Thermodynamics Review

You should look at all the labs and worksheets completed during the unit. The labs include: Heat Transfers, Heat of Reaction for Mg and HCl, Combustion, Canned Heat. You should be able to:

Define Temperature, Heat, and Specific Heat and Discuss Heat Transfers.

Temp = hot or cold

Heat = energy

Specific Heat = energy to raise 1g by 1°c

Make Calculations using q = mCΔt

If 200.0 grams of water is heated from 27°C to 51°C, how much energy was absorbed

$$q = 200.0\,g \cdot 4.18\,\frac{j}{g^\circ c} \cdot 24^\circ c = \boxed{20064\ j}$$

What is the mass of a sample of aluminum if 5234j of heat are required to raise its temperature from 15°C to 36°C?

$$5234 = m \cdot 90\,\frac{j}{g^\circ c} \cdot 21^\circ c = \boxed{277\,g}$$

(90 from periodic table)

Describe the two types of themochemical reactions:

Endo		Exo
absorbed	Is energy released or absorbed	released
increases	Does the stored energy increase or decrease	decreases
goes down	What happens to the temperature	goes up
	What would the graph of energy look like?	
ΔH is pos.	The ΔH would be (-) or (+)	ΔH is neg
heat = reactant	Is energy written as a reactant or a product?	heat = product

Use the following equation to answer question a through d:

$$N_2\,(g) + \underbrace{3}_{3(2g)} H_2\,(g) \rightarrow 2\,NH_3\,(g) + (23.1\ kcal)$$

ΔH is given

a. What is the ΔH (change in heat) for the reaction?

ΔH = -23.1 * Is negative because energy is product so reaction is exothermic

b. Is the reaction exothermic or endothermic?

exothermic

c. What does the graph of energy vs. time look like? Which has more energy, the reactants or the products?

Reactants have more stored energy

d. How much energy is produced when 31.5 g of H_2 reacts?

molar mass from periodic table x 3 moles → $\frac{3(2g\,H_2)}{31.5g} = \frac{23.1\,kcal}{x}$

$\boxed{x = 121\ kcal}$

Use the following equation to answer question a through d:

$N_2\,(g) + O_2\,(g) \rightarrow NO\,(g)$ change in enthalpy = +45 kcal

+ ΔH means endothermic

a. Write and balance the thermochemical equation? What is included in a thermochemical equation?

(28g) → from periodic table

$45\ kcal + N_2 + O_2 \longrightarrow 2\,NO$

b. Is the reaction exothermic or endothermic?

endothermic

c. What does the graph of energy vs. time look like? Which has more energy, the reactants or the products?

d. How much energy is required when 14.2 g of N_2 reacts?

from periodic table = molar mass

$\frac{45\ kcal}{x} = \frac{28g\ N_2}{14.2g\ N_2}$ $x = 22.8\ kcal$

Use a ΔH_f° chart to calculate the ΔH of a reaction:

Use chart of compounds

* Elements are 0

Calculate the heat of reaction for the following. (The reactions may not be balanced.)

$FeO\,(s) + CO\,(g) \rightarrow Fe\,(s) + CO_2\,(g)$

-63.7 -26.4157 | 0 -94.0518

-90.1157 | -94.0518

P − R

-94.0518 − (-90.1157)

= -3.9 kcal

$Fe_2O_3\,(aq) + 2Al\,(s) \rightarrow Al_2O_3\,(aq) + 2Fe\,(s)$

-196.5 0 | -399.09 0

-196.5 | -399.09

-399.05 − (-196.5)

= -202.55 kcal

$C_2H_4\,(g) + H_2O\,(l) \rightarrow C_2H_5OH\,(l)$

+54.164 -69.3174 | -66.356

-14.12 | -66.356

-66.356 − (-14.12)

= -52.236

* none of these had ~~more~~ more than 1 mole. If you had 2 moles, you multiply the ΔH_f° by 2 ...

Use a lab data to calculate the ΔH of a reaction:

18.0 grams of sodium was placed in 200.0 grams of water. Sodium hydroxide (NaOH) and hydrogen gas were produced. The temperature increased from 20.0°C to 25.0°C. (Exothermic or endothermic?)

Calculate the heat released by the reaction. $q = mc\Delta t$

$q = 200.0_g \cdot 4.18 \frac{j}{5^\circ c} \cdot 5^\circ c = 4180\ j$

* temp change was water, so use mass of water

Calculate the ΔH for the reaction. What sign does the ΔH have?

$2Na + 2HOH \rightarrow 2NaOH + H_2 + \boxed{\quad}$

$2(23_g)$; 18.0_g ; $4180\ j$

$\frac{2(23_g)}{18.0_g} = \frac{x}{4180}$

$x = 10682\ j$

Write the thermochemical equation for the reaction.

$2Na + 2HOH \rightarrow 2NaOH + H_2 + 10.68\ kj$

$\boxed{\Delta H = -10.68\ kj}$

* I made it negative because temp went up

Describe how fuels are used to produce energy.

What type of reaction is usually used to get the energy from the fuel? (for example, how do we use octane?)

we burn them = combustion reaction

Combustion is burning in presence of O_2

Write the equation for butane (C_4H_{10}) undergoing this type of reaction. What are always the products? The ΔH is

$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

underlined are always the same for combustion

What are some considerations that make a fuel good for specific application. (Sterno was good for using in a buffet, why?)

amount of energy released
physical state
stability etc

Sterno good because low heat, even heat, solid so won't spill.

How can the argument be made that all energy that we use (in foods and fuels) comes from the sun?

What is the reaction for storing the suns energy in biomolecules?

$energy + CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$

How is petroleum "buried sunshine"?

How does our body run on energy from the sun?

Plants ~~store~~ make food using suns energy and we eat the plant

Compare natural gas, coal, and petroleum as fuels. List advantages and disadvantages for each.

	good	bad
Coal -	we have lots	solid so harder to move, hard to mine lots of greenhouse gases
Gas	clean, easy to transport	limited supply
Petroleum	cleaner than coal liquid = pipeline	Has to be separated before use limited supply

How do we alter petroleum before use?

What is fractional distillation?

Petroleum is heated and separated into "fractions" Based on boiling point. They separate into groups by size. Small molecules on top. Big on bottom

What is cracking?

↳ Breaking long molecules of petroleum into smaller ones.

Describe octane ratings:

What does it tell you?

Tells you how badly the gas will cause knocking in the engine

How is it determined?

Branched = better fuel, straight chains = worse fuel

isooctane = 100 ——— n-heptane = 0

others ranked between

How can it be improved?

→ heating straight chains makes them branch

→ adding tetramethyl lead (we don't do any more) = unleaded

Discuss food and energy;

How do food Calories compare to calories?

Calorie = kcalorie or 1000 calories

What is a bomb calorimeter and how are Calories determined?

Food is burned in interior chamber
Water in outer chamber absorbs the heat
and calories are calculated w/ $q = mC\Delta t$
(just like we did, but w/ better apparatus)