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Day 25 Apr 23 Chemical reactions, bonding, and energy. Explosive materials.

Fire and Ice

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### 25.0.A Daily Outline

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Purpose:

- Creating a model for how heat is related to differences in bond energies of reactants/products
- Extending bond energy formulation to “explosions”
- The quality of energy, efficiency of using heat to produce work, and the Second Law of Thermodynamics

Board

- Exam clarifications?
- Posters up by 3:30 Tuesday. Hallway, anytime Tues. Classroom, after 2:30 pm. Can drop off poster at W106 Parsons anytime.

(Just put nametags out without saying make them. )

DON'T FORGET TO CLAPMaterials

- Name tags (4 per table)
- Folders containing Record Reports from Tues with comments – and subsequent handouts
- Ice, Dewar bowl, liquid nitrogen, little motor – have ice ready to go, microwave in front, have liquid nitrogen already in bowl Dewar enough to acclimate before class starts, have liquid nitrogen in a tall Dewar for easier pouring
- Piece of metal from thermal transfer kit
- Little motor

Returns

- Tiffany papers
- 

Distributions

- Rubric for posters
- Lavoisier reading
- Handout on second law

Starting Comments 1 minute max

- Select someone to clap
- Writings being returned
- Instructions in folders

Assignment

- Read about Lavoisier – talk about on the last day

Task 4 Continued (10 min max)

Maintain the same roles as on Tuesday

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Groups 2, 5 Continue where you left off – see my comments as well on Recorder Report

You don't have far to go to catch up to the other groups.

Groups 1, 3, 4 Review comments on Recorder Report from Tuesday (in folder). Rethink as necessary.

Group 1: write your reaction up on board (showing bonds), and Group 2's also

Group 3: write your reaction up on the board (showing bonds)

Group 4: write your reaction up on the board (showing bonds), and Group 5's also

Prepare your spokesperson (4.14)

We will hear from Spokespersons about how you did your calculation of reaction energy, and your answers to 4.12 and 4.13. You may have questions here. Note how useful this table is.

We'll hear all of the presentations, then give you a moment to ask questions about this process, or about any of the specific reactions.

This should bring out the "problem" with the ATP reaction outcome.

Much more going on with energetic than bonds.

Goes from 4- closely spaced charge to 3-

4- causes strain, weakens P—O bond that is broken

Doesn't happen all by itself in solution of water. Binds to an enzyme surface.

Task 5            In folders

Why do things explode?

Provide to each group. Let them talk. Check in with their responses.

a)            Report out 1 characteristic per group: what makes a good explosive?

Exothermic, Fast, Expands (small volume to large – does work)

b)            What common structural feature?    Nitro groups, or nitrogen

c)            Where does the energy come from?    Argue this out as a whole class.

Formation of very strong bonds from weaker ones; and in form of gas products

And adjacency of atoms

Point out nuances as they occur to me.

d)            Which one Nobel?

e)            Geopolitics and World War.

nitrate as a resource for fertilizer and explosives

Germany (Haber process) – reaction on board, conversion from ammonia to nitrate

Asimov's "The Final Question"

In your groups, take 5 minutes to discuss the article.

- What does it have to do with heat and energy?
- Other insights

Eavesdrop, then ask for report out – something from each group.

Listen,

Then do the demonstration -- talk through

Then refer to handout on "second law"

Any engine (mechanical energy) that draws energy from heat is limited in % of energy conversion. Better designs avoid converting the energy to heat. Convert to mechanical motion or position, or increase chemical potential energy, or electricity. Less waste heat, but not 100%.

### Demonstration

Prepare mug of ice slush – filled to near top

Prepare near boiling water in microwave – put in mug filled to near top

Prepare and set aside the Dewar of liquid nitrogen

Set ice water mug

If I put this piece of aluminum metal in like this, what will happen?

Heat transfer by conduction. Energy is moving but not doing anything useful.

Use this device instead. Two pieces of metal separated by a slab of material that conducts heat but at the same time creates a voltage difference, like a battery.

That voltage can be used to do work.

Put the device in – the blades eventually spin.

Similar principal in coal and oil combustion to make electricity

Combustion heats water into steam, steam which expands through a turbine (causing it to spin) and at the same time lowering the temperature of the steam (or condensing it to water). So, energy is released by the steam-to-water T drop and condensation, and that energy spins the turbine, and the turbine is connected to a generator to produce electricity.

Way back at start of semester I asked whether cold things have heat? How did you show that?

Looked for conduction of heat from something cold to something colder.

Does ice water have heat? Needs to conduct to something colder. Liquid nitrogen

Set it up. If the blades spin, then heat is being conducted.

Does liquid nitrogen have heat?

Need something colder.

Can we keep making this argument? Absolute zero say no.

Ability to turn heat into work requires having a warmer body and a colder body so that as heat moves warmer to colder, some of that can be converted into mechanical or electrical work (or potential energy). You can't capture all of the heat as work. That would require a cold body at absolute zero. But if you deliver heat to absolute zero, it's not at absolute zero anymore.