Mid-Semester Examination (CYL100)
2024-25-M Semester

Full Marks: 60 **Time: 2 h**

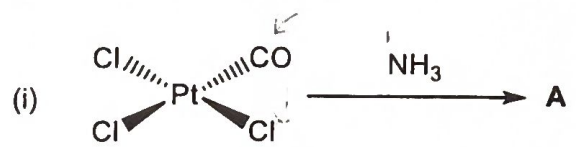
1. Comment on the observation with a schematic diagram that the addition of hydrogen gas to the complex *trans*-$[W(CO)_3(PCy_3)_2]$ (Cy = cyclohexyl) results in the formation of two complexes that are in equilibrium with one another. One complex has the tungsten center in a formal W(0) oxidation state while the other is in a formal W(2+) oxidation state. Removal of the H_2 atmosphere regenerates the starting material. **5 Marks**

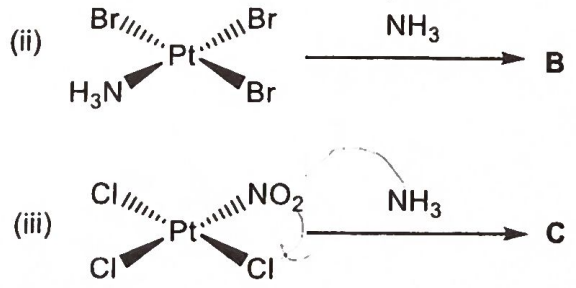
2. Suppose the crystallinity (X) of a polymer can be written as X = %Crystallinity/100. Then show that the density of the totally amorphous polymer (ρ_a) can be written as follows:

$$\rho_a = \frac{X-1}{X/\rho_c - 1/\rho_s}$$

Where ρ_s is the density of a specimen for which the percent crystallinity is to be determined and ρ_c is the density of the perfectly crystalline polymer. **5 Marks**

3. Draw the structure of the products **A-C** in the following scheme: **2 + 2 + 1 = 5 marks**





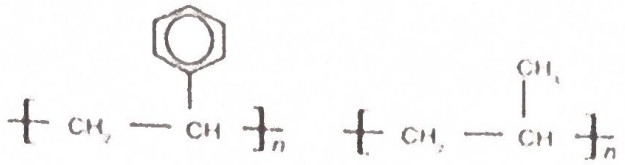
4. Which among the following compounds are hypervalent? Indicate the N-X-L notation for them: $PhICl_2$, Ph_5Te, XeO_2F_2, ClF_3, and SF_4. **5 Marks**

5. The enthalpy of hydration of Fe^{+2} is 48 kJ/mol higher than the expected value assuming no CFSE. Estimate the $10Dq_0$ value of $[Fe(OH_2)_6]^{+2}$. **5 Marks**

6. (a) Explain whether Fe_3O_4 will adopt a normal or inverse spinel structure. (b) Considering the normal spinel structure of $MgAl_2O_4$, predict whether Mg^{+2} will occupy the tetrahedral hole or octahedral hole. **4 + 1 = 5 Marks**

7. Comment on the molar extinction coefficients (in L mol^{-1} cm^{-1}) of the strongest visible absorption bands of the following complexes are $[Mn(H_2O)_6]^{2+}$: 0.035; $[MnBr_4]^{2-}$: 4.0; $[Co(H_2O)_6]^{2+}$: 10; and $[CoCl_4]^{2-}$: 600. **5 Marks**

8. (a) Explain which of the following polymers (**P1** or **P2**) will have the higher glass transition temperature (Tg) value.



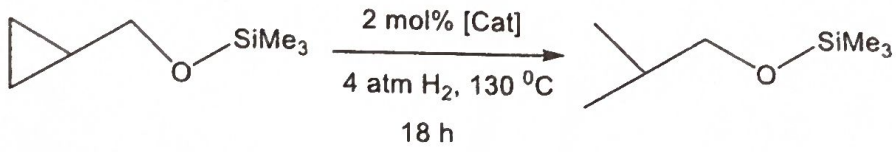
P1 **P2**

(b) With the increase of water or moisture content of the polymer the Tg value increase or decrease and why?

3 + 2 = 5 Marks

9. (a) Write down three characteristic features of Wilkinson's catalyst. (b) Explain why ethylene cannot be hydrogenated by using Wilkinson's catalyst? **2.5 + 2.5= 5 Marks**

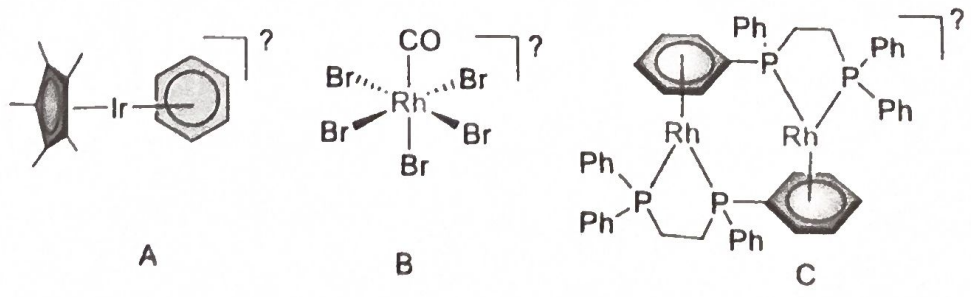
10. The following data were obtained for the catalytic hydrogenation of cyclopropyl substrate with a series of hydrogenation catalysts. Determine individually which among them gives the best TON and TOF value. **5 Marks**



Entry	Catalyst	% Product
1	$Pd(PPh_3)_4$	37
2	$(PPh_3)_3RhCl$	35
3	$[(COE)_2IrCl]_2$	38
4	$[(COD)RhCl]_2$	50
5	$[(COD)IrCl]_2$	25

[a]2.75 mM catalyst and 0.138 M substrate were used

11. The given cationic/anionic complexes obey the 18-electron rule. Identify the charge on the complexes). **5 Marks**



12. Among $[Ni(CO)_4]$, $[Co(CO)_4]^-$, and $[Fe(CO)_4]^{2-}$ complexes, which one should have (a) a longer M-C bond and (b) a shorter CO stretching frequency? **5 Marks**