

**CET (PG) – 2017**

**Important:** Please consult your Admit Card/Roll No. slip before filling your Roll Number on the Test Booklet and Answer Sheet.

Roll No. **In Figure** **In Words**

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O.M.R. Answer Sheet Serial No.

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Signature of Candidate: \_\_\_\_\_ Signature of Invigilator: \_\_\_\_\_

**Subject: M. Tech. (Nano Science and Nano Technology)**

**Time: 90 Minutes**      **Number of Questions: 75**      **Maximum Marks: 75**

DO NOT OPEN THE SEAL ON THE BOOKLET UNTIL ASKED TO DO SO.

**INSTRUCTIONS:**

1. Write your Roll No. on the Questions Booklet and also on the OMR Answer Sheet in the space provided and nowhere else.
2. Enter the Question Booklet Serial No. on the OMR Answer Sheet. Darken the corresponding bubbles with **Black Ball Point/Black Gel Pen**.
3. Do not make any identification mark on the Answer Sheet or Question Booklet.
4. Please check that this Question Booklet contains 75 Questions. In case of any discrepancy, inform the Assistant Superintendent within 10 minutes of the start of Test.
5. Each question has four alternative answer (A,B,C,D) of which only one is correct. For each question, darken only one bubble (A or B or C or D), whichever you think is the correct answer, on the Answer Sheet with **Black Ball Point/Black Gel Pen**. **There shall be negative marking for wrong answer,  $\frac{1}{4}$  of the marks of the question will be deducted for every wrong answer.**
6. If you do not want to answer a question, leave all the bubbles corresponding to that question blank in the Answer Booklet. No marks will be deducted in such cases.
7. Darken the bubbles in the OMR Answer Sheet according to the Serial No. of the question given in the Question Booklet.
8. If you want to change an already marked answer, erase the shade in the darkened bubble completely.
9. For rough work only the blank sheet at the end of the Question Booklet be used.
10. The University will provide Logarithmic table. Borrowing of log table or other material is not allowed.
11. The Answer Sheet is designed for computer evaluation. Therefore, if you do not follow the instructions given on the Answer Sheet, it may make evaluation by the computer difficult. **Any resultant loss to the candidate on the above account, i.e. not following the instructions completely, shall be of the candidate only.**
12. After the test, hand over the Question Booklet and the Answer Sheet to the Assistant Superintendent on duty.
13. In no case the Answer Sheet, the Question Booklet, or its part or any material copied/noted from this Booklet is to be taken out of the examination hall. Any candidate found doing so would be expelled from the examination.
14. A candidate who creates disturbance of any kind or changes his/her seat or is found in possession of any paper possibly of any assistant or found giving or receiving assistant or found using any other unfair means during the examination will be expelled from the examination by the Centre Superintendent/Observer whose decision shall be final.
15. **Communication equipment such as mobile phones, pager, wireless set, scanner, camera or any electronic/digital gadget etc., is not permitted inside the examination hall. Use of calculators is not allowed.**
16. The candidates will not be allowed to leave the Examination Hall/Room before the expiry of the allotted time.

(1067)

- Smallest repeat entity of the crystal structure is known as  
A) Lattice  
B) Unit cell  
C) Millar indices  
D) Phase
- Indium tin oxide is widely used in touch-screen displays due to  
A) High adhesion property  
B) Transparent and conductive properties  
C) Microwave characteristics  
D) Dust proof properties
- Ion implantation is a process  
A) To dope semiconductors  
B) In dental applications  
C) To protect cytotoxicity  
D) In residual life assessment
- The level of quantum confinement in quantum wires is  
A) 0  
B) 1  
C) 2  
D) 3
- In a nanostructured material  
A) The bandgap increases compared to bulk  
B) The bandgap decreases compared to bulk  
C) The bandgap is same as the bulk  
D) None of the above
- Among the following technique which is not useful for size characterization of nanomaterials  
A) Transmission microscope  
B) Infra-red spectroscopy  
C) X-ray diffraction  
D) Atomic force microscopy
- To the naked eye, a solution of gold nanoparticles at a diameter of around 50 nm appears \_\_\_\_\_ (fill in the blank)  
A) Red instead of gold because of surface plasmon resonance effects.  
B) Fluorescent because of short wavelength UV photon exchanges between the gold nanoparticles.  
C) Transparent because the particles are too small to be seen.  
D) Metallic gold because the photoelectric effect still holds at the nanoscale level.
- Which of the following is a direct bandgap semiconductor?  
A) Gallium Arsenide (GaAs)  
B) Germanium  
C) Silicon  
D) MoS<sub>2</sub>
- Does silicon have any allotropes like carbon?  
A) Silicon has no allotropes  
B) Silicon has an allotrope called silicene which is similar to graphene  
C) Silicon has two allotropes - crystalline and amorphous  
D) Silicon has 24 known allotropes ranging in atomic mass from 22 to 45



10. What types of excitons are there?  
A) Hole and Electron. B) Plasmon and Tunneling  
C) Lepton and Gluon. D) Wannier-Mott and Frenkel
11. In 2010, the Nobel prize was awarded to Andre Geim and Konstantin Novoselov for their work with which nanomaterial?  
A) Quantum dots B) Dendrimers  
C) Graphene D) Inorganic Nanowires
12. In nanotechnology, the arrangement of smaller components into more complex assemblies are known as:  
A) Bottom-up methods B) Top-down methods  
C) Scaled processes D) Vertical processes
13. Targeted drug delivery involves:  
A) Delivering a drug directly to the diseased part of the body  
B) Delivering a drug from the factory to the targeted population  
C) Making more drug available to the affected population  
D) None of the above
14. Which type of nanofabrication is the fastest and therefore the cheapest (also the least reliable)?  
A) Bottom up fabrication B) Nanolithography  
C) Top down fabrication D) Self assembly
15. What might be a concern about the use of nanotechnology?  
A) Nanobased materials could be toxic.  
B) Nanoparticles may build up in the brain or liver.  
C) Nanoparticles may not break down in the environment.  
D) All of the above are legitimate concerns about nanotechnology.
16. Wiedemann-Franz law is related to  
A) Deformation in plastics  
B) Optical properties of thin films  
C) Thermal conductivity of metals  
D) Mobility of charge carriers
17. Which are the POSSIBLE risks of nanotechnology today?  
A) Nanomachines might devour the world and turn everything into a "gray goo"  
B) Nano-robots could take pictures of secret documents and relay them to foreign agents  
C) Scattered nanoparticles may recombine in nature to form new elements and chemical compounds that are highly reactive and toxic  
D) Waste nanomaterials may end up in groundwater, rivers, and lakes where they kill off fish and other wildlife

18. Which of the following statement/s is are true?
- (i) Volume to surface area ratio is very large for nanomaterials.
  - (ii) The cut-off limit of human eye is  $10^{-5}$  m.
  - (iii) Hardness of a single wall carbon nanotube (SWNT) is about  $63 \times 10^9$  P(A)
  - (iv) Carbon nanotubes are cylindrical graphene.
- A) All four  
 B) (ii) and (iv)  
 C) (i), (ii) and (iv)  
 D) (ii), (iii) and (iv)
19. If we assume that there are no elements with principal quantum number  $>3$ , then the periodic table would consist of how many elements?
- A) 14      B) 28      C) 60      D) 108
20. Energy Dispersive Spectroscopy (EDS) in a typical scanning electron microscope enables elemental identification by collecting and examining which of the following:
- A) Secondary electrons from the sample
  - B) Back scattered electrons from the sample
  - C) Characteristic X-rays from the sample
  - D) Diffraction pattern from the sample
21. Which of the following rotational symmetry is forbidden in a perfectly periodic 3-dimensional lattice?
- A) 1-fold      B) 3-fold      C) 5-fold      D) 6-fold
22. Which of the following thermodynamic properties shows a discontinuity during a second-order phase transition?
- A) Volume      B) Enthalpy  
 C) Entropy      D) Heat capacity
23. Cross slip is easily promoted in metals having
- A) A low stacking fault energy.
  - B) A low grain boundary energy.
  - C) A high stacking fault energy.
  - D) A high grain boundary energy.
24. For a typical metal at room temperature and atmospheric pressure, the Fermi energy is defined as the energy level for which the probability of occupancy is:
- A) 0      B) 0.25      C) 0.5      D) 1
25. Which one of the following effects is the working principle of a thermocouple?
- A) Thomson      B) Seebeck  
 C) Peltier      D) Meissner

26. Match the following processes and the products obtained:
- |                               |                  |
|-------------------------------|------------------|
| P: Mechanical attrition       | 1. Thin films    |
| Q: Physical vapour deposition | 2. Plastics      |
| R: Injection moulding         | 3. Nanoparticles |
| S: Sintering                  | 4. Rails         |
|                               | 5. Carbide tools |
- A) P-1, Q-2, R-3, S-5  
 B) P-3, Q-1, R-2, S-5  
 C) P-4, Q-1, R-3, S-2  
 D) P-3, Q-4, R-1, S-2
27. Crystal structure of GaAs is  
 A) Body centred cubic  
 B) Face centred cubic  
 C) Cubic  
 D) Trigonal
28. Quantum dots are useful for biotechnology applications in imaging. Property that is useful for the purpose is  
 A) Absorption  
 B) Luminescence  
 C) Reflection  
 D) Transmission
29. Bucky balls are made of  
 A)  $C_{60}$  molecules  
 B) A metallic glass  
 C) A polymeric material  
 D) Superconductors
30. In which of the following compounds are hydrogen bonds between molecules the strongest?  
 A) HCl                      B) HF                      C) HBr                      D) HI
31. The distortion produced by the point defects in a lattice is classified as  
 A) Local                      B) Global  
 C) Surface                      D) None of these
32. As temperature increases, diffusivity of an atom in a solid material,  
 A) Increases  
 B) Decreases  
 C) Remains constant  
 D) Depends on the specific material



33. Match the terminologies given in **Column I** with their relations listed in **Column II**

**Column I**

- P. Domain wall
- Q. Fick's law
- R. Matthiessen's rule
- S. Hall-Petch relation
- T. Meissner effect

**Column II**

- 1. Superconductors
- 2. Mechanical properties
- 3. Ferromagnetic materials
- 4. Resistivity of impure metals
- 5. Diffusion

- A) P-1, Q-3, R-5, S-2, T-4
- B) P-3, Q-5, R-2, S-4, T-1
- C) P-3, Q-5, R-4, S-2, T-1
- D) P-3, Q-4, R-3, S-2, T-4

34. Match the microscopes listed in **Column I** with their principle of operation listed in **Column II**

**Column I**

- P. Scanning Electron Microscope (SEM)
- Q. Transmission Electron Microscope (TEM)
- R. Scanning Tunnelling Microscope (STM)
- S. Atomic Force Microscope (AFM)

**Column II**

- 1. Van Der Waals forces between atoms
- 2. Electrons to jump across a potential barrier
- 3. Diffraction of electrons
- 4. Detection of secondary electrons
- 5. Photo emission of electrons

- A) P-2, Q-5, R-3, S-1
- B) P-3, Q-4, R-5, S-2
- C) P-4, Q-3, R-2, S-1
- D) P-4, Q-3, R-5, S-2

35. The temperature of the antiferromagnetic-to-paramagnetic transition is called

- A) Curie temperature
- B) Curie-Weiss temperature
- C) Neel temperature
- D) Debye temperature

36. When the atoms in a solid are separated by their equilibrium distance,

- A) The potential energy of the solid is lowest
- B) The force of attraction between the atoms is maximum
- C) The force of repulsion between the atoms is zero
- D) The potential energy of the solid is zero

37. Match the techniques listed in **Column I** with the characteristics of the materials measured in **Column II**.

**Column I**

- P. DSC
- Q. XRD
- R. STM
- S. SEM

**Column II**

- 1. Density of states
- 2. Glass transition temperature
- 3. Cathodoluminescence
- 4. Crystal structure
- 5. Thermal expansion coefficient

- A) P-2, Q-3, R-4, S-1
- B) P-5, Q-4, R-5, S-1
- C) P-2, Q-4, R-1, S-3
- D) P-3, Q-5, R-4, S-2

38. Energy Dispersive Spectroscopy (EDS) in a typical scanning electron microscope enables elemental identification by collecting and examining which of the following:

- A) Secondary electrons from the sample
- B) Back scattered electrons from the sample
- C) Characteristic X-rays from the sample
- D) Diffraction pattern from the sample

39. The density of states (DOS) of a system describes the number of states per interval of energy at each energy level that are available to be occupied by electrons. These density distributions are:

- A) Continuous
- B) Discrete
- C) Quantized
- D) Spectral

40. In a diffraction experiment reflections from (111), (200), (220) and (311) was observed. The crystal structure of the material is likely to be

- A) Face Centered Cubic
- B) Body Centered Cubic
- C) Simple Cubic
- D) Diamond Cubic

41. In a canonical ensemble

- A) The energy and temperature are constant
- B) The entropy and the energy are constant
- C) The Temperature and the density are constant
- D) The density and entropy are constant

42. A real square matrix  $A$  is called skew-symmetric if

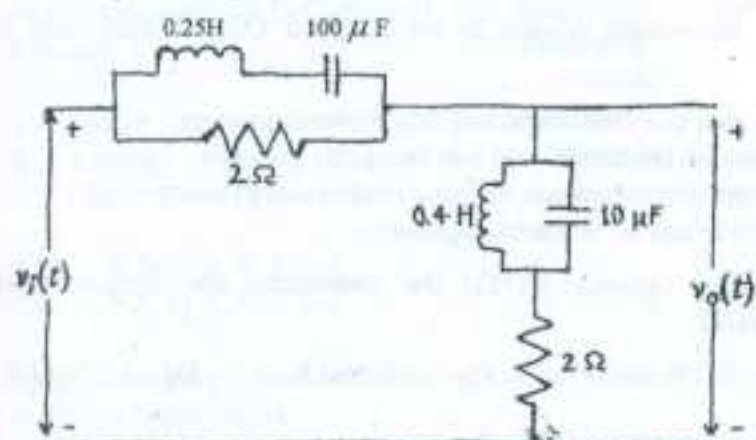
- A)  $A^T = A$
- B)  $A^T = A^{-1}$
- C)  $A^T = -A$
- D)  $A^T = A + A^{-1}$

43. Solutions of Laplace's equation having continuous second-order partial derivatives are called
- A) Biharmonic functions                      B) Harmonic functions  
 C) Conjugate harmonic functions            D) Error functions
44. The root of the function  $f(x) = x^3 + x - 1$  obtained after first iteration on application of Newton-Raphson scheme using an initial guess  $x_0 = 1$  is
- A) 0.682            B) 0.686            C) 0.750            D) 1.000
45. The cross-sections of two solid bars made of the same material are shown in the figure. The square cross-section has flexural (bending) rigidity  $I_1$ , while the circular cross-section has flexural rigidity  $I_2$ . Both sections have the same cross-sectional area. The ratio  $I_1/I_2$  is



- A)  $1/\pi$             B)  $2/\pi$             C)  $\pi/3$             D)  $\pi/6$
46. Which of the bearings given below SHOULD NOT be subjected to a thrust load?
- A) Deep groove ball bearing  
 B) Angular contact ball bearing  
 C) Cylindrical (straight) roller bearing  
 D) Single row tapered roller bearing
47. Engineering strain of a mild steel sample is recorded as 0.100%. The true strain is
- A) 0.010%            B) 0.055%            C) 0.099%            D) 0.101%

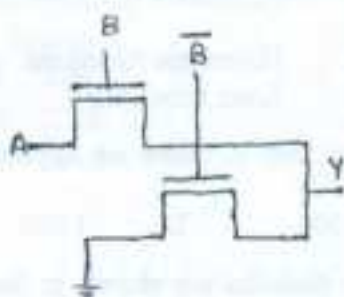
48. In the RLC circuit shown in the figure, the input voltage is given by  
 $v_i(t) = 2 \cos(200t) + 4 \sin(500t)$   
 The output voltage  $v_o(t)$  is



- A)  $\cos(200t) + 2 \sin(500t)$                       B)  $2 \cos(200t) + 4 \sin(500t)$   
 C)  $\sin(200t) + 2 \cos(500t)$                       D)  $2 \sin(200t) + 4 \cos(500t)$



49. The logic functionality realized by the circuit shown below is



- A) OR                      B) XOR                      C) NAND                      D) AND
50. If a right-handed circularly polarized wave is incident normally on a plane perfect conductor, then the reflected wave will be  
A) Right-handed circularly polarized  
B) Left-handed circularly polarized  
C) Elliptically polarized with a tilt angle of  $45^\circ$   
D) Horizontally polarized
51. Which of the following thermodynamic properties is NOT an intensive property of a thermodynamic system?  
A) Pressure                      B) Temperature                      C) Density                      D) Volume
52. The thermal efficiency of a Carnot engine is 0.5. If the temperature of the cold reservoir is 300 K, then the temperature of the hot reservoir is:  
A) 600K                      B) 1200K                      C) 900 K                      D) 450 K
53. In a reversible, constant-pressure, non-flow process, heat input is given by  
A) Change in internal energy  
B) Change in enthalpy  
C) Change in entropy  
D) Work output
54. Consider the following statements related to air-standard Otto, Diesel, and Brayton cycles:  
P. Brayton cycle has at least one isentropic and one isobaric process.  
Q. Otto cycle has at least one isentropic and one isochoric process.  
R. Diesel cycle has at least one isentropic and one isothermal process.  
S. At least one of the cycles has an isothermal process.  
For which of the following options, BOTH the statements are consistent with the operation of the above cycles:  
A) P and R                      B) P and Q                      C) R and S                      D) P and S
55. The polymer with minimum number of branches is  
A) HDPE                      B) VLDPE                      C) LDPE                      D) LLDPE

56. Polyethylene and polypropylene form an immiscible blend mainly due to
- |                   |                    |
|-------------------|--------------------|
| A) Entropy factor | B) Enthalpy factor |
| C) Crystallinity  | D) Solubility      |
57. The solubility parameter is determined by using
- |                        |
|------------------------|
| A) Bragg's equation    |
| B) Fox equation        |
| C) Hildebrand equation |
| D) Carother's equation |
58. Dynamic mechanical analysis of polystyrene ( $T_g = 100^\circ\text{C}$ ) measured at a frequency of 1 Hz shows the damping peak at  $110^\circ\text{C}$ . If the measurement is made at 104 Hz, then the peak temperature ( $^\circ\text{C}$ ) will be
- |          |          |          |          |
|----------|----------|----------|----------|
| A) 123.2 | B) 133.2 | C) 143.2 | D) 153.2 |
|----------|----------|----------|----------|
59. Which one of the following is not used in mass transfer analysis?
- |                    |
|--------------------|
| A) Biot number     |
| B) Peclet number   |
| C) Schmidt number  |
| D) Sherwood number |
60. Match the enzymes in **Column I** with their functions in **Column II**
- |                 |  |
|-----------------|--|
| <b>Column I</b> | <b>Column II</b>                                 |
| P. Amylase      | 1. Conversion of sucrose to glucose and fructose |
| Q. Invertase    | 2. Softening of dough                            |
| R. Phosphatase  | 3. Effectiveness of pasteurization               |
| S. Protease     | 4. Conversion of starch to maltose               |
- |                       |                       |
|-----------------------|-----------------------|
| A) P-1, Q-2, R-3, S-4 | B) P-4, Q-1, R-3, S-2 |
| C) P-1, Q-4, R-2, S-3 | D) P-2, Q-4, R-3, S-1 |
61. Match the products in **Column I** with their Original Phase in **Column II**
- |                 |                          |
|-----------------|--------------------------|
| <b>Column I</b> | <b>Column II</b>         |
| P. Milk         | 1. Colloidal             |
| Q. Butter       | 2. Solution              |
| R. Lactose      | 3. Water in oil emulsion |
| S. Casein       | 4. Oil in water emulsion |
- |                       |                       |
|-----------------------|-----------------------|
| A) P-3, Q-4, R-1, S-2 | B) P-3, Q-4, R-2, S-1 |
| C) P-4, Q-3, R-2, S-1 | D) P-4, Q-3, R-1, S-2 |
62. The estimation of the molecular weight of a polymer by gel permeation chromatography (GPC) is based on its
- |                                   |                  |
|-----------------------------------|------------------|
| A) Polarity                       | B) Size          |
| C) Adsorption to stationary phase | D) Crystallinity |



63. Which of the following electronic configurations correspond to a noble gas?  
 A) 2, 8, 4      B) 2,8,18      C) 2,8,18,7      D) 2,8,3
64. In Bose-Einstein condensates, the particles  
 A) Have strong interparticle attraction  
 B) Condense in real space  
 C) Have overlapping wavefunctions  
 D) Have large and positive chemical potential
65. With regard to the change in strength of materials based on grain (or crystallite)-size, the Hall-Petch equation says:  
 A) That the smaller the grain size, the stronger the material.  
 B) The larger the grain size, the stronger the material.  
 C) The larger the grain size, the stronger the material until a certain size regime (usually in the 10 - 100 nm range) is entered in which case the trend reverses and smaller grains create greater yield strength.  
 D) The smaller the grain size, the stronger the material until a certain size regime (usually in the 10 - 100 nm range) is entered in which case the trend reverses and smaller grains cause the material to lose yield strength.
66. The resolution of an optical microscope has a theoretical limit of resolution based primarily on what factor?  
 A) The focusing mechanism  
 B) The wavelength of light  
 C) Quality of optics  
 D) The working distance of the microscope
67. A liquid medium containing a colloidal suspension of ferromagnetic particles is known as  
 A) Magnetic resonance      B) Plasmonic fluid  
 C) Superconductor      D) Ferrofluid
68. Which one of the following is not a composite?  
 A) Bone      B) Sand      C) Fiberglass      D) Polymer
69. Fibers are examples for:  
 A) Photonic material      B) Semiconductor material  
 C) Conducting material      D) Protonic conductor material
70. Bernoulli's equation is valid for the following type of flow:  
 A) Compressible, steady, inviscid  
 B) Incompressible, steady, viscous  
 C) Compressible, unsteady, viscous  
 D) Incompressible, steady, inviscid

71. The number of amino acids present in oligomer are  
 A) 1-5                      B) 15-25                      C) 50-75                      D) 75-100
72. Sulphur containing amino acid is  
 A) Methionine                      B) Leucine  
 C) Valine                      D) Asparagine
73. The most abundant free nucleotide in mammalian cells is  
 A) ATP                      B) NAD                      C) GTP                      D) FAD
74. The following equation is known as:  

$$J = -D \frac{dC}{dX}$$
 where  $J$  = flux,  $D$  = diffusion coefficient,  $C$  = concentration  
 A) Fick's 2<sup>nd</sup> law                      B) Maxwell's equation  
 C) Fick's 1<sup>st</sup> law                      D) None
75. What is anodic bonding?  
 A) A method of fabrication for nanofluidic channels  
 B) A chemical bonding method  
 C) An electrode in electrochemistry  
 D) None

X-X-X