Worksheet for Quiz 7 (and Exam 3)

- Here is a way to understand the calculation of molar mass: If you imagine "ripping apart" 1 mole of C_5H_{12} into atoms, you'll have 5 moles of C + 12 moles of H, so "molar mass" is (5 mol C)(12 g/mol) + (12 mol H)(1 g/mol) = 72 g/mol, with 60 g of C + 12 g of H = 72 g C_5H_{12}

Problem-Solving Tips

Almost always, **if grams are "given"** you will convert this to moles by using moles/gram; and **if moles are "given"** you will convert this to grams by using grams/mole. For example, in #**4a** "g/mol" is used twice (flipped & as-is) and in-between you use the mole/mole reaction-ratio to convert from moles of what you are GIVEN into moles of what you are asked to FIND.

If you are asked to find an AMOUNT, you **must** begin with an AMOUNT, and then use conversion factors (= 1) to convert it into a different description of the same AMOUNT.

If you are asked to find a RATIO, either you can begin with a RATIO or (more commonly) use the "miles/hour strategy" as in this example: if you know that a sample of n-octane has mass = 265 g, and volume = 379 mL, to find its density in g/mL you divide the g by mL, (265 g / 379 mL) = .699 g/mL .

5a. What is the mass of 234 mL n-C_8H_{18} ? (density = .70 g/mL)
5b. What is the volume of 164 g of n-C_8H_{18} ?
5c. If 234 mL of n-C_8H_{18} is 164 g of it, what is its density?

6a. Write 4 equations, for incomplete combustion (to CO+H_2O) and complete combustion (CO_2+H_2O) for butane & butene.
6b. 43.8 g of butane produces ______ g of CO with incomplete combustion, and _____ g of CO_2 with complete combustion.

7. What is the name, formula, and molar mass of the alk<u>anes</u> with 1-8 carbons? the 7 smallest alk<u>enes</u> and alk<u>ynes</u> (how many C's do they have) with only one C=C or triple bond?

2a. In a complete combustion of 43.8 grams C_5H_{12} , what mass of CO_2 (in g) is produced? ***2b****. In the complete combustion of 43.8 tons C_5H_{12}, what weight of CO_2 (in tons) is produced?*

3a. What weight of CO_2 (in grams) is produced by the complete combustion of 1 gallon of gasoline? (1 gallon = 3785 mL ; assume gasoline is pure octane; C_8H_{18} density = .700 g/mL) [answer is 8180 g ; a solution-setup is at end of worksheet]

<u>ANSWERS for Problems — 5a-5b-5c , 6a-6b , 7</u>

<u>**5a**</u>. 234 mL (.70 g / 1 mL) = 164 g
<u>**5b**</u>. 164 g (1 mL / .70 g) = 234 mL
<u>**5c**</u>. (134 g / 234 mL) = .701 g/mL

<u>**6a**</u>. butane incomplete: $2\ C_4H_{10} + 9\ O_2 \rightarrow 8\ CO + 10\ H_2O$
butane complete: $2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$
butene incomplete: $2\ C_4H_8 + 8\ O_2 \rightarrow 8\ CO + 8\ H_2O$
butene complete: $2\ C_4H_8 + 12\ O_2 \rightarrow 8\ CO_2 + 8\ H_2O$
note: Cutting coefficient-#s in half is ok if they represent moles (... + 4.5 mol O_2 ...) not molecules. *Compared with incomplete combustion for 1 mole of C_4H_{10} (or C_4H_8), why is 2 more moles O_2 required for complete combustion? Why is 1 mole less H_2O produced per mole of butene, compared with butane?*

<u>**6b**</u>. C_4H_{10} -- incomplete (84.6 g CO), complete (133 g CO_2)

<u>**7**</u>. mother eats peanut butter (meth<u>ane</u> ethane propane butane), pentane hexane heptane octane; the number of C-and-H is C_nH_{2n+2} so it's CH_4 C_2H_6 C_3H_8 C_4H_{10} C_5H_{12} C_6H_{14} C_7H_{16} C_8H_{18} ; molar masses: 16 30 44 58 72 86 100 114

alk<u>enes</u>: names are like alkanes but with "ane" replaced by "ene": ~~methene~~ eth<u>ene</u> propene butene pentene... ; if one C=C , it loses 2 Hs; to see why, draw an alkane, then convert one C-C into C=C and (oops) two C's now have 5 bonds, so (because C wants 4 bonds) you must remove one H from each C, thus the loss of 2 H's ; now convert an alkane into a cycloalkane, and you also see a loss of 2 H ; for each, H's go from 2n+2 to 2n , and with C_nH_{2n} it's C_2H_4 C_3H_6 C_4H_8 C_5H_{10} C_6H_{12} C_7H_{14} C_8H_{16} and molar masses are 28 42 56 70 84 98 112
names: ~~methene~~ eth<u>ene</u> propene butene pentene hexene ...

alk<u>ynes</u>: eth<u>yne</u> propyne etc; formula is C_nH_{2n-2} (loses two more Hs; why?) - C_2H_2 C_3H_4 C_4H_6 C_5H_8 C_6H_{10} C_7H_{12} C_8H_{14}
molar masses: 26 40 54 68 82 96 110

<u>ENERGY BALANCE</u>

(on page 109 of CiC)

ENERGY BALANCES — <u>**incoming energy = outgoing energy**</u> is needed for a <u>steady state with constant temperature</u> in all of these ways: transient-<u>**radiation**</u> (100 = 6 + 25 + 46 + 23) and ultimate-<u>**radiation**</u> (100 = 6 + 25 + 60 + 9), <u>**atmosphere**</u> (23 + 37 = 60), <u>**earth**</u> (46 = 37 + 9). Figure 3.2 is simplified; it doesn't show some complex interactions; for example, "much of this heat is redirected and comes back..." (CiC, pg 110). Sun's EM radiation (UV, visible, infrared) differs (re: transmission, reflection, absorption, emission) as explained in CiC, shown by yellow, blue, red. 46% (of original) is emitted from earth, 37% is absorbed, so .37 / .46 = .80 = 80% which is the <u>normal</u> Greenhouse Effect. (if >80% is <u>enhanced</u> GE)

<u>Math-Setups and Answers for Problems — 2a-2b, 3a</u>

<u>**2a**</u>. (43.8 g C_5H_{12}) (1 mol C_5H_{12} / 72 g C_5H_{12}) (5 mol CO_2 / 1 mol C_5H_{12}) (44 g CO_2 / 1 mol CO_2) = 134 g CO_2.
<u>***2b***</u>. *Just "scale up" the reaction from grams to tons, so if 43.8 g C_5H_{12} produces 134 g CO_2, then 43.8 tons C_5H_{12} will produce 134 tons CO_2.*
<u>**3a**</u>: (1 gal) (3785 mL/gal) (.70 g C_8H_{18} / mL C_8H_{18}) **(1 mol C_6H_{18} / 114 g C_8H_{18}) (8 mol CO_2 / 1 mol C_8H_{18}) (44.0 g CO_2 / 1 mol CO_2)** = 8180 g

The 2-page version (from 2010 & 2011), linked to in our sections-page, has extra topics: On page 1, the logic of "ping pong balls versus golf balls" and lightweight molecules vs heavy molecules (left column); the top-right ("These equations describe...") is "more than you need to know" so you can ignore it; Problem 4 (lower-right) emphasizes diatomics -- H A H, i.e. Hydrogen, Air (N_2, O_2), Halogens (F_2, Cl_2, Br_2, I_2), 1 2 4 -- and interpreting "hydrogen" (or "oxygen",...) as the diatomic molecule. On page 2, the two tables showing isomer-possibilities are overly complex, so Friday (Nov 9) I'll give you simplified principles & examples; the lower-left has useful ideas about Cl, and the top-right (re: Cl) is less essential but is #5h on the Study Guide for Quiz 7.