

425

version

last name

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signature

McCord CH301
50070 BUR 106
TTh 9:30 am - 11 pm

Exam 5

Dec 5, 2017
Tuesday

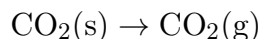
Remember to refer to the Periodic Table handout that is separate from this exam copy.

NOTE: Please keep this exam copy intact (all pages still stapled - including this cover page). You must turn in ALL the materials that were distributed. This means that you turn in your exam copy (name and signature included), bubble sheet, periodic table handout, and all scratch paper. Please also have your UT ID card ready to show as well.

This print-out should have 20 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 5.0 points

Carbon dioxide is a unique substance that sublimates at atmospheric pressure. Assuming no excess heat is supplied to the system at constant pressure, what are the signs of ΔH , ΔS , and w for the following phase change reaction at -78.5°C ?



1. $\Delta H < 0, \Delta S < 0, w = 0$
2. $\Delta H > 0, \Delta S < 0, w < 0$
3. $\Delta H > 0, \Delta S > 0, w = 0$
4. $\Delta H > 0, \Delta S > 0, w > 0$
5. $\Delta H > 0, \Delta S > 0, w < 0$

002 5.0 points

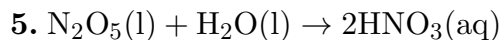
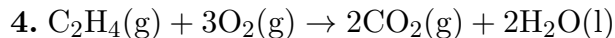
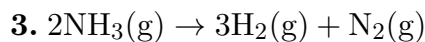
A 23 mL sample of liquid water at 39°C is frozen and cooled to a final temperature of -18°C . Calculate the heat of this process.

1. 11440 J
2. 12300 J
3. -12300 J
4. -8547 J
5. -534.8 J

003 5.0 points

For which of the following reactions is $\Delta U_{\text{sys}} > \Delta H_{\text{sys}}$ at constant external pressure?

1. $\text{SnO}_2(\text{g}) + \text{C}(\text{s}) \rightarrow \text{Sn}(\text{s}) + \text{CO}_2(\text{g})$
2. $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$



004 5.0 points

Determine the boiling point of methanol using the following thermodynamic phase data.

$$\Delta H_{\text{vap}} = 38.3 \frac{\text{kJ}}{\text{mol}} \quad \Delta S_{\text{vap}} = 113 \frac{\text{J}}{\text{mol} \cdot \text{K}}$$

1. 169 K
2. -339 K
3. 678 K
4. -678 K
5. 0.339 K
6. 339 K

005 5.0 points

A chemical reaction releases 86.9 kJ heat while 27.7 kJ work is done by the system via expansion. What is the change in the internal energy (ΔU) for the system?

1. -120 kJ
2. 59.2 kJ
3. -64.2 kJ
4. -59.2 kJ
5. -115 kJ
6. -142 kJ

006 5.0 points

A theoretical reaction has the following thermodynamic data:

$$\Delta H^\circ = 11 \text{ kJ/mol} \quad \Delta S^\circ = 87 \text{ J/mol}$$

What is the ΔG° for this reaction? Is this reaction spontaneous or non-spontaneous? Assume this reaction is run at 25°C .

1. -14.9 kJ, non-spontaneous
2. 8.82 kJ, non-spontaneous
3. -14.9 kJ, spontaneous
4. -9.43 kJ, spontaneous
5. -25920 kJ, spontaneous
6. -14930 kJ, non-spontaneous

007 5.0 points

You have equal masses of each of the following substances at room temperature:

$$C_{\text{lithium}} = 3.58 \frac{\text{J}}{\text{g}^\circ\text{C}} \quad C_{\text{iron}} = 0.450 \frac{\text{J}}{\text{g}^\circ\text{C}}$$

$$C_{\text{air}} = 1.012 \frac{\text{J}}{\text{g}^\circ\text{C}} \quad C_{\text{helium}} = 5.193 \frac{\text{J}}{\text{g}^\circ\text{C}}$$

$$C_{\text{mercury}} = 0.140 \frac{\text{J}}{\text{g}^\circ\text{C}}$$

Assuming no phase change occurs, which substance will have the highest final temperature after 22.7 J heat is added to each?

1. Iron
2. Lithium
3. The temperature change will be equal for each substance
4. Helium
5. Air
6. Mercury

008 5.0 points

The spontaneous vaporization of nitrogen at room temperature is an endothermic reaction. Which of the following statements is true about this process?

1. None of the statements are correct
2. There is a positive ΔS for the system ($\Delta S_{\text{sys}} > 0$)
3. The magnitude of ΔS for the surroundings must be greater than the magnitude of ΔS for the system ($|\Delta S_{\text{surr}}| > |\Delta S_{\text{sys}}|$)
4. There is no ΔS for the universe ($\Delta S_{\text{universe}} = 0$)
5. There is a negative ΔS for the universe ($\Delta S_{\text{universe}} < 0$)

009 5.0 points

For which of the following chemical equations would $\Delta H_{\text{rxn}}^\circ = \Delta H_f^\circ$?

1. $2\text{C}(\text{s, graphite}) + \text{O}_2(\ell) \rightarrow 2\text{CO}(\text{g})$
2. $\text{N}_2(\ell) + 3\text{Cl}_2(\text{g}) \rightarrow 2\text{NCl}_3(\ell)$
3. $\frac{1}{2}\text{N}_2(\text{g}) + \frac{3}{2}\text{H}_2(\text{g}) \rightarrow \text{NH}_3(\text{g})$
4. $\text{CH}_4(\text{g}) \rightarrow \text{C}(\text{s, graphite}) + 2\text{H}_2(\text{g})$
5. $\text{CH}_4(\text{g}) + 2\text{Cl}_2(\text{g}) \rightarrow \text{CCl}_4(\ell) + 2\text{H}_2(\text{g})$

010 5.0 points

Unlike state functions such as temperature, volume, and pressure, we consider enthalpy to be a "made-up" state function. Why is enthalpy so important?

1. The change in enthalpy (ΔH) is a measurement of heat at constant pressure and sets an important reference point for reactions in our atmosphere
2. The sign of the change in enthalpy (ΔH) is a direct indication of the spontaneity of a reaction
3. The change in enthalpy (ΔH) is a measurement of heat at constant pressure, which is directly measured by constant-volume gas phase reactions

4. The change in enthalpy (ΔH) is always equal to the sum of all kinetic and potential energy in a chemical system

5. Enthalpy is a measurement of heat at constant volume, which is an important standard for combustion reactions

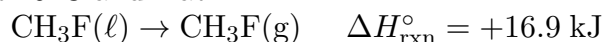
011 5.0 points

Which of the following will NOT result in a positive change in entropy for the system?

1. MgCl_2 is dissolved in water
2. Water is heated from room temperature to just below its boiling point
3. Sweat evaporates on your skin
4. Two gases are mixed together in a container
5. Half of the gas particles are removed from a container

012 5.0 points

Calculate the ΔS_{surr} for the following reaction at 10°C and 1 atm.



1. -59.7 J/K
2. -1.69 J/K
3. 1690 J/K
4. 1.69 J/K
5. -845 J/K
6. 59.7 J/K

013 5.0 points

Consider a reaction that has a negative change in entropy and a positive change in enthalpy. Which of the following conditions will favor spontaneity?

1. High Temperatures

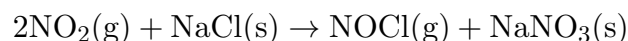
2. Low Temperatures

3. This reaction is non-spontaneous at all temperatures

4. This reaction is spontaneous at all temperatures

014 5.0 points

The atmospheric photochemical oxidation of nitrogen dioxide is an important contributor to rising HNO_3 levels in coastal acid rains. To simulate the first steps of this process, you run the following reaction in a piston:



If two moles of NO_2 gas are reacted with excess NaCl to completion at 29°C , what is the value of work for this reaction? Is work done on or by the system?

1. -5024 J , by the system
2. 2512 J , on the system
3. 2512 J , by the system
4. -2512 J , on the system
5. -5024 J , on the system
6. -241.1 J , by the system

015 5.0 points

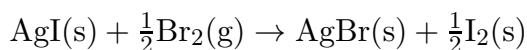
Which of the following statements is/are true regarding the first law of thermodynamics?

- I. The internal energy change of the system is equal to the heat plus the work
- II. $\Delta U_{\text{sys}} = -\Delta U_{\text{surr}}$
- III. A positive change in internal energy for the system must be matched with a negative change in internal energy for the universe
- IV. $\Delta U_{\text{universe}} = \Delta U_{\text{sys}} + \Delta U_{\text{surr}}$

- I, II, III and IV
- I and IV only
- I, II, and IV only
- I only
- II only
- III and IV only
- I and II only

016 5.0 points

Consider the following reaction and standard heats of formation:



$$\Delta H_f^\circ \text{ for AgI(s)} = -61.9 \text{ kJ/mol}$$

$$\Delta H_f^\circ \text{ for AgBr(s)} = -100.4 \text{ kJ/mol}$$

$$\Delta H_f^\circ \text{ for Br}_2(\text{g}) = +30.9 \text{ kJ/mol}$$

What is the $\Delta H_{\text{rxn}}^\circ$?

- 146.9 kJ/mol
- +69.4 kJ/mol
- 54.0 kJ/mol
- 69.4 kJ/mol
- 61.9 kJ/mol

017 5.0 points

Calculate the value of work when a gas expands from 13.5 to 22.9 liters against a pressure of 3.4 atm at constant temperature. Is work done on or by the system?

- +0.3154 J, on the system
- 0.3154 J, by the system
- 3238 J, by the system
- 3238 J, on the system

- +3238 J, on the system
- 0.3154 J, on the system

018 5.0 points

The unknown element X is a metallic solid that oxidizes at room temperature and pressure to form X_2O_3 . Given the following thermodynamic data, calculate the ΔG_f° .

Substance	ΔH_f° kJ/mol	S° J/mol K
X(s)	–	38.3
O ₂ (g)	–	205
O(g)	249	161
X ₂ O ₃ (s)	–860	92.2

- $6.09 \times 10^6 \text{ kJ mol}^{-1}$
- 1470 kJ mol⁻¹
- 742.35 kJ mol⁻¹
- 773 kJ mol⁻¹
- 5210 kJ mol⁻¹
- 1470 kJ mol⁻¹
- 773 kJ mol⁻¹
- 742.35 kJ mol⁻¹

019 5.0 points

When a 0.401 g sample of a clean-burning hydrocarbon (molecular weight = 42.05 g/mol) is combusted in a rigid container, the temperature increases from 24.987°C to 28.623°C. The total volume of water is 0.746 L. The sum of all hardware components of the calorimeter have a heat capacity of 2.55 kJ/°C. Calculate the internal energy of combustion for one mole of this hydrocarbon.

- 3.71799 kJ/mol

2. +9277.90 kJ/mol

3. +51.4232 kJ/mol

4. +2162.35 kJ/mol

5. +3.71799 kJ/mol

6. -2162.35 kJ/mol

7. +20.6207 kJ/mol

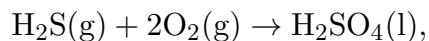
8. -20.6207 kJ/mol

020 5.0 points

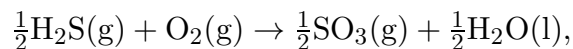
Consider the following balanced chemical reaction:



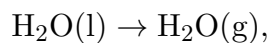
To solve for the $\Delta H_{\text{rxn}}^\circ$ for this reaction, you collect the following data in the lab:



$$\Delta H_{\text{rxn}}^\circ = -232.3 \text{ kJ/mol}$$



$$\Delta H_{\text{rxn}}^\circ = -102.8 \text{ kJ/mol}$$



$$\Delta H_{\text{rxn}}^\circ = 51.9 \text{ kJ/mol}$$

What is the $\Delta H_{\text{rxn}}^\circ$ of the overall balanced reaction?

1. -386 kJ/mol

2. 490 kJ/mol

3. 181 kJ/mol

4. -516 kJ/mol

5. 78.6 kJ/mol