MT:METALLURGICAL ENGINEERING

1. The yield point of the phenomenon observed in annealed low carbon steels is due to the presence of

   (a) silicon (b) chromium (c) phosphorous (d) carbon

   (GATE MT 2008)

2. In a tensile test of a ductile material, necking starts at

   (a) lower yield stress
   (b) upper yield stress
   (c) ultimate tensile strength
   (d) just before fracture

   (GATE MT 2008)

3. Fatigue resistance of a steel is reduced by

   (a) decarburization
   (b) polishing the surface
   (c) reducing the grain size
   (d) shot peening

   (GATE MT 2008)

4. The stress concentration factor K, for a circular hole located at the center of a plate is

   (a) 0 (b) 1 (c) 3 (d) tends to ∞

   (GATE MT 2008)

5. Cassiterite is an important source for

   (a) tin (b) titanium (c) molybdenum (d) thorium

   (GATE MT 2008)

6. High top pressure in the blast furnace

   (a) decreases the time of contact between gas and solid
   (b) increases the time of contact between gas and solid
   (c) increases fuel consumption
   (d) increases the rate of solution loss reaction

   (GATE MT 2008)

7. For a closed system of fixed internal energy and volume, at equilibrium

   (a) Gibb's free energy is minimum
   (b) entropy is maximum
   (c) Helmholtz's free energy is minimum
   (d) enthalpy is maximum

   (GATE MT 2008)

8. Intergranular corrosion of 18-8 stainless steel can NOT be prevented by

(a) reducing the carbon content to less than 0.05%

(b) quenching it from high temperature to prevent chromium carbide precipitation

(c) adding strong carbide forming elements

(d) increasing the carbon content

(GATE MT 2008)

9. Riser is NOT required for the castings of (GATE EE 2025)

(a) grey cast iron (b) white cast iron (c) Al-4% Cu (d) Al-12% Si

(GATE MT 2008)

10. The NDT technique used to detect deep lying defects in a large sized casting is

(a) liquid penetrant inspection

(b) magnetic particle inspection

(c) ultrasonic inspection

(d) eddy current inspection

(GATE MT 2008)

11. The maximum number of phases in a quaternary system at atmospheric pressure are

(a) 2 (b) 3 (c) 4 (d) 5

(GATE MT 2008)

12. In Cu-Al phase diagram, the solubility of Al in Cu at room temperature is about 10% and that of Cu in Al is less than 1%. The Hume-Rothery rule that justifies this difference is

(a) size factor

(b) electro-negativity

(c) structure

(d) valency

(GATE MT 2008)

13. Mannesmann process

(a) is a cold working process

(b) is used for making thin walled seamless tubes

(c) uses parallel rolls

(d) is used for making thick walled seamless tubes

(GATE MT 2008)

14. The intensive thermodynamic variables among the following are

(a) pressure (b) volume (c) temperature (d) enthalpy

(GATE MT 2008)

(a) P, Q (b) P, R (c) R, S (d) Q, R

(GATE MT 2008)

15. In a binary phase diagram, the activity of the solute in a two phase field at a given temperature

(a) increases linearly with the solute content
(b) decreases linearly with the solute content
(c) remains constant
(d) is proportional to the square root of the solute content

(GATE MT 2008)

16. In Jominy curves of steel A (Fe-0.4% C) and steel B (Fe-0.4% C -1.0% Ni),

(a) depth of hardening in steel A is more than in steel B
(b) depth of hardening in steel B is more than in steel A
(c) hardness at the quenched end in steel A is more than in steel B
(d) hardness at the quenched end in steel B is more than in steel A

(GATE MT 2008)

17. Determinant of $\begin{pmatrix} 3 & 1 & 2 \\ 1 & 2 & 1 \\ 4 & 2 & 3 \end{pmatrix}$

(a) -2 (b) -1 (c) 1 (d) 2

(GATE MT 2008)

18. $\int \frac{dx}{ax+b}$ is

(a) $\frac{1}{b}\ln(ax+b)+\mathrm{c}$ (b) $\ln(ax+b)+c)$ (c) $\mathrm{b}\ln(ax+b)+\mathrm{c}$ (d) $\frac{1}{a}\ln(ax+b)+\mathrm{c}$

(GATE MT 2008)

19. The value of dy/dx for the following data set at $x = 3.5$, computed by central difference method, is

x	1	2	3	4	5
y	0	3	8	15	24

(a) 3.5 (b) 7 (c) 10.5 (d) 14

(GATE MT 2008)

20. The velocity at which particles from a fluidized bed are carried away by the fluid passing through it, is known as

(a) elutriation velocity
(b) terminal velocity
(c) minimum fluidization velocity
(d) superficial velocity

(GATE MT 2008)

21. A metal with an average grain size of 36 μm has yield strength of 250 MPa and that with 4 μm has 500 MPa. The friction stress of the metal in MPa is

(a) 31.2 (b) 62.5 (c) 125 (d) 250

(GATE MT 2008)

22. The stacking sequence of close packed planes with a stacking fault is

(a) *a b c a b c a b c*
(b) *a b a b a b a b a b*
(c) *a b c a c a b c a b*
(d) *a b c a b a c b a*

(GATE MT 2008)

23. The slip directions on a $(\bar{1}1\bar{1})$ plane of a fcc crystal are

(a) [101], [011], [110]
(b) [101], [110], [101]
(c) [101], [110], [011]
(d) [101], [110], [011]

(GATE MT 2008)

24. The correct statements among the following are

(a) screw dislocations cannot climb
(b) screw dislocations cannot cross-slip
(c) edge dislocations cannot climb
(d) edge dislocations cannot cross-slip

(a) P, R (b) P, S (c) Q, R (d) Q, S

(GATE MT 2008)

25. A steel bar (elastic modulus = 200 GPa and yield strength = 400 MPa) is loaded to a tensile stress of 1 GPa and undergoes a plastic strain of 2%. The elastic strain in the bar in percent is

(a) 0 (b) 0.2 (c) 0.5 (d) 2.0

(GATE MT 2008)

26. The ASTM grain size number of a material which shows 64 grains per square inch at a magnification of 200X is

(a) 5 (b) 6 (c) 7 (d) 8

(GATE MT 2008)

27. Two samples P and Q of a brittle material have crack lengths in the ratio 4:1. The ratio of fracture strengths of P and Q, measured normal to the cracks, will be

(a) 1 : 4 (b) 1 : 2 (c) 2 : 1 (d) 4 : 1

(GATE MT 2008)

28. The structure-sensitive properties are

(a) elastic modulus
(b) yield strength
(c) melting point
(d) fracture strength

(a) P, S (b) Q, S (c) Q, R (d) P, R

(GATE MT 2008)

29. The time taken for 50% recrystallization of cold worked Al is 100 hours at 500 K and 10 minutes at 600 K. Assuming Arrhenius kinetics, the activation energy for recrystallization in kJ mol^{-1} is

(a) 50 (b) 80 (c) 160 (d) 320

(GATE MT 2008)

30. Match the mechanical behaviour in Group 1 with the terms in Group 2

Group 1

(P) Low cycle fatigue
(Q) Creep
(R) Impact toughness
(S) Stretcher strain

Group 2

(1) Charpy test
(2) Portevin-LeChatelier effect
(3) Coffin-Manson equation
(4) Larson-Miller parameter
(5) Jominy test

(a) P-2, Q-4, R-1, S-5
(b) P-2, Q-1, R-5, S-3
(c) P-3, Q-4, R-1, S-2
(d) P-3, Q-1, R-4, S-5

(GATE MT 2008)

31. Match the processes in Group 1 with the physical principles in Group 2

Group 1

(a) Floatation
(b) Jigging
(c) Tabling
(d) Heavy media separation

Group 2

(1) Differential initial acceleration
(2) Differential lateral movement
(3) Difference in density
(4) Modification of surface tension

(a) $P-4, Q-1, R-2, S-3$
(b) $P-4, Q-1, R-3, S-2$
(c) $P-2, Q-3, R-4, S-1$
(d) $P-1, Q-3, R-4, S-2$

(GATE MT 2008)

32. Which of the following is the solution for $\frac{\partial z}{\partial t} = \frac{\partial^2 z}{\partial^2 x}$

(a) $z(x,t) = [Asinx]e^{-\lambda^2 t}$
(b) $z(x,t) = [Asin(\lambda x)]e^{-\lambda^2 t}$
(c) $z(x,t) = \frac{A}{t}e^{-x^2 t}$
(d) $z(x,t) = [Acos(\lambda x)]\sqrt{t}$

(GATE MT 2008)

33. Match the unit processes in Group 1 with the objectives in Group 2

Group 1

(P) Leaching
(Q) Cementation
(R) Roasting
(S) Converting

Group 2

(1) Precipitation of metal in aqueous solution
(2) Selective dissolution of metal
(3) Conversion of matte to metal
(4) Conversion of sulphide to oxide
(5) Separation of metal from slag

(a) $P-2, Q-1, R-3, S-5$
(b) $P-2, Q-1, R-4, S-3$
(c) $P-3, Q-4, R-5, S-2$
(d) $P-4, Q-3, R-2, S-1$

(GATE MT 2008)

34. Match the following metals in Group 1 with their production methods in Group 2

Group 1

(P) Titanium
(Q) Nickel
(R) Magnesium
(S) Zinc

Group 2

(1) Mond's process
(2) Pidgeon's process
(3) Imperial smelting
(4) Kroll's process
(5) Cyanidation

(A) $P-5, Q-2, R-3, S-4$
(B) $P-3, Q-5, R-4, S-2$
(C) $P-4, Q-1, R-2, S-3$
(D) $P-4, Q-1, R-5, S-3$

(GATE MT 2008)

35. Manganese recovery in steelmaking is aided by

(P) oxidizing slag
(Q) reducing slag
(R) high temperature
(S) low temperature
(T) acidic slag

(A) P, Q (B) Q, S (C) Q, R (D) P, R

(GATE MT 2008)

36. A flotation plant treats 100 tons of chalcopyrite containing 2% Cu and produces 6 tons of concentrate. The concentrate has 25% Cu. The percentage Cu in the tailings is

(A) 0.35 (B) 0.53 (C) 0.86 (D) 0.93

(GATE MT 2008)

37. One ton of liquid steel initially containing 0.08% S is brought into equilibrium with 0.1 ton of liquid slag containing no sulphur. The sulphur distribution ratio $\frac{\%S_{\text{slag}}}{\%S_{\text{metal}}} = 30$ at equilibrium. The final sulphur content of steel in wt.% is

(A) 0.01 (B) 0.02 (C) 0.03 (D) 0.04

(GATE MT 2008)

38. Deoxidation of liquid steel with ferrosilicon produces spherical silica particles. The particles of 5 μm diameter take 3000 minutes to float up through a 2 m height of liquid steel. For particles of 50 μm diameter to float up through the same height, the time required in minutes is

(A) 30 (B) 300 (C) 960 (D) 3000

(GATE MT 2008)

39. Match applications in Group 1 with the commonly used corrosion protection methods in Group 2

Group 1	Group 2
(P) Seagoing vessel	(1) Inorganic coating
(Q) Underground pipeline	(2) Sacrificial anode
(R) Electric traction tower	(3) Aluminium paint
(S) Electric poles	(4) Impressed current

(A) $P-2, Q-4, R-5, S-3$ (C) $P-1, Q-2, R-5, S-4$
(B) $P-2, Q-3, R-5, S-1$ (D) $P-4, Q-3, R-1, S-2$

(GATE MT 2008)

40. For a regular solution A-B, ΔH is 2660.5 J at $x_B = 0.6$. The critical point of the miscibility gap in the system would be at

(A) $x_B = 0.5, T = 1000$ K (C) $x_B = 0.5, T = 500$ K
(B) $x_B = 0.6, T = 1000$ K (D) $x_B = 0.6, T = 2000$ K

(GATE MT 2008)

41. For Ni + $0.5O_2$ = NiO, $\Delta G^\circ = -250,000 + 100T$ Joules. At 1000 K, the p_{O_2} in equilibrium with Ni/NiO in atm is

(A) 2.13×10^{-16} (B) 8.54×10^{-16} (C) 1.46×10^{-8} (D) 2.92×10^{-8}

(GATE MT 2008)

42. The planar density for (111) plane in a fcc crystal is

(A) 0.68 (B) 0.74 (C) 0.85 (D) 0.91

(GATE MT 2008)

43. Iridium has fcc structure. Its density and atomic weight are 22,400 kg/m^3 and 192.2, respectively. The atomic radius of iridium in nm is

(A) 0.126 (B) 0.136 (C) 0.146 (D) 0.156

(GATE MT 2008)

44. Match the names in Group 1 with the invariant reactions in binary phase diagrams in Group 2

Group 1	Group 2
(A) Eutectic	(1) S1 = S2 + S3
(B) Eutectoid	(2) L = S1 + S2
(C) Peritectoid	(3) L1 = L2 + S
(D) Monotectic	(4) S1 + S2 = S3

(A) $P-2, Q-1, R-3, S-4$
(B) $P-2, Q-1, R-4, S-3$
(C) $P-3, Q-4, R-2, S-1$
(D) $P-4, Q-3, R-1, S-2$

(GATE MT 2008)

45. Match the properties in Group 1 with the units in Group 2

Group 1	Group 2
(P) Thermal conductivity	(1) $\mathrm{J\,m^{-2}\,s^{-1}\,K^{-1}}$
(Q) Heat transfer coefficient	(2) $\mathrm{J\,m^{-1}\,s^{-1}\,K^{-1}}$
(R) Specific heat	(3) $\mathrm{m^3\,s^{-1}}$
(S) Diffusivity	(4) $\mathrm{mol^{-1}\,K^{-1}}$

(A) $P-1, Q-2, R-4, S-3$
(B) $P-2, Q-3, R-1, S-4$
(C) $P-2, Q-1, R-4, S-3$
(D) $P-2, Q-4, R-3, S-1$

(GATE MT 2008)

46. Match the heat treatment processes of steels in Group 1 with the microstructural features in Group 2

Group 1	Group 2
(P) Quenching	(1) Bainite
(Q) Maraging	(2) Martensite
(R) Tempering	(3) Intermetallic precipitates
(S) Austempering	(4) Epsilon carbide

(A) $P-2, Q-3, R-1, S-4$
(B) $P-1, Q-3, R-2, S-4$
(C) $P-2, Q-3, R-4, S-1$
(D) $P-3, Q-2, R-1, S-4$

(GATE MT 2008)

47. Match the nonferrous alloys in Group 1 with their applications in Group 2

Group 1	Group 2
(P) Ti alloy	(1) Nuclear reactors
(Q) Zr alloy	(2) Bells
(R) Ni alloy	(3) Dental implants
(S) Cu alloy	(4) Gas turbines

(A) $P-3, Q-1, R-4, S-2$
(B) $P-2, Q-3, R-4, S-1$
(C) $P-2, Q-1, R-3, S-4$
(D) $P-3, Q-4, R-1, S-2$

(GATE MT 2008)

48. Match the materials in Group 1 with their functional applications in Group 2

Group 1	Group 2
(P) Nb_3Sn	(1) Dielectric
(Q) GaAs	(2) Soft magnet
(R) Fe-4%Si alloy	(3) Superconductor
(S) SiO_2	(4) Semiconductor

(A) $P-3, Q-1, R-4, S-2$
(B) $P-1, Q-4, R-2, S-3$
(C) $P-3, Q-2, R-4, S-1$
(D) $P-3, Q-4, R-2, S-1$

(GATE MT 2008)

49. An annealed hypoeutectoid steel has 10% of proeutectoid ferrite at room temperature. The eutectoid carbon content of the steel is 0.8%. The carbon content in the steel in percent is

(A) 0.58 (B) 0.68 (C) 0.72 (D) 0.78

(GATE MT 2008)

50. The melting point and latent heat of fusion of copper are 1356 K and 13 kJ mol^{-1}, respectively. Assume that the specific heats of solid and liquid are same. The free energy change for the liquid to solid transformation at 1250 K in kJ mol^{-1} is

(A) -4 (B) -3 (C) -2 (D) -1

(GATE MT 2008)

51. According to the Clausius Clapeyron equation, the melting point of aluminium

(A) increases linearly with pressure
(B) decreases linearly with pressure
(C) increases exponentially with pressure
(D) does not vary with pressure

52. Match the cast irons in Group 1 with the distinguishing microstructural features in Group 2

Group 1	Group 2
(P) Grey cast iron	(1) Temper graphite
(Q) Ductile cast iron	(2) Pearlite
(R) Malleable cast iron	(3) Graphite flakes
(S) White cast iron	(4) Massive cementite

(A) $P-3, Q-5, R-4, S-2$
(B) $P-1, Q-5, R-4, S-2$
(C) $P-2, Q-4, R-5, S-3$
(D) $P-3, Q-5, R-1, S-4$

(GATE MT 2008)

53. Match the casting defects in Group 1 with causes given in Group 2

Group 1	Group 2
(P) Hot tear	(1) Insufficient melt super heat
(Q) Misrun	(2) High residual stresses
(R) Blister	(3) Improper venting
(S) Rat tail	(4) Expansion of sand

(A) $P-1, Q-2, R-3, S-4$
(B) $P-3, Q-4, R-1, S-2$
(C) $P-4, Q-3, R-2, S-1$
(D) $P-2, Q-1, R-3, S-4$

(GATE MT 2008)

54. The thickness of a plate is to be reduced from 60 to 30 mm by multipass rolling. The roll radius is 350 mm and coefficient of friction is 0.15. Assuming equal draft in each pass, the minimum number of passes required would be

(A) 2 (B) 4 (C) 5 (D) 6

(GATE MT 2008)

55. Match the particle morphologies in Group 1 with the powder production methods in Group 2

Group 1	Group 2
(P) Superalloy powder with rounded morphology	(1) Carbonyl process
(Q) Monosized spherical Ta powder	(2) Gas atomization
(R) Fe powder with *onion peel* structure	(3) Oxide reduction
(S) Irregularly shaped W powder	(4) Rotating electrode process

(A) $P-2, Q-1, R-4, S-3$
(B) $P-1, Q-4, R-3, S-2$
(C) $P-2, Q-4, R-1, S-3$
(D) $P-4, Q-1, R-2, S-3$

(GATE MT 2008)

56. One mole of monatomic ideal gas is reversibly and isothermally expanded at 1000 K to twice its original volume. The work done by the gas in Joules is

(A) 2430 (B) 2503 (C) 5006 (D) 5763

(GATE MT 2008)

57. In the Ellingham diagram C→CO line intersects M→MO line at temperature T_1 and N→NO line at temperature T_2. M and N are metals. T_2 is greater than T_1. The correct statements among the following are:

(P) carbon will reduce both MO and NO at temperatures $T_1 > T_2$
(Q) carbon will reduce both MO and NO at temperatures between $T_1 and T_2$
(R) carbon will reduce both MO and NO at temperatures $T_2 < T_1$
(S) carbon will reduce MO but not NO at temperatures between $T_1 and T_2$
(T) carbon will reduce NO but not MO at temperatures between $T_1 and T_2$

(A) P, S
(B) Q, T
(C) R, S
(D) P, T

(GATE MT 2008)

58. Match the forms of corrosion in Group 1 with the typical examples in Group 2

Group 1	Group 2
(P) Filiform corrosion	(1) Austenitic stainless steel in chloride environment
(Q) Crevice corrosion	(2) Nut bolt with gasket
(R) Galvanic corrosion	(3) Painted food cans
(S) Stress corrosion cracking	(4) Steel studs in copper plate

(A) $P-3, Q-2, R-4, S-1$
(B) $P-1, Q-3, R-4, S-2$
(C) $P-3, Q-4, R-2, S-1$
(D) $P-2, Q-3, R-4, S-1$

(GATE MT 2008)

59. Given the following assertion 'a' and the reason 'r', the correct option is

Assertion a: Phosphorous removal in steelmaking is favoured by basic slag
Reason r: Basic slag decreases the activity of P_2O_5 in the slag

(A) Both a and r are true and r is the correct reason for a
(B) Both a and r are true
(C) a is true but r is false
(D) Both a and r are true but r is not the correct reason for a

(GATE MT 2008)

60. Given the following assertion 'a' and the reason 'r', the correct option is

Assertion a: In Bayer's process high pressure is used to dissolve alumina from bauxite
Reason r: Pressure increases the boiling point of water

(A) Both a and r are correct, but r is not the correct reason for a
(B) Both a and r are false
(C) Both a and r are correct and r is the correct reason for a
(D) a is true but r is false

(GATE MT 2008)

61. Match the alloys in Group 1 with the main precipitates responsible for hardening in Group 2

Group 1	Group 2
(P) Al-4.4%Cu-1.5%Mg-0.6%Mn	(1) Ni_3Mo
(Q) Fe-18.0%Ni-8.5%Co-3.5%Mo-0.2%Ti-0.1%Al	(2) Mg_2Si
(R) Al-1.0%Mg-0.6%Si-0.3%Cu-0.2%Cr	(3) $CuAl_2$
(S) Ni-15.0%Cr-2.7%Al-1.7%Ti-1.0%Fe	(4) $TiAl_3$

(A) $P-3, Q-5, R-2, S-4$
(B) $P-1, Q-3, R-2, S-4$
(C) $P-4, Q-1, R-3, S-5$
(D) $P-3, Q-1, R-2, S-5$

(GATE MT 2008)

62. Identify the attributes associated with dispersion hardened alloys

(P) dispersoids do not dissolve in the matrix even at high temperatures
(Q) dispersoids are coherent with the matrix
(R) dispersoids impart creep resistance to the alloy
(S) dispersoids improve the corrosion resistance of the alloy

(A) P, S
(B) Q, R
(C) Q, S
(D) P, R

(GATE MT 2008)

63. In a gaseous mixture, CO, CO_2 and O_2 are in equilibrium at temperature T. For the reaction CO + $0.5O_2 = CO_2$, $\Delta G^\circ = -281,400 + 87.6T$ Joules. The correct statements among the following are:

(P) The reaction will shift to left on increasing T
(Q) The reaction will shift to right on increasing T
(R) The reaction will shift to left on increasing pressure
(S) The reaction will shift to right on increasing pressure

(A) P, S
(B) P, Q
(C) Q, R
(D) R, S

(GATE MT 2008)

64. The casting processes that require expendable moulds are

(P) investment casting
(Q) low-pressure casting
(R) shell moulding
(S) slush casting

(A) P, Q
(B) Q, R
(C) R, S
(D) P, R

(GATE MT 2008)

65. Transport mechanisms that do **NOT** contribute to densification during sintering are

(P) surface diffusion
(Q) grain boundary diffusion
(R) bulk diffusion
(S) evaporation-condensation
(T) viscous flow

(A) P, Q
(B) Q, S
(C) Q, T
(D) P, S

(GATE MT 2008)

66. The order of decreasing weldability among the following steels is

(P) Fe-0.6%C
(Q) Fe-0.4%C
(R) HSLA

(A) R → Q → P
(B) P → Q → R
(C) Q → P → R
(D) Q → R → P

(GATE MT 2008)

67. Match the welding processes in Group 1 with the sources of heat in Group 2

Group 1

(P) Ultrasonic welding
(Q) Spot welding
(R) SMAW
(S) Thermit welding

Group 2

(1) Thermochemical
(2) Electrical resistance
(3) Conversion of matte to metal
(4) Friction
(5) Electrical arc

(A) P-3, Q-2, R-1, S-4
(B) P-4, Q-3, R-2, S-1
(C) P-1, Q-3, R-4, S-2
(D) P-3, Q-2, R-4, S-1

(GATE MT 2008)

68. A cup is to be made from a 2 mm thick metal sheet by deep-drawing. The height of the cup is 75 mm and the inside diameter is 100 mm. For a drawing ratio of 1.25, the blank diameter in mm is

(A) 62.5 (B) 125 (C) 225 (D) 250

(GATE MT 2008)

69. The defects that are **NOT** observed in extruded products are

(P) chevron cracking
(Q) fold
(R) piping
(S) surface cracking
(T) alligatoring

(A) P, Q
(B) R, T
(C) P, S
(D) Q, T

(GATE MT 2008)

70. Oil impregnated bronze bearings are manufactured using

(A) pressure die casting
(B) centrifugal casting
(C) solid-state sintering
(D) liquid phase sintering

Common Data Questions

Common Data for Questions 71, 72 and 73:

The diffusivities of carbon in γ-iron at 1173 K and 1273 K are 5.90×10^{-12} and 1.94×10^{-11} m^2s^{-1}, respectively. (GATE MT 2008)

71. The activation energy for diffusion in kJ mol^{-1} is

(A) 138 (B) 148 (C) 158 (D) 168

(GATE MT 2008)

72. The diffusivity of carbon in γ-iron at 1373 K in m^2s^{-1} is

(A) 3.4×10^{-11} (B) 4.4×10^{-11} (C) 5.4×10^{-11} (D) 6.4×10^{-11}

(GATE MT 2008)

73. During the carburization of a steel, a case depth of d has been obtained in 40 hours at 1173 K. For achieving a case depth of d/2 at 1273 K, the time required in hours is

(A) 1 (B) 2 (C) 3 (D) 4

Common Data for Questions 74 and 75:

A copper alloy powder has an apparent density of 3000 kg m^{-3} and tap density of 4500 kg m^{-3}. The powder is compacted in a cylindrical die at 300 MPa to a green density of 6000 kg m^{-3}. Subsequently, the compact is sintered to a density of 7500 kg m^{-3}. Th(GATE MT 2008)

74. If the powder is compressed to 10 mm height, the initial fill height in mm is

(A) 12 (B) 15 (C) 20 (D) 25

(GATE MT 2008)

75. The densification parameter of the sintered compact is

(A) 0.50 (B) 0.67 (C) 0.75 (D) 0.83

Linked Answer Questions: Q.76 to Q.85 carry two marks each.

Statement for Linked Answer Questions 76 and 77:

A polyester-matrix composite is unidirectionally reinforced with 60 vol.% of E-glass fibers. The elastic moduli of the matrix and the fiber are 6.9 and 72.4 GPa, respectively. (GATE MT 2008)

76. The elastic modulus of the composite parallel to the fiber direction in GPa is

(A) 15.1 (B) 23.1 (C) 43.4 (D) 46.2

(GATE MT 2008)

77. If a load of 100 kg is applied on the composite in the fiber direction, the load carried by the fibers in kg is

(A) 6 (B) 47 (C) 94 (D) 100

(GATE MT 2008)

Statement for Linked Answer Questions 78 and 79:

1000 kg of zinc concentrate of composition 78% ZnS and 22% inerts is roasted in a multiple hearth furnace. Roasting converts ZnS to ZnO, SO_2 and SO_3. The exit gas contains 6 vol.% SO_2 and 2 vol.% SO_3.
Molecular weights: Zn = 65, S = 32, O_2 = 32.
Composition of air (in vol.%) = 21% O_2 and 79% N_2.
1 kg mol of gas occupies 22.4 m^3 at 273 K and 1 atm.

78. Volume of the exit gas (at 1 atm pressure and 273 K) in m^3 is

(A) 2129 (B) 2252 (C) 2628 (D) 2923

(GATE MT 2008)

79. Stoichiometric amount of air used (at 1 atm pressure and 273 K) in m^3 is

(A) 1010 (B) 1394 (C) 1520 (D) 2020

(GATE MT 2008)

Statement for Linked Answer Questions 80 and 81:

Density of Al = 2700 kg m^{-3}, atomic weight of Al = 27, density of Al_2O_3 = 3700 kg m^{-3}.

80. The Pilling-Bedworth ratio for the oxidation of Al is

(A) 0.57 (B) 0.74 (C) 1.38 (D) 3.12

(GATE MT 2008)

81. The oxidation law that governs the high temperature oxidation of Al is

(A) parabolic (B) linear (C) logarithmic (D) paralinear

(GATE MT 2008)

Statement for Linked Answer Questions 82 and 83:

In the diffraction pattern of a fcc metal obtained using CuK_α radiation (wavelength of 0.154 nm), a diffraction peak appears at 2θ of 58.4°. The lattice parameter of the crystal is 0.316 nm.

82. The interplanar spacing in nm is

(A) 0.158 (B) 0.164 (C) 0.177 (D) 0.185

(GATE MT 2008)

83. The Miller indices of the reflecting plane are

(A) (111) (B) (200) (C) (220) (D) (222)

(GATE MT 2008)

Statement for Linked Answer Questions 84 and 85:

Mg casting with a volume to surface area ratio (casting modulus) of 0.1 m is made by gravity die casting. Heat transfer coefficient at the metal-mould interface is 1.9 kJ m^{-2} K^{-1} s^{-1}. The density and melting point of Mg are 1700 kg m^{-3} and 923 K, respectively. Assume ambient temperature to be 293 K.

84. If the solidification time is 50 s, the latent heat of fusion in kJ mol^{-1} is

(A) 300 (B) 352 (C) 472 (D) 532

(GATE MT 2008)

85. In a spiral channel of 10 mm diameter and with an entrance flow velocity of 300 mm s^{-1}, the fluidity of the melt in mm is

(A) 75 (B) 175 (C) 275 (D) 375

(GATE MT 2008)

END OF THE QUESTION PAPER