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2 SEM TDC MTMH (CBCS) C 3

2023

(May/June)

MATHEMATICS

(Core)

Paper : C–3

(Real Analysis)

Full Marks : 80
Pass Marks : 32

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* If $a \neq 0,\ b \neq 0,$ then show that

$$\frac{1}{(ab)} = \left(\frac{1}{a}\right)\left(\frac{1}{b}\right),\ a, b \in \mathbb{R}$$ 3

(b) Prove that, if x is a rational number and y is an irrational number, then $x+y$ is an irrational number. 3

(c) If $f(x) = \dfrac{2x^2 + 3x + 1}{2x - 1}$ for $2 \le x \le 3$, find a constant M such that $|f(x)| \le M$ for all x satisfying $2 \le x \le 3$. 3

(d) State the supremum property of real numbers $\mathbb{R}$. 1

(e) If $S = \left\{1 - \dfrac{(-1)^n}{n};\ n \in \mathbb{N}\right\}$, then find inf S and sup S. 4

Or

Let S be a non-empty bounded set in $\mathbb{R}$. Let $a < 0$ and $aS = \{as : s \in S\}$. Prove that

$$\inf(aS) = a \sup S,\ \sup(aS) = a \inf S$$

(f) Prove that an upper bound u of a non-empty set S in $\mathbb{R}$ is the supremum of S if and only if for every $\varepsilon > 0$ there exists an $s_\varepsilon \in S$ such that $u - \varepsilon < s_\varepsilon$. 3

(g) If x and y are any real numbers with $x < y$, then prove that there exists a rational number $r \in Q$ such that $x < r < y$. 3

(h) Prove that the set $\mathbb{R}$ of real numbers is not countable. 5

Or

If $I_n = [a_n, b_n]$, $n \in \mathbb{N}$ is a nested sequence of closed, bounded intervals such that the lengths $b_n - a_n$ of I_n satisfy $\inf\{b_n - a_n : n \in \mathbb{N}\} = 0$, then prove that the number ξ contained in I_n, $\forall\ n \in \mathbb{N}$ is unique.

(i) Show that if $a, b \in \mathbb{R}$ and $a \ne b$, then there exists ε-neighbourhoods U of a and V of b such that $U \cap V = \phi$. 5

Or

Prove that there does not exist a rational number r such that $r^2 = 2$.

2. (a) Define range of a real sequence. 1

(b) Write the limit point of the sequence (S_n), where

$$S_n = (-1)^n \left(1 + \frac{1}{n}\right),\ n \in \mathbb{N}$$ 2

(c) Every convergent sequence is bounded. Is the converse true? Justify. 1+2=3

(d) Prove that every bounded sequence has a limit point. 4

Or

Prove that $\lim_{n\to\infty}\left(\frac{1}{1+na}\right)=0,\ a>0.$

(e) Let the sequence $X=(x_n)$ converge to x. Prove that the sequence $(|x_n|)$ of absolute values converges to $|x|$. 4

(f) Define subsequence of a sequence of real numbers. 2

(g) If a sequence $X=(x_n)$ of real numbers converges to x, then prove that any subsequence $X'=(x_{n_k})$ of X also converges to x. 4

(h) Show that the sequence (e_n), where

$$e_n=\left(1+\frac{1}{n}\right)^n,\ n\in\mathbb{N}$$

is convergent. 5

Or

State and prove Bolzano-Weierstrass theorem.

(i) Show that the sequence (x_n), where

$$x_n=\frac{1}{1!}+\frac{1}{2!}+\frac{1}{3!}+\cdots+\frac{1}{n!},\ n\in\mathbb{N}$$

is convergent. 5

Or

Show that the sequence (x_n), where

$$x_n=1+\frac{1}{2}+\frac{1}{3}+\cdots+\frac{1}{n}$$

cannot converge.

3. (a) State the necessary condition for convergence of an infinite series. 1

(b) State True or False : 1

In convergent series, brackets may be inserted at will without affecting convergence but may not be removed.

(c) Discuss the convergence of a geometric series. 4

Or

Investigate the behaviour of the series whose nth term is $\sin\left(\frac{1}{n}\right)$.

(d) Prove that the p-series $\sum_{n=1}^{\infty} \frac{1}{n^p}$ converges when $p > 1$ and diverges when $0 < p \leq 1$. 4

Or

Establish the convergence or divergence of the infinite series whose nth term is

$$\{(n^3+1)^{1/3} - n\}$$

(e) Define alternating series and conditionally convergent series. 2

(f) State the conditions of Leibnitz test. 2

(g) Test the convergence of the following (any *two*) : 3×2=6

(i) $\frac{1\cdot 2}{3^2\cdot 4^2} + \frac{3\cdot 4}{5^2\cdot 6^2} + \frac{5\cdot 6}{7^2\cdot 8^2} + \cdots$

(ii) $\frac{1}{1+2} + \frac{2}{1+2^2} + \frac{3}{1+2^3} + \cdots$

(iii) $1 + \frac{4}{2!} + \frac{4^2}{3!} + \frac{4^3}{4!} + \cdots$

(iv) $\frac{1}{x} + \frac{1}{x-1} + \frac{1}{x+1} + \frac{1}{x-2} + \frac{1}{x+2} \cdots$, x being a positive fraction.

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2 SEM TDC MTMH (CBCS) C 4

2023

(May/June)

MATHEMATICS

(Core)

Paper : C–4

(Differential Equations)

Full Marks : 60
Pass Marks : 24

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* Write one example where mathematical model can be used. 1

(b) Write the order of the differential equation

$$\frac{d^2y}{dx^2}+\left(\frac{dy}{dx}\right)^3+y=x^4$$ 1

(c) Classify the differential equation

$$\frac{d^2y}{dx^2} + 7\frac{dy}{dx} + 2y^3 = x$$

as linear or non-linear. 1

(d) If for the equation $\frac{dy}{dx} = x$, $y(1) = 2$, then find the value of $y(2)$. 2

(e) Justify that for real values of x, function defined by $y = f(x) = 2\sin x + 3\cos x$ is an explicit solution of the differential equation

$$\frac{d^2y}{dx^2} + y = 0$$ 4

Or

Show that $\frac{dy}{dx} = 3x^2$ has an infinite family of functions as solutions.

(f) Solve (any *two*) : 3×2=6

(i) $\frac{dy}{dx} + 3y = 3x^2e^{-3x}$

(ii) $(3x + 2y)dx + (2x + y)dy = 0$

(iii) $x\frac{dy}{dx} - 2y = 2x^4$

(iv) $(x + y)\,dx - x\,dy = 0$

2. (a) State balance law of modelling. 1

(b) Write one example of applying compartmental notion in modelling. 1

(c) Write the word equation of modelling in births and deaths in a population. 2

(d) Draw the input-output compartmental diagram for drug assimilation model. 2

(e) Derive the differential equation for radioactive decay. 4

Or

Describe lake pollution model.

3. (a) Write when

$$a(x)\frac{d^2y}{dx^2} + b(x)\frac{dy}{dx} + c(x)y = f(x)$$

will become a homogeneous equation. 1

(b) Write when the solution of an nth order homogeneous linear differential equation will have a trivial solution. 1

(c) Write the number of arbitrary constants appearing in the solution of a third-order ordinary differential equation. 1

(d) Show that e^{-x}, e^{3x}, e^{4x} are linearly independent solutions of

$$\frac{d^3y}{dx^3} - 6\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 12y = 0$$ 4

Or

Solve :

$$\frac{d^2y}{dx^2} + 9y = 0$$

(e) Solve (any *one*) : 5

(i) $\frac{d^3y}{dx^3} - 3\frac{d^2y}{dx^2} + 4y = 4e^x$

(ii) $\frac{d^3y}{dx^3} - 5\frac{d^2y}{dx^2} + 7\frac{dy}{dx} - 2y = e^{2x}\cosh x$

4. (a) Justify that the solution of

$$\frac{d^2y}{dx^2} + 2x\frac{dy}{dx} + x^2y = e^{2x}$$

exists and unique for all $x \in R$. 2

(b) Solve (any *one*) : 5

(i) $\frac{d^2y}{dx^2} - y = x^2\cos x$

(ii) $\frac{d^4y}{dx^4} + 2\frac{d^2y}{dx^2} + y = x^2\cos^2 x$

(c) Solve by using the method of variation of parameters (any *one*) : 6

(i) $\frac{d^2y}{dx^2} + y = x$

(ii) $\frac{d^2y}{dx^2} + n^2y = \sec nx$

5. (a) Define equilibrium point in phase plane. 2

(b) Answer any *two* from the following questions : 4×2=8

(i) Write about interpretation of the phase plane.

(ii) Formulate the differential equation to study outbreak of cholera.

(iii) Write the assumptions considered in predator-prey model.

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Total No. of Printed Pages—3

2 SEM TDC BOTH (CBCS) C 3

2023

(May/June)

BOTANY

(Core)

Paper : C–3

(Mycology and Phytopathology)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* Choose and write the correct answer of the following : 1×3=3

(i) Motile spores are present in Puccinia / Synchytrium / Rhizopus / Penicillium.

(ii) Clamp formation is seen in Chytridiomycotina / Ascomycotina / Basidiomycotina / Deuteromycotina.

(iii) Which of these is a bacterial disease that affects the plants?
Crown gall / Mosaic / Smut / Blisters

(b) Fill in the blanks of the following : 1×2=2

(i) The plant diseases which spread widely but occur periodically are called _____.

(ii) Any organism capable of producing a disease is called _____.

2. Write short notes on any *three* of the following : 4×3=12

(a) Conidiophore and conidia of Penicillium

(b) Role of fungi in biotechnology

(c) Types of fruiting body in slime moulds

(d) Pathogenesis

(e) Fungi in pharmaceutical preparations

3. Describe the mode of nutrition in fungi. Give a brief account of the classification of fungi that you have studied. 5+7=12

Or

Describe the life-history of an edible fungus that you have studied. State its economic importance. 8+4=12

4. Write about the symbiotic association in lichen. Mention the economic and ecological importance of lichen. 6+3+3=12

Or

Write the role of fungi as biocontrol agents. Explain the significance of neurospora as genetic research tool. 7+5=12

5. Mention the symptoms, names of the causal organism, disease cycle and control measures of the diseases (any *two*) : (1+1+2+2)×2=12

(a) Citrus canker

(b) Tobacco mosaic viruses

(c) Early blight of potato

(d) Black stem rust of wheat

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Total No. of Printed Pages—3

2 SEM TDC BOTH (CBCS) C 4

2023

(May/June)

BOTANY

(Core)

Paper : C–4

(Archegoniate)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Fill in the blanks : 1×5=5

(a) The lid like structure found over moss capsule is called _____.

(b) The gametophyte of fern is commonly known as _____.

(c) Generally the xylem of gymnosperms lacks _____ tissue.

(d) Formation of gametophyte from sporophyte without spore formation is called _____.

(e) Non-vascular land plants appeared in _____ period.

2. Write short notes on any *three* of the following : 4×3=12

(a) Adaptive characters of archegoniate to survive on land

(b) Range of thallus organization in Bryophytes

(c) "Ginkgo is a living fossil." Justify the statement.

(d) Describe the process of fossilization.

3. With suitable sketch describes the evolution of sporophytes in bryophytes. Which one is most primitive according to your opinion? 7+3+2=12

Or

Describe any *two* of the following : 6×2=12

(a) Antheridiophore and Archegoniophore

(b) Characteristic features of class Hepaticopsida and Bryopsida

(c) Economic importance of bryophytes

4. Distinguish between homospory and heterospory. Describe the heterospory nature of *Selaginella* with suitable diagram. Mention the significance of heterospory in seed habit. 2+7+3=12

Or

Write notes on the following : 6×2=12

(a) Spore producing organs of *Equisetum* and *Ophioglossum*

(b) Prothallus of *Lycopodium* with suitable diagram.

5. Write short notes on any *three* of the following : 4×3=12

(a) Xerophytic characters of gymnosperms

(b) Female cone of *Pinus*

(c) Normal roots and coralloid roots of *Cycas*

(d) Spore bearing organs of *Psilophyton* and *Rhynia*

(e) Economic importance of *Ginkgo*

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2 SEM TDC PHYH (CBCS) C 3

2023

(May/June)

PHYSICS

(Core)

Paper : C–3

(Electricity and Magnetism)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option from the following : 1×5=5

(a) Electric field lines and equipotential lines are

(i) always orthogonal

(ii) orthogonal only when electric field is uniform

(iii) orthogonal only when potential does not change

(iv) None of the above

(b) If the free space between two plates of a capacitor is filled with dielectrics, then its capacitance will

(i) increase

(ii) decrease

(iii) not change

(iv) zero

(c) Choose the correct option :

(i) $\overline{\nabla} \times \overline{B} = 0$

(ii) $\overline{\nabla} \cdot \overline{A} = B$

(iii) $\overline{\nabla} \times \overline{B} = \mu J$

(iv) $\overline{\nabla} \times \overline{H} = \mu J$

(d) According to Faraday's law the e.m.f. is induced in the coil when

(i) the coil is stationary and flux is changing with time

(ii) the coil is moving and flux is changing with time

(iii) Both (i) and (ii)

(iv) None of the above

(e) In parallel resonance circuit, impedance at resonance is

(i) minimum

(ii) maximum

(iii) equal to difference of inductive and capacitive impedances

(iv) None of the above

2. (a) What is meant by electric flux? Give its SI unit. 2

(b) By applying Gauss theorem, find the electric field due to a uniformly charged thin spherical shell at an external point. 3

(c) Obtain the expression for the potential due to an electric dipole. Show that electrical potential at any point on the equatorial line of a dipole is zero. 3+1=4

3. (a) What do you mean by electrical potential energy of a system of charges? Derive an expression for it and show that energy density is given by

$$U = \frac{\varepsilon_0}{2} E^2$$

1+3=4

(b) The capacitance of a parallel-plate capacitor is 400 picofarad and the plates are separated by 2 mm of air. What will be the energy when it is charged to 1500 V? What will be the potential difference with the same charge if plate separation is doubled? 4

Or

Find the expression for the capacitance per unit length of capacitor consisting of two coaxial cylinders.

4. (a) Explain the term 'dielectric constant'. 1

(b) What do you understand by the polarization of dielectric? Define electric polarization vector. 1+1=2

(c) Define displacement vector (D). State the Gauss theorem in dielectric medium. 1+2=3

5. (a) State Ampere's circuital law and apply it to find the magnetic field at the centre of a long current-carrying solenoid. 1+3=4

(b) Calculate the magnetic force between two long straight current-carrying wires when currents are flowing in opposite direction. 3

Or

A wire of length 44 cm carries a current of 10 A is bent into a square. Find the magnitude of the magnetic field at the centre.

6. What do you mean by magnetic susceptibility (χ) and magnetic permeability (μ)? Derive the relation between them. 2+2=4

7. (a) State Lenz's law. Explain how Lenz's law establishes the law of conservation of energy. 1+1=2

Or

An e.m.f. of 250 V is applied to an inductor of 10 H. It has a resistance of 50 Ω. If the current attains the maximum value, then find the energy stored in the inductance. 2

(b) Calculate the mutual inductance of two concentric solenoids. 3

8. *(a)* Find the expression for current of an a.c. circuit containing L, C and R in series connected with a complex a.c. voltage. Under what condition, electrical resonance will occur? 3

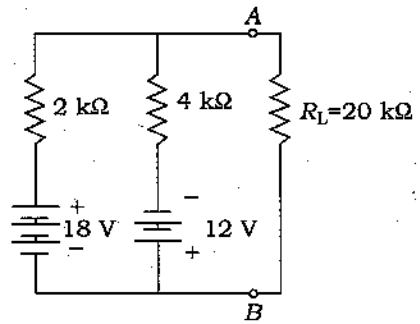
Or

A series L-C-R circuit has $L = 0{\cdot}12$ H, $C = 480$ nF and $R = 23$ ohm and is connected to an alternating 230 volt supply. Calculate the resonance frequency and maximum current, maximum power absorbed and Q-factor of the circuit.

(b) State and explain superposition theorem. To which type of system, is the superposition theorem valid? 2+1=3

Or

Using Thevenin's theorem, calculate V_{TH}, R_{TH} and current through the load $R_L = 20$ kΩ for the following circuit :



(Continued)

9. Derive a relation between the charge passing through a ballistic galvanometer and its corresponding throw. 3

Or

What is critical damping resistor in a ballistic galvanometer? How is a ballistic galvanometer made dead beat?

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2 SEM TDC PHYH (CBCS) C 4

2023

(May/June)

PHYSICS

(Core)

Paper : C–4

(Waves and Optics)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option from the following : 1×5=5

(a) The resultant amplitude due to superposition of harmonic waves expressed by $y = a\sin(\omega t - kx)$ and $y = a\cos(kx - \omega t)$ will be

(i) 0

(ii) a

(iii) $\sqrt{2}a$

(iv) $2a$

(b) Two periodic waves of amplitudes a and b pass through a region at the same time in the same direction. If $a > b$, then the difference in the maximum and minimum possible amplitudes is

(i) $a+b$ (ii) $a-b$

(iii) $2a$ (iv) $2b$

(c) The relation between path difference x and phase difference ϕ is

(i) $\phi = 2\pi\lambda x$

(ii) $\phi = \frac{2\pi}{\lambda} x$

(iii) $\phi = \frac{2\pi}{x\lambda}$

(iv) None of the above

(d) In Young's double-slit experiment with slit separation d, a monochromatic light of wavelength λ is used. The angular separation of the fringes is

(i) $\frac{d}{\lambda}$ (ii) $\frac{\lambda}{d}$

(iii) $\frac{2\lambda}{d}$ (iv) $\frac{\lambda}{2d}$

(e) If monochromatic light in Young's double-slit experiment is replaced by white light, then

(i) no fringes are observed

(ii) all bright fringes are white

(iii) all bright fringes are coloured but central fringe is white

(iv) None of the above

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

(a) Distinguish between wave velocity and group velocity.

(b) How many beats per second will be heard if two sources of frequencies 512 Hz and 516 Hz are sounded simultaneously? What will be the time interval between the sounds of successive maximum intensity? 1+1=2

(c) Describe the principle of holography in brief.

(d) What are Haidinger's and Fizeau's fringes?

(e) Describe the term 'Rayleigh's criterion' in connection with resolution of images.

3. Answer any *five* of the following : 6×5=30

(a) What are Lissajous figures? A point moving on a plane is subjected to simple harmonic motions perpendicular to each other given by $x = A\cos\omega t$ and $y = B\cos(\omega t + \phi)$. Show that the general motion of the point is in an elliptical path. Under what condition will it move in a circular path? 1+3+2=6

(b) Discuss the variation of speed of sound with pressure, temperature and humidity. The ratios of specific heats of H_2 and CO_2 are respectively 1·4 and 1·3. Compare the velocities of sound in hydrogen (H_2) and carbon dioxide (CO_2). 3+3=6

(c) Describe how refractive index of a liquid can be found by Newton's rings method. Newton's rings are formed with reflected light of wavelength 5095 Å with a liquid inserted between the lower surface of the planoconvex lens and upper surface of the plane glass plate. The diameter of the 5th bright ring is 0·3 cm and the radius of curvature of the planoconvex lens is 1 m. Calculate the refractive index of the liquid. 3+3=6

(Continued)

(d) What is an interferometer? What is sharpness of fringes? What is the advantage of using a Fabry-Perot interferometer over a Michelson's interferometer? Write down the expression for resolving power of a Fabry-Perot interferometer. 1+2+2+1=6

(e) Derive an expression for intensity in single-slit Fraunhofer's diffraction. Show that the intensity of diffraction maxima decreases with order number. 3+3=6

(f) Describe Huygens construction of half-period zone on a plane wavefront. Show that the area of each half-period zone is approximately equal. 3+3=6

4. Write short notes on (any *two*) : 4×2=8

(a) Newton's formula for velocity of sound

(b) Fresnel's biprism

(c) Missing orders in double-slit Fraunhofer's diffraction

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Total No. of Printed Pages—8

2 SEM TDC CHMH (CBCS) C 3

2023

(May/June)

CHEMISTRY

(Core)

Paper : C–3

(Organic Chemistry)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer from the following : 1×5=5

(a) Which is the most stable carbocation among the following?

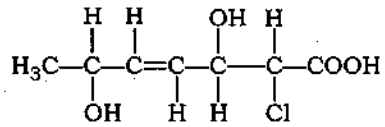
(i)

(ii) 

(iii)

(iv) 

(b) How many chiral carbons are present in the given molecule?



(i) 1

(ii) 2

(iii) 3

(iv) None of the above

(c) The reagent used in Corey-House synthesis is

(i) R_2CuLi

(ii) Li_2CuCl_4

(iii) RCuLi

(iv) R_2CuLi_2

(d) According to Baeyer's strain theory, cyclopentane is most stable cyclic compound because its bond angles are close to

(i) octahedral

(ii) tetrahedral

(iii) pentahedral

(iv) None of the above

(e) Which one of the following does not give isopropylbenzene as a product upon reaction with benzene?

(i) $(CH_3)_2CHCl/AlCl_3$

(ii) $CH_3CH_2CH_2Cl/AlCl_3$

(iii) $CH_3CH{=}CH_2/H_3PO_4$

(iv) $(CH_3)_2C{=}CH_2/H_3PO_4$

UNIT—I

2. Answer the following questions : 2×3=6

(a) Define electrophilic reagent and nucleophilic reagent. Select the electrophilic and nucleophilic reagent from the following :

H_3O^+, H_2O, BF_3, CH_3OH

(b) Benzyl carbocation is more stable than propyl carbocation. Explain.

Or

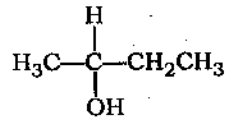
CO_2 is a non-polar molecule but SO_2 is a polar molecule. Explain.

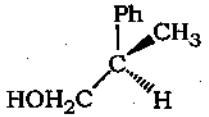
(c) Draw the energy profile diagram for a two-step endothermic reaction in which second step is the rate determining step.

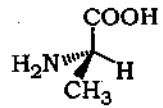
UNIT—II

3. Answer the following questions : 2×6=12

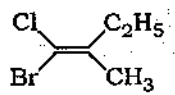
(a) Specify the following stereoisomers as *R* and *S* (any *two*) : 1×2=2

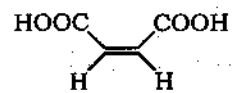
(i) 

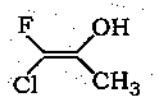
(ii) 

(iii) 

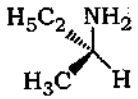
(b) Specify the following geometrical isomers as *E* and *Z* (any *two*) : 1×2=2

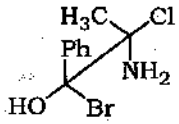
(i) 

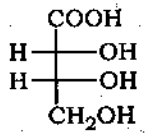
(ii) 

(iii) 

(c) Interconvert the following projections as directed (any *two*) : 1×2=2

(i)  to Fischer projection

(ii)  Sawhorse to Newman to Fischer

(iii)  Fischer to Newman to Sawhorse

(d) Explain why racemic tartaric acid can be resolved but not *meso*-tartaric acid. Give the chemical method of resolution. 2

(e) A 1·5 g of organic compound was dissolved in 10 ml of alcohol and placed the sample cell of 5 cm path length. The observed rotation of sodium *D*-line was 1·21°. Calculate the specific rotation of the compound. 2

(f) Describe the necessary conditions for a molecule to exhibit optical isomerism. 2

UNIT—III

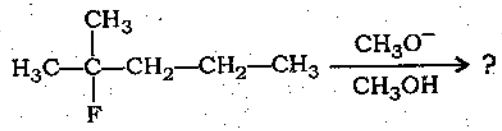
4. Answer the following questions :

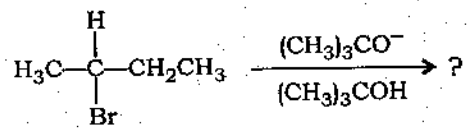
(a) Prepare toluene with the help of Wurtz-Fittig reaction. 2

(b) Give the mechanism of chlorination of methane. 2

(c) State Markovnikov's rule and explain the mechanism of addition of HBr to propene in the presence of peroxide. 1+2=3

(d) Write the product(s) of the following elimination reactions : 1½×2=3

(i) 

(ii) 

(e) Which dienophile is more reactive in Diels-Alder reaction? 2

$CH_2{=}CHCHO$ *or* $CH_2{=}CHCH_2CHO$

(f) What happens when 1,3-butadiene is treated with HBr? 2

(g) How will you distinguish between 1-butyne and 2-butyne? 2

Or

Illustrate the mechanism of hydro-boration-oxidation reaction.

UNIT—IV

5. *(a)* According to Baeyer's angle strain theory, cyclopentane is more stable than cyclohexane but practically cyclo-hexane is more stable. Explain. 2

(b) Draw the different conformations of *n*-butane (Newman projection formula) and show which one is most stable. 2

(c) How will you synthesize cyclopentane from diethyl adipate? 2

(d) Draw the energy profile diagram for the conformations of cyclohexane. 2

Or

Chair conformation of cyclohexane is more stable than boat conformation. Explain.

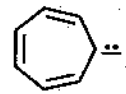
UNIT—V

6. *(a)* Which of the following compounds are aromatic, anti-aromatic and non-aromatic? 2

(i) 

(ii) 

(iii) 

(iv) 

(b) Discuss the mechanism of sulphonation of benzene. 2

(c) Explain why nitration of chlorobenzene gives *ortho*- and *para*-chloronitrobenzene but the chlorination of nitrobenzene gives *meta*-chlorobenzene. 2

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2 SEM TDC CHMH (CBCS) C 4

2023

(May/June)

CHEMISTRY

(Core)

Paper : C–4

(Physical Chemistry—II)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer : 1×6=6

(a) Which of the following is an intensive property?

(i) Internal energy

(ii) Enthalpy

(iii) Entropy

(iv) Temperature

(b) One mole of methane gas is formed from its constituents at temperature T. The difference between the heats of reaction at constant pressure and at constant volume is

(i) $-RT$

(ii) RT

(iii) $2RT$

(iv) 0

(c) One molal solution of a non-electrolyte boils at 100·51 °C, while pure water boils at 100 °C. Ebullioscopic constant K_b is

(i) 100·51 K kg mol^{-1}

(ii) 0·51 K kg mol^{-1}

(iii) 1·02 K kg mol^{-1}

(iv) 0·51 K mol kg^{-1}

(d) Chemical potential is

(i) partial molar enthalpy

(ii) partial molar volume

(iii) partial molar free energy

(iv) partial molar internal energy

(e) For a hypothetical gaseous reaction

$$2A(g) + B(g) \rightleftharpoons 3C(g) + D(g)$$

(i) $K_p = K_c RT$

(ii) $K_p = K_c (RT)^2$

(iii) $K_p = K_c$

(iv) $K_c = 1 / K_p$

(f) At constant temperature, the decrease in Helmholtz free energy is equal to the

(i) reversible work done by the system

(ii) irreversible work done by the system

(iii) total work done minus pressure-volume work in a reversible manner

(iv) decrease in entropy

2. Answer any *six* questions from the following : 2×6=12

(a) Explain why equimolar solutions of NaCl and glucose are not isotonic.

(b) Deduce a relation between k_1 and k_2 for the following equilibrium :

$$A_2 + B_2 \underset{}{\overset{k_1}{\rightleftharpoons}} 2AB$$

$$AB \xrightarrow{k_2} \frac{1}{2} A_2 + \frac{1}{2} B_2$$

(c) Explain the physical significance of chemical potential.

(d) Prove that Joule-Thomson effect is isoenthalpic in nature.

(e) State and explain Hess's law of constant heat summation.

(f) Calculate the entropy change for the melting of 1 mole of ice at 0 °C. Given that $\Delta H_{fus\ (ice)} = 334 \cdot 72\ J\ g^{-1}$.

(g) State and explain the third law of thermodynamics.

UNIT—I

Answer any *two* questions from the following : 8×2=16

3. (a) Define heat capacity of a substance. Explain why heat capacities are different at constant volume and at constant pressure. Show that for one mole of an ideal gas $C_P - C_V = R$. 1+1½+3½=6

(b) For reactions involving condensed phases, show that $\Delta H = \Delta E$. 2

4. (a) How are the pressure and volume related to each other during the adiabatic expansion of an ideal gas? Deduce the relation. 2½

(b) Deduce an expression for the entropy changes associated with the changes in temperature and volume of an ideal gas. 3½

(c) One mole of an ideal gas at 300 K expands reversibly and isothermally from $4 \times 10^{-2}\ m^3$ to $8 \times 10^{-2}\ m^3$. Calculate the entropy change for the gas. 2

5. (a) Write the physical significance of Helmholtz free energy and Gibbs free energy. 2

(b) Deduce an expression showing the variation of Helmholtz free energy with volume at constant temperature for an ideal gas. 2½

(c) Deduce the following relation : 2

$$\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$$

(d) For a reaction, ΔH and ΔS values are $4 \cdot 4\ kJ\ mol^{-1}$ and $400\ J\ mol^{-1}$, respectively. Calculate the temperature at which the reaction will be in equilibrium. 1½

UNIT—II

6. Answer *either (a) or (b)* : 3

(a) For a system of ideal gases, prove the relation

$$\mu_i = \mu_i^0 + RT \ln p_i \qquad 3$$

(b) Define partial molar quantity. Deduce the expression for variation of chemical potential with temperature. 1+2=3

UNIT—III

7. Answer any *two* questions from the following : 4×2=8

(a) Discuss any one characteristic of chemical equilibrium. Deduce the relationship between standard Gibbs free energy change and the equilibrium constant of a reaction. 1+3=4

(b) Find the value of Gibbs free energy change for mixing of ideal gases and prove that it is a spontaneous process. 4

(c) *(i)* Find the relation between K_p and K_c for the following equilibrium : 2½

$$aA + bB \rightleftharpoons cC + dD$$

(ii) Calculate K_c for the reaction—

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$$

for which $K_p = 3{\cdot}5 \times 10^{-25}$ at 27 °C. 1½

(Continued)

UNIT—IV

8. Answer any *two* questions from the following : 4×2=8

(a) What is depression in freezing point? Derive a relation between depression in freezing point and molecular weight of the solute. 1+3=4

(b) What is osmotic pressure? Derive the relation between osmotic pressure and concentration of a solution having non-volatile solute. 1+3=4

(c) Define molal elevation constant. What is van't Hoff factor? The boiling point of 5% (w/w) of non-volatile solute in water is 100·45 °C. Calculate the molecular mass of the solute. 1+1+2=4

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Total No. of Printed Pages—3

2 SEM TDC ZOOH (CBCS) C 3

2023

(May/June)

ZOOLOGY

(Core)

Paper : C–3

(Non-Chordates–II)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Fill in the blanks : 1×6=6

(a) True coelom is originated from _____.

(b) Septal nephridia in Annelida are _____.

(c) The compound eyes of Arthropoda consist of thousands of _____.

(d) Ecdysone is secreted by _____ gland.

(e) Onychophora is the connecting link between Annelida and _____.

(f) Starfish moves with the help of _____.

2. Write short notes on (any *three*) : 4×3=12

(a) Annelidan characters of Peripatus

(b) Classification of Annelida

(c) Morphological and functional variation in different castes of bees

(d) Water vascular system in Asteroidea

3. Distinguish between (any *four*) : 3×4=12

(a) Enterocoel theory and Nephrocoel theory

(b) Larval form in Holothuroidea and Larval form in Asteroidea

(c) Pharyngeal nephridia and Septal nephridia in Annelida

(d) Quasi-social insects and Semi-social insects

(e) Aquatic respiration and Aerial respiration of *Pila globosa*

(f) Social life in Bees and Termites

4. Describe torsion of Gastropoda with proper diagrams. 5

Or

Describe briefly the reproductive system of Peripatus. 5

5. What is pearl? Write its chemical and physical nature. Describe the process of pearl formation. 1+3+3=7

Or

Classify the phylum Mollusca up to class with characters and examples. 7

6. Describe, with diagram, the structural and functional peculiarities of urinogenital system in Hirudinaria. 5

Or

Write about evolution of coelom and metamerism in Annelida. 5

7. Write a note on evolutionary significance of trochophore larva. 6

Or

Describe the affinities of Echinodermata with Chordates. 6

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Total No. of Printed Pages—4

2 SEM TDC ZOOH (CBCS) C 4

2023

(May/June)

ZOOLOGY

(Core)

Paper : C–4

(Cell Biology)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer of the following : 1×5=5

(a) During mitosis, ER and nucleolus begin to disappear at

(i) late prophase

(ii) early metaphase

(iii) late metaphase

(iv) early prophase

(b) Which one among the following lipids is not found in the plasma membrane?

(i) Phosphoglyceride

(ii) Sphingolipid

(iii) Phytanic acid

(iv) Cholesterol

(c) Which of the following is not a function of cytoskeleton in a cell?

(i) Intracellular transport

(ii) Maintenance of cell shape and structure

(iii) Support of the organelle

(iv) Cell motility

(d) The largest family of cell surface receptors that transmit signals to intracellular targets is

(i) hormone

(ii) enzyme

(iii) G-protein

(iv) All of the above

(e) The site of aerobic respiration in eukaryotic cells is

(i) peroxisome

(ii) plastid

(iii) mitochondria

(iv) cilia

2. Distinguish between (any *two*) : 3×2=6

(a) Aerobic and Anaerobic respiration

(b) Tight junctions and Gap junctions

(c) Active and Passive transport

(d) G-protein and G-protein coupled receptors

3. Write short notes on (any *two*) : 3×2=6

(a) Nuclear envelope

(b) Second messengers

(c) Actin and myosin proteins

(d) Mitochondrial DNA

4. Describe different steps of electron transport system with diagrams. 6+2=8

Or

Write the different stages of meiosis with necessary diagrams. 5+3=8

5. What is cell signalling? Describe the structure of G-protein coupled receptor. 2+5=7

Or

What is nucleosome? Mention its importance in DNA packaging. 2+5=7

6. Discuss the structure and function of microtubules. 4+4=8

Or

Write the structure and function of lysosomes. 4+4=8

7. What is cell cycle? Explain the regulation of cell cycle in eukaryotes. 1+7=8

Or

What is facilitated transport? Explain how molecules/substances are transported across the cell membrane with suitable diagram through facilitated diffusion. 2+6=8

8. Write an account on fluid mosaic model of plasma membrane. 5

Or

State and explain endosymbiotic hypothesis. 5

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