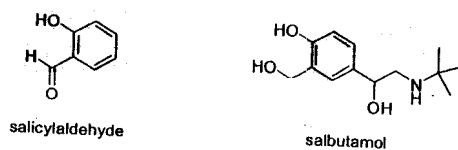
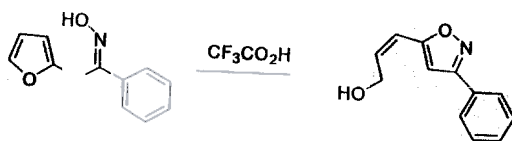


I

1. Device a short synthesis of salbutamol from salicylaldehyde. (5%)



2. Account for the acid-catalyzed rearrangement shown below. (5%)



3. Give at least one example to explain the following name reactions. (15%)

a) Baylis-Hillman reaction

b) Suzuki coupling

c) Heck reaction

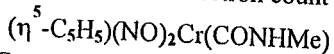
1. Explain the following term: (9%) 1) template effect, 2) Z-out, 3) β -elimination

2. Predict the structure of the following compounds: $\cdot\text{ClOF}_2^+$. (2%)

3. Explain why CaF_2 is more stable than CaF and NaCl_2 do not exist. (4%)

4. Determination the point group of the following compounds: ethane(staggered conformation) and C_3H_4 (allene). (4%).

5. Give the valence electron count for the following species. (3%)



6. Compare and explain the order stretching frequency (ν_{CO}) for the following compound: $(\text{PPh}_3)_3\text{Mo}(\text{CO})_3$, $(\text{PF}_3)_3\text{Mo}(\text{CO})_3$, $(\text{P}(\text{O}^i\text{Pr})_3)_3\text{Mo}(\text{CO})_3$ (3%)

III.

Answer the following questions as detailed as you can, please.

Spectroscopy

Please investigate the "Photoacoustic Effect"? How can this effect be employed in UV-Vis and IR spectroscopy and what is the specificity that ordinary UV-Vis and IR spectroscopy cannot achieve? (6%)

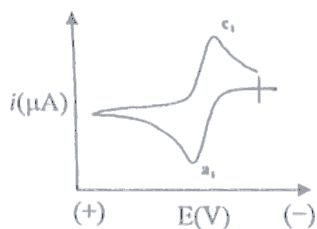
2. Please explain why the wave length of a fluorescence emission is always longer than that of the excitation radiation used to trigger the fluorescence emission?" (7%)

Chromatography

Generally, the "Partition Chromatography" can be divided into two different types; "Normal-Phase Chromatography" and "Reversed-Phase Chromatography". Please investigate the differences between them? (*Hint: these two categories are distinguished based on a physical property of the mobile phases and stationary phases*) (6%)

Electrochemistry

The cyclic voltammogram (CV) of a reversible reaction, $R \leftrightarrow O + ne^-$, is shown as the plot below where the reaction occurred at a platinum electrode. Because of the negative sign of the electron, an electron has higher potential energy in the electrode if a more negative potential is applied. Thus, which one of the two peaks, a_1 or c_1 , corresponds to the oxidation step; $R \rightarrow O + ne^-$? and please explain why peak-shape curve is always obtained from the cyclic voltammetry when the solution is not stirred? (R: the species in its reduced state, O: the species in its oxidized state, e^- : electron, n: number of transferred electron) (6%)



IV

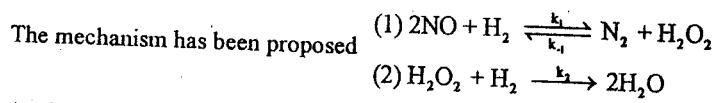
a. Define these phrases :

- (i) Clausius statement the 2nd Laws of Thermodynamics : (4 points)
 (ii) Franck-Condon Principle : (4 points)

b. Proceed by solving Eq. $\left(\frac{PV_m}{RT} = 1 + \frac{B_2}{V_m} + \frac{B_3}{V_m^2} + \frac{B_4}{V_m^3} + \dots \right)$ for P, B coefficients are called virial coefficients

and substituting this expression for P in Eq. $(PV_m = RT + A_2P + A_3P^2 + A_4P^3 + \dots)$, A_2, A_3, \dots are called pressure virial coefficients. Then use the fact that the coefficient of any power of $1/V_m$ must be the same on both sides of the equation. Show that $A_2=B_2$. (6 points)

c. For the gaseous reaction: $2NO + 2H_2 \rightarrow N_2 + 2H_2O$



Apply the steady-state approximation to this reaction:

Find the rate law if the steady-state approximation is used with inclusion of the reverse of step 1. (4 points)

. The work function of nickel equals 5.0 eV. Find (a) the threshold wavelength for nickel and (b) the maximum electron speed for a wavelength of 195 nm. (7 points)

Useful constants:

Planck constant $h = 6.626 \times 10^{-34} \text{ J s}$

Boltzmann constant $k = 1.381 \times 10^{-23} \text{ J K}^{-1}$

Avogadro constant $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$

$eV = 1.6022 \times 10^{-19} \text{ J eV}^{-1}$

Light speed $= 2.9979 \times 10^8 \text{ m s}^{-1}$