Fall 2011
CHEM 1110.40413
Test 4, Form A

Name: KEY

Part I. Multiple Choice: Clearly circle the best answer. (60 pts)

1. The common constituent in all acid solutions is
   A) H_2SO_4
   B) H_2
C C) H^+
   D) OH^-

2. Which of the following is a weak acid?
   A) HF
   B) HBr
A C) HCl
   D) H_2SO_4

3. What are the conditions of STP?
   A) 273.15°C and 760 torr
   B) 0 K and 1atm
C C) 273.15 K and 1 atm
   D) 0°C and 760 atm

4. What is the oxidation number for sulfur in sulfuric acid?
   A) –2
   B) –4
C C) +6
   D) +1

   +1 2-
   H_2SO_4
   2+ 6+ 8-

5. Select the precipitate that forms when aqueous NH_4S reacts with aqueous $Cu(NO_3)_2$.
   A) NH_4NO_3
   B) CuS
B C) $NH_4(NO_3)_2$
   D) Cu_2S

   CuS

6. What is the process where molecules go directly from the solid phase to the gas phase?
   A) sublimation
   B) condensation
A C) melting
   D) deposition

7. Which of the following is a strong acid?
   A) H_3PO_4
   B) NaCl
C C) HNO_3
   D) $Ba(OH)_2$

8. Which of the following is a strong base?
   A) $Al(OH)_3$
   B) NH_3
D C) $B(OH)_3$
   D) $Ca(OH)_2$

9. Which of these chemical equations describes an *acid-base neutralization reaction*?
   A) $2KBr(aq) + Cl_2(g) \rightarrow 2KCl(aq) + Br_2(l)$
   B) $LiOH(aq) + HNO_3(aq) \rightarrow LiNO_3(aq) + H_2O(l)$
   C) $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$
   D) $SO_2(g) + H_2O(l) \rightarrow H_2SO_3(g)$

B

10. Based on the solubility rules, which one of these compounds should be *insoluble* in water?
   A) $MgBr_2$
   B) AgBr
   C) NaCl
   D) $FeCl_2$

B

11. Deviations from the ideal gas law are greater at
   A) high temperatures and high pressures.
   B) low temperatures and low pressures.
   C) high temperatures and low pressures.
   D) low temperatures and high pressures.

D

12. What is the process where molecules go directly from the gas phase to the solid phase?
   A) sublimation
   B) condensation
   C) deposition
   D) freezing

C

13. Which one of the following substances should exhibit hydrogen bonding in the liquid state?
   A) CH_4
   B) CH_3OH
   C) H_2S
   D) PH_3

B

14. What is the net ionic equation when sodium sulfate is mixed with barium hydroxide?
   A) $Ba^{+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$
   B) $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$
   C) $Na^{+}(aq) + OH^{-}(aq) \rightarrow NaOH(s)$
   D) $Na^{+}(aq) + SO_4^{2-}(aq) \rightarrow Na_2SO_4(s)$

B

15. Which of these choices is the correct *net ionic equation* for the reaction that occurs when solutions of $Pb(NO_3)_2$ and NH_4Cl are mixed?
   A) $Pb^{2+}(aq) + 2NO_3^{-}(aq) + 2NH_4^{+}(aq) + 2Cl^{-}(aq) \rightarrow 2NH_4^{+}(aq) + 2NO_3^{-}(aq) + PbCl_2(s)$
   B) $Pb(NO_3)_2(aq) + 2NH_4Cl(aq) \rightarrow NH_4NO_3(aq) + PbCl_2(s)$
   C) $NH_4^{+}(aq) + NO_3^{-}(aq) \rightarrow 2NH_4NO_3(s)$
   D) $Pb^{2+}(aq) + 2Cl^{-}(aq) \rightarrow PbCl_2(s)$

D

16. Based on the solubility rules, which of these processes will occur if solutions of $CuSO_4(aq)$ and $BaCl_2(aq)$ are mixed?
   A) $BaCl_2$ will precipitate; Cu^{2+} and SO_4^{2-} are spectator ions.
   B) $CuCl_2$ will precipitate; Ba^{2+} and SO_4^{2-} are spectator ions.
   C) $CuSO_4$ will precipitate; Ba^{2+} and Cl^{-} are spectator ions.
   D) $BaSO_4$ will precipitate; Cu^{2+} and Cl^{-} are spectator ions.

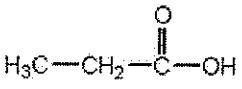
D

17. Select the precipitate that forms when the following reactants are mixed. $Na_2CO_3(aq) + BaCl_2(aq) \rightarrow$

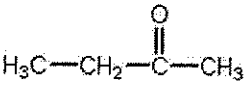
A) $BaCO_3$
B) NaCl
C) $NaCl_2$
D) Ba_2CO_3

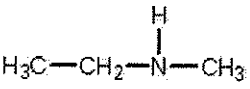
A

18. In which of the following compounds will the molecules *not* form hydrogen bonds in the liquid state?

a. 

b. 

C c. 

d. 

19. What is the formula which describes the relationship between the pressure and volume at constant temperature and constant moles?

A) $P \alpha 1/V$
B) $P \alpha V^2$
C) None of the answers is correct
D) $P \alpha V$

A

20. Arrange the following gases in order of increasing rate of effusion: C_2H_6, Ar, HCl, and PH_3.

30 39 36 33

A) $C_2H_6 < HCl < PH_3 < Ar$
B) $Ar < PH_3 < C_2H_6 < HCl$
C) $Ar < HCl < PH_3 < C_2H_6$
D) $C_2H_6 < PH_3 < HCl < Ar$

C

21. The oxidation number of Cr in $Cr_2O_7^{2-}$ is

+6 2-
+12 -14

A) −7
B) +7
C) −12
D) +6

D

22. Which of the following is insoluble in water?

A) $PbCl_2$
B) Li_2CO_3
C) $(NH_4)_2S$
D) NaOH

A

23. When the following redox reaction is balanced, what coefficient is in front of Ag?

$$Fe\ (s) + Ag^+\ (aq) \rightarrow Fe^{2+}\ (aq) + Ag\ (s)$$

A) 3
B) 4
C) 2
D) 1

C

24. Based on the solubility rules, which one of these compounds should be *soluble* in water?
A) $PbSO_4$
B) $CaSO_4$
C) K_2SO_4
D) $BaSO_4$

C C

25. Which of the following should have the highest boiling point?
A) CI_4 heaviest
B) CBr_4
C) CF_4
D) CCl_4

A A

26. Which of the following terms refers to the resistance of a liquid to flow?
A) Viscosity
B) Adhesion
C) Capillary action
D) Surface tension

A A

27. What is the volume of NH_3 produced in the following reaction when 3.0 L of H_2 reacts with excess N_2 at constant temperature and pressure?

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

A) 4.5 L
B) 3.0 L
C) 6.0 L
D) 2.0 L

D D

$3.0\,L\,H_2 \times \frac{2\,L\,NH_3}{3.0\,L\,H_2} = 2.0\,L\,NH_3$

28. What is the formula which describes the relationship between the volume and temperature at constant pressure and constant moles?
A) $V^2 \alpha T$
B) None of the answers is correct
C) $V \alpha T$
D) $V \alpha 1/T$

C C

29. In the following reaction, what ions, if any, are spectator ions?

$$Pb(NO_3)_2(aq) + 2NaCl(aq) \rightarrow PbCl_2(s) + 2NaNO_3(aq)$$

A) $Na^+(aq)$, $Cl^-(aq)$
B) $Pb^{2+}(aq)$, $Cl^-(aq)$
C) $Na^+(aq)$, $NO_3^-(aq)$
D) $Pb^{2+}(aq)$, $NO_3^-(aq)$

C C

30. What is the Kelvin temperature at 24°C?
A) 11.4 K
B) 297 K
C) 249 K
D) –297 K
E) –249 K

B B

Part II. Calculations: Clearly show all work for full credit. (35 pts)

1. (10 pts) If a constant number of moles of a gas is at a pressure of 1.35 atm and has a volume of 23.8 L at a temperature of 205.1 K then what is the final volume of the gas if the pressure changes to 2.84 atm and the temperature rises to 233.4 K?

$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$ $P_1 = 1.35\,atm$ $P_2 = 2.84\,atm$ $n_1 = n_2$

$V_1 = 23.8\,L$ $V_2 = ??$

$T_1 = 205.1\,K$ $T_2 = 233.4\,K$

$$V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{(1.35atm)(23.8L)(233.4k)}{(2.84atm)(205.1K)} = \boxed{12.9\,L}$$

2. (15 pts) Elemental chlorine gas is usually produced by the electrolysis of sodium chloride. How many liters of chlorine gas at 25°C and 0.950 atm can be produced by the reaction of 120.0 g of NaCl? (R = 0.08206 L • atm/K • mol, MM of NaCl = 58.43 g/mol)

$$2\,NaCl + 2\,H_2O \rightarrow Cl_2 + H_2 + 2\,NaOH$$

120.0 g NaCl ?? L

$T = 25°C + 273 = 298\,K$

$P = 0.950\,atm$

$$120.0\,g\,NaCl \times \frac{1\,mol\,NaCl}{58.43\,g\,NaCl} \times \frac{1\,mol\,Cl_2}{2\,mol\,NaCl} = 1.027\,mol\,Cl_2$$

$PV = nRT$

$$V = \frac{nRT}{P} = \frac{(1.027\,mol\,Cl_2)(0.08206\,\frac{L\,atm}{mol\,K})(298K)}{0.950\,atm} = \boxed{26.4\,L\,Cl_2}$$

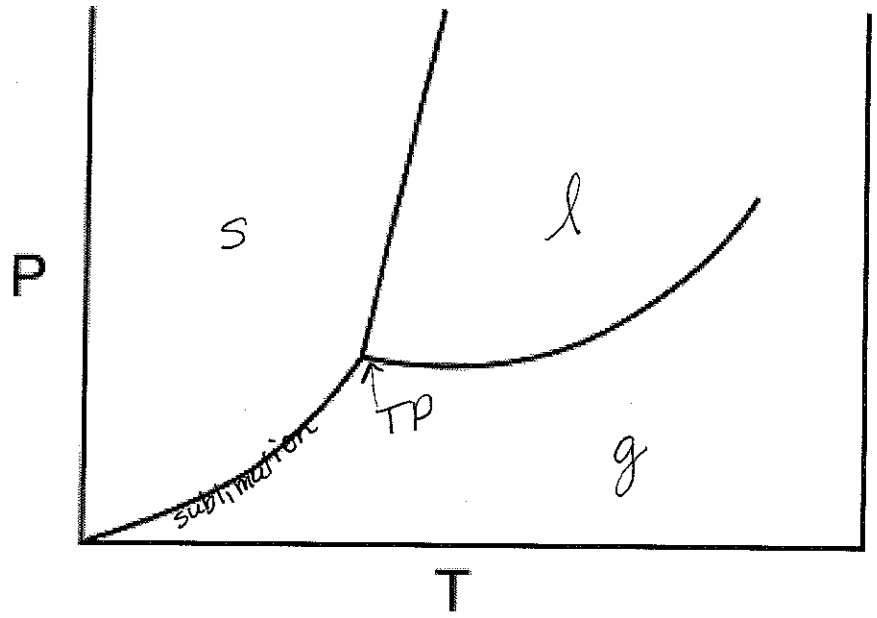
3. (10 pts) What is the mole fraction of NO in a 55.0 L gas cylinder at 30°C which comes from a mixture of N_2 and NO if you have 3.238 mol of N_2 and the gas cylinder has a total pressure of 2.14 atm?

$$P_{N_2} = \frac{n_{N_2}RT}{V} = \frac{(3.238\,mol\,N_2)(0.08206\,\frac{L\,atm}{mol\,K})(303K)}{55.0\,L} = 1.46\,atm$$

$$P_{NO} = P_{total} - P_{N_2} = 2.14\,atm - 1.46\,atm = 0.68\,atm$$

$$X_{NO} = 0.68\,atm / 2.14\,atm = 0.32$$

Part III. Phase Diagrams (5 pts): In the phase diagram below, label the three phases (s, l, and g) and the triple point (TP). Also, indicate the phase boundary where sublimation occurs.



	IA												IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1 **H** 1.008	IIA																2 **He** 4.00
2	3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.31	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.55	30 **Zn** 65.37	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
5	37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** [98]	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.40	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
6	55 **Cs** 132.9	56 **Ba** 137.3	71 **Lu** 175	72 **Hf** 178.5	73 **Ta** 181	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197	80 **Hg** 200.59	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209	84 **Po** [209]	85 **At** [210]	86 **Rn** [222]
7	87 **Fr** [223]	88 **Ra** [226]	103 **Lr** [262]	104 **Rf** [267]	105 **Db** [268]	106 **Sg** [271]	107 **Bh** [272]	108 **Hs** [270]	109 **Mt** [276]	110 **Ds** [281]	111 **Rg** [280]	112 **Uub** [285]	113 **Uut** [284]	114 **Uuq** [289]	115 **Uup** [288]	116 **Uuh** [293]		118 **Uuo** [294]

57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** [145]	62 **Sm** 150.4	63 **Eu** 152	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.93	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173
89 **Ac** [227]	90 **Th** 232	91 **Pa** [231]	92 **U** 238	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]