

Weather and Climate for Educators:

The Science of Weather and Climate

Wednesday, July 9: Energy

Morning

8:00 Refreshments

8:30 Warm Up

- Cubes & Discussion

8:45 Course & Content Overview

- Introductions / Teachers / Course presenters
- Pre-test
- Overview of course structure / assignment / credit
- Practical details

9:30 Engage / Explore / Explain: Energy & Radiation

- Energy concepts: *What is energy?*
- Conservation of energy: *Can energy be created or destroyed?*
- Numbers & efficiency: *How much energy does it take to climb a set of stairs?*

10:30 Break

10:45 Explain: EM Spectrum

- Scales of energy and wavelength
- Interaction of electromagnetic waves with matter

11:00 Engage / Explore / Explain: EM Radiation

- The visible spectrum: *Rainbow glasses*
- Beyond the rainbow, part I: *Can you see beyond the rainbow?*
- Beyond the rainbow, part II: *Would you get a sunburn on Mars?*
- Photon energy: *What is the difference between red light and blue light?*

11:45 Extend / Evaluate

- Investigation: *Why do the solar insects work under the incandescent bulbs but not under the fluorescent bulbs?*
- Activity / Discussion: Cubes, Part II (new version without clear patterns) Crux of the biscuit: *Everyone has something to add to discussions, and there are multiple ways to look at things.*

12:00 Lunch

Afternoon

1:00 Engage / Explore / Explain: Energy & EM Radiation

- Way beyond the rainbow, Part I (Thermal camera demonstrations): *Seeing thermal radiation.*
- Way beyond the rainbow, Part II (Thermal camera demonstrations): *Thermal energy transmission, emission, absorption.*
- Radiation as a means of energy transfer: *Can you “see” thermal radiation?*
- Introduction to the thermal sensors: *What do “infrared thermometers” measure?*

1:45 Extend / Evaluate

- Cubes: EM Cubes

2:00 Engage / Explore / Explain: Radiation and Energy on Earth, Part I

- Kinesthetic activity: *What makes a gas a greenhouse gas?*
- Energy and the atmosphere: *What is the greenhouse effect?*
- Understanding energy in the atmosphere, Part I: *What is a model?*
- Understanding energy in the atmosphere, Part II: *How does the atmosphere keep the Earth warmer?*

2:45 Extend / Evaluate

- Discussion: *Why does it get colder as you go higher in the atmosphere?*

3:00 Break

3:15 Engage / Explore / Explain: Radiation and Energy on Earth, Part II

- Greenhouse effect review: *How does the Earth cool itself off?*
- Absorption and albedo: *How does snow make the weather colder?*
- Absorption, emission, transmission: *Why does it get colder on clear nights than on cloudy nights?*

4:15 Extend / Evaluate: Radiation and Energy on Earth

- Discussion: *Why is July hotter than May? (Peak radiation vs. peak temperature discussion.)*

4:30 Adjourn

Evening The Light, The Dark and the Stars

- *Bring your thermal sensors to give a forecast for the morning temperature!*

Thursday, July 10: Air & water & clouds

Morning

8:00 Refreshments

8:30 Engage / Explore / Explain: Air, Water & Clouds, Part I

- Air is matter, Part I: *Does air weigh anything?*
- Air is matter, Part II: *How can you demonstrate the weight of the air?*
- Gas laws, Part I: *What causes pressure?*
- Gas laws, Part II: *Marshmallow mashers*
- The magnitude of atmospheric pressure: *Crushing a drum*

9:30 Extend / Evaluate

- Discussion: *Why does the pressure decrease as you go higher in the atmosphere?*

9:45 Engage / Explore / Explain: Air, Water & Clouds, Part II

- Temperature changes on compression/expansion: *If hot air rises, why is it cold in the mountains?*
 - ▶ Discussion: *Explain what is happening in terms of work & energy*
 - ▶ Discussion: *Explain what is happening at an atomic level*
 - ▶ Discussion: *Explain how this relates to the temperature profile of the atmosphere.*

10:15 Break (with convection activities!)

- Convection demos
 - ▶ Ice cube with food coloring
 - ▶ Coffee and tea with cream

10:30 Engage / Explore / Explain: Air, Water & Clouds, Part III

- Explain: *Pressure forces on air parcels, buoyant forces, sinking & floating*
- Launch wish lanterns
- Launch solar hot air balloon
- Stability: *Why do thunderstorms tend to form in the afternoon, Part I?*
- Stability: *Why do thunderstorms tend to form in the afternoon, Part II?*

11:30 Explain

- Pressure profiles in the atmosphere

11:40 Extend / Evaluate

- Discussion: *Which corresponds to rising air: high or low surface pressure?*

12:00 Lunch

Afternoon

1:00 Engage / Explore / Explain: Water, Energy and Phase Transitions, Part I

- Transferring energy with water vapor: *What is the opposite of sweating?*
- Transferring energy with water vapor: *Cooking with condensation*
- Heat packs - *How can freezing make something warmer?*
- Transpiration: *Do plants “sweat”?*
- Boiling & freezing & energy: *Making ice cream in 2 minutes*

2:00 Extend / Evaluate

- Discussion: *Why do we often get a period of warm, clear days after the first killing frost? (“Golden October” in Germany)*

2:15 Break

2:30 Engage / Explore / Explain: More Water, Energy and Phase Transitions

- Light & color & scattering: *Why are clouds white?*
- Vapor pressure: *Why can warm air “hold” more moisture than cold air?*
- Creating clouds: *Do cities affect the weather?*
- Explain: *Clouds and cloud processes*
- Make and Take: *Touch a Cloud*

3:30 Extend / Evaluate

- Cubes: Air, water clouds
- Discussion questions

4:00 Extend / Evaluate: Clouds in a Glass of Beer

4:30 Adjourn

Evening More clouds, more glasses of beer... Meet at Tap and Handle!

Friday, July 11: Global weather and climate

Morning

8:00 Refreshments

8:30 Engage / Explore / Explain: Weather on a Spinning Sphere, Part I

- Engage: Patterns on the globe: *Where are the forests? Where are the deserts?*
- Engage: Energy and angle: *Why is it tropical in the tropics?*

9:00 Extend / Evaluate

- Discussion: *The sun is up for 24 hours a day in the Alaskan summer. Why isn't it hotter?*

9:15 Engage / Explore / Explain: Weather on a Spinning Sphere, Part II

- Explain: *Forces on air parcels*
- Forces & circular motion, Part I: *How do you make something move in a circle?*
- Forces & circular motion, Part II: *What is an "apparent force"?*
- Forces on air parcels, Part I: *Why do hurricanes go counterclockwise?*
- Forces on air parcels, Part II: *Why doesn't the wind blow from high pressure to low pressure?*
- Weather on a spinning sphere: *Start the spin tanks.*

10:15 Break

10:30 Extend / Evaluate

- Activity: *See what has happened with the spin tanks.*
- Activity: *How does the motion of air on the globe leads to climate zones?*

11:30 Extend / Evaluate

- Discussion: *What would happen if you made the Earth spin faster?*
- Discussion: *How does the spin of other planets lead to different weather patterns?*

12:00 Lunch

Afternoon

1:00 Engage / Explore / Explain: Weather vs. Climate Basics

- Weather vs. climate, Part I: *What is the difference between weather and climate?*
- Weather vs. climate, Part II: *What is chaos?*

1:30 Engage / Explore / Explain: Feedbacks and forcings

- Forcing: Greenhouse gases
 - *Tailpipe vs. blow dryer*
 - *How much CO₂ comes out of your tailpipe*
- Effects of forcing: *Climate model with enhanced carbon dioxide*
- Feedback: Positive vs. negative: *What is a feedback?*

2:15 Extend / Evaluate

- Discussion: *Which is a positive feedback? Which is a negative feedback?*

2:30 Break

2:45 Engage / Explore / Explain: Solutions

- Explain: *The concept of the wedge*
- Choices, part I: *What choices do we make as a society?*
- Choices, part II: *Can you turn your carbon footprint into a carbon toepint?*

3:30 Extend / Evaluate: Next steps

- Applying lessons: *How can you use this in your teaching?*

4:00 Post Test / Questionnaire / Completing Credit

4:15 Closing

4:30 Adjourn