(d) What is enzyme inhibition ? Write briefly about different types of enzyme inhibition.   1+4=5

(e) Write the difference between simple protein and conjugate protein.

4. (a) Derive Michaelis-Menten equation for single substrate enzyme catalyzed reaction.   10

Or

(b) Discuss the different classes of carbohydrate with example and mention its biological significance.

5. (a) What are terpenes ? Discuss the biological importance of different types of terpenes with suitable example.   2+8=10

Or

(b) Describe the classification of amino acid. Write the difference between essential and non-essential amino acid.   7+3=10

6. (a) What are the bonds involved in stabilizing the protein structure ? Discuss the various level of organization of protein.   3+7=10

Or

(b) Describe the various classes of immunoglobulin and state its function.   10

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3 (Sem–3/CBCS) CHE HC 3

2023

CHEMISTRY

(Honours Core)

Paper : CHE–HC–3036

(Physical Chemistry III)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following as directed :   1×7=7

    (i)   What is Eutectic Point ?

    (ii) Give *one* example of a consecutive reaction.

    (iii) What is adsorption isobar and adsorption isotherm ?

(iv) How many components are present in the following equibria ?

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

(v) What is autocatalysis ?

(vi) A radioactive substance has $t_{1/2}$ of 6.93 *min*. Find its average life.

(vii) Under what condition of pressure, would the Lindemann theory of unimolecular gaseous reaction show first-order kinetics ?

2. Answer the following questions : 2×4=8

(i) Explain why the slope of vapour pressure *vs* temperature plot for solid-vapour equilibrium is steeper than the slope of liquid-vapour equilibrium.

(ii) Why are zeolites suitable as catalysts for cracking and reforming reactions ?

(iii) If the reaction A → Products follows zero-order kinetics, show with the help of a diagram, how [A] will change with time.

(iv) The activation energy of a certain uncatalyzed reaction at 300 K is 76 kJmol⁻¹. The activation energy is lowered to 57 kJmol⁻¹ by the use of a catalyst. By what factor is the rate of the catalysed reaction increased ?

3. Answer **any three** questions from the following : 5×3= 15

(i) Derive Gibbs' Phase rule. How is the number of component C calculated for systems involving ions and having some chemical reactions equilibrium among the constituents ? Evaluate the degrees of freedom for the following equilibrium 2+1+2 = 5

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g) \text{ when}$$
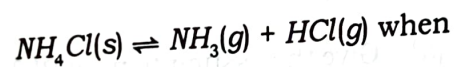
(a) $P_{NH_3} \neq P_{HCl}$

(b) $P_{NH_3} = P_{HCl}$

(ii) Draw and explain *five* general types of isotherms that have been observed during adsorption of gas on solid surface.

(iii) Draw and interpret the phase diagram for a two-component system involving simple eutectic.

(iv) What are chain reactions? Discuss the kinetics of $H_2 - Br_2$ chain reaction.

$$1+4=5$$

(v) Distinguish between order and molecularity of a reaction. Discuss one experimental method for the determination of the order of a reaction.

$$2+3=5$$

4. Answer *any three* questions from the following :

$$10\times3=30$$

(a) Give the assumptions of BET theory. On the basis of these assumptions, deduce the BET equation of adsorption.

$$3+7=10$$

(b) (i) Explain briefly the phase diagram for a two-component system with incongruent melting point. Explain the cooling curve for such a system.

$$5+2=7$$

(ii) Discuss the mutual solubility curve of a conjugate solution having upper critical solution temperature.

$$3$$

(c) What are the assumptions of Langmuir Isotherm? Derive Langmuir Adsorption Isotherm. Show that for adsorption of a gas with dissociation $(X_2 \rightarrow 2X)$ the Langmuir adsorption isotherm becomes

$$0 = (KP)^{1/2} / 1 + (KP)^{1/2}$$

Draw the Langmuir Isotherms for with and without dissociation.

$$2+4+2+2=10$$

(d) Discuss Enzyme catalysis with an example. For the Michaelis-Menten mechanism of enzyme action
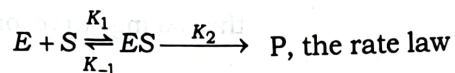
$$E + S \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} ES \xrightarrow{K_2} P,$$ the rate law is given by

$$r = K_2 [E]_0 [S]_0 / [S]_0 + K_M$$

Where $K_M = K_2 + K_{-1} / K_1$ is Michaelis constant.

Answer the following :

(i) Show that enzyme reaction is of first-order and zero-order with respect to low and high initial concentration of S respectively.

(ii) What type of graph is expected between the rate and $[S]_0$?

(iii) Show that if $K_2 << K_{-1}$, K_M represents the dissociation constant for ES.

(iv) What is 'Turnover number' of an enzyme catalyst ? 3+2+2+2+1=10

(e) (i) How does the reaction rate depend on temperature ? Show how Arrhenius plot of a reaction can be obtained. What is the significance of the pre-exponential factor ?

(ii) Write the mechanism of unimolecular reaction as proposed by Lindemann. Using this mechanism, deduce an expression for the rate of unimolecular reaction. 5+5=10

(f) State and explain the Nernst Distribution Law. Under what conditions the law is valid ? How is the law derived from thermodynamic considerations ? Discuss the practical applications of the Nernst Distribution Law. 2+2+4+2=10

_____

Total number of printed pages–11

2023

CHEMISTRY

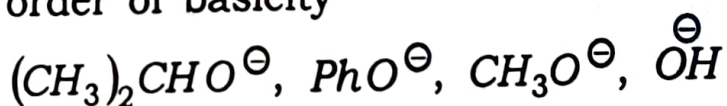(Honours Core)

Paper : CHE–HC–3026

(*Organic Chemistry–II*)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.
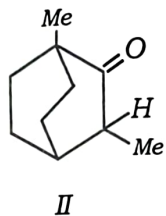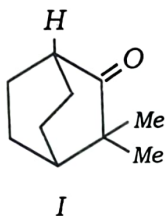
1. Answer the following questions : $1 \times 7 = 7$

   (a) Arrange the following in increasing order of basicity

   $(CH_3)_2CHO^{\ominus}$, $PhO^{\ominus}$, $CH_3O^{\ominus}$, $\overset{\ominus}{O}H$

   (b) Draw the energy profile diagram of $E|CB$ mchanism of β-elimination reaction.

(c) Which one of the following bridged bicyclic compounds will exhibit Keto-Enol tautomerism.

I   II

(d) DMF and DMSO favours S_N2 reaction although they are polar solvents. Explain.

(e) Potassium – t – butoxide is a widely used base in organic reactions but the corresponding sodium compound is unknown. Give reason.

(f) Why is thioethanol more acidic than ethanol ?

(g) Name the reagent that can be used to convert Cis – 2 – butene to racemic 2,3 – butanediol.

2. Answer the following questions :   2×4=8

(a) Arrange the following compounds in increasing boiling point and give reason for your answer.
n–hexanol, n–butanol and t–butanol

(b) Between $CH_3CH_2CH_2Cl$ and CH_3OCH_2Cl, which would react faster in S_N1 solvolysis. Explain.

(c) The phenols shown have approximate pKa value of 4, 7, 9 and 11. Suggest with explanation which pKa value belong to which phenol :

I   II   III   IV
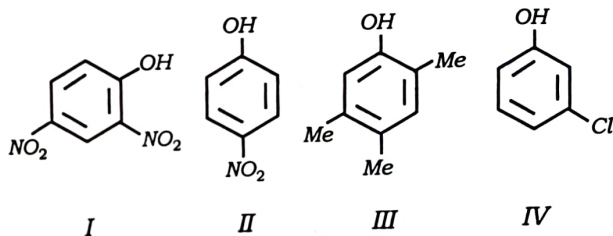
(d) Arrange the following carboxylic acid derivatives in order of increasing reactivity towards hydrolysis reaction and justify your answer :

$R - COOR'$, $R CONH_2$, $R COCl$

3. Answer *any three* questions : 5×3=15

(a) Write the mechanism of Benzoin condensation. Explain why p-dimethylaminobenzaldehyde fails to undergo benzoin condensation but when mixed with benzaldehyde the condensation occurs. 3+2=5

(b) (i) Explain why alcohols are weaker acids than phenols but phenols are stronger nucleophiles. 2

(ii) Provide the required reagents and conditions for the following conversion : 1½×2=3
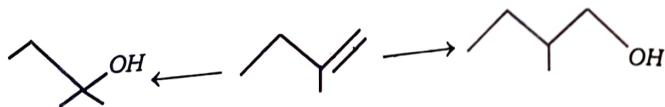
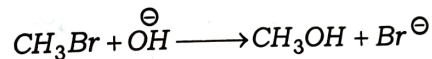(c) (i) Predict the major product of the following reaction and explain its formation mechanistically. 3
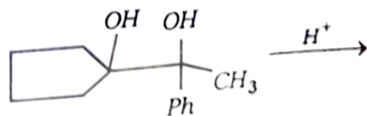
(ii) How do you carry out the following conversion ? 2

$$CH_3CH_2 - C \equiv CH \longrightarrow CH_3CH_2CH_2CHO$$

(d) (i) Why are vinylic and aryl halides unreactive towards both S_N1 and S_N2 reactions ? 3

(ii) The rate equation of S_N2 reaction

$$CH_3Br + \overset{\ominus}{OH} \longrightarrow CH_3OH + Br^{\ominus}$$
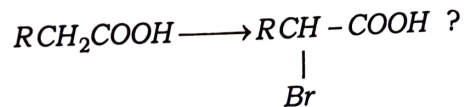
Rate = $k[CH_3Br][OH]$

What type of changes are expected in the rates of the reaction if

(a) the concentration of each of the reactants is made double ?

(b) the concentration of CH_3Br is made half ?

(e) (i) What is ortho effect ? Explain, why almost all ortho substituted benzoic acids are stronger acid than benzoic acids ? 1+2=3

(ii) How can you convert : 2

$$RCH_2COOH \longrightarrow \underset{\underset{Br}{|}}{RCH} - COOH \ ?$$

Contd.

4. Answer *any three* questions : 10×3=30

(a) (i) What is lucas reagent ? How is it used to distinguish between $1°$, $2°$ and $3°$ alcohols ? 1+2=3

(ii) Methyl chloromethyl ether is readily hydralysed by water to $HCH = 0$ and CH_3OH but $CH_3OCH_2CH_2Cl$ does not. Explain. 2
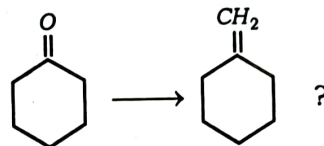
(iii) Picric acid liberates CO_2 from aqueous Na_2CO_3 but phenol does not. Explain. 2

(iv) Give the products of Reimen-Tiemann reaction on *p*–Cresol. Explain the reaction with mechanism. 3

(b) (i) Write the mechanism of Michael addition reaction. 3

(ii) What is Wittig reagent ? 1

(iii) How will you convert

Write the mechanism of the reaction involved. 3

(iv) Write the significance of Wittig reaction. 2

(v) What do you mean by ylides ? 1

(c) (i) Both *O*– and *m*–bromo misole give the same product on treatment with $NaNH_2$ in liq. NH_3. Account for the observation with appropriate mechanism. 5

(ii) Write down the mechanism of the following reaction :

Contd.
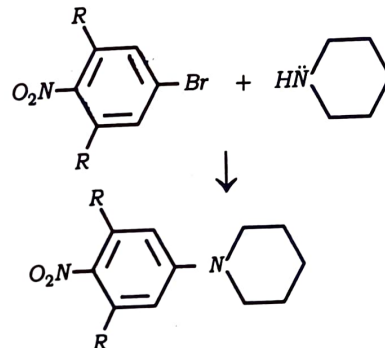
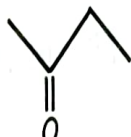Account for the fact that the compound that has $R = H$ reacts 35 times as fast as the one that has $R = CH_3$. 3+2=5

(d) (i) Give the mechanism of alkaline hydrolysis of the following ester in ordinary water (H_2O^{16}) and indicate the distribution O^{18} is the products in each case. 4

(I) $Ph - \overset{\overset{\displaystyle O}{\|}}{C} - O^{18} - Et$

(II) $Me - \overset{\overset{\displaystyle O}{\|}}{C} - O^{18} - tbu$
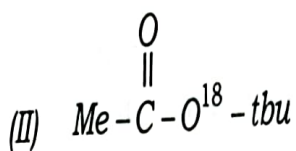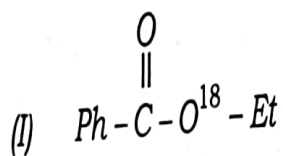
(ii) What happens when an acid chloride is treated with excess of diazomethane and the product reacts with EtoH in the presence of Ag_2O catalyst? 2

(iii) Write the Strecker reaction for preparation of methyl sulphonic acid. 2

(iv) How can CH_3CH_2SH be prepared from thiourea? Write the reactions. 2

(e) (i) What are active methylene compounds? 1

(ii) Convert EAA to 3

(iii) 7-chloro cyclohepta $-1, 3, 5$-triene readily forms white $AgCl$ ppt. When boiled with $AgNO_3$ solution but 5-chlorocyclopenta $-1, 3$-diene does not give reason. 2

(iv) Two dicarboxylic acids have the genral formula $COOH - CH = CH - COOH$. On treatment with cold dil. $KMnO_4$ solution, they yield two diastereomeric tartaric acids. Show how this information allows one to write the stereochemical formula for two acids. 4
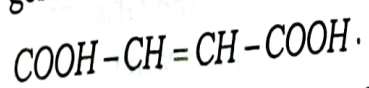
(f) (i) When an alkyl halide is converted to a Grignard reagent then the carbon atom linked to halogen atom changes its polarity. Justify this statement with an example.

3

(ii) Identify the product/products for the following reaction and offer explanation :

3
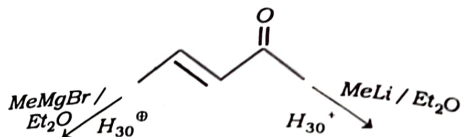
(iii) Write the Grignard reagent that is formed when
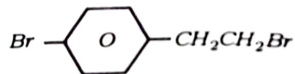
is treated with one mole of Mg in dry ether.

2

(iv) Why Clemmensen reduction of 4–methyl–5–hydroxyhexan–3–one to 3–methylhexan–2–ol cannot be carried out ?

2

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3 (Sem–3/CBCS) BOT HC 2

2023

BOTANY

(Honours Core)

Paper : BOT–HC–3026

(Economic Botany)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following : 1×7=7

    (a) Name the centre of origin of coffee.

    (b) What is sattu ?

    (c) What is retting ?

    (d) What is the importance of legumes in our meal ?

    (e) What type of fiber is cotton ?

(f) Name a drug obtained from opium poppy.

(g) Mention the use of bagasse.

2. Answer the following questions : 2×4=8

(a) Mention the uses of rice bran.

(b) What is crepe rubber?

(c) Differentiate green tea from black tea.

(d) Mention the health hazards of tobacco.

3. Answer *any three* of the following questions : 5×3=15

(a) Write a note on the role of legumes in eco-system.

(b) Mention the importance of germpasm diversity.

(c) Write a comparative account on fatty oils and essential oils.

(d) Write a note on habit-forming drugs.

(e) Mention the uses of teak and pine wood.

4. Answer the following questions : *(any three)* 10×3=30

(a) Describe the various centres of the origin of cultivated plants given by Vavilov.

(b) Give an account of millets cultivated in India.

(c) Give an account of morphology and processing of sugarcane mentioning the products and byproducts of sugarcane industry.

(d) Give an account of essential oils mentioning their sources and uses.

(e) Give an account of morphology, process of extraction and uses of jute.

(f) Give a general account of spices grown in India mentioning their economic importance and parts used.

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3 (Sem–3/CBCS) ZOO HC 2

2023

ZOOLOGY

(Honours Core)

Paper : ZOO–HC–3026

(Animal Physiology : Controlling and Coordinating Systems)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following/Choose the correct answer : 1×7=7

    (a) Transitional epithelium is found on

    (i) Stomach

    (ii) Lungs

    (iii) Liver

    (iv) Urinary bladder

(b) The synaptic vesicles at neuromuscular junction discharge

(i) Adrenaline

(ii) Epinephrine

(iii) Acetylcholine

(iv) None of the above

(c) A small band of dense, white and fibrous elastic tissue is grouped as

(i) Ligament

(ii) Muscle junction

(iii) Muscle filament

(iv) Muscle cartilage

(d) The longest bone in the body is

(i) Femur

(ii) Radius

(iii) Hip Bone

(iv) Ilium

(e) Which of the following tissue envelopes the bone ?

(i) Periosteum

(ii) Pericardium

(iii) Myocardium

(iv) None of the above

(f) Spongy bones do not have a haversian system. (True **or** False)

(g) Ovulation generally takes place at the _____ of a menstrual cycle.

(i) Day 12

(ii) Day 14

(iii) Day 16

(iv) Day 28

2. Answer the following questions : 2×4=8

(a) Mention the posterior pituitary hormones with their functions.

(b) What is tetanus ?

(c) Describe the structure of neuromuscular junction.

(d) What is bone arification ?

3. Answer the following questions : *(any three)* 5×3=15

(a) What is bone ? Describe different types of bones with example.

(b) Describe briefly the characteristics of muscle twitch.

(c) Describe the structure of thyroid gland with labelled diagram.

(d) What is Reflex action ? Describe with example.

(e) Classify epithelial tissue with example.

4. (a) Describe the structure of connective tissue with neat and labelled diagram.

7+3=10

Or

(b) What is nerve impulse ? Describe the process of nerve impulse conduction through unmyclinated nerve fibre.

2+8=10

5. (a) What is puberty ? Describe the role of hormones involved in puberty.

2+8=10

Or

(b) Describe the process of signal transduction for non-steroidal hormones.

10

6. (a) Describe the physiology of vision with neat and labelled diagram. 7+3=10

Or

(b) Describe the molecular and chemical basis of muscle contraction. 5+5=10

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3 (Sem–3/CBCS) PHY HC 2

2023

PHYSICS

(Honours Core)

Paper : PHY–HC–3026

(Thermal Physics)

Full Marks : 60

Time : Three hours

**The figures in the margin indicate
full marks for the questions.**

1. Answer the following questions :   1×7=7

    (a) What are intensive thermodynamic variables ?

    (b) Write the differential form of 1st law of thermodynamics.

    (c) What is the change in internal energy of a system over one complete cycle ?

    (d) Why the workdone in isochoric process is zero ?

    (e) State 3rd law of thermodynamics.

(f) Name the transport phenomenon present in gas that involves transfer of mass.

(g) How does mean free path of gas molecule change when temperature and pressure are doubled?

2. Answer the following questions : 2×4=8

(a) 'Work and heat are equivalent to each other' – Explain.

(b) Why efficiency of a Carnot engine cannot be 100%?

(c) Find the change in entropy when 10 gm of ice at 0°C is converted into water at the same temperature.

(d) If critical temperature of a gas is 300K, find its temperature of inversion.

3. Answer **any three** of the following : 5×3=15

(a) Derive an expression of work done in adiabatic process.

(b) Derive the expression of change in entropy of a perfect gas when its state changes from (T_1, P_1) to (T_2, P_2).

(c) Using laws of thermodynamics derive Maxwell's first thermodynamic relation.

(d) State law of equipartion of energy using this law find the expression of ratio between two specific heat of a gas in terms of degree of freedom. 1+4=5

(e) The molecular diameter of a gas molecule is $10^{-8}cm$. Calculate the mean free path at temperature 27°C and at pressure $10^5 dyne/cm^2$. [Boltzmann constant, $k=1·4×10^{-16} erg/K$]

4. Answer **any three** of the following : 10×3=30

(a) What is heat engine? Is Carnot engine a heat engine? Describe the four processes involved in a Carnot engine and hence derive the efficiency of the engine. 1+1+8=10

(b) Derive Clausius-Clapeyron equation from Maxwell's thermodynamic relation. Using this law explain the effect of pressure (i) on boiling point of liquid (ii) on melting point of solid. 6+2+2=10

(c) Derive the expression of average speed, r.m.s speed and most probable speed of gas molecules using Maxwell's velocity distribution law and hence find their ratio. 3+3+3+1=10

(d) Derive the relation, $\eta = \frac{1}{3}\rho\bar{c}\lambda$, where

$\eta \rightarrow$ coefficient of viscosity

$\rho \rightarrow$ density

$\bar{c} \rightarrow$ average velocity

$\lambda \rightarrow$ mean free path

(e) What is equation of state? Write the ideal gas equation. Explain the two correction introduced in ideal gas equation to derive van der Waals equation of state. On what factors do the van der Waals constant a and b depend?   1+1+6+2=10

(f) Write short notes on **any two** of the following :   5+5=10

(i) Reversible and irreversible process

(ii) Refrigerator and coefficient of performance

(iii) Gibbs potential

(iv) Joule-Thomson cooling

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3 (Sem–3/CBCS) MAT HC 2

2023

MATHEMATICS

(Honours Core)

Paper : MAT–HC–3026

(Group Theory–1)

Full Marks : 80

Time : Three hours

The figures in the margin indicate full marks for the questions.

1.   Answer the following questions as directed :
$$1 \times 10 = 10$$

(a)   Define order of an element of a group.

(b)   In the group Q^* of all non-zero rational numbers under multiplication, list the elements of $\left\langle \dfrac{1}{2} \right\rangle$.

(c)   Find elements A, B, C in D_4 such that $AB = BC$ but $A \neq C$.

(d) Define simple group.

(e) State Cauchy's theorem on finite Abelian group.

(f) State whether the following statement is true **or** false:

"If H is a subgroup of the group G and $a \in G$, then $Ha = \{ha : a \in G\}$ is also a subgroup of G."

(g) Write the order of the alternating group A_n of degree n.

(h) Give an example of an onto group homomorphism which is not an isomorphism.

(i) State whether the following statement is true **or** false :

"If the homomorphic image of a group is Abelian then the group itself is Abelian."

(j) Which of the following statement is true ?

(a) A homomorphism from a group to itself is called monomorphism.

(b) A one-to-one homomorphism is called epimorphism.

(c) An onto homomorphism is called endomorphism.

(d) None of the above

2. Answer the following questions : 2×5=10

(a) In D_3, find all elements X such that $X^3 = X$.

(b) Consider the group Z_2 under $+_2$ and Z_3 under $+_3$. List the elements of $Z_2 \oplus Z_3$ and find $|Z_2 \oplus Z_3|$.

(c) Express $\alpha = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 5 & 6 & 7 & 1 & 4 & 3 & 2 \end{pmatrix}$ as product of transposition and find its order.

(d) If $\psi : G \to G'$ is a group homomorphism and e and e' be the identity elements of the group G and G' respectively then show that $\psi(e) = e'$.

(e) Show that in a group G, if the map $f : G \to G'$ defined by $f(x) = x^{-1}$, $\forall x \in G$ is a homomorphism then G is Abelian.

3. Answer **any four** questions : 5×4=20

(a) Let G be a group and H be a non-empty finite subset of G. Prove that H is a subgroup of G if and only if H is closed under the operation in G.

(b) If a is an element of order n in a group and k is a positive integer then prove that
$$\langle a^k \rangle = \langle a^{\gcd(n,k)} \rangle \text{ and}$$
$$\left| a^k \right| = \frac{n}{\gcd(n,k)}.$$

(c) Show that a subgroup H of a group G is a normal subgroup of G if and only if product of two right cosets of H in G is again a right coset of H in G.

(d) If a, n are two integers such that $n \geq 1$ and $\gcd(a, n) = 1$, then prove that $a^{\phi(n)} \equiv 1 \pmod{n}$, where $\phi(n)$ is the Euler's phi function.

(e) Show that any finite cyclic group of order n is isomorphic to $\dfrac{\mathbb{Z}}{\langle n \rangle}$, where $\mathbb{Z}$ is the additive group of integers and $\langle n \rangle = \{0, n, 2n, \dots\}$.

(f) Let $\sigma : G \to \overline{G}$ be a group homomorphism and $a, b \in G$.

 (i) Show that
 $$\sigma(a) = \sigma(b) \Leftrightarrow a \ker \sigma = b \ker \sigma.$$

 (ii) If $\sigma(g) = g'$ then show that
 $$\sigma(g') = \{x \in G : \sigma(x) = g'\} = g \ker \sigma.$$
 2+3=5

Answer **either** (a) **or** (b) from the following questions : 10×4=40

4. (a) Describe the elements of D_4, the symmetries of a square. Write down a complete Cayley's table for D_4. Show that D_4 forms a group under composition of functions. Is D_4 an Abelian group? 2+3+4+1=10

 (b) Prove that every subgroup of a cyclic group is cyclic. Also show that if $|\langle a \rangle| = n$, then the order of any subgroup of $\langle a \rangle$ is a divisor of n.

 Moreover, show that the group $\langle a \rangle$ has exactly one subgroup $\left\langle a^{\frac{n}{k}} \right\rangle$ of order k.

 Find the subgroup of Z_{30} which is of order 3. 4+2+3+1=10

5. (a) Show that every quotient group of a cyclic group is cyclic. Give example to show that converse of this statement is not true in general. Find $\dfrac{\mathbb{Z}}{N}$ where $\mathbb{Z}$ is the additive group of integers and $N = \{5n : n \in \mathbb{Z}\}$. 4+3+3=10.

(b) (i) Show that every finite group can be represented as a permutation group. 7

(ii) Let $\phi : G \to \overline{G}$ be a group homomorphism and H be a subgroup of G. If $\overline{K}$ is a normal subgroup of $\overline{G}$ then show that $\phi^{-1}[\overline{K}] = \{k \in G : \phi(k) \in \overline{K}\}$ is a normal subgroup of G. 3

6. (a) (i) State and prove Lagrange's theorem for the order of subgroup of a finite group. Is the converse true? Justify your answer. 1+5+1=7

(ii) List the elements of $\dfrac{\mathbb{Z}}{4\mathbb{Z}}$ and construct a Cayley's table for it. 3

(b) (i) Show that any two disjoint cycles commute. 5

(ii) Let G be a group and $Z(G)$ be the center of G. If $\dfrac{G}{Z(G)}$ is cyclic then show that G is Abelian. 5

7. (a) Let G be a group and H be any subgroup of G. If N is any normal subgroup of G, then show that :

(i) $H \cap N$ is a normal subgroup of H.

(ii) N is a normal subgroup of HN.

(iii) $\dfrac{HN}{N} \cong \dfrac{H}{H \cap N}$.

2+2+6=10

Contd.

(b) Let $f : G \to G'$ be an onto group homomorphism and H be a subgroup of G, H' a subgroup of G'. Prove that :

(i) $f[H]$ is a subgroup of G'.

(ii) $f^{-1}[H']$ is a subgroup of G containing $K = \ker f$, where

$$f^{-1}[H'] = \{x \in G : f(x) \in H'\}.$$

(iii) There exists a one-to-one correspondence between the set of subgroups of G containing K and set of subgroups of G'.

2+3+5=10

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3 (Sem–3/CBCS) BOT HG 1/2/RC

2023

BOTANY

(Honours Generic/Regular)

Answer the Questions from any one Option.

OPTION – A

For Honours Generic/Regular

Paper : BOT–HG–3016/RC–3016

(Plant Physiology and Metabolism)

OPTION – B

For Honours Generic

Paper : BOT–HG–3026

(Environmental Biotechnology)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer **either** in English **or** in Assamese.