CHEM 130 **Name** ____

Quiz 7 – October 27, 2017

Complete the following problems. Write your final answers in the blanks provided.

1. Determine the ΔH^o for this reaction from the data below. (8 pts)

$$N_2 + 4H_2O \rightarrow N_2H_4 + 2H_2O_2$$

Reaction	ΔH^o
$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$	-622.2 kJ
$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$	-285.8 kJ
$H_2 + O_2 \rightarrow H_2O_2$	-187.8 kJ

We need to re-write the reactions so that we end up with the appropriate reactants and products, with the correct stoichiometry, and do the same things to the ΔH's that we do to the reactions.

Reverse 1st reaction	$N_2(g) + 2H_2O(\ell) \rightarrow N_2H_4(\ell) + O_2(g)$	$\Delta H^o = -(-622.2\ kJ)$
Reverse 2nd reaction and multiply by 2	$2[H_2O(\ell) \rightarrow H_2(g) + \frac{1}{2} O_2(g)]$	$\Delta H^o = (-2)(-285.8\ kJ)$
Multiply 3rd reaction by 2	$2[H_2(g) + O_2(g) \rightarrow H_2O_2(\ell)]$	$\Delta H^o = (2)(-187.8\ kJ)$

Now our overall reaction is:

$$N_2(g) + 2H_2O(\ell) + 2H_2O(\ell) + \cancel{2H_2(g)} + \cancel{2O_2(g)} \rightarrow N_2H_4(\ell) + \cancel{O_2(g)} + \cancel{2H_2(g)} + \cancel{O_2(g)} + 2H_2O_2(\ell)$$

$$N_2(g) + 4H_2O(\ell) \rightarrow N_2H_4(\ell) + 2H_2O_2(\ell)$$

And the ΔH^o = (-1)(-622.2 kJ) + (-2)(-285.8 kJ) + (2)(-187.8 kJ) = +818.2 kJ

Answer_____+818.2 kJ ________

2. You are planning to deep fry some Oreos by heating cooking oil in a pan on a natural gas stove. Your source of heat will be the combustion of natural gas (methane, molar mass 16.04 g/mol), shown below. What mass of methane must burn to heat 2.02 kg of cooking oil from 72°F (22.2°C) to 375°F (190.6°C) to make some delicious treats? The specific heat capacity of the cooking oil is 1.75 J/(g°C), the specific heat capacity of water is 4.184 J.(g°C). (9 pts)

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g) \quad \Delta H^o = -882.0\ kJ$$

$$q_{rxn} = -q_{oil}$$

$$n_{rxn}\Delta H^o_{rxn} = -m_{oil}C_{oil}\Delta T_{oil}$$

$$n(-882.0\ kJ/mol\ CH_4) = -(2.02\ kg)(1.75\ J/g^oC)(190.6 - 22.2^oC)$$

$$n(-882.0\ kJ/mol\ CH_4) = -595.3\ kJ$$

$$n = -595.3\ kJ/(-882.0\ kJ/mol\ CH_4)$$

$$n = 0.675\ mol\ CH_4$$

$$0.675\ mol\ CH_4 \times \frac{16.04\ g\ CH_4}{1\ mol\ CH_4} = 10.8\ g\ CH_4$$

Answer_____10.8 g CH_4______

3. The overall reaction for the combustion of benzene (C_6H_6) is shown below. Use the data in the table at the right to calculate ΔH^o_f of benzene. (8 pts)

$2\ C_6H_6(\ell) + 15\ O_2(g) \rightarrow 12\ CO_2(g) + 6\ H_2O(\ell)\quad \Delta H^o = -6535\ kJ$

Substance	**ΔH^o_f (kJ/mol)**
C(g)	**+716.7**
C(graphite)	**0**
CO(g)	**-110.5**
$CO_2(g)$	**-393.5**
H(g)	**+218.0**
$H_2(g)$	**0**
$H_2O(g)$	**-241.8**
$H_2O(\ell)$	**-285.8**
O(g)	**+249.2**
$O_2(g)$	**0**
$O_3(g)$	**+142.7**

$\Delta H^\circ_{rxn} = -6535\ kJ = \Sigma(n\Delta H^\circ_{f,products}) - \Sigma(n\Delta H^\circ_{f,reactants})$

$-6535\ kJ = [12\ mol(-393.5\ kJ/mol) + 6\ mol\ (-285.8\ kJ/mol)] - [2\ mol(\Delta H^\circ_f[C_6H_6(\ell)]) + 6\ mol(0\ kJ/mol)]$

$-6535\ kJ = -6437 kJ - 2\ mol(\Delta H^\circ_f[C_6H_6(\ell)])$].

$-98\ kJ = -2\ mol(\Delta H^\circ_f[C_6H_6(\ell)])$].

So, $(\Delta H^\circ_f[C_6H_{12}O_6(s)] = +49\ kJ/mol\ C_6H_6(\ell)$

Answer____+49 kJ/mol $C_6H_6(\ell)$_______

Possibly Useful Information

$KE = \frac{1}{2}mv^2$	$K = {}^oC + 273.15$	$q_{lost} = -q_{gained}$
$q=mc\Delta T$	$q=n_{LR}\Delta H_{rxn}$	$q=m\Delta H$