

PGAT 2017  
METALLURGICAL ENGINEERING

There are a total of 60 questions. All questions are of multiple choice types. A question will have four choices for the answer with only one correct choice.

- Q1. The crystal structure of  $\alpha$  iron is  
(A) Face Centred Cubic  
(B) Simple Cubic  
(C) Closed Packed Hexagonal  
(D) Body Centred Cubic
- Q2. What is the range of carbon percent in gray cast iron?  
(A) 5 to 8%  
(B) 0.35 to 0.75 %  
(C) 3 to 4%  
(D) 7 to 9%
- Q3. Zinc is used in galvanizing because  
(A) Iron forms  $\text{Fe}^{2+}$  ions more readily than zinc  
(B) Iron forms  $\text{Fe}^{2+}$  ions less readily than zinc  
(C) Zinc forms  $\text{Zn}^{2+}$  ions less readily than iron  
(D) All of the above
- Q4. VOD process is preferred over AOD process for making extra low carbon stainless steel because  
(A)  $p_{\text{CO}}$  can be lowered to a much lower level in the VOD than in the AOD  
(B) AOD does not have adequate stirring  
(C) AOD refractory is not stable in contact with extra low carbon  
(D) Free-board needed for such operation is not available in the AOD
- Q5. Aluminium is not commercially produced by carbothermic reduction primarily because  
(A) Melting point of aluminium is too low  
(B) Aluminium metal will have excessive dissolved oxygen  
(C) Al- $\text{Al}_2\text{O}_3$  line is too low in the Ellingham diagram and needs excessively high temperature  
(D) It does not vaporize at reasonable temperature
- Q6. In a froth flotation process, collector is a reagent which primarily  
(A) Absorbs on unwanted mineral and makes it sink  
(B) Promotes separation of particles from the froth  
(C) Promotes bubble break-up and stabilize the foam  
(D) Adsorbs on the surface of the minerals, and makes it hydrophobic

- Q7. With the increase in the degree of super cooling, the growth rate of a nucleus follows which one of the following trends
- (A) Only decreases
  - (B) First decreases and then increases
  - (C) First increases and then decreases
  - (D) Only increases
- Q8. In slush casting
- (A) Consumable patterns are used
  - (B) Plunger is used to force molten metal to fill up cavities
  - (C) Vacuum is applied to facilitate complete filling casting
  - (D) When a solid shell of sufficient thickness has formed, remaining liquid is poured out
- Q9. The rate of burning of coke in blast furnace is directly proportional to
- (A) The area of fuel exposed to the blast furnace
  - (B) The temperature and pressure of the blast
  - (C) The affinity of particular type of carbon for oxygen
  - (D) All of the above
- Q10. During LD blow in steelmaking the impurity that gets removed first is
- (A) Carbon
  - (B) Phosphorous
  - (C) Manganese
  - (D) Silicon
- Q11. Which one is NOT an agglomeration process?
- (A) Nodulizing
  - (B) Briquetting
  - (C) Roasting
  - (D) Pelletizing
- Q12. The important factors for the production of low silicon pig iron in a blast furnace are;
- (A) Higher temperature and higher basicity
  - (B) Lower temperature and lower basicity
  - (C) Lower temperature and higher basicity
  - (D) Higher temperature and lower basicity
- Q13. High top pressure in a blast furnace operation
- (A) Favours the solution loss reaction
  - (B) Suppresses the solution loss reaction
  - (C) Decreases gas-solid contact time
  - (D) Increases coke rate



- Q14. Which one of the following factors is NOT desirable for effective phosphorous removal in BOF steel making process?
- (A) Higher FeO level in the slag  
 (B) Higher basicity  
 (C) Higher temperature  
 (D) Lower temperature
- Q15. Which of the following NDT techniques CANNOT be used to detect an internal crack in a steel shaft?
- (A) Liquid penetration inspection  
 (B) Radiography  
 (C) Ultrasonic testing  
 (D) X-ray tomography
- Q16. Match the alloys names listed in Group-I with the main elements present in them listed in Group-II

Group I		Group II	
P	Babbit	1	Fe-Ni
Q	Muntz metal	2	Ni-Cr-Fe
R	Invar	3	Cu-Zn
S	Inconel	4	Sn-Sb-Cu

- (A) P-3, Q-1, R-4, S-2  
 (B) P-3, Q-4, R-1, S-2  
 (C) P-4, Q-1, R-2, S-3  
 (D) P-4, Q-3, R-1, S-2
- Q17. If the free energy change ( $\Delta G$ ) for a chemical reaction is very large and negative, then the reaction is
- (A) Not feasible  
 (B) Just feasible  
 (C) Very much feasible  
 (D) Unpredictable as  $\Delta G$  is not a measure of feasibility of a reaction.
- Q18. Blow holes are casting defects caused by
- (A) Some sand shearing from the cope surface  
 (B) Excessive gaseous substance not able to escape.  
 (C) Discontinuity in casting resulting from hindered contraction  
 (D) Two stream of metals that are too cold to fuse properly.
- Q19. Which is the material of construction of mould used for casting ferrous materials in continuous casting process?
- (A) Copper

- (B) Mild steel
- (C) High carbon steel
- (D) Low carbon steel

- Q20. In which of the steel making processes, the converter/vessel/furnace is rotated around its axis during refining operation?
- (A) L.D. process
  - (B) Kaldor vessel
  - (C) Bessemer converter
  - (D) Open hearth furnace
- Q21. As per Sievert's law for solubility of diatomic gases like  $H_2$ ,  $N_2$  and  $O_2$  in steel at a particular temperature, the percentage of dissolved gas is proportional to
- (A)  $p$
  - (B)  $\sqrt{p}$
  - (C)  $p^2$
  - (D)  $1/p$
- Q22. In Rotary Kiln processes for the production of sponge iron the reducing agent used is
- (A) Coke
  - (B) Metallurgical coke
  - (C) Non-metallurgical coal
  - (D)  $H_2$  gas
- Q23. Thermit welding is a form of
- (A) Fusion welding
  - (B) Resistance welding
  - (C) Forge welding
  - (D) Gas welding
- Q24. The crystal structure of  $CsCl$  is
- (A) BCC
  - (B) HCP
  - (C) FCC
  - (D) None of these
- Q25. The metal flow under combined stress state in the metal working process is
- (A) Extrusion
  - (B) Wire drawing
  - (C) Tube drawing
  - (D) All of these
- Q26. The imaging of Scanning Electron Microscope is produced by
- (A) Secondary electrons



- (B) Primary electrons
  - (C) Backscattered electrons
  - (D) Transmitted electrons
- Q27. The flow curve of metals is dependent on
- (A) Strain rate
  - (B) Temperature
  - (C) Flow stress
  - (D) All of these
- Q28. The intensity of X ray diffraction depends on
- (A) Atomic scattering factor
  - (B) Polarisation factor
  - (C) Structure factor
  - (D) All of the above
- Q29. Fettling is an operation carried out
- (A) Before casting
  - (B) After casting
  - (C) During casting
  - (D) None of these
- Q30. The nickel matte consists of
- (A) Ni-Cu alloy
  - (B)  $\text{Ni}_3\text{S}_2$
  - (C)  $\text{Cu}_2\text{S}$
  - (D) All of the above
- Q31. The effect of alloying element decreases the eutectoid temperature
- (A) Cr
  - (B) Ni
  - (C) C
  - (D) All the three
- Q32. The single crystal growth of semiconductor grade silicon is carried out by
- (A) Czochralaski method
  - (B) Floating zone method
  - (C) Both (A) & (B)
  - (D) None of these
- Q33. The activation energy (Q) for diffusion in polycrystalline materials follows
- (A)  $Q_{\text{surface}} < Q_{\text{grain boundary}} < Q_{\text{lattice}}$
  - (B)  $Q_{\text{surface}} < Q_{\text{grain boundary}} > Q_{\text{lattice}}$
  - (C)  $Q_{\text{surface}} > Q_{\text{grain boundary}} > Q_{\text{lattice}}$

(D) All of the these

- Q34. The concentration gradient in solids is expressed as  
(A)  $\text{mol/m}^{-4}$   
(B)  $\text{mol/m}^{-3}$   
(C)  $\text{mole/m}^{-2}\text{s}^{-1}$   
(D) None of the these
- Q35. The degree of freedom at which the FCC iron and BCC iron coexist in equilibrium  
(A) 2  
(B) 1  
(C) 3  
(D) None of these
- Q36. If one solid phase splits into one liquid plus one solid phase on heating, the reaction is  
(A) eutectiod  
(B) eutectic  
(C) peritectic  
(D) peritectiod
- Q37. The maximum solubility of Cu in Cu-Al alloy system is  
(A) 0.2%  
(B) 4.5%  
(C) 5.65%  
(D) None of these
- Q38. Ceramics is brittle in nature, because  
(A) No dislocation  
(B) Amorphous  
(C) wide dislocation  
(D) Higher Peierls Nabarro stress
- Q39. The linear thermal expansion coefficient depends on  
(A) Bond strength  
(B) Potential energy  
(C) Potential well  
(D) All the three
- Q40. Corrosion rate is commonly expressed as  
(A) Inch/ year  
(B) Month/year  
(C) Mils per year  
(D)  $\text{Mg/dm}^2/\text{day}$

- Q41. Activation energy of a chemical reaction, homogeneous or heterogeneous, is graphically estimated from a plot between
- (A)  $k$  versus  $T$
  - (B)  $1/k$  versus  $T$
  - (C)  $1/k$  versus  $\ln T$
  - (D)  $\ln k$  versus  $1/T$
- [Where,  $k$  is the rate constant and  $T$  is the absolute temperature]
- Q42. The chemical formula of wüstite is
- (A)  $\text{FeS}_2$
  - (B)  $\text{Fe}_2\text{O}_3$
  - (C)  $\text{Fe}_3\text{O}_4$
  - (D)  $\text{Fe}_{1-x}\text{O}$
- Q43. For an ideal hexagonal-closed packed structure, the packing efficiency is
- (A) 52%
  - (B) 74%
  - (C) 68%
  - (D) 80%
- Q44. A plastically deformed metal crystal at low temperature exhibits wavy slip line pattern due to
- (A) Dislocation pile-up
  - (B) Large number of slip systems
  - (C) Low stacking fault energy
  - (D) Dislocation climb
- Q45. Creep resistance decreases due to
- (A) Small grain size
  - (B) Fine dispersoid size
  - (C) Low stacking fault energy
  - (D) High melting point
- Q46. The process NOT associated with casting is
- (A) Gating
  - (B) Fettling
  - (C) Stack Moulding
  - (D) Calendaring
- Q47. Of the following welding processes
- [P] Laser Beam Welding
  - [Q] Submerged Arc Welding
  - [R] Metal Inert Gas Welding



the width of the heat-affected zone in decreasing order is

- (A)  $P > Q > R$
- (B)  $Q > R > P$
- (C)  $R > P > Q$
- (D)  $P > R > Q$

Q48. For dye-penetrant test, the CORRECT statement is

- (A) Pre- and post-cleaning of parts are not required
- (B) Internal defects can be detected
- (C) Surface oxides help in crack identification
- (D) Dye with low contact angle is required

Q49. Match the deformation processes in Column I with the corresponding stress states in Column II

Column I	Column II
[P] Wire Drawing	[1] Direct Compression
[Q] Forging	[2] Indirect Compression
[R] Stretch Forming	[3] Tension
[S] Cutting	[4] Shear

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

Q50. With  $\epsilon$  = true plastic strain and  $n$  = strain-hardening coefficient, necking in a cylindrical tensile specimen of a work-hardening metal occurs when

- (A)  $\epsilon = n$
- (B)  $\epsilon = 2n$
- (C)  $\epsilon = n^{0.5}$
- (D)  $\epsilon = n^2$

Q51. Loading in Mode I fracture refers to

- (A) Opening mode
- (B) Sliding mode
- (C) Tearing mode
- (D) Twisting mode

Q52. Which one of the following alloy systems exhibits complete solid solubility?

- (A) Cu-Ni
- (B) Fe-Cu
- (C) Pb-Sn
- (D) Cu-Zn



Q53. In the TTT diagram for the eutectoid carbon steel, the austenite to pearlite transformation is the fastest at temperatures in the nose region of the C – curve. At temperatures below the nose of the C-curve the transformation is slower due to low diffusivity. At higher temperatures above the C- curve the delay is due to

- (A) Low driving force for transformation
- (B) Low mobility of dislocations
- (C) Low concentration of vacancies
- (D) Low diffusivity.

Q54. Match the fracture processes in Group-I to the fracture surface morphologies in Group-II.

Group-I	Group-II
(P) Ductile fracture	(1) Cleavage
(Q) Brittle fracture	(2) Dimples
(R) Fatigue fracture	(3) Striations
	(4) Veins

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

Q55. A defect that is bound by two mirror planes is

- (A) Twin
- (B) Stacking fault
- (C) Grain boundary
- (D) Edge dislocation

Q56. Fick's first law relates

- (A) Flux of atoms and the concentration gradient
- (B) Amount of gas dissolved in the molten metal and the partial pressure
- (C) Applied normal stress and the orientation of slip system
- (D) Heat flux and the temperature gradient

Q57. Hardenability of steel does NOT depend on the

- (A) Alloy content
- (B) Grain size
- (C) Amount of carbon present
- (D) Amount of cold work

Q58. Regarding the role of Stacking fault energy (SFE) on the work hardening ability of a metal the correct logical sequence is

- (A) High SFE → easy cross slip → low work hardening
- (B) High SFE → difficult cross slip → high work hardening

- (C) Low SFE  $\rightarrow$  easy cross slip  $\rightarrow$  low work hardening  
(D) Low SFE  $\rightarrow$  difficult cross slip  $\rightarrow$  low work hardening

Q59. In an Ellingham diagram, the standard free energy change  $\Delta G^\circ$  for the oxidation reaction of a metal M given by:  $xM + O_2(g) \rightarrow M_xO_2(s)$ , is plotted as a function of temperature. The slope of this line is positive because

- (A)  $\Delta S^\circ$  is positive  
(B)  $\Delta S^\circ$  is negative  
(C)  $\Delta H^\circ$  is positive  
(D)  $\Delta H^\circ$  is negative

Q60. Solution loss reaction is

- (A)  $\{CO_2\}_g + \langle C \rangle_s = 2\{CO\}_g$   
(B)  $2\{CO\} = \{CO_2\} + \langle C \rangle_g$   
(C)  $\langle C \rangle_g + \{CO\} = 2\{CO_2\}$   
(D) none of these