Weekly Quiz 6 take-home CHEM122/124 due April 3, 2019 Name: KEY

1) What is the ΔH_{RXN} for the reaction to make carbon monoxide, CO (g), and hydrogen gas H_2 (g) from water, H_2O (l), and methane gas, CH_4 (g); Show your work! (6 pts)

CH_4 (g) + H_2O (l) → CO (g) + 3 H_2 (g)

Given the following reactions:

2 CO (g) + O_2 (g) → 2 CO_2 (g)	ΔH_{RXN} = -566.0 kJ (Rxn 1)
2 H_2 (g) + O_2 (g) → 2 H_2O (g)	ΔH_{RXN} = -483.6 kJ (Rxn 2)
CH_4 (g) + 2 O_2 (g) → CO_2 (g) + 2 H_2O (g)	ΔH_{RXN} = -836.3 kJ (Rxn 3)
H_2O (l) → H_2O (g)	ΔH_{VAP} = +44.0 kJ/mol (Rxn 4)

ΔH_{RXN} = +216.1 kJ

Reverse ½ Rxn 1 $CO_2(g) \rightarrow CO(g) + \frac{1}{2}O_2(g)$ $\Delta H = +283.0$ kJ

Reverse 3/2 Rxn 2 $3H_2O(g) \rightarrow 3H_2(g) + \frac{3}{2}O_2(g)$ (leaving one mole $H_2O(g)$) $\Delta H = +725.4$ kJ

Forward 1 Rxn 3 $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ $\Delta H = -836.3$ kJ

Forward 1 Rxn 4 $H_2O(l) \rightarrow H_2O(g)$ $\Delta H = +44.0$ kJ

$\Delta H_{RXN} = +216.1$ kJ

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2) A 2.095 g sample of glucose, $C_6H_{12}O_6$, which has a molar mass of 180.16 g/mol, is analyzed in a bomb calorimeter at constant volume in order to measure its heat of combustion. The heat flows from the reaction into the calorimeter and the water. (9 pts)

$$C_6H_{12}O_6\,(s) + 6\,O_2\,(g) \rightarrow 6\,CO_2\,(g) + 6\,H_2O\,(l)$$

The calorimeter alone has a heat capacity (also called calorimeter constant) of 839 J / °C.
It also contains 1062 g of water which has a specific heat of 4.184 J/g °C.
The initial temperature of the calorimeter and water is 25.267 °C.
After the sample is combusted, the final temperature rises to 31.416 °C.

For Parts A and B

$\Delta T = 31.416°C - 25.267°C = 6.145°C$

A) Find the heat flow, q_{water}, to or from the water. Be sure to include the correct sign for q.

$q_{water} = C\,m\,\Delta T = 4.184\ \frac{J}{g°C} \times 1062\,g \times 6.145°C$

$= 27{,}304.74216\ J$ unrounded $\rightarrow$ Round to 4 sig. figs $\rightarrow 2730 \times 10^4\ J$ or $27.30\ kJ$

B) Find the heat flow, $q_{calorimeter}$, to or from the calorimeter. Be sure to include the correct sign for q.

$q_{calorimeter} = C\Delta T = 857\ \frac{J}{°C} \times 6.145°C = 5266.265\ J$ unrounded

Round to 3 sig. figs 5270 J or 5.27 kJ

C) Find the heat flow, $q_{combust}$, to or from the combustion reaction of the sample of glucose.

Combustion is the system; water and calorimeter are the surroundings.

$q_{system} = -q_{surround}$

negative 4 sig. figs

$q_{combustion} = -(27.30\,kJ + 5.27\,kJ) = -32.57\,kJ$

D) Find the heat of combustion in kilojoules (kJ) per mole of glucose combusted.

$2.095\,g\ glucose \times \frac{1\,mol}{180.16\,g} = 0.01163\,mol\ glucose$

$\frac{q_{comb}}{n_{glucose}} = \frac{-32.57\,kJ}{0.01163\,mol} = 2801\ kJ/mol$

E) Which state function corresponds to the answer from part D? (Circle one)

better answer

ΔH_{RXN} Because $\Delta n = 0$, the number of moles of gas remain the same and therefore $\Delta P = 0$ $\Delta H = \Delta U + P\Delta V$

ΔU_{RXN} Because at Const V, $\Delta V = 0$ $\Delta U = q - P\Delta V$