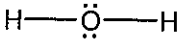
Fall 2011
CHEM 1110.40413
Test 3, Form A

Name: KEY

Part I. Multiple Choice: Clearly circle the best answer. (40 pts)

1. What is the molecular shape of the H_2O molecule?
   A) square planar.
   B) bent.
   C) tetrahedral.
   D) trigonal pyramidal



B

2. What is the total number of electron domains for a H_2O molecule?
   A) 2
   B) 5
   C) 3
   D) 4

D

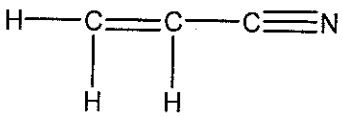
3. What is the hybridization of the oxygen atom in H_2O?
   A) sp^3
   B) sp^3d
   C) sp
   D) sp^2

A

4. Which process defines how ionic compounds break apart into its constituent ions upon dissolution?
   A) Decomposition
   B) Electrolysis
   C) Dissociation
   D) Dissolution

C

5. The number of pi bonds in the molecule below is
   A) 5
   B) 9
   C) 3
   D) 2



C

6. What is the name given to the quantitative relationship between the substances that are consumed and produced in a chemical reaction?
   A) Percent Composition
   B) Law of Molecular Balance
   C) Law of Definite Proportions
   D) Stoichiometry

D

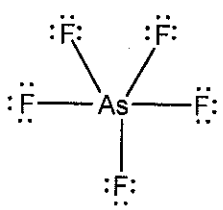
7. When balanced with smallest set of whole numbers, the coefficient of O_2 in the following equation is

$$\_\_\ C_2H_4 + 3\ O_2 \rightarrow 2\ CO_2 + 2\ H_2O$$

   A) 3
   B) 2
   C) 4
   D) 6

A

8. Predict the molecular geometry of the AsF_5 molecule.
   A) T-shaped
   B) trigonal bipyramidal
   C) tetrahedral
   D) octahedral



B

9. What is the hybridization of the As atom in the AsF_5 molecule?

A

A) sp^3d
B) sp^3d^2
C) sp^3
D) sp

10. Which is a balanced equation for the combustion of benzene (C_6H_6)?

C

A) $2C_6H_6(l) + 9O_2(g) \rightarrow 6H_2O(g) + 12CO_2(g)$
B) $C_6H_6(l) + 9O_2(g) \rightarrow 3H_2O(g) + 6CO_2(g)$
C) $2C_6H_6(l) + 15O_2(g) \rightarrow 6H_2O(g) + 12CO_2(g)$
D) $C_6H_6(l) + 15O_2(g) \rightarrow 3H_2O(g) + 6CO_2(g)$

$2\left[C_6H_6 + \frac{15}{2}O_2 \rightarrow 3H_2O + 6CO_2\right]$

11. Balance the following equation: ___$K_2CO_3(aq)$ + 2 $HCl(aq)$ → 2 $KCl(aq)$ + ___$H_2CO_3(aq)$

A

A) $K_2CO_3(aq) + 2\ HCl(aq) \rightarrow 2\ KCl(aq) + H_2CO_3(aq)$
B) $2\ K_2CO_3(aq) + HCl(aq) \rightarrow 4\ KCl(aq) + H_2CO_3(aq)$
C) $2\ K_2CO_3(aq) + 2\ HCl(aq) \rightarrow 4\ KCl(aq) + 2\ H_2CO_3(aq)$
D) $K_2CO_3(aq) + HCl(aq) \rightarrow KCl(aq) + H_2CO_3(aq)$

12. The distinguishing characteristic of all electrolyte solutions is that they

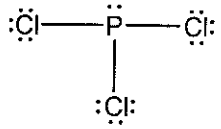
B

A) always contain acids.
B) conduct electricity.
C) conduct heat.
D) react with other solutions.

13. Use VSEPR theory to predict the shape of the PCl_3 molecule.

D

A) trigonal planar
B) linear
C) tetrahedral
D) trigonal pyramidal



14. Indicate the type of hybrid orbitals used by the central atom in PCl_3.

D

A) sp
B) sp^3d
C) sp^3d^2
D) sp^3

15. What is the coefficient of H_2O when the following equation is properly balanced with the smallest set of whole numbers? 2 Na + 2 H_2O → 2 NaOH + ___ H_2

D

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

16. Which of these chemical equations describes a *decomposition reaction*?

D

A) $2KBr(aq) + Cl_2(g) \rightarrow 2KCl(aq) + Br_2(l)$
B) $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$
C) $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$
D) $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

17. Which of these chemical equations describes a *combustion reaction*?

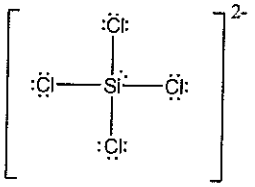
B

A) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
B) $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$
C) $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$
D) $LiOH(aq) + HNO_3(aq) \rightarrow LiNO_3(aq) + H_2O(l)$

18. According to the VSEPR theory, the molecular shape of $SiCl_4^{2-}$ is

A) see-saw.
B) trigonal bipyramidal.
C) trigonal planar.
D) tetrahedral.

A



19. What is the number of lone electron pairs on the central atom $SiCl_4^{2-}$?

A) 3
B) 0
C) 2
D) 1

D

20. Which one of the following molecules is *nonpolar*?

A) H_2O
B) AsF_5
C) PCl_3
D) $SiCl_4^{2-}$

B

Part II. Calculations: Clearly show all work for full credit. (65 pts --- 5 bonus points!)

1. (10 pts) Phosphine, an extremely poisonous and highly reactive gas, will react with oxygen to form tetraphosphorus decaoxide and water. Calculate the mass of P_4O_{10} formed when 225 g of PH_3 reacts with excess oxygen. (MM of PH_3 = 34.00 g/mol, MM of P_4O_{10} = 195.00 g/mol)

$$4\ PH_3(g) + 8\ O_2(g) \rightarrow P_4O_{10}(s) + 6\ H_2O(g)$$

225g PH_3 ?? g P_4O_{10}

$$225\text{g } PH_3 \times \frac{1\text{mol } PH_3}{34.00\text{g } PH_3} \times \frac{1\text{mol } P_4O_{10}}{4\text{mol } PH_3} \times \frac{195.00\text{g } P_4O_{10}}{1\text{mol } P_4O_{10}} = 323\text{g } P_4O_{10}$$

2. (10 pts) How many grams of sugar are needed to make 4.25L of 0.375 mol/L sugar? (MM of sugar = 180.12 g/mol)

$$4.25\text{L} \times \frac{0.375\text{mol}}{1\text{L}} \times \frac{180.12\text{g}}{1\text{mol}} = 287\text{g sugar}$$

3. (5 pts) In an experiment, a student needs 125 mL of a 0.250 M NaOH solution. A stock solution of 5.00 M NaOH is available. How much of the stock solution is needed?

$$M_c \times V_c = M_d \times V_d$$

$$(5.00\text{M})(V_c) = (0.250\text{M})(125\text{mL})$$

$$V_c = 6.25\text{ mL}$$

4. (30 pts) The insecticide DDT was formerly in widespread use, but now it is severely restricted owing to its adverse environmental effects. DDT is prepared from the reaction of chloral and chlorobenzene. A chemist reacts 10.0 g of chloral with 10.0 g of chlorobenzene. (MM of C_2HCl_3O = 147.39 g/mol, MM of C_6H_5Cl = 112.56 g/mol, MM of $C_{14}H_9Cl_5$ = 354.49 g/mol)

chloral		*chlorobenzene*		*DDT*		
C_2HCl_3O	+	$2\ C_6H_5Cl$	→	$C_{14}H_9Cl_5$	+	H_2O
10.0g C		10.0g CB		??g DDT		

a. What is the limiting reactant?

$$10.0\text{g C} \times \frac{1\text{mol C}}{147.3\text{g C}} = 0.0679\text{mol C} \qquad 10.0\text{g CB} \times \frac{1\text{mol CB}}{112.56\text{g CB}} = 0.0888\text{mol CB}$$

$$0.0679\text{mol C} \times \frac{2\text{mol CB}}{1\text{mol C}} = 0.136\text{ mol CB}$$

$$0.0888\text{mol CB} \times \frac{1\text{mol C}}{2\text{mol CB}} = 0.0444\text{ mol C}$$

0.0670 mol C requires 0.136 mol CB (don't have)

0.0888 mol CB requires 0.0444 mol C, CB is Limiting Reactant

b. What is the mass (g) of the excess reagent left over when the reaction is complete?

$$0.0444\text{mol C} \times \frac{147.3\text{g C}}{1\text{mol C}} = 6.54\text{g C used}$$

$$10.0\text{g} - 6.54\text{g C used} = 3.5\text{ g C leftover}$$

c. What is the theoretical mass (g) of DDT which could be formed?

$$0.0888\text{mol CB} \times \frac{1\text{mol DDT}}{2\text{mol CB}} \times \frac{354.49\text{g DDT}}{1\text{mol DDT}} = 15.7\text{g DDT}$$

d. What is the percent yield, if 12.5 g of DDT is produced?

$$\%\text{yield} = \frac{12.5\text{g}}{15.7\text{g}} \times 100 = 79.6\%$$

5. (10 pts) Automobile batteries use 3.0 *M* H_2SO_4 as an electrolyte. What volume (in L) of 1.20 *M* NaOH will be needed to neutralize 225 L of 3.0 *M* H_2SO_4?

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow 2H_2O(l) + Na_2SO_4(aq)$$

$\frac{3.0 \text{ mol } H_2SO_4}{L}$ $\frac{1.20 \text{ mol NaOH}}{L}$

225 L ?? L

$$225\text{ L} \times \frac{3.0\text{ mol } H_2SO_4}{\text{L}} \times \frac{2\text{ mol NaOH}}{1\text{ mol } H_2SO_4} \times \frac{1\text{ L}}{1.20\text{ mol NaOH}}$$

$$= 1125\text{ L}$$

$$\boxed{1.1 \times 10^3\text{ L}}$$

	IA												IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1 H 1.008	IIA						VIIIB			IB	IIB						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						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]