HW08 - Enthalpy & Fossil Fuels

(NOTE: the links in this pdf do not work. The links are active when inside of canvas.)

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

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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

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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

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3 6 points

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

$$ClF + CO \longrightarrow COClF$$

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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

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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

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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

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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.

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8 6 points

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

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

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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

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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

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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
- ○ $q = 2(m - C_s\Delta T)$

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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

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13 4 points

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

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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.

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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.**

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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.**

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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.**

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18 5 points

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

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19 5 points

The specific heat for liquid argon and gaseous argon is 25.0 J/mol·°C and 20.8 J/mol·°C, 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 °C below its boiling point to 1 mole of gaseous Ar at 5 °C above its boiling point?

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