5 SEM TDC PHYH (CBCS) C 11

2 0 2 3

(November)

PHYSICS

(Core)

Paper : C–11

(Quantum Mechanics and Applications)

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 momentum of a photon of energy *E* is

   (i) *Ec*   (ii) *E/c*

   (iii) $E^2 c$ (iv) E/c^2

   (b) The Hamiltonian operator is expressed as

   (i) $\hat{H} = \dfrac{\hbar^2}{2m}\nabla^2 + V(\vec{r})$

   (ii) $\hat{H} = -\dfrac{\hbar^2}{2m}\nabla^2 + V(\vec{r})$

(*Turn Over*)

(2)

(iii) $\hat{H} = -\dfrac{\hbar^2}{2m} \nabla^2 - V(\vec{r})$

(iv) $\hat{H} = \dfrac{\hbar^2}{2m} \nabla^2 - V(\vec{r})$

(c) The zero point energy of a harmonic oscillator is

(i) $\dfrac{5}{2}\hbar\omega$

(ii) $\dfrac{3}{2}\hbar\omega$.

(iii) $\dfrac{1}{2}\hbar\omega$

(iv) zero

(d) The number of values of magnetic quantum numbers (m_l) for a given l is

(i) $2l-1$

(ii) $2l+1$

(iii) $2l$

(iv) infinite

(e) One Bohr magneton is defined as

(i) $\mu_B = \dfrac{eh}{2m}$

(ii) $\mu_B = \dfrac{\hbar}{2m}$

(iii) $\mu_B = \dfrac{2e\hbar}{m}$

(iv) $\mu_B = \dfrac{e\hbar}{2m}$

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

(a) Briefly discuss the principle of linear superposition of quantum states.

(Continued)

(3)

(b) How does a Gaussian wave packet spread with time?

(c) What are the boundary conditions which should be satisfied by a wave function and its derivative at the boundary of a potential?

(d) What do you mean by gyromagnetic ratio? What are the values of orbital and spin gyromagnetic ratios of an electron?

(e) What is total angular momentum of an electron? Calculate its value for an electron in the d orbital.

3. (a) Calculate the expectation value of $\hat{p}$ for the wave function

$$\psi(x) = \left(\dfrac{2}{L}\right)^{\frac{1}{2}} \sin\dfrac{\pi x}{L}$$

in the region $0 < x < L$. 3

(b) Briefly explain the concept of space quantization. 3

(c) What are identical particles? How can Pauli's exclusion principle be proved using the concept of symmetric and anti-symmetric wave functions? 1+3=4

(d) Show the ordering of various possible terms for the $3p\,3d$ configuration using Hund's rule. 5

(Turn Over)

4. *(a)* Obtain an expression for the general solution of the time-dependent Schrödinger equation in terms of linear combinations of stationary states.   6

Or

Show that the momentum space wave function is Fourier transform of the position space wave function.

(b) Obtain an expression for the energy eigenfunction of a simple harmonic oscillator and hence express the ground state eigenfunction using the concept of Hermite polynomials.   6

(c) Obtain the Schrödinger equation in spherical polar coordinates from the corresponding equation in Cartesian coordinates.   7

Or

Obtain three independent differential equations from the Schrödinger equation in each of the spherical polar coordinates for the electron of the hydrogen atom.

5. Write a short note on any *one* of the following :   4

(a) Normal Zeeman effect

(b) Paschen-Back effect

★ ★ ★

5 SEM TDC PHYH (CBCS) C 12

2 0 2 3

(November)

PHYSICS

(Core)

Paper : C–12

(Solid-State Physics)

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
(any *five*) :   1×5=5

   (a) If 0·28 nm is the interatomic distance in
        NaCl crystal, the lattice parameter is

        (i) 0·14 nm

        (ii) 0·56 nm

        (iii) 0·08 nm

        (iv) None of the above

(b) The Miller indices of the plane parallel to y and z axes are

   (i) (1 0 0)

   (ii) (0 1 0)

   (iii) (0 0 1)

   (iv) (1 1 1)

(c) At lower temperature, the lattice specific heat varies as

   (i) T^3

   (ii) $1/T^3$

   (iii) T

   (iv) $1/T$

(d) For a given dielectric, as the temperature increases, the ionic polarizability

   (i) increases

   (ii) decreases

   (iii) remains unchanged

   (iv) None of the above

(e) Ferromagnetic materials or ferrites are obtained from

   (i) copper

   (ii) zinc

   (iii) aluminium

   (iv) None of the above

(Continued)

(f) A superconducting material on being subjected to the critical field changes to

   (i) critical conductivity

   (ii) superconductivity which is independent of temperature

   (iii) normal state

   (iv) Remains uninfluenced

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

(a) Define unit cell and atomic packing factor.

(b) Define atomic radius in crystal. Calculate the atomic radius in case of b.c.c. lattices.

(c) What is meant by hysteresis in magnetic material?

(d) Draw the (111) plane for a simple cubic structure.

(e) What are Curie law and Curie temperature?

(f) What is penetration depth? Explain briefly.

(Turn Over)

3. *(a)* What is diffraction of X-rays? Explain Bragg's law for X-ray diffraction. 2+3=5

(b) What is a reciprocal lattice? Find the reciprocal lattice vectors for b.c.c. lattice. 2+4=6

Or

What are atomic and geometrical factors? Explain. 6

4. Derive the expression for the dispersion relation for a linear monoatomic chain of atoms. 6

5. *(a)* Distinguish dia- and para-magnetism. Explain classical Langevin theory of diamagnetic domain. 2+4=6

(b) Explain classical theory of electric polarizability. 5

Or

Deduce Clausius-Mossotti equation.

(c) Distinguish conductor, semi-conductor and insulator on the basis of band theory of solids. 5

Or

What is mobility? Discuss Hall effect.

6. What is critical magnetic field? Explain type-I and type-II superconductors. 2+3=5

★ ★ ★

5 SEM TDC DSE CHM (CBCS) 1 (H/NH)

2 0 2 3

(November)

CHEMISTRY

(Discipline Specific Elective)

(For Honours/Non-Honours)

Paper : DSE–1

(Analytical Methods in Chemistry)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

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

1. শুদ্ধ উত্তৰটো বাছি উলিওৱা :   1×6=6

Choose the correct answer :

(a) UV-Vis, IR আৰু মাইক্ৰ'ৱেভ স্পেক্ট্ৰ'স্কপিত সংঘটিত হোৱা পৰিৱৰ্তনৰ প্ৰকাৰবোৰ হ'ল

The types of transitions involved in the UV-Vis, IR and microwave spectroscopic techniques are

(i) ক্ৰমে কম্পনীয়, ইলেক্ট্ৰ'নীয় আৰু পৰিক্ৰমণীয়

vibrational, electronic and rotational respectively

(Turn Over)

(ii) ক্রমে ইলেক্ট্র'নীয়, পৰিক্রমণীয় আৰু কম্পনীয়

electronic, rotational and vibrational respectively

(iii) ক্রমে পৰিক্রমণীয়, কম্পনীয় আৰু ইলেক্ট্র'নীয়

rotational, vibrational and electronic respectively

(iv) ক্রমে ইলেক্ট্র'নীয়, কম্পনীয় আৰু পৰিক্রমণীয়

electronic, vibrational and rotational respectively

(b) তলৰ কোনটো বিদ্যুত-বিশ্লেষিক পদ্ধতি নহয় ?

Which of the following is not an electro-analytical method?

(i) ভ'ল্টামেট্রি/Voltammetry

(ii) প'লাৰ'গ্রাফি/Polarography

(iii) কেল'ৰিমেট্রি/Calorimetry

(iv) এমপিৰ'মেট্রি/Amperometry

(c) নোজ'ল হ'ল

Nujol is

(i) টেট্রাক্ল'ৰ'বিউটাডাইন/tetrachlorobutadiene

(ii) টেট্রাক্ল'ৰ'বিউটিন/tetrachlorobutene

(iii) হেক্সাক্ল'ৰ'বিউটাডাইন/hexachlorobutadiene

(iv) হেক্সাক্ল'ৰ'বিউটেন/hexachlorobutane

(Continued)

(d) N টা পৰ্যবেক্ষণৰ বাবে t-পৰীক্ষা আৰু F-পৰীক্ষাত স্বতন্ত্রতাৰ মাত্রা হ'ল

For t-test and F-test, the degrees of freedom for N number of observations is

(i) $N+1$

(ii) $N-1$

(iii) N^2+1

(iv) $(N+1)^2$

(e) V_{aq} ml জলীয় দ্রৱত W_0 g দ্রাব্য আছিল। প্রতিবাৰতে V_{or} ml কৈ জৈৱ যৌগ ব্যৱহাৰ কৰি nতম বাৰ নিষ্কাশন কৰাৰ পিছত জলীয় দ্রৱত অৱশিষ্ট থাকি যোৱা দ্রাব্য (W_n)ৰ পৰিমাণ হ'ল

W_0 g of a solute is present in V_{aq} ml of aqueous solution. The amount of solute (W_n) left in the aqueous solution after nth extraction with V_{or} ml of organic solvent in each step is given by the relation

(i) $W_n = W_0 \left[\dfrac{V_{aq}}{DV_{aq} + V_{or}} \right]^n$

(ii) $W_n = W_0 \left[\dfrac{V_{aq}}{V_{aq} + DV_{or}} \right]^n$

(Turn Over)

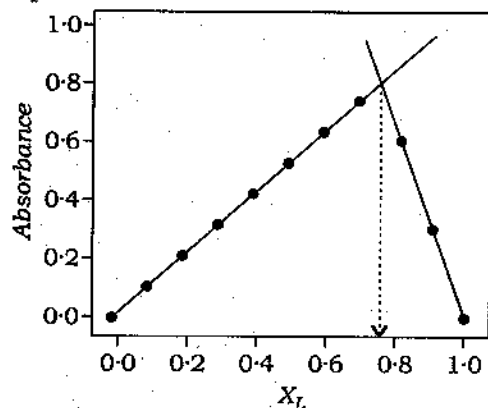(iii) $W_n = W_0 \left[\dfrac{V_{or}}{DV_{aq} + V_{or}} \right]^n$

(iv) $W_n = W_0 \left[\dfrac{V_{or}}{V_{aq} + DV_{or}} \right]^n$

য'ত D হ'ল বিতৰণ গুণাংক ।

where D is the distribution coefficient.

(f) Jobৰ অবিৰত পৰিবৰ্তন পৰীক্ষাত ধাতু M আৰু লিগান্দ L ৰ ক্ৰমিক দ্ৰৱ কিছুমানৰ বাবে তলৰ লেখচিত্ৰটো পোৱা গ'ল । ধাতুৰ জটিল যৌগটোৰ সংকেত হ'ল

The following graph is obtained from the Job's continuous variation experiment for a series of solutions of the metal M and the ligand L. The symbol of metal complex is

(i) ML (ii) ML_2

(iii) ML_3 (iv) ML_4

(Continued)

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2. তলৰ প্ৰশ্নবোৰৰ উত্তৰ দিয়া :   2×5=10

Answer the following questions :

(a) জিয়'লাইটসমূহক আয়ন বিনিময়ক হিচাপে ব্যৱহাৰ কৰাত সীমাবদ্ধতাবোৰ কি কি ?

What are the limitations of zeolites as ion exchangers?

(b) Bolometerসমূহ কি কি ?

What are bolometers?

(c) HPLC পদ্ধতিত বিলম্ব সময় (t_0) আৰু ধাৰণ সময় (t_R) কি ?

What are delay time (t_0) and retention time (t_R) in HPLC?

(d) প্ৰত্যক্ষ প'টেনচিওমেট্ৰিক পৰিমাপৰ তুলনাত প'টেনচিওমেট্ৰিক টাইট্ৰেচনৰ সুবিধাসমূহ আলোচনা কৰা ।

Discuss the advantages of potentiometric titrations in contrast to direct potentiometric measurements.

(e) UV-Vis স্পেক্ট্ৰ'ফ'ট'মিটাৰ ব্যৱহাৰ কৰি অজ্ঞাত দ্ৰৱৰ গাঢ়তা নিৰ্ণয় কৰোঁতে ক্ৰমাঙ্কন লেখচিত্ৰ পদ্ধতিৰ তুলনাত প্ৰমাণ সংযুক্ত পদ্ধতিটোৰ সুবিধাবোৰ কি কি ?

What are the advantages of the standard addition technique as compared to a calibration curve method in determination of concentration of unknown solutions using UV-Vis spectrophotometer?

(Turn Over)

3. প্ৰণালীৱদ্ধ ক্ৰটি হ্ৰাস কৰিবৰ বাবে যি কোনো তিনিটা পদ্ধতি আলোচনা কৰা ।   3

Discuss any three methods for minimizing systematic error.

নাইবা / Or

আইৰণৰ শতাংশ পুনঃপুনঃ নিৰ্ণয় কৰাত তলৰ ফলাফলসমূহ পোৱা গ'ল । কোনোবা এটা মান প্ৰত্যাখ্যানযোগ্য নেকি, Q-পৰীক্ষাৰ সহায়ত ঠিৰাং কৰা :

%   আইৰণ : 53·30, 53·47, 53·50, 53·51 আৰু 53·46

(দিয়া আছে, 90% আত্মবিশ্বাস স্তৰত $n = 5$ৰ কাৰণে $Q_{tab} = 0.64$)

In replicate determination of iron, the following results of percentage of iron were obtained. Should any of the results be rejected by Q-test?

% Fe : 53·30, 53·47, 53·50, 53·51 and 53·46

(Given, for $n = 5$, $Q_{tab} = 0.64$ at 90% confidence level)

4. তলৰ যি কোনো চাৰিটা প্ৰশ্নৰ উত্তৰ লিখা :   4×4=16

Answer any *four* questions from the following :

(a) Beer-Lambertৰ বিধিটো লিখা (কেৱল সমীকৰণ) । যৌগ এটাৰ ম'লাৰ শোষণ ক্ষমতা হ'ল $2.0×10^4$ cm^{-1} mol^{-1} dm^3. যদি কিউভেটৰ

পথৰ দৈৰ্ঘ্য 5·0 cm হয়, তেন্তে যৌগটোৰ $2.0×10^{-6}$ $mol\ dm^{-3}$ দ্ৰৱ এটাৰ ট্ৰান্সমিটেন্স গণনা কৰা ।   1+3=4

Write the Beer-Lambert law (equation only). The molar absorptivity of a substance is $2.0×10^4$ cm^{-1} mol^{-1} dm^3. Calculate the transmittance through a cuvette of path length 5·0 cm containing $2.0×10^{-6}$ $mol\ dm^{-3}$ solution of the substance.

(b) UV-Vis স্পেক্ট্ৰ'ফ'ট'মিটাৰত একক-আলোক ৰশ্মি আৰু দ্বৈত-আলোক ৰশ্মিৰ ৰূপৰেখা/সজ্জা কি ? উপযুক্ত খণ্ডচিত্ৰৰ সহায়ত আলোচনা কৰা ।

What are single-beam and double-beam configurations in UV-Vis spectrophotometer? Discuss with suitable block diagram.

(c) IR স্পেক্ট্ৰ'ফ'ট'মিটাৰত সচৰাচৰ ব্যৱহাৰ কৰা যি কোনো দুটা IR ৰশ্মিৰ উৎসৰ বিষয়ে চমু টোকা লিখা ।   2+2=4

Write short notes on any two IR sources commonly employed in the IR spectrophotometers.

(d) শিখা পাৰমাণৱিক শোষণ স্পেক্ট্ৰ'ফ'ট'মিটাৰৰ উপাংশসমূহ উল্লেখ কৰা । শিখা পৰমাণুকৰণৰ বিষয়ে চমুকৈ আলোচনা কৰা । শিখা পৰমাণুকৰণ পদ্ধতিৰ আসোঁৱাহসমূহ লিখা ।

Mention the components of a flame atomic absorption spectrophotometer. Discuss briefly about flame atomizers. Write the disadvantages of flame atomization method.

(e) FT-IR স্পেক্ট্ৰ'ফ'ট'মিটাৰ কি ? FT-IR স্পেক্ট্ৰ'-ফ'ট'মিটাৰৰ বিচ্ছুৰিত প্ৰতিৰূপৰ তুলনাত FT-IR স্পেক্ট্ৰ'ফ'ট'মিটাৰৰ সুবিধাসমূহ উল্লেখ কৰা ।

What are FT-IR spectrophotometers? Enumerate the advantages of FT-IR spectrophotometer over its dispersive counterpart.

(f) এটা IR বৰ্ণালীত কাৰ্যকৰী মূলক এলেকা/অংশ বুলিলে কি বুজা ? জৈৱ যৌগ এটাৰ গঠন নিৰ্ণয় কৰাত ই কিদৰে সহায়ক হয় ? জৈৱ যৌগৰ যি কোনো দুটা কাৰ্যকৰী মূলকৰ বাবে আনুমানিক IR কম্পনাংক (cm^{-1}) উল্লেখ কৰা ।

What is meant by functional group region of an IR spectrum? How is it useful in determining the structure of an organic molecule? Mention the approx IR frequency (in cm^{-1}) of any two common functional groups of organic molecule.

(g) IR স্পেক্ট্ৰ'স্কপিত কঠিন পদাৰ্থৰ নমুনা প্ৰস্তুতকৰণৰ বিভিন্ন পদ্ধতিবোৰ চমু আলোচনা কৰা ।

Briefly describe the different sampling techniques for solid samples in IR spectroscopy.

5. CaO আৰু CaCO$_3$ৰ মিশ্ৰণ এটা TGAৰ সহায়ত বিশ্লেষণ কৰোঁতে দেখা গ'ল যে 600 °Cৰ পৰা 900 °C উষ্ণতাৰ পৰিসৰত নমুনাটোৰ ভৰ 250·6 mgৰ পৰা 190·8 mg লৈ হ্ৰাস হৈছে । মিশ্ৰণটোত CaCO$_3$ৰ শতাংশৰ পৰিমাণ গণনা কৰা ।   4

A mixture of CaO and CaCO$_3$ is analyzed by TGA. The result indicates that mass of the sample decreases from 250·6 mg to 190·8 mg only between 600 °C and 900 °C. Calculate the percentage of CaCO$_3$ in the mixture.

নাইবা / Or

TGA পদ্ধতিত হ'ব পৰা ত্ৰুটিসমূহৰ উৎসসমূহ ব্যাখ্যা কৰা । ইয়াৰ পৰা কিদৰে হাত সাৰিব পাৰি ?

Explain the various sources of errors in TGA. How can these be avoided?

6. তলৰ প্ৰশমন বিক্ৰিয়া দুটাৰ বাবে conductometric টাইট্ৰেচনৰ লেখচিত্ৰ অংকন কৰা :

(a) যদি NH$_4$OHৰ দ্ৰৱ এটাক HClৰ দ্বাৰা (বুৰেটত লৈ) টাইট্ৰেচন কৰা হয়

(b) যদি HClৰ দ্ৰৱ এটাক NH$_4$OHৰ দ্বাৰা (বুৰেটত লৈ) টাইট্ৰেচন কৰা হয়

Conductometric টাইট্ৰেচন লেখচিত্ৰবোৰৰ পাৰ্থক্যৰ কাৰণবোৰ ব্যাখ্যা কৰা ।   5

Sketch the conductometric titration curves for the following neutralization titrations :

(a) NH_4OH is titrated with HCl taken in the burette

(b) HCl is titrated with NH_4OH taken in the burette

Explain the reasons for the difference in the nature of the conductometric titration curves.

নাইবা / Or

প'টেনচিওমেট্রিক সহায়ত অধঃক্ষেপণ বিক্রিয়াৰ টাইট্রেচন কেনেদৰে কৰা হয়, উপযুক্ত উদাহৰণসহ ব্যাখ্যা কৰা ।

With a suitable example, explain how precipitation titrations done potentiometrically.

7. তলৰ যি কোনো তিনিটা প্রশ্নৰ উত্তৰ লিখা : 3×3=9

Answer any *three* questions from the following :

(a) পেপাৰ আৰু thin-layer বৰ্ণলেখন পদ্ধতিত ব্যৱহৃত বিভিন্ন চাক্ষুষকৰণ/দৃশ্যমানতা কৌশলসমূহ আলোচনা কৰা ।

Discuss various visualization techniques used in paper and thin-layer chromatography.

(b) HPLC পদ্ধতিৰ তত্ত্ব/নীতি লিখা ।

Write the principles of HPLC.

(c) p-Nitrobenzoic acid আৰু resorcinolৰ দ্বৈত মিশ্রণ এটাৰ পৰা উপাদানসমূহ কেনেদৰে পৃথক কৰিব পাৰি, উপযুক্ত প্রবাহ-চিত্রৰ দ্বাৰা আলোচনা কৰা । 'Oxalic acid আৰু resorcinol'ৰ মিশ্রণটোৰ বাবে পৃথকীকৰণত কিবা পাৰ্থক্য থাকিলে প্রদৰ্শন কৰা ।

Using suitable flowchart, discuss the separation of the components in the binary mixture of p-nitrobenzoic acid and resorcinol. Is there any difference for the mixture of 'oxalic acid and resorcinol'? If yes, point out the differences.

(d) জলীয় দ্রৱৰ পৰা ধাতুৰ আধান পৃথকীকৰণত ব্যৱহৃত বিভিন্ন দ্রাৱক নিষ্কাশন পদ্ধতিবোৰ আলোচনা কৰা । Salting প্রভাৱ কি ?

Discuss the different solvent extraction methods of metal ions from aqueous solution. What is salting effect?

(e) ব্যাচ/গোট, ক্রমাগত আৰু বিপৰীত-প্রবাহ নিষ্কাশন পদ্ধতিবোৰ আলোচনা কৰা ।

Discuss the batch, continuous and counter-current extraction techniques.

★★★

5 SEM TDC DSE CHM (CBCS) 2 (H)

2 0 2 3

(November)

CHEMISTRY

(Discipline Specific Elective)

(For Honours)

Paper : DSE–2

(Green 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) Basically 'risk' is a function of

   (i) pollution × prevention

   (ii) pollution × hazard

   (iii) hazard × exposure

   (iv) pollution × exposure

(b) Photochemical smog of London was reported around

   (i) 1–5 December, 1950

   (ii) 1–5 December, 1952

   (iii) 5–9 December, 1950

   (iv) 5–9 December, 1952

(c) The book, *Silent Spring* was written by

   (i) Rachel Carson

   (ii) B. M. Trost

   (iii) Lord Carson

   (iv) John Warner

(d) Which of the following is not a green chemistry principle?

   (i) Maximizing atom economy

   (ii) Using catalysts

   (iii) Producing derivatives

   (iv) Use of renewable feedstock

(Continued)

(e) Which of the following is not an ionic liquid?

   (i) [bmin] [BF_4]

   (ii) Ph_3PO

   (iii) [emin] [BF_4]

   (iv) [bmim] [PF_6]

(f) Which of the following reactions is most atom economical?

   (i) Substitution reaction

   (ii) Addition reaction

   (iii) Elimination reaction

   (iv) Rearrangement reaction

2. Answer the following questions (any *nine*) :
                                                2×9=18

(a) Explain the term 'atom economy' with a suitable example.   1+1=2

(b) What are green solvents? Name two green solvents.   1+1=2

(c) What is the need of green chemistry?

(d) How can you convert toluene into benzoic acid in green method?

(e) Give one example of microwave-assisted reaction in organic solvents.

(f) How do you prepare imidazole in solvent-free conditions using microwave?

(g) What are the main differences between classical heating and microwave heating?

(h) What do you mean by piezoelectric effect?

(i) What is chemoselective reaction? Give one example of it.   1+1=2

(j) What are solid-state reactions? Give one example.   1+1=2

(k) How can you prepare adipic acid in green way?

3. Answer the following questions (any *six*) :
                    3×6=18

(a) Why is glycerol a green solvent? Explain with a suitable example.   1+2=3

(b) What are ionic liquids? How can Michael reaction be carried out with the help of ionic liquids?   1+2=3

(c) What is supercritical CO_2? How is it used as solvent in hydrogenation reaction?   1+2=3

(d) Write the alternative green procedure of pinacol-pinacolone rearrangement. Compare it with conventional procedure.   2+1=3

(e) What are sonication reactions? How can alcohol be prepared from Grignard reagent in green way?   1+2=3

(f) How can catechol be synthesized in green way? Compare the method with conventional method.   2+1=3

(g) Explain three principles of green chemistry.

(h) What are enzymes? Mention the advantages of using enzymes in relevance to green chemistry.   1+2=3

4. Answer the following questions (any *two*) :

                           3½×2=7

(a) How has disodium iminodiacetate (DSIDA) been synthesized traditionally by Strecker process? Write an alternative green procedure to prepare the DSIDA.   1½+2=3½

(b) What are the important factors that have to be considered while designing a green alternative reagent for a synthesis?

(c) Describe in brief why photochemical reactions are considered as green synthesis.

5. *(a)* Instead of anhydrous $AlCl_3$, what green option will you suggest in Friedel-Crafts reaction?   2

Or

(b) What are the advantages of green synthesis?

(c) Write a note on combinatorial green chemistry.   2

Or

(d) What are the characteristics of an ideal chemical reaction?

★ ★ ★

5 SEM TDC CHMH (CBCS) C 12

2 0 2 3

(November)

CHEMISTRY

(Core)

Paper : C–12

(Physical Chemistry, Quantum Chemistry and Spectroscopy)

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 : 1×4=4

   (a) Quantum mechanical operator for momentum is

   (i) $\dfrac{h}{2\pi i}\nabla$

   (ii) $\dfrac{h}{2\pi i}$

   (iii) $-\dfrac{h^2}{8\pi^2 m}\nabla^2$

   (iv) $\dfrac{\hbar}{2i}\nabla$

(Turn Over)

(b) The energy required to excite (to first excited state) a particle of mass m confined in a length l is

(i) $\dfrac{3h^2}{8ml^2}$

(ii) $\dfrac{h^2}{8ml^2}$

(iii) 0

(iv) h^2

(c) The number of NMR signals formed by 2-chloropropene is

(i) 2

(ii) 3

(iii) 1

(iv) None of the above

(d) Some chemical reactions take place not by the absorption of light by one of the reactants but by a third substance which transfers the absorbed energy to the reactants. This process is known as

(i) quenching

(ii) photosensitization

(iii) chemiluminescence

(iv) None of the above

(Continued)

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

(a) Why is $\psi\psi^*$ taken instead of ψ^2? What is angular part of wave function?

(b) What is zero-point energy? What is its significance?

(c) Why is TMS used as a reference standard in NMR spectroscopy?

(d) Describe Born-Oppenheimer approximation with its importance.

(e) What is the basic difference between fluorescence and phosphorescence?

UNIT—I

3. Answer any *four* questions from the following : 4×4=16

(a) Solve Schrödinger's wave equation for a particle moving freely in a three-dimensional cubic box. 4

(b) Write Schrödinger's wave equation for rigid rotator system and separate the variables. 4

(Turn Over)

(c) (i) Write a short note on eigenfunctions and eigenvalues. Normalize the function $\psi = x^2$ over the interval $0 \le x \le k$, where k is a constant. 2

(ii) What will happen if the walls of the one-dimensional box are suddenly removed? 2

(d) (i) What does angular part of wave function depict? 2

(ii) How can spherical harmonics wave function for hydrogen atom be written? 2

(e) (i) Write down Schrödinger's wave equation for H-atom in polar coordinates. 2

(ii) Write a short note on orthogonal wave function. 2

UNIT—II

4. Answer any *four* questions from the following : 4×4=16

(a) (i) Discuss about the interaction of electromagnetic radiation with a rotating molecule. 2

(ii) Microwave studies are done only in gaseous state. Explain why. 2

(b) (i) Explain fundamental frequencies and overtones with examples. 2

(ii) Calculate the force constant for $H^{35}Cl$ from the fact that the fundamental vibrational frequency is $8 \cdot 667 \times 10^{13}$ s^{-1}. 2

(c) Discuss the relaxation processes in NMR spectroscopy. What is chemical shift? 3+1=4

(d) Write short notes on the following : 2×2=4

(i) Chromophores

(ii) Bathochromic shift

(e) (i) What are P, Q and R branches of vibrational rotational spectrum? 3

(ii) Why is electronic spectrum a band spectrum? 1

UNIT—III

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

(a) What is Beer-Lambert law? Explain. What are the limitations of Beer-Lambert law? 2½+2=4½

(b) What is the role of photochemical reactions in biochemical process? 4½

(c) What is meant by photostationary state? What is chemiluminescence?

3+1½=4½

★ ★ ★

5 SEM TDC CHMH (CBCS) C 11

2 0 2 3

(November)

CHEMISTRY

(Core)

Paper : C–11

(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 (any *five*) :   1×5=5

   (a) Which of the following amino acids has an amide side chain?

   (i) Aspartic acid

   (ii) Glutamic acid

   (iii) Asparagine

   (iv) Methionine

(b) Sanger's reagent is

   (i) 1-fluoro-2,4-dinitrobenzene

   (ii) phenylisothiocyanate

   (iii) ninhydrin

   (iv) 2,4-dinitrophenylhydrazine

(c) The number of H-bonds between adenine and thymine in a DNA molecule is

   (i) two

   (ii) three

   (iii) four

   (iv) None of the above

(d) Which of the following synthons is an example of umpolung?

   (i)

   (ii)

   (iii)

   (iv) $CH_3 \overset{..}{C}H_2$
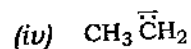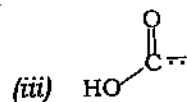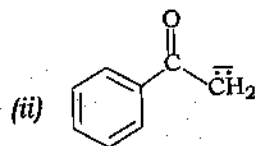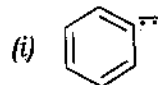
       (Continued)

(e) Which of the following drugs is not classified in the criteria based on pharmacological effect?

   (i) Antihistamines

   (ii) Antiseptics

   (iii) Analgesics

   (iv) Antipyretics

(f) Which of the following is not a function of protein?

   (i) Helps in digesting food

   (ii) Carries genetic information

   (iii) Fights against invading pathogen

   (iv) Helps in transporting oxygen in blood

UNIT—I

2. (a) Draw the structure of a nucleotide present only in RNA and write down its name.   2

(b) Write down the synthesis of a base which is present only in DNA.   3

Or

How does DNA replicate? How is the process responsible for preservation of heredity?

(c) Write down the important structural difference between DNA and RNA.   2

       (Turn Over)

UNIT—II

3. (a) What is ninhydrin reagent? Explain with chemical reaction how it is used to detect amino acid.   3

Or

What is isoelectric point? How is it helpful in separating amino acid from a mixture?

(b) How can you synthesize alanine by Gabriel phthalimide synthesis?   2

(c) Explain briefly the α-helix structure of protein.   2

(d) How will you prepare alanyl-glycyl-valine only from glycine, valine and alanine using suitable amino protecting group and carboxy activating group?   2

Or

What are conjugated proteins? How are they classified?

UNIT—III

4. (a) How are enzymes classified on the basis of their functions?   2

Or

Explain stereospecificity of enzyme with suitable example.

(b) Write short notes on any *two* of the following :   2×2=4

(i) Active site

(ii) Coenzyme

(iii) Inhibitors

(c) Discuss briefly the lock and key theory of enzyme action.   3

UNIT—IV

5. Answer any *three* questions :   2×3=6

(a) What is saponification value of a fat? What is its significance in determining the quality of lipid?

(b) "Melting point of unsaturated fatty acid is lower than those of saturated fatty acid." Explain.

(c) Discuss how vegetable ghee is prepared from oils.

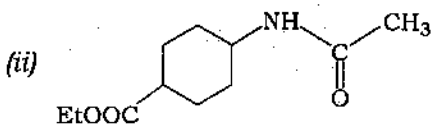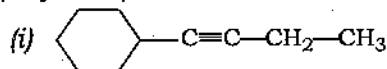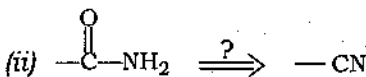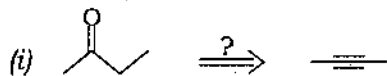(d) What is iodine number? How is it helpful in determining the quality of oil?

UNIT—V

6. *(a)* Applying retrosynthesis, how would you prepare the following compound (any *one*) ? 3

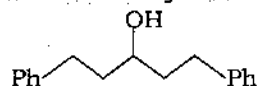*(i)*

(ii)
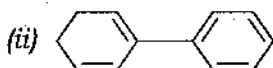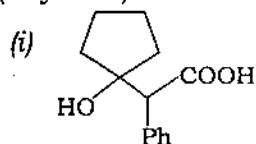
(b) Carry out disconnection of the molecules given below and show their synthons and synthetic equivalents (any *one*) : 2

(i)

(ii)

(c) How can the following FGIs be carried out? 2

(i)

(ii)

(d) How can you disconnect the following molecule and carry its synthesis? 2

(Continued)

UNIT—VI

7. *(a)* "Sulpha drugs are bacteriostatic but not bacteriocidal." Explain. 2

Or

Write down the preparation of sulphaguanidine.

(b) Write down the molecular structure of curcumin and its medicinal importance. 2

(c) Write down the synthesis of the following (any *one*) : 2

(i) Chloroquine

(ii) Chloramphenicol

(d) What is the importance of vitamin C in our body? 2

Or

Write down the synthesis of an antipyretic.

★ ★ ★

5 SEM TDC DSE BOT (CBCS) 4 (H)

2023

(November)

BOTANY

(Discipline Specific Elective)

(For Honours)

Paper : DSE-4

(Industrial and Environmental Microbiology)

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 : 1×2=2

   (a) TDS stands for _____.

   (b) For cell disruption, _____ technique is used.

2. Answer very briefly : 1×3=3

   (a) Name the pigment present in nodule that protects nitrogenase.

(Turn Over)

(b) Who first discovered fermentation technique?

(c) Name one free-living bacterium that fixes atmospheric nitrogen.

3. Write short notes on any *three* of the following : 3×3=9

(a) Nitrogenase

(b) VAM

(c) Role of Rhizobium

(d) Application of immobilized enzyme

4. Answer briefly : 2×4=8

(a) Write on aerobic and anaerobic fermentations.

(b) Mention the working principle of centrifugation.

(c) What is bioreactor?

(d) Point out the uses of alcohol as energy sources.

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

(a) Discuss about the role of microbes in sewage treatment.

(b) Write an account on phytoremediation.

(Continued)

(c) Describe the isolation method of root nodulating bacteria.

(d) Differentiate between solid-state and liquid-state fermentations.

6. Describe about a test to determine contamination of water by coliform bacteria. 6

Or

Describe the production process of citric acid mentioning the microorganisms used and different stages of production.

7. What is biological nitrogen fixation? Describe the biochemical method of nitrogen fixation by symbiotic bacteria. 3+7=10

Or

Describe the application of immobilized enzymes—glucose isomerase and penicillin acylase. 5+5=10

★ ★ ★

5 SEM TDC DSE BOT (CBCS) 1 (H/NH)

2 0 2 3

(November)

BOTANY

(Discipline Specific Elective)

(For Honours/Non-Honours)

Paper : DSE–1

(Analytical Techniques in Plant Science)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* তলত দিয়াবোৰৰ খালী ঠাই পূৰ কৰা : 1×3=3

Fill in the blanks of the following :

(i) _____ হৈছে দৈৰ্ঘ্যতা জোখৰ আটাইতকৈ সূক্ষ্ম একক ।

_____ is the smallest unit of measurement of length.

(ii) স্ফটিকৰ পাৰমাণৱিক আৰু আণৱিক গঠন নিৰ্ণয় কৰিবলৈ _____ ব্যৱহাৰ কৰা হয় ।

For determining the atomic and molecular structure of crystal, _____ is used.

(iii) ভাইৰাছ পৃথকীকৰণত _____ পদ্ধতি ব্যৱহাৰ কৰা হয় ।

To separate viruses, _____ method is used.

(b) তলত দিয়াবোৰৰ শুদ্ধ উত্তৰটো বাচি উলিওৱা : 1×2=2

Choose the correct answer of the following :

(i) যদি পাঁচজন মানুহৰ উচ্চতা ক্ৰমে 142 ছে. মি., 150 ছে. মি., 149 ছে. মি., 156 ছে. মি. আৰু 153 ছে. মি. হয়, তেন্তে গড় উচ্চতা হ'ব 150 ছে. মি. / 149 ছে. মি. / 151 ছে. মি. ।

If the height of five people are 142 cm, 150 cm, 149 cm, 156 cm and 153 cm, then the mean height is 150 cm / 149 cm / 151 cm.

(ii) GLCত চলমান মাধ্যম হৈছে নাইট্ৰ'জেন / পেট্ৰ'লিয়াম ইথাৰ / দ্ৰাৱকৰ মিশ্ৰণ ।

In GLC, the mobile phase is nitrogen / petroleum ether / mixture of solvents.

2. তলত দিয়াবোৰৰ ওপৰত চমু টোকা লিখা (যি কোনো তিনিটা) : 4×3=12

Write short notes on the following (any *three*) :

(a) ক্ৰম'জ'ম বেণ্ডিং
Chromosome banding

(Continued)

(b) এক্স-ৰে ক্ৰিষ্টেল'গ্ৰাফী
X-ray crystallography

(c) আল্ট্ৰাচেন্ট্ৰিফিউগেচন
Ultracentrifugation

(d) সূক্ষ্ম-স্তৰী বৰ্ণলেখন
Thin-layer chromatography

3. সমস্থানিক আৰু তেজস্ক্ৰিয় সমস্থানিকৰ সংজ্ঞা লিখা । জীৱবিজ্ঞানত তেজস্ক্ৰিয় সমস্থানিকৰ প্ৰভাৱৰ বিষয়ে এক আলোচনা আগবঢ়োৱা । 4+8=12

Define isotope and radioisotope. Give an account on the role of radioactive isotope in biological science.

অথবা / Or

ফ্ল'ৰেছেঞ্চ কি ? ফ্ল'ৰেছেঞ্চ অণুবীক্ষণ যন্ত্ৰৰ কাৰ্যনীতি আৰু প্ৰয়োগসমূহ আলোচনা কৰা । 2+(5+5)=12

What is fluorescence? Discuss the principle and applications of fluorescence microscopy.

4. বৰ্ণলেখন কি ? পত্ৰবৰ্ণলেখনৰ মূলতত্ত্ব, যন্ত্ৰশৈলী আৰু ব্যৱহাৰ বৰ্ণনা কৰা । 2+(3+3+4)=12

What is chromatography? Describe the principle, instrumentation and uses of paper chromatography.

(Turn Over)

অথবা / Or

তলত দিয়াবোৰৰ ওপৰত ব্যাখ্যামূলক টোকা লিখা : 6×2=12

Write explanatory notes on the following :

(a) ভৰ স্পেক্ট্ৰ'মিট্ৰী

Mass spectrometry

(b) ট্ৰেঞ্চমিচন ইলেক্ট্ৰন অণুবীক্ষণ যন্ত্ৰ

Transmission electron microscope

5. প্ৰামাণিক বিচ্যুতি কি ? তলত দিয়া তথ্যসমূহৰ পৰা গড়, বহুলক আৰু মধ্যমা উলিওৱা : 3+(3+3+3)=12

What is standard deviation? Calculate the mean, mode and median from the following data :

Class Interval শ্ৰেণী অন্তৰাল	15–25	25–35	35–45	45–55	55–65	65–75
Frequency বাৰংবাৰতা	4	11	19	14	0	2

অথবা / Or

তলত দিয়াবোৰৰ ওপৰত চমু টোকা লিখা : 6×2=12

Write short notes on the following :

(a) গড় বিচ্যুতি আৰু প্ৰামাণিক বিচ্যুতি

Mean deviation and standard deviation

(b) চাই-স্কুৱাৰ টেষ্ট অৱ চিগ্নিফিকেঞ্চ

Chi-square test of significance

★★★

5 SEM TDC BOTH (CBCS) C 11

2 0 2 3

(November)

BOTANY

(Core)

Paper : C–11

(Reproductive Biology of Angiosperms)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks
for the questions

1. Answer the following as directed :   1×5=5

   (a) _____ discovered double fertilization in angiosperms.

   (Fill in the blank)

   (b) Ovule changes into fruit/seed/flower.

   (Choose the correct answer)

   (c) The most primitive type of ovule is _____.

   (Fill in the blank)

(Turn Over)

(d) The study of pollen is known as Palaeontology/Palynology/Embryology.

(Choose the correct answer)

(e) Allium type of embryo sac is monosporic/bisporic/tetrasporic.

(Choose the correct answer)

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

(a) Function and types of tapetum

(b) Different kinds of endosperm

(c) Apomixis and its significance

(d) Ontogeny of flower

(e) Parasexual hybridization

3. Describe the different contrivances or mechanisms to perform cross-pollination. Why does nature prefer cross-pollination? 10+2=12

Or

What is NPC system of classification? Write about the classification of pollen types based on NPC system. 2+10=12

4. With suitable diagrams, describe the different types of embryo sacs of angiosperms. 12

Or

Write notes on the following : 4×3=12

(a) Male germ unit (MGU)

(b) Self-incompatibility

(c) Microsporogenesis

5. With suitable diagram, write briefly about the development of embryo in dicots. 12

Or

Write briefly about the various mechanisms of seed dispersal and its importance. 12

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5 SEM TDC BOTH (CBCS) C 12

2 0 2 3

(November)

BOTANY

(Core)

Paper : C–12

(Plant Physiology)

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) Which of the following forms of
   soil water is commonly absorbed by
   plants?

   (1) Capillary water

   (2) Combined water

   (3) Hygroscopic water

   (4) Gravitational water

(Turn Over)

(ii) Which of the following is a chelating agent?

(1) 2,4-D

(2) 2,4,5-T

(3) DTPA

(4) $MgSO_4$

(iii) The sieve tubes contain several types of fibrillar proteins called

(1) G-proteins

(2) S-proteins

(3) P-proteins

(4) X-proteins

(b) Fill in the blanks :   1×2=2

(i) Chemically kinetin is _____.

(ii) The term 'vernalization' was coined by _____.

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

(a) Water potential

(b) Physiological role of potassium in plants

(c) Florigen

(d) Siderophores

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3. What is transpiration? Write about the mechanism of opening and closing of stomata. How do plants adapt itself to check excessive transpiration?   2+6+4=12

Or

Explain the evidence which proves that phloem is the channel of transport of organic substances in plants. Describe the 'pressure-flow' model of translocation of solutes in plants.   5+7=12

4. What is photoperiodism? Describe the different types of plants in response to photoperiod. What role does phytochrome play in flower initiation?   2+6+4=12

Or

Write explanatory notes on the following :

         6×2=12

(a) Role of phytochrome in photomorphogenesis

(b) Causes of seed dormancy

5. What are phytohormones? Describe biosynthesis and physiological role of auxin in plants.   2+5+5=12

Or

Write explanatory notes on the following :

6×2=12

(a) Carrier hypothesis of salt uptake

(b) Passive absorption of water by plants

★★★