HW08 - Enthalpy & Fossil Fuels

You might need to grab some data from here for the bond energy problems.
Stuck on bomb calorimeters? Here's a video: Thermodynamics - Calorimetry Pt II - Bomb Calorimeter Example
Still feel like you aren't fully there with the conceptual part of calorimetry? Here's a video: Thermodynamics - Calorimetry - Part I

1 6 points

A 1.00 g sample of n-hexane (C_6H_{14}) undergoes complete combustion with excess O_2 in a bomb calorimeter. The temperature of the 1815 g of water surrounding the bomb rises from 26.15°C to 29.97°C. The heat capacity of the hardware component of the calorimeter (everything that is not water) is 5068 J/°C. What is the *change in energy* for the combustion of n-C_6H_{14}? One mole of n-C_6H_{14} is 86.1 g. The specific heat of water is 4.184 J/g·°C.

- ○ -6.33×10^4 kJ/mol
- ○ -4.40×10^3 kJ/mol
- ○ -4.16×10^3 kJ/mol
- ○ -5.25×10^3 kJ/mol

2 5 points

Fill in the blanks to receive credit for each part of this question.

An unknown fuel distilled in a refinery (molar mass 64.0 g/mol) is combusted in a bomb calorimeter holding 991 mL water. When 0.182 grams of the fuel source is combusted in the bomb calorimeter, the temperature of the surroundings raises from 25.0 °C to 27.2 °C. The heat capacity for the hardware component is 2.260 kJ/ °C. The heat capacity of water is 4.184 J/ g °C.

In a bomb calorimeter, the thermometer is in the _____.

The combustion of the fuel that we are measuring here is _____. The enthalpy of this reaction is equal to _____ kJ. The enthalpy per gram of this reaction is about _____ kJ/g. The enthalpy per mole of this reaction is closest to _____ kJ/mol.

system | surroundings | exothermic | (no way to tell) | endothermic | -26.8 | -8.37 | -22.1 | -8.73 | -14.1 | -8.36 | -1210 | -2.56 | -22.1 | -77.4 | -4956 | -120.9 | -163.8 | -1.209 | -288 | -460.7

3 6 points

Calculate the change in enthalpy of the following reaction in kJ/mol using bond energy data:

$$ClF + CO \longrightarrow COClF$$

4 6 points

Using the bond energy data provided, calculate ΔH for the following reaction:

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

Bond	Bond Energy (kJ/mol)
H-H	436
Cl-Cl	242
H-Cl	432

- ○ 186 kJ/mol
- ○ -186 kJ/mol
- ○ -246 kJ/mol
- ○ 246 kJ/mol

5 6 points

Estimate the change in enthalpy of the following reaction using bond energy data:

$$N_2H_4(g) + H_2(g) \longrightarrow 2NH_3(g)$$

- ○ 850 kJ/mol
- ○ 1241 kJ/mol
- ○ -183 kJ/mol
- ○ -1469 kJ/mol

6 6 points

What is the value of heat flow for the combustion of hydrogen in kJ/g ? ΔH° for this process is -286 kJ/mol.

- ○ -572 kJ/g
- ○ 572 kJ/g
- ○ -71.5 kJ/g
- ○ -286 kJ/g
- ○ -143 kJ/g

7 5 points

This is a question that requires you to be completely precise and accurate. The numeric answer to this is exact based on the numbers that you have to use. So the answer is a large integer (4 digits to be exact) and I need you to be EXACTLY right on this. If you follow the steps that I showed in class on 11-16-2021, you should be able to do this easily.
QUESTION: What is the heat of combustion (it is a positive value because it is the heat given off - or released from the combustion) of exactly one mole of heptane? You answer has to be exactly right and in kJ.

8 6 points

Which of the following is the most efficient fuel based on its combustion enthalpy per gram?

- ○ wood
- ○ coal
- ○ octane
- ○ methane
- ○ hydrogen

9 6 points

What is the more efficient method to break a high molar mass fraction from a crude oil refinery down to a specific fuel?

- ○ reforming
- ○ thermal cracking
- ○ fractional distillation
- ○ catalytic cracking

10 6 points

An octane isomer can be made into a more efficient fuel by adding branching through the process of...

- ○ catalytic cracking
- ○ catalytic reforming
- ○ thermal cracking
- ○ fractional distillation

11 4 points

If you want to calculate the heat flow involving a temperature change, which equation will you use?

- ○ $q = mC_s\Delta T$
- ○ $q = m\Delta H$
- ○ $q = mC$
- ○ Σn bonds breaking -Σn bonds forming
- ○ $q = 2(m - C_s\Delta T)$

12 4 points

If you want to calculate the heat flow involving a phase change, which equation will you use?

- $q = m\Delta H_{trans}$
- $q = mC$
- $q = 2(m - C_s\Delta T)$
- $q = mC_s\Delta T$
- Σn bonds breaking -Σn bonds forming

13 4 points

Designate the sign of the heat flow (+ or -) for each of the following physical changes:
Vaporization: _____ Fusion: _____ Freezing: _____
_____ Sublimation: _____

14 5 points

What is the heat required to completely melt a 11.33 g sample of silicon (Si, molar mass = 28.09 g/mol) solid that is already at its melting point? ΔH_{fus} = 50.2 kJ/mol. Answer in units of kJ and round to one decimal place.

15 5 points

(Part 1 of 4) Draw the heating curve for the process of heating 14.0 g pure ice from -18.0 ˚C to 84 ˚C and use it to answer the next four questions.
What is the heat required to heat the ice to 0 ˚C? **Answer in joules to the nearest whole number.**

16 5 points

(Part 2 of 4) What is the heat required to fully melt the ice at 0 ˚C? **Answer in joules to the nearest whole number.**

17 5 points

(Part 3 of 4) What is the heat required to heat the water from 0 ˚C to 84 ˚C? **Answer in joules to the nearest whole number.**

18 5 points

(Part 4 of 4) What is the total heat applied during this process? **Answer in kilojoules (!) to three significant figures.**

19 5 points

The specific heat for liquid argon and gaseous argon is 25.0 J/mol·ºC and 20.8 J/mol·ºC, respectively. The enthalpy of vaporization of argon is 6506 J/mol. How much energy is required to convert 1 mole of liquid Ar from 5 ºC below its boiling point to 1 mole of gaseous Ar at 5 ºC above its boiling point?

- 6631 J
- 6735 J
- 6610 J
- 229 J
- 125 J