1.) Metallic gold crystallizes in the face-centered cubic lattice with an edge length of 407 pm. From this information, estimate the density of gold in g/cm^3.

2.) Starting with a 70.8 g sample of benzene (C_6H_6, 78.11 g/mol) at 48.6°C and 1.00 atm of pressure, how much energy should be removed in order to lower its temperature to -68.5°C, at constant pressure?

$\Delta_{vap}H° = 33.9$ kJ/mol	$C_{P,liq} = 1.73$ J/g°C	$C_{P,s} = 1.51$ J/g°C	Normal $T_{melting} = 5.5$°C
$\Delta_{fus}H° = 9.8$ kJ/mol	$C_{P,gas} = 1.06$ J/g°C	$\rho = 0.879$ g/cm^3	Normal $T_{boiling} = 80.1$°C

3.) Which of the following will decrease the equilibrium concentration of an inert gas (such as N_2) in a beaker of water assuming that equilibrium is re-achieved?

I. Decreasing the temperature of the water

II. Increasing the volume of the water

III. Decreasing the pressure of the gas above the liquid

(1) I only   (2) II only   (III) III only   (IV) I and III   (V) I, II, and III

4.) Place the following substances in order of *increasing* normal boiling point: SF_6, SiH_4, SF_4

(1) $SF_6 < SF_4 < SiH_4$ (2) $SF_6 < SiH_4 < SF_4$ (3) $SiH_4 < SF_6 < SF_4$

(4) $SiH_4 < SF_4 < SF_6$ (5) $SF_4 < SF_6 < SiH_4$

5.) Identify the Period 2 element which has the following successive ionization energies, in kJ/mol

       $IE_1 = 520$; $IE_2 = 7298$; $IE_3 = 11,815$; $IE_4 = 16,000$;

       $IE_5 = 22,831$; $IE_6 = 27,277$; $IE_7 = 32,987$; $IE_8 = 38,235$

(1) Beryllium   (2) Lithium   (3) Nitrogen   (4) Oxygen   (5) Neon

6.) When the chlorite ion is oxidized to form the chlorate ion, which of the following occurs?

(1) The Cl-O bond order changes from 1.50 to 1.33

(2) The formal charge on the chlorine atom changes from 0 to +1

(3) The oxidation state of the chlorine atom changes from +4 to +6

(4) The hybridization of the chlorine atom remains as sp^3

(5) The geometry of the anion changes from linear to trigonal planar

7.) How many sigma and pi bonds, respectively, are in NH$_2$CH$_2$CHCHCOOH?

(1) 13, 2   (2) 12, 1   (3) 11, 4   (4) 10, 2   (5) 9, 1

8.) In an experiment, 25.0 ml of a gas with a pressure of 1.00 atm is contained in a balloon at 25.00°C. The balloon's temperature is adjusted until the pressure is 0.75 atm at a volume of 31.1 ml. What is the final temperature of the gas under the new conditions?

**9.) How many resonance structures does the oxalate dianion [O$_2$CCO2]$^{2-}$ have?**

10.) Compare the ionic sizes of Cl$^-$ and K$^+$. (Z$_{eff}$ = effective nuclear charge)

(1) K$^+$ will have a larger ionic size because its outer electrons experience a higher Z$_{eff}$

(2) K$^+$ will have a larger ionic size because its outer electrons experience a smaller Z$_{eff}$

(3) K$^+$ will have a smaller ionic size because its outer electrons experience a higher Z$_{eff}$

(4) K$^+$ will have a smaller ionic size because its outer electrons experience a smaller Z$_{eff}$

(5) K$^+$ will have the same ionic size because it and Cl$^-$ experience the same Z$_{eff}$

11.) A sample of a hydrocarbon produced 3.14 grams of CO$_2$ and 1.28 grams of H$_2$O during combustion analysis. If the hydrocarbon has a molar mass between 50 and 60 g/mol, what is its molecular formula?

12.) A mixture of Xe(g) and O_2(g), formed by the complete decomposition of XeO_4(g), is collected over water at 34°C at a total pressure of 760 mmHg. If the vapor pressure of water is 40 mmHg at 34°C, what is the partial pressure of O_2?

13.) According to molecular orbital theory, what are the bond order and the number of unpaired electrons in CN, respectively? The valence molecular orbital sequence for CN is:

$\sigma_{2s}, \sigma^*_{2s}, \pi_{2px} = \pi_{2py}, \sigma_{2p}, \pi^*_{2px} = \pi^*_{2py}, \sigma^*_{2p}$
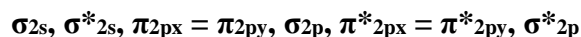
14.) When 50.0 ml of 0.200 M $AgNO_3$ and 50.0 ml of 0.100 M $CaCl_2$, both at 25.0°C, are reacted in a coffee-cup calorimeter, the temperature of the reacting mixture increases to 26.0°C. Calculate ΔH in kJ/mol of AgCl produced. Assume the density of the solution is 1.05 g/mol and the specific heat capacity of the solution is 4.20 J/g°C.

15.) Rate data have been determined at a particular temperature for the reaction

2 NO(g) + Cl_2(g) → 2 NOCl(g). What is the numerical value for the rate constant?

Experiment	[NO] (M)	[Cl₂] (M)	Rate (M/s)
1	0.0300	0.0100	3.4×10^{-4}
2	0.0150	0.0100	8.5×10^{-5}
3	0.0150	0.0400	3.4×10^{-4}

16.) Benzene (C_6H_6, 78.11 g/mol) is a liquid at room temperature with a normal boiling point of 80°C, and its molal boiling point elevation constant K_b is 2.65 °C kg/mol. Anthracene ($C_{14}H_{10}$, 178.23 g/mol) is a solid at room temperature but is quite soluble in liquid benzene. Predict the boiling point of a solution that is 25%-by-mass anthracene dissolved in benzene.