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M.Sc. (Fourth Semester)
EXAMINATION, May-June, 2022
CHEMISTRY
Paper Third (CH-21)
(Material and Nuclear Chemistry)

Time : Three Hours] *[Maximum Marks: 80*

Note -Attempt all sections as directed

Section - A

(Objective/Multiple Type Questions)

20×1=20

Note- Attempt all questions.

Choose the correct answer.

1. Which of the following statements is incorrect?
   (A) The Nobel Prize in chemistry 1968 was awarded to llya Prigogine for studies non-equilibrium thermodynamics.
   (B) The entropy production is the core of irreversible thermodynamics.
   (C) For all irreversible processes entropy increases. Time also continues to increase.
   (D) The Onsager's reciprocity theory is based on the prin ciple of microscopic reversibility.

2. Which of the following thermodynamic processes can be reversed?
   (A) Heating of an oven
   (B) Combustion of petrol
   (C) Free expansion of gases
   (D) Isothermal expansion of an ideal gas in a cylinder with a frictionless piston

3. The heat transfer process:

   JQ=-K$\frac{dT}{dX}$ is known as.

   (A) Onsager Law
   (B) Fourier Law
   (C) Ohm's Law
   (D) Fick's L aw

4. Which of the most important biological application of irre-versible thermodynamic -
   (A) Transport across biological membranes
   (B) Photochemistry of vision
   (C) Photosynthesis
   (D) None of the above

5. To extend thermodynamics to non-equilibrium processes the rate of entropy production (P) per unit time can be expressed as:

(J_{P-}= Rates of various irreversible processes and X_p=Corresponding generalized forces)

(A) P= $\frac{d_i S}{dt} = \sum_P J_P X_P \leq 0$

(B) $P = \frac{d_i S}{dt} = \sum_P J_P X_P = 0$

(C) $P = \frac{d_i S}{dt} = \sum_P J_P X_P \geq 0$

(D) $P = \frac{d_i S}{dt} = \sum_P J_P X_P$

6. The binding of oxygen molecules and heterotetrameric hemoglobin is an example of :

(A) Intramolecular Cooperativity

(B) Allosteric Cooperativity

(C) Interannular Cooperativity

(D) Intraannular Cooperativity

7. $\pi - \pi$ interaction occurs -

(A) When the functional groups that are interacting and properly oriented

(B) Between metal ions and electron rich atoms and is of moderate strength

(C) By the interactions of dipoles

(D) Between aromatic rings face cach other

8. Which of the following statements is incorrect for CRYPTAND?

(A) Cryptands were introduced by Jean-Marie-Lehn in 1969.

(B) Cryptands are a family of synthetic bicyclic and poly cyclic multidentate ligande

(C) Cryptands form complexes with many “hard anions”.

(D) Cryptands bind the guest ions using both nitrogen and oxygen donors.

9. Which of the following forms inclusion complex and improves aqueous solubility and dissolution rate

(A) Cyclodextrins

(B) Polyethelene Glycol

(C) Poloxamer

(D) None of the above

10. The suitable example of catalysis by reactive anion receptor molecule is;

(A) Binding of primary ammonium ions with macrocydic polyethers

(B) Nucleophilic substitution reaction with cyclophone

(C) Reaction of B-cyclodixtrin linked porphyrin complexes

(D) ATP hydrolysis catalyzed by macrocydic polyamines

11. Which of the following is not a scanning probe micro scope?

(A) Atomic Force Microscope

(B) Scanning Electron Microscope

(C) Scanning Tunnelling Microscope

(D) Near Field Scanning optical Microscope

12. The zero-dimensional nano structure is called:

(A) Nanowires

(B) Quantum well

(C) Quantum dots

(D) Bulk

13. If the surface area to volume ratio of a sphere is 1 cm^{-1}, what is its volume(in cm^3) ? π =3.14

(A) 113.04

(B) 3

(C) 112.13

(D) 3.14

14. Which one of the following does not come under the category of ceramic material?

(A) Al_2O_3

(B) SiO_2

(C) Si_2N_4

(D) ZnO

15. Nanocrystalline materials synthesized by sol-gel technique results in a foam like structures called : -.-.-.-.-.-.

(A) Gel

(B) Aerogel

(C) Aerosol

(D) Foam

16. Which of the following best explain the process of Nuclear-Fission?

(A) Proton-Proton Cycle

(B) Sommerfeild Model

(C) Partide Model

(D) Liquid-drop Model

17. The radius of nucleon value is 1.25 Fermi. The nuclear radius of ^{27}Al is -

(A) 3.75 Fermi

(B) 2.50Fermi

(C) 0.675 Fermi

(D) 4.21 Fermi

18. The asymmetry term in semi-empirical mass formula is due to -

(A) Non-spherical shape of the nucleus

(B) Non-zero spin of the nucleus

(C) Unequal number of protons and neutrons in the nucleus

(D) Odd number of protons inside the nucleus

19. A nuclear reactor is a device to produce nuclear energy with the help of.....

(A) Nuclear fusion

(B) Controlled chain reaction

(C) Graphite as fuel

(D) Uncontrolled chain reaction

20. Match the following radioisotopes(I) with their applications(II).

[I] RADIOISOTOPES		[II]	Application
(a)	Cobalt-60	[I]	Thyroid therapy
(b)	Iodine-131	[II]	Cancer therapy
(c)	Phosphorus 32	[III]	Archeological Dating
(d)	Carbon-14	[IV]	Leukemia therapy

(A) (a)-(iv),(b)-(iii),(c)-(i),(d)-(ii)

(B) (a)-(iii),(b)-(i),(c)-(ii),(d)-(iii)

(C) (a)-(i),(b)-(ii),(c)-(iii),(d)-(iv)

(D) (a)-(ii),(b)-(i),(c)-(iv),(d)-(iii)

Section - B

(Very Short Answer Type Questions)

8×2=16

Note: -Attempt all questions.

1. Write two examples of non-equilibrium thermodynamics.

2. What are the criterion of the flow and forces?

3. Write two important difference between SEM and TEM?

4. What are the different origins for the unique physical properties of nanoparticles?

5. What are the basic functions of supramolecular species?

6. Write two applications of cyclodextrins.

7. How do you explain periodicity in nuclear properties?

8. What is Breeder reactor?

Section-C

(Short Answer Type Questions)

8×3=24

Note: -Attempt all questions.

1. Define Coupled reaction. What is the importance of coupled reactions in Biology?

2. Derive the theory of minimum entropy production $\left(\frac{\partial \sigma}{\partial \times 2}\right)_{x_1} = 0$

3. What are the charactertics of Sol-gel method for the synthesis of ceramics?

4. Why do nanoparticles exhibit surface plasmon resonance? Write optical properties of nanoparticles.

5. Write molecular interactions in molecular recognition.

6. What is calixarene? Write its application in host-guest chemistry.

7. Discuss the role of slow are fast neutrons in nuclear fission reactions?

8. What is nuclear potential? Explain the harmonic oscillator potential.

Section-D

(Long Answer Type Questions)

4×5=20

Note: -Attempt all questions.

1. What is Onsager's reciprocity relation? Show that in a two-flux two force systems where linear phenomenlogical relation are obeged $(L_{12} + L_{21})^2 < 4L_{11}L_{22}$ where L_{12} are cross-phenomenological coefficients and L_{11} and L_{22} are straight coefficient.

OR

What is the role of entropy production in application to biology? Discuss the application of non-equilibrium thermodynamics to transport processes through biological membranes.

2. Define top-down and bottom-up approaches for the synthesis of nanoparticles. Discuss briefly synthesis of metal, metal oxide and metal sulfide nanoparticles with suitable examples.

OR

Why the characterization of nanomaterials is necessary? Write the name of various techniques. Discuss SEM and TEM methods for the determination of size and shape of the nanoparticles.

3. Define molecular receptors and receptor chemistry. Discuss design of molecular receptors using macropolycyclic cryptands.

OR

Discuss the principle of supramolecular reactivity and catalysis. Explain with example catalysis by reactive anion receptor molecules.

4. Describe liquid drop model in terms of its analogy, semiempirical mass equation and mean binding energy. Write its merits and demerits.

OR

Describe radiochemical principles involved in the use of radioactive tracers. Discuss the role of radio isotopes as fracers in the study of reaction mechanisms and structure de0terminations.