Dougherty Valley HS Chemistry
Thermochemistry – Molar Heats and Energy of Reactions

Worksheet #7

Name: **Period:** **Seat#:**

MOLAR HEATS

1) How much energy does it take to heat a 3.45 mole sample of silver from 15°C to 120°C if the specific heat of silver is 0.240 J/g°C? *9378.18 J*

2) If the temperature of a 50.0 gram block of aluminum increases by 10.9K when heated by 500 Joules, calculate the specific heat of the aluminum block and the molar heat capacity of the aluminum block. *0.917 J/g°C, 24.8 J/mol°C*

3) The specific heat of gold is 0.128 J/g•K. Calculate the molar heat capacity. *25.21 J/mol•K*

4) Calculate the amount of heat necessary to melt 27 grams of ice if the molar heat of fusion of ice is 6.009 kJ/mol. Use the molar heat value given here (not regular latent heat in grams), and get your answer in kJ. *9.01 kJ*

5) If the molar heat capacity of Magnesium is 24.89 J/mol•K, calculate the energy required to heat 35 grams of magnesium from 30°C to 55°C. *895.9 J*

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HEATS OF REACTION

6) $B_2O_3 + 3H_2O \rightarrow 3O_2 + B_2H_6$ $\Delta H = +2035$ kJ

a. Is this reaction endo or exothermic?

b. Rewrite the equation with the heat written as a reactant or a product based on your answer to part A

c. How much energy is involved when 15 grams of B_2O_3 is reacted, and is it absorbed or released? *436.6 kJ*

7) If the ΔHrxn for the combustion of tetracarbon decahydride is -5756 kJ/mol$_{rxn}$, how much energy is released when 50 grams of the fuel is combusted? *-2475.9 kJ*

8) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ $\Delta H° = -890.4$ kJ/mol$_{rxn}$

a. How much energy is given off when 2.50 mol of CH_4 are burned? *-2226 kJ*

b. How much energy is released when 22.4 g of O_2 are consumed while excess CH_4 is burned? *-311.64 kJ*

9) Sometimes you don't know what the heat of reaction is for a given equation. BUT if you know how much energy it takes to FORM each of the chemicals in the reaction, then you can figure out what the heat of reaction is for the equation you are interested in! $\Delta H°_{rxn}$ **=** $\Delta H°_{formation}$ **Products -** $\Delta H°_{formation}$ **Reactants** *Don't forget you want to take into account the number of moles of each product and reactant in the balanced equation!*

a. Calculate the $\Delta H°_{rxn}$ for the combustion of methane using the "Heats of Formation" given below. *-890.36 kJ*
$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Substance	ΔH_f (kJ)
CH_4	-74.80
O_2	0
CO_2	-393.50
H_2O	-285.83

b. What do you notice about your answer to #9 and the $\Delta H°$ value you were given for the combustion of methane in #8 ?

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10) Ethanol is used as an additive in many fuels today. What is the $\Delta H°_{rxn}$ for the combustion of ethanol? *-2470. kJ*

$2C_2H_5OH + 6O_2 \rightarrow 4CO_2 + 6H_2O$

Formula	$\Delta H°_f$
C_2H_5OH (*l*)	–277.6
CO_2 (*g*)	–393.5
H_2O (*g*)	–241.8
H_2O (*l*)	–285.8

11) What would $\Delta H°$ be for the reverse of the reaction below?

$SrO_{(s)} + CO_{2\,(g)} \rightarrow SrCO_{(s)}$ $\Delta H° = -234$ kJ/mol

12) What would $\Delta H°$ be for double the reaction below?

$SrO_{(s)} + CO_{2\,(g)} \rightarrow SrCO_{(s)}$ $\Delta H° = -234$ kJ/mol

13) Find $\Delta H°$ for the reaction below, using the steps provided. *-58 kJ*

$2\,NO_{2\,(g)} \rightarrow N_2O_{4\,(g)}$

1. $N_{2\,(g)} + 2\,O_{2\,(g)} \rightarrow 2\,NO_{2\,(g))}$ $\Delta H° = 67.7$ kJ
2. $N_{2\,(g)} + 2\,O_{2\,(g)} \rightarrow N_2O_{4\,(g)}$ $\Delta H° = 9.7$ kJ

14) Find $\Delta H°$ for the reaction below, using the steps provided. *15.3 kJ*

$2C_{(s)} + 2\,H_2O_{(g)} \rightarrow CH_{4\,(g)} + CO_{2\,(g)}$

1. $C_{(s)} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2\,(g)}$ $\Delta H° = 131.3$ kJ
2. $CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2\,(g)} + H_{2\,(g)}$ $\Delta H° = -41.2$ kJ
3. $CH_{4\,(g)} + H_2O_{(g)} \rightarrow 3H_{2\,(g)} + CO_{(g)}$ $\Delta H° = 206.1$ kJ

15) Find $\Delta H°$ for the reaction below, using the steps provided. *-30 kJ*

$A + B \rightarrow C$

1. $2A \rightarrow 2D$ $\Delta H° = 110$ kJ
2. $D + B \rightarrow C$ $\Delta H° = -85$ kJ

BOND ENERGIES – use this table to perform any calculations.

Average Bond Enthalpies (kJ/mol)

Single Bonds

C—H	413	N—H	391	O—H	463	F—F	155
C—C	348	N—N	163	O—O	146		
C—N	293	N—O	201	O—F	190	Cl—F	253
C—O	358	N—F	272	O—Cl	203	Cl—Cl	242
C—F	485	N—Cl	200	O—I	234		
C—Cl	328	N—Br	243			Br—F	237
C—Br	276			S—H	339	Br—Cl	218
C—I	240	H—H	436	S—F	327	Br—Br	193
C—S	259	H—F	567	S—Cl	253		
		H—Cl	431	S—Br	218	I—Cl	208
Si—H	323	H—Br	366	S—S	266	I—Br	175
Si—Si	226	H—I	299			I—I	151
Si—C	301						
Si—O	368						

Multiple Bonds

C=C	614	N=N	418	O_2	495
C≡C	839	N≡N	941		
C=N	615			S=O	523
C≡N	891			S=S	418
C=O	799				
C≡O	1072				

16) Fill in the blanks.

It _____
energy to break bonds

It _____
energy to form bonds

Breaking bonds is _____

Forming bonds is _____

Breaking bonds has a _____
algebraic sign for $\Delta H°$

Forming bonds has a _____
algebraic sign for $\Delta H°$

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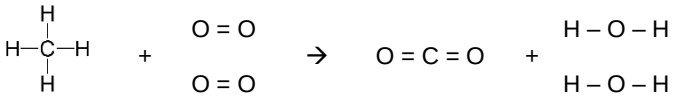
17) Find $\Delta H°$ for the formation of water. $2\ H_2 + O_2 \rightarrow 2\ H_2O$ *-482 kJ*

H – H + O = O → H – O – H
H – H H – O – H

18) Find $\Delta H°$ for the combustion of methane. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ *-808 kJ*



19) Find the $\Delta H°$ for the reaction: $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ *-104 kJ*

20) Find the $\Delta H°$ for the reaction: *-208 kJ*

_____CH_4 + _____Cl_2 → _____CH_2Cl_2 + _____HCl

Average Bond Enthalpies (kJ/mol)

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