## **Quiz 7** — Principles for Isomers & "Precision"

(this still isn't complete, but will be later tonight)

**Finding Patterns** - organizing your knowledge improves understanding, remembering, using; is emphasized in lecture, and illustrated in Quizzes 1 (tnksueaeoehygyhtcadlnm) and 2 (lunch dog my sneaky the ate), and 3 (making it a story).

**isomers** have *same* **chemical formula** (number of each atom), *different* **structural formula** (connectivity of atoms).

to **convert a name into a structure**, begin at name's right side and work leftward: 2,2,4-trimethylpentane (Lecture 25, slide 24) shows there are no double bonds (ane), # of Cs in the longest chain (pent), what else (trimethyl) and where (2,2,4).

**alkyl groups:** e.g., ethane (CH3-CH3, complete as-is) vs ethyl (CH3-CH2- , must connect to another C to be complete with 4 bonds for each C); similar for methane vs methyl, ...

**carbons are numbered** so sum of numbers is minimized; e.g. slides 33-34 show 2-methylhexane, not 5-methylhexane; for slides 49-55 it's 1-pentene (not 2-) and 2-pentene (not 3-). { also priorities* that (I think) are not used in 108 [* not just sums] }

hydrocarbon name is based on **longest continuous chain**, which may not be longest straight chain; e.g., 2-ethyl pentane is wrong, it's 3-methyl hexane. (slides 37-38)

**n-**____ (n-butane, n-pentane,...) has all C's in a continuous "straight chain" with no branching.

usually, **iso-**_____ (iso-butane, iso-pentane,...) has simplest possible branching, with methyl group on 2-carbon, forms "V" in line diagram; these are named for total number of carbons (iso-pentane is 2-methyl butane,...); for historical reasons, iso-octane (2,4,4-trimethylpentane) doesn't fit this pattern.

**drawing isomers:** creative thinking (get all possibilities) + critical thinking (eliminate duplicates with same connectivity).
draw 3 isomers of $C_5H_{12}$ (longest chains have 5 Cs, 4, and 3).
draw 9 isomers for $C_5H_{10}$ (five alkenes; four cyclo, 5 4 3 3).
draw all 5 isomers of $C_6H_{14}$ (one with 6 in longest chain, two with 5 in longest chain, and two with 4 in longest chain).

a **saturated hydrocarbon** (alkane) is totally "loaded up" with maximum possible H's; **unsaturated hydrocarbon** (e.g. alkene with one or more C=C's) can have more H's added to it.
each **C=C** or **cyclic ring** removes 2 H's (draw to see why) so $C_5H_{10}$ can be alkenes or cyclo-alkanes, which are isomers. But n-pentane and cyclopentane (both alkanes) are not isomers.

**only connectivity matters** — you can "flip" & "bend" & "rotate" molecules without changing structural formula, so the name doesn't change (use this to check for duplicates), IF the atom-connections don't change. (page 442, #31; key on A-27)

These (above) are not structural formulas. (wrong on a test)

**chemical formula** (shows only atoms), e.g. $C_3H_8$ or $C_3H_8O$ .
**condensed structural formula** (shows connectivity, but is symbolically encoded) as in $CH_3CH_2CH_3$ or $CH_3CH_2CH_2OH$ .
**structural formula:** shows all atoms and all bonds.
**Lewis structure:** structural formula + unshared electrons ; shared electrons can be drawn as dots ( : ) or line ( – ).
unshared els (non-bonding els, lone els) ≠ unpaired el (in a radical); for a radical (Lewis or structural formula) you must put unpaired el on atom where it belongs (•OH instead of OH•).

in a condensed structural formula, you have **options when writing location of Hs**, so either of these ( $\mathbf{H_2C}$=CH-$CH_2$-$CH_3$ or $\mathbf{CH_2}$=CH-$CH_2$-$CH_3$ ) is OK.

**line diagrams:** C (with Hs) is at each corner and line-end. in slide 63, all are acceptable; pentane =

**shape around C=C bond** is trigonal planar (≈ 120° angles).

for **molecular shape**, imagine sitting on central atom, asking two questions: A) in how many directions can I see **electrons**? B) in how many directions can I see **atoms**? The combinations,

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A: | **4** | 4 | 4 | **3** | 3 | **2** | 2 |
| B: | **4** | 3 | 2 | **3** | 2 | **2** | 1 |
| | $CH_4$ | $NH_3$ | $H_2O$ | $SO_3$ | $SO_2$ | $CO_2$ | CO |
| | tetrahedral | trigonal pyramid | bent | trigonal planar | bent | linear | (trivial) |
| | *symmetric* | *not-sym* | *not-sym* | *sym* | *not-sym* | *sym* | |
| | *nonpolar* | *polar* | *polar* | *nonpolar* | *polar* | *nonpolar* | |

but atoms also must be symmetric ($CH_4$ nonpolar, $CH_2F_2$ polar) { Be careful – a "yes" for symmetry causes "no" for polarity. }

**gasoline** is a homogeneous mixture of hydrocarbons (mostly $C_5$-$C_{10}$) so it's nonpolar, a liquid with density of ≈.7 g/mL (less than $H_2O$, 1.00 g/mL), a fuel. [mix: alkanes, alkenes, aromatics]

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**Precision in Arithmetic**

Significant Figures (underlined): .0070800 70800. 70800 ,
19.00 g F / 1 mole F , .692 g iso-octane / 1 mL iso-octane ;
"infinite" sig figs: 1000 g / 1 kg , 8 mole $CO_2$ / 1 mole $C_8H_{18}$

Arithmetic Operations with Sig Figs and Decimal Columns:

| **multiplication or division (use sig figs)** | **addition or subtraction (use decimal columns)** |
|---|---|
| 387.1 | 387.1 |
| x **1.25** | + 1.25 |
| **483**.875 (-> **484**) | 388.35 (-> 388.4) |

No single H-isotope is 1.0079 g/mole; the **atomic mass** is the "averaged" mass (in g/mole) for a naturally occurring mix of isotopes. In lab a *mole* = an amount of H with mass of 1.0079 g.

**Acid-Forming Reactions** [some 2nd-$H^+$ come from all $H_2$...]

$H_2O + CO_2 \rightarrow H_2CO_3 \rightarrow H^+ + HCO_3^-$ (slight rain-acidity)
$H_2O + SO_2 \rightarrow H_2SO_3 \rightarrow H^+ + HSO_3^-$ ($SO_2$ washed out)
½ $O_2$
Acid $H_2O + SO_3 \rightarrow H_2SO_4 \rightarrow H^+ + HSO_4^-$ (and $\rightarrow H^+ + SO_4^{2-}$)
Rain $4\ NO_2 + 2\ H_2O + O_2 \rightarrow 4\ HNO_3 \rightarrow H^+ + NO_3^+$