

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	N ₂ (g)	0	191.61	0
CO ₂ (g)	-393.52	213.80	-394.39	NH ₃ (g)	-45.90	192.77	-16.37
CO ₂ (aq)	-413.80	117.6	-385.98	NH ₃ (aq)	-80.29	111.3	-26.50
HCO ₃ ⁻ (aq)	-691.99	91.2	-586.77	NH ₄ ⁺ (aq)	-132.51	113.4	-79.31
CO ₃ ²⁻ (aq)	-677.14	-56.9	-527.81	NO(g)	90.29	210.76	86.60
HCO ₂ H(aq)	-425.43	163	-372.3	N ₂ O(g)	82.05	219.96	104.18
HCO ₂ ⁻ (aq)	-425.55	92	-351.0	NO ₂ (g)	33.10	240.03	51.26
H ₂ O(l)	-285.83	69.95	-237.14	N ₂ O ₄ (s)	-35.05	150.29	99.60
H ₂ O(g)	-241.83	188.83	-228.58	N ₂ O ₄ (g)	9.08	304.38	97.79

PRINT NAME _____

SIGN NAME _____

CIRCLE your recitation section in the list below.

A: M 9:00 NS 317	B: M 10:00 NS 317
C: T 11:00 NS 128	D: W 8:00 HM 207
E: W 12:00 DA 209A	F: Th 4:00 HM 210

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.

_____ For a pure substance, $\Delta S_{\text{fus}}^{\circ} > \Delta S_{\text{vap}}^{\circ}$.

_____ For every process, $\Delta S_{\text{sys}} = -\Delta S_{\text{surr}}$.

_____ For any exergonic reaction, the maximum driving force is at the start of the reaction.

_____ All simple mechanisms are unimolecular.

_____ Faster reactions have longer half-lives.

_____ For every elementary reaction, $\Delta H = E_{\text{a,fwd}} - E_{\text{a,rev}}$.

_____ The industrial production of NH_3 requires a catalyst.

_____ Small changes in ΔG° can lead to large changes in K .

_____ At equilibrium, at the normal boiling point of any liquid, $K = \text{zero}$.

_____ When you reverse an equation, then Q is inverted.

- ** 2. (6 pts) The following equation is balanced.



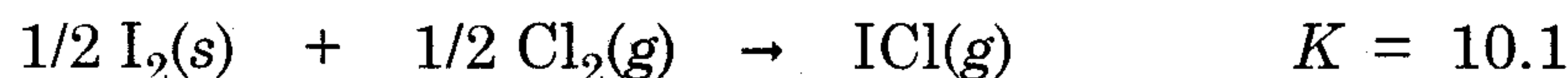
For the following conditions, circle the value of Q below.

0.442 atm O_2 11.3 mol H_2O 1.46 g MnO_2 0.0438 M H^+ 0.0243 M Mn^{2+}

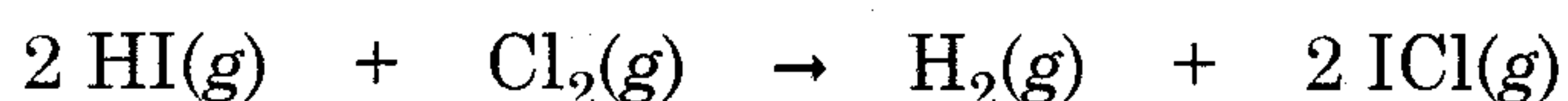
63.1 70.9 104 188 252 287

336 371 448 470. 522 566

3. (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.



18.9 40.6 90.2 118 147 180.

231 262 274 331 359 392

- ** 4. (10 pts) The following reaction is first order in C_2H_5I ; $k = 4.0 \times 10^{-3} s^{-1}$ at 700 K.



The reaction begins with $[C_2H_5I] = 3.30 \times 10^{-4} \text{ mol/L}$. Circle the concentration (in mol/L) of C_2H_5I which remains after 300. s.

1.7×10^{-5} 2.2×10^{-5} 3.0×10^{-5} 4.7×10^{-5} 5.6×10^{-5} 6.4×10^{-5}
 7.2×10^{-5} 8.6×10^{-5} 9.9×10^{-5} 1.3×10^{-4} 1.6×10^{-4} 1.9×10^{-4}

Circle the concentration (in mol/L) of HI which has formed in 300. s. (Above answer must be correct for credit here.)

1.40×10^{-4} 1.70×10^{-4} 2.00×10^{-4} 2.31×10^{-4} 2.44×10^{-4} 2.58×10^{-4}
 2.66×10^{-4} 2.74×10^{-4} 2.83×10^{-4} 3.00×10^{-4} 3.08×10^{-4} 3.13×10^{-4}

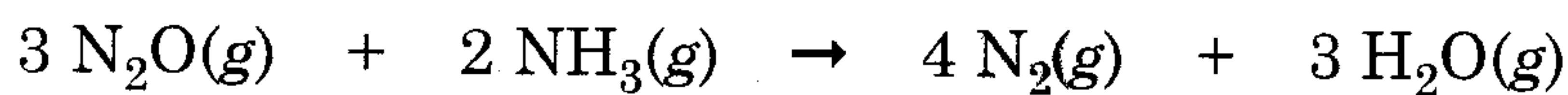
5. (6 pts) Give the sign of ΔS° for each of the following processes.

Combustion reaction of $H_2S(g)$
to $SO_2(g)$ and $H_2O(g)$ _____

Condensation _____

Dissolving $Ar(g)$ into water _____

- ** 6. (6 pts) Circle the value of $\Delta S^\circ_{\text{rxn}}$ (in J/K) for the following balanced equation.



137.22 153.18 170.61 196.41 221.70 243.05
 268.17 287.51 307.63 318.01 337.52 356.19

- ** 7. (6 pts) Consider the solubility equilibrium of $NH_3(g)$ in water at 298 K.



Circle the value of K .

13.2 18.0 23.6 26.3 30.7 38.2
 42.9 46.1 54.8 59.7 63.8 68.0

last name: _____

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

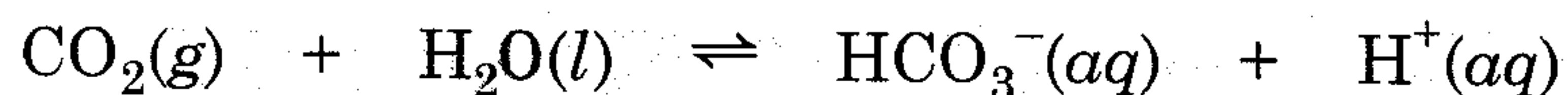


Write the rate law. _____

What is the overall order of the step? _____

What free radicals are involved? _____

9. (10 pts) The following equation is balanced.



Circle the value of ΔG° in kJ.

26.37	27.28	31.34	35.45	44.76	49.67
55.08	57.93	62.18	67.50	73.41	76.98

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

0.603 atm CO_2	250. g H_2O	0.00641 M HCO_3^-	0.00389 M H^+		
2.3	8.5	19.7	21.8	34.3	42.3
57.2	65.8	70.5	82.5	91.4	103.2

- ** 10. (6 pts) Circle all of the following substances which have $\Delta G_f^\circ = 0$.

$\text{I}_2(g)$ $\text{Cl}^-(aq)$ $\text{Al}(s)$ $\text{Ne}(g)$ $\text{Br}_2(g)$ $\text{C}(\text{diamond})$

11. (6 pts) Consider the following equilibrium, for which $K = 17.5$ at 298.15 K.



The reaction begins with all reactants and products at standard conditions. Circle the pressure (in atm) of N_2O at equilibrium.

0.0873	0.0906	0.102	0.271	0.386	0.440
0.560	0.614	0.729	0.898	0.909	1.08