

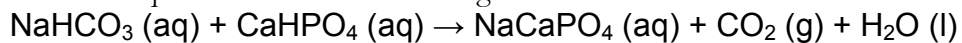
**Exam 3a**  
**Chem 141**  
**Fall 2006**

Show all work to receive credit!

Name: \_\_\_\_\_

- Q1. Convert  $-5\text{ }^{\circ}\text{C}$  to Kelvin. (4 pts.)
- Q2. 3.50 moles of an ideal gas occupies a volume of 5.44 L at a temperature of 295 K. Predict the pressure of the gas. (6 pts.)
- Q3. Give two reasons that explain why *real* gases deviate from *ideal* behavior. (4 pts.)  
(i) (ii)
- Q4. A canister of gas at a pressure of 3.50 atm and a temperature of  $-12\text{ }^{\circ}\text{C}$  is heated to a temperature of  $459\text{ }^{\circ}\text{C}$ . Assuming the canister does not change volume, and that the gas behaves ideally, calculate the final pressure of the gas. (8 pts.)
- Q5. Convert a pressure of 455 torr to atmospheres. (4 pts.)

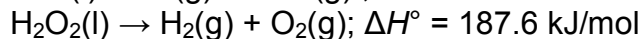
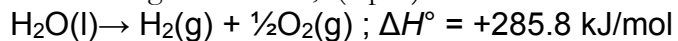
- Q6. Baking powder is made up of sodium hydrogen carbonate and calcium hydrogen phosphate. When baking powder is wet, these components react to produce carbon dioxide. The equation for this reaction is given below.



How many liters of carbon dioxide can be formed at room temperature from 4.50 g of  $\text{NaHCO}_3$  and excess  $\text{CaHPO}_4$ ? (12 pts.)

- Q7. Calculate the enthalpy of reaction for  $\text{H}_2(\text{g}) + \text{C}_2\text{H}_4(\text{g}) \rightarrow \text{C}_2\text{H}_6(\text{g})$ . (4 pts.)  
[ $\Delta H^\circ_f(\text{C}_2\text{H}_4(\text{g})) = 52.3 \text{ kJ/mol}$ ;  $\Delta H^\circ_f(\text{C}_2\text{H}_6(\text{g})) = -84.7 \text{ kJ/mol}$ ;  $\Delta H^\circ_f(\text{H}_2(\text{g})) = 0 \text{ kJ/mol}$ ]

- Q8. Given the following  $\Delta H^\circ$  values, (6 pts.)



calculate  $\Delta H^\circ_{\text{rxn}}$  for the reaction  $2\text{H}_2\text{O}_2(\text{l}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$

Q9. A sheet of gold weighing 10.0 g at a temperature of 18.0 °C is placed flat on a sheet of iron weighing 20.0 g and at a temperature of 55.6 °C. What is the final temperature of the combined metals? (The specific heat of gold is 0.129 J/g·°C, the specific heat of iron is 0.444 J/g·°C) (10 pts.)

Q10. Calculate the pressure exerted by 2.75 moles of CO<sub>2</sub> confined in a volume of 5.00 L at 450 K using the van der Waals equation. ( $a = 3.59 \text{ atm} \cdot \text{L}^2 \cdot \text{mol}^{-2}$ ,  $b = 0.0427 \text{ L} \cdot \text{mol}^{-1}$ ) Compare the pressure with that calculated using the ideal gas equation. (12 pts.)

- Q11. How many grams of ethylene ( $\text{C}_2\text{H}_4$ ) would have to be burned to produce 450 kJ of heat? (6 pts.)
- $$2\text{C}_2\text{H}_4 + 6\text{O}_2 \rightarrow 4\text{CO}_2 + 2\text{H}_2\text{O}; \Delta H^\circ_{\text{rxn}} = -2822 \text{ kJ/mol}$$

- Q12. Calculate the root-mean-square speed of  $\text{UF}_6(\text{g})$  at  $73^\circ\text{C}$ . (8 pts.)

**Multiple Choice. 2 points each.**

- Q13. An exothermic reaction causes the surroundings to
- A. warm up.                      B. become acidic.                      C. condense.  
D. decrease in temperature.    E. release  $\text{CO}_2$ .
- Q14. Calculate the amount of heat necessary to raise the temperature of 12.0 g of water from  $15.4^\circ\text{C}$  to  $93.0^\circ\text{C}$ . The specific heat of water =  $4.18 \text{ J/g}\cdot^\circ\text{C}$ .
- A. 0.027 J    B. 324 J    C. 389 J    D. 931 J    E. 3,890 J
- Q15. Which gas has molecules with the greatest average molecular speed at  $25^\circ\text{C}$ ?
- A.  $\text{CH}_4$                       B. Kr                      C.  $\text{N}_2$                       D.  $\text{CO}_2$                       E. Ar

- Q16. To which one of the following reactions occurring at 25°C does the symbol  $\Delta H^\circ_f[\text{H}_2\text{SO}_4(\text{l})]$  refer?
- A.  $2\text{H}(\text{g}) + \text{S}(\text{g}) + 4\text{O}(\text{g}) \rightarrow \text{H}_2\text{SO}_4(\text{l})$   
B.  $\text{H}_2(\text{g}) + \text{S}(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{SO}_4(\text{l})$   
C.  $\text{H}_2\text{SO}_4(\text{l}) \rightarrow \text{H}_2(\text{g}) + \text{S}(\text{s}) + 2\text{O}_2(\text{g})$   
D.  $\text{H}_2\text{SO}_4(\text{l}) \rightarrow 2\text{H}(\text{g}) + \text{S}(\text{s}) + 4\text{O}(\text{g})$   
E.  $\text{H}_2(\text{g}) + \text{S}(\text{s}) + 2\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{SO}_4(\text{l})$
- Q17. A glass containing 200. g of  $\text{H}_2\text{O}$  at 20°C was placed in a refrigerator. The water loses 11.7 kJ as it cools to a constant temperature. What is its new temperature? The specific heat of water is 4.184 J/g·°C.
- A. 0.013°C    B. 4°C    C. 6°C    D. 14°C    E. 34°C
- Q18. Calculate the density, in g/L, of  $\text{SF}_6$  gas at 27 °C and 0.500 atm pressure.
- A.  $3.38 \times 10^{-3}$  g/L    B. 2.96 g/L    C. 22.4 g/L    D. 32.9 g/L    E. 3.38 kg/L
- Q19. 0.500 mole of ammonia ( $\text{NH}_3$ ) occupies a 1.2 L flask at 150 °C. Calculate the pressure of the ammonia inside the flask.
- A.  $6.91 \times 10^{-2}$  atm    B. 5.13 atm    C. 12.2 atm    D. 14.5 atm    E. 22.4 atm
- Q20. Which of the following gas molecules have the highest average kinetic energy at 25°C?
- A.  $\text{H}_2$     B.  $\text{O}_2$     C.  $\text{N}_2$     D.  $\text{Cl}_2$   
E. All the gases have the same average kinetic energy.

### BONUS Questions:

- a. Define what is meant by STP. Be as specific as possible. (4 pts.)
- b. Sketch a Torricelli barometer, and explain how it may be used to determine atmospheric pressure. (3 pts.)

## Useful information

$$R = 0.08206 \text{ L} \cdot \text{atm} / \text{mol} \cdot \text{K} \quad pV = nRT$$

$$(p + an^2/V^2)(V - nb) = nRT$$

$$R = 8.3145 \text{ J/mol} \cdot \text{K} = 8.3145 \text{ kg} \cdot \text{m}^2/\text{s}^2 \cdot \text{mol} \cdot \text{K}$$

$$1 \text{ atm} = 760 \text{ mmHg}$$

$$p\mathcal{M} = dRT$$

$$q = ms\Delta t = C\Delta t$$

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\Delta H^{\circ}_{\text{rxn}} = \sum n \Delta H^{\circ}_{\text{f}}(\text{products}) - \sum m \Delta H^{\circ}_{\text{f}}(\text{reactants})$$

# Periodic Table of the Elements

IA		IIA																				IIIA	IVA	VA	VIA	VIIA	VIIIA										
1	H																					2															
1.00794		3	4																			5	6	7	8	9	10										
Li	Be																					B	C	N	O	F	Ne										
6.941	9.012182																					10.811	12.0107	14.00674	15.9994	18.998403	20.1797										
11	12																					13	14	15	16	17	18										
Na	Mg																					Al	Si	P	S	Cl	Ar										
22.989770	24.3050																					26.981538	28.0855	30.973762	32.066	35.4527	39.948										
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36																				
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																				
39.0983	40.078	44.95591	47.867	50.9415	51.9961	54.938049	55.845	58.9332	58.6934	63.546	65.39	69.723	72.61	74.92160	78.96	79.904	83.80																				
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																				
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																				
85.4678	87.62	88.90585	91.224	92.90638	95.94	[98]	101.07	102.9055	106.42	107.8682	112.411	114.818	118.71	121.76	127.60	126.90447	131.29																				
55	56	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86																				
Cs	Ba*	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																				
132.90545	137.327	174.967	178.49	180.9479	183.84	186.207	190.23	192.217	195.078	196.96655	200.59	204.3833	207.2	208.98038	[210]	[210]	[222]																				
87	88	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118																				
Fr	Ra**	Lr	Rf	Db	Sg	Bh	Hs	Mt																													
[223]	[226]	[261]	[262]	[266]	[264]	[265]	[268]	[269]	[272]	[277]																											
																					57	58	59	60	61	62	63	64	65	66	67	68	69	70			
																					La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb			
																					138.9055	140.116	140.90765	144.24	[145]	150.36	151.964	157.25	158.92534	162.50	164.93032	167.26	168.93421	173.04			
																					89	90	91	92	93	94	95	96	97	98	99	100	101	102			
																					** Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No			
																					[227]	232.0381	231.03588	238.0289	[241]	[244]	[243]	[247]	[247]	[251]	[252]	[257]	[258]	[259]			