REV-01
MSC/15/20

2024/07

SET A

M.Sc. CHEMISTRY
FOURTH SEMESTER
MATERIAL CHEMISTRY & THERMODYNAMICS
MSC – 401 [SPECIAL REPEAT]

[USE OMR FOR OBJECTIVE PART]

Duration: 3 hrs. **Full Marks: 70**

Objective

Time: 30 min. **Marks: 20**

Choose the correct answer from the following: ***1X20=20***

1. The molar chemical potential is given by the equation
   a. $\partial U/\partial S$ b. $\partial U/\partial n$
   c. $\partial U/\partial V$ d. All of the above

2. The concept of "local equilibrium" in non-equilibrium thermodynamics implies
   a. Uniform distribution of energy b. Constant temperature throughout the system
   c. Spatial variation in thermodynamic properties d. Absence of entropy production

3. The driving force behind non-equilibrium thermodynamic processes is
   a. Heat flow b.
   c. Equilibrium d.

4. Entropy production in a non-equilibrium system indicates
   a. Decrease in disorder b. Increase in order
   c. Creation of a gradient d. Maintenance of equilibrium

5. A process is carried out t constant volume and at a constant entropy. It will be spontaneous if
   a. $\Delta G < 0$ b. $\Delta H < 0$
   c. $\Delta U < 0$ d. $\Delta A < 0$

6. Polymer nanocomposites have
   a. Excellent mechanical properties and low thermal stability b. Excellent mechanical properties and high thermal stability
   c. Poor mechanical properties and thermal stability d. Poor properties than neat polymer

7. Ostwald ripening process occurs because larger particles are
   a. Less agglomerates b. Optically stable
   c. More energetically favored d. Thermally stable

8. Composition of Romanian paint is
   a. Gold nanoparticles dispersed in solvent b. Gold nanofibers dispersed in solvent
   c. Gold nanoparticles of different sizes having different colors d. Both (a) and (c)

9. The surface plasmon resonance shifts to lower energies due to
   a. Dilution
   b. Aggregation
   c. Oxidation
   d. Phosphorescence

10. Graphene nanosheets and carbon dots are
   a. 0D and 3D nanomaterials
   b. 0D and 1D nanomaterials
   c. 2D and 1D nanomaterials
   d. 2D and 0D nanomaterials

11. Which of the following smart materials is used as a sensor
   a. Active SM
   b. Piezoelectric SM
   c. Passive SM
   d. Both (a) and (b)

12. The "flux-force" relations in non-equilibrium thermodynamics establish a connection between
   a. Entropy and temperature
   b. Chemical potential and concentration gradient
   c. Enthalpy and pressure
   d. Volume and temperature changes

13. In non-equilibrium systems, the Onsager reciprocity relations describe
   a. Energy conservation
   b. Entropy production
   c. Heat transfer
   d. Coupled transport processes

14. A smart material that converts mechanical energy to electric energy is called
   a. Joule effect of magnetization
   b. Villary effect
   c. Converse Effect
   d. Direct Effect

15. The chemical potential μ of a pure substance is equal to
   a. Molar Gibbs energy
   b. Entropy
   c. Internal Energy.
   d. All of the above

16. For a system of variable composition, the internal energy depends on
   a. Entropy
   b. Volume
   c. Moles
   d. All of the above

17. Pervoskites is an example of
   a. Direct piezoelectric effect
   b. Reverse piezoelectric effect
   c. Both (a) and (b)
   d. None of them

18. Cobalt ferrite is an example of
   a. Magnetostrictive material
   b. Electrostrictive material
   c. Thermoelectric material
   d. Both (a) and (b)

19. For a closed system, in the absence of non PV work, the correct statement is
   a. $dU=T.dS-P.dV$
   b. $dG=V.dP+S.dT$
   c. $dH=T.dS-P.dV$
   d. $dH=T.dS-P.dV$

20. Which one of the following is not a property of smart material:
   a. Villary effect
   b. Photostriction effect
   c. Magneto-optic effect
   d. None of them

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Descriptive

Time : 2 hrs. 30 mins. Marks : 50

[Answer question no.1 & any four (4) from the rest]

1. a. What is partial molar volume? For a substance in a mixture, write the relation between chemical potential and the partial molar Gibbs energy. 3+2+2+3 =10
   b. What is non-equilibrium thermodynamics? Explain with an example.
   c. Define the term piezoelectric smart materials with one example.
   d. Write down the advantage and disadvantage of smart materials.

2. a. Match the following column: 2+2+2+4 = 10

Column 1	Column 2
(I) Data Acquisition	(i) Muscles
(II) Data Instructions	(ii) Sensory nerves
(III) Data Transmission	(iii) Brain
(IV) Action Devices	(iv) Motor nerves
(V) Command and Control Unit	(v)Tactile sensing

   b. Discuss the physical interpretation of the dependence of the Gibbs energy on the temperature and pressure.
   c. Define the term Converse effect with one example.
   d. Explain the concept of entropy production in non-equilibrium thermodynamics and calculate the rate of entropy production by giving a suitable example.

3. a. Write two characteristics of active smart materials with one example. 2+2+2+3 +1=10
   b. Derive the Gibbs energy of mixing for two perfect gases.
   c. Write two application of magneto-active polymer based smart material.
   d. Match the following

Column 1	Column 2
(I) Gold nanoparticles	(i) crystalline TiO_2
(II) Gratzel cell	(ii) Nanoclay
(III) Maya Blue	(iii) Scanning probe microscopy technique
(IV) Transmission electron microscope	(iv) Burst Schifrin Method
(V) Scanning tunnelling microscope	(v) Scanning electron

microscopy Technique

e. Define is quantum confinement?

4. a. Fill in the blanks: 4+3+3=10
(i)Terfenol-D is an example of _____
(ii) At lower temperature Shape memory alloy is stable in _____ phase.
(iii) Optical fibers is an example of _____ smart materials
(iv) Pyroelectric smart material is an example of active smart materials due to _____ exchange.

b. Derive the Clausius–Clapeyron equation? What is the importance of this equation?

c. Describe the Onsager reciprocal relations and their significance in non-equilibrium thermodynamics

5. a. Define the term Converse effect with one example. 2+3+2+2=10
b. Explain the different types of transitions associated with CdSe based semiconductors.
c. From the relation, dG = VdP – SdT, derive the equation
$(\partial S/\partial P)_T = -(\partial S/\partial P)_P$
d. Discuss the concept of local equilibrium and its relevance in the context of non-equilibrium thermodynamics.
e. What is flux and forces in non-equilibrium thermodynamics?

6. a. Establish the relation, 2+2+2+2=10
$dG = VdP \quad SdT$
b. Write the full form of following smart materials:
(i) PMN (ii) PEO-b-PLL
c. Mention two differences between interband and intraband transitions.
d. Write the criterion of equilibrium at constant temperature and pressure.
e. How do you classify the shape memory alloy?

7. a. What is Chemical Potential? Write the relations how the chemical potential is related to internal energy and enthalpy? 2+2+4+2=10
b. Write down the name of different types of photovoltaic cell smart materials with one example for each.
c. Write down the advantages of solution-based techniques. Mention the basic stages involved in this technique for the

preparation of nanomaterials.

d. Discuss the importance of the second law of thermodynamics in understanding non-equilibrium systems.

8. a. How many types of mesoporous structured silica nanomaterials can be fabricated from M41S. Which surfactant is a better choice for the synthesis of MCM-41? **4+2+4 =10**

b. Explain the Curiee-Prigogine principle in non-equilibrium thermodynamics.

c. Fill up the blanks

i. Photolithography is one form of ---------- approach.

ii. To prevent Ostwald ripening ---------- are added that help to stabilize the particles against growth and dissolution.

iii. In the ----------process chemical species are delivered sequentially to a substrate on which a single monolayer deposits.

iv. The ---------- nanoparticles in the glass matrix generate the ruby red colour in the windows.

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