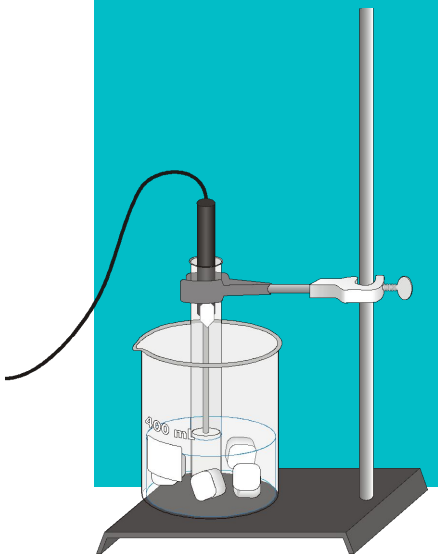
DCI, CCC, and SEPs Oh My! Sweet and Salty Investigations a 3-D Twist!

Stacy Thibodeaux

Southside High School, Youngsville, LA

svthibodeaux@gmail.com

Twitter: @stacythib



https://education.ti.com/en/activities/ngss-activities

What is the 5E Model of Instruction?

1 2 3 4 5

Engage

Explore

Explain

Extend

Evaluate

HS-PS1-3

Students who demonstrate understanding can:

HS-PS1-3. **Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.** [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [*Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.*]

The performance expectation above was developed using the following elements from *A Framework for K-12 Science Education*:

Science and Engineering Practices

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.

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.

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.

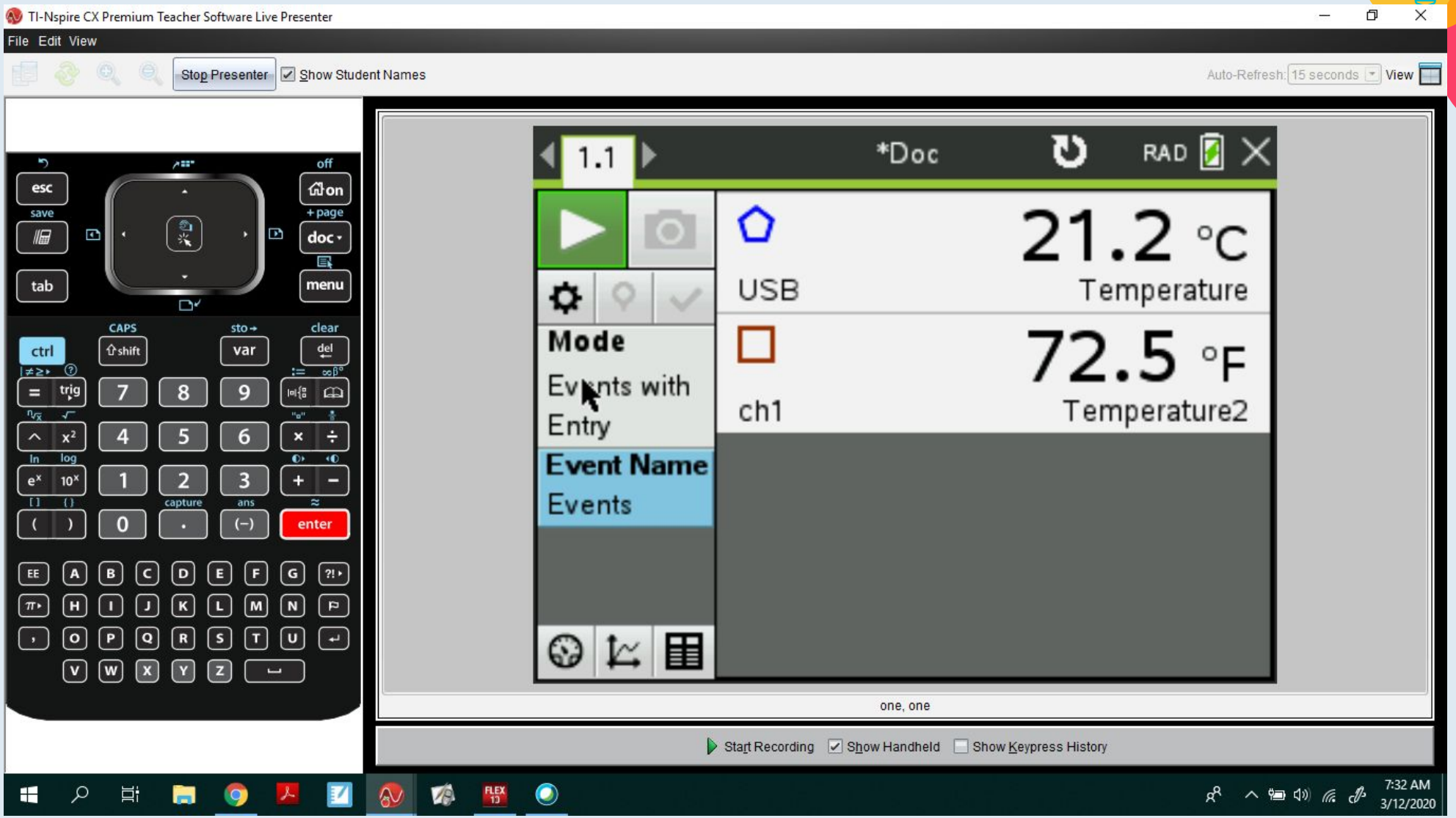
PHENOMENA

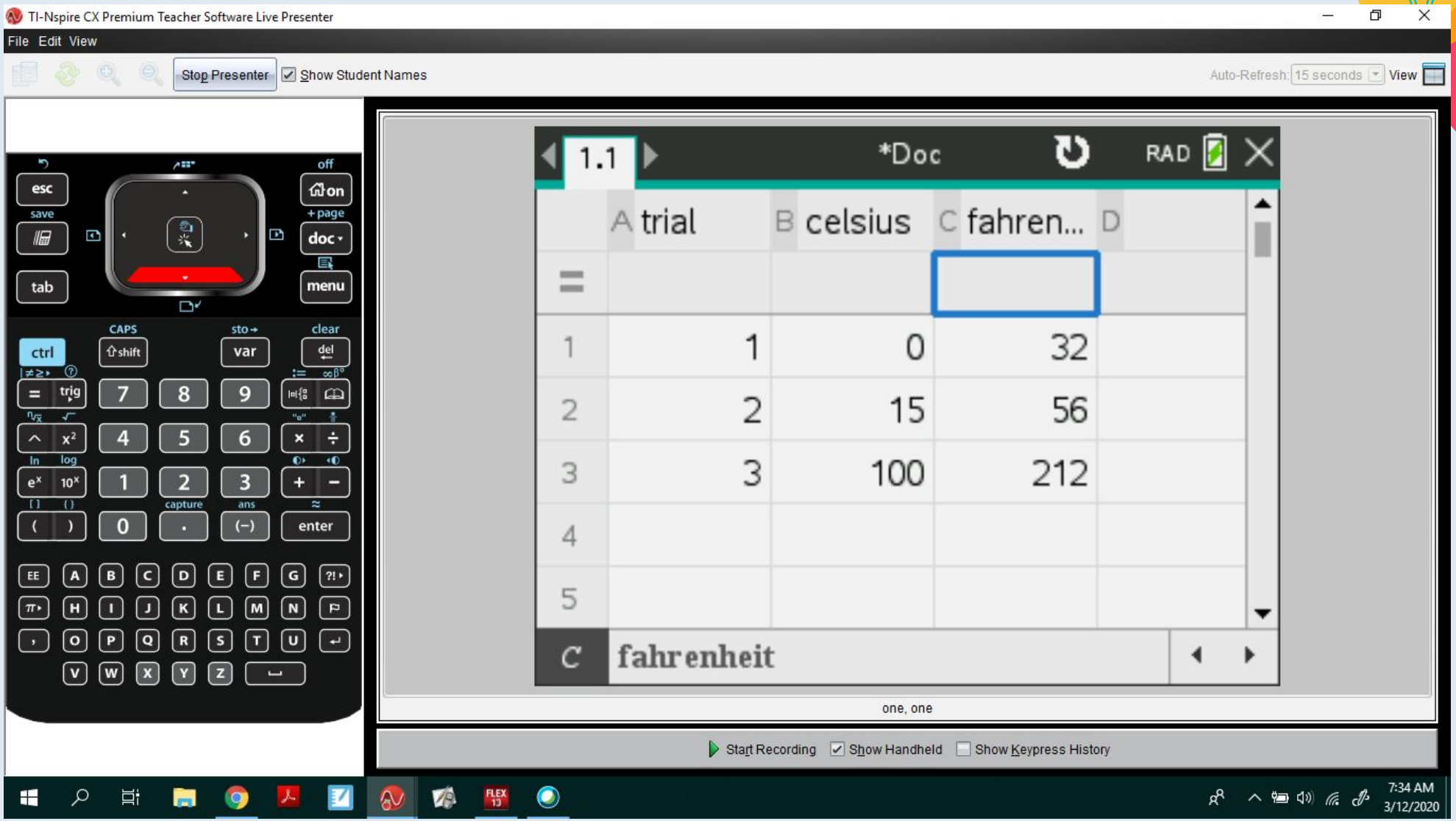
ENGAGE

Students will investigate:

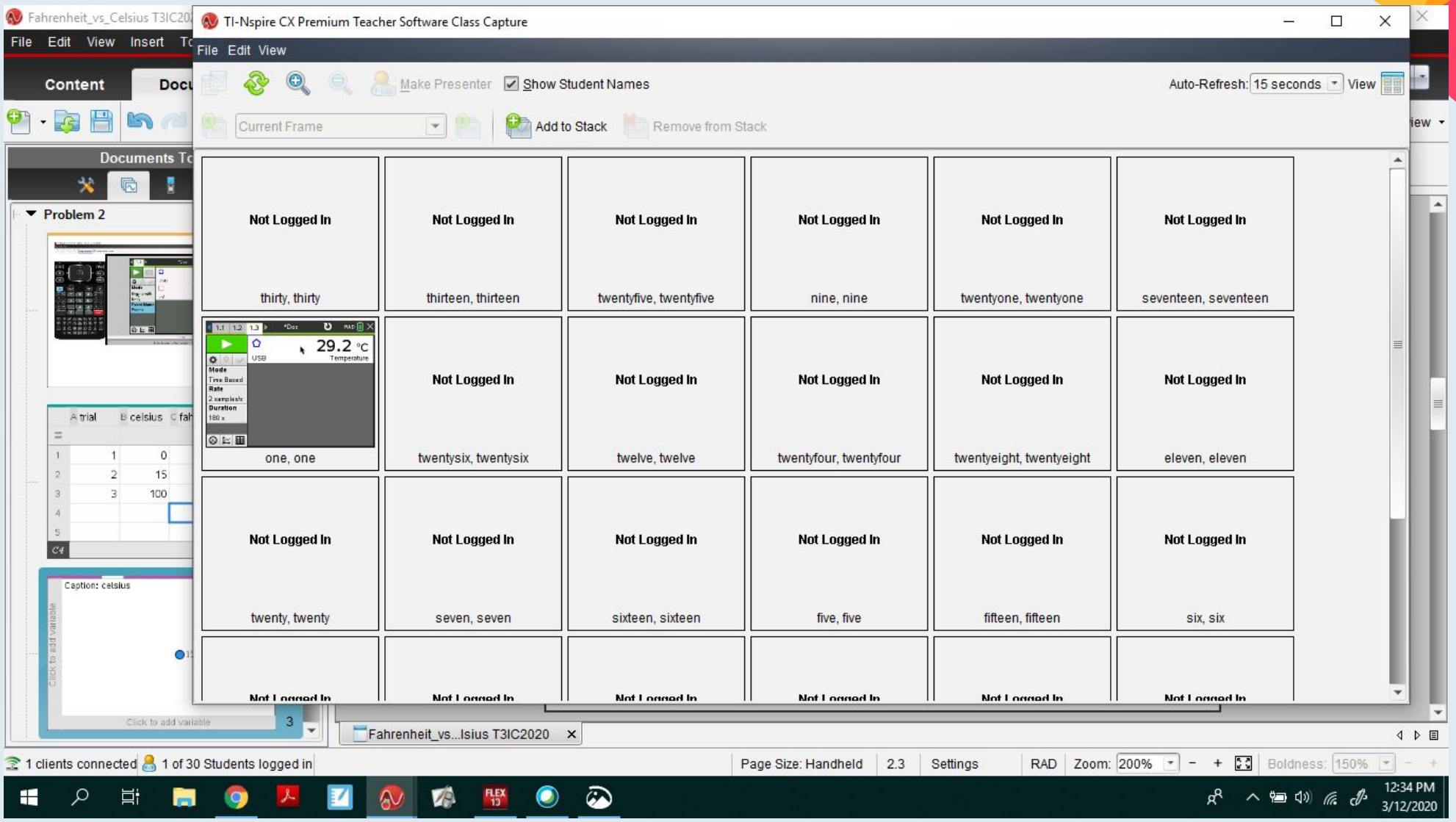
What is the mathematical relationships between Fahrenheit and Celsius temperature scales?

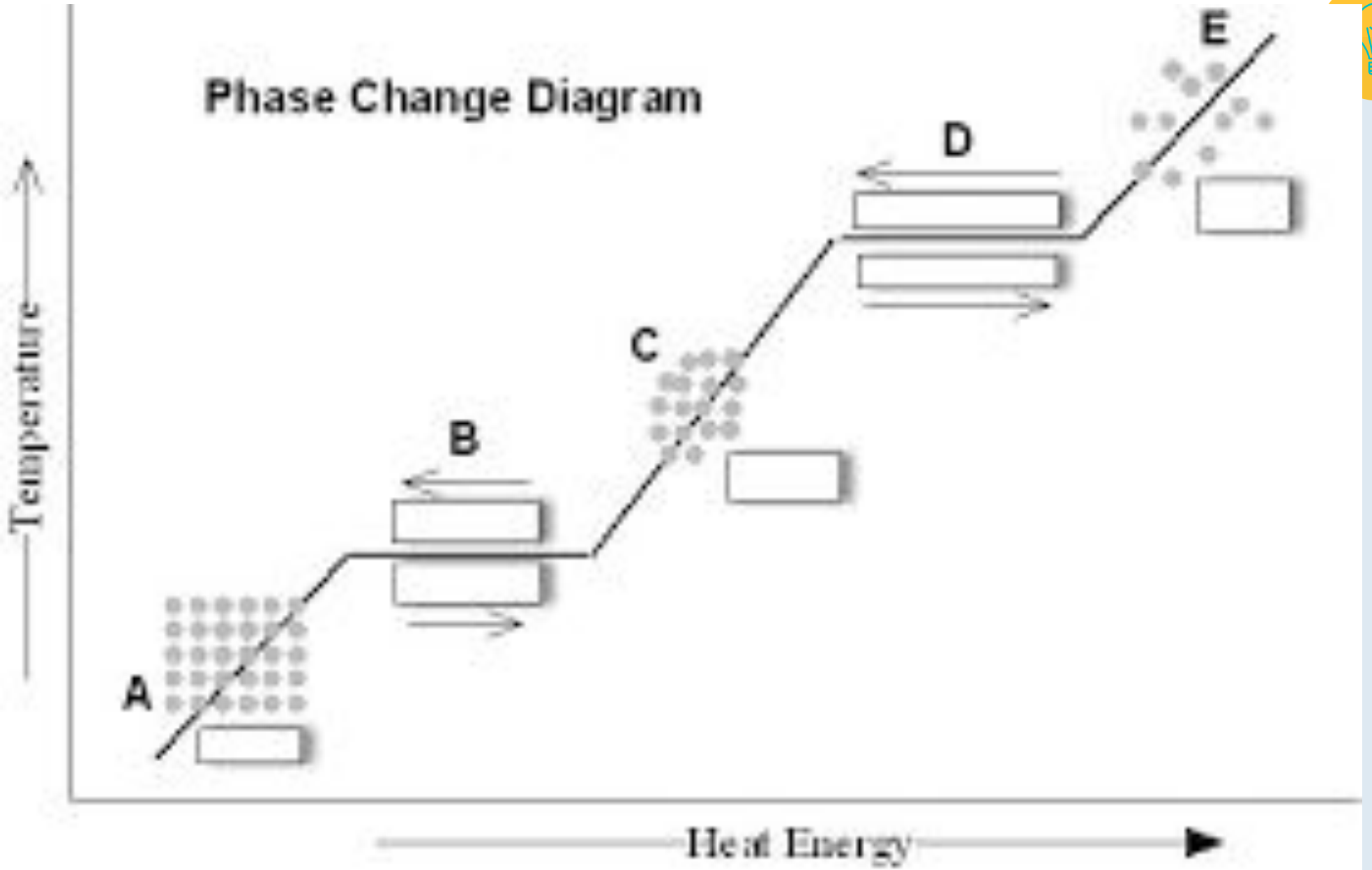
EXPLORE

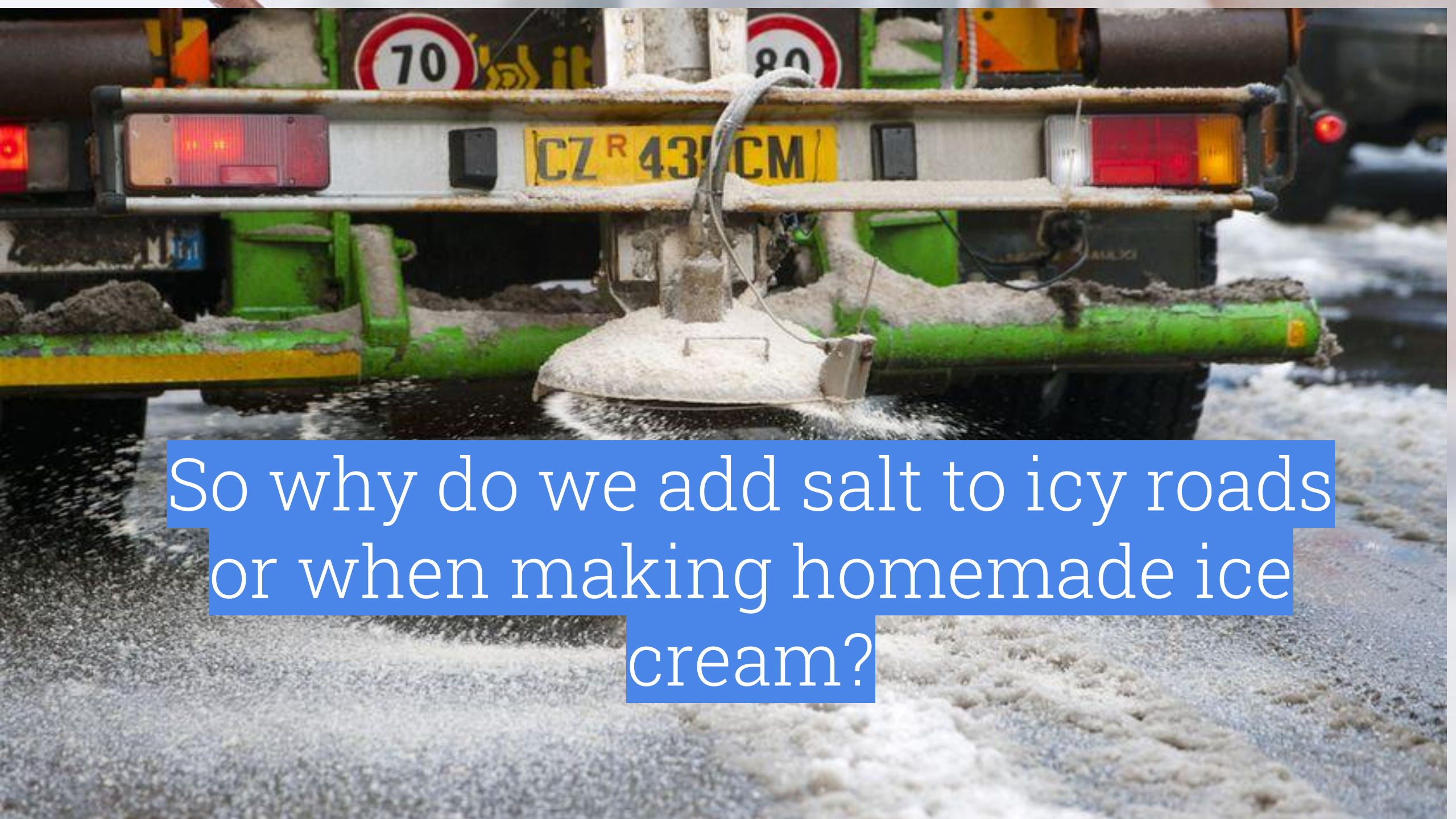

TI-Nspire CX Premium Teacher Software Live Presenter
File Edit View
Stop Presenter
Show Student Names
Auto-Refresh: 15 seconds
View
1.1
*Doc
RAD
21.2 °C
Temperature
USB
72.5 °F
Temperature2
ch1
Mode
Events with Entry
Event Name
Events
one, one
Start Recording
Show Handheld
Show Keypress History
7:32 AM
3/12/2020


TI-Nspire CX Premium Teacher Software Live Presenter
File Edit View
Stop Presenter
Show Student Names
Auto-Refresh: 15 seconds
View
1.1
*Doc
RAD
A trial
B celsius
C fahren...
D
1 1 0 32
2 2 15 56
3 3 100 212
4
5
c fahrenheit
one, one
Start Recording
Show Handheld
Show Keypress History
7:34 AM
3/12/2020

EXPLAIN


TI-Nspire CX Premium Teacher Software Class Capture
File Edit View
Make Presenter
Show Student Names
Auto-Refresh: 15 seconds
View
Current Frame
Add to Stack
Remove from Stack
Not Logged In
thirty, thirty
thirteen, thirteen
twentyfive, twentyfive
nine, nine
twentyone, twentyone
seventeen, seventeen
one, one
twentysix, twentysix
twelve, twelve
twentyfour, twentyfour
twentyeight, twentyeight
eleven, eleven
twenty, twenty
seven, seven
sixteen, sixteen
five, five
fifteen, fifteen
six, six
Problem 2
Fahrenheit_vs...Isius T3IC2020
1 clients connected
1 of 30 Students logged in
Page Size: Handheld
Settings
RAD
Zoom: 200%
Boldness: 150%
12:34 PM
3/12/2020


Phase Change Diagram
Temperature
Heat Energy
A
B
C
D
E


So why do we add salt to icy roads or when making homemade ice cream?

YOUR TASK

Investigate why salt is added to ice when making homemade ice cream

AND

why salt is added to icy roads.

EXPLORE

YOUR MATERIALS

TI Nspire CX handheld

Vernier Temperature Sensor

Cups

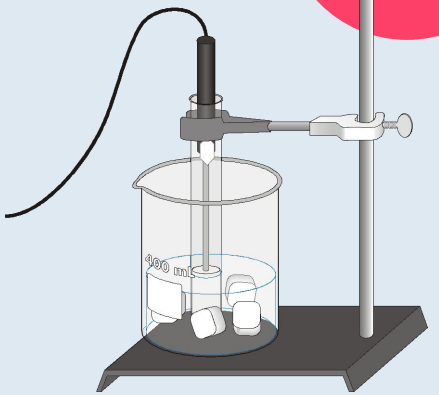
Ice

Water

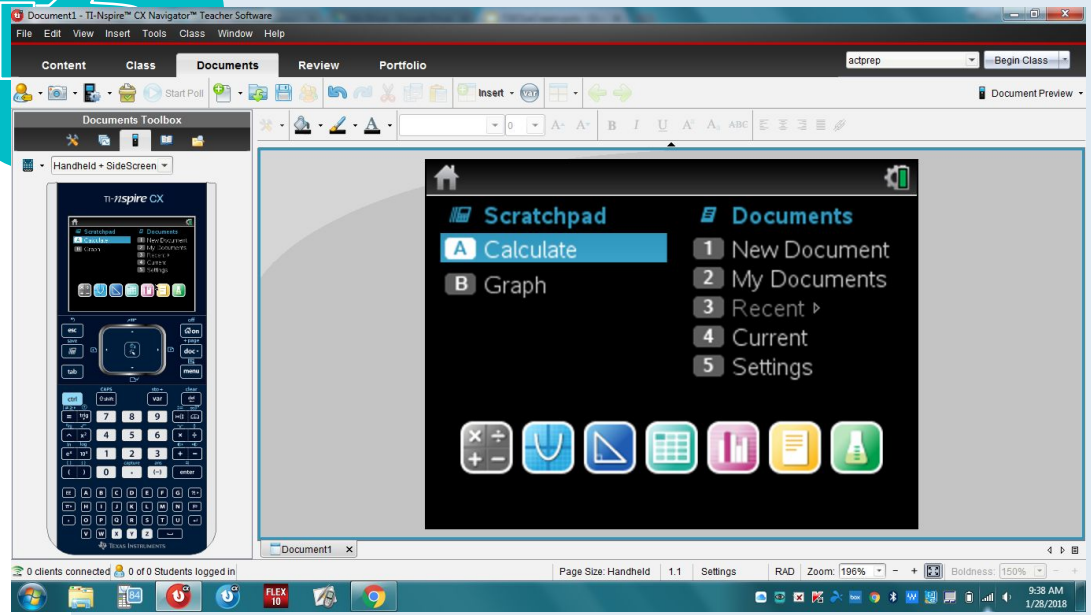
Salt

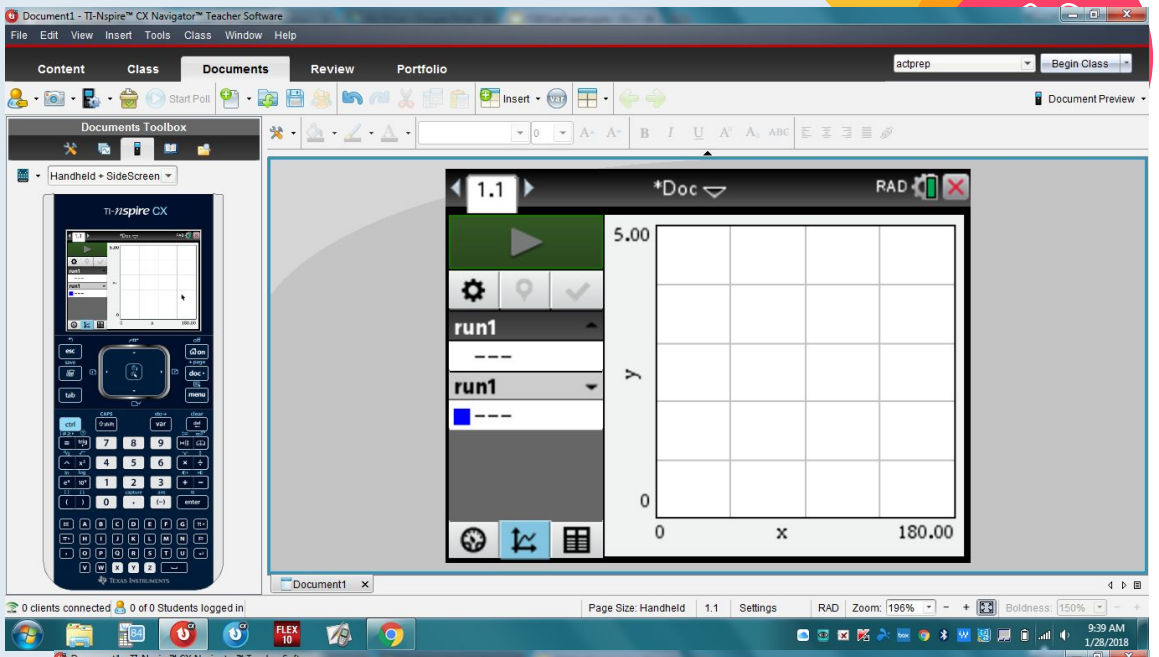
Sugar

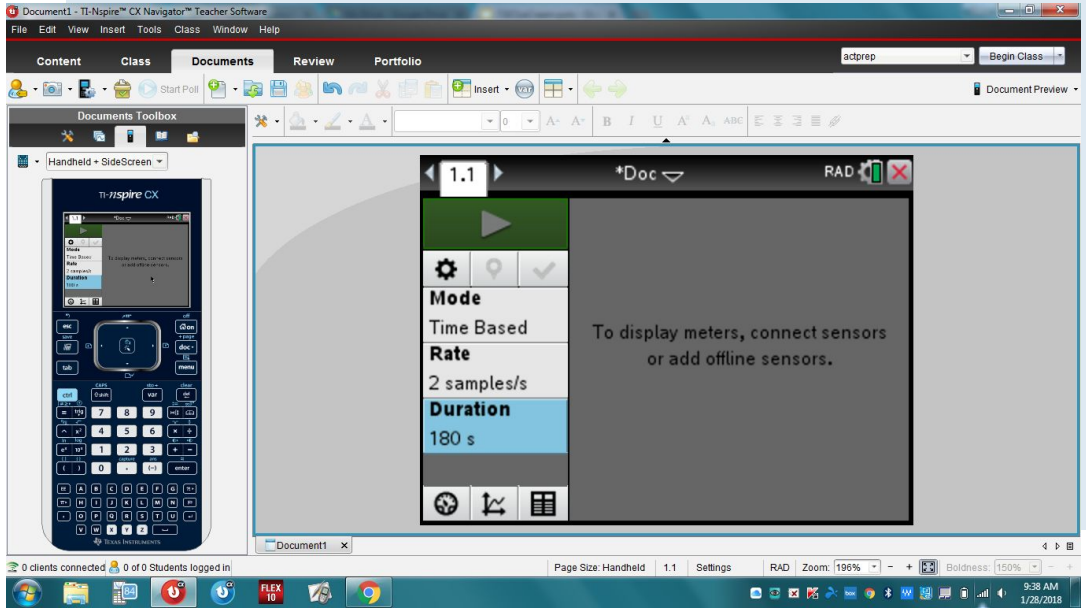
Spoons

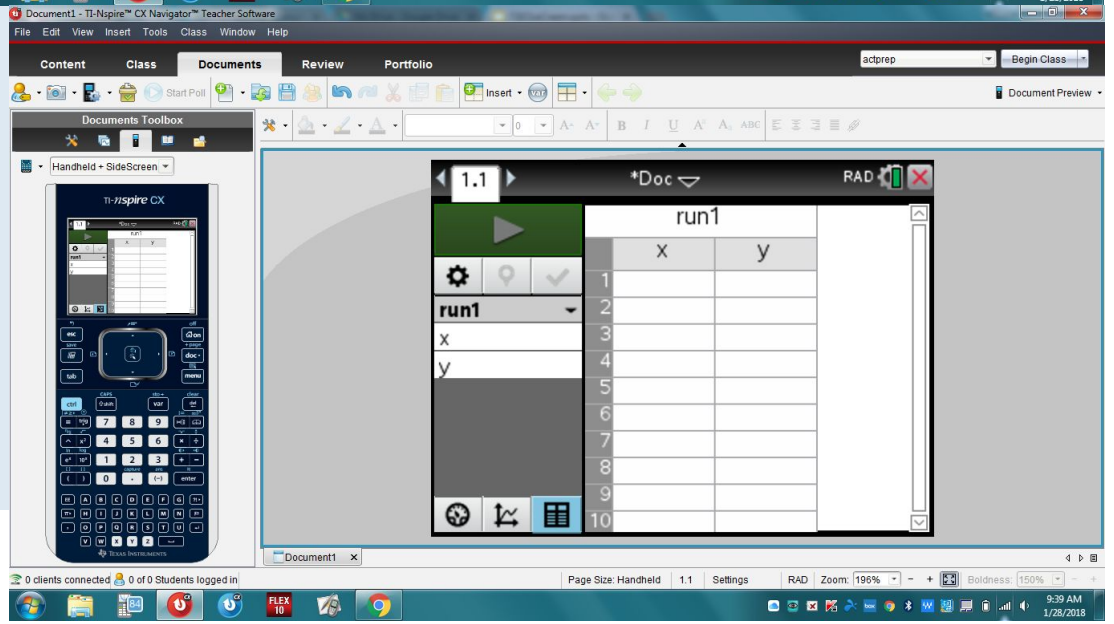


Handheld Set-Up





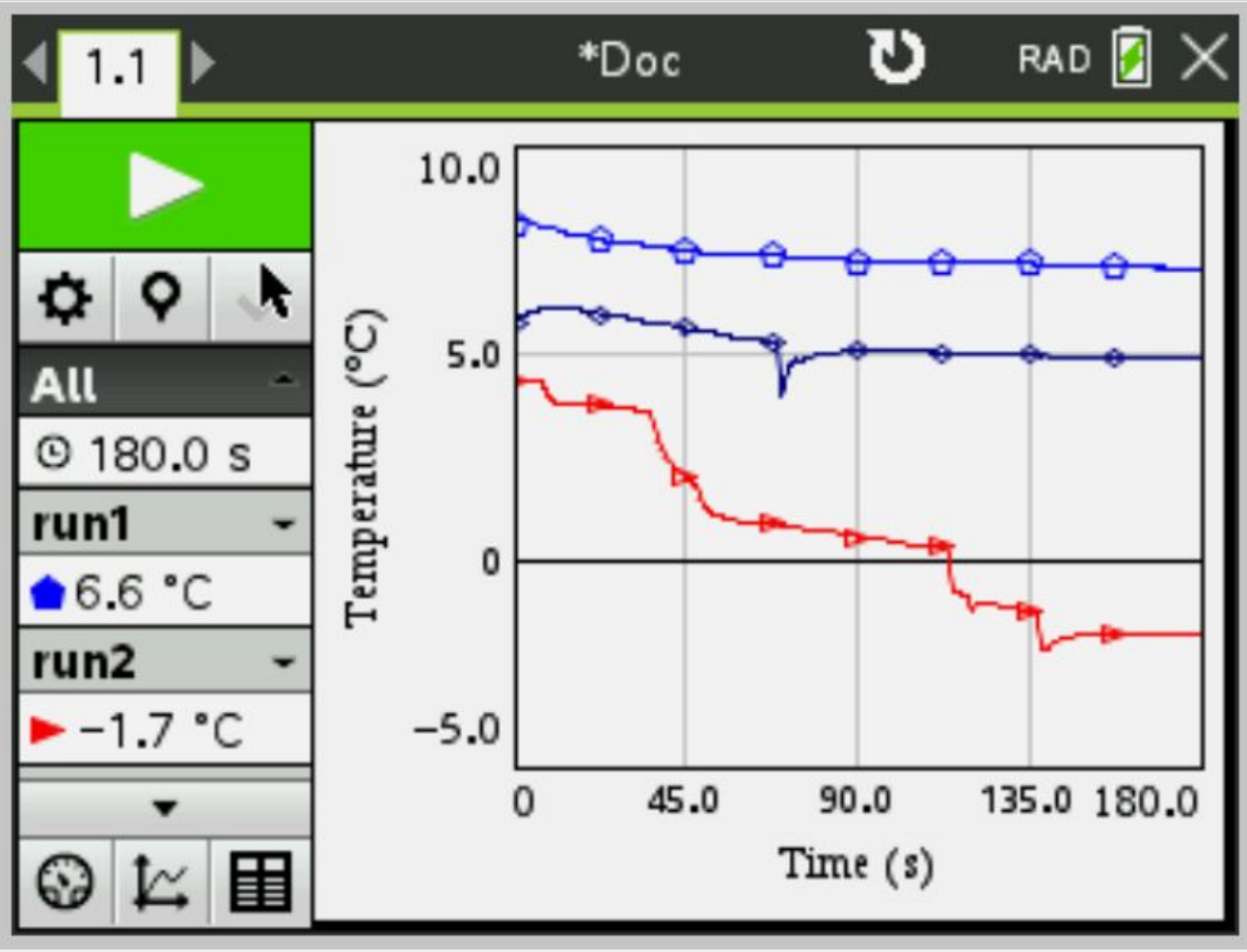




TI-Nspire CX Premium Teacher Software Live Presenter

File Edit View

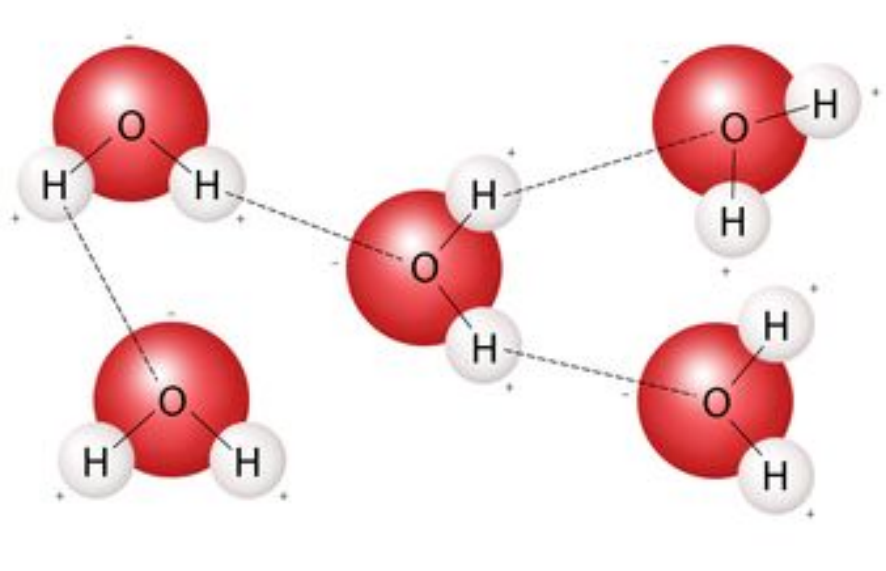
Stop Presenter | Show Student Names | Auto-Refresh: 15 seconds | View

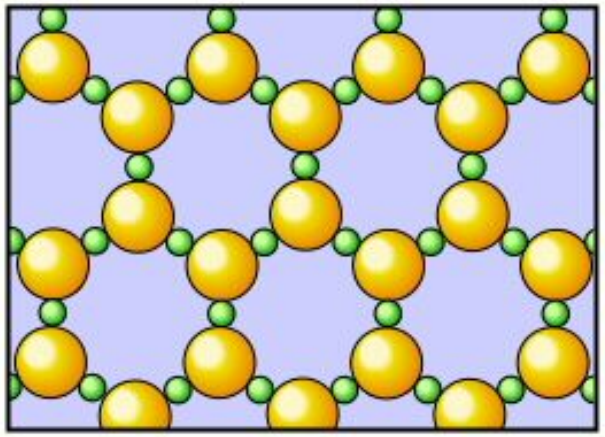


one, one

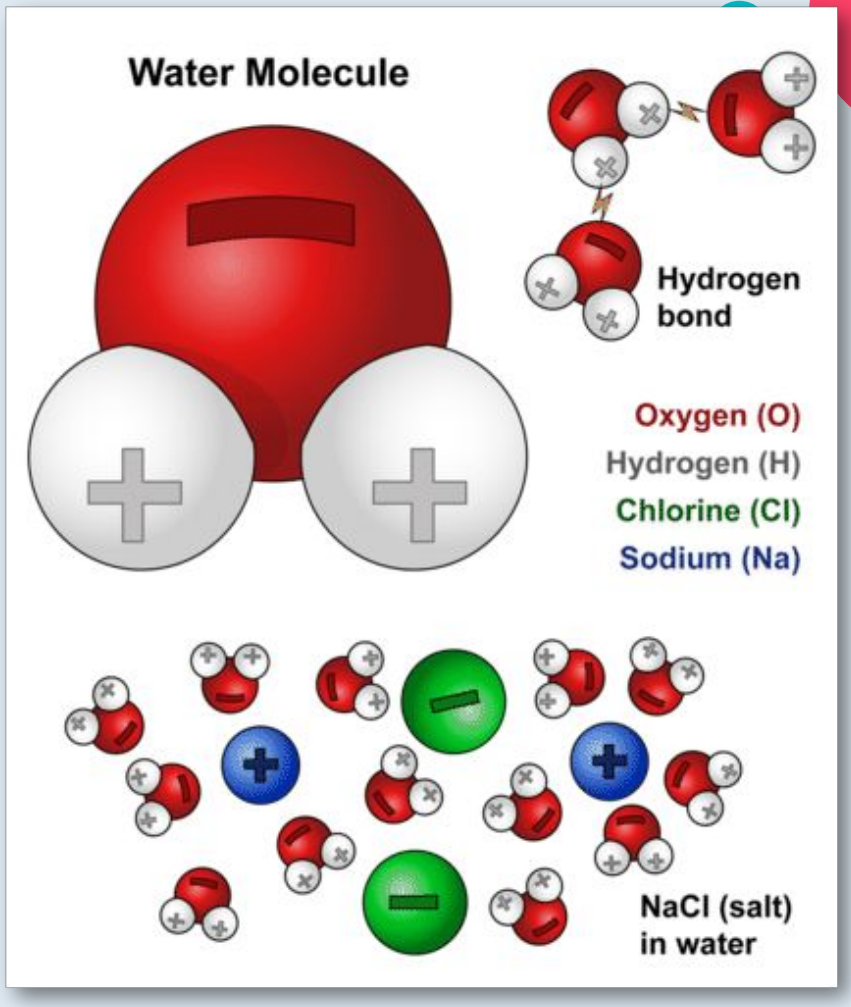
Start Recording | Show Handheld | Show Keypress History

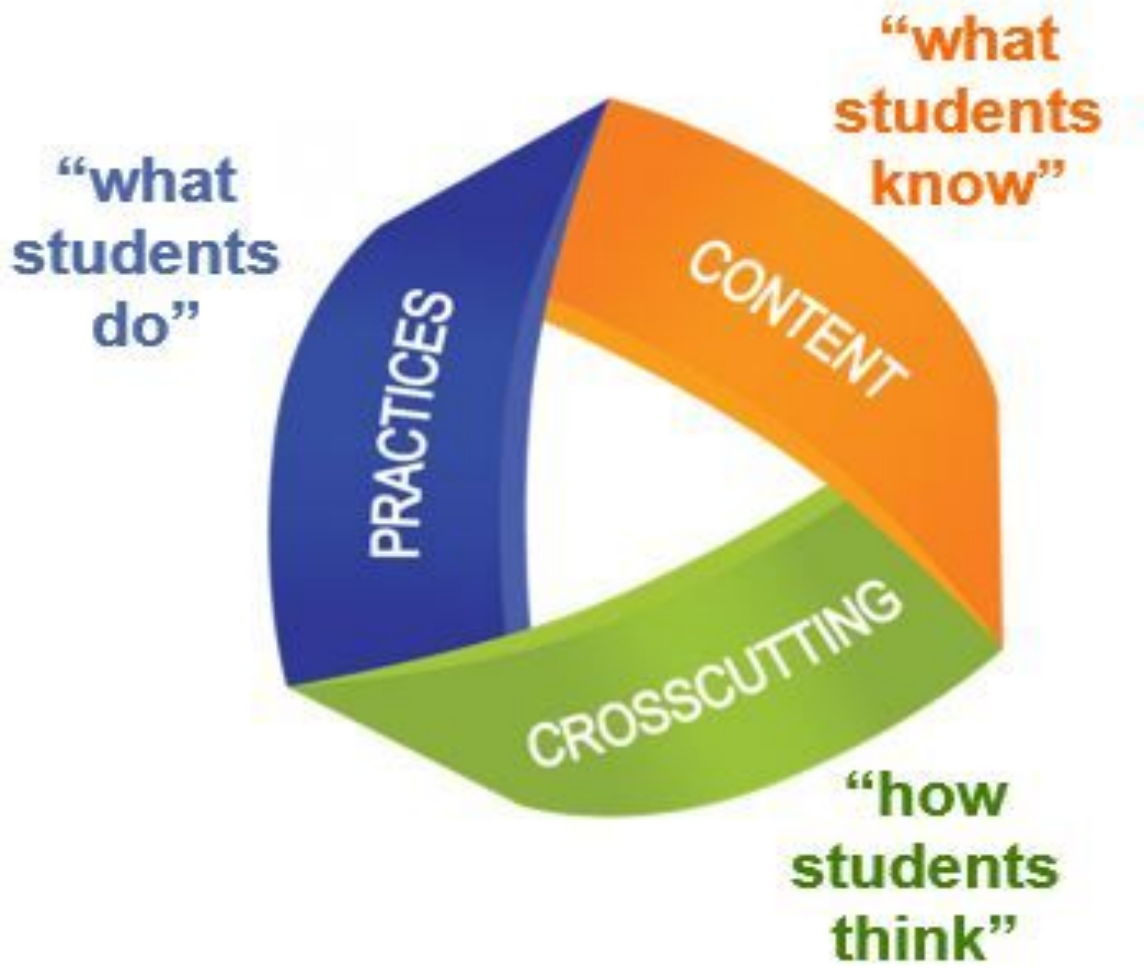
9:17 AM
3/13/2020



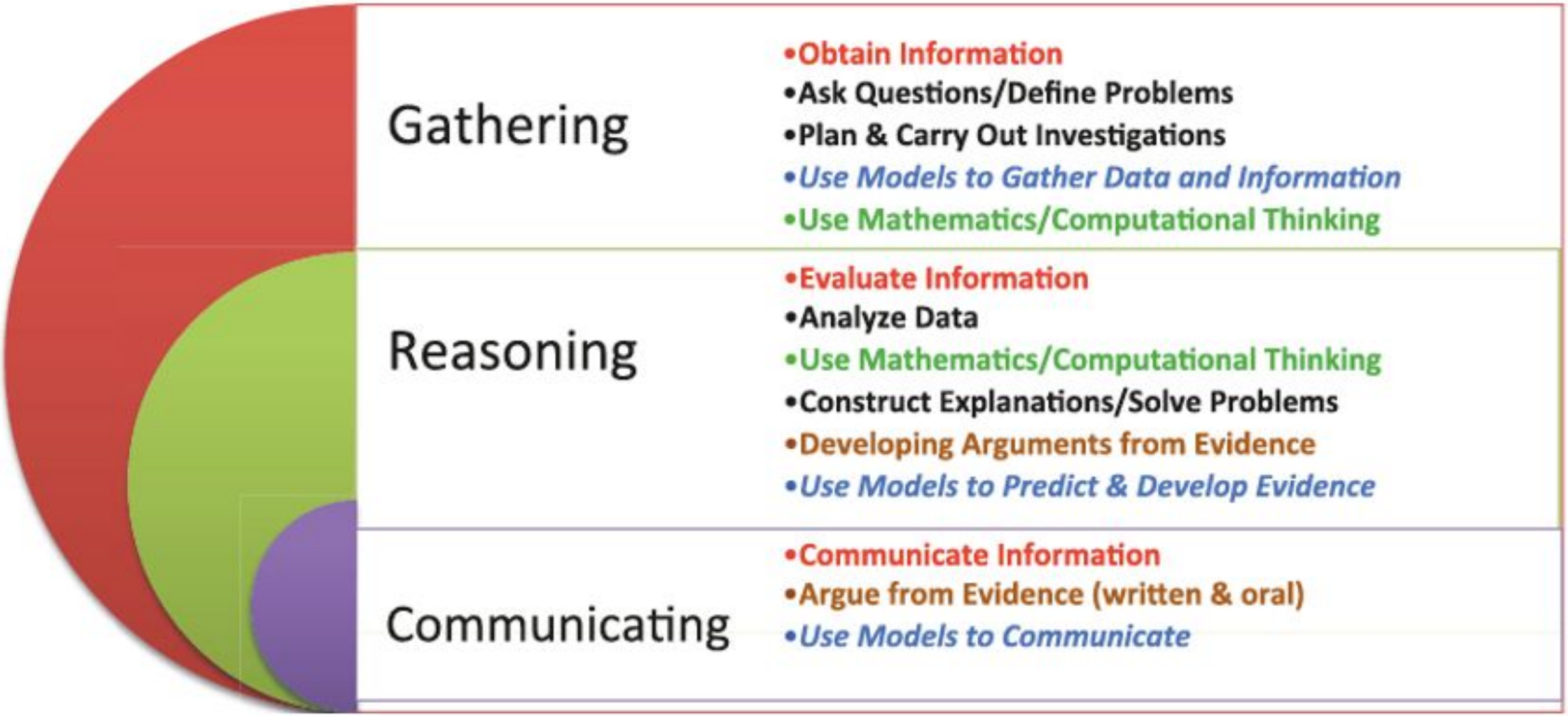


Ordered Molecular Structure of Frozen Water





Quoted text from Peter A'Hearn


Gathering
•Obtain Information
•Ask Questions/Define Problems
•Plan & Carry Out Investigations
•Use Models to Gather Data and Information
•Use Mathematics/Computational Thinking
Reasoning
•Evaluate Information
•Analyze Data
•Use Mathematics/Computational Thinking
•Construct Explanations/Solve Problems
•Developing Arguments from Evidence
•Use Models to Predict & Develop Evidence
Communicating
•Communicate Information
•Argue from Evidence (written & oral)
•Use Models to Communicate

EXPLAIN

CER Student Graphic Organizer

Question:

Claim: *What is your answer to the question? It should be more than a "yes" or "no".*

Reasoning: *How does evidence support your claim? What is the science principle that explains why evidence is linked to the claim?*

Reasoning: *How does evidence support your claim? What is the science principle that explains why evidence is linked to the claim?*

Reasoning: *How does evidence support your claim? What is the science principle that explains why evidence is linked to the claim?*

Evidence: *What is a specific observation or data from the lab that supports your claim?*

Evidence: *What is a specific observation or data from the lab that supports your claim?*

Evidence: *What is a specific observation or data from the lab that supports your claim?*

3-D Standard

SEP – Science and Engineering Practices - what the students will **do** to meet the standard.

DCI – Disciplinary Core Ideas - what concepts must be covered in order for the student to meet the standard.

CCC – Crossing Cutting Concepts -what concepts or themes are covered in this standard that are common in other content areas.

SCIENCE AND ENGINEERING PRACTICES

1. **ASKING QUESTIONS** – ASKING QUESTIONS AND DEFINING PROBLEMS IN 9–12 BUILDS ON K–8 EXPERIENCES AND PROGRESSES TO FORMULATING, REFINING, AND EVALUATING EMPIRICALLY TESTABLE QUESTIONS AND DESIGN PROBLEMS USING MODELS AND SIMULATIONS.

2. **DEVELOPING AND USING MODELS** - MODELING IN 9–12 BUILDS ON K–8 EXPERIENCES 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.

3. **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.

SCIENCE AND ENGINEERING PRACTICES

4. **ANALYZING AND INTERPRETING DATA** – ANALYZING DATA IN 9–12 BUILDS ON K–8 EXPERIENCES AND PROGRESSES TO INTRODUCING MORE DETAILED STATISTICAL ANALYSIS, THE COMPARISON OF DATA SETS FOR CONSISTENCY, AND THE USE OF MODELS TO GENERATE AND ANALYZE DATA.

5. **USING MATHEMATICAL AND COMPUTATIONAL THINKING** – MATHEMATICAL AND COMPUTATIONAL THINKING IN 9- 12 BUILDS ON K-8 EXPERIENCES 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.

SCIENCE AND ENGINEERING PRACTICES

6. **CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS** – CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS IN 9–12 BUILDS ON K–8 EXPERIENCES AND PROGRESSES TO EXPLANATIONS AND DESIGNS THAT ARE SUPPORTED BY MULTIPLE AND INDEPENDENT STUDENT-GENERATED SOURCES OF EVIDENCE CONSISTENT WITH SCIENTIFIC IDEAS, PRINCIPLES, AND THEORIES.

7. **ENGAGING IN ARGUMENT FROM EVIDENCE** – ENGAGING IN ARGUMENT FROM EVIDENCE IN 9–12 BUILDS ON K–8 EXPERIENCES AND PROGRESSES TO USING APPROPRIATE AND SUFFICIENT EVIDENCE AND SCIENTIFIC REASONING TO DEFEND AND CRITIQUE CLAIMS AND EXPLANATIONS ABOUT THE NATURAL AND DESIGNED WORLD(S). ARGUMENTS MAY ALSO COME FROM CURRENT SCIENTIFIC OR HISTORICAL EPISODES IN SCIENCE.

8. **OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION –** OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION IN 9–12 BUILDS ON K–8 EXPERIENCES AND PROGRESSES TO EVALUATING THE VALIDITY AND RELIABILITY OF THE CLAIMS, METHODS, AND DESIGNS.

DISCIPLINARY CORE IDEAS

Life Science	Earth & Space Science	Physical Science	Engineering & Technology
LS1: From Molecules to Organisms: Structures and Processes LS1.A: Structure and Function LS1.B: Growth and Development of Organisms LS1.C: Organization for Matter and Energy Flow in Organisms LS1.D: Information Processing **LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.A: Interdependent Relationships in Ecosystems LS2.B: Cycles of Matter and Energy Transfer in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS2.D: Social Interactions and Group Behavior **LS3: Heredity: Inheritance and Variation of Traits** LS3.A: Inheritance of Traits LS3.B: Variation of Traits **LS4: Biological Evolution: Unity and Diversity** LS4.A: Evidence of Common Ancestry and Diversity LS4.B: Natural Selection LS4.C: Adaptation LS4.D: Biodiversity and Humans	**ESS1: Earth's Place in the Universe** ESS1.A: The Universe and Its Stars ESS1.B: Earth and the Solar System ESS1.C: The History of Planet Earth **ESS2: Earth's Systems** ESS2.A: Earth Materials and Systems ESS2.B: Plate Tectonics and Large-Scale System Interactions ESS2.C: The Roles of Water in Earth's Surface Processes ESS2.D: Weather and Climate ESS2.E: Biogeology **ESS3: Earth and Human Activity** ESS3.A: Natural Resources ESS3.B: Natural Hazards ESS3.C: Human Impacts on Earth Systems ESS3.D: Global Climate Change	**PS1: Matter and Its Interactions** PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions PS1.C: Nuclear Processes **PS2: Motion and Stability: Forces and Interactions** PS2.A: Forces and Motion PS2.B: Types of Interactions PS2.C: Stability and Instability in Physical Systems **PS3: Energy** PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes and Everyday Life **PS4: Waves and Their Applications in Technologies for Information Transfer** PS4.A: Wave Properties PS4.B: Electromagnetic Radiation PS4.C: Information Technologies and Instrumentation	**ETS1: Engineering Design** ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution **ETS2: Links Among Engineering, Technology, Science, and Society** ETS2.A: Interdependence of Science, Engineering, and Technology ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World ***Note:*** *In NGSS, the core ideas for Engineering, Technology, and the Application of Science are integrated with the Life Science, Earth & Space Science, and Physical Science core ideas*

CROSS CUTTING CONCEPTS

1. **PATTERNS –** OBSERVED PATTERNS IN NATURE GUIDE ORGANIZATION AND CLASSIFICATION AND PROMPT QUESTIONS ABOUT RELATIONSHIPS AND CAUSES UNDERLYING THEM.

2. **CAUSE AND EFFECT –** EVENTS HAVE CAUSES, SOMETIMES SIMPLE, SOMETIMES MULTIFACETED. DECIPHERING CAUSAL RELATIONSHIPS, AND THE MECHANISMS BY WHICH THEY ARE MEDIATED, IS A MAJOR ACTIVITY OF SCIENCE AND ENGINEERING.

3. **SCALE, PROPORTION AND QUANTITY –** IN CONSIDERING PHENOMENA, IT IS CRITICAL TO RECOGNIZE WHAT IS RELEVANT AT DIFFERENT SIZE, TIME, AND ENERGY SCALES, AND TO RECOGNIZE PROPORTIONAL RELATIONSHIPS BETWEEN DIFFERENT QUANTITIES AS SCALES CHANGE.

CROSS CUTTING CONCEPTS

4. **SYSTEMS AND SYSTEM MODELS** –A SYSTEM IS AN ORGANIZED GROUP OF RELATED OBJECTS OR COMPONENTS; MODELS CAN BE USED FOR UNDERSTANDING AND PREDICTING THE BEHAVIOR OF SYSTEMS.

5. **ENERGY AND MATTER** – TRACKING ENERGY AND MATTER FLOWS, INTO, OUT OF, AND WITHIN SYSTEMS HELPS ONE UNDERSTAND THEIR SYSTEM'S BEHAVIOR.

6. **STRUCTURE AND FUNCTION** – GRADES 9-12: THE WAY AN OBJECT IS SHAPED OR STRUCTURED DETERMINES MANY OF ITS PROPERTIES AND FUNCTIONS.

Resources

GENERAL INFORMATION:

- CER information
- education.ti.com
- Gather Reasoning Communicating resource
- Next Generation Science Standards (NGSS)
- NGSS Hub

BOOKS:

- A Vision and Plan for Science Teaching and Learning
- A Framework for K-12 Science Education
- The NSTA Quick-Reference Guide to the NGSS

ARTICLES:

- Three-Dimensional Instruction - A New Type of Teaching