

**ENTRANCE EXAMINATIONS 2018**  
**PhD(Nanoscience and Technology)**

Marks: 80

Time: 2.00 hrs

Hall Ticket no:

- I. Write your Hall Ticket Number on the OMR Answer Sheet given to you. Also write the Hall Ticket Number in the Space provided above.
- II. Read the following instructions carefully before answering the questions.
- III. This Question paper has TWO parts: PART 'A' AND PART 'B'

1. Part 'A': It consists of 20 objective type questions of **TWO** marks each.  
There is a negative marking of **0.66** marks for every wrong answer.
2. Part 'B': It consists of 40 objective questions of one mark each with no negative marking.
3. All questions are to be answered. Answers for these questions are to be entered on the OMR sheet, filling the appropriate circle against each question. For example, if the answer to a question is D, it should be marked as below:



No additional sheets will be provided. Rough work can be done in the question paper itself and rough work sheets provided at the end of the booklet.

4. Hand over the OMR answer sheet at the end of the examination to the invigilator
5. Mobile phones, log tables and calculators of any type are NOT permitted inside the Examination Hall.
6. This book contains 11 pages including this cover sheet.

**PART A**

1. Identify the equation for a hyperbola among the following:
  - A.  $Y=aX+b$
  - B.  $Y^2=4aX+b$
  - C.  $(X^2/a^2)-(Y^2/b^2) = 1$
  - D.  $3Y^3+2X^2+aX= b$
  
2. A clock is set exactly at 8 am. The clock gains 10 minutes in 24 hr. What will be the right time when the clock indicates 1 pm on the following day?
  - A. 11.40 pm
  - B. 12.48 pm
  - C. 12.00 pm
  - D. 10.00 pm
  
3. The sum of digits in a two digit number is 12. If the new number formed by reversing the digits is greater than the original number by 54, find the original number
  - A. 39
  - B. 58
  - C. 65
  - D. 90
  
4. Saina Nehwal who is facing east, turns  $100^\circ$  in the anti-clockwise direction and then  $145^\circ$  in the clock-wise direction. What is the direction that she is facing now?
  - A. South East
  - B. South
  - C. North West
  - D. West
  
5. If there is 10 cm rain fall, what is the water volume in a football field of  $10^4 \text{ m}^2$ ?
  - A.  $10 \text{ m}^3$
  - B.  $100 \text{ m}^3$
  - C.  $1000 \text{ m}^3$
  - D.  $10000 \text{ m}^3$
  
6. If a solid of  $31.4 \text{ cm}^3$  volume is made into a rod of 4 mm diameter , then the length of the rod is
  - A. 0.5 m
  - B. 1.5 m
  - C. 2.5 m
  - D. 3.5 m

7. Rahul Dravid made an investment of Rs. 10,000 on a stock of Rs. 200 to earn an income of Rs. 10,000. What is the dividend from this stock?
  - A. 50%
  - B. 100%
  - C. 200%
  - D. 10%
  
8. Chris Gayle has equal number of 50, 100 and 2000 rupee notes totaling to a sum of Rs. 51, 600. What is the total number of notes that he has got
  - A. 6
  - B. 12
  - C. 24
  - D. 48
  
9. In a clock, how many times are the minute hand and hour hand at right angles in a span of 24h
  - A. 44
  - B. 22
  - C. 20
  - D. 12
  
10. If  $n$  is a natural number, then  $5n^2 + 5^n$  is always divisible by
  - A. Only 5
  - B. Both 5 and 10
  - C. Only 10
  - D. Only 15
  
11. If two  $3 \times 3$  matrices (say,  $A$  and  $B$ ) commute, i.e.  $[AB - BA] = 0$ , which of the following statement is true?
  - A.  $A$  and  $B$  have the same set of eigen values.
  - B.  $A$  and  $B$  share the same set of eigen vectors.
  - C. Their determinants are equal.
  - D.  $A$  and  $B$  are necessarily inverses of each other.
  
12. Consider two fair dice bearing the numbers 1, 2, 3, 4, 5 and 6 on the six faces of each die. What is the probability that the sum of numbers from a random roll of the two dice is exactly 2?
  - A.  $2/6$
  - B.  $1/6$
  - C.  $2/36$
  - D.  $1/36$

13. A random experiment consists of tossing four coins (each with two outcomes) and four dice (each with six outcomes). How many elementary outcomes exist in the sample space of this experiment?
- 32
  - 144
  - 4096
  - 20736
14. Which of the following statements is not true about the function  $f(x) = |\sin(x)|$  defined over the real axis?
- It is continuous everywhere.
  - It can be differentiated everywhere.
  - It can be integrated everywhere.
  - It is finite everywhere.
15. The average of first 97 natural numbers is
- 47
  - 37
  - 48
  - 49
16. A mixture contains alcohol and water in the ratio of 12:5. On adding 14 litres of water, the ratio of alcohol to water becomes 4:3. What is the quantity of alcohol in this mixture?
- 18 litres
  - 42 litres
  - 26 litres
  - 32 litres
17. A ladder is placed so as to reach a window of 63 cm height. The ladder is then turned over to the opposite side of the street and is found to reach a point at a height of 56 cm. If the ladder is 65 cm long, the width of the street is
- 59 cm
  - 39 cm
  - 49 cm
  - 69 cm
18. If X and Y are two numbers whose arithmetic mean is 25 and geometric mean is 7, a probable value of X among the following could be
- 10
  - 20
  - 49
  - 25

19. The radius of a circle is 13 cm and the length of one of its chords is 24 cm. The distance of the chord from the center would be
- A. 10 cm
  - B. 8 cm
  - C. 5 cm
  - D. 5.5 cm
20. Consider the equation  $M^2 = CA + 1$ , C can be determined from the
- A. Slope of a graph between  $M^2$  and A
  - B. Slope of a graph between M and A
  - C. X-intercept of a graph between  $M^2$  and A
  - D. Y-intercept of a graph between  $M^2$  and A

**PART B**

21. Recrystallization is the temperature at which
- Crystals first start forming from molten metal when it is cooled.
  - Strain-free grains begin to form out of the parent strained material
  - Crystals grow bigger in size
  - Change of allotropic form takes place
22. Rayleigh criterion is applied to image features with a diameter less than
- $\frac{1}{2}$  the wavelength of the radiation
  - $\frac{1}{3}$  the wavelength of the radiation
  - $\frac{1}{10}$ th the wavelength of the radiation
  - $\frac{1}{5}$ th the wavelength of the radiation
23. The bandgap of an elemental intrinsic semiconductor
- Does not depend on atom size
  - Increases with increase in atom size
  - Decreases with increase in atom size
  - Decreases with decrease in atom size
24. Which one of the following statements is not correct about phase diagrams (Temperature vs Composition)
- They give information on transformation rates
  - Relative amounts of different phases can be found under given equilibrium conditions
  - Phase transformation temperatures can be depicted
  - Solid solubility limits can be depicted
25. Nose of a C curve in a time-temperature-transformation (TTT) diagram represents
- Shortest time required for a specified fraction of transformation
  - Longest time required for a specified fraction of transformation
  - Average time required for a specified fraction of transformation
  - No information regarding time required for a specified fraction of transformation
26. Schottky defect is generally defined as
- An interstitial impurity
  - A vacancy-interstitial pair of cations
  - A pair of a cation and anion vacancy
  - A substitutional impurity
27. Which of the following is important for shafts that transmit rotation
- Tensile forces
  - Shear forces
  - Torsional load
  - Flexural strength

28. Identify the correct sequence that happens during heating of a strained material
- Grain growth, recrystallization, stress relief
  - Stress relief, grain growth, recrystallization
  - Stress relief, recrystallization, grain growth
  - Grain growth, stress relief, recrystallization
29. Thermal conductivity has the following units (W=Watt, K=Kelvin, m=metre)
- W.K/m
  - W/m/K
  - W. m/K
  - W. m. K
30. Oxidation rate of a nanomaterial in comparison to its bulk form will be
- More
  - Less
  - Same
  - Zero
31. If two mechanical springs (with spring constants  $k_1$  and  $k_2$ ) are connected in parallel, then the effective spring constant is
- $k_1+k_2$
  - $1/k_1+1/k_2$
  - $k_1 \times k_2$
  - $k_1/k_2$
32. Materials having body centered cubic crystal structure are not very ductile at room temperature due to
- High dislocation density.
  - Limited number of slip systems.
  - Many slip systems.
  - Low dislocation density.
33. It is defined that  $0\text{K} = -273.15\text{ }^\circ\text{C}$ . The lowest temperature measured experimentally so far is (K=Kelvin)
- $273.15\text{ }^\circ\text{C}$
  - $-273.15\text{ }^\circ\text{C}$
  - $-273.14\text{ }^\circ\text{C}$
  - $273.14\text{ }^\circ\text{C}$
34. Martensite has the following crystal structure
- Face centered tetragonal
  - Body centered tetragonal
  - End centered tetragonal
  - Right centered tetragonal

35. In Young's double slit experiment, the first slit has a width which is four times the width of second slit. Then, ratio of the maximum intensity to the minimum intensity in the interference fringe system is
- A. 2:1
  - B. 4:1
  - C. 9:1
  - D. 8:1
36. In order to double the frequency of the fundamental note emitted by a stretched spring, the length is reduced to  $3/4^{\text{th}}$  of the original length and the tension is changed. To achieve this, tension of the string has to be
- A. Increased by a factor of  $9/4$
  - B. Decreased by a factor of  $9/4$
  - C. Decreased by a factor of  $4/9$
  - D. Increased by a factor of  $4/9$
37. Which of the following statements is true about Lennard-Jones potential
- A. It is dependent only on the separation between particles
  - B. It is dependent only on the depth of the potential well
  - C. It is dependent only on the diameter of the particles
  - D. It is dependent on the separation between particles and depth of the potential well but independent of the diameter of the particles.
38. Under certain conditions, a beam of electrons impinging on a crystal surface will diffract and a scattering pattern of the beam can be obtained. If the lattice spacing of the crystal is 0.4 nm, then the kinetic energy of electrons needed to observe the pattern is approximately:
- A. 0.1 eV
  - B. 1 eV
  - C. 15 eV
  - D. 50 eV
39. If the spacing between the parallel Bragg planes in a crystal is "d" and the electrons of a fixed energy corresponding to a wavelength " $\lambda$ " are incident on it, then which of the following conditions must be minimally satisfied to observe strong reflections for at least two different angles
- A.  $\lambda > d$
  - B.  $\lambda > d/2$
  - C.  $\lambda < d$
  - D.  $\lambda < 2d$
40. Which of the following is not a characteristic property of a ceramic material
- A. High temperature stability
  - B. High mechanical strength
  - C. Low elongation
  - D. Low hardness



41. Catalytic activity of nano particles in comparison to their bulk form will be
- Less
  - More
  - Remains unchanged
  - Zero
42. With increase in mean free path of electrons in a crystal at room temperature, its electrical conductivity
- Increases
  - Decreases
  - Remains constant
  - Tends to zero
43. With decrease in temperature of a semiconductor, its resistance
- Decreases
  - Increases
  - First decreases and then increases
  - Remains unchanged
44. Mn has an oxidation number of +4 in
- MnO
  - Mn<sub>2</sub>O<sub>3</sub>
  - MnO<sub>2</sub>
  - Mn<sub>2</sub>O<sub>7</sub>
45. The yield strength of a polycrystalline material (average grain size = 50  $\mu\text{m}$ ) in comparison to its nanocrystalline (average grain size = 50 nm) form will be
- More
  - Less
  - 50 GPa
  - 50 MPa
46. The sequence of precipitation to reach a stable equilibrium during ageing of Al-4.5wt% Cu alloy is
- GP zones  $\rightarrow \theta' \rightarrow \theta'' \rightarrow \theta$
  - GP zones  $\rightarrow \theta'' \rightarrow \theta' \rightarrow \theta$
  - GP zones  $\rightarrow \theta \rightarrow \theta'' \rightarrow \theta'$
  - GP zones  $\rightarrow \theta'' \rightarrow \theta \rightarrow \theta'$
47. The primary mechanisms of accommodating plastic strain at low temperatures in crystalline materials are
- Slip and twinning
  - Dislocation climb and slip
  - Slip and diffusion
  - Viscous flow and slip

48. Dye penetrant test is based on the principle of
- Polarized sound wave in liquid
  - Magnetic domain
  - Absorption of X-rays
  - Capillary action
49. If  $a_0$  is the Bohr radius and  $Z$  is the atomic number, then the approximate radius of the first orbit is
- $a_0 Z$
  - $a_0/Z$
  - $a_0/2Z$
  - $2a_0/Z$
50. Argon and Neon can be crystallized into which one of the following crystal structures?
- HCP
  - FCC
  - BCC
  - SC
51. Holes and electrons are distinguished using
- Compton effect
  - Rayleigh scattering
  - Hall effect
  - Thomson effect
52. Galvanizing is the process of coating iron with
- Tin
  - Zinc
  - Copper
  - Nickel
53. Identify the iron ore among the following:
- Hematite
  - Wolframite
  - Dynamite
  - Wurtzite
54. Aluminium is extracted by
- Hund's process
  - Hummer's process
  - Bayer's process
  - Mond's process
55. Which one of the following is not a mineral beneficiation method
- Froth flotation
  - Gravity concentration
  - Magnetic separation
  - Oxidation

56. Chromium is added to steel to impart
- A. Colour
  - B. Corrosion resistance
  - C. Ductility
  - D. Impact toughness
57. In a martensitic phase transformation, one of the following is correct ( $M_s$  = Martensite start temperature and  $M_f$  is martensite finish temperature)
- A.  $M_s$  and  $M_f$  are well defined
  - B.  $M_s$  is well defined whereas  $M_f$  is not well defined
  - C.  $M_s$  and  $M_f$  are not well defined
  - D.  $M_s$  is not well defined whereas  $M_f$  is well defined
58. Identify the equilibrium defects from the following
- A. Dislocations
  - B. Stacking faults
  - C. Vacancies
  - D. Grain boundaries
59. Superalloys are used to manufacture
- A. Car bodies
  - B. Aero engines
  - C. Bicycles
  - D. Cutlery
60. One of the following can not be used to decrease the temperature of a system
- A. Solid carbon dioxide
  - B. Liquid nitrogen
  - C. Liquid helium
  - D. Mercury