1. What is the pH of a 2 M ammonia solution? ($K_b = 1.8 \times 10^{-5}$) (5 %)

2. The molar heats of fusion of benzene is 10.9 kJ/mol and the melting point is 5.5 °C. Calculate the entropy changes for the solid to liquid transitions for benzene. (5 %)

3. Consider the heterogeneous equilibrium of decompositon reaction of $CaCO_3(s)$ to $CaO(s)$ and $CO_2(g)$, at 800 °C, the pressure of CO_2 is 0.236 atm. Calculate (a) Kp and (b) Kc for the reaction at this temperature. [(a) 2% , (b) 4 %]

4. Please show the reactions to explain why BeO is an amphoteric oxide. (6 %)

5. Draw two of resonance structures (including formal charges) for dinitrogen tetraoxide (N_2O_4). (6 %)

6. The rate constants for a certain reaction were measured at different temperatures. Plot the lnK on the Y-axis versus 1/T on the X-axis found the slope is -2.09×10^4 k, Please determine the activation energy for the reaction. (gas constant R = 8.314 J/K· mol) (6 %)

7. Calculate the packing efficiency for a simple cubic cell. (6 %)

8. The reaction 2A + 3 B ---> C is first order with respect to A and B. When the initial concentrations are [A] = 1.6×10^{-2} M and [B] = 2.4×10^{-3} M, the rate is 4.1×10^{-4} M/s/ Calculate the rate constant of the reaction. (6 %)

9. The density of a 2.45 M aqueous methanol (CH_3OH) solution is 0.976 g/ml. What is the molality of the solution? The molar mass of methanol is 32.04 g. (8 %)

10. Explain the reason why ^{14}C can be used to determine the ages of artifacts. (8 %)

11. Draw all possible CHIRAL isomers for the molecule C_4H_7Br. (8 %)

12. (a) Calculate the standard Gibbs free energy change at 25 °C for the thermal decomposition of calcium carbonate given that for this reaction, standard molar enthapy ΔH = 178 kJ/mol, and the standard molar entopy ΔS = 161 J/K. mol. (5 %)
(b) At what temperature would the reaction become spontaneous- assuming that ΔH and ΔS are independent of temperature? (5 %)

13. A quanitiy of 100 ml of 0.500 M HCl is mixed with 100 ml of 0.500 M NaOH in a constant-pressure calorimeter having a heat capacity of 335 J/°C. The initial temperature of the HCl and NaOH solutions is the same, 22.50 °C, and the final temperature of the mixed solutionis 24.90 °C. Calculate the heat change for the neutralization reaction

$$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$$

Assume that the densities and specific heats of the solutions are the same as for water (1.00 g/ml and 4.184 J/g. °C, respectively) (10 %)

14. Draw the molecular orbital energy level diagram and account for the paramagnetism of the O_2 molecule. (10 %)