

CHEM 188 – Spring, 2013

Hour Exam 4 (Early)

April 24, 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	$N = N_0 \exp(-kt)$

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1. Two flasks of equal volume are connected together and a total of 8 molecules placed within them. What is the **probability** of all 8 molecules ending up in the same flask?
- A. 0.25 B. 0.0625 C. 0.0156 **D. 3.9×10^{-3}** E. 9.8×10^{-4}
2. Which response includes *all* the following processes that are accompanied by a **decrease in entropy**?
- $2\text{I(g)} \rightarrow \text{I}_2\text{(g)}$
 - $\text{I}_2\text{(s)} \rightarrow \text{I}_2\text{(g)}$
 - $2\text{NH}_3\text{(g)} \rightarrow \text{N}_2\text{(g)} + 3\text{H}_2\text{(g)}$
 - $\text{Mg}^{2+}\text{(aq)} + 2\text{OH}^-\text{(aq)} \rightarrow \text{Mg(OH)}_2\text{(s)}$
- A. 1, 2 B. 1, 3 **C. 1, 4** D. 3 E. 2, 3
3. For a **spontaneous process**, which one of the following is always positive?
- A. ΔU B. ΔH C. ΔS_{sys} **D. ΔS_{univ}** E. ΔS_{surr}

4. What are the signs (+/−) of ΔS and ΔH for the following reaction?



- A. $\Delta S = (+)$ and $\Delta H = (+)$
- B. $\Delta S = (+)$ and $\Delta H = (0)$
- C. $\Delta S = (-)$ and $\Delta H = (+)$
- D. $\Delta S = (-)$ and $\Delta H = (-)$

5. For the reaction



$\Delta H^\circ = 284.4 \text{ kJ}$ and $\Delta S^\circ = -139.8 \text{ J/K}$ at 298K. Which of the following statement(s) is(are) **true**? (Assume that the surroundings are also at 298K.)

- 1. $\Delta S_{\text{surr}} = +139.8 \text{ J/K}$
- 2. $\Delta S_{\text{surr}} = +954 \text{ J/K}$
- 3. $\Delta S_{\text{univ}} = 0 \text{ J/K}$
- 4. $\Delta S_{\text{univ}} = -1094 \text{ J/K}$

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

6. For the reaction



$\Delta G^\circ = 173.4 \text{ kJ}$ at 298 K. What is the **standard free energy of formation**, ΔG_f° , of $NO(g)$?

- A. -173.4 kJ/mol B. -86.7 kJ/mol C. 0 kJ/mol
D. 86.7 kJ/mol E. 173.4 kJ/mol

7. Calculate ΔG at 298 K for the reaction



	<u>ΔG_f° (kJ/mol) at 298K</u>
$N_2O_4(g)$	98.3
$NO_2(g)$	51.8

- A. -46.5 kJ B. -5.3 kJ C. 0 kJ D. 5.3 kJ E. 46.5 kJ

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



Assume that $\Delta H^\circ = 178.3 \text{ kJ}$ and $\Delta S^\circ = 160.55 \text{ J/K}$ for this reaction at 1000°C.

- A. -26.1 kJ B. 14.1 kJ C. 54.2 kJ D. 94.3 kJ E. 130.5 kJ

9. A reaction will be **spontaneous only at high temperatures** when

- 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 - at all temperatures.

10. The normal freezing point of ammonia is -78°C . **Predict the signs** of ΔH , ΔS , and ΔG for ammonia when it freezes at -80°C and 1 atm: $\text{NH}_3(l) \rightarrow \text{NH}_3(s)$

	ΔH	ΔS	ΔG
A.	-	-	0
B.	-	+	-
C.	+	-	+
D.	+	+	0
E.	-	-	-

11. For the reaction



$\Delta H^\circ = 178.3 \text{ kJ}$ and $\Delta S^\circ = 160.55 \text{ J/K}$ at 25°C. Estimate the **minimum temperature** at which this reaction will be spontaneous under standard state conditions.

- A. 0 K B. 273 K C. 448 K D. 838 K E. 1100 K

12. For the reaction



$\Delta G^\circ = 2.60 \text{ kJ/mol}$ at 25°C. If $P(\text{H}_2) = 5.00 \text{ atm}$, and $P(\text{HI}) = 0.500 \text{ atm}$, calculate ΔG (in kJ/mol) for this reaction at this temperature.

- A. -14.5 B. -4.82 C. 2.60 D. 12.3 E. 19.7