A Very Cool Investigation:

A Thermochemistry Lab

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Bloomingdale High School

- Bloomingdale, Michigan
- Public High School – 350 students
- Introductory chemistry course
- All Juniors take chemistry A and B
- Lab is designed for chemistry students of all levels

Rationale

- Address misconceptions in the area of thermochemistry
- Prevent students getting lost in math without understanding its purpose
  - 88.3% do not meet benchmark in math (66.8%)
- Increase student engagement
- Practice experimental design

Known Misconceptions

- Heat is not a measurable concept
  - (Yeo, 2001)
- Heat and temperature are the same thing
  - (Erickson, 1985; Viennoit, 1997)

Approach to Lab

- Present students with a situation they find intriguing
- Give them access to a source of the necessary information
- Ask them to design and carry out experiment
- Students produce a journal article type report as their final product

Situation

- A plane has crashed and passengers are stranded on island
- Students are members of Coast Guard Rescue Team
- A man is having a heart attack but rescue is going to be delayed
- How can you save the man?

Part 1

- Find quantity of heat that must be extracted from the man
- Information available:
  - Mass of man
  - Specific heat of human body
  - Temperature of normal human body
  - Temperature the man needs to be cooled to (students must find in article)

$$q = ms\Delta T$$

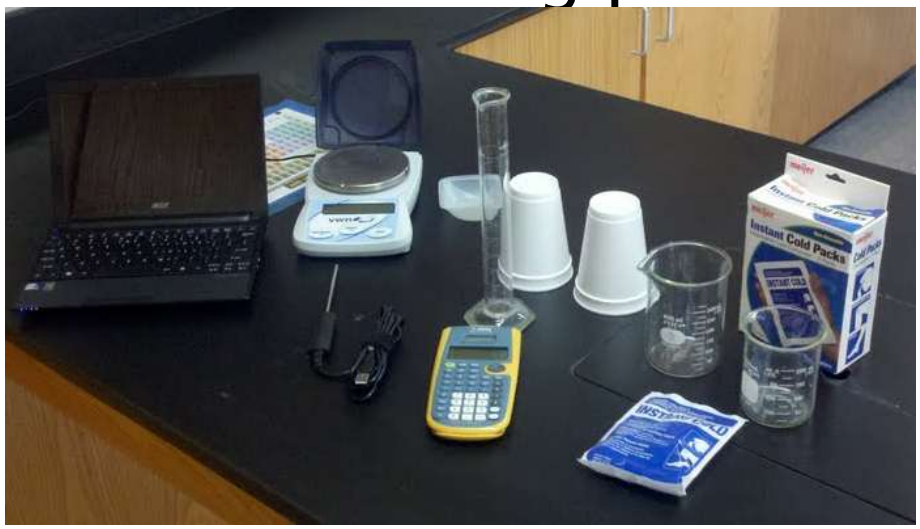
Value of Therapeutic Hypothermia after Cardiac Arrest Confirmed by New Research

ScienceDaily (Feb. 18, 2011) — Mayo Clinic researchers confirmed that patients who receive therapeutic hypothermia after resuscitation from cardiac arrest have favorable chances of surviving the event and recovering good functional status. In therapeutic hypothermia, a patient's body temperature is cooled to 33 degrees Celsius following resuscitation from cardiac arrest, in order to slow the brain's metabolism and protect the brain against the damage initiated by the lack of blood flow and oxygenation.

"Therapeutic hypothermia is a neuroprotective strategy. Brain recovery is the main determinant of outcome for patients who survive cardiac resuscitation," says Alejandro Rabinstein, M.D., a Mayo Clinic neurologist. "For a number of years, we have collected information about what determines whether or not a patient is going to wake up after resuscitated cardiac arrest. However, most of this information comes from the time when patients were not treated with therapeutic hypothermia, which now has become the standard of care for many cases of cardiac arrest. We wanted to know whether hypothermia therapy changed what we knew before about how to estimate neurological prognosis in these patients."

Part 2

- Determine the number of cold packs needed to induce hypothermia without killing patient.
- Materials available:
  - Temperature Probe
  - Instant Cold Pack
  - Electronic Balance
  - Styrofoam Cups
  - Stirring Rod
  - 100 mL and 400 mL beaker
  - Scissors



Student Responsibilities

- Design experiment
- Manage resources

Student Responsibilities

- Record Procedure

PROCEDURE (Record your procedure here)

We are going to use Ammoium Nitrate and H_2O,

put the Stirofoam cup into the beaker

use tap water

only put limited amount of Ammonium Nitrate

PROCEDURE (Record your procedure here)

1. Fill two styrofoam cups with tap water
2. Measure temperature of water cup 1 - 19.8°C
3. Measure out 2 dishes of AlN_3 each with different masses
4. Put thermometer in cup 1
5. Start adding AlN_3 and collect data
6. Repeat steps 4 and 5

Student Responsibilities

- Collect and Record Data

DATA AND OBSERVATIONS (Make a proper data table here)

Cup 1	Cup 2
$\frac{18.8°C}{13.5} = 10.1$	$\frac{20.1°C}{17.6} = 9.2$

DATA AND OBSERVATIONS (Make a proper data table here)

	Water in grams	NH_4NO_3 in Grams	Temperature Before	Temperature After
Trial 1	14.2 g	17 g	20.6°C	2.9°C
Trial 2	17.9	17g	20.3°C	0.7°C
Trial 3	35.6	26g	21°C	-1.3°C

Analysis

- Determine the energy change in Joules when 1g of ammonium nitrate is dissolved.
- Determine the energy change in Joules for an entire cold pack.
- Determine how many of your cold packs you will need to use to induce therapeutic hypothermia in the patient.
- The cold packs on the plane contained 200 grams of ammonium nitrate each. How many of those cold packs should be used to cool the patient?

Discussion

- Student reviews procedures and data of a student from another group.
  - Was their experiment presented in an understandable way?
  - Did they approach this differently from you?
  - Could you learn anything from them?
  - Why do your results differ?

Articles

A few things we may have done wrong was we spilled a little bit of the ammonium nitrate when we were pouring it. Also on a trial we threw out, we spilled the cup and could not record accurate data from it. It we were to do this again, I would make sure we would not spill any material. From the data we could use the previous equation, $q=ms\Delta T$, to calculate the amount of joules per gram of ammonium nitrate, which for us was 406.4J. From there you can calculate that there are 24,505.92J per 60.3g cold pack, and it would take 34 of them to cool the man down to 33 degrees Celsius, or ten 200g cold packs that they had on the plane. If we did this experiment

TARGET INQUIRY:
Improving High School Chemistry

The Camille & Henry Dreyfus Foundation, Inc.

Grand Valley State University

- Acknowledgments
  - My students
  - The Target Inquiry Faculty
- Website
  - www.gvsu.edu/targetinquiry
- Funding:
  - National Science Foundation (ESI-0553215), the Camille and Henry Dreyfus Foundation 2005 Special Grant Program in the Chemical Sciences, Grand Valley State University (please acknowledge Chemistry Department and Office of Undergraduate Research and Scholarship).

Any opinions, findings, conclusions or recommendations expressed in these materials are those of the TI project and do not necessarily reflect the views of the National Science Foundation.