TDC (CBCS) Odd Semester Exam., 2022

CHEMISTRY

(1st Semester)

Course No. : CHMDSC/GE–101T

(Atomic Structure Bonding General Organic Chemistry and Hydrocarbons)

Full Marks : 50
Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *three* questions from the following : 1×3=3

(a) What are the principal and azimuthal quantum numbers of electrons in $4f$ orbitals?

(b) Fill the blanks : ½×2=1

(i) The number of nodal planes in a p_x orbital is ____.

(ii) An orbital that has no radial nodes and has two angular nodes is ____.

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(c) Draw the shapes of d_{z^2} and $d_{x^2-y^2}$ orbitals.

(d) Write the electronic configuration of an atom with atomic number 47.

2. Answer any *one* question from the following : 2

(a) State Heisenberg's uncertainty principle and explain its significance.

(b) What is the kinetic energy of an electron whose de Broglie wavelength is 10^{-10} m? [Planck's constant $(h) = 6{\cdot}626\times10^{-34}$ J-Hz^{-1}, mass or $e^- = 9{\cdot}10\times10^{-31}$ kg]

3. Answer any *one* question from the following : 5

(a) (i) Show that Bohr's postulate of quantized angular momentum for an electron moving in a circular orbit can be derived by the application of de Broglie's hypothesis. 3

(ii) Discuss the origin and physical significances of magnetic quantum number. 2

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(b) Explain 'radial function' and 'radial distribution function' of an orbital. Compare the radial distribution plots for $2s$ and $2p$ orbitals and hence comment on their relative penetrating property. 2+2+1=5

2

UNIT—II

4. Answer any *three* questions from the following : 1×3=3

(a) Which of the following molecules is linear?

CO_2, H_2O, SF_2, N_2O

5

(b) How does Fajan's rule explain the relative covalent/ionic character of the following pair of compounds?

LiI, CSI

(c) Draw the structures of BF_3 and NH_3.

(d) Which of the following compounds has the highest lattice energy and why?

LiF, LiCl, NaCl, MgO

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5. Answer any *one* question from the following : 2

(a) "CO and N_2 are isoelectronic but differ greatly in donor properties." Explain with the aid of an approximate molecular orbital energy-level diagram.

(b) Draw the possible resonance structures of isoelectronic NO_2 and O_3.

6. Answer any *one* question from the following : 5

(a) Define the term 'lattice energy'. Establish Born-Landé equation for lattice energy for crystal having NaCl structure explaining the various terms.

1+4=5

(b) Draw the energy-level diagram for the MOs of CO molecule and hence explain its low polarity and ligational behaviour towards metal ion.

UNIT—III

7. Answer any *three* questions from the following : 1×3=3

(a) Indicate which type of effect (+*I*, –*I*, +*R* or –*R*) is shown by each of the following substituents. Inductive effects should be compared with hydrogen :

Br, —OCH_3, CH_2CH_3

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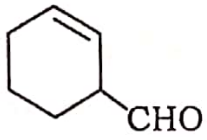
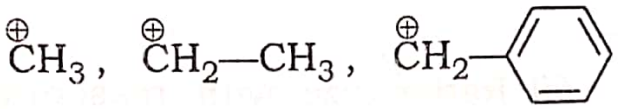
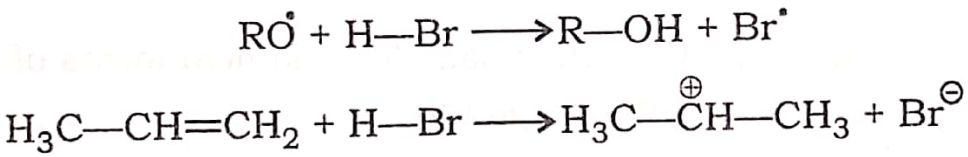
(b) Draw the resonance structures of



(c) Arrange the following species in order of increasing stability :

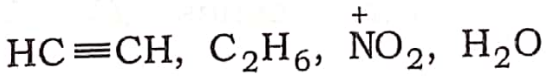


(d) For the following reaction steps, use curved arrows to show the electron flow :



8. Answer any *one* question from the following : 2

(a) Classify the following into electrophile, nucleophile or neither :



(b) What are carbanions? Discuss the stability of various types of carbanions.

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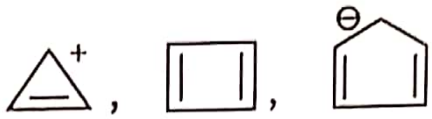
9. Answer any *one* question from the following : 5

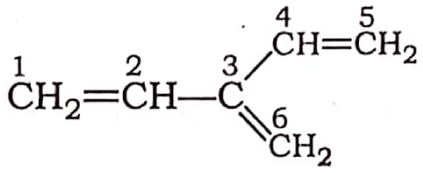
(a) *(i)* Classify the following species as aromatic/antiaromatic and give reasons : 1×3=3



(ii) Rationalize with reasoning, which compound of the following pair has higher dipole moment? 2

Butanal and 2-butenal

(b) *(i)* Give the possible canonical forms of the compound



and hence predict the relative double bond character of the three double bonds ($C_1 - C_2$, $C_4 - C_5$, $C_3 - C_6$). 3

(ii) Write the differences between hyperconjugation and resonance. 2

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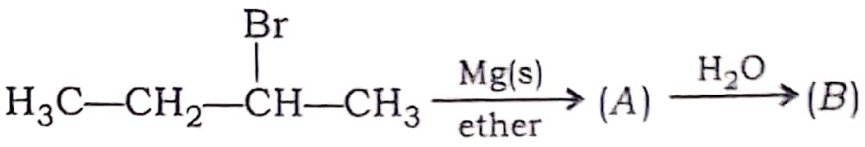
UNIT—IV

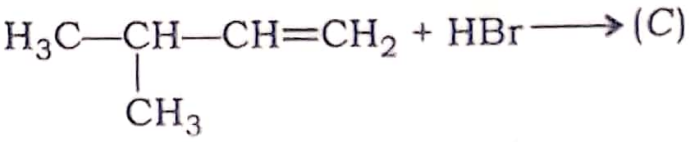
10. Answer any *three* questions from the following : 1×3=3

(a) Identify (*A*) and (*B*) for the following reaction :

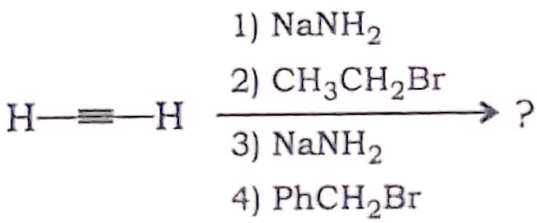


(b) Which compound on electrolysis gives *n*-butane? Give reaction.

(c) Identify (*C*) in the following reaction :

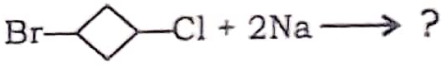


(d) Predict the product of the following reaction :



11. Answer any *one* question from the following : 2

(a) Predict the major product of the following reactions :

(i) 

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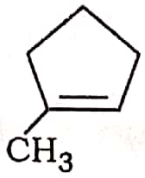
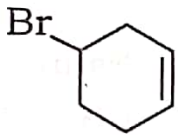
(ii)  $\xrightarrow[2)\ H_2O]{1)\ KMnO_4}$?

(b) How will you prepare acetylene from calcium carbide? (Give balanced chemical equation.)

12. Answer any *one* question from the following : 5

(a) (i) Give the major product (*E*2 elimination) of the following reactions and suggest mechanisms : 1½×2=3

(1) $H_3C-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_2-CH_3 + KOH \longrightarrow$?

(2)  + KOH ⟶ ?

(ii) Predict the major product of the following reaction and suggest mechanism : 2

$$H_3C-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH=CH_2 + Br_2 \xrightarrow{CH_2Cl_2} \text{?}$$

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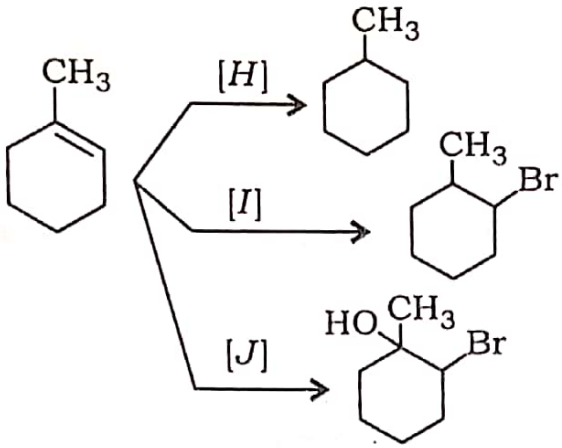
(b) (i) Identify [*H*], [*I*] and [*J*] from the following reaction : 1½



(ii) Provide the major product of the following reactions and give mechanisms : 1½+2=3½

(1) $H_3C—CH_2—CH_2—\underset{\displaystyle CH_3}{\overset{|}{C}}=CH—CH_3 \xrightarrow[2)\ Zn,\ H_2O]{1)\ O_3} ?$

(2) $H_3C—CH_2—CH_2—CH=CH_2 \xrightarrow[2)\ H_2O_2]{1)\ O_3} ?$

UNIT—V

13. Answer any *three* questions from the following : 1×3=3

(a) Convert phenol into benzene.

(b) Convert acetylene into benzene.

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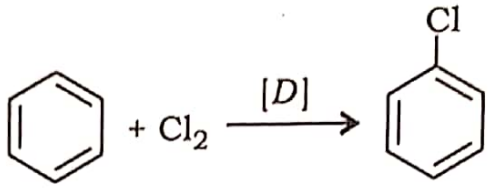
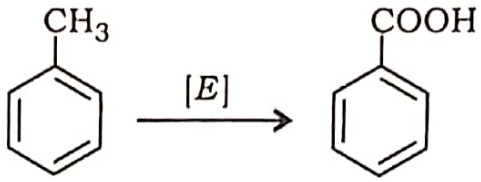
(c) Identify [D] in the following reaction :



(d) Identify [E] in the following reaction :



14. Answer any *one* question from the following : 2

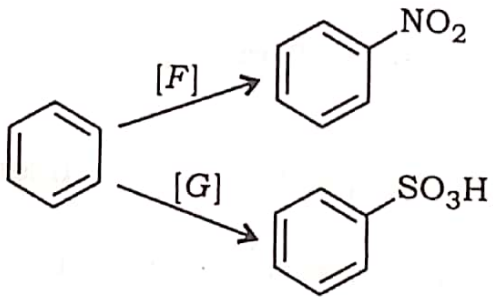
(a) List the members of the following sets of compounds in order of decreasing reactivity towards electrophilic substitution. Give reasons :

(i) Benzene

(ii) Phenol

(iii) Nitrobenzene

(b) Identify [F] and [G] from the following reaction : 1+1=2



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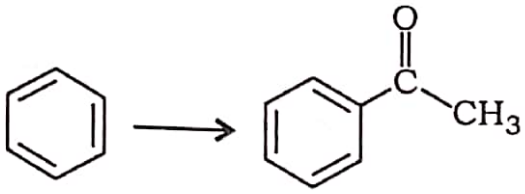
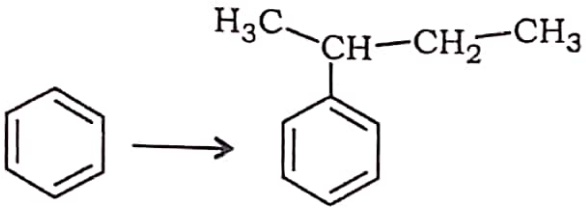
15. Answer any *one* question from the following : 5

(a) Carry out the following transformations and provide mechanisms : 2½×2=5

(i)

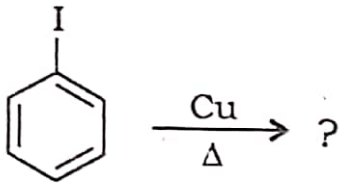


(ii)

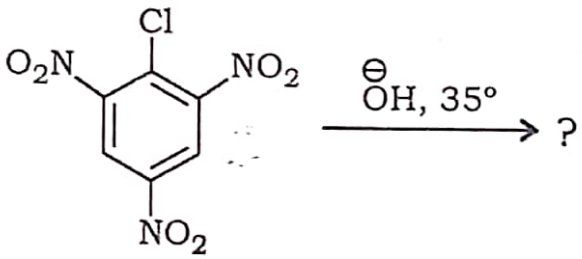


(b) *(i)* Complete the following reactions : 1×2=2

(1)



(2)



(ii) Write and describe the mechanism of nitration reaction of benzene using acid mixture by showing the intermediates. 3

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