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; 43.8 lb of butene produces _____ lb of CO with incomplete combustion, and ____ lb of CO_2 with complete combustion.

7. What is the name, formula, and molar mass of the alkanes with 1-8 carbons? the 7 smallest alkenes and alkynes (how many C's do they have) with only one C=C or triple bond?

8a. Draw isomers for alkanes with 1-6 carbons & *(optional) 7-8*. The number of isomers for CH_4 and C_2H_6 and C_3H_8 is only 1; C_4H_{10} has 2 isomers, and C_5H_{12} has 3; C_6H_{14} has 5 isomers, with table-columns (2345678) giving hints for what they are (1 with longest chain of 6 Cs, 2 where longest chain is 5 Cs, and 2 with longest chain of 4 Cs); *if you want a challenge, C_7H_{16} has 9 isomers (1, 2, 5, and 1 for chains with lengths of 7, 6, 5, and 4); C_8H_{18} has 18 isomers (1, 3, 7, 6, 1 for chains with longest lengths of 8, 7, 6, 5, and 4 carbons),*
http://www.kentchemistry.com/links/organic/isomersofalkanes.htm

alkanes	#	longest chain	2	3	4	5	6	7	8
C_3H_8	1		0	1	-	-	-	-	-
C_4H_{10}	2		0	1	1	-	-	-	-
C_5H_{12}	3		0	0	2	1	-	-	-
• C_6H_{14}	5		0	0	2	2	1	-	-
C_7H_{16}	9		0	0	1	5	2	1	-
C_8H_{18}	18		0	0	1	6	7	3	1

8b. Draw isomers for alkenes with 2-5 carbons & *(optional) 6-7*. C_2H_4 and C_3H_6 have 1 isomer, C_4H_8 has 3; C_5H_{10} has 5 (2 and 3 for C-chains with lengths of 5 and 4). With cyclo-isomers, C_3H_6 and C_4H_8 and C_5H_{10} have 1,2, and 4 more isomers, respectively.

alkenes	#	cyclo	2	3	4	5	6	7
C_3H_6	1	+1	0	1	-	-	-	-
• C_4H_8	3	+2	0	1	2	-	-	-
C_5H_{10}	5	+4	0	0	0 3	2	-	-
C_6H_{12}	13	+7	0	0	1 2	3 4	3	-
C_7H_{16}	27	+11	0	0	1	1 2 2 2 5	5 6	3

USEFUL

• Chlorine: A chlorine atom has 7 valence electrons, so it is a neutral free radical (because with an odd number it MUST have an unpaired electron) without an octet, and it's very reactive, as in its reaction that begins the ozone-depleting reaction cycle. / A chlorine molecule, Cl_2, is neutral, has two octets, no unpaired electrons (has unshared non-bonding els); is stable by itself but can be split by visible light, often reacts with other chemicals. / A chloride ion has charge of -1, and 8 valence electrons (octet); usually it's chemically stable, unreactive with other chemicals.

In the Periodic Table, notice that Cl has two numbers: **17** (its **atomic number**) shows that every Cl has 17 protons; **35.45** (its **molar mass**) shows that 1 mole of "natural Cl" is 35.45 grams.

OPTIONAL

Chlorine has two main isotopes: 76% is ^{35}Cl (34.97 g/mole) with 18 neutrons, 24% is ^{37}Cl (36.97 g/mole) with 20 neutrons; a **weighted average** of this **naturally occurring mixture of isotopes** is 35.45 g/mol. Using math intuition for a **weighted** average, does it make sense that 35.45 is closer to 35 than 37?

There is no Cl-isotope with molar mass = 35.45, but 1 mole of "naturally occurring" Cl atoms will have mass of 35.45 g.

This skill may be useful elsewhere, but for 108-exams you won't need to calculate a weighted average: .76 (34.97) + .24 (36.97) = 35.45

for Fall 2010 — 6th edn 7

• answers for assigned problems in CiC, p 146-7: **40a** (1 3 2 3), **40b** (2), **40c** (30); **41c** (6 vs 8); **45** ([73 mt CH_4][12 mt C / 16 CH_4] = 55 mt C); and online - **1b** (.43g $NaHCO_3$ → .18g CO_2), **3e** (1600g , 1875 mL)

ANSWERS for Problems — 4 , 7 , 6a-6b , 5a-5b-5c:

4. 64 g (1/32) = 2 mole of O_2 , 64 g (1/2) = 32 mole of H_2 .
diatomics: Hydrogen (H_2), Air (N_2 O_2), Halogens (F_2 Cl_2 Br_2 I_2)
5-6 are below.

7. mother eats peanut butter (methane 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

alkenes: names are like alkanes but with "ane" replaced by "ene": methene ethene 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'll 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 ethene propene butene pentene hexene ...

alkynes: ethyne propyne etc; formula is C_nH_{2n-2} (losing 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

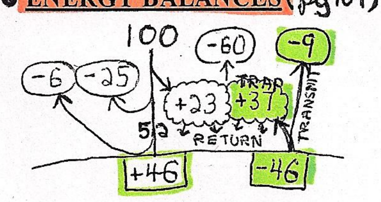
6a. butane incomplete: $2\ C_4H_{10} + 9\ O_2 \rightarrow 8\ CO + 10\ H_2O$
butane complete: $2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$
butene incomplete: $2\ C_4H_8 + 8\ O_2 \rightarrow 8\ CO + 8\ H_2O$
butene complete: $2\ C_4H_8 + 12\ O_2 \rightarrow 8\ CO_2 + 8\ H_2O$

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? Do these differences (a. 2 more moles O_2 , b. 1 less mole H_2) change if the hydrocarbon changes from C_4 to C_8? (a changes, b is same)*

6b. C_4H_{10} (84.6g CO, 133g CO_2); C_4H_8 (87.6 lb CO, 138 lb CO_2)

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

• ENERGY BALANCES (CiC pg 109)



in grams — in lbs

3a: (1 gal) (3785 mL/gal) (.70 g C_8H_{18} / mL C_8H_{18}) **(1 mol C_8H_{18} / 114 g C_8H_{18}) (8 mol CO_2 / 1 mol C_8H_{18}) (44 g CO_2 / 1 mol CO_2)** (1 lb / 454 g)

• **ENERGY BALANCES**: changed by **enhanced** * greenhouse effect? **incoming E = outgoing E** is needed for steady state with constant temperature; transient-**radiation** (100 = 6 + 25 + 46 + 23) and ultimate-**radiation** (100 = 6 + 25 + 60 + 9), **atmosphere** (23 + 37 = 60), **earth** (46 = 37 + 9). Figure 3.2 is simplified, so it doesn't show some complex interactions; for example, "much of this heat is redirected and comes back..." (CiC, pg 103) Sun's EM radiation (UV, visible, infrared) differs (re: transmission, reflection, absorption, emission) as explained in CiC, shown by yellow, blue, red.

* of 46% out, 9% Transmitd (into SPACE), 37% absorbed (trapped) } 37% abs / 46% total = .80 (≡ normal non-enhanced GH Effect (due to "return") is good, helps keep earth LIFE comfy for LIFE)

ENHANCED GH Effect if >.80