

Roll No.

E-990

M. Sc. (Fourth Semester) (Main/ATKT)

EXAMINATION, May-June, 2021

CHEMISTRY

Paper Third (CH-21)

(Material and Nuclear Chemistry)

Time : Three Hours]

[Maximum Marks : 80

Note : Attempt all Sections as directed.

Section—A

1 each

(Objective/Multiple Choice Questions)

Note : Attempt all questions.

Choose the correct answer :

1. The rate equations can be expressed in the form of linear phenomenological equation (J = Flux and X = Force) :

(a)
$$X_i = \sum_{j=1}^n L_{ij} J_j$$

(b)
$$J_i = \sum_{j=1}^n L_{ij} X_j$$

(c)
$$J_i = \sum_{n=1}^i R_{ij} J_i$$

(d)
$$J_i = \sum_{j=1}^n L_{ij}$$

P. T. O.

2. If the system is subjected to irreversible process, the $d_i S$ will be :
- (a) $d_i S = 0$
 - (b) $d_i S < 0$
 - (c) $d_i S = dS$
 - (d) $d_i S > 0$
3. Which one of the following is biological application of irreversible thermodynamics ?
- (a) Transport across biological membrane
 - (b) The synthesis of RNA
 - (c) Muscle contraction to perform mechanical work
 - (d) All of the above
4. Which of the following statements is correct ?
- (a) The matrix of the phenomenological coefficients is symmetric provided a proper choice of fluxes and forces is made.
 - (b) In an irreversible process the entropy production is always negative.
 - (c) Entropy of the system is an intensive property.
 - (d) Fick's law is used for the heat transfer.
5. The rate of entropy production ($d\sigma$) for the irreversible process can be written as :
- (a) $d\sigma = -\frac{dq}{T}$

(b) $d\sigma = \frac{dq}{T}$

(c) $d\sigma = dS + dS_{\text{rev}}$

(d) $d\sigma = dS - dS_{\text{rev}}$

6. The lowering of the melting points of nanoparticles of metals and semiconductors as compared to with bulk forms is due to

- (a) Reduced imperfection
- (b) Surface energy increases with a decreasing size
- (c) Spatial confinement
- (d) None of the above

7. Degree of scattering in Transmission Electron Microscope (TEM) is a function of :

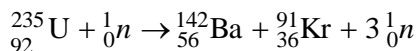
- (a) Wavelength of electron beam used
- (b) Number of atoms that lie in the reaction path
- (c) Mass of atoms that lie in the electron path
- (d) Number of mass of atoms that lie in the electron path

8. The following ceramic product is mostly used as pigment in paints :

- (a) TiO_2
- (b) SiO_2
- (c) UO_2
- (d) ZnO_2

9. Which ratio decides the efficiency of naomaterials ?
- (a) Weight/Volume
 - (b) Volume/Weight
 - (c) Surface area/Volume
 - (d) Surface volume/Surface area
10. The semiconductor nanoparticle GaN (Gallium Nitride) can be used as :
- (a) Light-emitting diodes
 - (b) Aerospace industry
 - (c) Amplifiers
 - (d) All of the above
11. What type of guest would a cyclic polyether be able to bind ?
- (a) Anions
 - (b) Zwitterions
 - (c) Cations
 - (d) Neutral species
12. Choose the incorrect statement :
- (a) Supramolecular chemistry may be defined as chemistry beyond the molecule.
 - (b) The ability of acyclic ligands to form more stable and selective complexes than macrocyclic ligands.
 - (c) Supramolecular reactivity and catalysis involve binding and transformation of the bound species into products.
 - (d) Selective binding of a specific substrate to its receptors involves a molecular recognition process.

13. Which of the following cyclodextrins is called cycloheptamylose ?
- (a) β -cyclodextrin
 - (b) γ -cyclodextrin
 - (c) α -cyclodextrin
 - (d) None of the above
14. Which one of the following elements is likely to participate in a hydrogen bond ?
- (a) F
 - (b) N
 - (c) O
 - (d) S
15. Which one of the following represents weakest interaction between two species ?
- (a) Hydrogen bond
 - (b) Dispersion force
 - (c) Dipole-dipole force
 - (d) Disulfide bond
16. For a given nuclear fission reaction of ^{235}U :



The amount of energy (in kJ/mol) released during this process is (Given $^{235}\text{U} = 235.0439$ a.m.u., $^{142}\text{Ba} = 141.9164$ amu, $^{91}\text{Kr} = 90.9234$ amu, neutron = 1.00866 a.m.u.) :

- (a) 1.68×10^{10}
- (b) 1.0×10^9
- (c) 2.8×10^{11}
- (d) 3.12×10^{12}

17. The particles postulated to always accompany the positron emission among :

- (A) Neutrino
- (B) Anti-neutrino
- (C) Electron

Codes :

- (a) A, B and C
- (b) A and B
- (c) A and C
- (d) B and C

18. Which one of the following pairs has two magic numbers for closed nuclear shells ?

- (a) 8, 10
- (b) 50, 82
- (c) 10, 20
- (d) 82, 130

19. In the nuclear reactor, the material used to control the chain reaction is :

- (a) Bismuth
- (b) Zinc
- (c) Iron
- (d) Cadmium

20. Which nuclei has the highest nuclear binding energy per nucleon ?

- (a) ^{238}U
- (b) ^4He
- (c) ^{62}Ni
- (d) ^{52}Cr

Section—B

2 each

(Very Short Answer Type Questions)

Note : Attempt all questions. Write answer in 2-3 sentences.

1. Define forces and fluxes.
2. What is the difference between equilibrium state steady state ?
3. Define size and shape controlled synthesis of nanoparticles.
4. What are ceramics ? Give their examples.
5. What do you mean by 'Host and Guest Chemistry' in the case of supramolecules ?
6. Write the names of *two* cryptands with structure.
7. Explain briefly the strength of radioisotopes.
8. Write *two* applications of tracers in chemical investigation.

Section—C

3 each

(Short Answer Type Questions)

Note : Attempt all questions.

1. Explain Prigogini's principle of minimum entropy production in non-equilibrium thermodynamics.
2. What is the relationship between coupled reactions and non-equilibrium thermodynamics ?
3. What are the advantages of sol-gel method for synthesis of nanoparticles ?
4. Discuss briefly the different properties of nanoparticles which make them different from bulk material.
5. Discuss the principle of molecular receptor and design in supramolecular chemistry.
6. What are cyclophanes ? Write some important applications.
7. Write the analytical application of radiochemistry.
8. What is the significance of nuclear shells and magic numbers ?

Section—D

5 each

(Long Answer Type Questions)

Note : Attempt all questions.

1. What are the fundamental concepts of non-equilibrium thermodynamics ? Explain phenomenological laws and Onsager's reciprocity relations.

Or

Discuss the application of non-equilibrium thermodynamics for biological system.

2. Describe different methods for the preparation of nanoparticles. Discuss synthesis of metallic and semiconductor nanoparticles.

Or

How is nanoparticles characterized ? Discuss SEM and TEM methods for the morphological study of nanoparticles.

3. How reactivity and catalysis represent major features of the functional properties of supramolecular systems ?

Or

State and explain shapes and dimensions of the α , β and γ cyclodextrin molecules. Discuss and chemical features and their molecular complexations.

4. Derive semi-empirical mass equation. Give its application and limitation.

Or

Write short notes on any *two* of the following :

- (i) Nuclear fission and chain reaction
- (ii) Radioactive isotopes
- (iii) Nuclear potentials
- (iv) Liquid drop model