Entrance Test For Admission 2011

INDIAN INSTITUTE OF SCIENCE
BANGALORE - 560012

Program : Research
Entrance Paper : Materials Science
Paper Code : MR

General Instructions

1. This question paper has two parts (A&B). Answer all the questions from part A. Each question carries one mark. Answer any 5 questions from part B. Each question carries 10 marks.
2. Answers for part A have to be marked in the OMR sheet, while part B should be answered in the answer book provided.
3. For each question, darken the appropriate bubble in the OMR to indicate your answer.
4. Use only HB pencils for darkening the bubble.
5. Darken only one bubble per question. If you darken more than one, the answer will be evaluated as incorrect.
6. In case you wish to change your answer, erase the existing one completely before darkening another bubble.
7. There is no negative marking.

The following physical constants and conversion factors may be of some use:

Planck's constant (h),	=	6.626×10^{-34}	J.s
Electron rest mass (m_e),	=	9.108×10^{-31}	kg
Proton rest mass (m_p),	=	1.673×10^{-27}	kg
Electronic charge (e),	=	1.602×10^{-19}	C
Boltzmann's constant (k_B),	=	1.380×10^{-23}	J/K
Avagadro's number (N_A),	=	6.022×10^{23}	mol^{-1}
Speed of light in vacuum (c),	=	2.998×10^{8}	m/s
Permittivity of free space (ε_o),	=	8.854×10^{-12}	F/m
Permeability of free space (μ_o)	=	$4\pi\times10^{-7}$	H/m
Bohr Magneton (μ_B)	=	9.274×10^{-24}	J/T
1 eV	=	1.602×10^{-19}	J

MATERIALS SCIENCE-2011

Q.1 A certain crystal has $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^o$. the crystal system it belongs to is

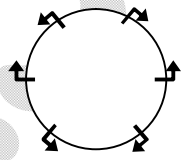
(a) monoclinic (b) rhombohedral

(c) tetragonal (d) orthorhombic

Q.2 A plane in a cubic crystal intersects the a-axis at 1, b-axis at 2 and the c-axis at infinity. The Miller indices of the plane are

(a) (1 2 0). (b) (2 1 0) (c) (1 2 ∞). (d) (2 1 ∞).

Q.3 The point group symmetry that can be ascribed to the diagram below is



(a) 3m (b) 3

(c) 6m (d) 6mm

Q.4 Tetrahedral voids in an FCC crystal are located

(a) exactly half way between the close packed layers.

(b) closer to one of the close packed layers.

(c) at (1/8 1/8 1/8) type positions.

(d) at (1/2 1/2 1/2) type positions.

Q.5 Which one of the following compounds has a structure that can be described as a close-packed structure of anions with occupying all the octahedral voids?

(a) TiO_2 (b) Al_2O_3 (c) NiAs (d) $MgAl_2O_4$

Q.6 A compound $A^{+2}B^{+4}O_3$ has a perovskite structure. Which one of the following statements is true?

(a) Both B and A have 4-fold coordination.

(b) Both B and A have octahedral coordination

(c) B has octahedral coordination and A has 12-fold coordination.

(d) A has octahedral coordination and B has 12-fold coordination.

Q.7 The ionic radii of A^{+1} and B^{-1} are 1.70 and 1.81 respectively. The most likely coordination number of A will be

(a) 3 (b) 4 (c) 6 (d) 8.

Q.8 The wavelength of an electron accelerate through a potential of 100 kV is

(a) 37 Å (b) 0.037 Å (c) 3 nm (d) 3 μm.

Q.9 Which one of the following reflections will be absent in the X-ray diffraction pattern of a face-centered cubic crystal with a monoatomic basis?

(a) (100) (b) (200) (c) (111) (d) (220)

Q.10 Which one of the following cannot be obtained by X-ray diffraction?

(a) Crystal structure. (b) Strain.

(c) Grain size. (d) Particle size.

Q.11 Which one of the following statements regarding a peak in an X-ray diffraction pattern is incorrect?

(a) The peak width will increase with a decrease in crystallite size.

(b) The peak width will decrease with an increase in non-uniform strain.

(c) The peak position will shift with a change in the magnitude of uniform strain.

(d) The peak profile in a θ-2θ scan cannot be used to determine the degree of texture.

Q.12 The interaction energy, E, of two atoms a distance R apart can be written as $E = (a/R) + (b/R^7)$. For this two atom system, R, at equilibrium will be,

(a) $\sqrt{7ab}$ (b) 1 (c) $(7b/a)^{1/8}$ (d) $\sqrt{(b^7/a)}$

Q.13 If the vibrations of a lattice were purely harmonic, then which one of the following statements would be true?

(a) Thermal Expansion would be zero (b) Elastic modulus would be zero.

(c) Thermal conductivity would be zero. (d) Specific heat would be zero.

Q.14 For an ionic material, a higher Madelung constant means

(a) lower lattice energy

(b) higher coordination.

(c) smaller coordination.

(d) higher lattice energy

Q.15 If $|\psi|^2$ is the probability density, then which one of the following is incorrect?

(a) ψ is finite (b) ψ is single-valued

(c) ψ is continuous (d) ψ is always positive.

Q.16 Which one of the following, relations is **not** followed by the Pauli spin matrices σ_x, σ_y and σ_z ?

(a) $\sigma_x^2 = \sigma_y^2 = \sigma_z^2$ (b) $\sigma_x \sigma_y = \sigma_z$

(c) $\sigma_y \sigma_z = i\sigma_x$ (d) $\sigma_x \sigma_y + \sigma_y \sigma_x = 0$

Q.17 The energy of an electron follows the dispersion relation $E = ck^2$, where k is the wave number and c is a constant. The mass of the electron is given by

(a) $2/c$ (b) 1 (c) $h^2/8\pi^2 c$ (d) $h/2\pi c$

Q.18 Which one of the following pairings between type of transition and wavelength of the corresponding energy involved is typically incorrect regarding molecular spectra?

(a) Electronic- infrared (b) Rotational – Far-infrared

(c) Vibrational – Infrared (d) Electronic – Ultraviolet

Q.19 $J_+ |jm\rangle =$

(a) $\sqrt{(j+m+1)(j-m)}\,|j, m+1\rangle$ (b) $\sqrt{(j+m+1)(j-m)}\,|j, m-1\rangle$

(c) $\sqrt{(j-m+1)(j+m)}\,|j, m+1\rangle$ (d) $\sqrt{(j+m-1)(j+m)}\,|j, m+1\rangle$

Q.20 If $\psi(x) = (\pi/\alpha)^{-1/4} \exp(-\alpha^2 x^2/2)$, then the value of $< x >$ is

(a) π/α (b) $(\pi/\alpha)^2$ (c) 0 (d) 1

Q.21 At temperatures above absolute zero, all crystalline solids will contain as defects, an equilibrium concentration of

(a) dislocations (b) grain boundaries.

(c) vacancies (d) stacking faults.

Q.22 The substitutional dissolution of $CaCl_2$ into NaCl will result in

(a) vacancies in the Cl site

(b) Cl^{-1} interstitials

(c) vacancies in the Na site

(d) Na^{-1} interstitials

Q.23 Which one of the following defects plays an important role in the functioning of solid oxide fuel cells?

(a) V_0^{+1} (b) V_0^{-2} (c) V_0^{+2} (d) V_0^{-1}

Q.24 An edge dislocation

(a) has its Burgers vector perpendicular to dislocation line

(b) can cross slip

(c) has a higher energy than a screw dislocation

(d) leads to formation of spirals during crystal growth

Q.25 A boundary obtained by relative rotation of two crystals about an axis that is perpendicular to the boundary is called

(a) a high angle tilt boundary (b) a tilt boundary

(c) a tilt + twist boundary (d) a twist boundary

Q.26 Which one of the following dislocation reactions is possible?

(a) $\frac{a}{2}[0\bar{1}1] = \frac{a}{6}[1\bar{2}1] + \frac{a}{6}[\bar{1}12]$

(b) $\frac{a}{6}[1\bar{2}1] + \frac{a}{6}[\bar{1}\bar{1}2] = \frac{a}{2}[0\bar{1}1]$

(C) $\frac{a}{2}[0\bar{1}1] = \frac{a}{6}[1\bar{2}1] + \frac{a}{6}[\bar{1}\bar{1}2]$

(d) $\frac{a}{2}[0\bar{1}1] = \frac{a}{6}[1\bar{2}1] + \frac{a}{6}[\bar{1}\bar{1}\bar{2}]$

Q.27 Schottky defects involve

(a) equal concentrations of positively and negatively charged interstitials.

(b) vacancies in the anionic lattice, balanced by negatively charged interstitials

(c) vacancies in the cationic lattice, balanced by positively charged interstitials

(d) equal concentrations of vacancies in the anionic and cationic lattices.

Q.28 Under conditions of constant temperature and pressure the phase rule is given as

(a) F= C-P (b) F = C-1 + P (c) F = C-2 + P (d) F = C+P

Q.29 If entropic contributions and non-nearest neighbour interactions are neglected, then the surface energy of the (100) face of a simple cubic crystal with monotomic basis, lattice parameter a and bond strength ψ is given as

(a) ψ/a^2 (b) $\psi/2a^2$ (c) $2\psi/a^2$ (d) $\psi/4a^2$

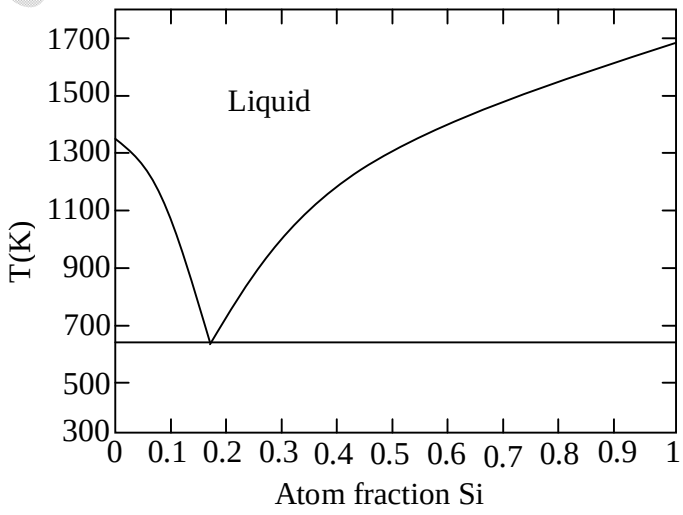
Q.30 Given the Au-Si phase diagram, the solubility of Au in an Au-Si solid alloy at 1100 K can be described as

(a) immiscible

(b) slightly miscible

(c) completely miscible

(d) independent temperature



Q.31 Given the phase diagram in Q. 30, the fraction of Si in the solid phase due to the eutectic reaction in an alloy containing 0.6 atom fraction Si at 300 K is

(a) 0.6 (b) 0.5 (c) 0.3 (d) 0.1

Q.32 In the metastable iron-carbon system containing Fe_3C, the phase pearlite is a

(a) eutectoid mixture of ferrite and cementite

(b) eutectic mixture of ferrite and cementite

(c) eutectoid mixture of ferrite and austenite

(d) peritectic mixture of cementite and austenite

Q.33 The critical radius for homogenous nucleation of water from steam at equilibrium is a

(a) zero (b) finite (c) infinite (d) unity

Q.34 Diffusivity, D, is typically given as $D = Nb^2f$, where b is the jump distance and f is the jump frequency. N for diffusion in one dimension is

(a) 1 (b) ½ (c) ¼ (d) 1/6

Q.35 In comparison to a metal cooled slowly, a metal quenched to 298 K from elevated temperatures closed to its melting point will display

(a) enhanced diffusivity of substitutional species

(b) decreased diffusivity of interstitial species

(c) decreased diffusivity of substitutional species

(d) no change in diffusivity

Q.36 The thickness of the SiO_2 layer grown on Si wafer is 40 nm after 5 min at 1100 ^oC. The thickness will be double after

(a) 7.07 min (b) 10 min (c) 15 min (d) 20 min

Q.37 The heat of freezing for the reaction, H_2O (Liquid) = H_2O (Solid), is 80 units. The free energy change associated with the reaction at 260K is

(a) +3.8 units (b) -3.8 units (c) 0 units (d) -5 units

Q.38 In comparison to metallic crystals, it is more difficult to grow non-metallic crystals by strain annealing, because

(a) it is not easy to deform them plastically

(b) of their polycrystalline nature

(c) it is easy to deform them plastically

(d) of the presence of large number of point defects

Q.39 In the float-zone method of growing single crystals, if L and r are respectively the length and diameter of the zone, then which of the following conditions has to be satisfied for the stability of the molten zone?

(a) $L > r$ (b) $L = r$ (c) $L < r$ (d) $L \geq r$

Q.40 Match the materials in column I the growth technique in column II below and then choose the correct set from the four choices given

Column I	Column II
a. Si	1. Czochralski
b. KH_2PO_4	2. Flux
c. Al_2O_3	3. Holdens rotary crystallizer
d. SiC	4. Vernueil
	5. Bridgman-Stockbarger
	6. Zone Melting

(a) a-1, b-3, c-4, d-2 (b) a-2, b-3, c-5, d-6

(c) a-3, b-1, c-2, d-4 (d) a-1, b-5, c-6, d-2

Q.41 In the pulling technique of crystal growth, the exact shape of the solid-liquid interface plays a crucial role, as large radial temperature gradients result in

(a) strain and dislocations (b) sound growth rate

(c) large crystals in diameter (d) dendritic growth

Q.42 The shape of the crucible is very important in intiating single crystal growth in

(a) Vernueil technique (b) Bridgram-Stockbarger technique

(c) Czochralski technique (d) Kyropoulos technique

Q.43 In crystal growth by strain annealing, the unstrained single crystalline regions in the material grow at the expense of strained regions. As a result,

(a) the grain size increases

(b) there is no change in the microstructure

(c) the grain size decreases

(d) there is an increase in the number of crystallites.

Q.44 If growth of a thin film on a substrate happens by the 3-D or Volmer- Weber mode then which of the following is true? Γ is the specific interfacial energy.

(a) $\gamma_{\text{film}} + \gamma_{\text{interface}} > \gamma_{\text{substrate}}$

(b) $\gamma_{\text{film}} + \gamma_{\text{interface}} < \gamma_{\text{substrate}}$

(c) $\gamma_{\text{substrate}} > 0$

(d) $\gamma_{\text{substrate}} > \gamma_{\text{interface}}$

Q.45 The density of states of a quantum wire depends on the energy (E) as

(a) $\sqrt{E}$ (b) $1/\sqrt{E}$ (c) $\delta(E)$ (d) $E^{3/2}$

Q.46 Which one of the materials below be used as a infrared (IR) photodetector?

(a) Zns (b) CdS (c) CdSe (d) PbS

Q.47 If the mobility of electrons in a metal increases, then the resistivity

(a) decreases (b) increases

(c) first decreases and then increases (d) first increases and then decreases

Q.48 If, M_1 and M_2 be the effective mass of electrons in two materials 1 and 2 respectively and $M_1 > M_2$, then the change of band gap ΔE_g with a reduction in crystallite size will be such at

(a) $\Delta E_g (M_1) > \Delta E_g (M_2)$

(b) $\Delta E_g (M_1) < \Delta E_g (M_2)$

(c) $\Delta E_g (M_1) = \Delta E_g (M_2) \neq 0$

(d) $\Delta E_g (M_1) = \Delta E_g (M_2) = 0$

Q.49 The average drift velocity v of electrons in a metal is related to the electric field E and collision time τ as

(a) $v = \sqrt{eE\tau / m}$ (b) $v = m / eE\tau$ (c) $v = eE\tau / m$ (d) $v = \sqrt{m / eE\tau}$

Q.50 The junction between a metal and an *n*-type semiconductor will be ohmic if

(a) the metal has a lower work function than that of the semiconductor

(b) the metal has a higher work function than that of the semiconductor

(c) band gap of the semiconductor is direct

(d) band gap of the semiconductor is indirect

Q.51 The difference in energy between the bottom of the conduction band and the donor level in an n-type semiconductor will be of the order of

(a) 100 eV (b) 10 eV (c) 1 eV (d) 0.01 eV

Q.52 In a moderately doped n-type semiconductor, with an increase in temperature, the Fermi level moves

(a) into the valence band

(b) towards the top of the valence band

(c) into the conduction band

(d) towards the middle of the energy gap

Q.53 If the Fermi energy of a metal is 1.4 eV, the Fermi temperature of the metal is approximately

(a) 1.6×10^8 K (b) 1.6×10^6 K (c) 1.6×10^4 K (d) 1.6×10^2 K

Q.54 $GaAs_xP_{1-x}$ is used in light emitting diodes. The band gap of GaAs is 1.43 eV, while that of GaP is 2.26 eV. Assuming a suitable relation for the variation of band gap with *x*, determine the value of *x* that will yield orange light (630 nm).

(a) 0.23 (b) 0.35 (c) 0.65 (d) 0.95

Q.55 When an insulator (dielectric) is subjected to a potential difference, charge polarization occurs and it

(a) persists when the voltage is removed

(b) disappears when the voltage is removed

(c) disappears and reappears after a few minutes of switching off the field

(d) results in long range motion of electrons

Q.56 At sufficiently high frequencies, ionic polarization in dielectrics cannot keep up with the applied alternating signal. As a consequence

(a) the voltage leads the current

(b) the current leads the voltage exactly by 90^o

(c) the current leads the voltage by less than 90^o

(d) the current leads the voltage greater than 90^o

Q.57 In ferroelectric BaTiO3 domain structures form because

(a) adjacent dipoles compete with each other in aligning themselves.

(b) contiguous TiO6 dipoles tend to align parallel to each other.

(c) of high dielectric constant associated with BaTiO3

(d) of its anisotropic structure at 300K

Q.58 Noncentrosymmetric materials associated with spontaneous polarization that cannot be reversed by an externally applied electric field are known as

(a) piezoelectric materials

(b) ferroelectric materials

(c) antiferroelectric materials

(d) pyroelectric materials

Q.59 When conducting particles are present within a dielectric, polarization may occur and very strongly particularly in the low frequency regime. This is due to

(a) electronic polarization

(b) space charge polarization

(c) ionic polarization

(d) molecular polarization

Q.60 Alumina (Al_2O_3) is specifically chosen as an effective insulator in automobile spark plugs because

(a) of its high electrical resistance

(b) of its smaller mass

(c) smaller mass associated with individual elements and high vibration frequency for rapid thermal conduction

(d) of its low thermal expansion

Q.61 The capacitance of a parallel plate capacitor is

(a) directly proportional to the area of the plates

(b) directly proportional to the distance between the plates

(c) directly proportional to the thickness of the dielectric inserted between the plates

(d) inversely proportional to the area of the plates

Q.62 Silicon and germanium appear metallic with an absorption edge

(a) at the end of the visible spectrum

(b) at wavelengths shorter than 200 nm

(c) at the IR end of the spectrum

(d) at 540 nm.

Q.63 Materials with smaller masses and weak bonding are required for

(a) UV transmission (b) visible transmission

(c) far infrared transmission (d) near infrared transmission

Q.64 If the domain walls in a magnetic material can be moved easily, such a material is said to display

(a) low flux density (b) low permeability

(c) high permeability (d) high flux density

Q.65 Some materials become ferromagnetic below a certain (transition) temperature. Such a change is an example of a

(a) zeroth order phase transition

(b) first order phase transition

(c) second order phase transition

(d) third order phase transition

Q.66 The Curie temperature (T_c) of a magnetic material is the temperature at which:

(a) the magnetic domain become entirely randomly magnetized

(b) the saturation magnetization intensity becomes zero

(c) the saturation magnetization intensity attains its highest value

(d) the specific heat reaches a minimum value

Q.67 It is possible to measure the magnetic moment of a material by using a "vibrating sample magnetometer" (VSM), in which a sample of the material to be measured is placed in a known magnetic field and made to vibrate. Hence, the operation of the VSM must depend on

(a) Farafy's law of induction (b) the Biot-Savart Law

(c) Fick's Law (d) the Curie-Weiss Law

Q.68 Nickel is ferromagnetic, with a saturation magnetization per atom of 0.6 μ_B, where μ_B is the Bohr magneton, equal to 9.27 x 10^{-24} J/T. Given that the atomic weight of nickel is 58.71 and that the density of nickel is 8.9 g/cm^3, the molar saturation magnetization of nickel is

(a) 1.5 x 10^5 A-m^{-1} (b) 5.1 x 10^5 A-m^{-1} (c) 3.6 x 10^3 A-m^{-1} (d) 3.6 x 10^{-3} A-m^{-1}

Q.69 A long, thin, and flat copper strip of rectangular cross- section (0.1 nm x 1.0 cm) carries a current of 5.0 A along its length. If it is placed in a magnetic field of strength 1.0 Tesla perpendicular to the plane of the strip, what is the Hall voltage generated?

(a) 1.75 mV (b) 0.93 μV (c) 0.55 mV (d) 0.37 μV

Q.70 The electronic specific heat of solids

(a) increases linearly with T.

(b) decreases linearly with T.

(c) increases exponentially with T.

(d) decreases exponentially with T

Q.71 The classical theory fails to predict the reduction in specific heat of solids with temperature because

(a) it assumes a common wavelength cut-off for the transverse and the longitudinal modes

(b) it does not account for the temperature dependence of the average energy of an oscillator

(c) it assumes that all oscillators vibrate with the same frequency

(d) it does not account for the frequency dependence of the average energy of an oscillator

Q.72 With an increase in the concentration of defects, the thermal conductivity of solids

(a) becomes increasingly independent of temperature at all temperatures

(b) becomes increasingly independent of temperature at values above the Debye temperature of the solid

(c) becomes increasingly independent of temperature at values below the Debye temperature of the solid

(d) remains unaffected

Q.73 Which one of the following materials would you choose as a thermal insulator?

(a) SiC (b) Diamond (c) Zirconia (d) Graphite

Q.74 The Pockels effect occurs in crystals that lack

(a) 4 fold rotational symmetry (b) mirror symmetry

(c) 3 fold rotational symmetry (d) inversion symmetry

Q.75 Slip

(a) takes place on close packed planes along close packed directions

(b) on (110) planes of FCC crystals

(c) takes place in a direction perpendicular to the direction of the Burgers vector

(d) direction in FCC is <111>

Q.76 Stress in 3-dimensions is a

(a) tensor of zeroeth rank

(b) tensor of first rank

(c) tensor of second rank

(d) tensor of third rank

Q.77 If σ_x, σ_y and σ_z be the normal stresses in the x, y and z directions for a continuum, then the elastic strain in the *x* direction, ε_x, is given for small deformations as

(a) $\frac{1}{E}\left[\sigma_x - V\left(\sigma_y + \sigma_z\right)\right]$

(b) $\frac{1}{E}\left[\sigma_x + V\left(\sigma_y + \sigma_z\right)\right]$

(c) $\frac{\sigma_x}{E}$

(d) $\frac{1}{E}\left[\sigma_x + \sigma_y + \sigma_z\right]$

Q.78 Stress concentration increases with

(a) a decrease in the crack size

(b) an increase in the radius of curvature of the crack tip

(c) a decrease in the radius of curvature of the crack tip

(d) an increase in the surface energy of the crack

Q.79 The fracture toughness of polycrystalline alpha-alumina is typically be of the order of

(a) 0.2 MPa$\sqrt{m}$

(b) 2 MPa$\sqrt{m}$

(c) 20 MPa$\sqrt{m}$

(d) 200 MPa$\sqrt{m}$

Q.80 The presence of carbon is found to strengthen iron. A mechanism responsible for this is that

(a) interstitial carbon completely locks down dislocations

(b) substitutional carbon completely locks down dislocations

(c) interstitial carbon clusters around dislocation cores impeding their motion

(d) substitutional carbon clusters around dislocation cores impeding their motion

Q.81 There is an increase in strengthen on cold working because

(a) the grain size increases

(b) the dislocation density increases

(c) the vacancy concentration increases

(d) the density of slip planes decreases

Q.82 In order to measure the average hardness of a heterogeneous multiphase material you would choose which one of the following identers?

(a) Brinells indenter (b) Vickers indenter

(c) Knoop indenter (d) Nano indenter

Q.83 Which one of the following methods would one use to minimize the susceptibility to fatigue failure?

(a) Increase the rms value of surface roughness

(b) Introduction of compressive stresses on the surface

(c) Increase in the size of the component

(d) Introduce deep notches into the surface at regular intervals

Q.84 Blades in aircraft engines are made up of single crystals to minimize the tendency to

(a) fail by oxidative corrosion

(b) fail by creep

(c) fail by brittle fracture

(d) fail by grain boundary melting

Q.85 The driving force for sintering is

(a) the reduction in the volume free energy of the system

(b) the release of residual strain in the powder compact

(c) the reduction in the excess energy associated with surfaces

(d) the reduction in the total volume of the compact

Q.86 If you wanted to produce nanosized stable single crystals from the solution route with shape other than the equilibrium shape, you would consider adding chemicals that

(a) alter the surface free energies per unit area

(b) alter the bulk free energies per unit volume

(c) reduce the rate of the reaction

(d) increase the rate of the reaction

Q.87 Gas turbine components operating at high temperatures and in oxidizing environments are often coated with a layer of NiCrAlY. The most plausible reason for the coating is that NiCrAlY

(a) has high thermal conductivity

(b) forms a stable oxide layer

(c) does not get oxidized

(d) forms a stable oxide layer with high oxygen ion conductivity

Q.88 If the transition temperature of a superconductor is 30 K, then the superconducting energy gap according to the BCS theory is

(a) 2.6 meV (b) 5.2 meV (c) 9.1 meV (d) 26 meV

Q.89 Switching times with a Josephson junction are of the order of

(a) 10^{-15} s (b) 10^{-2} ns (c) 0.1 μs (d) 1 μs

Q.90 A type-II superconductor in the mixed state exhibits

(a) perfect diamagnetism (b) diamagnetism

(c) paramagnetism (d) ferromagnetism

Q.91 Materials belonging to which one of the following point groups exhibits linear electrooptic effect?

(a) 4/mmm (b) mmm (c) 4/m (d) 4mm

Q.92 Carbide fibers with a modulus of 400 GPa are used to reinforce a matrix with a modulus of 100 GPa. Under isostrain conditions the modulus of a composite containing 20 vol. % of fibres would be

(a) 340 GPa (b) 160 GPa (c) 500 GPa (d) 250 GPa

Q.93 The hybridization that prevails in fullerene is

(a) sp2 (b) sp3 (c) sp (d) sp2 and sp3

Q.94 The Taylor series expansion of e^{-x} can be given as

(a) $1 - x + x^2/2 + \ldots..$ (b) $- x - x^2/2 + \ldots..$

(c) $1 - x - x^2/2 + \ldots\ldots$ (d) $1 + x + x^2/2 + \ldots\ldots$

Q.95 The Eigen values of Matrix $A = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$ are

(a) – 2, 4 (b) – 2, 5 (c) 2, – 5 (d) 2, 5

Q.96 If $F = \{(3x^2 + 6y)\mathbf{i} - 14yz\mathbf{j} + 20xz^2\mathbf{k}\}$, what is the value of $\int \mathbf{F}.d\mathbf{r}$ from (0,0,0) to (1,1,1) along the curve given by $x = t$, $y = t^2$, $z = t^3$

(a) 4 (b) 6 (c) 5 (d) 0

Q.97 The area of a right-angled triangle is 10 cm^2. Assume that the length of each side of the triangle, in centimeters, is a positive integer (for example, 5 cm). If √ represents the square root, what is the LEAST POSSIBLE length of the hypotenuse?

(a) √29 (b) √41 (c) √59 (d) √71

Q.98 A soccer team has a roster of 30 players. From this roster, 7 players are selected randomly for drug testing. What is the probability that both the captain and the vice-captain of the team are selected for drug testing?

(a) 3/110 (b) 9/155 (c) 6/117 (d) 7/145

Q.99 If c be any constant, the general solution to the differential equation $(dy/dx) = ky$ is

(a) $y = e^{kx}$ (b) $y = e^{kx/c}$ (c) $y = e^{cx}$ (d) $y = ce^{kx}$

Q.100 If f(x, y, z) represents potential, then the force in the electrostatic field is given by

(a) Grad *f* (b) Div (Grad *f*) (c) Curl (Grad *f*) (d) Div (Curl *f*)