



**The Concord  
Consortium**

Revolutionary digital learning  
for science, math and engineering

# Powerful, Free Models and Simulations for Chemistry Teaching

Chad Dorsey, President & CEO  
The Concord Consortium, Concord, MA



Project work supported by funding  
from the National Science Foundation



Science education today is  
changing at a blinding pace





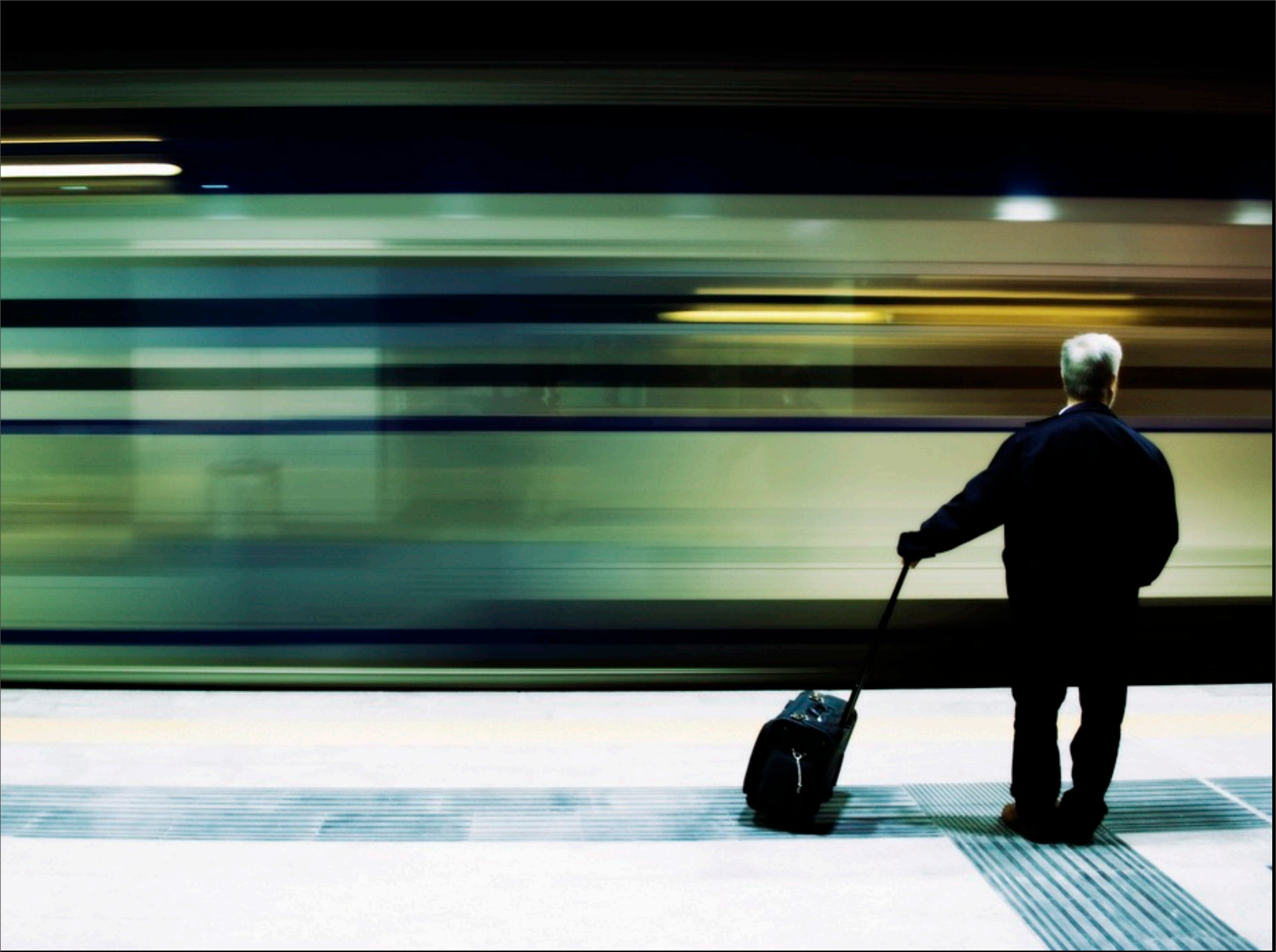
You want  
your  
children to  
be prepared  
for the  
needs of  
tomorrow





Today's education needs to keep pace with the needs of tomorrow's world



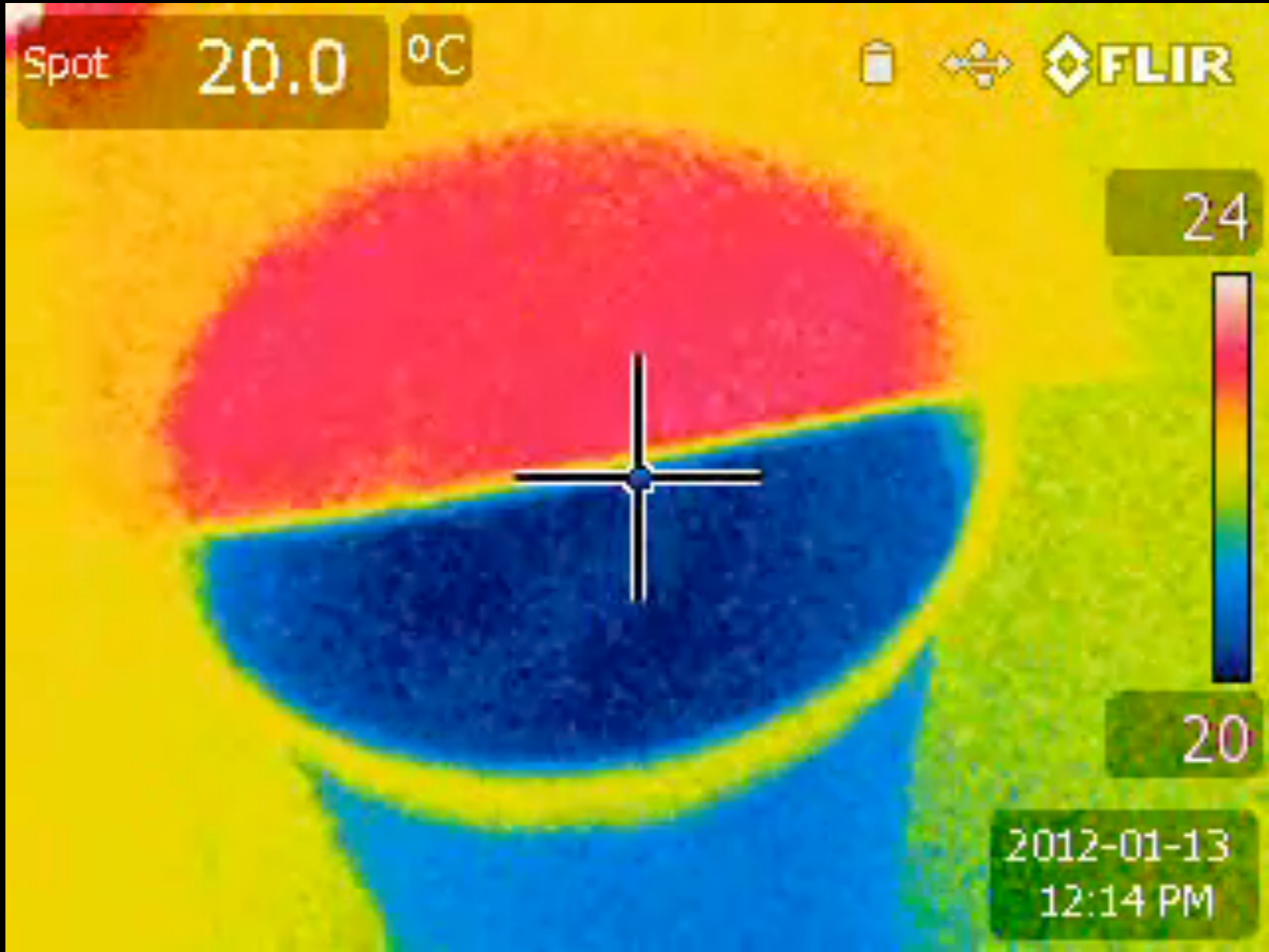








# Thermal (IR) camera







**Overview  
and Background**



**Examples of  
The Practices**



**Putting them  
into Action**



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**NEXT GENERATION**

**SCIENCE**

**STANDARDS**



# A FRAMEWORK FOR K-12 SCIENCE EDUCATION

Practices, Crosscutting Concepts, and Core Ideas

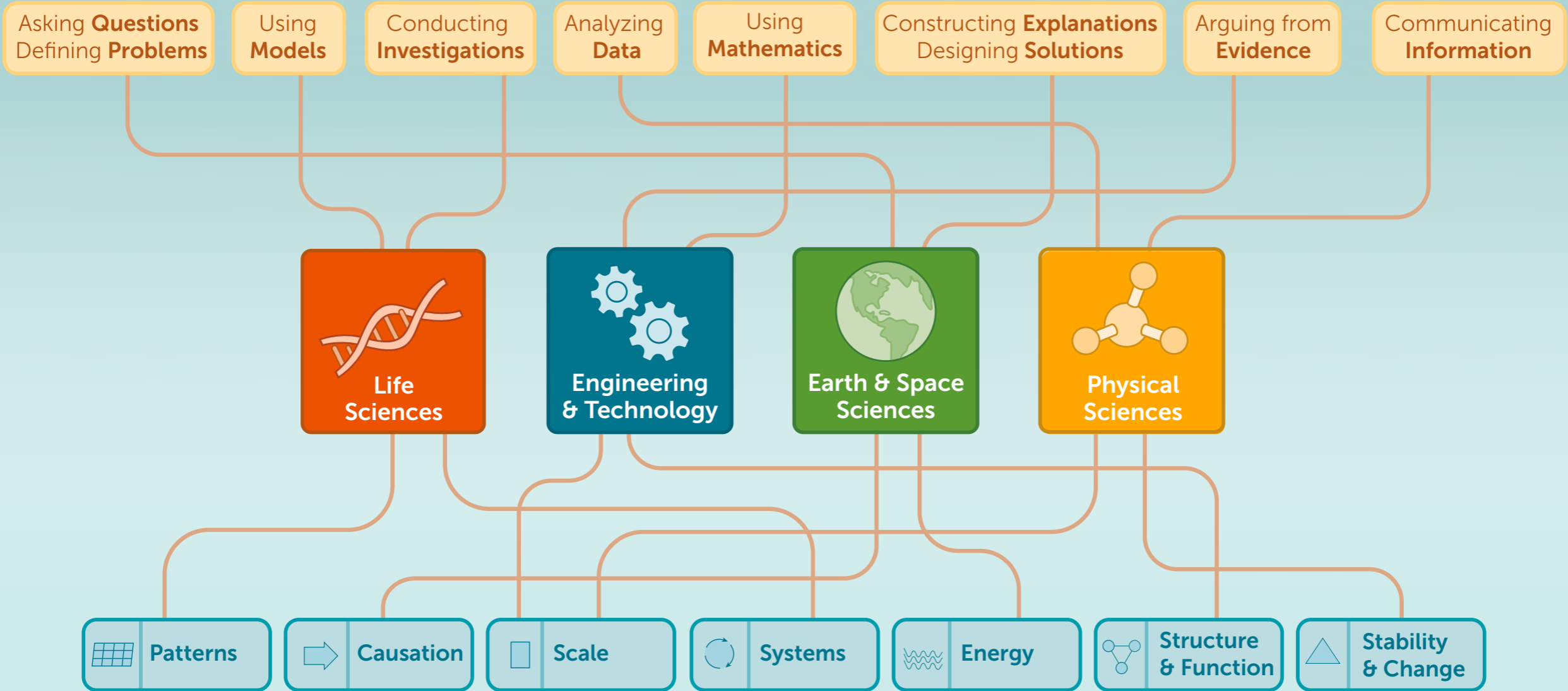
NATIONAL RESEARCH COUNCIL  
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# Scientific and Engineering Practices

- Asking questions / defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations / designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, communicating information







Overview  
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Examples of  
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Putting them  
into Action

# Asking Questions



# Asking Questions

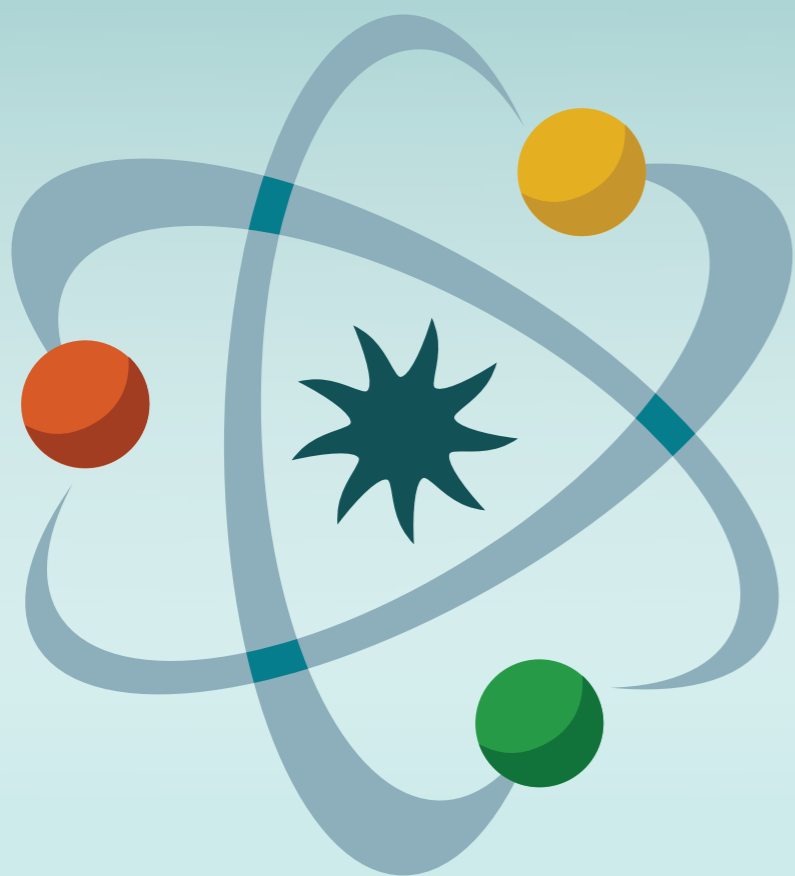
- Asking questions is essential to developing scientific habits of mind
- Questions are important in both science and engineering
- Students should be able to ask scientific questions that can be investigated
- Students should be able to distinguish scientific from non-scientific questions

# Developing and Using Models



# Developing and Using Models

- Models are representations of phenomena
- Models are always analogous to the phenomena they represent in some way
- Many kinds of models exist
  - Drawings
  - Physical models
  - Mathematical equations
- Many concepts are often modeled best through simulation



# **Molecular Workbench**



# Next-Generation Molecular Workbench

Now you can use our award-winning molecular simulations anytime, anywhere.

## Try These Activities



### States of Matter

Learn what gas, liquid and solids look like at the atomic scale.



### Boiling Point

See what happens at the molecular level when a substance starts to boil.



### Solubility

Discover why some substances dissolve in water while others do not.

Molecular Workbench is already one of the most versatile ways to experience the science of atoms and molecules. Now thanks to Google's generosity and the power of HTML5, we're bringing it to Web browsers everywhere. Try out the activities listed at right to see for yourself.

### Molecular Models

Need a simple model to show intermolecular attractions, gas laws or phase change? Embed these interactives in your own website or blog. [Find an interactive now](#) »

## Try These Activities



### States of Matter

Learn about phase change — a major factor in creating climate on Earth among many other interesting phenomena.

[Run Activity](#) »



### Boiling Point

The temperature at which substances boil is determined by intermolecular attractions. Explore how these forces affect a substance's boiling point.

[Run Activity](#) »



### Solubility

Have you ever wondered why oil and water don't mix? Discover why some substances dissolve in water while others do not.

[Run Activity](#) »

# Intermolecular Attractions and Boiling Point

All molecules attract to each other.

The model shows a drop of a polar liquid and a drop of a non-polar liquid. By heating these liquids, you can vaporize (boil) them, causing molecules to break free of their intermolecular attractions.

Which liquid boiled first?

- polar
- non-polar

Check Answer

How could you tell when the liquids boiled?

Rubbing alcohol is less polar than water.  
Both are liquids at room temperature.  
Which one boils first? Why?

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Full Screen

Share About

210 K

Cool Heat

Oil and Water Shaken Up and Mixed

6.7 (s)

Gravity (m/s<sup>2</sup>) 9.8

Rod Length (cm) 100

1 20 10 cm 2 m

Share About

A wall with a pressure gauge.

Volume ↑ Volume ↓ Volume of Gas 1.40 nm<sup>3</sup>

Pressure (Bar) 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0

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# Planning & Carrying Out Investigations

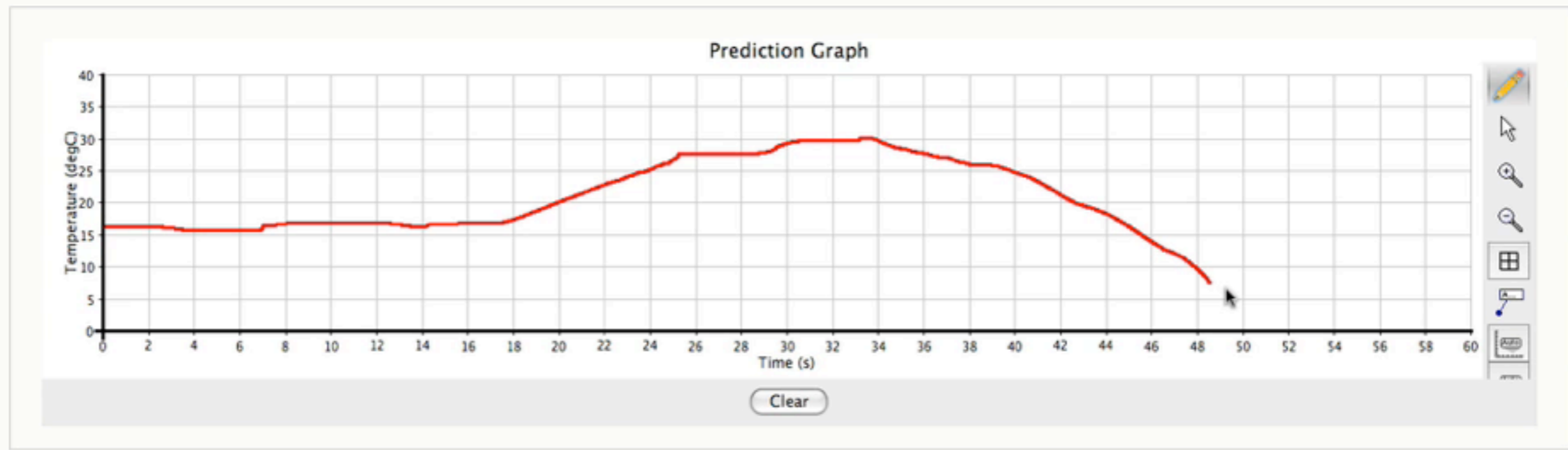


# Planning and Carrying Out Investigations

- Scientists and engineers explore the world in part to test theories and explanations
- Testing explanatory models requires planned investigation
- Investigations must identify the relevant variables and consider how they might be observed, measured and controlled
- Planning for controls is an important part of the design of investigations

Time (s)

Start Stop Clear



4. Test your prediction:

- a. Measure the cold water for 10 seconds.
- b. Measure the warm water for 10 seconds.
- c. Pour the small cup of water into the large cup. Measure and record the temperature of the mixture.



# **Engaging in Argument from Evidence**



# Arguing from Evidence

- Science is replete with arguments that take place both informally and formally.
- Historical case studies show how new ideas are often difficult to accept and have to be argued for.
- The knowledge and ability to detect “bad science” are requirements both for the scientist and the citizen.
- Students should be able to understand and construct arguments, identify flaws, and improve their arguments

# Heat of Solution

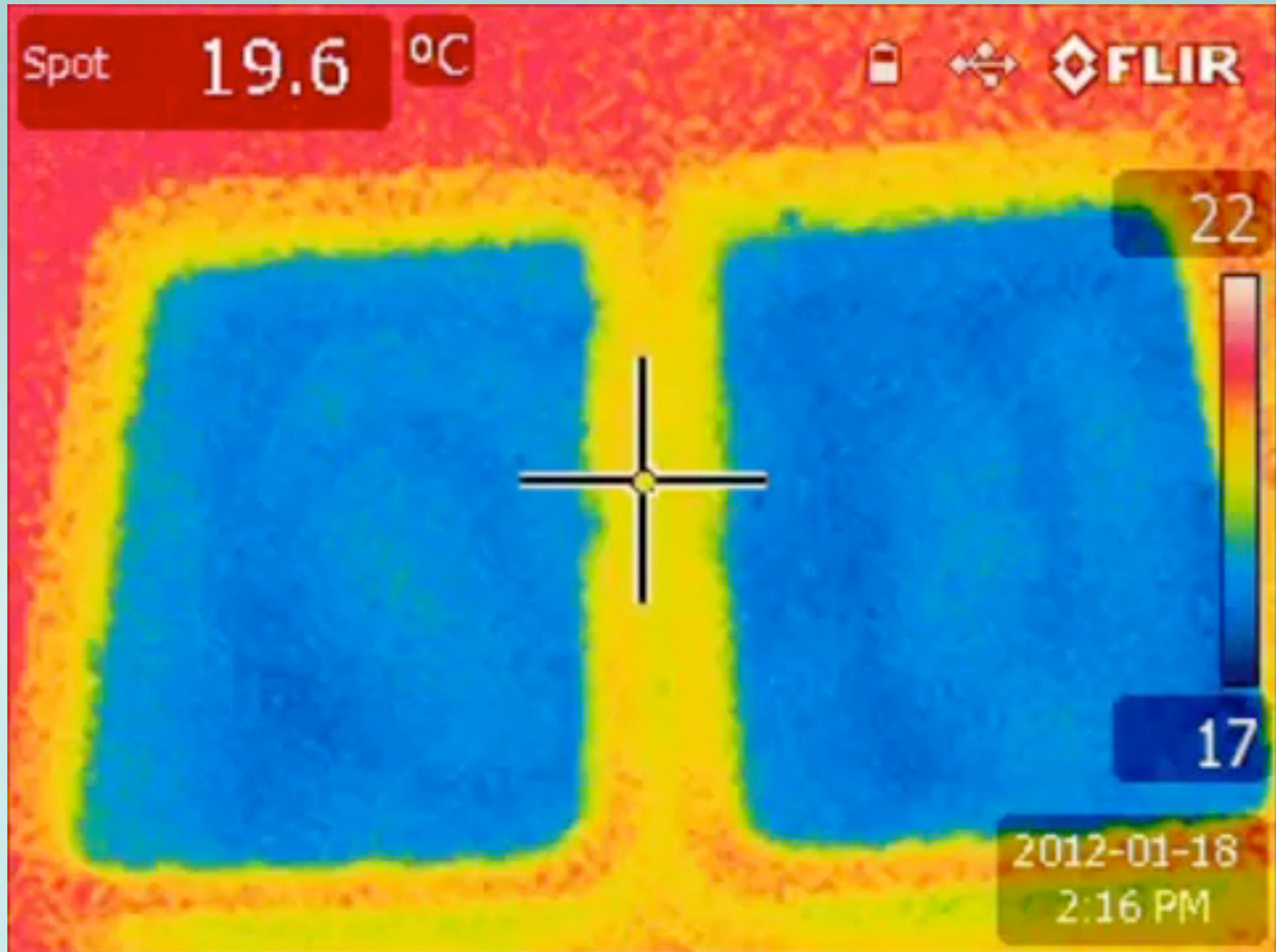


Table salt

Fresh water



# Freezing Point Depression



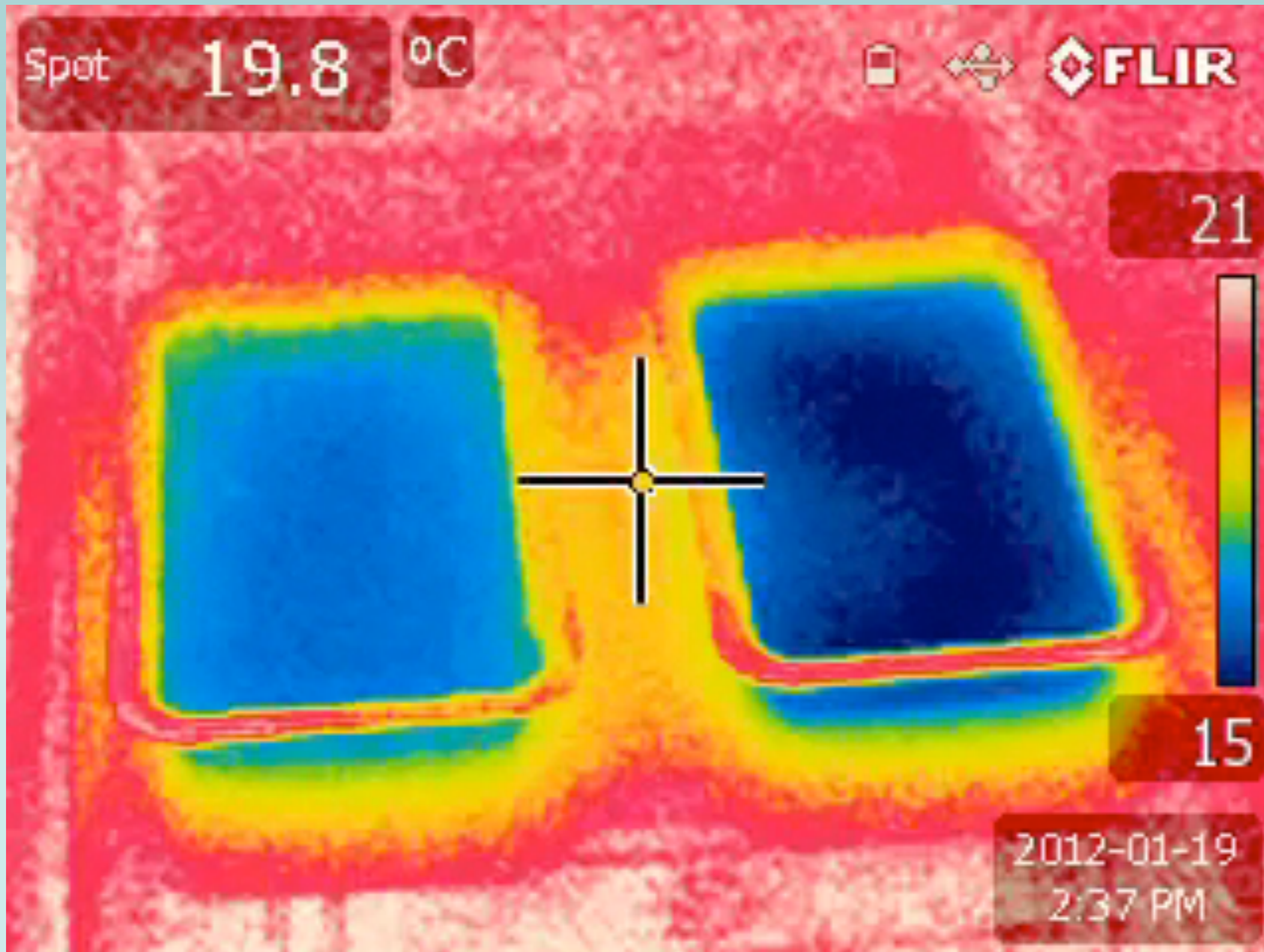
Table salt

Sugar

Ice



# Vapor Pressure Lowering

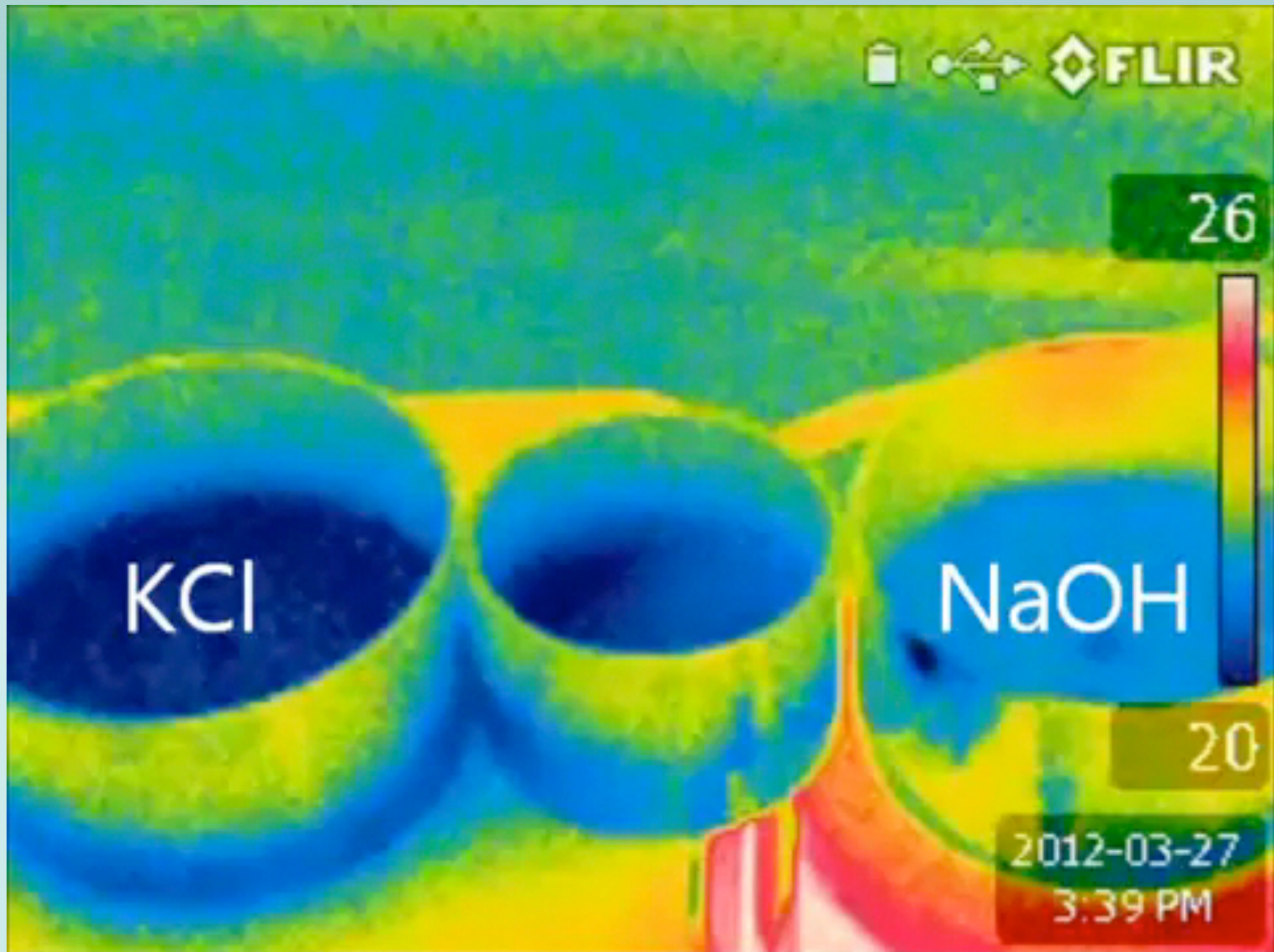


Salt water

Fresh water



# Heats of Solution



From Darren Binnema, The King's University College



**Overview  
and Background**



**Examples of  
The Practices**



**Putting them  
into Action**



Activities

For School & Home

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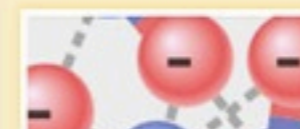
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### SmartGraphs Contest

Create a math, science or social science activity for our SmartGraphs software and you could win an iPod, \$100 Amazon gift card and have your activity featured on our website! Graphs are everywhere in STEM classrooms, but

understanding them is another matter. Free SmartGraphs activities provide interactive hints and scaffolding for students as they learn. We're excited to see what kinds of activities you create using our new authoring system. [Learn more »](#)



### Molecular Workbench Co-Design Workshop

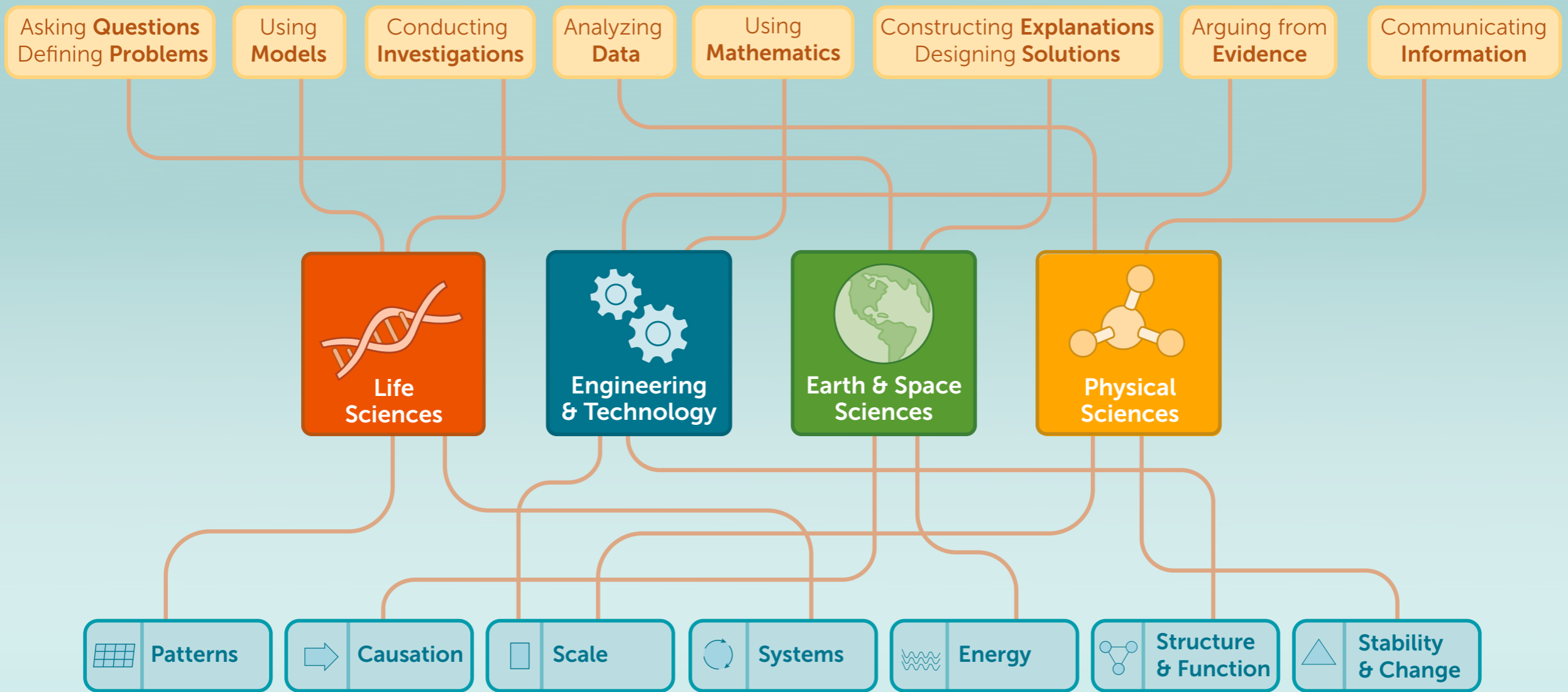
Have you dreamed up molecular

# HTML



Google





[concord.org/ngss](http://concord.org/ngss)

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