

ee24btech11015 - Dhawal

- 40) The axial velocity profile of a laminar, incompressible and fully-developed flow in a circular pipe of radius (R) is given as

$$u_z = -\frac{1}{4\mu} \frac{\partial p}{\partial z} R^2 \left(1 - \frac{r^2}{R^2}\right),$$

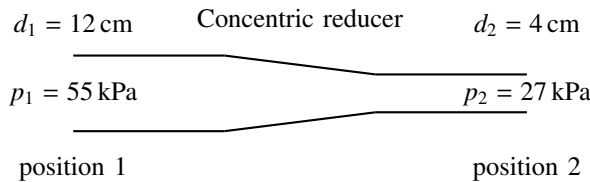
where r, z, μ , and p are radial direction, axial direction, fluid viscosity, and pressure, respectively. If the average velocity of the flow is given by

$$u_{z,\text{avg}} = \frac{1}{K} \left(-\frac{R^2}{\mu} \frac{\partial p}{\partial z} \right),$$

then the value of K (answer in integer) is _____

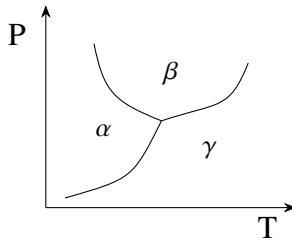
- 41) The velocity potential function in a two-dimensional flow field is given by $\Phi(x, y) = -(axy + bx^2 - by^2) \text{ m}^2/\text{s}$ where $a = 2$ per second and $b = 0.5$ per second. The magnitude of the velocity (in m/s, answer in integer) at $x = 2 \text{ m}, y = 1 \text{ m}$ is _____.

- 42) Consider the incompressible, steady and irrotational flow through a concentric reducer in a horizontal pipeline. The pipe diameter reduces from $d_1 = 12 \text{ cm}$ to $d_2 = 4 \text{ cm}$ as shown in figure. The pressure at position 1 and position 2 of the reducer is $p_1 = 55 \text{ kPa}$ and $p_2 = 27 \text{ kPa}$, respectively. The specific weight of fluid is 7 kN/m^3 . Acceleration due to gravity is 10 m/s^2 .



Neglecting frictional effects, the mass flow rate (in kg/s, rounded off to two decimal places) of the fluid through the reducer is _____.

- 43) Consider the incompressible fluid flow over a flat plate with a free stream velocity, $U_\infty = 1 \text{ m/s}$. The fluid kinematic viscosity is $10^{-6} \text{ m}^2/\text{s}$ and density is 1 kg/m^3 . The velocity profile within the boundary layer at any location x is given by $u(y) = U_\infty \left(\frac{3}{2} \frac{y}{\delta} - \frac{1}{2} \left(\frac{y}{\delta} \right)^3 \right)$, where boundary layer thickness, $\delta = \frac{4.64x}{\sqrt{R_{\text{ex}}}}$, and $R_{\text{ex}} = \frac{U_\infty x}{\nu}$. The local wall shear stress at $x = 1 \text{ m}$ from the leading edge is _____ $\times 10^{-3} \text{ N/m}^2$ (rounded off to two)
- 44) The correct combination of phases in the one-component H_2O phase diagram, as given below, is



- a) α – water; β – vapour; γ – ice
 b) α – ice; β – water; γ – vapour
 c) α – vapour; β – ice; γ – water
 d) α – water; β – ice; γ – vapour

45) Mechanical behaviour of a crystalline ceramic material is best described as

- a) ductile b) brittle c) viscoelastic d) viscoplastic

46) Differential scanning calorimetry involves measurement of

- a) weight change b) entropy c) heat d) vapour pressure

47) In ball milling of ceramic powder, selection of grinding media depends on the _____ difference between grinding media and powder particles.

- a) thermal conductivity c) hardness
 b) dielectric constant d) density

48) Which one of the following unit cell parameters represents a tetragonal crystal system?

- a) $a = b = c; \alpha = \beta = \gamma \neq 90^\circ$ c) $a = b \neq c; \alpha = \beta = 90^\circ, \gamma = 120^\circ$
 b) $a \neq b \neq c; \alpha = \beta = \gamma = 90^\circ$ d) $a = b \neq c; \alpha = \beta = \gamma = 90^\circ$

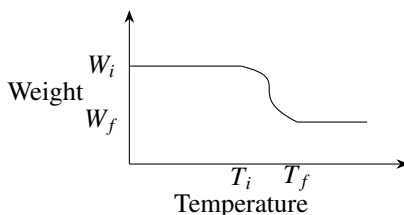
49) Which of the following types of materials exhibit(s) positive magnetic susceptibility?

- a) Paramagnetic b) Diamagnetic c) Ferrimagnetic d) Ferromagnetic

50) Which of the following is/are responsible for pitting corrosion in a metal ?

- a) Rough surface c) Polished surface
 b) Grain boundaries d) Polymer coated metal surface

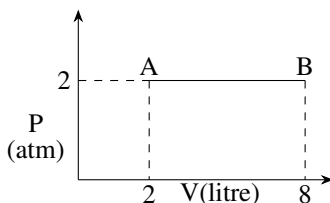
51) In thermogravimetric analysis (TGA), weight change of a material sample during decomposition with temperature is shown in the figure below.



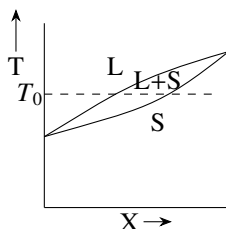
W_i and W_f represent the weight of the material, corresponding to temperatures T_i and T_f , respectively. Which of the following factor(s) can influence T_i and T_f ?

- a) Heating rate
- b) Particle size of the material
- c) Atmosphere in the sample chamber
- d) Initial weight of the sample

52) The work done by a body expanding from an initial state A to the final state B, as shown in the P-V diagram below, is (in units of litre-atm) _____ (rounded off to nearest integer).



53) A binary phase diagram is given below.



Which one of the following figures qualitatively represents the G-X (Gibbs free energy - composition) plot at temperature T_0 shown in the phase diagram?

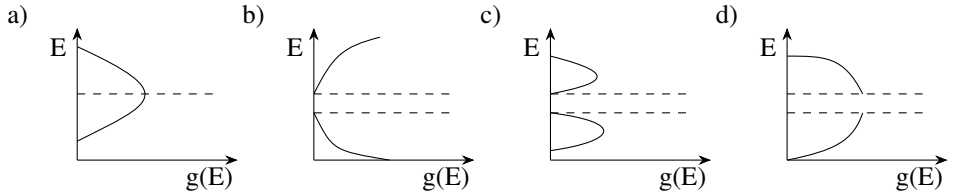
- a)

b)

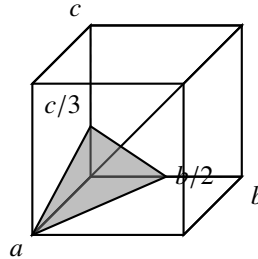
c)

d)

54) Which one of the following figures corresponds to the density of states $g(E)$ of a typical intrinsic semiconductor? (E represents the energy level of a charge carrier)

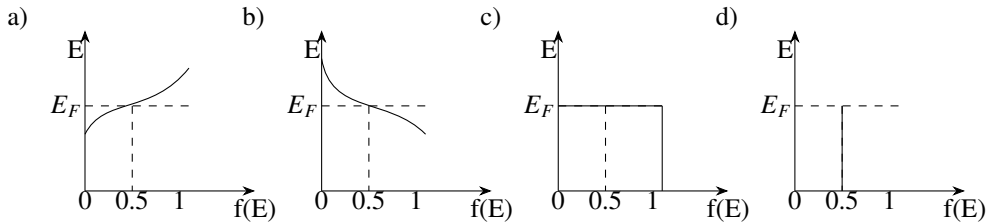


55) The Miller indices for the shaded plane shown in the unit cell below is



- a) [632] b) [123] c) (632) d) (123)

56) Which one of the following curves best represents the E vs. $f(E)$ behavior of the hot end of a metal rod demonstrating Seebeck Effect? ($f(E)$ is the probability of electron occupancy at an energy state E ; E_F is the Fermi energy)



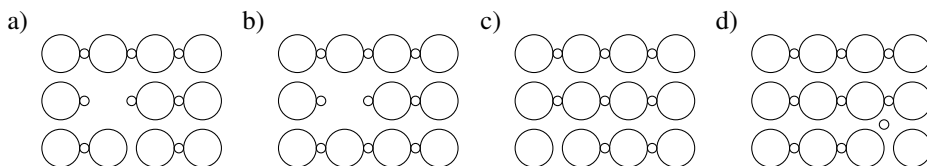
57) In a typical light emitting diode (LED), which of the following type(s) of materials is/are used?

- a) Indirect bandgap semiconductor with transition metal impurities
 b) Direct bandgap semiconductor
 c) Indirect bandgap semiconductor with isoelectronic impurities
 d) Indirect bandgap semiconductor without any impurity

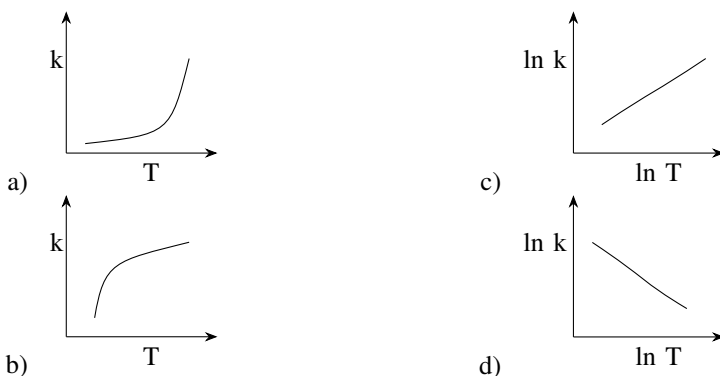
58) Which of the following options is/are true for glass transition temperature T_g ?

- a) Above T_g , glass transforms from an amorphous solid to a viscous liquid.
 b) At T_g , glass transforms from an amorphous solid to a crystalline solid.
 c) T_g is dependent on the heating rate.
 d) Below T_g , nucleation and growth takes place in glass.

59) Which of the following figures schematically represent(s) either the Frenkel defect or the Schottky defect in ionic solids?

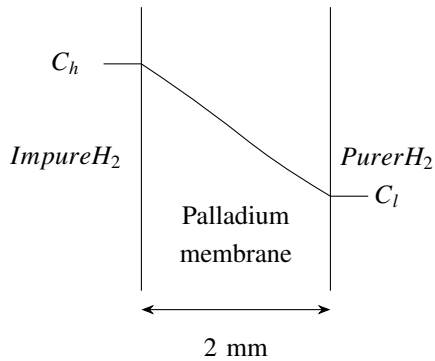


60) Given that k is the first order reaction rate constant and T is the temperature in absolute scale, the temperature dependence of rate constant is/are represented by



61) For chemical vapour deposition (CVD) process, which of the following statements is/are correct?

- Target material is stripped off by the bombardment of positive ions
 - Source material is vapourized and thermally decomposed
 - Partial hydrolysis of alkoxide in water solvent
 - Suitable for preparing films of high density and uniform thickness
- 62) At room temperature, the electrical conductivity and electron mobility for aluminum are $3.8 \times 10^7 (\Omega m)^{-1}$ and $0.0012 m^2 V s^{-1}$, respectively. Density of free electrons for aluminum at room temperature is (in units of m^{-3}) $\text{_____} \times 10^{27}$ (rounded off to nearest integer). Given: Electrical charge on an electron is $1.6 \times 10^{-19} C$.
- 63) A 2mm thick palladium sheet of $1000 mm^2$ cross-section is used as a diffusional membrane to purify hydrogen. The hydrogen concentration is maintained at a steady state with $c_h = 1.5 kg m^{-3}$ and $c_l = 0.3 kg m^{-3}$ on the two sides of the membrane as shown in the figure below.



The rate of hydrogen purification is (in units of kg hr^{-1} _____ $\times 10^{-6}$ (rounded off to one decimal place).

The diffusion coefficient of hydrogen in palladium is $1.0 \times 10^{-8} \text{ m}^2 \text{ s}^{-1}$.

- 64) In X-ray powder diffraction pattern obtained from a face centered cubic (FCC) metal, the first five reflections are at $\theta = 21.65^\circ, 25.21^\circ, 37.06^\circ, x$ and 47.58° . The Bragg angle, θ of the fourth reflection is missed out and is represented by x . The value of x is (in degree) _____ (rounded off to one decimal place).
- 65) Consider a unidirectionally aligned continuous glass fibre reinforced epoxy composite with 40 vol. % reinforcement. The elastic modulus of the composite along the fibre direction is (in units of GPa) _____ (rounded off to one decimal place).
Given: Elastic modulus of epoxy is 6.9 GPa and that of glass fibre is 69 GPa.