Exam 3a
Chem 141
Fall 2006

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Name:_____

Q1. Convert –5 ºC 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 ºC is heated to a temperature of 459 ºC. 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.

$$NaHCO_3\,(aq) + CaHPO_4\,(aq) \rightarrow NaCaPO_4\,(aq) + CO_2\,(g) + H_2O\,(l)$$

How many liters of carbon dioxide can be formed at room temperature from 4.50 g of $NaHCO_3$ and excess $CaHPO_4$? (12 pts.)

Q7. Calculate the enthalpy of reaction for $H_2(g) + C_2H_4(g) \rightarrow C_2H_6(g)$. (4 pts.)
[$\Delta H°_f(C_2H_4(g)) = 52.3$ kJ/mol; $\Delta H°_f(C_2H_6(g)) = -84.7$ kJ/mol; $\Delta H°_f(H_2(g)) = 0$ kJ/mol]

Q8. Given the following $\Delta H°$ values, (6 pts.)

$H_2O(l) \rightarrow H_2(g) + \frac{1}{2}O_2(g)$; $\Delta H° = +285.8$ kJ/mol

$H_2O_2(l) \rightarrow H_2(g) + O_2(g)$; $\Delta H° = 187.6$ kJ/mol

calculate $\Delta H°_{rxn}$ for the reaction $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$

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_2 confined in a volume of 5.00 L at 450 K using the van der Waals equation. (a = 3.59 atm·L^2·mol^{-2}, b = 0.0427 L·mol^{-1}) Compare the pressure with that calculated using the ideal gas equation. (12 pts.)

Q11. How many grams of ethylene (C_2H_4) would have to be burned to produce 450 kJ of heat? (6 pts.)

$2C_2H_4 + 6O_2 \rightarrow 4CO_2 + 2H_2O$; $\Delta H°_{rxn} = -2822$ kJ/mol

Q12. Calculate the root-mean-square speed of $UF_6(g)$ at 73 °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 CO_2.

Q14. Calculate the amount of heat necessary to raise the temperature of 12.0 g of water from 15.4°C to 93.0°C. The specific heat of water = 4.18 J/g·°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°C?

A. CH_4 B. Kr C. N_2 D. CO_2 E. Ar

Q16. To which one of the following reactions occurring at 25°C does the symbol $\Delta H°_f[H_2SO_4(l)]$ refer?

A. $2H(g) + S(g) + 4O(g) \rightarrow H_2SO_4(l)$
B. $H_2(g) + S(g) + 2O_2(g) \rightarrow H_2SO_4(l)$
C. $H_2SO_4(l) \rightarrow H_2(g) + S(s) + 2O_2(g)$
D. $H_2SO_4(l) \rightarrow 2H(g) + S(s) + 4O(g)$
E. $H_2(g) + S(s) + 2O_2(g) \rightarrow H_2SO_4(l)$

Q17. A glass containing 200. g of H_2O 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 SF_6 gas at 27 °C and 0.500 atm pressure.

A. 3.38×10^{-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 (NH_3) occupies a 1.2 L flask at 150 °C. Calculate the pressure of the ammonia inside the flask.

A. 6.91×10^{-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. H_2 B. O_2 C. N_2 D. 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

$R = 0.08206$ L·atm/mol·K $\quad pV = nRT \quad (p + an^2/V^2)(V - nb) = nRT$

$R = 8.3145$ J/mol·K $= 8.3145$ kg·m^2/s^2·mol·K $\quad 1$ atm $= 760$ mmHg

$p\mathscr{M} = dRT \quad q = ms\Delta t = C\Delta t \quad v_{rms} = \sqrt{\frac{3RT}{M}}$

$\Delta H^\circ_{rxn} = \Sigma n \Delta H_f^\circ(\text{products}) - \Sigma m \Delta H_f^\circ(\text{reactants})$

Periodic Table of the Elements

IA	IIA											IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H 1.00794																	2 He 4.002602
3 Li 6.941	4 Be 9.012182											5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.998403	10 Ne 20.1797
11 Na 22.989770	12 Mg 24.3050											13 Al 26.981538	14 Si 28.0855	15 P 30.973762	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.95591	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.9332	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc [98]	44 Ru 101.07	45 Rh 102.9055	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90447	54 Xe 131.29
55 Cs 132.90545	56 Ba* 137.327	71 Lu 174.967	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.96655	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98038	84 Po [210]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra** [226]	103 Lr [262]	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [265]	109 Mt [268]	110 [269]	111 [272]	112 [277]	113	114 [285]	115	116 [289]	117	118 [293]

*	57 La 138.9055	58 Ce 140.116	59 Pr 140.90765	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.92534	66 Dy 162.50	67 Ho 164.93032	68 Er 167.26	69 Tm 168.93421	70 Yb 173.04
**	89 Ac [227]	90 Th 232.0381	91 Pa 231.03588	92 U 238.0289	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]