MULTIPLE CHOICE (3 points each)

1) Elements from opposite sides of the periodic table tend to form __________.
   A) covalent compounds   B) ionic compounds   C) compounds that are gaseous at room temperature   D) homonuclear diatomic compounds

2) Lattice energy is __________.
   A) the energy required to convert a mole of ionic solid into its constituent ions in the gas phase.
   B) the energy given off when gaseous ions combine to form one mole of an ionic solid.
   C) the energy required to produce one mole of an ionic compound from its constituent elements in their standard states.
   D) the sum of ionization energies of the components in an ionic solid.

3) A double bond consists of __________ pairs of electrons shared between two atoms.
   A) 1   B) 2   C) 3   D) 4

4) Of the atoms below, __________ is the least electronegative.
   A) Rb   B) F   C) Si   D) Cl

5) Of the bonds below, __________ is the least polar.
   A) Na-S   B) P-S   C) C-F   D) Si-Cl

6) The ion NO\(^-\) has __________ valence electrons.
   A) 15   B) 14   C) 16   D) 12

7) How many equivalent resonance forms can be drawn for SO\(_2\) without expanding octet on the sulfur atom (sulfur is the central atom)?
   A) 0   B) 2   C) 3   D) 4

8) Using the table of average bond energies below, the \(\Delta H\) for the reaction is __________ kJ.

   \[
   \text{H} \equiv \text{C} \equiv \text{C} \equiv \text{H} + \text{H} \equiv \text{I} \rightarrow \text{C} \equiv \text{C} \equiv \text{I} \equiv \text{H} \equiv \text{H}
   \]

   Bond: C≡C  C≡C  H-I  C-I  C-H
   D (kJ/mol): 839  614  299  240  413

   A) +506   B) -931   C) -506   D) -129

9) According to VSEPR theory, if there are three electron domains in the valence shell of an atom, they will be arranged in a(n) __________ geometry.
   A) octahedral   B) linear   C) tetrahedral   D) trigonal planar
10) The molecular geometry of the H$_3$O$^+$ ion is _________.  
A) linear  B) trigonal planar  C) bent  \[\text{D) trigonal pyramidal}  \]

11) The central iodine atom in IF$_5$ has ________ unbonded electron pairs and ________ bonded electron pairs in its valence shell.  
\[\text{A} \) 1, 5  \quad \text{B} \) 0, 5  \quad \text{C} \) 5, 1  \quad \text{D} \) 4, 1  \]

12) Of the molecules below, only ________ is polar.  
A) CCl$_4$  B) CH$_4$  C) SeF$_4$  D) SiCl$_4$  

13) The combination of two atomic orbitals results in the formation of ________ molecular orbitals.  
A) 1  B) 2  C) 3  D) 4  

14) The hybridization of orbitals on the central atom in a molecule is \[sp\]. The electron-domain geometry around this central atom is ________.  
A) octahedral  B) linear  C) trigonal planar  D) trigonal bipyramidal  

15) Of the following, the central atom is \[sp^3d^2\] hybridized only in _________.  
A) PCl$_5$  B) XeF$_4$  C) PH$_3$  D) Br$_3^-$  

16) There are ________ unhybridized p atomic orbitals in an \[sp\]-hybridized carbon atom.  
A) 0  B) 1  C) 2  D) 3  

17) A typical triple bond _________.  
\[A\) consists of one sigma bond and two pi bonds  \quad B) consists of three shared electrons  \quad C) consists of two sigma bonds and one pi bond  \quad D) consists of six shared electron pairs  \]

18) Based on molecular orbital theory, the only molecule in the list below that has unpaired electrons is _________.  
A) C$_2$  B) N$_2$  C) F$_2$  D) O$_2$  

19) According to MO theory, overlap of two s atomic orbitals produces _________.  
A) one bonding molecular orbital and one hybrid orbital  \[\text{B) one bonding molecular orbital and one antibonding molecular orbital}  \quad C) two bonding molecular orbitals and two antibonding molecular orbitals  \quad D) two bonding molecular orbitals and one antibonding molecular orbital  \]

20) Of the following, ________ is a correct statement of Boyle's law.  
\[A) \text{PV} = \text{constant}  \quad B) \text{P/V} = \text{constant}  \quad C) \text{V/P} = \text{constant}  \quad D) \text{V/T} = \text{constant}  \]

21) A balloon originally had a volume of 4.39 L at 44°C and a pressure of 729 torr. The balloon must be cooled to ________°C to reduce its volume to 3.78 L (at constant pressure).  
A) 38  B) 0  C) 72.9  D) 273  

22) The pressure exerted by 1.3 mol of gas in a 13 L flask at 30°C is ________ kPa. (1 atm = 101.325 kPa)  
A) 560  B) 252  C) 18  D) none of the these
23) Which statement about ideal behavior of gases is false?
   A) Low pressures and high temperatures typically cause deviations from the ideal gas behavior.
   B) Volume of 2.00 moles of oxygen gas, O₂, is assumed to be the same as that of 2.00 moles of carbon dioxide gas, CO₂, as long as the temperature and pressure conditions are the same.
   C) Gas ideality assumes that there are no interactions between gas particles.
   D) All particles in the ideal gas behave independently of each other.

24) A vessel contained N₂, Ar, He, and Ne. The total pressure in the vessel was 987 torr. The partial pressures of nitrogen, argon, and helium were 44, 486, and 218 torr, respectively. The partial pressure of neon in the vessel was _________ torr.
   A) 42.4    B) 521    C) 19.4    D) 239

25) The average kinetic energy of the particles of a gas is directly proportional to _________.
   A) the rms speed   B) the square of the rms speed
   C) the square root of the rms speed   D) the square of the particle mass

Problems

(5 points) The gas pressure in an aerosol can is 1.5 atm at 25° C. What would the pressure be if the can were heated to 450° C?

\[
\frac{P_1}{T_1} = \frac{P_2}{T_2}
\]

*this can be derived from Charles’ Law and the Ideal Gas Law*

\[
T_1 = 25 + 273 = 298K
\]

\[
T_2 = 450 + 273 = 723K
\]

\[
\frac{1.5atm}{298K} = \frac{P_2}{723K}
\]

\[
P_2 = 3.6atm
\]
(10 points) Draw the Lewis Structures for the following substances:

**SF₆**

![Lewis Structure for SF₆]

**CO₃²⁻**

![Lewis Structure for CO₃²⁻]

**XeF₄**

![Lewis Structure for XeF₄]

(10 points) The metabolic oxidation of glucose, C₆H₁₂O₆, in our bodies produces CO₂, which is expelled from our lungs as a gas:

\[
C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)
\]

Calculate the volume of dry CO₂ produced at body temperature (37°C) and 0.970atm when 24.5g of glucose are consumed in this reaction.

\[
\text{moles } C_6H_{12}O_6 = \frac{24.5g}{180g/mol} = 0.136\text{mol}
\]

- now determine the moles of CO₂

\[
\frac{6CO_2}{1C_6H_{12}O_6} = \frac{x}{0.136\text{moles}}
\]

\[
x = 0.817\text{ moles } CO_2
\]

- use the Ideal gas law

\[
PV = nRT
\]

\[
(0.970\text{atm})V = (0.817\text{mol})(0.08206)(273 + 37)
\]

\[
V = \frac{(0.817\text{mol})(0.08206)(310K)}{0.970\text{atm}}
\]

\[
= 21.4L
\]