ISM M.Sc. Chemistry Entrance -2010

Answer all questions. Each question is of 10 marks.

1. (a) Indicate the maximum number of ions accommodated in a plane of a unit cell of NaCl ?

(b) Between NH_3 and NF_3 which molecule will have smaller dipole moment and give the reasoning of your answer ?

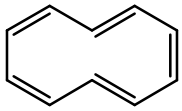
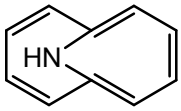
(c) One mole of ionic crystal MX(s) is formed from the following reaction, $M^+_{(g)} + X^-_{(g)} \rightarrow MX_{(s)}$

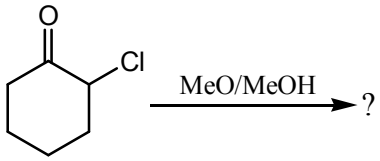
Whether energy is absorbed or released for the formation of the ionic crystal ?

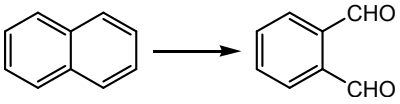
(d) $Na_2S_2O_3$ gives $Na_2S_4O_6$ in a particular reaction. What is the equivalent weight of $Na_2S_2O_3$ if you assume the molecular weight of $Na_2S_2O_3$ is M ?

(e) Indicate the direction of reaction if the reactants are mixed together at high temerature.

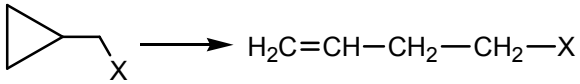
$$K + NaCl = Na + KCl$$

2. (a) Compare the stability of  and 

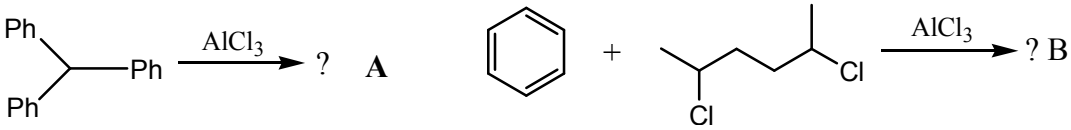
(b) Write down product of the following reaction with proper mechanism, 

(c) Convert 

(d) Write the name of the reaction and explain the mechanism.



(e) Write down the products of the following reactions.



3. (a) Ephedrine, a central nervous system stimulant, is used in nasal sprays as a decongestant. This compound is a weak organic base:

$$C_{10}H_{15}ON(aq) + H_2O\ (1) \longrightarrow C_{10}\ H_{15}ONH^+\ (aq) + OH^-\ (aq)$$

A 0.035 M solution of ephedrine has a pH of 11.33. Calculate K_b for ephedrine.

(b) For the reaction A + B $\rightarrow$ C, the rate constant at 215ºC is 5.0×10^{-3} and the rate constant at 452ºC is 1.2×10^{-1}.

(a) What is the activation energy in kJ/mol ? (b) What is the rate constant at 100ºC ?

(c) Give two reasons why most molecular collisions do not lead to a reaction ?

(d) Indicate the surface charge of AgCl precipitate when (i) trace amount of $AgNO_3$ solution is mixed with large excess of NaCl solution and (ii) trace amount NaCl solution is mixed with large excess of $AgNO_3$ solution (ignore surface charge neutralization by double layer).

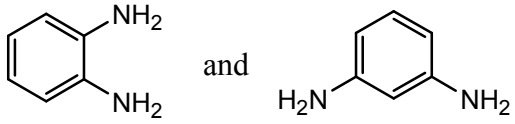
(e) The degeneracy of the level of hydrogen atom that has energy - $R_H/16$ is

(a) 16 (b) 4 (c) 2 (d) 1

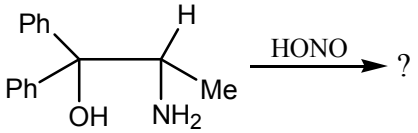
4. (a) A test tube contains an aqueous solution of cobaltous nitrate and another test tube contains $[Fe(bipyridyl)_3]^{2+}$ complex of same concentration. Using a visible spectrophotometer how would you distinguish the compounds ?

(b) A precipitate of PbI_2 (obtained from an aqueous solution of $Pb(NO_3)_2$ and KI) another precipitate of $PbCrO_4$ (obtained from an aqueous solution of $Pb(NO_3)_2$, and K_2CrO_4) are given to you in two different test tubes. Both are yellow in colour. How can you perform an experiment to identify the precipitates without using any reagent ?

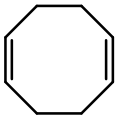
5. (a) Which one is more basic in aqueous solution ? CH_3NH_2,$(CH_3)_2NH$,$(CH_3)_3N$ and how do you distinguish between the following two compounds ?



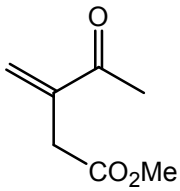
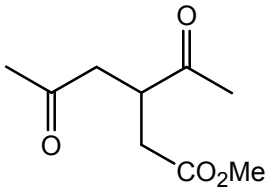
(b) Write down product of the following reaction with proper mechanism.



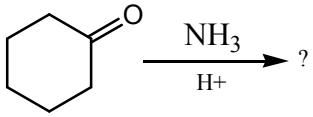
and convert RCHO to RCHOHCHO in maximum three steps.

6. (a)  $\xrightarrow{BH_3}$ A ?

What is A ? Tell one utility of A in organic synthesis and convert m-nitro toluene from toluene

(b) Convert  to 

In maximum four steps and write down the products of the following reactions.



$R_3B + CO \xrightarrow[2.\ H_2O_2]{1.\ LiBH_4}$

7. (a) Sketch diagrams for the reversible Carnot cycle of an ideal gas with constant C_p and C_v (i) U versus p and (ii) H versus S.

(b) Hydrogen reacts with oxygen explosively; yet a mixture of hydrogen and oxygen can exist indefinitely together at room temperature without reacting. Explain.

8. (a) Draw a potential energy diagram for a two-step exothermic reaction where step 2 is the rate-dtermining step.

(b) Write down the half cell reaction for Pt/fumarate^{2-} , $2H^+$, succinate.

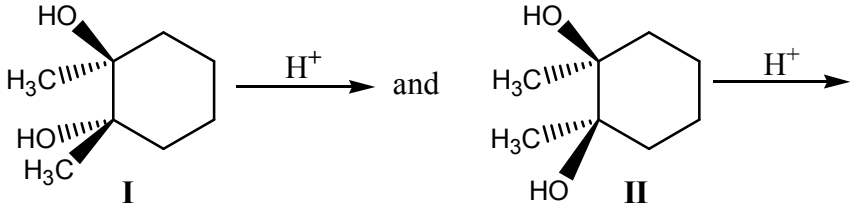
9. A solid crystalline compound (A) upon heating with a strong base (B) evolves NH_3. The compound A with aqueous solution of $MgCl_2$, aqueous NH_3 solution does not give any precipitate. But then the mixture (containing A + $MgCl_2$ + NH_3) with Na_2HPO_4 given a white crystalline compoud C as a precipitate.

Identify A, B and C.

What would be your observation when $MgCl_2$ solution is mixed first with NH_3 solution and then with the compound A ?

Again what will you notice if $MgCl_2$ solution is mixed first with A and then with NH_3.

10. (a) How can you relate the d^6 high spin octahedral arrangement with the d^1 octahedral case ?
(b) Write down the products with mechanism. Name the reaction.



I **II**

(c) THe first ionization energy for magnesium is 730 kJ/mol. The third ionization energy for magnesium is 7700 kJ/mol. What is the most probable value for second ionization energy for magnesium ?
(i) 490 kJ, (ii) 1400 kJ, (iii) 4200 kJ, (iv) 7100 kJ, (v) 8400 kJ