Announcements

- Turn on the Clicker (the red LED comes on).
- Push “Join” button followed by “20” followed by the “Send” button (switches to flashing green LED if successful).

- Flatulence lab handout is available in the lab handout section of the class web site.

- First exam in class Thursday.
  - Do not enter class room until I let you in.
  - Bring yourself, calculator, pencils and possibly something to drink.
  - Stop at the bathroom before class.
  - No cell phones, PDAs, etc...
- Will be starting Chapter 13 next Tuesday.

Review

- Alcohols have C-O-H functional group. Named by replacing “e” at end of alkane name with “ol”.
- Ethers contain C-O-C functional group, Name by placing the names of the two alkyl groups in alphabetical order before the word ether.
- Carbohydrates $C_x(H_2O)_x$
  - Monosaccharides contain -OH, and C=O groups.
  - Keto- (ketone) vs. aldo- (aldehyde) sugars.
  - Cyclization reaction (α vs. β forms).
  - Polysaccharides
    - Condensation reaction
    - Starch(α linkage) vs. cellulose (β linkage)

Review Continued

- Biomass fuels (primarily CH_3CH_2OH and CH_4 produced by bacteria)
  - Carboxylic acids -C(=O)-OH are precursors
    - Acidic because $-COO^-$ ion is stabilized by resonance.
    - CH_3COOH is acetic acid.
  - Amines R_3N are also precursors (R = hydrocarbon or H)
  - The ethanol and methane are by-products of metabolic processes from which the bacteria get energy. This means the biomass fuels USUALLY HAVE LESS ENERGY CONTENT THEN WHAT THEY ARE DERIVED FROM.
- Coal is old biomass fuel converted by heat and pressure under low oxygen conditions to mostly C.

Coal

Hydrogen as fuel

- High fuel value (kJ/g burned)
  - Very low density gas => hard to handle
  - Large volumes make kJ/L very small
  - Even low T liquid is very low density
- Some potential solutions
  - Form metal hydrides: $M + H_2 \rightarrow MH_2$
  - Adsorption onto buckyball or buckytubes
  - Store as a hydrocarbon (ethanol or methanol) and strip the H of chemically

Coal

Alkene (C=C double bonds)

Figure 12.25

Naming Alkenes

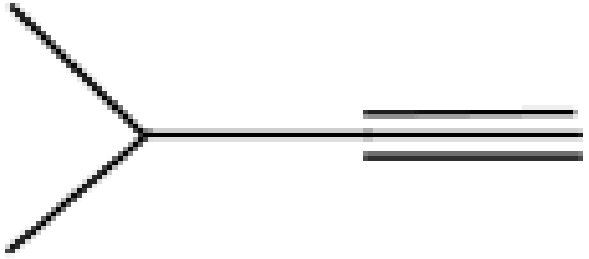
- Replace -ane in the backbone name with -ene and precede the backbone name with # indicating location of double bond.
- Branch names & #'s + # for double bond position + root for backbone length + ene.
- $CH_3CH{=}CH_2$ is 1-propene or just propene.
- $CH_3CH{=}CHCH_3$ is 2-butene
- Don't forget about cis- and trans-

Alkynes (C≡C triple bonds)

Figure 12.25

Naming Alkynes

- Replace -ane in the backbone name with -yne and precede the backbone name with a number indicating the position of the triple bond.
- Branch names & #'s + # for triple bond position + root for backbone length + yne.
- CH_3-C≡C-CH_3 is 2-butyne
- $(CH_3)_2CH_2$-C≡CH is 3-methyl-1-butyne

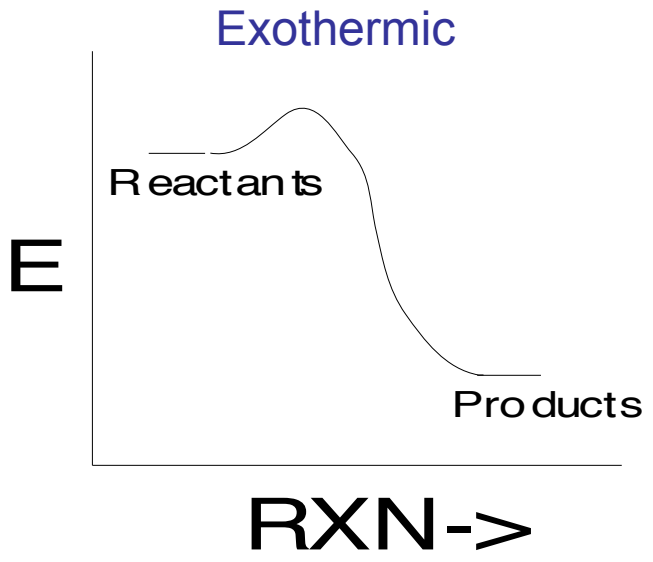


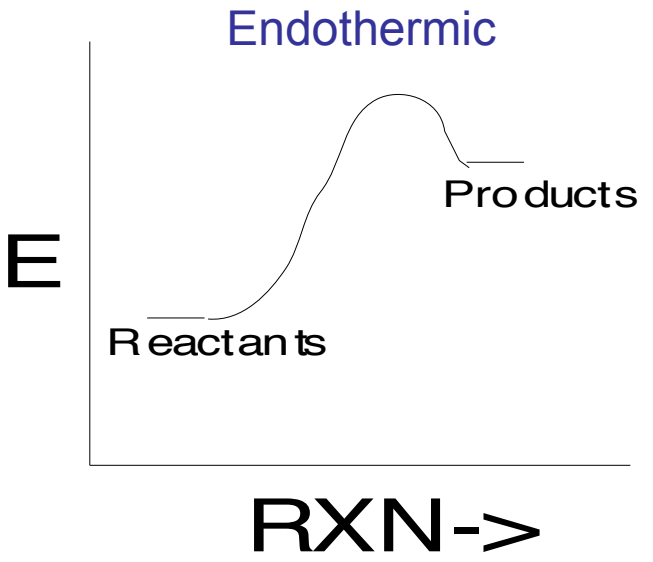
Combustion Analysis of Hydrocarbons

- Assumes complete combustion and collection of all CO_2 and H_2O.
- Ex: Sample contains C & H, Start with 1.00 g, burns to produce 2.743 g CO_2 and 2.246 g H_2O. What is the empirical formula for this sample?
  - Step 1 calculate moles of C and H that ended up in the products.
  - Step 2 calculate the molar ratio.
- Harder example: Compound contains, C, H and O. Start with 2.000 g, burns to produce 2.931 g CO_2 and 1.200 g H_2O. What is the empirical formula ?

Review

- Thermochemistry = study of energy in chemical reactions.
- Exothermic processes release heat (lower chemical potential energy of the system)
- Endothermic processes absorb heat (raise the chemical potential enerty of the system)
- Rates (kinetics) will be determined by what happens in the middle of a reaction process. (RXN path energy diagrams).





Review

- Thermodynamic System= Everything we are interested in. In chemistry, at minimum, this contains all reactants and products. First law of thermodynamics $\Delta E=q+w$, energy is conserved.
- Pressure volume work: $w = -P\Delta V$. Take care with sign (work done on surroundings or by system is negative, work done on system is positive.)
- Enthalpy (ΔH) is easier to keep track of because under constant P conditions $\Delta H = q$ (or sometimes q_p, to indicate constant pressure).
- $q = C_p\Delta T$, C_p = constant pressure heat capacity of sample ($C_p = nc_p$, c_p = molar heat capacity).

Review

- Calorimetry
  - Key relationship: $0 = \Delta H_{RXN} + C\Delta T \Rightarrow \Delta H_{RXN} = - C\Delta T$
- Bond energies to calculate ΔH_{RXN}
  - Breaking bonds requires putting energy in (+) (Don't forget to multiply # bonds in molecule by stoichiometric coefficients)
  - Making bonds releases energy (-) (Remember stoichiometric coefficients)
  - $\Delta H_{RXN} = \Delta H_{break} + \Delta H_{make}$

Review

- ΔH^o_f to calculate ΔH_{RXN}
  - Key relationship: $\Delta H^o_{RXN} = \sum \Delta H^o_f(prod) - \sum \Delta H^o_f(react)$
- Turning ΔH_{RXN} into molar ΔH_{RXN}.
- Fuel values = kJ/g (get by dividing molar ΔH_{RXN} by molar mass)
- CO_2 efficiency (contribution to greenhouse effect) quantified by kJ/mol CO_2 released.
- Hess's law:
  - ΔH_{RXN} (A --> C) = ΔH_{RXN} (A --> B)+ ΔH_{RXN} (B --> C)

Review

- Petroleum is separated (refined) by fractional distillation.
  - Raoult's law $P_{tot} = X_1P^o_1 + X_2P^o_2$+.. used to show how distillation works.
  - Branched alkanes are harder to ignite (higher octane)
  - cycloalkanes (other than 5 membered are puckered to maintain 109˚ sp^3 bond angles)
  - aromatic compounds (resonance = delocalization of π electrons = greater stability)
- Oxygenates also added to gasoline (alcohols and ethers).

Nomenclature Review

- N-alkanes with >10 C: greek prefix for (#C-10) + decane
- Cycloalkanes: cyclo + prefix for # of C + ane
- Branched Alkanes:

  1)Find the longest chain (backbone).

  2)Find the largest side group and number the backbone from the end nearest this side chain.

  3)Use the numbers to indicate the positions of the side groups.

  4)Alphabetize the side groups.

- Same naming rules for alkenes and alkynes except that the ending is -ene or -yne and a number indicating the position of the multiple bond precedes the backbone name.

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