



WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 3rd Semester Examination, 2023-24

CEMACOR06T-CHEMISTRY (CC6)

Time Allotted: 2 Hours

Full Marks: 40

*The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.*

Answer any three questions taking one from each unit

UNIT-I

1. (a) State the basis of 'radius ratio rule' for ionic compounds. Calculate the limiting radius ratio for tetrahedral lattice surface. 1+3
- (b) Are the bond angles $\angle\text{HCH}$ and $\angle\text{FCF}$ in CH_2F_2 molecule equal? Give reasons in support of your answer. 2
- (c) Using VSEPR theory, predict the shape of PCl_2F_3 . Indicate the state of hybridisation of the central atom. 2
- (d) Calculate the Lattice energy of ThO_2 using Born Lande equation. Madelung Constant = 2.519, Born Exponent for Th^{4+} is 14. Radii of $\text{Th}^{4+} = 108 \text{ pm}$ and $\text{O}^{2-} = 126 \text{ pm}$. 3
- (e) Comment on the following dipole moments: 3
 $\text{NH}_3 = 1.4 \text{ D}$, $\text{NF}_3 = 0.2 \text{ D}$
- (f) CsF is more soluble in water than CsI , while LiF is less soluble than LiI . — Explain. 2
2. (a) Derive Born-Lande equation. 3
- (b) Using Born-Haber cycle and the following – calculate the electron affinity of chlorine: 3
 $\Delta H_f(\text{RbCl}) = -102.9 \text{ Kcal.mol}^{-1}$
 $\text{IP}(\text{Rb}) = 95 \text{ Kcal.mol}^{-1}$
 $\Delta H_{\text{sub}}(\text{Rb}) = -20.5 \text{ Kcal.mol}^{-1}$
 $D(\text{Cl}_2) = 54 \text{ Kcal.mol}^{-1}$
 $U(\text{RbCl}) = -166 \text{ Kcal.mol}^{-1}$
- (c) What do you mean by polarizing power and polarizability? Why AgF is soluble in water while AgI is almost insoluble? 1+1+1
- (d) Why melting point of MgCl_2 is less than that of CaCl_2 ? 2
- (e) Explain Schottky and Frenkel defects with example. 3
- (f) Predict the shape of the molecules: 2
 (i) XeO_2F_2 (ii) BrF_4^-

UNIT-II

3. (a) Construct the MO energy level diagram of H_2O molecule and hence predict the nature of bonds formed. 3+1
- (b) What do you mean by dipole-induced dipole interaction? Cite one example. 2
- (c) CO and N_2 are isoelectronic but they differ greatly in donor properties. — Explain. 2
- (d) ZnO white when cold but looks yellow when hot. — Explain. 2
- (e) The electrical conductivity of pure germanium is enhanced when doped with arsenic. — Explain. 2
- (f) Explain the paramagnetic nature of O_2 molecule using MO concept. 2
- (g) The dielectric constant of HCN is much greater than that of H_2O , though the H-bond strength in H_2O is greater than that of HCN. — Justify. 2
4. (a) Draw the MO diagram of HF and find out the number of non-bonded electrons. Explain the stability of H_2F^+ in light of MO theory. 2+2
- (b) Helium does not form diatomic molecule. — Justify. 2
- (c) B_2 and O_2 are paramagnetic in nature. — Explain MO diagram. 3
- (d) Explain n-type and p-type semiconductors with suitable example. 3
- (e) $(\text{CH}_3)_2\text{O}$ is completely miscible in water while $(\text{CH}_3)_2\text{S}$ is partly soluble. — Why? 2
- (f) Arrange the following molecules / ions with their increasing bond order: 2
- N_2 , N_2^+ and N_2^-

UNIT-III

5. (a) Why D_2O instead of H_2O in the nuclear reactor to thermalise the fast neutrons? 1
- (b) Define half life period and average life period. Show that $t_{1/2} = 0.693 t_{av}$. 2+2
- (c) The nuclear bonding energy per nucleon $^{12}_6\text{C}$ is 7.683 eV. The isotopic mass for $^{12}_6\text{C}$ is 12.00 amu. Find the mass defect and mass of six protons and six neutrons. 3
6. (a) The isotopic masses of two atoms, $^{56}_{26}\text{X}$ and $^{139}_{57}\text{Y}$ are 55.9521244 and 138.9621461 a.m.u. respectively. Compare their nuclear stability. [Given: mass of electron = 0.0005486, proton = 1.0072765 and neutron = 1.0086650 a.m.u.] 3
- (b) Account for the (n-n) nuclear force π -meson field theory. 2
- (c) Write down balanced nuclear reactions for the conversion of $^{98}\text{Mo}_{42}$ to $^{99}\text{Te}_{43}$ by the process that include neutron capture and subsequent β -decay. 2
- (d) What do you mean by magic number? 1

—x—



WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 3rd Semester Examination, 2023-24

CEMACOR05T-CHEMISTRY (CC5)

PHYSICAL CHEMISTRY-II

Time Allotted: 2 Hours

Full Marks: 40

*The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.*

Answer any three questions taking one from each unit

UNIT-I

1. (a) What is the dimension of Diffusion coefficient? Write down Fick's first law of diffusion. 1+1
- (b) The densities of acetone and water at 20°C are 0.792 g/cm³ and 0.9982 g/cm³, respectively. The viscosity of water is 1.002×10⁻³ Pa.s at 20°C. If water requires 120.5 sec to run between the marks on a viscometer and acetone requires 49.5 sec, what is the viscosity of acetone? 3
- (c) Write down Kohlrausch's law of migration of Ions. At 25°C the molar ionic conductivities of Na⁺ and K⁺ are 5.01 mSm²mol⁻¹, and 7.35 mSm²mol⁻¹, respectively. What are their mobilities? 1+2
- (d) For a strong electrolyte HCl, will there be any change in equivalent conductance with dilution? Justify your answer. 2
- (e) Define transference number. Why H⁺ has very high transference number? 1+1
2. (a) Molecular explanation for dependence of viscosity coefficient on the temperature for gases is different to that for liquids. — Explain. 2
- (b) A metal ball of density 7.9 g/cubic centimeter and 4 mm diameter requires 55 seconds to fall a distance of 1 meter through an oil of density 1.1 g/cubic centimeter. Neglecting the correction due to the viscometer tube, calculate the viscosity of the oil in poise. 3
- (c) What is Debye-Falkenhagen effect? 2
- (d) The boundary of a HCl solution (conc. 0.011N) with Lithium chloride solution moved 7.5 cms in a capillary tube of radius 5 mm. When a current of 11.5 milliamperes were passed for 12 minutes. Calculate the transport number of H⁺ ion. 2
- (e) Give the Schematic conductometric titration curve for titration of aqueous solution of sodium acetate by hydrochloric acid conductometrically. Give explanations. 3

UNIT-II

3. (a) Show that, $\left(\frac{\partial(\Delta\mu_i/T)}{\partial T}\right)_{P, n_i} = -\frac{\Delta\bar{H}_i}{T^2}$, the letters have their usual meaning. 3
- (b) Derive the Gibbs-Duhem equation. 2
- (c) What do you mean by 'fugacity' of gas? Show that for a pure real gas its fugacity (f) at moderate pressure can be expressed as $f \cong \frac{P^2\bar{V}}{RT}$ [\bar{V} = molar volume of the gas]. 1+3
- (d) The chemical potential of a constituent in a homogeneous mixture is defined as 2+2

$$\mu_i = \left(\frac{\partial G}{\partial n_i}\right)_{T, P, n}$$

Show that it may be expressed as

$$(i) \mu_i = \left(\frac{\partial H}{\partial n_i} \right)_{S, P, n} \quad (ii) \mu_i = \left(\frac{\partial A}{\partial n_i} \right)_{V, T, n}$$

- (e) What do you mean by Ideal solution? How is Raoult's law modified so as to describe the vapor pressure of real solutions? 1+2
4. (a) Chemical potential is a measure of escaping tendency — Justify or criticise. 2
- (b) Prove that $\left[\frac{\partial(G/T)}{\partial(1/T)} \right]_P = H$. 3
- (c) Chemical potential μ and standard chemical potential μ° of a real gas is related as $\mu = \mu^\circ + RT \ln f$, where 'f' is the fugacity. Comment on the pressure and temperature dependence of μ and μ° . 3
- (d) 'The partial molar volume of all the gases in a mixture of ideal gases has the same value.' — Justify or criticise. 3
- (e) Calculate the changes in the thermodynamic quantities G , S , H and V for mixing of $\frac{1}{2}$ mole of oxygen with $\frac{1}{2}$ mole of nitrogen at 25°C , assuming the gases to behave ideally. 3
- (f) Draw the plot of $\ln K_p$ versus $1/T$ of an endothermic reaction with $\Delta C_p = 0$ for the reaction. 2

UNIT-III

5. (a) Given that mass of electron is 9.109×10^{-31} kg and speed of light is 2.998×10^8 m.sec⁻¹. Calculate the de Broglie wavelength of an electron travelling 2.00% of the speed of light. 2
- (b) Show that e^{ax} is an eigenfunction of the operator $\frac{d^n}{dx^n}$. What is the eigenvalue, when n is even number? Is there any difference in eigenvalue if n is odd number? 2+1+1
- (c) Write down the Planck distribution for black body radiation and show that under particular condition it reduces to Rayleigh-Jeans law. 1+2
- (d) If ψ_1 and ψ_2 describe a twofold degenerate state with eigenvalue 'a' then any linear combination of ψ_1 and ψ_2 is also an eigenfunction with eigenvalue 'a' for a linear operator. — Justify. 3
6. (a) Show that two eigenfunctions belonging to different eigenvalues of a Hermitian operator are orthogonal. 3
- (b) What is the wave function of a free electron? Calculate average position of a particle in box of length 10 nm. 1+2
- (c) Show that $[\hat{L}_y, \hat{L}_z] = i\hbar \hat{L}_x$. 3
- (d) The most commonly occurring continuous probability distribution is the Gaussian or Normal distribution given by $f(x)dx = ce^{-x^2/2a^2} dx$ ($-\infty \leq x \leq \infty$). Find c. 3

[Given: $\int_0^\infty e^{-bx^2} dx = \frac{1}{2} \left(\frac{\pi}{b} \right)^{1/2}$, $b > 0$, a , b , c are constants. The normalisation

condition is, $\int_{-\infty}^{+\infty} f(x) dx = 1$.]

—x—



WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 3rd Semester Examination, 2023-24

CEMACOR07T-CHEMISTRY (CC7)

Time Allotted: 2 Hours

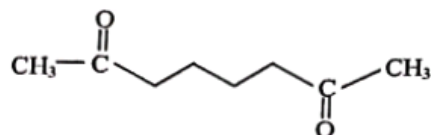
Full Marks: 40

*The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.*

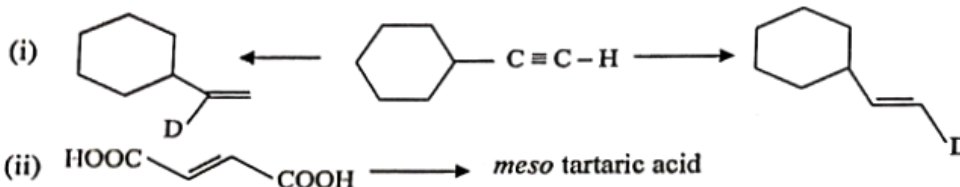
Answer any four questions taking one from each unit

UNIT-I

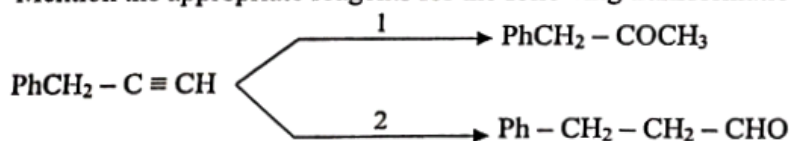
1. (a) Give the structural formula for the alkene that gives the following ozonolysis product: 2



- (b) How can you carry out the following transformations? 2+2



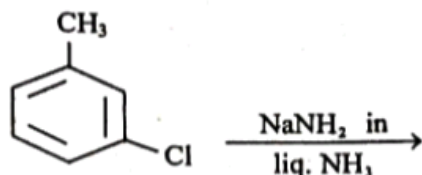
- (c) Singlet carbene adds to *cis*-2-butene in a stereospecific manner whereas triplet carbene does not. — Explain. 2
- (d) Allene reacts with aqueous H_2SO_4 to form acetone and not allyl alcohol. Explain the fact. 2
2. (a) Mention the appropriate reagents for the following transformations. 2



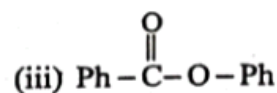
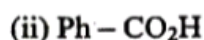
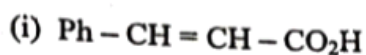
- (b) What products are expected in the reaction of 1-hexene with NBS in CCl_4 in presence of peroxides? — Explain. 3
- (c) Addition of HCl to 3,3-dimethyl-but-1-ene gives two isomeric alkyl chlorides. — Explain. 3
- (d) Explain mechanistically Kharasch effect with suitable example. 2

UNIT-II

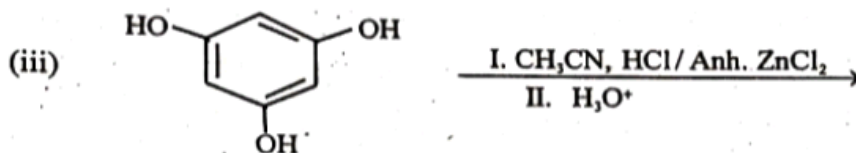
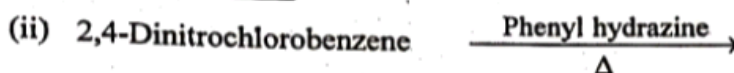
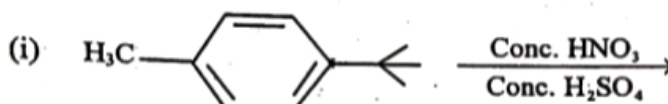
3. (a) Write down the possible products formed in the following reaction. Which would be the major product? Explain with mechanism. 3



- (b) Predict the favoured position of aromatic electrophilic substitution of the following compounds and justify your answer in each case: 2 / 4 3



4. (a) Predict the product(s) of the following reaction with plausible mechanism. (Any two): 2+2

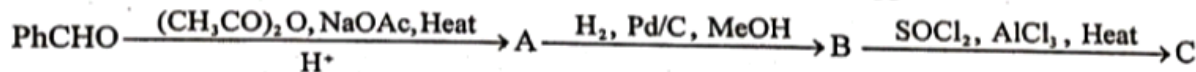


- (b) Explain the following fact. 2

Anisole affords *o*-nitroanisole with nitric acid and acetic anhydride mixture.

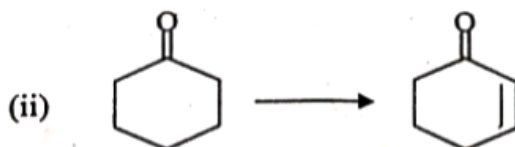
UNIT-III

5. (a) Identify the products in the following sequence of reactions and suggest mechanism. 4



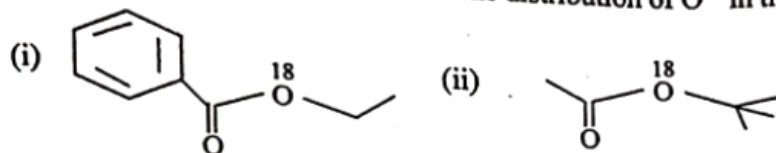
- (b) Acetylation with acetyl chloride requires dry condition but benzoylation is carried out in aqueous alkaline solution. — Explain. 2

- (c) Convert the following: 2×2 = 4



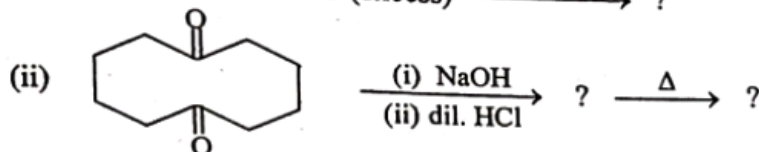
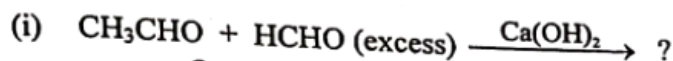
- (d) Explain the mechanism of alkaline hydrolysis of the following O^{18} labelled esters in ordinary water (H_2O^{16}) and indicate the distribution of O^{18} in the products in each case:

2+2



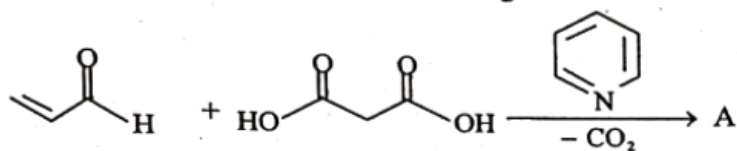
- (e) Identify the products of the following reactions:

2+2



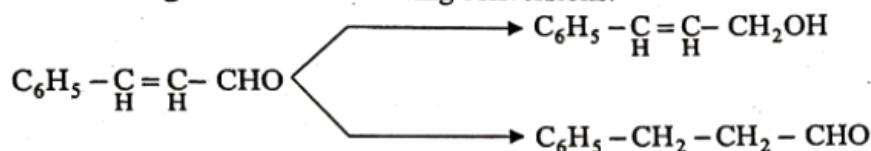
6. (a) What will be the product for the following reaction? Give mechanism.

3



- (b) Give the reagents for the following conversions.

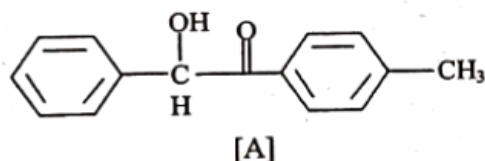
1+1



- (c) Account for the following observations:

2+2
+3+2

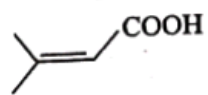
- (i) In the Perkin reaction of benzaldehyde with Ac_2O and $NaOAc$, little styrene is obtained although cinnamic acid does not decarboxylate under the reaction conditions.
- (ii) Benzoin gives the compound [A] when treated with *p*-methylbenzaldehyde in presence of KCN / $EtOH$.



- (iii) 1,3-Dithiane, as protected carbonyl, is not deprotected to the corresponding carbonyl compound with acid or alkali, but in the presence of $HgCl_2$, it is cleaved accordingly.
- (iv) Rate of reduction of a ketone by $LiAlH_4$ decreases when crown ether (12-Crown-4) is added to the reaction mixture.

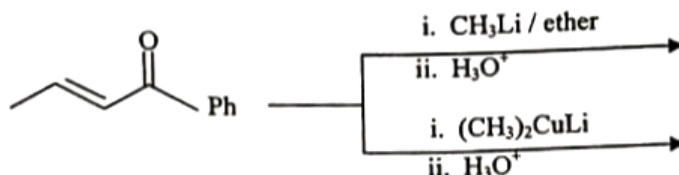
- (d) How can you achieve the following transformations? (Any two)

2×2 = 4

- (i) Acetone \longrightarrow 
- (ii) Benzaldehyde \longrightarrow $PhCH_2CHO$
- (iii) $CH_3COCH_2CO_2Et \longrightarrow CH_3CH_2COCH_2CO_2Et$

UNIT-IV

7. (a) Identify the products in the following reaction and explain.

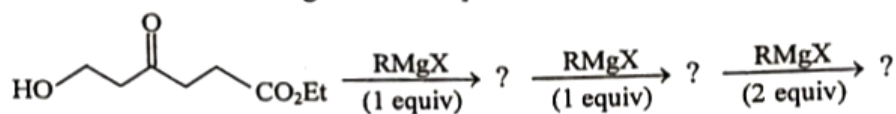
 $1\frac{1}{2} + 1\frac{1}{2}$ 

- (b) Outline the best possible route for the preparation of 2-pentene starting with ethanol and 1-propanol
- via*
- a Grignard reagent.

3

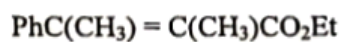
8. (a) Comment on the following reaction sequence:

3



- (b) Use Reformatsky reaction for the synthesis of

2



- (c) Write the product when an organolithium compound (RLi) is added to dry ice.

1

—x—