

CHEM 188 – Spring, 2013

Hour Exam 4 (Green)

April 25, 2013

Instructions:

Your scantron answer sheet must show your **NAME**, **7-DIGIT KU ID NUMBER**, and **LAB SECTION**. (Begin these entries at the **LEFT** end of the space provided.) In answering the questions, be careful to fill in the corresponding circles on the answer sheet according to the number of the question on the exam. **USE A SOFT (No. 2) PENCIL**.

Note that a **periodic table** of the elements is attached at the end of the exam.

<u>Useful information:</u>	Avogadro's number	$N_{\text{Avo}} = 6.02 \times 10^{23} \text{ mol}^{-1}$
	Speed of light	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
	Gas Constant	$R = 0.08206 \text{ L atm/K mole}$ $= 8.314 \text{ J/K mole}$
	Conversion factors	$1 \text{ amu} = 1.66 \times 10^{-27} \text{ kg}$ $1 \text{ atm} = 760 \text{ mmHg} = 760 \text{ torr}$
	First-order kinetics	$N = N_0 \exp(-kt)$

- Consider a sample of solid carbon dioxide consisting of five molecules of CO, each of which can be oriented in either of two directions. If these two directions are equally probable, **how many ways, W**, can these five molecules be arranged?
A. 5 B. 8 C. 16 **D. 32** E. 64
- For which of the following processes will the **entropy of the system** decrease?
 - a solid melts
 - a liquid freezes
 - a liquid boils
 - a vapor condenses
 - a gas is compressed isothermallyA. 1 & 3 only B. 2 & 4 only C. 3 & 5 only D. 1 & 5 only **E. 2, 4 & 5 only**
- For a **spontaneous process**, which one of the following is always positive?
A. ΔU B. ΔH C. ΔS_{sys} D. ΔS_{surr} **E. ΔS_{univ}**

4. Calculate ΔS for the reaction $3\text{O}_2(\text{g}) \rightarrow 2\text{O}_3(\text{g})$.

	$S^\circ(\text{J/K}\cdot\text{mol})$
$\text{O}_2(\text{g})$	205
$\text{O}_3(\text{g})$	239

- A. +137 J/K B. -137 J/K C. +34 J/K D. -34 J/K E. +444 J/K

5. For the reaction



$\Delta H^\circ = 58.04$ kJ and $\Delta S^\circ = 176.6$ J/K at 298K. Which of the following statement(s) is(are) **false**? (Assume that the surroundings are also at 298K.)

1. $\Delta S_{\text{sur}} = -194.8$ J/K
2. $\Delta S_{\text{sur}} = +194.8$ J/K
3. $\Delta S_{\text{univ}} = 0$ J/K
4. $\Delta S_{\text{univ}} = -18.2$ J/K

- A. 1 only B. 2 only C. 1 & 4 only D. **2 & 3 only** E. none are true

6. Given the following data at 25°C:



What is ΔG° at 25°C for the reaction



- A. +670.4 kJ B. +70.7 kJ C. **-70.0 kJ** D. -670.4 kJ E. none of these

7. Which choice is **true** for the following process?



- A. ΔH is + and ΔS is +.
B. ΔH is $-$ and ΔS is $-$.
C. ΔH is + and ΔS is $-$.
D. ΔH is $-$ and ΔS is +.
E. ΔG is + for all temperatures.

8. Estimate ΔG° at 1000°C for the reaction



Assume that $\Delta H^\circ = -26.9 \text{ kJ}$ and $\Delta S^\circ = -11.3 \text{ J/K}$ for this reaction at 1000°C.

- A. -41.3 kJ B. -35.6 kJ C. -23.5 kJ D. -18.2 kJ E. -12.5 kJ

9. The reaction



is **spontaneous** at all temperatures. We can conclude that

- A. ΔH° is + and ΔS° is + for this reaction.
B. ΔH° is - and ΔS° is - for this reaction.
C. ΔH° is + and ΔS° is - for this reaction.
D. ΔH° is - and ΔS° is + for this reaction.
E. ΔG° is + for all temperatures for this reaction.

10. For the reaction



$\Delta H^\circ = -92.6 \text{ kJ}$ and $\Delta S^\circ = -199 \text{ J/K}$ at 298K. Which of the following statement(s) is(are) **true**?

1. $\Delta G^\circ = -33.3 \text{ kJ}$ at 298K
2. $\Delta G^\circ = +59.2 \text{ kJ}$ at 298K
3. The reaction is spontaneous at this temperature
4. The reaction is non-spontaneous at this temperature

- A. 1 only B. 2 only C. 1 & 3 only D. 2 & 4 only E. none are true

11. Use the following data to determine the **normal boiling point** of N_2O_4 in degrees Celsius.

$$\text{N}_2\text{O}_4(l): \quad \Delta H_f^\circ = -19.50 \text{ kJ/mol}$$

$$S^\circ = 209.2 \text{ J/K} \cdot \text{mol}$$

$$\text{N}_2\text{O}_4(g): \quad \Delta H_f^\circ = 9.16 \text{ kJ/mol}$$

$$S^\circ = 304.3 \text{ J/K} \cdot \text{mol}$$