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1 SEM TDC BOTH (CBCS) C 1

2019

(December)

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 and write the correct answer of the following : 1×3=3

(i) Water bloom is generally caused by hydrilla/bacteria/blue-green algae/ green algae.

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

(iii) Cup-shaped chloroplast is present in *Chara/Oedogonium/Chlamydomonas/Fucus.*

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

(i) Genetic recombination in bacteria mediated by a virus is known as _____.

(ii) Gram stain was introduced by _____.

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

(a) Dwarf male of *Oedogonium*

(b) Haplo-diplontic type of life cycle in algae

(c) Nutrition of photosynthetic bacteria

(d) Characteristic features of viruses

3. Give a detailed account of the range of thallus structure in algae with suitable diagrams. 8+4=12

Or

Write notes on the following : 6+6=12

(a) Asexual reproduction of *Nostoc*

(b) Sexual reproduction of *Fucus*

4. Describe with diagram the ultrastructure and vegetative reproduction of bacteria. 4+3+5=12

Or

Write on the following : 6+6=12

(a) Mycoplasma

(b) Role of bacteria in agriculture

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

Or

What are viroids and prions? Draw and describe the structure of tobacco mosaic virus. 2+2+3+5=12

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Total No. of Printed Pages—3

1 SEM TDC BOTH (CBCS) C 2

2019

(December)

BOTANY

(Core)

Paper : C2

(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 : 1×5=5

(a) The hydrolysis of fat by organisms is called _____.

(b) The cells of the multicellular organisms are held together by _____.

(c) The process of intake of fluid vesicles by living cells is called _____.

(d) The two strands of the double helix of DNA are held together by _____ bonds.

(e) Prokaryotic ribosomes are _____ S type.

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

(a) Characteristic features of prokaryotic cell

(b) ATP as energy currency

(c) Significance of meiosis

(d) Properties of water

3. Describe the structures and functions of protein with example. 8+4=12

Or

Write short notes on the following : 4×3=12

(a) pH and buffer

(b) Biological properties of lipids

(c) Ribonucleic acid

4. With suitable diagram, describe the structure and functions of mitochondria. 3+5+4=12

Or

Write short notes on the following :

(a) Membrane transport 4

(b) Structure and functions of DNA 6+2=8

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

(a) First law of thermodynamics

(b) Polysaccharides as reserve food materials

(c) Redox reactions

(d) Properties of enzymes

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Total No. of Printed Pages—6

1 SEM TDC PHYH (CBCS) C 1

2019

(December)

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 : 1×3=3

(a) The divergence of curl of a vector is

(i) 1

(ii) 0

(iii) $\frac{1}{2}$

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

(b) The condition for a differential equation of the form $Mdx + Ndy = 0$, to be exact is

(i) $\frac{\partial M}{\partial y} + \frac{\partial N}{\partial x} = 0$

(ii) $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$

(iii) $\frac{\partial M}{\partial y} \neq \frac{\partial N}{\partial x}$

(iv) $\frac{\partial M}{\partial x} = \frac{\partial N}{\partial y}$

(c) The order of a differential equation is always

(i) positive integer

(ii) negative integer

(iii) rational number

(iv) whole number

2. Check whether the function defined by $f(x) = x^2 - \sin x + 5$ is continuous at $x = \pi$. 2

3. (a) Solve the following differential equations (any *two*) : 3×2=6

(i) $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 0$

(ii) $\frac{dy}{dx} - \frac{y}{x} = 2x$

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

(b) State the existence theorem and uniqueness theorem to check whether a solution of a differential equation for a particular boundary value exists or not. 1+1=2

4. (a) Find the partial differentiations $\frac{\partial f}{\partial x}$, $\frac{\partial f}{\partial y}$, $\frac{\partial^2 f}{\partial x^2}$ and $\frac{\partial^2 f}{\partial y^2}$ for the following function : 2

$$f(x, y) = \log (x^2 + y^2)$$

(b) Solve the following differential equations : 2+2=4

(i) $\frac{\partial^2 z}{\partial x^2} = \cos (2x + 3y)$

(ii) $(2x \log x - xy)\, dy + 2y\, dx = 0$

Or

Describe the method of Lagrange's undetermined multipliers for a constrained system. 4

5. *(a)* If $\vec{A} \times \vec{B} = 0$, is it necessary that $\vec{A}$ and $\vec{B}$ must be parallel? 1

(b) Show that

$$\vec{A} \cdot (\vec{B} \times \vec{C}) = \vec{B} \cdot (\vec{C} \times \vec{A}) = \vec{C} \cdot (\vec{A} \times \vec{B})$$ 2

(c) For vectors $\vec{a} = 5\hat{i} - 3\hat{j} + 4\hat{k}$ and $\vec{b} = \hat{j} - \hat{k}$, determine the sine of the angle between $\vec{a}$ and $\vec{b}$. 2

6. *(a)* Evaluate $\iint_S \vec{r} \cdot \hat{n}\, dS$, where S is a surface enclosing a volume V and $\vec{r}$ denotes position vector of a point. 2

(b) Find $\vec{\nabla}\phi$ at the point $(-1, -2, 1)$, where $\phi = x^2y + xz$. 2

(c) Find a unit vector normal to the surface $z = x^2 + y^2$ at the point (1, 2, 5). 2

(d) Prove that

$$\nabla^2\left(\frac{1}{r}\right) = 0$$ 3

7. *(a)* Express Green's theorem in a plane in vector notation. 2

(b) If

$$\vec{v} = (3x^2 + 6y)\hat{i} - 14yz\hat{j} + 20xz^2\hat{k},$$

evaluate $\int \vec{v} \cdot \vec{dr}$ along a straight line from (0, 0, 0) to (1, 0, 0), then to (1, 1, 0) and then to (1, 1, 1). 3

(c) By Stokes theorem prove that

$$\oint \vec{r} \cdot \vec{dr} = 0$$ 4

8. *(a)* Find the expression for gradient of a scalar function in orthogonal curvilinear coordinates. 3

(b) Express Laplacian in curvilinear coordinates and convert it to cylindrical coordinates. 2

9. What is probability distribution of a random variable? Find the probability distribution for occurrence of a head in tossing a coin twice. Write down the probability distribution function for binomial distribution. 1+2+1=4

Or

What are discrete and continuous probability distributions? Under what condition binomial probability distribution reduces to Poisson's distribution? Write down the probability distribution function for Poisson's distribution. 2+1+1=4

10. Define Dirac delta function. Express it in terms of rectangular function. 1+1=2

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Total No. of Printed Pages—7

1 SEM TDC PHYH (CBCS) C 2

2019

(December)

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 option from the following : 1×4=4

(a) Which of the following quantities is/are not invariant under Galilean transformation?

(i) Space and velocity

(ii) Acceleration

(iii) Force

(iv) Velocity and acceleration

(b) A particle moves under the effect of force $F = cx$; from $x = 0$ to $x = x_1$. The work done in the motion of the particle is

(i) zero

(ii) cx_1^2

(iii) $\frac{(cx_1)^2}{2}$

(iv) cx_1^4

(c) The time period of an earth satellite in circular orbit is independent of

(i) both the mass and radius of the orbit

(ii) the radius of the orbit

(iii) the mass of the satellite

(iv) neither the mass of the satellite nor the radius of its orbit

(d) A body of mass m is placed on the earth's surface. It is taken from the earth's surface to a height $h = 3R$ (where R is the radius of the earth). The change in gravitational PE of the body is

(i) $\frac{2}{3}mgR$ (ii) $\frac{3}{4}mgR$

(iii) $\frac{1}{2}mgR$ (iv) $\frac{1}{4}mgR$

2. (a) "An inertial frame is one in which law of inertia or Newton's first law is valid." Prove the above statement. 2

(b) Write the Poiseuille's equation. Draw and explain the profile or the velocity distribution curve of the advancing liquid through a tube. 2

Or

The acceleration due to gravity on the surface of moon is $1{\cdot}7\ m\ s^{-2}$. What is the time period of a simple pendulum on the surface of moon, if its time period on the surface of earth is 3·5s?

3. (a) Show that the basic laws of physics are invariant under Galilean transformation. 3

Or

Derive the equation of motion of a rocket

$$v = u \log e \frac{M_0}{M} - gt$$

where v is the velocity of the rocket relative to earth.

u is the exhaust velocity of gases relative to rocket.

M_0 is the initial mass of rocket-fuel system.

M is the mass of the rocket after time t.

g is the acceleration due to gravity.

(b) State work-energy theorem. Also draw energy diagram for PE, KE and total energy for the case of a spring. 1+2=3

Or

Prove the principle of conservation of energy for the freely falling bodies under the action of gravity. 3

4. *(a)* Show that the rate of change of angular momentum vector of a particle is equal to torque acting on it. What kind of motion is expected for $\vec{L} = 0$? 3+2=5

(b) For rotational motion of rigid body, derive an expression for kinetic energy in terms of moment of inertia and angular velocity. Also obtain an expression for the moment of inertia of a circular ring about an axis passing through its centre and perpendicular to the plane of the ring. 3+2=5

(c) Show that for a satellite moving in a circular orbit, the square of the period of revolution is proportional to the cube of its distance from the centre of the earth ($T^2 \propto r^3$). What is geosynchronous or geostationary orbit? 4+1=5

Or

State Kepler's three laws of planetary motion. Prove any one of Kepler's laws. 3+2=5

5. *(a)* Find out the expression of potential energy ($w = \frac{1}{2} c\phi^2$) of a twisted cylinder, when it has a twist ϕ. 3

(b) What is damped vibration? What will happen when—

(i) damping is large;

(ii) damping is critical;

(iii) damping is small? 1+1+1+1=4

Or

What is forced vibration? Discuss the condition for resonance in forced vibration. 1+3=4

(c) Derive an expression for the *(i)* gravitational potential and *(ii)* gravitational field due to a spherical shell of radius R and mass M at any distance r from its centre, where $r > R$. 3+2=5

Or

What is a geosynchronous satellite? A rocket is launched vertically upward from the surface of the earth with an initial velocity of v_0. Show that its velocity v at a height h is given by

$$v_0^2 - v^2 = \frac{2gh}{1+\frac{h}{R}}$$

where R is the radius of the earth and g is the acceleration due to gravity at earth's surface. 1+4=5

(d) A frame of reference rotates with angular velocity $\vec{\omega}$. For this frame, establish the identity (operator)

$$\frac{d}{dt} = \frac{d'}{dt} + \vec{\omega}x$$

3

Or

Calculate the magnitude and direction of Coriolis acceleration of a rocket moving with a velocity of 2 km/s at 60° south latitude.

(e) At what speed a particle will move if the mass is equal to three times its rest mass? 3

(Continued)

Or

Calculate the wavelength of gamma ray photon produced in two-quarter annihilation of an electron and positron. ($h = 6{\cdot}6\times10^{-34}$ J-sec; $c = 3\times10^{8}$ m/s; $m_e = m_p = 9\times10^{-31}$ kg)

6. *(a)* Deduce the expression for relativistic variation of mass with velocity. 4

Or

Deduce the mathematical expression for the law of addition of velocity.

(b) A rocket is moving with a speed of 0·9 c with respect to the earth in a certain direction. With what speed must another rocket move with respect to earth so that it overtakes the first rocket by 0·4c? 2

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Total No. of Printed Pages—5

1 SEM TDC MTMH (CBCS) C1

2019

(December)

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 $\frac{d}{dx}(\cosh x)$. 1

(b) Let $f(x)$ is a differentiable function on an open interval I. Write when it is concave up. 1

(c) Find $\frac{d}{dx}(\tanh\sqrt{1+x^2})$. 2

(d) Find y_n (any *one*) : 3

(i) $y = \sin^2 x \cos^2 x$

(ii) $y = \sin x \sin 2x \sin 3x$

(e) If $y = x^2 \tan^{-1} x$, then find y_n. 4

Or

If $y = (\sin^{-1} x)^2$, then show that

$$(1-x^2)y_{n+2} - (2n+1)xy_{n+1} - n^2 y_n = 0$$

(f) If $y = e^{ax+b} \sin x$, then find y_n. 3

(g) Evaluate (any *one*) : 3

(i) $\lim\limits_{x \to 0} \dfrac{\tan x - x}{x - \sin x}$

(ii) $\lim\limits_{x \to \infty} \dfrac{x^2 + 3x}{1 - 5x^2}$

(h) Find the minimum value of the function

$$f(x) = 1 + 2\sin x + 3\cos^2 x, \; x \in \left[0, \frac{\pi}{2}\right]$$ 3

2. (a) Show that

$$\int_0^{\frac{\pi}{2}} \sin^n x \, dx = \int_0^{\frac{\pi}{2}} \cos^n x \, dx$$ 1

(b) Obtain the reduction formula for

$$\int \sin^n x \, dx, \; n > 1$$

and hence write the value of $\int \sin^3 x \, dx$.

4+1=5

(c) Evaluate (any *one*) : 4

(i) $\int \tan^5 x \, dx$

(ii) $\int \sec^5 x \, dx$

(d) A region bounded by the curve $y = x^2 + 1$ and the line $x + y = 3$ is revolved about the x-axis to generate a solid. Find the volume of the solid. 5

Or

A region is enclosed by the triangle with vertices (1, 0), (2, 1), (1, 1). Find the volume of the solid generated by revolving the region about the y-axis.

3. (a) Write the equation of parabola in polar form. 1

(b) Find an equation for the hyperbola with eccentricity $\frac{5}{3}$ and directrix $x = 3$ in polar form. 2

(c) Find the parametric equations and a parameter interval for the motion of a particle that starts at $(a, 0)$ and traces the circle $x^2 + y^2 = a^2$, once clockwise. 2

(d) Determine the nature of the conic represented by

$$x^2 + 2xy + y^2 + 2x - y + 2 = 0$$ 2

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1 SEM TDC MTMH (CBCS) C 2

2019

(December)

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 complex number $-1+i$ in the polar form. 1

(b) Show that the n numbers of n th root of unity form a geometric progression indicating the common ratio. 2

(c) Find the values of $(-16)^{\frac{1}{4}}$. 3

(d) Writing $\cos\theta + i\sin\theta$ as $\text{cis}\theta$, if $x = \text{cis}\alpha$, $y = \text{cis}\beta$, $z = \text{cis}\gamma$ and $xyz = x + y + z$, show that

$$1 + \cos(\beta - \gamma) + \cos(\gamma - \alpha) + \cos(\alpha - \beta) = 0$$ 4

2. *(a)* Give an example of the well-ordering property of positive integers. 1

(b) Let $f: \mathbb{R} \to \mathbb{R}$ and $g: \mathbb{R} \to \mathbb{R}$ be two functions. Consider the composite of f and g. Following conclusions are drawn :

I. fg is the composite of f and g.

II. Range of f is contained in the domain of g.

Choose the correct answer from the following : 1

(i) Both the statements I and II are true

(ii) I is true and II is false

(iii) I is false and II is true

(iv) Both the statements I and II are false

(c) Consider the functions $f: \mathbb{Z} \to \mathbb{R}$ defined as $f(x) = 2x$ and $g: \mathbb{N} \to \mathbb{R}$ defined as $g(x) = \sqrt{x}$. Find the composites gf and fg, if they exist. Justify your answer in each case. 2

(d) Show that the relation 'congruence modulo m' ($\equiv$) over the set of positive integers is an equivalence relation. 3

(e) Let $f: X \to Y$ be invertible. Show that f is a bijection. Show that $g: \mathbb{R} \to \mathbb{R}$ defined by $g(x) = 2x + 1$ is a bijection and find its inverse. 3+2+1=6

(f) Let $b > 0$ be an integer and a be any integer. Show that there exist unique integers q and r such that $a = bq + r$, where $0 \leq r < b$. 4+2=6

(g) What is Euclidean algorithm? Let $a, b \in \mathbb{Z}$ and either $a \neq 0$ or $b \neq 0$. Show that there exists greatest common divisor d of a and b such that $d = ax + by$ for some integers x and y and d is uniquely determined by a and b. 1+5=6

Or

Show that $an \equiv bn \pmod{m} \Leftrightarrow a \equiv b \left(\mod \frac{m}{d} \right)$, where $(m, n) = d$.

3. *(a)* Define linear combination of the vectors $v_1, \cdots, v_p$ in $\mathbb{R}^n$. 1

(b) Give an example of a 3×5 matrix in the row reduced echelon form. 1

(c) A linear system of equations in five variables has been reduced to the

associated system

$x_1 + 6x_2 + 3x_4 = 0;\ x_3 - 4x_4 = 5;\ x_5 = 7$

with reference to the reduced augmented matrix

$$\begin{bmatrix} 1 & 6 & 0 & 3 & 0 & 0 \\ 0 & 0 & 1 & -4 & 0 & 5 \\ 0 & 0 & 0 & 0 & 1 & 7 \end{bmatrix}$$

Indicate the basic variables and the free variables. 2

(d) A vector equation $x_1 v_1 + \cdots + x_p v_p = 0$ where each $v_i \in \mathbb{R}^n;\ 1 \le i \le p$ and each $x_i;\ 1 \le i \le p$ is a scalar, has the trivial solution. State the consequences with reference to x_i's and v_i's separately. 1+1=2

(e) Define span $\{v_1, \cdots, v_p\}$, where $v_1, \cdots, v_p \in \mathbb{R}^n$. Justify whether $0 \in$ span $\{v_1, \cdots, v_p\}$ or not. Determine, for what value(s) of h, $w = \begin{bmatrix} 3 \\ 1 \\ h \end{bmatrix}$ is in span $\{v_1, v_2, v_3\}$, where $v_1 = \begin{bmatrix} 1 \\ -1 \\ -2 \end{bmatrix}$, $v_2 = \begin{bmatrix} 5 \\ -4 \\ -7 \end{bmatrix}$, $v_3 = \begin{bmatrix} -3 \\ 1 \\ 0 \end{bmatrix}$. 5

Or

Let A be an $m \times n$ matrix, $x \in \mathbb{R}^n$ and $b \in \mathbb{R}^m$. When does the equation $Ax = b$ have a solution? Further for $u, v \in \mathbb{R}^n$ and a scalar c show that—

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

(ii) $A(cu) = cAu$.

(f) Describe all the solution of $Ax = b$, where

$$A = \begin{bmatrix} 3 & 5 & -4 \\ -3 & -2 & 4 \\ 6 & 1 & -8 \end{bmatrix},\ b = \begin{bmatrix} 7 \\ -1 \\ 4 \end{bmatrix}$$

by—

(i) row reducing the augmented matrix $[A\ \ b]$ to echelon form;

(ii) transforming the above to row reduced echelon form;

(iii) giving the solution in the form $x = p + tv,\ t \in \mathbb{R}$. 2+2+1=5

(g) Prove that an indexed set of two or more vectors $S = \{v_1, \cdots, v_p\}$ is linearly dependent if and only if at least one of the vectors in S is a linear combination of the others. 4

Or

Determine a linear dependence relation among the vectors $v_1 = \begin{bmatrix}1\\2\\3\end{bmatrix}$, $v_2 = \begin{bmatrix}4\\5\\6\end{bmatrix}$, $v_3 = \begin{bmatrix}2\\1\\0\end{bmatrix}$.

4. *(a)* Let $T: \mathbb{R}^5 \to \mathbb{R}^2$ and $T(x) = Ax$ for some matrix A and for each $x \in \mathbb{R}^5$. How many rows and columns are there in A? 1

(b) Define the column space of a matrix A. 1

(c) Show that the null space of an $m \times n$ matrix A is a subspace of $\mathbb{R}^n$. 2

(d) Show that $u = \begin{bmatrix}6\\-5\end{bmatrix}$ is an eigenvector of $A = \begin{bmatrix}1 & 6\\5 & 2\end{bmatrix}$ and state the corresponding eigenvalue. 2

(e) Determine the eigenvalues of $A = \begin{bmatrix}2 & 3\\3 & -6\end{bmatrix}$. 2

(Continued)

(f) Let $T: \mathbb{R}^n \to \mathbb{R}^m$ be linear. Then show that T is one-to-one if and only if the equation $T(x) = 0$ has the trivial solution. 4

(g) Let $T: \mathbb{R}^n \to \mathbb{R}^m$ be linear. Show that there exists a unique matrix A such that $T(x) = Ax \ \forall \ x \in \mathbb{R}^n$. 4

Or

Let $T: \mathbb{R}^2 \to \mathbb{R}^4$ be linear and given $T(e_1) = \begin{bmatrix}3\\1\\3\\1\end{bmatrix}$, $T(e_2) = \begin{bmatrix}-5\\2\\0\\0\end{bmatrix}$, where $e_1 = \begin{bmatrix}1\\0\end{bmatrix}$ and $e_2 = \begin{bmatrix}0\\1\end{bmatrix}$. Find a formula for the image of an arbitrary x in $\mathbb{R}^2$.

(h) Row reduce the augmented matrix $[A \ \ I]$, where $A = \begin{bmatrix}1 & 0 & -2\\-3 & 1 & 4\\2 & -3 & 4\end{bmatrix}$ and I, the identify matrix so that $[A \ \ I]$ is row equivalent to $[I \ \ A^{-1}]$. Verify that $AA^{-1} = I$. 3+2=5

(Turn Over)

(i) Determine the rank of

$$A = \begin{bmatrix} 2 & 5 & -3 & -4 & 8 \\ 4 & 7 & -4 & -3 & 9 \\ 6 & 9 & -5 & 2 & 4 \\ 0 & -9 & 6 & 5 & -6 \end{bmatrix}$$

by row reducing it to echelon form. 4

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Total No. of Printed Pages—7

1 SEM TDC CHMH (CBCS) C 1

2019

(December)

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 from the following : 1×6=6

(a) Heisenberg's uncertainty principle is

(i) $\Delta x \cdot \Delta P = \frac{h}{4\pi m}$

(ii) $\Delta x \cdot \Delta P = \frac{h}{mV}$

(iii) $\Delta x \cdot \Delta P \geq \frac{h}{4\pi}$

(iv) $\Delta x \cdot \Delta P \leq \frac{h}{4\pi}$

(b) The standard electrode potentials of four electrodes are

Electrode :	$Zn^{2+}\|Zn$	$Cd^{2+}\|Cd$	$Ag^{+}\|Ag$	$Fe^{3+}\|Fe$
$E^{\circ}(V)$:	−0·76	−0·40	0·80	−0·44

Which of the following cells is not feasible?

(i) $Zn|Zn^{2+}||Cd^{2+}|Cd$

(ii) $Fe|Fe^{3+}||Zn^{2+}|Zn$

(iii) $Cd|Cd^{2+}||Ag^{+}|Ag$

(iv) $Fe|Fe^{3+}||Ag^{+}|Ag$

(c) The electronegativity of C, N, P and Si increases in the order

(i) C < N < Si < P

(ii) N < Si < C < P

(iii) Si < P < C < N

(iv) P < Si < N < C

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

(i) BeO

(ii) MgO

(iii) CaO

(iv) SrO

(Continued)

(e) The geometrical shape of ClF_3 molecule is

(i) pyramidal

(ii) trigonal planar

(iii) T-shape

(iv) tetrahedral

(f) Which of the following is paramagnetic?

(i) O_2^-

(ii) CO

(iii) NO^+

(iv) CN^-

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

(a) What are normalized and orthogonal wave functions? 1+1=2

(b) Write Schrödinger's wave equation and give the meanings of the symbols used there. 1+1=2

(c) Arrange H_2O, H_2S, H_2Se and H_2Te in the increasing order of bond angle, giving the proper explanation for this trend. 2

(Turn Over)

(d) What do you mean by ionization potential? Why is the value of second ionization potential higher than the first ionization potential? 1+1=2

(e) Define electron affinity. Electron affinity value increases from nitrogen to fluorine in the periodic table. Explain giving reason. 2

(f) Which of the following orbitals are not possible and why? 2

$1p$, $2s$, $2p$ and $3f$

(g) Using VSEPR theory, predict the structures of the following : 1×2=2

(i) SF_4

(ii) XeF_2

(h) Using Fazans' rule, explain that "AlF_3 is high-melting solid while $AlCl_3$ is low-melting volatile solid". 2

(i) Arrange the following in the increasing order of bond length : 2

O_2, O_2^-, O_2^+, O_2^{2+}

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

(a) (i) State and explain the principles applied to build up the electronic configuration of nitrogen atom. 2

(ii) Determine the values of n, l, m and s for the valence shell electron of potassium. 2

(b) Derive de Broglie equation. Calculate the wavelength associated with a moving electron having kinetic energy $1{\cdot}375\times10^{-25}$ J. ($h = 6{\cdot}626\times10^{-34}$ J-s) 2+2=4

(c) (i) Write the radial and angular wave functions for hydrogen atom. 2

(ii) Write a note on contour boundary. 2

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

(a) What is effective nuclear charge? Explain on the basis of Slater's rule, why $4s$ orbital is filled earlier than $3d$ orbital taking potassium atom as an example. 1+2=3

(b) What do you mean by electronegativity of an element? Calculate the electronegativity of fluorine using Allred-Rochow equation. (Covalent radius of fluorine = 0·72 Å) 1+2=3

(c) Nitrogen has positive electron gain enthalpy whereas oxygen has negative. However, oxygen has lower ionization enthalpy than nitrogen. Explain. 3

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

(a) What do you mean by percentage of ionic character? HBr molecule has H—Br bond length $1{\cdot}41\times10^{-10}$ m and its dipole moment is $0{\cdot}79\times10^{-29}$ cm. Calculate the percentage of ionic character of HBr molecule. (Given, electronic charge = $1{\cdot}602\times10^{-19}$ C) 1+2=3

(b) What do you mean by hydrogen bond? What are the different types of hydrogen bond? Explain why *o*-hydroxybenzaldehyde is a liquid whereas *p*-hydroxybenzaldehyde is a solid. ½+1+1½=3

(c) What do you mean by bond order of a molecule? The bond dissociation energy of C_2 (599 kJ mol^{-1}) decreases slightly on forming C_2^+ (513 kJ mol^{-1}) and increases greatly on forming C_2^- (818 kJ mol^{-1}). Why? 1+2=3

6. Write short notes on any *two* of the following : 2½×2=5

(a) Solvation energy

(b) Defects in solids

(c) Mulliken-Jaffé electronegativity scales

7. What is standard electrode potential? Explain two important applications of its inorganic reaction. 1+1½+1½=4

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Total No. of Printed Pages—7

1 SEM TDC CHMH (CBCS) C 2

2019

(December)

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) The critical temperature is that temperature

(i) at which a gas behaves ideally

(ii) above which a gas can be easily liquefied

(iii) below which a gas can be liquefied by pressure alone

(iv) at which a gas cannot be liquefied

(b) The gases which have the same kinetic energy at a given temperature and pressure are

(i) H_2 and N_2

(ii) N_2 and CH_4

(iii) CH_4 and N_2

(iv) All of the above

(c) Water is a liquid at room temperature because it

(i) has high dipole moment of 1·85 *D*

(ii) is a symmetrical molecule

(iii) is extensively H-bonded with other molecules

(iv) has large dispersion forces

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

(a) Xe has $P_c = 58{\cdot}0$ atm and $T_c = 289{\cdot}7$ K. Determine its van der Waals' constants *a* and *b*.

(b) Out of *n*-pentane and neo-pentane (both are isomers of pentane) which has higher boiling point and why?

(c) Silver crystallizes in a face-centred cubic lattice with all the atoms at the lattice points. The length of the edge of the unit cell as determined by X-ray diffraction studies is found to be $4{\cdot}077\times10^{-8}$ cm. The density of silver is $10{\cdot}5$ g cm^{-3}. Calculate the atomic mass of silver.

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

(e) Derive the relation $P_cV_c = \frac{3}{8}RT_c$.

(f) A buffer solution contains 0·4 mole of NH_4OH and 0·5 mole of NH_4Cl per litre. Calculate the pH of the solution. Dissociation constant of NH_4OH at the room temperature is $1{\cdot}81\times10^{-5}$.

UNIT—I

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

(a) (i) Derive van der Waals' equation for *n* moles of a real gas. 4

(ii) Show that the excluded volume *b* is four times the actual volume of the molecule. 3

(b) (i) From the kinetic gas equation, derive the expression for root-mean-square velocity. 2

(ii) Derive the relationship between most probable, average and root-mean-square velocity. 2

(iii) Calculate the temperature at which the average velocity of oxygen equals that of hydrogen at 20 K. 3

(c) (i) What are reduced pressure, temperature and volume? Derive the reduced equation of state. Write its significance. 1½+2½+1=5

(ii) The reduced volume and temperature of a gas are 10·2 and 0·7. What will be its pressure if its critical pressure is 4·25 MPa? 2

UNIT—II

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

(a) (i) Explain three different inter-molecular forces present in liquids. Give examples. 3

(ii) What structural part of a liquid makes it flow? Explain briefly how a liquid flows. 2

(b) (i) Describe drop number method for determining the surface tension of a liquid. 3

(ii) In the determination of surface tension of a liquid using stalagmometre, 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 $0{\cdot}998\ g\ mol^{-1}$ while that of the liquid is $0{\cdot}795\ g\ mol^{-1}$. The surface tension of water at the given temperature is $70{\cdot}8\ dynes\ cm^{-1}$. What is the surface tension of the liquid? 2

UNIT—III

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

(a) What are liquid crystals? Name the different types and how do they differ in their molecular arrangement. Write any one application of liquid crystal. 1+3+½=4½

(b) (i) Derive Bragg's equation for crystal structure determination. 3

(ii) Sodium metal crystallizes in b.c.c. lattice with the cell edge 4·29 Å. What is the radius of sodium atom? 1½

(c) (i) What are Miller indices? Illustrate (111) plane in cubic system. 1+1½=2½

(ii) Electrical conductivity of semi-conductor increases with increase in temperature. Explain from band theory. 2

UNIT—IV

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

(a) (i) Define the terms solubility and solubility product of a substance. Explain the use of solubility product in qualitative analysis. 2+3=5

(ii) 0·00094 gm of AgCl is dissolved in 500 ml of water at 25 °C to form a saturated solution. Calculate the solubility product of AgCl. (Ag = 108, Cl = 35·5). 2

(b) (i) What is buffer solution? Derive Henderson's equation for acidic buffer. Write three applications of buffer solution. 1+2½+1½=5

(*Continued*)

(ii) Calculate the pH value of a solution obtained by mixing 0·083 moles of acetic acid and 0·091 moles of sodium acetate and making the volume 500 ml. K_a for acetic acid is $1{\cdot}75\times10^{-5}$. 2

(c) (i) What is salt hydrolysis? For a salt of weak base and strong acid, prove that $K_h = \frac{K_w}{K_b}$. Deduce an expression for pH of such salt solution. 1+2+2=5

(ii) Explain why phenolphthalein is not a suitable indicator in the titration of ammonium hydroxide and HCl. 2

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Total No. of Printed Pages—3

1 SEM TDC ZOOH (CBCS) C 1

2019

(December)

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) Euglena belongs to subclass _____.

(b) Canal system is found in _____.

(c) Phylum Cnidaria is characterized by _____ cells.

(d) In jellyfish, the mouth is at the end of the _____.

(e) Cydippid larva is found in the phylum _____.

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

(a) Parazoa and Metazoa

(b) Coral and Coral reefs

(c) Polyp and Medusa

3. Write short notes on (any *three*) : 3×3=9

(a) Locomotion of Protists

(b) Segmentation in Metazoa

(c) Symptoms of Ascariasis

(d) Polymorphism in Cnidaria

4. Explain the process of sexual or asexual reproduction of Protists. 5

5. Describe the general characters and classification of Porifera up to class. 3+3=6

Or

Give a description of different types of canal system in Porifera. 6

6. Describe in brief the life cycle of Obelia. 5

7. Describe the evolutionary significance of Ctenophora. 4

Or

Write four distinguishing characters of Ctenophora.

8. Describe the life cycle and pathogenicity of *Taenia solium.* 4+3=7

9. Describe the parasitic adaptations of helminthes. 6

Or

What do you understand by pseudocoelomata? Describe the life cycle of *Ascaris lumbricoides.* 1+5=6

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Total No. of Printed Pages—4

1 SEM TDC ZOOH (CBCS) C 2

2019

(December)

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. Select the correct answer from the following options : 1×5=5

(a) The most important factor for the success of animal population is

(i) natality

(ii) adaptability

(iii) unlimited food

(iv) interspecies activity

(b) The formula for exponential growth form of population is

(i) $dN / dt = rN$

(ii) $dt / dN = rN$

(iii) $dx / rN = dt$

(iv) $rN / dN = dt$

(c) Threatended species are included as

(i) critically endangered species

(ii) endangered species

(iii) vulnerable species

(iv) All of the above

(d) Regulation of population density may be

(i) behavioural

(ii) physiological

(iii) population based

(iv) All of the above

(e) The branch of ecology which deals with the study of soil and its influence on organisms is

(i) landscape ecology

(ii) pedo-ecology

(iii) autecology

(iv) community ecology

2. (a) Distinguish between any *three* of the following pairs : 2×3=6

(i) *r*-selection and *K*-selection

(ii) Economical and ecological value of wildlife conservation

(iii) Autecology and synecology

(iv) Crude density and ecological density

(b) Write brief notes on any *two* of the following : 3×2=6

(i) Advances of *ex situ* conservation

(ii) Laws of limiting factors

(iii) Food chain

3. What is ecological succession? Describe the process of ecological succession with an example. 1+6=7

Or

What is meant by ecotone and edge effect? Describe different types of ecotones. 2+5=7

4. What is species diversity? How is it measured? 1+4=5

Or

What is Gause's principle? Explain the laboratory examples of Gause's principle. 5

5. Answer any *three* of the following questions :

(a) What is population? Describe the characteristics of population. 1+7=8

(b) Describe the flow of energy in ecosystem with the help of suitable models. 8

(c) Describe the nitrogen cycle with suitable diagram. 8

(d) Define survivorship curve. Describe different types of survivorship curves with examples. 1+7=8

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