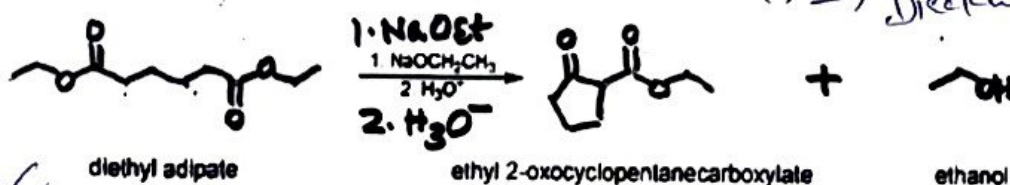# Major Exam; Chemistry (CYL1010); 120 Minutes; 20 Points

Note: All questions are of short answer type. Please adhere

1. Explain pictorially 0D, 1D, 2D, and 3D nanomaterials in behaviour and applications? (2)

2. Explain pictorially the bottom-up and top-down approaches to nanomaterial synthesis. Give two examples of our daily life where the above processes are used. (2)

3. Explain mathematically that the smaller the size, the higher the surface area to volume ratio in the context of a cube. (2)

4. Based on the HSAB principle explain the following…(2)

(a) $MgCO_3$ $CaCO_3$ Al_2O_3 occur in nature but MgS CaS or $Al_2 S_3$ do not.

(b) which is stable out of $[Ag(CN)_2]^-$ and $[AgCl_2]^-$ and why?

5. Identify the below-name reaction and write its mechanism. (2) → Dieckmann

diethyl adipate   ethyl 2-oxocyclopentanecarboxylate   ethanol

1. NaOEt
1 NaOCH₂CH₃
2 H₃O⁺
2. H₃O⁻

6. (a) Write the structure of Chiral Alanine and give R and S configuration using Cahn - Prelog - Ingold rules. (1)

(b) What is the fundamental difference between Aldol and Knoevenagel condensation? Explain with an example. (1)

7. Identify the products A, C, G, and I in the following reactions. (2)
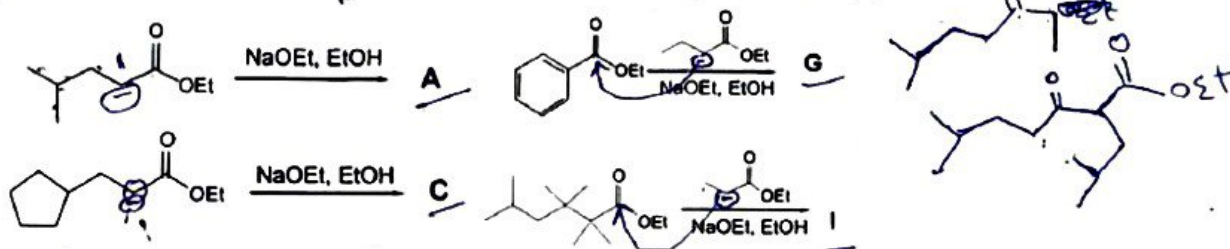
8. Explain how the doping of polyacetylene increases the electric conductivity. Draw the structure for explanation. (2)

9. Write various steps of free radical polymerization for polystyrene. (2)

$CH_3 - C$

10. How to recognize electrophiles and nucleophiles? What is a basic difference between basicity and nucleophilicity? Explain with examples. (2)
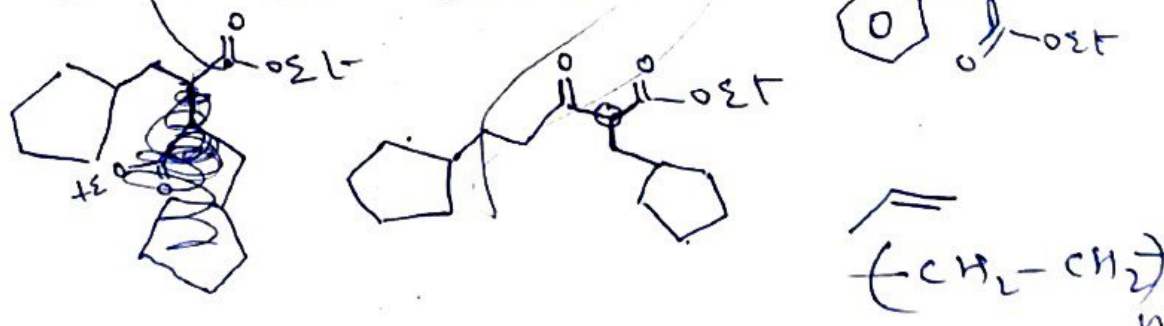
Remarks: 1. All questions are compulsory
2. Understanding a question is also part of the examination

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1. List the applications of EMF measurement. Why the lead-acid battery is classified as a secondary cell? Write the working principle and chemical reaction associated with the lead-acid and Nickel-cadmium batteries. [1+1+2=4]

2. How does the surface area to volume ratio change on decreasing the length of a cubical nanoparticle from 1000 nm to 100 nm to 10 nm (must include a plot). Why is the surface area important for nanomaterials? [2+1 =3 Marks]

3. Find whether the following options are correct or not with proper justification (simply writing the options without justification carries no mark) [2]

   (a) The fundamental frequency of IR spectra of F_2 can be observed at 10^{14} Hz

   (b) The Hamiltonian operator and the square of Angular momentum operator will have a simultaneous set of eigenfunctions

   (c) For the Hydrogen atom wave function $\frac{4}{27\sqrt{10}(3a_0)^{3/2}} \frac{r^2}{a_0^2} e^{-r/3a_0} \frac{\sqrt{15}}{4}\sin^2\theta \frac{1}{\sqrt{2\Pi}}e^{2i\phi}$, degeneracy is 9 and n=3, l=2, and m=2.

   (d) The Schrodinger equation for the He atom is an exactly solvable problem in quantum chemistry.

4. (a) Can you explain the effect of conjugation leading to a bathochromic shift in the absorption band (UV/Visible spectroscopy) using an example of ethylene, 1,3-butadiene, and 1,3,5-hexatriene? [2]

   Hint: Remember the number of nodes in a particle in a box and HOMO and LUMO!

   (b) Evaluate $\langle x^2 \rangle$ and $\langle p^2 \rangle$ for the state of a Harmonic Oscillator using the following equation [3]

   $$(n+1)^{1/2}\psi_{n+1} - \left(\frac{2m\omega}{\hbar}\right)^{1/2} x\psi_n + n^{1/2}\psi_{n-1} = 0$$