

PART 'A'

1. For first order differential equation, $\frac{dy}{dx} + ky = 0$ where k is a constant and $y(x=0) = 1$, the solution is
 - A. $y = e^{kx}$
 - B. $y = e^{-kx}$
 - C. $y = e^{k/x}$
 - D. $y = e^{x/k}$

2. An example of intensive thermodynamic property is
 - A. Entropy
 - B. Pressure
 - C. Volume
 - D. Free energy

3. In a homogeneous system with ' c ' components and ' n ' phases under constant temperature and pressure, the total number of independent thermodynamic variables is
 - A. $c - n$
 - B. $c + n$
 - C. $c - n + 2$
 - D. $c - n - 2$

4. Which of the following statements is true?
 - A. Both screw and edge dislocation contain extra plane above or below the slip plane
 - B. Edge dislocation contain extra plane above or below the slip plane
 - C. Screw dislocation contain extra plane above or below the slip plane
 - D. None of the above

5. The dimensional formula for specific heat capacity (all symbols have standard meaning) is
- A. $M^0L^2T^{-2}\theta^{-1}$
 - B. $MLT^2\theta^{-1}$
 - C. $M^0LT^2\theta^{-1}$
 - D. $M^0L^{-2}T^{-2}\theta^{-1}$
6. For a thermodynamic system to be stable under constant temperature and pressure,
- A. Its Gibb's free energy should be maximum
 - B. Its Gibb's free energy should be minimum
 - C. Its enthalpy should be minimum
 - D. Its entropy should be minimum
7. The number of close packed planes in face centred cubic structure are
- A. 2
 - B. 4
 - C. 6
 - D. 8
8. The limit of resolution of an optical microscope is equal to
- A. The wavelength of the radiation
 - B. Magnifying power of the eyepiece
 - C. Aperture size
 - D. Polarization of the radiation
9. Which one of the following elements can have positive oxidation state?
- A. Cs
 - B. Br
 - C. O
 - D. None of the above

10. The work function of Na is 2.3eV. What is the maximum wavelength of light that will cause photoelectrons to be emitted from Na?
- A. 488 nm
 - B. 540 nm
 - C. 668 nm
 - D. 780 nm
11. Paramagnetic alpha iron changes to gamma iron at
- A. 770°C
 - B. 1440°C
 - C. 910°C
 - D. 1539°C
12. For an ideal gas $C_p - C_v$ is
- A. R
 - B. -R
 - C. 0
 - D. ∞
13. Units of Diffusion Coefficient are:
- A. No units
 - B. m^2/sec
 - C. N/m^2
 - D. N/sec^2
14. Which variety of Cu has the best electrical conductivity?
- A. Pure annealed Cu
 - B. Cu containing moderate concentration of oxygen
 - C. Cold worked Cu
 - D. None of the above

15. Nickel which is to the left of Cu ($3d^{10}4s^1$) in the first transition metal series has an outer electronic configuration of
- A. $3d^94s^1$
 - B. $3d^84s^2$
 - C. $3d^{11}4s^1$
 - D. $3d^{10}4s^2$
16. Atomic packing factor for the diamond cubic structure is
- A. 0.74
 - B. 0.68
 - C. 0.34
 - D. 0.25
17. The value of the summation $\sum_{n=1}^{\infty} \frac{x^n}{n!}$ is
- A. $\ln(x)$
 - B. $\ln(x) + 1$
 - C. e^x
 - D. $e^x - 1$
18. The following thermocouple may be used to measure temperature up to 1773 K
- A. Chromel - alumel
 - B. Copper - constantan
 - C. Iron - constantan
 - D. Platinum - Platinum rhodium
19. The alloy used for cladding in thermal power reactors containing natural uranium as fuel is
- A. Stainless steel
 - B. Zirconium alloy
 - C. Cadmium alloy
 - D. Aluminium alloy

20. The melting temperature of an intermetallic compound is
- A. Spread over a range
 - B. A single temperature
 - C. Indeterminate
 - D. Always greater than the melting point of the major constituent
21. Which one is the natural polymer ?
- A. Cellulose
 - B. Polyethylene
 - C. Polyester
 - D. Vulcanized rubber
22. Ester is formed when alcohol reacts with
- A. Carboxylic acid
 - B. Aldehyde
 - C. Ketone
 - D. Ether
23. The domain wall motion in ferromagnetic Fe is obstructed by
- A. Dislocation tangles
 - B. Impurity atoms
 - C. Non-magnetic inclusions
 - D. All of the above
24. For lasing action the energy gap of a semiconductor should be
- A. Direct bandgap
 - B. Indirect gap
 - C. No band gap
 - D. None of the above

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25. c/a ratio of ideal HCP unit cell is

- A. 1
- B. 1.54
- C. 1.63
- D. 1.88

PART 'B'

26. Cast iron is used in the base of machinery subjected to intermittent loading because of its

- A. Load shedding capacity
- B. Damping capacity
- C. Anti-friction property
- D. High thermal conductivity

27. $\lim_{x \rightarrow 0} \frac{x \sin \frac{x}{2}}{1 - \cos x}$ is

- A. 1
- B. 2
- C. 0
- D. $\frac{1}{2}$

28. If a wire of length L is embedded along the axis in a cylinder of height H ($H > L$), the probability of observing the wire when a random section is cut perpendicular to axis of cylinder is

- A. L/H
- B. H/L
- C. $2L/H$
- D. none of these

29. Which of the following statements is true?

- A. Engineering stress and true stress have the same value
- B. Engineering strain and true strain have the same value
- C. Engineering stress is higher than the true stress
- D. Engineering stress is lower than the true stress

30. Indirect extrusion is also known as
- A. Forward extrusion,
 - B. Backward extrusion
 - C. Extrusion
 - D. Shape extrusion
31. The volume occupied by the parallelepiped formed by the vectors $\bar{a} = \frac{1}{2} \hat{i} + \frac{\sqrt{3}}{2} \hat{j}$, $\bar{b} = -\frac{1}{2} \hat{i} + \frac{\sqrt{3}}{2} \hat{j}$ and $\bar{c} = \frac{4}{\sqrt{3}} \hat{k}$ is
- A. 2
 - B. $4/\sqrt{3}$
 - C. 1
 - D. $2/\sqrt{3}$
32. Zone refining is
- A. An equilibrium process
 - B. Non-equilibrium process
 - C. Grain refining process
 - D. Deformation process
33. In energy dispersive spectrometer attached to an electron microscope, the elemental identification is carried out using
- A. Characteristic x-rays
 - B. Bremsstrahlung
 - C. Auger electrons
 - D. Photoelectrons
34. Stacking sequence along [110] direction of face centred cubic structure is
- A. ABABABABAB....
 - B. ABCABCABC.....
 - C. ABACABACAB.....
 - D. AABBAABBAABB...

35. Driving force for grain growth after complete recrystallisation is
- A. Stored energy of cold work
 - B. Reduction in grain boundary area
 - C. Reduction in dislocation density
 - D. None of the above
36. The number of second nearest neighbours in simple cubic structure is
- A. 8
 - B. 6
 - C. 12
 - D. 10
37. Torsion test can be used to determine
- A. Young's modulus of material
 - B. Shear modulus of material
 - C. Bulk modulus of material
 - D. Elastic limit of material
38. Pig iron is produced in
- A. Bessemer converter
 - B. Open hearth furnace
 - C. Blast furnace
 - D. Cupola
39. Forging is a
- A. Batch process
 - B. Continuous process
 - C. A semi-continuous process
 - D. Sheet working process

40. If $C = AB - BA$, where $A = \frac{1}{2} \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ and $B = \frac{1}{2} \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$, then the eigen values of C are
- A. $\frac{i}{2}$ and $-\frac{i}{2}$
 - B. $\frac{1}{2}$ and $-\frac{1}{2}$
 - C. $\frac{i}{4}$ and $-\frac{i}{4}$
 - D. $\frac{1}{4}$ and $-\frac{1}{4}$
41. A radioactive nucleus of type 1 decays exponentially with a decay constant λ_1 to stable nucleus of type 2 if at time $t = 0$, the number of type 1 and 2 nuclei are respectively $N_1(t = 0) = N_0$ and $N_2(t = 0) = 0$, what is the number of type 2 nucleus present at time t ?
- A. $N_0 \exp - \lambda_1 t$
 - B. $N_0 (1 - \exp - \lambda_1 t)$
 - C. $N_0 (1 + \exp - \lambda_1 t)$
 - D. $1 - N_0 \exp - \lambda_1 t$
42. Above Curie temperature, the hysteresis loop of a ferro-electric material merges into a
- A. Point
 - B. Straight line
 - C. Parabola
 - D. Cycloid
43. Above the Neel temperature, a magnetic material becomes
- A. Ferromagnetic
 - B. Paramagnetic
 - C. Diamagnetic
 - D. None of the above

44. In superconducting state
- A. Entropy and thermal conductivity decrease
 - B. Entropy and thermal conductivity increase
 - C. Entropy decreases while thermal conductivity increases
 - D. Entropy increases while thermal conductivity decreases
45. The Miller indices are same for
- A. a plane and directions in those planes
 - B. Parallel planes
 - C. Planes perpendicular to each other
 - D. Planes having the same interplanar spacing
46. A certain amount of ice at 0°C melts into water at 0°C and in so doing gains 1kg of mass. Calculate its initial mass.
- A. 2.7×10^{11} g
 - B. 2.7×10^{11} kg
 - C. 3.8×10^{11} g
 - D. 3.8×10^{11} kg
47. Erosion – corrosion is a
- A. Chemical attack
 - B. Mechanical abrasion
 - C. Combined action of chemical attack and mechanical abrasion
 - D. Due to fluid velocity
48. Laplace transform $F(s) = \int_0^{\infty} dt e^{-st} f(t)$ of the function $f(t) = \frac{1}{\sqrt{\pi t}}$ is
- A. $\frac{1}{\sqrt{s}}$
 - B. \sqrt{s}
 - C. $\frac{1}{\sqrt{\pi s^{3/2}}}$
 - D. $\frac{1}{\sqrt{\pi s}}$

49. Which of the following is the hardest material?
- A. Hardened steel
 - B. Tungsten carbide
 - C. Boron carbide
 - D. Alloy steels
50. Permalloy is a
- A. Kind of stainless steel
 - B. Polymer
 - C. Nickel and iron alloy having high permeability
 - D. Cutting tool material
51. Which of the following is not a casting process?
- A. Chills process
 - B. Extrusion
 - C. Semi-centrifuge method
 - D. Slush process
52. Which is the false statement about tempering?
- A. Improves toughness
 - B. Improves machinability
 - C. Releases stresses
 - D. Reduces hardness and brittleness
53. The minimum energy required to impose an elastic strain of ϵ to a metal having unit volume and a constant flow stress, σ , is
- A. $\sigma \epsilon$
 - B. $2 \sigma \epsilon$
 - C. $\frac{1}{2} \sigma \epsilon$
 - D. $\frac{3}{4} \sigma \epsilon$

54. The elastic strain in copper is due to
- A. Change in atomic bond length
 - B. Breakage of atomic bonds
 - C. Motion of dislocation
 - D. None of the above
55. During tensile test, a ductile fracture is characterized by
- A. Beach marks
 - B. Cup and Cone
 - C. Cleavage facets
 - D. Quasi-cleavage
56. Dislocation generation in polycrystalline materials occurs by
- A. Cottrell-Bilby source
 - B. Johnston-Gilman source
 - C. Frank-Read source
 - D. Nabarro-Herring source
57. A small amount of thoria is doped into tungsten filament wires used in light bulbs. This is because thoria particles
- A. Decreases solute diffusivity
 - B. Enhances the mobility of grain boundary
 - C. Increases solute segregation to grain boundary
 - D. Are effective in limiting grain growth
58. Shear modulus of Al is 28.0 GPa. The theoretical fracture strength of dislocation free single crystal of aluminium is
- A. 28.0 GPa
 - B. 9.3 GPa
 - C. 0.1 GPa
 - D. 0.01 GPa

59. A crystal undergoes a transformation from FCC to BCC structure but the lattice parameter remains the same for both phases. Which of the following statements is true?
- A. Density of materials before and after the transformation and the volume of the unit cell are different
 - B. Density of materials before and after the transformation is the same but volume of the unit cell is different
 - C. Density of materials before and after the transformation is the same but volume of the unit cell before and after the transformation is the same
 - D. Density of materials before and after the transformation is different but volume of the unit cell remains the same
60. The spectrum of radiation emitted by black body at a temperature of 1000 K peaks in the
- A. Visible range of wavelengths
 - B. Infra red range of wavelengths
 - C. Ultra violet range of wavelengths
 - D. Radio wave range of wavelengths
61. If the volume of unit cube of a material does not change during deformation, then the Poisson's ratio should be
- A. 0.25
 - B. 0.37
 - C. 0.50
 - D. 1.0
62. The defects which have most detrimental effect on the fracture toughness of materials are
- A. Fine coherent precipitates
 - B. Inclusion
 - C. Incoherent spherical precipitates
 - D. Microcracks

63. The empirical relationship that exhibits linear relationship between cyclic stress and mean stress on fatigue life is called as
- A. Gerber's relationship
 - B. Goodman relationship
 - C. Baushinger relationship
 - D. Coffin-Manson relationship
64. During the ferromagnetic to paramagnetic transition of iron, the property that changes abruptly is
- A. Gibb's free energy
 - B. Enthalpy
 - C. Entropy
 - D. Heat capacity
65. During stretching of an ideal elastomer, its enthalpy
- A. Increases
 - B. Remains constant
 - C. Decreases
 - D. None of the above
66. Eutectoid reaction is given by
- A. $\text{Liquid}_1 \leftrightarrow \text{Solid}_1 + \text{Liquid}_2$
 - B. $\text{Liquid}_1 + \text{Liquid}_2 \leftrightarrow \text{Liquid}_3$
 - C. $\text{Liquid}_1 \leftrightarrow \text{Solid}_1 + \text{Solid}_2$
 - D. $\text{Solid}_1 \leftrightarrow \text{Solid}_2 + \text{Solid}_3$
67. Radiation pyrometers are used
- A. For measurement of radiation dose
 - B. For determining viscosity of liquids
 - C. For temperature measurement
 - D. For measuring length of rail track

68. The yield-point phenomenon observed in annealed low carbon steel is due to the presence of
- A. Silicon
 - B. Carbon
 - C. Phosphorous
 - D. Chromium
69. A cold worked material is annealed at high temperature. Increase in the percentage of cold work, the recrystallization temperature
- A. Increases
 - B. Decreases
 - C. Remains constant
 - D. None of the above
70. Why are semiconductors transparent to IR light although opaque to visible light?
- A. Valence electrons can find unoccupied excited energy states in the conduction band for any excitation energy, however small
 - B. The energy gap is so large that photons of visible light cannot provide enough excitation energy from electrons in the valence band to reach the conduction band
 - C. The energy gap is small and so photons of visible light can excite valence electrons to the conduction band although photons of IR light have insufficient energy for the purpose
 - D. None of the above
71. Routine inspection for defects in locomotive axles and rails can be possible by
- A. Radiography
 - B. Ultrasonic testing
 - C. Thermography
 - D. Holography

72. On increasing the impurity concentration in the metal, the residual component of the resistivity
- A. Decreases
 - B. Increases
 - C. Remains constant
 - D. Can be made zero
73. The processing method used to improve the creep resistance of the material by reduction of transverse grain boundaries is
- A. Rotary swaging
 - B. Directional solidification
 - C. Cold rolling
 - D. Hot extrusion
74. Martensitic transformation is a
- A. Diffusional transformation
 - B. Displacive transformation
 - C. Spinodal transformation
 - D. Ordering transformation
75. The ASTM grain size number N for a structural steel which shows 65 grains per square inch at a magnification of $100X$ is
- A. 1
 - B. 3
 - C. 5
 - D. 7