Ch 5 p157-159 #1-15

All Problems shown here, though not all have been assigned

Key

1.) C Of the metals listed, gold has the lowest specific heat and will experience the greatest temperature change.

2.) A $q = cm\Delta T$ $\Delta T = (-8) - (-16) = 8.0^\circ C = 8.0 K$

$m = \frac{q}{c\Delta T} = \frac{(40\ J)}{(2.0\ J/g \cdot K)(8.0 K)}$

$= \boxed{2.5\ g}$

3.) C $q = cm\Delta T$ $\Delta T = 30 - 25 = 5^\circ C = 5 K$

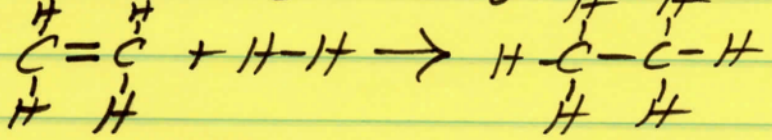
$= (0.90\ J/g \cdot K)(2.0 g)(5 K)$

$= \boxed{9.0\ J}$

4.) C $q = cm\Delta T = (4.18\ J/g \cdot ^\circ C)(20 g)(10^\circ C) \times \frac{1 kJ}{1000 J}$

$= \frac{20 \times 10 \times 4.18}{1000}$

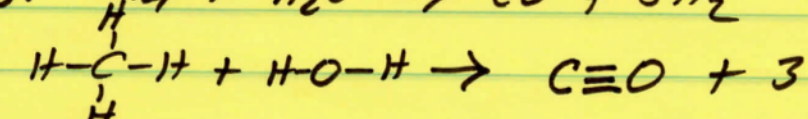
5.) a. $C_2H_4 + H_2 \rightarrow C_2H_6$



$\Delta H = (614)_{C=C} + 4(414)_{C-H} + (436)_{H-H} + (-346)_{C-C} + 6(-414)_{C-H} = \boxed{-124 kJ}$

You can solve #5 using the enthalpies of formation (table12) or as I and the answer key of your text did, using bond enthalpies (table 11)

6. $CH_4 + H_2O \rightarrow CO + 3H_2$



$\Delta H = 4(414)_{C-H} + 2(463)_{O-H} + (-1072)_{C\equiv O} + 3(-436)_{H-H} = \boxed{202 kJ}$

☺ Not in data booklet

6.) **a)** the enthalpy change when one mole of compound is formed from its elements in their standard state at standard conditions of 298 K/25°C and 101 325 Pa/1 atm

b. $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$

$\Delta H = [4(-394) + 4(-242)] - [(1) + 6(0)] = \boxed{-2545 \text{ kJ}}$

error in text!

(ii) products more stable than reactants; bonds are stronger in products than reactants/ $H_p < H_R$/enthalpy/stored energy of products less than reactants;

(iii) same/equal, because the same bonds are being broken and formed

7.) D $2NO_2 \rightarrow N_2O_4$, $\Delta H = ?$

2 × C $(\frac{1}{2}N_2 + O_2 \rightarrow NO_2, \Delta H = -57 \text{ kJ})$

add $[N_2 + 2O_2 \rightarrow N_2O_4, \Delta H = +9 \text{ kJ}$

$2NO_2 \rightarrow N_2 + 2O_2, \Delta H = +114 \text{ kJ}]$

$2NO_2 \rightarrow N_2O_4, \Delta H = +123 \text{ kJ}$

8.) $\frac{1}{2} \times (2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O, \Delta H = -3120)$

$\frac{1}{2} \times C (2H_2 + O_2 \rightarrow 2H_2O, \Delta H = -572)$

C $(C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O, \Delta H = -1411)$

$C_2H_6 + \frac{7}{2}O_2 \rightarrow 2CO_2 + 3H_2O, \Delta H = -1560$

$H_2O \rightarrow H_2 + \frac{1}{2}O_2, \Delta H = +286$

$2CO_2 + 2H_2O \rightarrow C_2H_4 + 3O_2, \Delta H = +1411$

$C_2H_6 \rightarrow C_2H_4 + H_2, \boxed{\Delta H = +137}$

9.) A

$2HF \rightarrow H_2 + F_2$

$\Delta H = 2(565_{H-F}) + (-430) + (-155) = \boxed{+545\ kJ}$

10. a) $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$

b) products more stable than reactants/reactants less stable than products; products lower in energy; reactants higher in energy;

c) (overall) bonds in reactants weaker and (overall) bonds in product stronger; all bonds in product are σ bonds; weaker π bond broken and a (stronger) σ bond formed; less energy needed to break weaker bonds/more energy produced to make stronger bonds (thus reaction is exothermic);

or

bond breaking is endothermic (requires energy) and bond making is exothermic (releases energy); stronger bonds in product mean process is exothermic overall;

11.)

a) standard enthalpy (change) of reaction; temperature increase; reaction is exothermic; sign of $\Delta H^{\ominus}$ is negative;

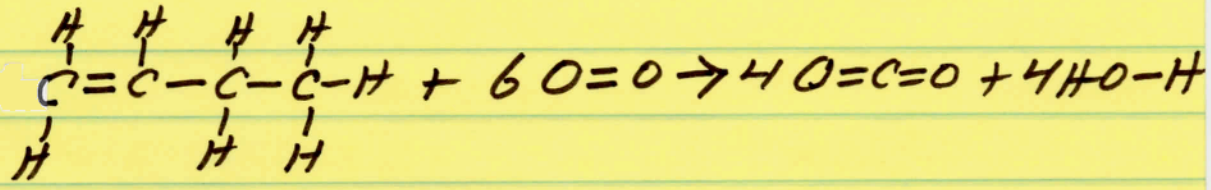
b) more negative; heat given out when gas changes to solid; solid has less enthalpy than gas;

c.) $S + O_2 \rightarrow SO_2$, $\Delta H = -297$

$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$, $\Delta H = -92$

$S + 1\frac{1}{2}O_2 \rightarrow SO_3$ $\quad \Delta H = \boxed{-389\ kJ}$

12.) a.) $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$, $\Delta H = ?$



$\Delta H = 8(412_{C-H}) + (612_{C=C}) + 2(348_{C-C}) + 6(496_{O=O}) + 8(-743_{O=C}) + 8(-463_{H-O}) = \boxed{-2068\ kJ}$

13.) $CF_4(g) \rightarrow C(g) + 4F(g)$, $\Delta H = ?$

$C(s) + 2F_2(g) \rightarrow CF_4(g)$, $\Delta H = -680$

$2\times(F_2(g) \rightarrow 2F(g)$, $\Delta H = +158)$

add

$C(s) \rightarrow C(g)$, $\Delta H = +715$

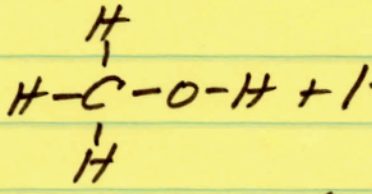
$CF_4(g) \rightarrow C(s) + 2F_2(g)$, $\Delta H = +680$

$2F_2(g) \rightarrow 4F(g)$, $\Delta H = +316$

$CF_4(g) \rightarrow C(g) + 4F(g)$, $\Delta H = 1711\ kJ$

$\Delta H_{bond}(C\text{-}F) = \frac{1711}{4} = \boxed{428\ kJ/mol}$ | To break 4 C-F bonds.

14.) a.) $CH_3OH + 1\frac{1}{2}O_2 \rightarrow CO_2 + 2H_2O$, $\Delta H = ?$



$\Delta H = 3(+414)_{C\text{-}H} + (+358)_{C\text{-}O} + (+463)_{O\text{-}H} + 1\frac{1}{2}(+498)_{O=O} +$

$2(-804)_{C=O} + 4(-463)_{O\text{-}H} = \boxed{-650.\ kJ}$

b.) i.) mass $CH_3OH = 0.523g$

$0.523g \times \frac{1mol}{32.05g} = 0.0163mol$

ii.) $q = cm\Delta T$ $\Delta T = 26.4 - 21.5 = 4.90°C$

$q_{H_2O} = (4.18\ J/g\cdot°C)(20.000g)(4.90°C) = 410.J$

iii) $q_{rxn} = -410.J$

$\Delta H = \frac{-410.J}{0.0163mol} = -25,200\ J/mol$

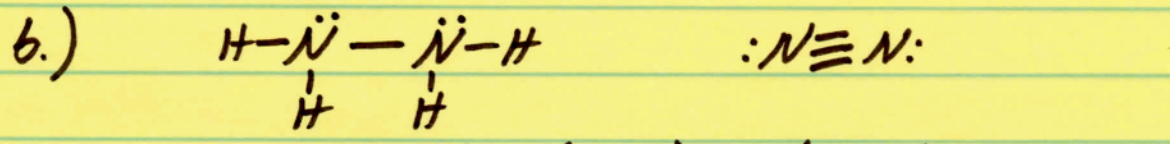
$= \boxed{-25.2\ kJ/mol}$

c) (i) bond enthalpies are average values/differ (slightly) from one compound to another (depending on the neighbouring atoms); methanol is liquid, not a gas in the reaction;

(ii) not all heat produced transferred to water; heat lost to surroundings/environment ; incomplete combustion (of methanol); water forms as $H_2O(l)$ instead of $H_2O(g)$;

15.) a.) $N_2H_4(g) + 2F_2(g) \rightarrow N_2(g) + 4HF(g)$, $\Delta H = ?$

b.)



c.) $\Delta H = 4(+391_{N-H}) + (+158_{N-N}) + 2(+159_{F-F}) + (-945_{N\equiv N}) + 4(-567) = \boxed{-1173\ kJ}$

d.) $N_2H_4 + F_2$ is more exothermic, therefore would make a better rocket fuel than $N_2H_4 + O_2$.