT

(4) Science concepts. The student knows the characteristics of matter and can analyze the relationships between chemical and physical changes and properties. The student is expected to: (A) differentiate between physical and chemical changes and properties;

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to: (D) perform calculations involving heat, mass, temperature change, and specific heat;

(1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to: (A) demonstrate safe practices during laboratory and field investigations, including the appropriate use of safety showers, eyewash fountains, safety goggles, and fire extinguishers;

DAY 7 — BIG IDEA: INTRO TO SPECIFIC HEAT EQUATION



LEARNING OBJECTIVE

Students will be able to explain the role of each variable in the specific heat equation using evidence from inquiry based labs.

ACTIVITIES

Student Handout: 07 Intro to Q

Inquiry based lab (guidance given in student handout)

ASSESSMENTS

Have students answer the EQ on the student handout before the lab and then revise their answers at the end of the class.

Part 4 provides an assessment of student mastery of both the conceptual understanding of the equation and the ability to solve the equations.

TEKS ALIGNMENT

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to: (D) perform calculations involving heat, mass, temperature change, and specific heat;

(1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to: (A) demonstrate safe practices during laboratory and field investigations, including the appropriate use of safety showers, eyewash fountains, safety goggles, and fire extinguishers;

DAY 8 — BIG IDEA: HEAT CALCULATIONS

LEARNING OBJECTIVE

Students will be able to solve a variety of types of specific heat calculation problems.

ACTIVITIES

Student Handout: 08 Heat Calculations

Student Handout: 08 Round Robin Heat Calculations (same problems, just reformatted for this learning strategy)

Teacher Handout: Engaging Strategies for Calculations Practice

ASSESSMENTS

Practice Problems on student handout.

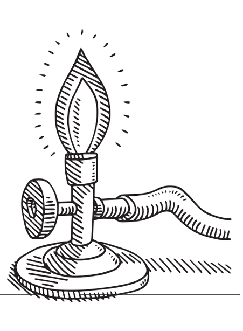
Have students respond to Need to Know "Why are Coffee Joulies made out of steel and not a cheaper substance?"

TEKS ALIGNMENT

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to: (D) perform calculations involving heat, mass, temperature change, and specific heat;

(2) Scientific processes. The student uses scientific methods to solve investigative questions. The student is expected to (G) express and manipulate chemical quantities using scientific conventions and mathematical procedures, including dimensional analysis, scientific notation, and significant figures;

DAY 9 — BIG IDEA: HEAT REVIEW



LEARNING OBJECTIVE

Students will review specific heat concepts and calculations through practice and writing evaluations asked about the coffee joulie.

ACTIVITIES

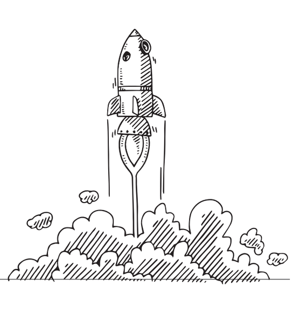
Student Handout: 09 Heat Review

See Region 13's Teacher Toolkit for fun class review strategies.

TEKS ALIGNMENT

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to: (D) perform calculations involving heat, mass, temperature change, and specific heat;

DAY 10 — BIG IDEA: HEAT TEST



LEARNING OBJECTIVE

Students will show mastery of specific heat concepts and calculations through a standardized test.

ASSESSMENT

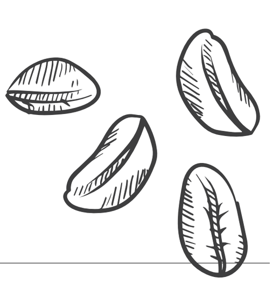
Teacher created test {not included in the Implementation Guide}

TEKS ALIGNMENT

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to: (D) perform calculations involving heat, mass, temperature change, and specific heat;

WEEK 3: HOW CAN WE TEST THE CLAIMS OF THE JOULIE AND REPORT BACK?

DAY 11 — BIG IDEA: TEST JOULIES



LEARNING OBJECTIVE

Students will use scientific reasoning to design an experiment to test the effectiveness of the Coffee Joulie in absorbing and releasing heat.

ACTIVITIES

Students design their own experiment to test Coffee Joulie against at least 1 other control.

Alternatively - use Student Handout 11 Joulie Lab which provides a more structured approach. 11 Testing the Joulie is a ppt to support the class during the lab.

ASSESSMENTS

If students design the lab set up themselves, this is a great form of assessment that you can evaluate in class as you approve the procedures and data tables they develop.

Graphing and Conclusion sections of the Student Handout 11 lab is an assessment tool as well.

TEKS ALIGNMENT

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to: (D) perform calculations involving heat, mass, temperature change, and specific heat;

DAY 12 — BIG IDEA: COMPLETE REPORT

LEARNING OBJECTIVE

Students will use scientific reasoning to evaluate the claims of a product and communicate findings from labs through a report.

ACTIVITIES

Students prepare final reports to Mark Cuban:

a. 12 Coffee Joulie Final Project provides details final report should include
b. Students should be encouraged to build off of the writing from Day 5.

Consider providing another copy of the CEI Pre-Writing Handout and using that for Peer Review.

TEKS ALIGNMENT

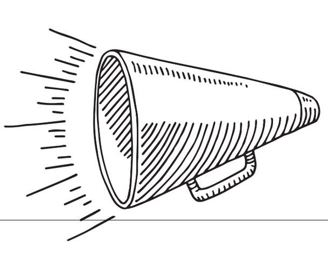
(2) Scientific processes. The student uses scientific methods to solve investigative questions. The student is expected to: (I) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphs, journals, summaries, oral reports, and technology based reports

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to: (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to: (A) understand energy and its forms, including kinetic, potential, chemical, and thermal energies; (B) understand the law of conservation of energy and the processes of heat transfer;

(D) perform calculations involving heat, mass, temperature change, and specific heat;

DAY 13 — BIG IDEA: PRESENTING REPORTS TO AUDIENCE



LEARNING OBJECTIVE

Students will clearly communicate their findings on the Coffee Joulies and make recommendation as to whether they are a good investment or not based on the evidence collected through experimentation.

ACTIVITIES

Students will share their reports with the class and a public audience (see Project Roll out for suggestions).

Students should complete Student Evaluation of Coffee Joulie PBL.

ASSESSMENTS

Students' final reports.

Students' evaluations - these should be an informative assessment of how the project went and shouldn't be a graded piece. However, they are still important for both teacher and student to reflect on the process of the project.

TEKS ALIGNMENT

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to: (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

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