Physical Chemistry I: Thermodynamics Name _____

Heating your home.

Maintaining the temperature inside of a space/home is one modern convenience that quickly became a necessity. The general term used to describe the control of temperature in a home is called, ***HVAC*** or ***H***eating, ***V***entilation, and ***A***ir ***C***onditioning. Although many homes do not have a central cooling system (commonly called just "AC") very few are without a means to heat.

The following fuel used to heat spaces:

Wood: Wood has a molecular formula that can be approximated by a simple sugar ($C_6H_{12}O_6$). Write below the balanced combustion reaction for $C_6H_{12}O_6$ with CO_2 (g) and H_2O (g) as products:

$C_6H_{12}O_6$ (s) +

Using the heats for formation (ΔH_f) calculate the enthalpy of combustion (ΔH_{comb}) for $C_6H_{12}O_6$:

ΔH_f ($C_6H_{12}O_6$ - solid) =

ΔH_f (O_2 - gas) =

ΔH_f (CO_2 - gas) =

ΔH_f (H_2O - gas) =

ΔH_{comb} =

Natural Gas: Natural gas is found in deposits around the world. This gas consist of methane (~95%) with the balance being mainly ethane (~4%). Natural gas is piped directly to homes/businesses just like water. Write below the balanced combustion reaction for CH_4:

CH_4 (g) +

Using the heats for formation (ΔH_f) calculate the enthalpy of combustion (ΔH_{comb}) for CH_4:

ΔH_f (CH_4 - gas) =

ΔH_{comb} =

Propane: Propane (C_3H_8) can be extracted from natural gas (only ~0.2%) or recovered during the refining of petroleum/gasoline. Liquified propane gas (under pressure) is stored in horizontal, *pill-shaped* tanks or in small "gas-grill" cylinders. Write below the balanced combustion reaction for C_3H_8:

C_3H_8 (g) +

Using the heats for formation (ΔH_f) calculate the enthalpy of combustion (ΔH_{comb}) for C_3H_8:

ΔH_f (C_3H_8 - gas) =

ΔH_{comb} =

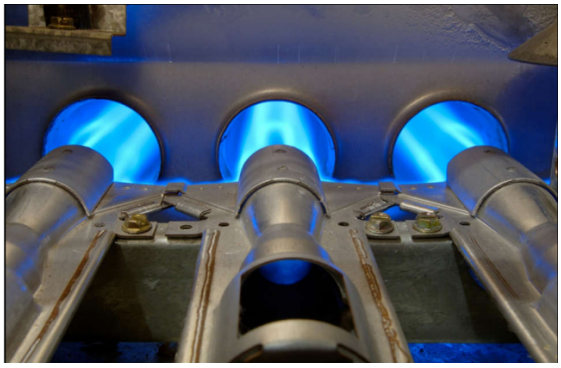
Summary:

Fuel	ΔH_{comb} *(kJ/mol)*	ΔH_{comb} *(kJ/gram)*
Wood		
Methane		
Propane		

The above combustion reactions are written as if CO_2 (g) and H_2O (g) were the only two products. Depending on the quality and cleanliness of the "burner" the above reactions can be written in terms of an incomplete combustion generating not only CO_2 (g), but CO (g) , and C (s).

Incomplete combustion…

Complete combustion…



Calculate the incomplete ΔH_{comb} for the following:

Wood/sugar

$C_6H_{12}O_6$ (s) + 3 O_2 (g) → 6 CO (g) + 6 H_20 (g)

ΔH_{comb} =

$C_6H_{12}O_6$ (s) + 4 O_2 (g) → 3 CO_2 (g) + 2 CO (g) + C (s) + 6 H_2O (g)

ΔH_{comb} =

Methane

$2\ CH_4\ (g) + 3\ O_2\ (g) \rightarrow 2\ CO\ (g) + 4\ H_2O\ (g)$

$\Delta H_{comb} =$

$4\ CH_4\ (g) + 5\ O_2\ (g) \rightarrow 2\ CO\ (g) + 8\ H_2O\ (g) + 2C\ (s)$

$\Delta H_{comb} =$

Propane

$2\ C_3H_8\ (g) + 7\ O_2\ (g) \rightarrow 6\ CO\ (g) + 8\ H_2O\ (g)$

$C_3H_8\ (g) + 4\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ CO\ (g) + 4\ H_2O\ (g)$

$2\ C_3H_8\ (g) + 9\ O_2\ (g) \rightarrow 4\ CO_2\ (g) + 2\ CO\ (g) + 8\ H_2O\ (g)$

Problem: Brad's "home heating system" question…I collect ½ gal of liquid water per day when the outside temperature is ~50 °F (10 °C).

a) Write below the balanced combustion reaction for CH_4, note the H_2O (l) is the product.

b) how many grams natural gas (ie. methane) do I consume per day, considering that ½ gal of H_2O (l) is generated?

b) how much heat (kJ) was required to keep my home at 68 °F (20 °C)?