Chemistry 202: Quiz #6

1. You have ice in a freezer, take it out, place it on the counter in your kitchen, and forget about it. In which case is the value of ΔS_{univ} greatest for the process that occurs?

   a) The freezer is set at –15°C and room temperature is 25°C.
   b) The freezer is set at –15°C and room temperature is 0°C.
   c) The freezer is set at –25°C and room temperature is 25°C.
   d) The freezer is set at –15°C and room temperature is 35°C.
   e) At least two of the ΔS_{univ} values would be the same.

2. Consider the reaction between $NO_2(g)$ and $O_2(g)$ to produce N_2O_5(g) at 25.0°C. Assuming $\Delta H°$ and $\Delta S°$ values are independent of temperature, determine the temperatures at which this reaction will occur spontaneously at 1 atm. Use the following data:

	$NO_2(g)$	**$O_2(g)$**	**$N_2O_5(g)$**
$\Delta H_f°$ (kJ/mol)	33.10		11.30
$S°$ (J/mol K)	240.0	205.2	346.6

   a) The process will only occur spontaneously above temperatures of about –40°C.
   b) The process will only occur spontaneously below temperatures of about –40°C.
   c) The process will only occur spontaneously above temperatures of about 40°C.
   d) The process will only occur spontaneously below temperatures of about 40°C.
   e) The process is spontaneous at any temperature.

3. Determine the sign (positive, negative, or zero) for the given quantity in each of the processes described below. For how many of them is the sign positive?

   - The value of q for an isothermal compression of 1.00 mole of an ideal monatomic gas.
   - The value of ΔH for water vaporizing at 95.0°C and 1 atm.
   - The value of ΔS_{univ} for water vaporizing at 95.0°C and 1 atm.
   - The value of ΔS_{univ} for water freezing at 0°C and 1 atm.
   - The value of ΔG for the spontaneous isothermal compression of 1.00 mole of an ideal monatomic gas.
   - The value of ΔS for water freezing at 0°C and 1 atm.

   a) 0 b) 1 c) 2 d) 3 e) 4

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4-5. In lecture we looked at problem 122 from Chapter 9 to introduce the concept of entropy. In this problem, you have 2.4 moles of a gas (ideal monatomic) in a 4.0-L bulb at a temperature of 32°C. This bulb is connected to a 20.0-L sealed, initially evacuated bulb via a closed valve. The valve is opened.

4. Determine the value of ΔS_{univ} (in J/K) for the process that occurs.

a) 0 b) 13.38 c) 14.90 d) 32.11 e) 35.75

5. Determine the value of ΔG (in kJ) for the process that occurs.

a) 0 b) −10.90 c) −9.79 d) 9.79 e) 10.90

6-8. Consider the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ at 25.0°C and the following data:

	$SO_2(g)$	**$SO_3(g)$**
ΔG_f° (kJ/mol)	–300.	–371

6. You have a mixture of the three gases (SO_2, O_2, and SO_3) at equilibrium. How will the system respond to an increase in temperature?

a) Equilibrium will shift toward the left (producing more SO_2 and O_2).
b) Equilibrium will shift to the right (producing more SO_3).
c) Equilibrium will not shift.
d) Without more information there is no way to know how equilibrium will shift.

7. Suppose you mix SO_2 and O_2 gases each at 2.00 atm in a rigid container and allow them to react to equilibrium at 25.0°C. Determine the equilibrium pressure of SO_3 gas.

a) 7.17×10^{-13} atm
b) 1.01×10^{-12} atm
c) 2.02×10^{-12} atm
d) 1.00 atm
e) 2.00 atm

8. How does the value of the equilibrium constant at 50.0°C compare to the value of the equilibrium constant at 25.0°C?

a) The equilibrium constant at 50.0°C is greater than that at 25.0°C.
b) The equilibrium constant at 50.0°C is less than that at 25.0°C.
c) The equilibrium constant at 50.0°C is the same as that at 25.0°C.
d) Without more information there is no way to know how the equilibrium constant will change.

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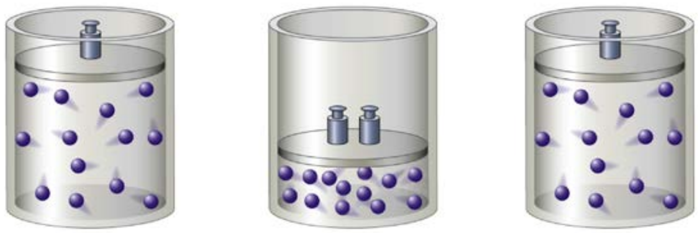
9. We discussed in the videos and in lecture about the isothermal compression and expansion of an ideal, monatomic gas. We discussed this by considering the gas in a container fitted with a piston for which a weight added to the top of the piston (causing the compression of the gas) and then the weight was removed (allowing for the expansion):



State A → State B → State C

The overall goal for this question is to **show and explain/justify** whether or not the compression and/or the expansion are **spontaneous processes**.

Make sure to discuss how/if the **gas sample** and the **universe have been changed** as the gas goes from State A to State C as shown above.

Your answers (for the compression, expansion, and overall) should include:

- **Determining** and **explaining/justifying** the **signs** (positive, negative, or zero) of:
  - ΔH
  - ΔE
  - q
  - w
  - ΔS
  - ΔS_{surr}
  - ΔS_{univ}
  - ΔG

- **Determining** and **explaining/justifying** the **relative magnitudes** of q and w.
- **Determining** and **explaining/justifying** the **relative magnitudes** of ΔS and ΔS_{surr}.

Use *PV* diagrams like the ones discussed in the videos, textbook, and lectures, and a **discussion of w_{rev} and q_{rev}** to **support your answers**.

Full credit is reserved for a logical and systematic presentation of ideas.

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10. The overall goal for this problem is to quantitatively support the fact that the freezing of water is not spontaneous at 5.0°C and 1 atm. Suppose you are given the following information:

- ΔH_f° for $H_2O(s)$ and for $H_2O(l)$.
- Heat capacity for $H_2O(s)$ and for $H_2O(l)$.
- The melting point of water

We will make the assumption that the heat capacity values are independent of temperature, but we will not assume that the ΔH_f° values are independent of temperature.

a. Before you begin calculating anything, **explain the process** you will follow. **How will you prove spontaneity**? **Explain/justify what you will need** to determine along the way to evaluating spontaneity, **how you will get there**, and **defend your answers**. Full credit is reserved for a logical, systematic description of the process.

b. Use the numbers given below to show that the freezing of water is not spontaneous at 5.0°C and 1 atm. **Show all work** and **explain how** your quantitative answer supports non-spontaneity.

- ΔH_f° for $H_2O(s)$ = –290.90 kJ/mol
- ΔH_f° for $H_2O(l)$ = –285.83 kJ/mol
- Heat capacity for $H_2O(s)$ = 37.5 J/Kmol
- Heat capacity for $H_2O(l)$ = 75.3 J/Kmol
- Melting point of water = 0°C, 1 atm

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KEY: 1d, 2b, 3c, 4e, 5b, 6a, 7e, 8b; 10. ΔS_{univ} = –0.28 J/K