Practice Quiz 1 (Thermodynamics)

1. Based on the following bond energies: C-H is 413 kJ/mol, O=O is 498 kJ/mol, C=O is 799 kJ/mol, and O-H is 463 kJ/mol, estimate ΔH for the gas-phase reaction
   \[ \text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \]
   1. +802 kJ/mol rxn
   2. -351 kJ/mol rxn
   3. -802 kJ/mol rxn correct
   4. +351 kJ/mol rxn
   5. None of these is correct within 10 percent.

2. A reaction that is endothermic:
   1. is never spontaneous
   2. is spontaneous if the temperature is high enough correct
   3. is spontaneous if the volume is large enough
   4. is spontaneous if the volume is small enough
   5. is spontaneous if the temperature is low enough

3. Which one of the following reactions has the most positive entropy change?
   1. 2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})
   2. \text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})
   3. \text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})
   4. \text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g}) correct
   5. \text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})

4. Consider the reaction
   \[ \text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g}) \]
   Assuming the gases are ideal, calculate the work done and the sign for a system at a constant pressure of 1 atm at 50°C in the conversion of 1.00 mole \text{C}_3\text{H}_8(\text{g})
   1. +8.0 kJ correct
   2. -8.0 kJ
   3. +7.5 kJ
   4. -2.7 kJ
   5. +2.7 kJ

   \[ w = -\Delta n RT \]
   \[ w = -(-3)(8.3)(323) \]
   \[ +8000 \text{ J} \]
   +8.0 kJ
   \[ \Delta n = -3 \] (\text{sign for } \text{H}_2\text{O}(\text{g}) \text{ it is not a gas})

   Positive, system gets smaller, "working" to do work.
5. Using the heat of formation data given below, calculate the enthalpy change at 25°C for the reaction

\[ \text{C}_2\text{H}_5\text{OH}(l) + 5\text{O}_2(g) \rightarrow 3\text{CO}_2(g) + 4\text{H}_2\text{O}(g) \]

The heat of formation values are:

- \( \Delta H_f \) for \( \text{H}_2\text{O}(l) \) = -242 kJ/mol
- \( \Delta H_f \) for \( \text{C}_2\text{H}_5\text{OH}(l) \) = -104 kJ/mol
- \( \Delta H_f \) for \( \text{CO}_2(g) \) = -375 kJ/mol

\[ \Delta H_f \text{reaction} = -2046 \text{ kJ} \]

This result was worked on p. 10 of the enthalpy worksheet.

1. insufficient information to calculate an answer
2. -2046 kJ/mol correct
3. 2046 kJ/mol
4. -576 kJ/mol
5. 576 kJ/mol

6. When work is done by the system:

1. \( w \) is negative; the system volume decreases
2. \( w \) is positive; the system volume increases
3. \( w \) is negative; the system volume increases correct
4. \( w \) is positive; the system volume decreases

7. 100 g of nacho cheese is burned in a calorimeter that contains 750 ml of water initially at 30.2°C. After the combustion, the temperature is 43.5°C. The heat capacity of the calorimeter is 75 J/°C, the specific heat of water is 4.18 J/g°C and the density of water is 1 g/ml. How much heat is evolved per gram of chips burned?

\[ \Delta H = m \cdot \text{CAT失控} + m \cdot \text{CAT calorimeter} \]
\[ = (250g \times 4.18 \times (13.3)) + 75(13.3) = 42,700 \text{ J} \]

8. Which of the following statements about thermodynamics is true?

1. work is a state function
2. the energy of a system is always increasing
3. the energy of the system is always equal to the energy of the universe minus the internal energy of the surroundings correct
4. adding heat to the system has a negative sign
5. \( \Delta H \) is a measure of the entropy of the system

\[ \text{Energy} = E_{\text{sys}} + E_{\text{sur}}. \]

but 42,700 J is for 100 g of nacho, so divide by 100 to get 427 J/gram.