Total No. of Printed Pages—4

**1 SEM TDC MTMH (CBCS) C 1**

**2022**

( Nov/Dec )

MATHEMATICS

( Core )

Paper : C–1

**( Calculus )**

*Full Marks* : 60

*Pass Marks* : 24

*Time* : 3 hours

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

**1.** *(a)* Write the value of $\frac{d}{dx}\tanh x$. 1

*(b)* Write the curve on which the point $(\cosh x, \sinh x)$ lies. 1

*(c)* Write the interval on which 'secant' is one-to-one. 1

*(d)* Find $y_n$, if $y = \sin 5x \cos 2x$. 2

*(e)* Find $y_n$, if $y = x^3 \sin x$. 3

*(f)* Sketch the general shape of the graph of $y = f(x)$, where $\frac{dy}{dx} = 2 + x - x^2$. 3

(g) Find $y_n$, if $y = e^{ax+b} \sin x$. 4

*Or*

Evaluate $\lim_{x \to 0} \frac{\tan x - x}{x - \sin x}$.

(h) Find the asymptotes of the curve

$$y^2 - x^2 - 2x - 2y - 3 = 0$$ 5

*Or*

For the curve $y = x + \sin 2x$, $-\frac{2\pi}{3} \le x \le \frac{2\pi}{3}$, find the local maximum, local minimum and the interval on which the curve is concave up and concave down.

**2.** (a) Write the washer's area with outer radius $R(x)$ and inner radius $r(x)$. 1

(b) Obtain the reduction formula for $\int x^n e^{-ax}\, dx$. 4

(c) Obtain the reduction formula for $\int \cos^n x\, dx$. 5

*Or*

Find $\int \tan^4 x\, dx$.

(d) Find the value of $\int_0^1 \frac{\sin^3 x}{\cos^6 x}\, dx$. 5





*Or*

Find the volume of the solid generated by revolving the region bounded by the curve $y = x^2$ and the line $y = 0$, $x = 2$, about $x$-axis.

**3.** (a) Write the parametrization of the graph of the function $f(x) = x^2$. 1

(b) If a curve is symmetric about $x$-axis and the point $(r, \theta)$ lies on the graph, then write which of the following also lies on the graph : 1

(i) $(r, \pi - \theta)$

(ii) $(-r, \pi - \theta)$

(iii) $(-r, -\theta)$

(iv) $(-r, \theta)$

(c) Define a parametric curve. 2

(d) Write the polar equation of $xy = 1$. 1

(e) Write the equivalent Cartesian equation of $r^2 \sin 2\theta = 2$. 2

(f) Find the perimeter of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, which is defined parametrically by $x = a \sin t$, $y = b \cos t$, $a > b$ and $0 \le t \le 2\pi$. 4

*Or*

Find the centroid of the first-quadrant arc of the asteroid $x = \cos^3 t$, $y = \sin^3 t$, $0 \le t \le 2\pi$.

*(g)* Find the length of the curve $x = \cos t$, $y = t + \sin t$, $0 \le t \le \pi$. 4

*Or*

Find the centre, foci, vertices of the conic section $x^2 + 2x + 4y - 3 = 0$.

**4.** *(a)* Define a vector function. 1

*(b)* Write the value of $(\vec{u} \times \vec{v}) \cdot \vec{v}$. 1

*(c)* Define triple scalar product of vectors. 2

*(d)* Show that vector and its first derivative are orthogonal. 3

*Or*

Evaluate $\int_0^1 (te^{t^2}\hat{i} + e^{-t}\hat{j} + \hat{k})\,dt$.

*(e)* Find the unit tangent vector of the curve $\vec{r}(t) = \sin 2t\hat{i} + \cos 2t\hat{j} + \hat{k}$, $0 \le t \le \pi$. 3

*Or*

Find the acceleration of the particle described by $\vec{r} = (t-1)\hat{i} + (t^2 - 1)\hat{j} + 2t\hat{k}$ at $t = 1$.

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**1 SEM TDC MTMH (CBCS) C 2**

**2022**

( Nov/Dec )

MATHEMATICS

( Core )

Paper : C–2

**( Algebra )**

*Full Marks* : 80
*Pass Marks* : 32

*Time* : 3 hours

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

**1.** *(a)* State the modulus of the complex number $(1+\cos\theta+i\sin\theta)^5$. 1

*(b)* If $\cos\alpha+\cos\beta+\cos\gamma=0$
$=\sin\alpha+\sin\beta+\sin\gamma$
then show that
$\sin 3\alpha+\sin 3\beta+\sin 3\gamma=3\sin(\alpha+\beta+\gamma)$ 2

(c) Show that

$$(1+i)^n + (1-i)^n = 2^{\frac{n}{2}+1} \cos\frac{n\pi}{4}$$ 3

*Or*

If $\text{cis}\theta = \cos\theta + i\sin\theta$ and $x = \text{cis}\alpha$; $y = \text{cis}\beta$; $z = \text{cis}\gamma$ with $x+y+z=0$, show that $x^{-1}+y^{-1}+z^{-1}=0$.

(d) Show that the product of $n$-numbers of $n$th root of unity is $(-1)^{n-1}$ and their sum is zero. 4

**2.** (a) Explain why the set of integers with the relation 'less than or equal to' ($\leq$) is not an equivalence relation. 1

(b) Give an example of a bijective map. 1

(c) Given $f(x) = |x|$, show that $(f \circ f)(x) = f(x)$. 2

(d) If g.c.d $(a, b) = d$, show that

$$\text{g.c.d.}\left(\frac{a}{d}, \frac{b}{d}\right) = 1$$ 2





(e) Show that the relation of equality on the set of integers is an equivalence relation. 3

(f) Use mathematical induction to show that (any *one*)—

(i) 2 is a factor of $5^n - 3^n \forall n \in \mathbb{N}$;

(ii) $1^3 + 2^3 + \cdots + n^3 = \left[\frac{n}{2}(n+1)\right]^2$. 3

(g) Show that if $f : X \to Y$ is a bijection, then $\exists$ a map $g : Y \to X$ such that $g \circ f$ and $f \circ g$ are identity maps. 3

(h) Let $k > 0$ be an integer and $j$ be any integer. Then show that $\exists$ unique integers $q$ and $r$ such that $j = kq + r$ where $0 \leq r < k$. 5

(i) Show that if $a$ is an odd integer, then $a^{2^n} \equiv 1 (\text{mod} 2^{n+2})$ for any $n \geq 1$. 5

**3.** (a) State whether true or false : 1

Each matrix is row equivalent to one and only one reduced Echelon matrix.

(b) Fill in the blank : 1

The equation $x = \alpha u + \beta v$ where $\alpha$ and $\beta$ are fixed scalars and neither $u$ nor $v$ is a multiple of the other, geometrically represents _____ through the origin.

(c) Solve

$$x_1\begin{bmatrix}1\\2\end{bmatrix} + x_2\begin{bmatrix}2\\1\end{bmatrix} = \begin{bmatrix}0\\0\end{bmatrix}$$

and state the nature of the two non-zero vectors. 1+1=2

(d) State whether the following vectors are linearly dependent or independent by inspection justifying the region thereof : 1+1=2

$$\begin{bmatrix}3\\5\\1\end{bmatrix}, \begin{bmatrix}0\\0\\0\end{bmatrix}, \begin{bmatrix}6\\5\\4\end{bmatrix}$$

(e) Show that $\forall u, v, w \in \mathbb{R}^n$,

$$(u + v) + w = u + (v + w).$$ 2





(f) Reduce the matrix

$$\begin{bmatrix}1 & 3 & 1\\-4 & -9 & 2\\0 & -3 & -6\end{bmatrix}$$

to row reduced Echelon form using forward and backward phases of row operations. 4

(g) Solve the following system by reducing the augmented matrix to row reduced Echelon form indicating the basic and free variables : 4

$$x_1 + 3x_2 - 5x_3 = 4$$
$$x_1 + 4x_2 - 8x_3 = 7$$
$$-3x_1 - 7x_2 + 9x_3 = -6$$

(h) For an $m \times n$ matrix $A$, if $u, v \in \mathbb{R}^n$, and $c$ is any scalar, show that—

(i) $A(u + v) = Au + Av$;

(ii) $A(cu) = c(Au)$. 2+2=4

**4.** (a) For a linear transformation $T$, show that $T(0) = 0$. 1

(b) For the linear transformation $T : \mathbb{R}^5 \to \mathbb{R}^2$ given by $T(x) = Ax$, state the order of the matrix $A$. 1

(c) For $A = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$, give the geometric description of the transformation $x \mapsto Ax$. 2

(d) Show that the map $f : \mathbb{R} \to \mathbb{R}$ given by $f(x) = mx$ is a linear transformation. 2

(e) Let $T : \mathbb{R}^n \to \mathbb{R}^m$ be linear. Show that $\exists$ a unique matrix $A$ such that $T(x) = Ax$ $\forall x \in \mathbb{R}^n$. 3

(f) If $A$ is an invertible $n \times n$ matrix, then $\forall b \in \mathbb{R}^n$, show that the matrix equation $Ax = b$ has the unique solution $x = A^{-1}b$. 3

(g) Show that null $A$ is a subspace of $\mathbb{R}^n$. 4

(h) Find the eigenvalues of

$$A = \begin{bmatrix} 4 & 0 & 1 \\ -2 & 1 & 0 \\ -2 & 0 & 1 \end{bmatrix}$$ 4



( Continued )



(i) Find the bases for col $A$ and null $A$ stating their dimensions where

$$A = \begin{bmatrix} 1 & -3 & 2 & -4 \\ -3 & 9 & -1 & 5 \\ 2 & -6 & 4 & -3 \\ -4 & 12 & 2 & 7 \end{bmatrix}$$ 5

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**1 SEM TDC BOTH (CBCS) C 1**

**2022**

( Nov/Dec )

BOTANY

( Core )

Paper : C-1

**( Microbiology and Phycology )**

*Full Marks* : 53
*Pass Marks* : 21

*Time* : 3 hours

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

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

*(i)* The principal pigment in *Phaeophyceae* is phycoerythrin / fucoxanthin / xanthophyll / phycocyanin.

*(ii)* Female sex organ of *Rhodophyceae* is termed as carpogonium / oogonium / sporogonium / archegonium.

(iii) The algae *Chara* is called 'stonewort' because its plant body is encrusted with calcium bicarbonate / calcium carbonate / calcium chloride / calcium oxalate.

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

(i) The nucleus of bacteria is called as _____.

(ii) A bacterium without flagella is known as _____.

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

(a) Cell structure of *Chlamydomonas*

(b) Role of algae in biotechnology

(c) Nutritional types of bacteria

(d) Structure of RNA virus

**3.** What are the criteria based on which algae are classified? Give a brief account of the classification of algae suggested by Fritsch. 3+9=12

*Or*

Describe the mode of sexual reproduction of *Oedogonium*. Do these algae have an alternation of generation? Draw the diagram of the life cycle of *Oedogonium*. 7+1+4=12





**4.** What do you mean by genetic recombination? Give an account of conjugation in bacteria. 3+9=12

*Or*

Distinguish between the following : 6+6=12

(a) Archaebacteria and Eubacteria

(b) Gram-positive and Gram-negative bacteria

**5.** What is bacteriophage? Describe with diagram the lytic and lysogenic cycle of bacteriophage. 2+5+5=12

*Or*

How are viruses classified? Discuss the Baltimore's system of classification of viruses. 3+9=12

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Total No. of Printed Pages—3

**1 SEM TDC BOTH (CBCS) C 2**

**2022**

( Nov/Dec )

BOTANY

( Core )

Paper : C–2

**( Biomolecules and Cell Biology )**

*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 of the following : 1×5=5

*(a)* A water molecule has _____ polar covalent bonds.

*(b)* The _____ bond of ATP is the highest energetic bond.

*(c)* Prokaryotic ribosomes are of _____S types.

(d) DNA synthesis occurs in synthetic phase of _____.

(e) Phospholipids are _____ in nature.

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

(a) Saponification

(b) Nitrogenous bases

(c) ATP as energy currency

(d) Membrane transport

**3.** With labelled sketches, describe the structure and functions of ribosomes and lysosomes. 6+6=12

*Or*

Write short notes on : 4×3=12

(a) Function of chromosome

(b) Fluid mosaic model

(c) Function of chloroplasts

**4.** What is protein denaturation? Describe the biological roles of proteins. 6+6=12





*Or*

Write on the following ; 6×2=12

(a) Role of enzymes

(b) Cell cycle checkpoints

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

(a) "Mitochondria is the powerhouse of the cell."

(b) Function of endoplasmic reticulum

(c) Composition of carbohydrates

(d) Endocytosis

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Total No. of Printed Pages—7

**1 SEM TDC PHYH (CBCS) C 1**

**2022**

( Nov/Dec )

PHYSICS

( Core )

Paper : C–1

**( Mathematical Physics—I )**

*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 : 1×5=5

(a) If $z = x^2 + y^2$, then

$$\left(\frac{\partial z}{\partial x} - \frac{\partial z}{\partial y}\right)^2$$

is equal to

(i) $2(x-y)^2$

(ii) $4(x-y)^2$

(iii) 0

(iv) None of the above

(b) The order and degree of the differential equation

$$x^2\left(\frac{d^2y}{dx^2}\right)^3 + y\left(\frac{dy}{dx}\right)^4 + y^4 = 0$$

are

(i) 3 and 2

(ii) 2 and 3

(iii) 4 and 3

(iv) None of the above

(c) If $\vec{A}$ is a solenoidal vector, then

(i) $\vec{\nabla}\cdot\vec{A} = 1$

(ii) $\vec{\nabla}\times\vec{A} = 0$

(iii) $\vec{\nabla}\cdot\vec{A} = 0$

(iv) None of the above



( Continued )



(d) By Stokes's theorem

$$\iint_S (\nabla\times\vec{A})\cdot\hat{n}dS$$

is equal to

(i) $\int_S \vec{A}\cdot d\vec{S}$

(ii) $\oint_C \vec{A}\cdot d\vec{r}$

(iii) $\oint_C \vec{A}\cdot d\vec{S}$

(iv) None of the above

(e) $\vec{\nabla}r^n$ is equal to

(i) $nr^{n-2}$

(ii) $(n-2)r^n\hat{r}$

(iii) $nr^{n-2}\hat{r}$

(iv) $(n-2)r^n$

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

(a) Show that $|x|$ is continuous but not differentiable.



( Turn Over )

(b) Find the value of $m$, if $\vec{A} = 2\hat{i} - 4\hat{j} + 5\hat{k}$, $\vec{B} = \hat{i} - m\hat{j} + \hat{k}$ and $\vec{C} = 3\hat{i} + 2\hat{j} - 5\hat{k}$ are coplanar.

(c) If $u_p$ represents orthogonal co-ordinates and $h_p$ represents the corresponding scale factors, then show that

$$|\nabla u_p| = h_p^{-1}$$

(d) Show that Green's theorem in a plane can be expressed as follows :

$$\oint_C \vec{A} \cdot d\vec{r} = \iint_R (\vec{\nabla} \times \vec{A}) \cdot \hat{k} dR$$

(e) Evaluate using property of Dirac delta function

$$\int_{-\infty}^{\infty} e^{-5t} \delta(t-2) dt$$

**3.** Answer any *five* questions from the following : 4×5=20

(a) What do you mean by integrating factor? Solve the differential equation

$$(x^3 - x)\frac{dy}{dx} - (3x^2 - 1)y = x^5 - 2x^3 + x \qquad 1+3=4$$





(b) Solve the following differential equation : 4

$$xdx + ydy = \frac{a^2(xdy - ydx)}{x^2 + y^2}$$

(c) Using Lagrange's method of undetermined multipliers, find the minimum value of $x^2 + y^2 + z^2$ subject to the condition $xyz = a^3$. 3+1=4

(d) Find a unit outward normal drawn to the surface of the paraboloid of revolution $z = x^2 + y^2$ at the point (1, 2, 5). 4

(e) Write the probability distribution functions for Binomial and Poisson distribution. Three distinguishable balls are distributed in three cells. Find the conditional probability that all the three occupy the same cell. Given that at least two of them are in the same cell. 1+3=4

(f) Evaluate

$$\int_C \vec{F} \cdot d\vec{r}$$

where $\vec{F} = x^2\hat{i} + xy\hat{j}$ and $C$ is the boundary of the square in the plane $z = 0$ and bounded by the lines $x = 0$, $x = a$, $y = 0$, $y = a$. 4

**4.** Answer any *three* questions from the following : 6×3=18

*(a)* If

$$y_1 = e^{-x}\cos x$$

$$y_2 = e^{-x}\sin x$$

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

then calculate the Wronskian determinant. Verify that $y_1$ and $y_2$ satisfy the given differential equation. Also, check whether $y_1$ and $y_2$ are linearly independent. 3+2+1=6

*(b)* What is directional derivative of a scalar? Find the directional derivative of $\frac{1}{|\vec{r}|}$ in the direction of $\vec{r}$. 1+5=6

*(c)* State the Gauss divergence theorem. Evaluate

$$\iint_S \vec{F}\cdot\hat{n}dS$$

where $\vec{F} = 4xz\hat{i} - y^2\hat{j} + yz\hat{k}$ and $S$ is the surface of the cube bounded by $x=0$, $x=1$, $y=0$, $y=1$, $z=0$, $z=1$. 1+5=6





*(d)* Derive the expression for gradient of a scalar in curvilinear co-ordinates. Find the expression for gradient in spherical polar co-ordinates. 3+3=6

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**1 SEM TDC PHYH (CBCS) C 2**

**2022**

( Nov/Dec )

PHYSICS

( Core )

Paper : C–2

**( Mechanics )**

*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)* The curl for conservative force is

*(i)* one

*(ii)* zero

*(iii)* infinite

*(iv)* None of the above

(b) The moment of inertia of a body rotating about an axis is

(i) $\frac{2K}{\omega^2}$

(ii) $\frac{K}{\omega^2}$

(iii) $\frac{MK}{\omega^2}$

(iv) $\frac{\omega^2}{2K}$

(c) The couple required to twist a rod through $\varphi$ radians is

(i) $\frac{\pi\eta r^4}{2l}$

(ii) $\frac{\pi\eta^2 r^2}{2}$

(iii) $\frac{\pi\eta^2 r^2}{4l}$

(iv) $\frac{\pi\eta}{2l}$





(d) The velocity profile of a liquid flowing through a capillary tube is

(i) straight line

(ii) parabolic

(iii) hyperbolic

(iv) circular arc

(e) The phase difference between driving force and velocity of forced oscillator is

(i) $\varphi$

(ii) $\frac{\pi}{2}+\varphi$

(iii) $\varphi-\frac{\pi}{2}$

(iv) $\frac{\pi}{2}-\varphi$

**2.** (a) What is meant by inertial frame of reference? Can you regard earth as an inertial frame? Explain. 1+1=2

(b) Establish the relation between torque and angular momentum. 2

*Or*

Derive the law of conservation of linear momentum from Newton's laws of motion.

(c) Calculate the angular momentum and rotational KE of earth about its own axis. The mass of earth is $6\times10^{24}$ kg and the radius is $6\cdot4\times10^{3}$ km. 2

(d) Calculate Poisson's ratio for silver. Given Young's modulus $=7\cdot25\times10^{10}\,N/m^2$ and Bulk modulus $=11\times10^{10}\,N/m^2$. 2

(e) Why was the apparatus of Michelson-Morley experiment rotated through 90°? 2

**3.** What is Galilean transformation? Derive Galilean transformation equation for two inertial frames. 1+3=4





**4.** (a) Explain the concept of potential energy. Show that potential energy may be defined as a function of position whose negative gradient gives the intrinsic force. 1+2=3

*Or*

A constant force of 5 N acts for 10 sec on a body whose mass is 2 kg. The body was initially at rest. Calculate the work done by the force and the final kinetic energy. 1½+1½=3

(b) Show that in a head on collision between two particles the transfer of energy is maximum when their mass ratio is unity. 3

(c) Define moment of inertia and radius of gyration of a body rotating about an axis, hence explain their physical meaning. 1½+1½=3

**5.** *(a)* Deduce an expression for the gravitational potential and attraction due to this spherical shell at a point outside the shell. 4

*(b)* Show how by introducing the concept of reduced mass, a two-body problem under central forces can be reduced to a one-body problem. 3

*Or*

When a particle moves under central force, prove that the angular momentum of a particle is constant.

*(c)* Mention the limitations of Poiseuille's formula. 2

**6.** *(a)* A particle is oscillating under a damping force. Show that power dissipation is $P = \frac{E}{\tau}$, where $E$ is average energy and $\tau$ is relaxation time. 4

*Or*

What is sharpness of resonance? Explain the effect of damping on sharpness and resonance. 1+3=4





*(b)* A particle executes simple harmonically as

$$y = 0 \cdot 1 \sin (100 \pi t + \frac{\pi}{4}) \text{ m}$$

Find maximum amplitude and angular frequency of oscillation. 2

**7.** Discuss the effects of the centrifugal force due to earth rotation. 5

**8.** What is relativistic Doppler effect? Derive relation for longitudinal Doppler effect. 1+4=5

*Or*

Derive transformation formulae for relativistic momentum. 5

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Total No. of Printed Pages—3

**1 SEM TDC ZOOH (CBCS) C 1**

**2022**

( Nov/Dec )

ZOOLOGY

( Core )

Paper : C–1

**( Non-Chordates—I )**

*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 sub-kingdom _____ includes multicellular animals.

*(b)* Pore-bearing animals are known as _____.

*(c)* Presence of cnidoblast cells is the characteristic feature of the phylum _____.

(d) *Ascaris* belongs to the phylum _____.

(e) *Fasciola hepatica* belongs to the phylum _____.

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

(a) Parazoa and Metazoa

(b) Binary fission and Multiple fission in Protozoa

(c) Holozoic and Holophytic nutritions

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

(a) General characters or evolutionary significance of Ctenophora

(b) Evolution of symmetry or segmentation in Metazoa

(c) Structural organization of *Euglena* or *Paramecium*

(d) Metacercaria larva

**4.** Classify the phylum Porifera up to class. Write briefly about syconoid type of canal system. 3+3=6

*Or*

What is the skeletal material in Porifera? Write a note on it. 1+5=6





**5.** What is pathogenicity? Write the pathogenicity in *Wuchereria bancrofti*. 1+5=6

*Or*

Discuss the parasitic adaptation in Helminths. 6

**6.** Explain the life cycle of *Taenia solium* or the pathogenicity of *Fasciola hepatica*. 9

**7.** What is metagenesis? Explain the metagenesis in *Obelia*. 1+8=9

*Or*

What is coral? Write about the types of coral reefs. 9

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Total No. of Printed Pages—4

**1 SEM TDC ZOOH (CBCS) C 2**

**2022**

( Nov/Dec )

ZOOLOGY

( Core )

Paper : C–2

**( Principle of Ecology )**

*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 : 1×5=5

*(a)* The transfer of food and energy in an ecosystem through a series of organisms is called

*(i)* food and energy transfer

*(ii)* food chain

*(iii)* food web

*(iv)* None of the above

(b) Forest and wildlife are

(i) renewable resources

(ii) non-renewable resources

(iii) inexhaustible natural resources

(iv) None of the above

(c) The term 'ecosystem' was first coined by

(i) Linnaeus

(ii) Bentham and Hooker

(iii) A. G. Tansley

(iv) None of them

(d) The flow of energy in an ecosystem is

(i) unidirectional

(ii) multidirectional

(iii) bidirectional

(iv) None of the above

(e) The main components of an ecosystem are

(i) the sun and plants

(ii) the sun and animals

(iii) plants and animals

(iv) biotic and abiotic factors





**2.** Write short notes on any *two* of the following : 4×2=8

(a) Life tables

(b) $r$ and $k$ strategies

(c) Survivorship curves

**3.** Discuss the role of temperature and light in ecosystem. 3+3=6

**4.** Define species diversity. Write briefly about the different forms of species diversity. 2+4=6

*Or*

Discuss briefly about ecotone and edge effect. 3+3=6

**5.** What is biogeochemical cycle? Describe nitrogen cycle. 3+5=8

*Or*

Define ecosystem. Write about the different types of ecosystem with reference to forest ecosystem. 2+2+4=8

**6.** Write short notes on (any *two*) : 5×2=10

*(a)* Ecological pyramid

*(b)* Energy flow in ecosystem

*(c)* Human modified ecosystem

**7.** Define population. Explain the Lotka-Volterra equation for competition. 2+8=10

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**1 SEM TDC CHMH (CBCS) C 1**

**2022**

( Nov/Dec )

CHEMISTRY

( Core )

Paper : C–1

**( Inorganic 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 : 1×6=6

*(a)* Which of the following are the possible values of $n$, $l$ and $m$ for an atom having maximum value of $m = \pm 2$?

*(i)* $n = 4,\ l = 3,\ m = +2$

*(ii)* $n = 3,\ l = 2,\ m = -2$

*(iii)* $n = 3,\ l = 3,\ m = +2$

*(iv)* $n = 4,\ l = 3,\ m = -2$

(b) The ground-state energy for H atom is –13·6 eV. Ground-state energy for $Li^{2+}$ is

(i) –3·4 eV

(ii) –13·6 eV

(iii) –40·8 eV

(iv) –122·5 eV

(c) Which of the following species has the highest electronegativity?

(i) C [*sp*-hybridized]

(ii) N [$sp^2$-hybridized]

(iii) N [*sp*-hybridized]

(iv) C [$sp^3$-hybridized]

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

(i) BeO

(ii) MgO

(iii) CaO

(iv) SrO

(e) What type of hybridization is possible in square planar complexes?

(i) $sp^3d$

(ii) $sp^3d^2$

(iii) $dsp^2$

(iv) $d^4s$





(f) Which compound has maximum covalent character?

(i) $MgCl_2$

(ii) $BeCl_2$

(iii) $BaCl_2$

(iv) $CaCl_2$

**2.** Answer the following questions : 2×9=18

(a) State Heisenberg's uncertainty principle. Write the mathematical statement of the principle in terms of energy and time.

(b) Calculate the wavelength (in nano-meter) associated with a proton moving at $1·0\times10^3$ $ms^{-1}$. [Mass of the proton = $1·67\times10^{-27}$ kg and $h = 6·63\times10^{-34}$ J-s]

(c) Write down the Schrödinger's wave equation and give the significance of $\psi$ and $\psi^2$.

(d) What is Born-Haber cycle? Explain its applications and limitations.

(e) What is radial probability distribution function? Draw the radial distribution curve for 2*p*-orbital.

(f) What do you mean by polarization? Discuss Fajan's rules.

(g) Draw different shapes of the *d*-orbitals.

(h) What is the relation between solvation energy and lattice energy of an ionic crystal? Justify with suitable example.

(i) 4*s*-orbital filled first followed by 3*d*-orbital, but removal of electron initially take place from 4*s*. Why, give reason.

*Or*

Arrange the following in order of increasing bond order or bond length :

$O_2$; $O_2^-$; $O_2^+$; $O_2^{2+}$

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

(a) How can lattice energy of an ionic crystal be calculated theoretically? Deduce the equation. Give the limitation of Born-Landé equation. 3+1=4

(b) (i) The first ionization energy of Be is higher than that of B, while the second ionization energy of B is higher than that of Be. Explain giving reason.





(ii) Explain why the dipole moment of $NF_3$ is nearly zero. 2+2=4

(c) Discuss the metallic bonding in terms of band theory. Explain the following properties of metals in terms of Band theory : 2+1+1=4

(i) Semi-conductor and conductor

(ii) Insulator

**4.** Answer any *two* of the following questions : 3×2=6

(a) Define Pauling scale of electro-negativity. The ionic resonance energy of C—H bond is 5·75 kcal. The electro-negativity of H is 2·1. Find the electro-negativity of carbon. 3

(b) Draw the resonating structures of the following molecules and ions : 1×3=3

(i) $O_3$

(ii) $NO_3^=$

(iii) $CO_3^=$

(c) What is lattice energy? Calculate the lattice energy of NaCl with the help of the following data : 1+2=3

Electronic charge = $4{\cdot}8\times10^{-10}$ esu
Born exponent = 9
Madelung constant for NaCl = 1·748

Ionic radius of $Na^+$ = 0·95 Å
Ionic radius of $Cl^-$ = 1·81 Å
Avogadro no. ($N$) = $6{\cdot}023\times10^{23}$

(d) What do you mean by hydrogen bonding? Mention the electrostatic theory of hydrogen bonding and discuss its limitation. 1+1½+½=3

**5.** Answer any *four* of the following questions : 3×4=12

(a) What is formal charge? Calculate the formal charge in $CO_3^{2-}$ ion. 1½+1½=3

(b) Define Slater's rule. Calculate the effective nuclear charge for valence electron of K atom. 1+2=3

(c) Draw the molecular orbital energy level diagram for $O_2$ molecule. Explain the paramagnetic nature of $O_2$ with MOT. 2+1=3





(d) Using VSEPR theory, predict the structure of the following : 1×3=3

(i) $BF_3$

(ii) $XeO_3$

(iii) $PCl_5$

(e) What are weak intermolecular forces? Outline the role of induced dipole interaction in inter-molecular bonding. 1½+1½=3

(f) Explain the following : 1½×2=3

(i) *o*-Nitrophenol is more volatile than *p*-nitrophenol.

(ii) Boiling point of $H_2O > HF > NH_3$ although electronegativity of $F > O > N$.

**6.** How is standard electrode potential used in the volumetric estimation of oxalate using $KMnO_4$? Why is $KMnO_4$ a secondary standard? 2+1=3

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**1 SEM TDC CHMH (CBCS) C 2**

**2022**

( Nov/Dec )

CHEMISTRY

( Core )

Paper : C–2

**( Physical 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 : 1×3=3

*(a)* If the volume of a gas molecule is $v$, then the excluded volume is

*(i)* $2v$

*(ii)* $\frac{1}{2}v$

*(iii)* $3v$

*(iv)* $4v$

(b) With the increase in temperature, the viscosity of a liquid

(i) increases

(ii) decreases

(iii) at first increases and then decreases

(iv) remains same

(c) Solution $A$ has pH = 3 and solution $B$ has pH = 6. Find the correct statement from the following.

(i) Solution $A$ is twice as acidic as $B$.

(ii) Solution $B$ is twice as acidic as $A$.

(iii) Solution $A$ is 1000 times more acidic than $B$.

(iv) Solution $B$ is 1000 times more acidic than $A$.

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

(a) Explain why the viscosity of a gas increases with increase of temperature.

(b) Mention the physical significances of van der Waals' constants $a$ and $b$.

( Continued )





(c) Frenkel defect is not shown by alkali metal halides but silver halides show. Explain.

(d) Explain ionic product of water. What is the effect of temperature on it?

(e) The surface tension of a liquid vanishes at its critical temperature. Explain.

UNIT—I

**3.** Answer any *two* from the following questions : 7×2=14

(a) (i) Deduce the reduced equation of states from van der Waals' equation of states and state the law of corresponding states from it. 3+1=4

(ii) State the law of equipartition of energy. Calculate the various degrees of freedom for $H_2O$ and $CO_2$ molecules. 1+1+1=3

(b) (i) Deduce van der Waals' equation of states for a real gas. 4

(ii) Define Boyle's temperature. 1



( Turn Over )

(iii) Calculate the temperature at which the root-mean-square velocity of $CO_2$ gas is same as that of $Cl_2$ gas at 293 K. 2

(c) (i) Briefly describe the Maxwell's law of distribution of molecular velocities. Discuss the effect of temperature on it. 2+2=4

(ii) Write kinetic gas equation. Deduce Charles' law from it. 1+2=3

UNIT—II

**4.** Answer any *one* from the following questions : 5

(a) Define coefficient of viscosity. Write its SI unit. Describe the laboratory method for determining the coefficient of viscosity of a liquid. 1+1+3=5

(b) (i) Briefly discuss the cleansing action of detergents. 2½





(ii) In the determination of surface tension of a liquid by drop number method using stalagmometer, the liquid gave 58 drops while water gave 24 drops, the volume of the liquid and water being the same. The density of water is 0·998 g/ml while that of the liquid is 0·795 g/ml. If the surface tension of water at the given temperature is 70·8 dyne/cm, then calculate the surface tension of the liquid. 2½

UNIT—III

**5.** Answer any *two* from the following questions : 4½×2=9

(a) (i) Define unit cell. Name the seven crystal systems. Which of them is the most symmetrical and which one is the most unsymmetrical? 1+1+1=3

(ii) State and explain the law of constancy of interfacial angles. 1½

(b) (i) Derive Bragg's equation. 3

(ii) Calculate the Miller indices of a crystal plane which cuts through the crystal axes at $(2a, -3b, -3c)$. 1½

(c) (i) What are liquid crystals? Classify them giving one example of each. 3

(ii) Briefly discuss some of the applications of liquid crystals. 1½

UNIT—IV

**6.** Answer any *two* from the following questions : 7×2=14

(a) (i) Define salt hydrolysis. Derive an expression for the pH of an aqueous solution of a salt of strong base and weak acid. 1+3=4

(ii) Calculate the degree of hydrolysis, hydrolysis constant and pH of 0·02 *M* of aqueous solution of sodium acetate. The dissociation constant of acetic acid is $1 \cdot 8 \times 10^{-5}$, $k_w = 10^{-14}$. 1+1+1=3

(b) (i) What are buffer solutions? Write briefly about the applications of buffers in biological systems and in agriculture. 1+2=3

(ii) What is buffer capacity? 1

(iii) Derive Henderson equation for a basic buffer solution. 3





(c) (i) What is common ion effect? Write the difference between ionic product and solubility product. 1+2=3

(ii) Explain why ZnS is precipitated in alkaline medium whereas CuS is precipitated in acidic medium. 2

(iii) Deduce the relation between solubility and solubility product for $As_2S_3$. 2

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