

INFORMATION, SCRAP, AND COVER PAGE

This page contains information which may or may not be needed. This page can also be used for scrap paper or for cover paper. THIS PAGE WILL NOT BE COLLECTED. TEAR THIS PAGE OFF THE EXAM. DO NOT TURN IN THIS PAGE.

$$R = 0.08206 \text{ L} \cdot \text{atm}/(\text{mol} \cdot \text{K}) = 8.314 \text{ J/K or J}/(\text{mol} \cdot \text{K})$$

$$T(\text{K}) = T(^{\circ}\text{C}) + 273.15$$

Free energy $\Delta G = \Delta G^{\circ} + RT \ln Q$

$$\Delta G^{\circ} = -RT \ln K$$

First order kinetics $\ln \frac{[A]_0}{[A]_t} = akt$ $t_{1/2} = \frac{\ln 2}{ak}$

Second order kinetics $\frac{1}{[A]_t} - \frac{1}{[A]_0} = akt$ $t_{1/2} = \frac{1}{ak [A]_0}$

Arrhenius $k = A e^{-E_a/RT}$

Quadratic equation $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

	ΔH_f° kJ/mol	S° J/K·mol	ΔG_f° kJ/mol		ΔH_f° kJ/mol	S° J/K·mol	ΔG_f° kJ/mol
CO(g)	-110.53	197.65	-137.16	H ₂ O(l)	-285.83	69.95	-237.14
CO ₂ (g)	-393.52	213.80	-394.39	OH ⁻ (aq)	-229.99	-10.75	-157.24
CO ₂ (aq)	-413.80	117.6	-385.98	S(s)	0	32.06	0
HCO ₃ ⁻ (aq)	-691.99	91.2	-586.77	S ²⁻ (aq)	33.1	-14.6	85.8
CO ₃ ²⁻ (aq)	-677.14	-56.9	-527.81	HS ⁻ (aq)	-17.6	62.8	12.08
NO(g)	90.29	210.76	86.60	H ₂ S(g)	-20.50	205.76	-33.33
N ₂ O(g)	82.05	219.96	104.18	H ₂ S(aq)	-39.7	121	-27.83
NO ₂ (g)	33.10	240.03	51.26	SO ₂ (g)	-296.84	248.21	-300.12
N ₂ O ₄ (g)	9.08	304.38	97.79	SO ₂ (aq)	-322.98	161.9	-300.68

PRINT NAME _____

SIGN NAME _____

CIRCLE your recitation section in the list below.

A: W 8:00 NS 130 B: F 1:00 HM 210

C: T 9:00 NS 108 D: W 9:00 NS 317

E: Th 9:00 HM 210 F: F 12:00 NS 128

SCORED GRADE: _____

All answers should be with the correct significant figures.

The Periodic Table and the Information Page will not be collected. They can be used as scratch paper or as cover paper. Do not turn them in.

Be certain your answers are clear. If an answer is not clear, it can be considered wrong.

Problems marked with ** in the margin are from the assigned homework. These total 34 points.

Place your name in the space provided at the top of each question page. This helps to identify the pages if they are accidentally separated during grading and processing.

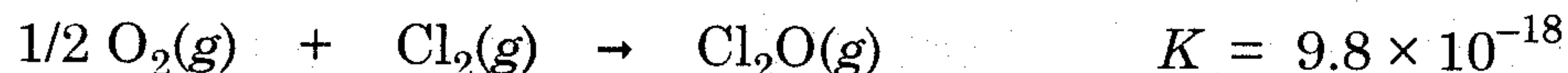
Work promptly. Use your time effectively.

****KEEP YOUR WORK AND ANSWERS COVERED.****

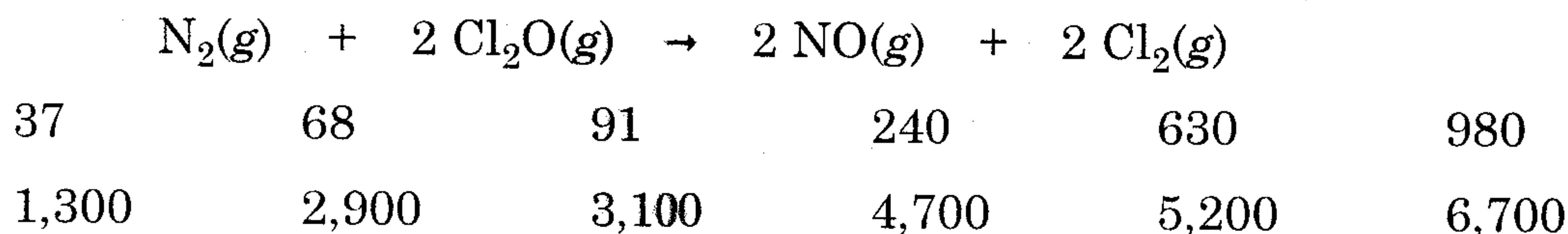
1. (30 pts) Indicate whether each statement is true (T) or false (F). Be certain T or F is clearly indicated.

- _____ Every reaction with a positive ΔS_{sys} is allowed.
- _____ S° of $\text{SF}_4(\text{g})$ is greater than S° of $\text{SF}_6(\text{g})$.
- _____ ΔG_f° for $\text{O}_2(\text{g})$ is zero.
- _____ The direction of allowed, net change is always towards equilibrium.
- _____ The units of k for a second order rate law are $(\text{conc}^{-1} \cdot \text{t}^{-1})$.
- _____ For any elementary step, $E_{\text{a,fwd}} = -E_{\text{a,rev}}$.
- _____ Increasing T increases $t_{1/2}$.
- _____ A catalyst does not change $\Delta H_{\text{rxn}}^\circ$.
- _____ For any given reaction with $Q > K$, the exergonic direction is forward.
- _____ Whenever ΔG° is zero, then K is one.

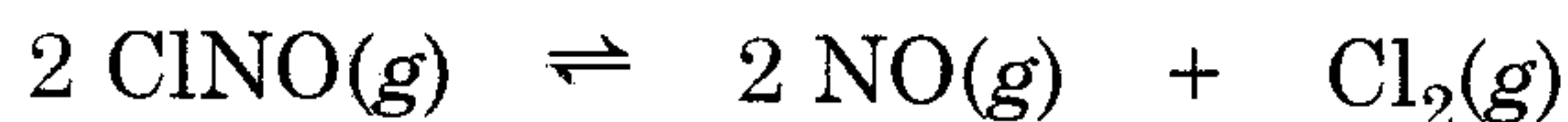
2. (6 pts) Consider the following formation equations with their equilibrium constants at 298.15 K.



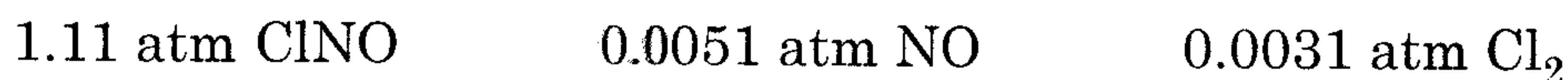
Use these to calculate (and circle below) the equilibrium constant of the following reaction.



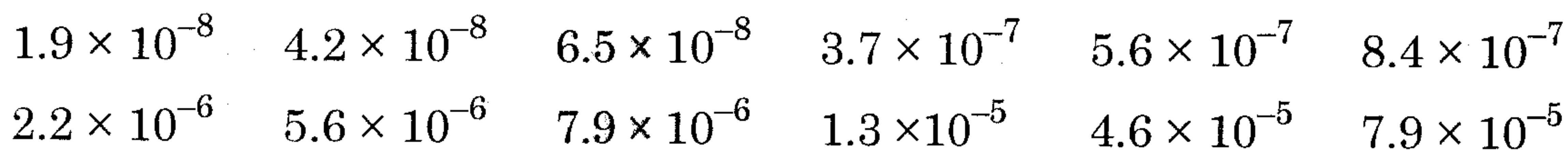
- ** 3. (6 pts) Consider the following equilibrium system.



The following conditions were measured at equilibrium.



Circle the value for K .



last name: _____

4. (6 pts) Give the sign of ΔS° for each of the following processes.

Combustion reaction of $\text{CS}_2(g)$
to $\text{CO}_2(g)$ and $\text{SO}_2(g)$

Formation reaction for $\text{H}_2\text{O}(l)$

Lattice energy equation for $\text{NaCl}(s)$

5. (10 pts) The following equation is balanced.



Circle the value of ΔG° in kJ.

-81.67	-87.20	-91.59	-96.06	-102.22	-109.54
-115.42	-117.94	-122.51	-127.64	-133.08	-136.89

For the following conditions at 298.15 K, circle ΔG (in kJ). (Above answer must be correct for credit here.)

0.0652 M H_2S	0.560 M SO_2	2.45 mol S	500. g H_2O		
-76.6	-79.3	-87.2	-89.5	-100.4	-102.9
-112.6	-118.1	-121.9	-129.5	-130.4	-137.5

6. (8 pts) The following is an elementary step.



Write the rate law.

What is the molecularity of the step?

Is the step exothermic or endothermic?

- ** 7. (6 pts) The equilibrium vapor pressure of water at 50.00 °C is 92.6 Torr. Circle the value of $\Delta G_{\text{vap}}^\circ$ (in kJ) at this temperature.

3.40	3.68	4.05	4.58	5.32	5.66
6.18	6.72	7.49	7.97	8.15	8.43

- ** 8. (6 pts) Write the Q expression for the following equation.



- ** 9. (10 pts) The following reaction is second order in NO_2 ; $k = 0.68 \text{ (L/mol)/s}^{-1}$ at 500 K.



The reaction begins with $[\text{NO}_2] = 0.0341 \text{ mol/L}$. Circle the concentration (in mol/L) of NO_2 which remains after 30. s.

0.010	0.012	0.014	0.016	0.018	0.020
0.022	0.024	0.026	0.028	0.030	0.032

Circle the percent completion after 30. s. (Above answer must be correct for credit here.)

4.8%	7.0%	13%	19%	24%	30%
36%	42%	48%	53%	59%	65%

- ** 10. (6 pts) Circle the change in free energy (in kJ) at standard conditions for the combustion of 7.94 g $\text{H}_2(g)$ to form $\text{H}_2\text{O}(l)$.

-101	-180.	-265	-344	-422	-509
-588	-667	-745	-821	-934	-985

11. (6 pts) Consider the following equilibrium system, for which $K = 0.0222$ at 298.15 K.



The reaction begins with all reactants and product at standard conditions. Circle the pressure (in atm) of C_2H_6 at equilibrium.

0.0810	0.0962	0.113	0.208	0.396	0.407
0.593	0.656	0.751	0.887	0.904	1.01