

**NANOTECHNOLOGY
(CHEN 3233)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) For hexagonal crystal system
(a) $a = b \neq c$ and $\alpha = \beta = 90^\circ, \gamma = 120^\circ$ (b) $a \neq b = c$ and $\alpha = \beta = \gamma = 90^\circ$
(c) $a = b = c$ and $\alpha = \beta = 90^\circ, \gamma = 120^\circ$ (d) $a \neq b \neq c$ and $\alpha = \beta = \gamma \neq 90^\circ$
- (ii) The Schrödinger equation has a counterpart in classical mechanics, namely the equation of
(a) Mass conservation (b) Momentum conservation
(c) Energy conservation (d) Number of particles conservation
- (iii) In intrinsic semiconductors
(a) $n > p$ (b) $n = p$ (c) $n < p$ (d) $n = p$
- (iv) Surface diffusion of reactive species plays an important role in
(a) Sputtering (b) Molecular beam epitaxy
(c) Ion cluster beam deposition (d) Chemical vapour deposition.
- (v) Sol-gel process is used in the preparation of
(a) silicon dioxide on silicon substrate
(b) linking two DNA molecule using immobilization
(c) formation of TiO₂ nanoparticles
(d) none of above
- (vi) Apoferritin is used in
(a) storing iron in human blood
(b) supplying iron when it is deficient in blood
(c) trapping nanoparticles
(d) none of above
- (vii) A photoresist is usually based on a _____ that undergoes photochemical reaction
(a) polymer (b) thermosetting plastic
(c) inorganic liquid (d) organic long chain molecules

- (viii) The transmission electron microscope works much like a
(a) camera (b) slide projector
(c) magnifier (d) none of above
- (ix) Porous silicon exhibits the following effect
(a) electroluminescence (b) quantum confinement
(c) photoluminescence (d) electron diffraction
- (x) In carrying out its process, dip pen lithography uses the tip of
(a) a nano needle (b) carbon nanotube
(c) atomic force microscope (d) none of above

Group – B

2. (a) Draw (201) and (100) planes for primitive lattice.
(b) Explain Wigner-Seitz cell with diagram.
(c) What is the position of fermi level in extrinsic semiconductor?
(d) Differentiate between n-type and p-type semiconductor.
(e) Explain monoatomic lattice vibration for one dimensional crystal lattice.
 $2 + 2 + 2 + 3 + 3 = 12$
3. (a) What does Fermi level mean? What are the drawbacks of free electron theory?
(b) What does the density of states tell us? What is density of states in metals? How are plasmons generated?
(c) What do you mean by **Quantum tunnelling**? What is quantum confinement effect?
(d) How does size change affect the optical properties of nanoparticles?
 $(1 + 2) + (1 + 1 + 2) + (2 + 1) + 2 = 12$

Group – C

4. (a) Draw schematics of two equipments that use lasers in synthesizing nano particles. Important distinguishing features of the equipment should be labelled.
(b) Explain the difference in operating principles of the two methods illustrated above.
 $8 + 4 = 12$
5. (a) Describe the concept by which two gold electrode can be connected by a molecular wire.
(b) Give two specific examples of nano particle synthesis using plants.
(c) What is self assembly? Give an example of self assembly in biosynthesis.
 $4 + 4 + 4 = 12$

Group – D

6. (a) Explain the working principle of scanning tunnelling microscope with a labelled sketch. Important features of the instrument should be labelled.
- (b) What is a dichroic mirror and where is it used?

8 + 4 = 12

7. (a) State two differences in working principle of a scanning and transmission electron microscope. State the kind of samples that can be examined with each device.
- (b)

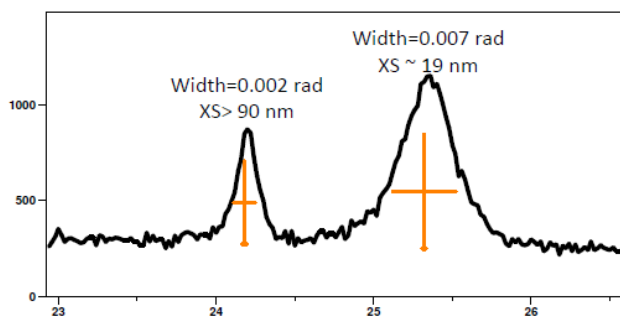
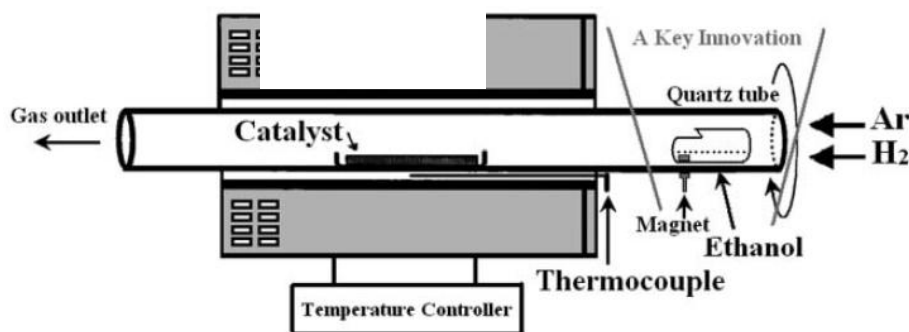
**Fig. 1**

Fig.1 above shows the peaks when XRD is performed on a material containing nanocrystallites. Assuming that the incident X-ray wavelength is 0.154 nm and the peak widths are given in radians (Pk 1 width = 0.002 rad and Pk 2 width= 0.007 rad) as shown in figure, calculate the size of nanocrystallites present in the material.

6 + 6 = 12**Group – E**

8. (a)



The figure above demonstrates the schematics of a system used in carbon nanotube synthesis. What is the name of process that occurs in the system? Describe in detail with a diagram the multiple bulk and surface phenomena that occur during this process.

- (b) Give details of conditions (reactants, temperature, pressure, flow rate etc.) used in carbon nanotube manufacturing using this process.

6 + 6 = 12

B.TECH/CHE/6TH SEM/CHEN 3233/2021

9. (a) What makes certain polymers electrically conducting? Give two examples of a conducting polymer.
- (b) What difference in process of drying lead to the formation of xerogels and aerogels?
- (c) Explain physics of the drying process used in aerogel formation.

4 + 4 + 4 = 12

Department & Section	Submission Link
CHE	https://classroom.google.com/c/Mjk5MzYwMjQwOTkw/a/MzY0NTUyODkxODQw/details