

Written Test for PhD admission
Department of Metallurgical and Materials Engineering, IITM
Sample question paper

All questions are compulsory. Write **only** in the provided answer sheet and use the back of the answer sheet for rough work. Return the question paper and answer sheet when you are done.

- 1) The energy of a covalent bond is typically
a) 5 meV b) 500 meV c) 5 eV d) 50 eV
- 2) Atomic radius _____ as we move across the periodic table from left to right.
- 3) Gibb's phase rule (at constant pressure) can be written as _____, where, P= number of phases, F= degrees of freedom, C= number of components.
- 4) Energy balance equation is derived from _____ law of thermodynamics.
- 5) An incompressible fluid maintains steady flow through a expansion of a channel with circular cross section. At the narrower end, where the diameter is 2 cm, the fluid has a velocity of 8 m/s. What is the expected velocity at the wider end of the channel where the diameter is 4 cm?
- 6) SI Unit for thermal conductivity is _____.
- 7) The condition for the differential $df = P(x,y)dx + Q(x,y)dy$ to be exact is _____.
- 8) Graphene is the 2D form of carbon. A recently discovered 2D form of tin is called _____.
- 9) The deflection of an electric charge by a magnetic field is called Lorentz law. In vector form, Lorentz force can be written as $\vec{F} =$ _____.
- 10) The net electric flux through any closed surface is equal to $\frac{1}{\epsilon}$ times the net electric charge enclosed within that surface. This is called _____.
- 11) The ring rolling process is used for
a) producing seamless tube
b) increasing the thickness of a ring
c) decreasing the thickness of a ring
d) producing large cylinder
- 12) The maximum shear stress available for the stress tensor $\begin{bmatrix} 21 & 0 & 0 \\ 0 & 9 & 0 \\ 0 & 0 & 6 \end{bmatrix}$ is _____.
- 13) With reference to the iron-carbon system, the crystal structure of martensite is _____.
a) BCC b) FCC c) Orthorhombic d) BCT

- 14) In metal forming, earing is a defect normally associated with:
- Rolling of a sheet
 - Extrusion of a rod
 - Drawing of a tube
 - Deep drawing of a cup
- 15) Viscosity of a CO gas in blast furnace is
- Indifferent to temperature
 - decreases with temperature
 - Increases with temperature
 - None of these options
- 16) What properties are exhibited by nickel-base superalloys, from the ones given below?
- Good creep strength and oxidation resistance
 - Good creep strength but low fatigue resistance
 - Good wear resistance and low ductile to brittle transition temperature
 - Good magnetic properties and low electrical resistivity
- 17) The reaction $(\text{Solid})_1 \rightarrow (\text{Solid})_2 + (\text{Solid})_3$ is called _____ reaction.
- 18) The part of a sand casting mold that acts as a reservoir of molten metal is called _____.
- 19) A room temperature strengthening mechanism for pure Al is _____.
- 20) The steady state potential of a metal (in an electrochemical experiment) in the absence of polarization is called _____ potential.
- 21) What is SCE? It is a reference electrode used for corrosion experiments.
- Standard Copper Electrode
 - Standard Copper Electrode; Cu, CuSO₄ (sat)
 - Standard Calomel Electrode; Ag, AgCl(s)/ sat. KCl
 - Saturated Calomel Electrode; Hg, Hg₂Cl₂(s)/ sat.KCl
- 22) Which of the following expression correctly represents the force acting on a dislocation of burgers vector **b**, line direction **t**, and stress tensor **s**
- $\mathbf{s} \times (\mathbf{t} \cdot \mathbf{b})$
 - $\mathbf{t} \times (\mathbf{s} \cdot \mathbf{b})$
 - $\mathbf{t} \times (\mathbf{s} \times \mathbf{b})$
 - $\mathbf{t} \cdot (\mathbf{s} \times \mathbf{b})$
- 23) The tendency of some alloys to separate along grain boundaries when deformed at temperatures near melting point is referred to as _____.
- 24) Chemical potential of component 1 in a binary solution can be defined as
- $(\partial A / \partial n_1)_{T, V, n_2}$
 - $(\partial V / \partial n_1)_{S, V, n_2}$
 - $(\partial H / \partial n_1)_{T, S, n_2}$
 - $(\partial G / \partial n_1)_{T, P, n_2}$
- 25) Thermit welding is a form of
- resistance welding
 - gas welding
 - fusion welding
 - forge welding
- 26) Cold cracking of weld is normally due to the presence of _____ gas in the weld.

- 40) The motion of the boundary layer between two metals that occurs as a consequence of the difference in diffusion rates of the metal atoms is known as _____.
- 41) An optical microscope, with a numerical aperture of 0.3, operates at a wavelength of 500 nm. Its resolution is equal to _____.
- 42) The Lennard-Jones potential best describes which of the following:
 a) The energy required to break a typical metal b) How defects affect lattice energy
 c) The energy associated with stretching an atom d) Potential energy of a dislocation
- 43) Electrical conductivity in gold is reduced by alloy addition due to decrease in electron _____.
- 44) ITO is a commonly used transparent semiconductor. ITO expands as _____.
- 45) Polystyrene is obtained from the monomer styrene. The chemical formula for the monomer is
 a) C_8H_8 b) C_2H_2 c) CH_3OH d) C_2H_5OH
- 46) In the crystal structure of $BaTiO_3$, if Ti atoms are located at the corners of the unit cell, then Ba atoms are located at _____.
- 47) In Raman spectroscopy, if the emitted photon has a lower energy than the absorbed photon, it is called _____ shift.
- 48) A ceramic compound commonly used as a thermionic source in TEM is _____.
- 49) The binding energy of an electron in an H atom is -13.6 eV. What will the corresponding value be for He^+ ?
- 50) A thin film layer that is grown with the same lattice spacing as the substrate is called a _____ layer.