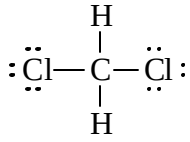
CHM-102 Exam I Spring 2002

Name Key

Raw Score _____
T-Score _____

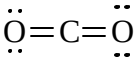
- You will have **one hour** to complete the exam.
- There is **one best answer** to each question and all questions are worth the same number of points.
- ***Sign* your name on the answer sheet** above the General Purpose logo on the front.
- Print and fill in your name (**last name**-space-**first name**) on the back of your answer sheet.
- Be sure to mark the correct answers on your exam booklet so you can compare your answers to the answer key.
- An answer key will be posted immediately following the test at http://aa.uncwil.edu/chm102/keys/. It will also be posted outside DO-236.

The following six Lewis structures may be useful in answering questions 1 to 5.



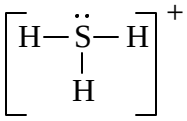
I.

ED Geo *tetrahedral*
Mol Geo *tetrahedral*
Angles *109º*



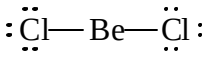
II.

ED Geo *linear*
Mol Geo *linear*
Angles *180º*



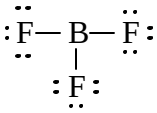
III.

ED Geo *tetrahedral*
Mol Geo *trigonal pyramidal*
Angles *109º*



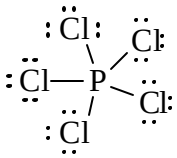
IV.

ED Geo *linear*
Mol Geo *linear*
Angles *180º*



V.

ED Geo *trigonal planar*
Mol Geo *trigonal planar*
Angles *120º*



VI.

ED Geo *trigonal bipyramidal*
Mol Geo *trigonal bipyramidal*
Angles *90º, 120º, 180º*

1. Which molecule(s) has (have) tetrahedral <u>electron domain geometry</u> around the central atom?

a. I
b. I, II
c. I, II, III
d. I, III

2. Which molecules have a bond angle of 180° around the central atom?

a. I, III
b. I, II
c. II, IV, VI
d. I, ,II, IV

3. Which molecules are nonpolar?

a. II, IV, V, VI
b. II, III, IV, V, VI
c. I, II, IV, V, VI
d. They are all nonpolar

4. Which molecule(s) has (have) sp^2 hybridization around the central atom?

a. II, III, IV
b. II, IV,V
c. V
d. III,V

5. Which molecule(s) has (have) tetrahedral molecular geometry around the central atom?

a. I
b. I, II
c. I, II, III
d. I, VI

6. How many sigma (σ) and pi (π) bonds respectively are there in H-C≡C-H ?

a. 5σ, no π
b. 2 σ, 5π
c. 2σ, 3π
d. 3σ, 2π

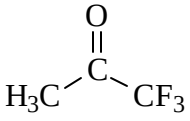
Single bonds are sigma bonds. In multiple bonds, one of the bonds is sigma and all the rest are pi bonds.

7. What is the hybridization on the carbon atoms in H-C ≡C-H ?

a. *sp*
b. sp^2
c. sp^3
d. sp^3d

The electron domain geometry around each carbon atom is linear. Therefore the hybridization is sp.

8. The molecular geometry of the central carbon atom bonded to oxygen in the molecule below is



a. trigonal planar
b. tetrahedral
c. trigonal pyramidal
d. octahedral

The central carbon atom has three electron domains and no lone pairs. Therefore, the both the electron domain geometry and the molecular geometry are trigonal planar.

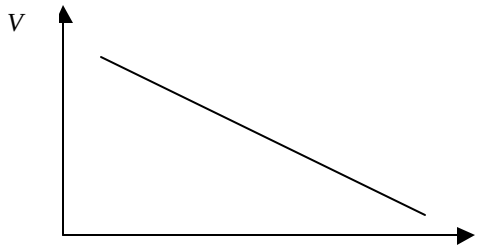
9. In a typical multiple bond, the sigma bond (σ) results from overlap of _____ orbitals and the pi (π) bond(s) result from overlap of _____ orbitals

a. hybrid, atomic b. hybrid, hybrid
c. atomic, hybrid d. atomic, atomic

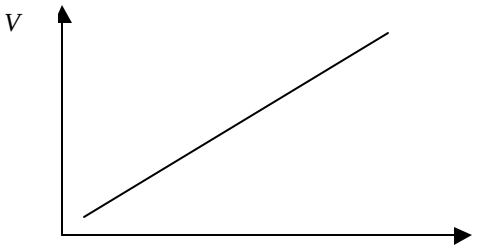
Hybrid orbitals overlap along the internuclear axis to produce sigma bonds. Unhybridized p atomic orbitals overlap above and below the internuclear axis to produce pi bonds.

10. Which of the following is the correct representation of the volume vs. temperature relationship for a fixed amount of an ideal gas at constant pressure?

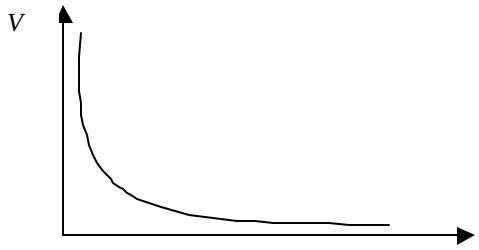
a.



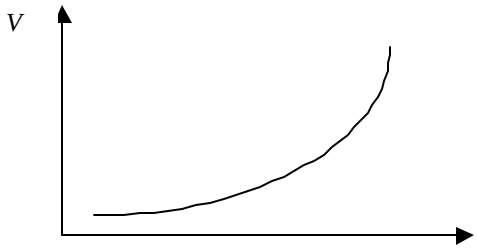
b.



c.



d.



Charles's Law states that there is a linear relationship between volume and temperature, V = kT.

11. The pressure (atm) exerted by 1.3 mole of gas in a 13 L flask at 22 °C is (R = 0.0821 L· atm/mol K)

a. 5.5 atm b. 2.4 atm c. 0.41 atm d. 0.18 atm

PV = nRT
P = nRT/V
P = (1.3 mol)(0.0821 L· atm/K· mol)(295 K)/13 L = 2.4 atm

12. A sample of gas originally at 25 ^{0}C and 1.00 atm pressure in a 2.5 L flask is allowed to expand until the pressure is 0.85 atm and the temperature is 15 ^{0} C. What is the final volume of the gas in liters? (R = 0.0821 L· atm/mol· K)

a. 3.0 L b. 2.8 L c. 2.6 L d. 2.1 L

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

$$V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{(1.00atm)(2.5L)(288K)}{(0.85atm)(298K)} = 2.8L$$

13. For the following reaction

$$2\ NaN_3\ (s) \rightarrow 2\ Na\ (s) + 3\ N_2\ (g)$$

What mass (g) of NaN_3 is required to provide 40.0 L of N_2 (g) at 25 ^{o}C and 763 mm Hg? (R = 0.0821 L· atm/mol· K)

a. 1.64 g b. 1.09 g c. 160 g d. 71.1 g

Step 1: calculate the number of moles of N_2(g) produced using PV = nRT.
Step 2: Use the stoichiometric factor from the balanced chemical equation to determine how Many moles of NaN_3 are equal to this number of moles of N_2.
Step 3: Convert moles of NaN_3 to grams of NaN_3.

14. If 5.0 grams of CO and 5.0 grams of CO_2 are placed in a 750 mL container at 50 ^{0}C, what will be the resulting total pressure (atm) in the container? (R = 0.0821 L· atm/mol· K)

a. 10.3 atm b. 4.02 atm c. 6.31 atm d. 0.292 atm

The total pressure in the system is the sum of the partial pressures of CO and CO_2. So, we must calculate the partial pressures of each gas using the ideal gas equation, $P = \frac{mRT}{MV}$, and then add them together.

15. What is the molecular weight of a gas if 3.5 grams of the gas occupies 2.1 L at STP? (R = 0.0821 L· atm/mol· K)

a. 41 b. 5.5 x 10^3 c. 37 d. 4.6 x 10^2

STP = 0 °C and 1 atm

$$M = \frac{mRT}{PV} = \frac{(3.5g)(0.0821\frac{L \cdot atm}{K \cdot mol})(273K)}{(1atm)(2.1L)} = 37\frac{g}{mol}$$

16. According to the kinetic molecular theory , molecules of different gases at the same temperature always have the same _____.

a. molecular mass
b. pressure
c. root mean square speed
d. average kinetic energy

17. A real gas will behave most like an ideal gas under conditions of

a. high temperature and high pressure
b. high temperature and low pressure
c. low temperature and high pressure
d. low temperature and low pressure

At high temperatures and low pressures, the molecules of a gas are moving very fast and are very far apart. This minimizes the effects of intermolecular attractive forces and excluded volume, which causes a real gas to behave more like an ideal gas.

18. What is the predominant intermolecular force in CBr_4?

a. London dispersion forces
b. ion-dipole interaction
c. dipole-dipole attraction
d. hydrogen bonding

CBr_4 is a nonpolar molecule, therefore the only intermolecular forces present are London dispersion forces.

19. Which of the following has the highest boiling point?

a. N_2 b. Br_2 c. H_2 d. Cl_2

All of the substances in this list are nonpolar. Therefore, the substance with the highest molecular weight will have the largest London forces and therefore the highest boiling point.

20. Which one of the following substances will have hydrogen bonding as its primary intermolecular force?

a. H_2S b. PH_3 c. HF d. SiH_4

HF is the only substance in the list which has a hydrogen atom covalently bonded to a fluorine, oxygen, or nitrogren atom. Hydrogen bonds can form between the hydrogen atom on one HF molecule and the fluorine atom on another HF molecule.

21. Increasing intermolecular forces in a liquid will lead to an increase in the _____ of the liquid.

a. boiling point
b. viscosity
c. surface tension
d. all of the above

Intermolecular forces in a liquid cause the molecules of a liquid to "stick" together. The stronger the intermolecular forces are in a liquid, the more energy it will take to tear the molecules apart to form a gas (higher boiling point), the more resistance there will be to the liquid flowing (higher viscosity), and the greater the energy required to increase the surface area of the liquid (higher surface tension).

$$PV = nRT \qquad \frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} \qquad PV = \frac{mRT}{M} \qquad P_T = P_1 + P_2 + P_3 + \ldots$$

$$X_a = \frac{n_a}{n_T} \qquad P_a = X_a P_T \qquad \frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

Use the space below for scratch paper. A periodic table is on the back of this page.

PERIODIC TABLE OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 0 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
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 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 108.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Ha (262)	106 Unh (263)	107 Uns (262)		109 Une (266)									

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	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)	103 Lr (260)