2. 600 Cal = 600 kcal

$$600 \text{ kcal} \times \frac{4.184 \text{ kJ}}{1 \text{ kcal}} = 2510.4 \text{ kJ}$$

+1

The US candy bar has less food energy with 2510.4 kJ. The Swiss bar has 3000 kJ.

10. a. exothermic
b. endothermic
c. endothermic
d. exothermic

+1

11. a. CFCs contain Carbon bonded to Chlorine, fluorine or other carbons. C-C bonds energy is 356 kJ/mol, C-Cl is 327 kJ/mol and C-F is 485 kJ/mol. These are amongst the highest values for single bonds.

+2

b. It takes 485 kJ to break a mole of C-F bonds but only 327 kJ to break a mole of C-Cl bonds.

23. a. This fuel acts like a mixture of 92% iso-octane and 8% n-heptane. It will knock less than gas with an octane rating of 87.

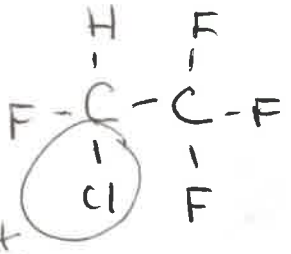
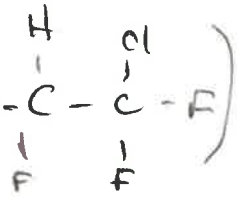
+2

b. It doesn't say it has oxygenates, but they are highly likely to be used for anti-knocking purposes.

28. a. C-Br bond is most easily broken. The Br radical will be free to destroy ozone (like Chlorine radical)

+2

b. (next page)

28b  (or equivalent such as )

most easily broken [C-F 485 kJ/mol, C-Cl 327 kJ/mol, C-H 434 kJ/mol, C-C 346 kJ/mol]

Cl radicals will be formed as this compound decomposes, and can destroy O_3.

30a. boiling pt +2

b. positon A + B will have fewer carbon atoms because they will have lower boiling pts. Position D will have more carbon atoms because it will have a higher boiling pt.

34a. n-octane and iso-octane have very similiar energy content but very different octane ratings. Octane rating is not a measure of the energy content. +2

b. knocking produces objectionable sounds, loss of power, overheating + engine damage.

c.

~~36. A~~

38ab +2

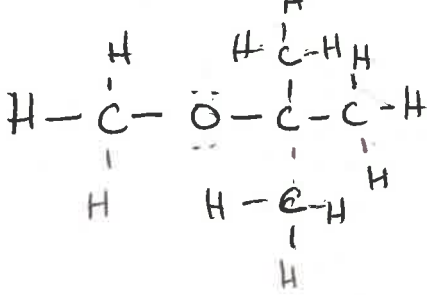
41 +2

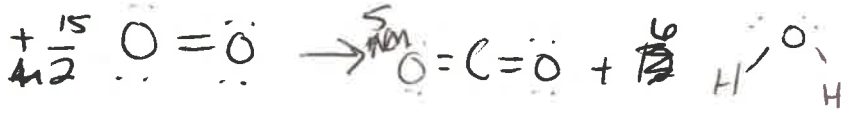
42 +1

49 +1

41

MTBE





$2C_5H_{12}O + 15O_2 \rightarrow 10CO_2 + 12H_2O$

or

$C_5H_{12}O + \frac{15}{2} O_2 \rightarrow 5CO_2 + 6H_2O$

bonds broken

12	C-H	416
2	C-O	336
3	C-C	356
$\frac{15}{2}$	O=O	498

bonds formed

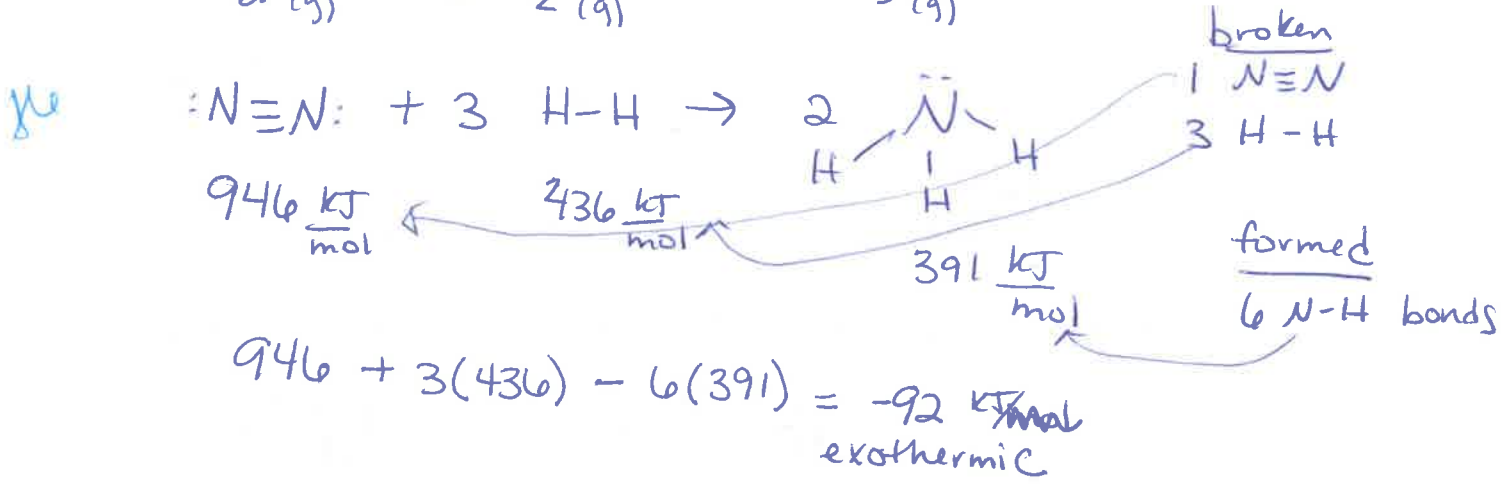
10	C=O	803
12	H-O	467

$12(416) + 336(2) + 3(356) + \frac{15}{2}(498) - 803(10) - 467(12) = -3167$ kJ

Extra Problems

all are gases unless noted

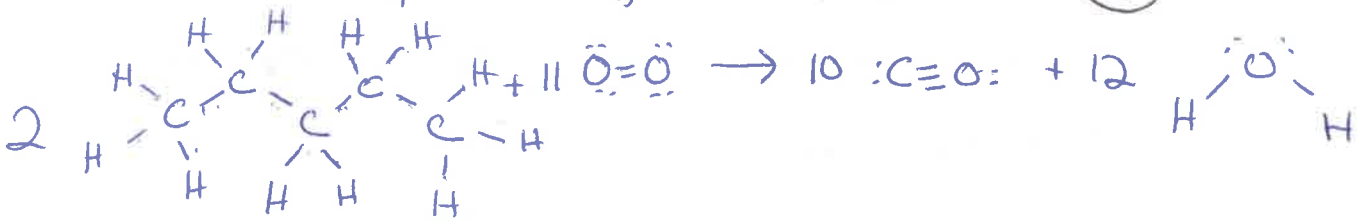
1. a. $N_{2(g)} + 3\ H_{2(g)} \rightarrow 2\ NH_{3(g)}$



$946 + 3(436) - 6(391) = -92$ kJ/mol

exothermic

b. $2\ C_5H_{12(g)} + 11\ O_{2(g)} \rightarrow 10\ CO_{(g)} + 12\ H_2O_{(g)}$ liquid



broken			formed		
24	C-H	416 kJ/mol	10	C≡O	1073 kJ/mol
11	O=O	498 kJ/mol	24	O-H	467 kJ/mol
8	C-C	356 kJ/mol			

$8(356) + 24(416) + 11(498) - 10(1073) - 24(467) = -6408 + 3628$ kJ/mol

exothermic

c. $H_{2(g)} + Cl_{2(g)} \rightarrow 2\ HCl_{(g)}$

H–H + :Cl–Cl: → 2 H–Cl:

broken

1	H–H	436 kJ/mol
1	Cl–Cl	242 kJ/mol

formed

2	H–Cl	431 kJ/mol

436 + 242 − 2(431) = −184 kJ/mol

exothermic

d. $2\ H_{2(g)} + CO_{(g)} \rightarrow CH_3OH_{(g)}$

2 H–H + :C≡O: → H–C(H)(H)–O–H

broken

2	H–H	436 kJ/mol
1	C≡O	1073 kJ/mol

formed

3	C–H	416 kJ/mol
1	C–O	336 kJ/mol
1	O–H	467 kJ/mol

2(436) + 1073 − 3(416) − 336 − 467

= −106 kJ/mol

endothermic

etc

e. $H_{2(g)} + O_{2(g)} \rightarrow H_2O_{2(g)}$

H–H + :O=O: → H–O–O–H

broken

H–H		436 kJ/mol
O=O		498 kJ/mol

formed

2	H–O	467 kJ/mol
1	O–O	146 kJ/mol

436 + 498 − 2(467) − 146 = −146 kJ/mol

exothermic

f. $2\ BrCl_{(g)} \rightarrow Br_{2(g)} + Cl_{2(g)}$

2 :Br–Cl: → :Br–Br: + :Cl–Cl:

broken

2	Br–Cl	217 kJ/mol

formed

Br–Br		193 kJ/mol
Cl–Cl		242 kJ/mol

2(217) − 193 − 242 = −1 kJ/mol

exothermic (barely!)

Extra # 2

#19 +1

Pentane	liquid		
Triacontane	solid	←	not good for fuel because it would be hard to transport + pump (it's not a liquid until a temp of 450°C)
Octane	liquid		