Written Test for MS/Direct 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 tendency of an atom to attract electrons to it is called _____.

2) Different flow regimes such as laminar and turbulent are characterized by a non-dimensional number called the _____ number.

3) The SI unit for kinematic viscosity is _____.

4) A material state that is not a thermodynamic equilibrium state, but lasts for a long time is called a _____ state.

5) An odd number, between 11 and 50, whose sum and product of the digits lie between 4 and 8 is _____.

6) The cyclotron frequency for an electron of mass **m**, moving with velocity **v** in a magnetic field **B** is _____.

7) The general solution to the differential equation $\dfrac{d^2x}{dt^2} + 10\dfrac{dx}{dt} + 25x = 0$ is

(a) $(C_1 + C_2 t)e^{-5t}$
(b) $C_1 e^{-2t}$
(c) $C_1 e^{-5t} + C_2 e^{5t}$
(d) $C_1 e^{-5t} + C_2 e^{2t}$

8) If the binding energy for a H atom is -13.6 eV, then the corresponding value for Li^{2+} is _____ eV.

9) The relation $\Delta x \times \Delta p \geq \hbar/2$ is called _____.

10) Determinant of the following matrix $\begin{pmatrix} 1 & 0 & 0 & 0 \\ 100 & 1 & 0 & 0 \\ 100 & 200 & 1 & 0 \\ 100 & 200 & 300 & 1 \end{pmatrix}$ is _____

11) Viscosity of a CO gas in blast furnace is
    a) Indifferent to temperature
    b) Decreases with temperature
    c) Increases with temperature
    d) None of these

12) The ratio of the shear stress to the principal stress on a principal plane is _____.

13) A jog in an edge dislocation has a character of _____dislocation.

14) A low creep rate in metallic materials is derived from
   a) high melting temperature   b) bcc crystal structure
   c) fine grain size   d) None of the above

15) The additive that promotes heterogeneous nucleation in casting is called _____.

16) The hardenability of steel relates to the increase in hardness due to
   a) Carbide formation during tempering   b) Pearlite formation during normalizing
   c) Martensite formation during quenching   d) Thermomechanical treatment

17) The most common gas based commercial process for manufacturing sponge iron is _____.

18) The plane strain fracture toughness (K_{IC}) and yield strength of materials are 100 $MNm^{-3/2}$ and 500 MNm^{-2}, respectively. The minimum plate thickness (in centimeters), to determine K_{IC}, is _____.

19) In a binary metallic phase diagram, intermediate phases with fixed compositions are called _____.

20) In a Daniel cell the maximum potential between the Zn & Cu electrode can be obtained by
   a) Dilute Zn sulphate and saturated Cu sulphate
   b) Concentrated Zn sulphate and dilute Cu sulphate
   c) Having Zn sulphate and Cu sulphate of same concentration
   d) No effect by changing the concentration

21) If a metal is described as perfectly plastic, then the strain hardening exponent n is _____.

22) Corrosion rate can be calculated by measuring the thickness lost as a function of time. Normally it is expressed as "mpy", which expands as _____.

23) What slip systems *do* b.c.c. crystals slip on?
(a) <1 -1 1>{110}
(b) <1 -1 1>{111}
(c) <1 -1 0>{110}
(d) <001>{110}

24) The θ' precipitate in Al–Cu alloys is (semi-)coherent along which the following planes
   a) (001)   b) (010)   c) (100)   d) None of the above

25) For positive values of σ_0 and k, the Hall-Petch equation is correctly represented by which of the following?

     (a) $\sigma_y = \sigma_0 + kd^{1/2}$ (b) $\sigma_y = \sigma_0 - kd^{1/2}$

     (c) $\sigma_y = \sigma_0 + kd^{-1/2}$ (d) $\sigma_y = \sigma_0 - kd^{-1/2}$

26) By duplex process of steel making, generally we mean
   a) Acid Bessemer and acid open hearth
   b) Basic Bessemer and acid open hearth
   c) Acid Bessemer and basic open hearth
   d) Basic Bessemer and basic open hearth

27) The hardening in maraging steel is due to the formation of _____ precipitate.
   a) Al_4C_3
   b) MoC_2
   c) Ni_3Ti
   d) Al_3Ti

28) If σ_1, σ_2, and σ_3 are the principal stresses and σ_o the yield strength, the Tresca yield criteria can be stated as
   a) $\sigma_1 + \sigma_2 + \sigma_3 = \sigma_o$
   b) $\sigma_1 - \sigma_3 = \sigma_o$

   c) $\sigma_1 - \sigma_3 = 2\sigma_o$
   d) $(\sigma_1 + \sigma_2 + \sigma_3)/3 = \sigma_o$

29) Which of the following is true in case of "flash roasting"
   a) Concentrated ore is piled in the form of pyramid, upon a foundation of wood and latter is ignited
   b) Concentrated ore is kept in the rakes of the roaster and hot air is circulated
   c) Concentrated ore is roasted in contact of chlorine
   d) None of these

30) Which of the following statement is **false** with respect to metals and alloys?
   a) Values of strain hardening exponent usually decrease as temperature is increased.
   b) Values of strain rate sensitivity parameter usually increase as temperature is increased.
   c) Values of strain hardening exponent are usually >1 at room temperature.
   d) High values of strain rate sensitivity parameter are required to exhibit superplasticity.

31) A certain X-ray photon has an energy of 1.240 keV. Its wavelength is _____ nm.

32) An example of a p-type dopant for Si is _____.

33) The temperature above which a ferromagnetic material becomes paramagnetic is called _____ temperature.

34) The bonding in gallium arsenide is mainly _____ bonding.

35) The crystal structure of an ionic ceramic, with chemical formula ABO_3, is determined by _____ rules.

36) An intermediate phase is likely to exist in a binary metallic system when
   a) The atomic size difference < 15%
   b) Heat of mixing is highly negative
   c) One of the metals is a transition element
   d) Melting points are vastly different

37) Which of the following is a position of an octahedral void in FCC?
   a) 0,1/4,0
   b) 0,0,1/2
   c) 1/4,1/4,1/4
   d) 1,1/4,3/4

38) In magnetic nanoparticles, magnetization can flip randomly due to thermal fluctuations. This is called _____

39) Which of the following is not a ceramic material?
   a) SiC   b) MgO   c) TiB_2 d) TiAl

40) Which of the following is not a valid Miller index
   a) (211)   b) (1024)   c) (12¼)   d) (114)

41) A ceramic compound commonly used as a thermionic source in TEM is _____.

42) The ideal **c/a** ratio for an hcp structure is _____.

43) Typical wavelength of electrons used in a TEM is _____. (Order of magnitude is enough).

44) The depth of field of a microscope increases with
   a) Decreasing wavelength   b) Increasing wavelength
   c) Increasing semi-apex angle   d) None of the above

45) If the first reflection from a FCC crystal has a Bragg angle of $21.5°$, the second reflection will have an angle of _____.

46) Nafion is formed by incorporating perflourovinyl ether groups, terminated with sulfonate groups, onto which backbone
   a) Polyethylene   b) Tetraflouroethylene
   c) Polyethylene Terephthalate   d) Polystyrene

47) In Raman spectroscopy, if the emitted photon has a higher energy than the absorbed photon, it is called _____ shift.

48) _____ electrons are used for providing topographical information in a SEM.

49) A characterization technique, for identifying the chemical state of the components of a solid, is XPS. XPS expands as _____

50) The monomer for polythene is
   a) C_8H_8 b) C_2H_2 c) CH_3OH d) C_2H_5OH