S K Mondal's

Engineering Materials

Contents of this section

S K Mondal's

Basic Concepts (Structure of Solids)

Objective Questions (GATE, IES & IAS)

Previous 20-Years GATE Questions

GATE-1. **Decreasing grain size in a polycrystalline material** **[GATE-1998]**
(a) Increases yield strength and corrosion resistance.
(b) Decreases yield strength and corrosion resistance
(c) Decreases yield strength but increases corrosion resistance
(d) Increases yield strength but decreases corrosion resistance.

GATE-1. **Ans. (a)**

GATE-2. **When the temperature of a solid metal increases,** **[GATE-2005]**
(a) Strength of the metal decreases but ductility increases
(b) Both strength and ductility of the metal decrease
(c) Both strength and ductility of the metal increase
(d) Strength of the metal increases but ductility decreases

GATE-2. **Ans. (a)**

Previous 20-Years IES Questions

IES-1. **Which one of the following factors is more relevant to represent complete solubility of two metals in each other?** **[IES-2006]**
(a) Chemical affinity (b) Valency factor
(c) Crystal structure factor (d) Relative size factor

IES-1. **Ans. (c)**

IES-2. **Assertion (A): Elements are classified into metals and non-metals on the basis of their atomic weights.**
Reason (R): The valence electron structures contribute to the primary bonding between the atoms to form aggregates. **[IES-2008]**
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-2. **Ans.(d)**

IES-3. **Assertion (A): Unlike in the case of ionic bonds, the co-ordination numbers for covalently bonded atoms are not controlled by the radii ratio.** **[IES-2003]**
Reason (R): A covalent bond has a specific direction of bonding in space.
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-3. **Ans. (c)**

IES-4. **Which of the following statement is true about brittle fracture?** **[IES-1992]**
(a) High temperature and low strain rates favour brittle fracture
(b) Many metal with HCP crystal structure commonly show brittle fracture
(c) Brittle fracture is always preceded by noise
(d) Cup and cone formation is characteristic for brittle materials

IES-4. **Ans. (b)**

Previous 20-Years IAS Questions

IAS-5. Magnesium is extruded and not rolled because **[IAS-1998]**

(a) It has a low melting point
(b) It has a low density
(c) Its reactivity with roll material is high
(d) It has a dose-packed hexagonal structure

IAS-5. Ans. (a)

Hardness Test

Objective Questions (GATE, IES & IAS)

Previous 20-Years GATE Questions

GATE-1. **Match the items in Column I and Column II.** **[GATE-2006]**

Column I	**Column II**
P. Charpy test	1. Fluidity
Q. Knoop test	2. Micro hardness
R. Spiral test	3. Formability
S. Cupping test	4. Toughness
	5. Permeability

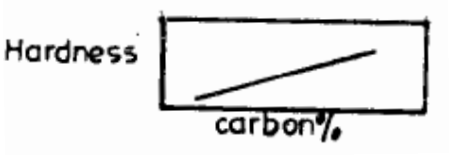
(a) P - 4, Q - 5, R - 3, S – 2
(b) P - 3, Q - 5, R - 1, S - 4
(c) P - 2, Q - 4, R - 3, S – 5
(d) P- 4, Q - 2, R - 1, S – 3

GATE-1. **Ans. (d)**

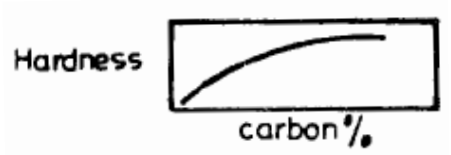
Previous 20-Years IES Questions

IES-1. **Hardness as a function of carbon content is shown in** **[IES-1992]**

(a) Fig-A

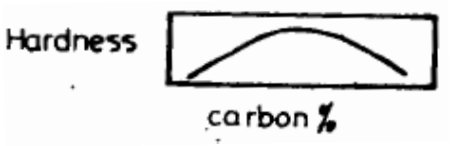


(b) Fig-B



(c) Fig-C

(d) Fig-D



IES-1. **Ans. (b)**

IES-2. **Assertion (A): The hardness test is a slow, expensive method of assessing the mechanical properties of materials.** **[IES-2002]**
Reason (R): The hardness is a function of yield stress and the work hardening rate of material.

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-2. Ans. (b)

IES-3. A carbon steel having Brinell Hardness number 100 should ultimate tensile strength closer it [IES-1992]

(a) 100 N/mm^2 (b) 200 N/mm^2
(c) 350 N/mm^2 (d) 1000 N/mm^2

IES-3. Ans. (c)

IES-4. Which of the following would you prefer for checking the hardness of very thin sections? [IES-1992]

(a) Hebert cloud burst test (b) Shore's Scleroscope
(c) Knoop hardness test (d) Vickers hardness test

IES-4. Ans. (c)

IES-5. Herbert cloudburst Hardness test is conducted to know [IES-1992]

(a) Uniformity of hardness over a surface
(b) Softness of non-metallic components
(c) Hardness of non-metallic components
(d) Hardness at specified depth inside the surface.

IES-5. Ans. (a)

In this metal surface is subjected to rain of several hundred thousand 3 mm diameter hard steel balls talling from a known height. The impact of each ball produces an imprint varying inversely in size with the hardness of the material at the point of impact. The imprint-size pattern shows whether or not there is uniformity of hardness over the entire test are.

Previous 20-Years IAS Questions

IAS-1. With the increase of percentage of carbon in the steel, which one of the following properties does increase? [IAS-2001]

(a) Modulus of elasticity (b) Ductility
(c) Toughness (d) Hardness

IAS-1. Ans. (d)

IAS-2. A measure of Rockwell hardness is the [IAS-1999]

(a) Depth of penetration of indenter (b) Surface area of indentation
(c) Projected area of indentation (d) Height of rebound

IAS-2. Ans. (a)

Crystalline Materials

Objective Questions (GATE, IES& IAS)

Previous 20-Years GATE Questions

GATE-1. **The material property which depends only on the basic crystal structure is**
(a) Fatigue strength (b) Work hardening **[GATE-2010]**
(c) Fracture strength (d) Elastic constant

GATE-1. **Ans. (c)** The material property which depends only on the basic crystal structure is fracture strength. Elastic constant depends not only on material parameters but also on the experimental geometry.

Previous 20-Years IES Questions

IES-1. **For a Rhombohedral space lattice, which one of the following is correct?**
(a) $\alpha = \beta = \gamma = 90^0$ (b) $\alpha = \beta = \gamma \neq 90^0$ **[IES 2007]**
(c) $\alpha = \gamma = 90^0 \neq \beta$ (d) $\alpha \neq \beta \neq \gamma \neq 90^0$

IES-1. **Ans. (b)**

IES-2. **Which one of the following pairs of axis lengths (a, b, c) and inter-axial angles (α, β, γ) represents the tetragonal crystal system? [IES-2001]**
(a) $a = b = c; \alpha = \beta = \gamma = 90^0$ (b) $a = b \neq c; \alpha = \beta = \gamma = 90^0$
(c) $a \neq b \neq c; \alpha = \beta = \gamma = 90^0$ (d) $a = b = c; \alpha = \beta = \gamma \neq 90^0$

IES-2. **Ans. (b)**

IES-3. **Which one of the following pairs is not correctly matched? [IES-2006]**
Space Lattice — Relation between Atomic radius **r** and Edge element **a**
(a) Simple cubic structure : $\mathbf{a}^2 = 4\,\mathbf{r}^2$
(b) Body-centred cubic structure : $3\mathbf{a}^2 = 16\mathbf{r}^2$
(c) Triclinic : $2\mathbf{a}^2 = 3\mathbf{r}^2$
(d) Face-centred cubic structure : $\mathbf{a}^2 = 8\mathbf{r}^2$

IES-3. **Ans. (c)**

IES-4. **Match List-I (Crystal Structure) with List-II (Example) and select the correct answer using the codes given below the Lists: [IES-2003]**

List-I (Crystal Structure)	**List-II (Example)**
A. Simple Cubic	1. Zinc
B. Body-centered Cubic	2. Copper
C. Face-centered Cubic	3. Alpha iron at room temperature
D. Hexagonal Close Packed	4. Manganese

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	4	3	1	2	(b)	4	3	2	1
(c)	3	4	2	1	(d)	3	4	1	2

IES-4. **Ans. (b)**

No of lattice point $= 1 + \frac{1}{4} \times 1 = 2;$ area $= a^2$ $\therefore$ planner densiy $= 2/a^2$

IES-5. **Match List-I (Name of the Element) with List-II (Crystal Structure) and select the correct answer using the codes given below the lists:** **[IES-2001]**

List I	**List II**
A. Fluorspar	1. Body-centered cubic
B. Alpha-Iron	2. Hexagonal closed packed
C. Silver	3. Simple cubic
D. Zinc	4. Face-centered cubic

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	3	2	4	1	(b)	4	1	3	2
(c)	4	2	3	1	(d)	3	1	4	2

IES-5. **Ans. (d)**

IES-6. **What is the planar density of (100) plane in FCC (face-centred cubic) crystal with unit cell side a equal to?** **[IES-2006]**

(a) $\frac{1.484}{a^2}$ (b) $\frac{2}{a^2}$ (c) $\frac{1}{a^2}$ (d) $\frac{\sqrt{2}}{a^2}$

IES-6. **Ans. (b)** Plane (100) intercepts $(1, \alpha, \alpha)$

IES-7. **Match List-I (Element) with List-II (Crystal Structure) and select the correct answer using the code given below the Lists:** **[IES-2006]**

List - I	**List - II**
A. Alpha Iron	1. Hexagonal closed packed
B. Copper	2. Body-centred cubic
C. Zinc	3. Amorphous
D. Glass	4. Face-centred cubic

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	2	3	1	4	(b)	1	4	2	3
(c)	2	4	1	3	(d)	1	3	2	4

IES-7. **Ans. (c)**

IES-8. **In Zinc Blende structure, each atom is surrounded by four atoms of the opposite kind which are located at the comers of which one of the following?** **[IES-2006]**

(a) Tetrahedron (b) Hexahedron (c) Cube (d) Orthorhombic

IES-8. **Ans. (a)**

IES-9. **Consider the following temperature ranges:** **[IES-2004]**

1. Room temperature
2. 0 to 910°C
3. 910°C to 1400°C
4. 1400°C to below melting point

In which of the above temperature ranges ferrite with body centered cubic structure is indicated in, the Fe-Fe_3C phase diagram?

(a) 1, 2 and 4 (b) 2, 3 and 4 (c) 1 and 3 (d) 2 and 3

IES-9. **Ans. (a)**

IES-10. **A metal has FCC structure. Suppose its atomic weight and atomic radius is A and r respectively. Let N denotes Avogadro's number. What is the density of the material?** **[IES-2004]**

(a) $\frac{A}{2\sqrt{2}r^3N}$ (b) $\frac{A}{4\sqrt{2}r^3N}$ (c) $\frac{A}{8\sqrt{2}r^3N}$ (d) $\frac{A}{16\sqrt{2}r^3N}$

IES-10. **Ans. (b)**

$$\text{latice constant (a)} = \left(\frac{nA}{\rho N}\right)^{1/3} \quad \text{For F.C.C. n = 4, } r = \frac{\sqrt{2}}{4}a$$

$$\text{or } \left(\frac{4r}{\sqrt{2}}\right)^3 = \frac{4A}{\rho N} \qquad \text{or } \rho = \frac{4A}{N \times \frac{4^3 r^3}{2\sqrt{2}}} = \frac{A}{4\sqrt{2}r^3 N}$$

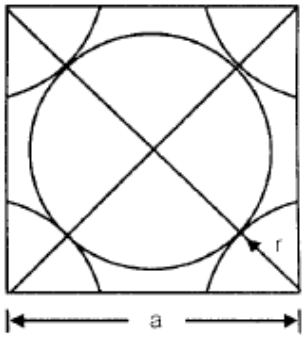
IES-11. **In the atomic hard-sphere model of the crystal structure of Copper, what is the edge length of unit cell?** **[IES-2008]**

(a) 2 x Atomic radius (b) $(4/\sqrt{3})$ x Atomic radius

(c) $\left(2\sqrt{2}\right)$ x Atomic radius (d) J2 x Atomic radius

IES-11. **Ans. (c)**

Cu – F.C.C Structure



$4r = \sqrt{2}\ a$

$a = \frac{4r}{\sqrt{2}} = 2\sqrt{2}r$

Edge length of unit all = $\left(2\sqrt{2}\right)$ × Atomic radius.

IES-12. **The microstructure composition of pearlite for a Fe_3C diagram consists of**

(a) Carbon dissolved in alpha iron having a body cantered cubic structure. **[IES-1992]**

(b) Carbon dissolved in gama iron having a face cantered cubic structure.

(c) A mixture of body-cantered alpha iron and face-entered gamma iron

(d) Carbon dissolved in body-cantered alpha iron and an Fe, Fe_3C.

IES-12. **Ans. (d)**

IES-13. **The coordination number for FCC crystal structure is** **[IES-2003]**

(a) 4 (b) 8 (c) 12 (d) 16

IES-13. **Ans. (c)**

IES-14. **The effective number of lattice points in the unit cell of simple cubic, body centered cubic, and face cantered cubic space lattices, respectively, are[GATE-2009]**

(a) 1, 2, 2 (b) 1, 2, 4 (c) 2, 3, 4 (d) 2, 4, 4

IES-14. **Ans. (b)**

IES-15. **Assuming atoms to be perfect spheres, what is the value of the highest possible atomic packing factor (APF) in metals?** **[IES-2004]**

(a) 0.95 (b) 0.74 (c) 0.66 (d) 0.5

IES-15. **Ans. (b)** Packing factor = 0.74 which is maximum and for F.C.C and HCP structure.

IES-16. **Atomic packing factor (APF) in the case of copper crystal is** **[IES-2000]**

(a) 0.52 (b) 0.68 (c) 0.74 (d) 1.633

IES-16. **Ans. (c)**

IES-17. **Match List-I (Crystal structure) with List-II (Atomic packing factor) and select the correct answer using the codes given below the Lists:** **[IES-1999]**

List-I	**List-II**
A. Simple cubic	1. 74%
B. Body-centered cubic	2. 74%

C. Face-centered cubic 3. 52%
D. Hexagonal close packed 4. 68%

Codes:

	A	B	C	D		A	B	C	D
(a)	3	4	2	1	(b)	4	3	2	1
(c)	3	4	1	2	(d)	4	3	1	2

IES-17. **Ans. (a & c)** Maximum packing of atoms is in hexagonal closed packed arrangement followed by face-centred cubic, body-centered cubic, and least in simple cubic.

IES-18. **Which one of the following is the correct ascending order of packing density for the given crystal structures of metals?** **[IES 2007]**
(a) Simple cubic – Face centred cubic – Body centred cubic
(b) Body centred cubic - Simple cubic - Face centred cubic
(c) Simple cubic - Body centred cubic - Face centred cubic
(d) Body centred cubic - Face centred cubic - Simple cubic

IES-18. **Ans. (c)**

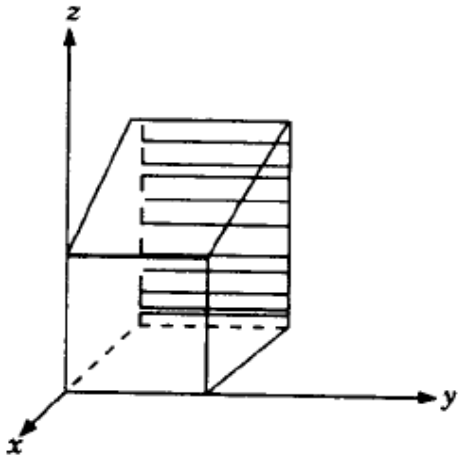
IES-19. **Consider the following statements about FCC and HCP crystal structure:**
1. Both have same coordination number and atomic packing fraction. **[IES-2005]**
2. Both represent closely packed crystal structures.
3. Both structures are generated by stacking of close packed plants on top of one another, but only the stacking sequence is different.

Which of the statements given above are correct?
(a) 1 and 2 (b) 2 and 3 (c) 1, 2 and 3 (d) 1 and 3

IES-19. **Ans. (d)** Both have same co-ordination number 12 and atomic packing fraction 0.74.

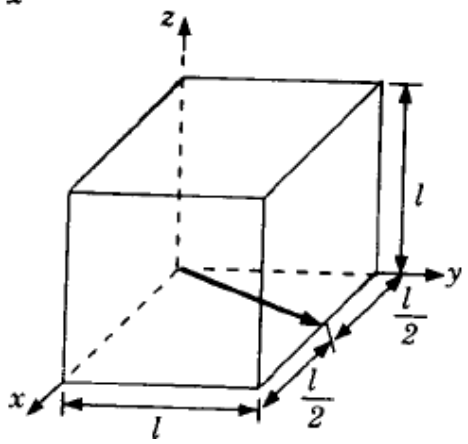
Miller Indices

IES-20. **The set of Miller indices of the plane shown in the given figure is** **[IES-1999]**
(a) $(\bar{1}\,0\,0)$ (b) (1 0 0)
(c) (1 0 1) (d) (1 1 0)



IES-20. **Ans. (a)** Intercepts on x, y and z axes are - 1, ∞, ∞. Their reciprocals are $\bar{1}$,0, 0

IES-21. **A unit cell of a crystal is shown in the given figure. The Miller indices of the direction (arrow) shown in the figure is**
(a) [0 1 2] (b) [0 2 1]
(c) [2 1 0] (d) [2 0 1]



IES-21. **Ans. (c)**

[IES-1998]

Defects in crystalline materials

IES-22. **Which of the following properties of a solid are dependent on crystal imperfections?** **[IES-1997]**
1. Yield stress 2. Melting point 3. Semiconductivity 4. Ductility
Select the correct answer using the codes given below:
(a) 1 and 3 (b) 1, 3 and 4 (c) 2, 3 and 4 (d) 2 and 4
IES-22. **Ans. (b)**

Schottky defect

IES-23. **Which of the following is a point imperfection?** **[IES-1992]**
1. Vacancy 2. Interstitialcy
3. Frenkel imperfection 4. Schottky imperfection
(a) 1 and 2 only (b) 2 and 3 only
(c) 2, 3 and 4 only (d) 1, 2, 3 and 4
IES-23. **Ans. (d)**

IES-24. **Which one of the following defects is 'Schottky defect'?** **[IES-2009]**
(a) Vacancy defect (b) Compositional defect
(c) Interstitial defect (d) Surface defect
IES-24. **Ans. (a)** Schottky defect is a type of vacancy defect in which cation vacancy is associated with anion vacancy.

Interstitial

IES-25. **Which one of the following pairs is *not* correctly matched?** **[IES-2003]**
(a) Point defect in crystal lattice : Self interstitials
(b) Linear defect in crystal lattice : Grain boundary
(c) Planar defect in crystal lattice : External surface
(d) Volume defect in crystal lattice : other phases
IES-25. **Ans. (b)**

IES-26. **Assertion (A): Carbon forms interstitial solid solution when added to iron.**
Reason (R): The atomic radius of carbon atom is much smaller than that of iron.
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true **[IES-1998; 1999]**
IES-26. **Ans. (a)**

IES-27. **Which of the following factors govern solubility of two non-ferrous metals both in liquid state, as well as in solid state?** **[IES-2001]**
1. Crystal structure 2. Relative size factor
3. Chemical-affinity factor 4. Relative valence factor
Select the correct answer using the codes given below:
Codes:
(a) 1, 2 and 3 (b) 2, 3 and 4 (c) 1 and 4 (d) 1, 2, 3 and 4
IES-27. **Ans. (d)**
Substitution
(b) Line Imperfections

Screw

IES-28. **A screw dislocation** **[IES-2003]**

1. Lies parallel to its Burger's vector
2. Lies perpendicular to its Burger's vector
3. Moves in a perpendicular direction to the Burger's vector
4. Moves in an inclined direction to the Burger's vector

Select the correct answer using the codes given below:

Codes:

(a) 1 and 4 (b) 1 and 3 (c) 2 and 3 (d) 2 and 4

IES-28. Ans. (b)

IES-29. Which one of the following is correct for "Burger's vector" in screw dislocation? **[IES-2009]**

(a) Perpendicular to the dislocation line
(b) Inclined to the dislocation line
(c) Parallel to the dislocation line
(d) Opposite to the dislocation line

IES-29. Ans. (c) In screw dislocation Burger Vector is parallel to the dislocation line whereas in Edge dislocation, dislocation is perpendicular to the dislocation line.

IES-30. Which one of the following statements is correct in the case of screw dislocations? ($\vec{b}$ = Burgers Vector; $\vec{t}$ = Imaginary Vector) **[IES-2008]**

(a) $\vec{b}$ is perpendicular to $\vec{t}$
(b) $\vec{b}$ is parallel to $\vec{t}$
(c) $\vec{b}$ is inclined to $\vec{t}$
(d) $\vec{b}$ and $\vec{t}$ are non-coplanar and non-intersecting

IES-30. Ans. (b) Burger vector $\left(\vec{b}\right)$ is parallel to imaginary vector $\left(\vec{t}\right)$ in case of screw dislocation.

IES-31. What is the approximate strain energy expression for a dislocation of unit length, irrespective of its edge or screw character? **[IES 2007]**

(a) $\frac{G^2b}{2}$ (b) $\frac{Gb^2}{2}$ (c) $\frac{G^2b}{4}$ (d) $\frac{Gb^2}{4}$

IES-31. Ans. (b)

IES-32. Assertion (A): Refining the grain size of a polycrystalline material renders it harder and stronger. **[IES-1998]**
Reason (R): Grain boundaries provide easy paths to dislocation motion.

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-32. Ans. (c)

IES-33. Chemicals attack atoms within grain boundaries preferentially because they have

(a) Lower energy than those in the grains **[IES-2002]**
(b) Higher energy than those in the grains
(c) Higher number of atoms than in the grains
(d) Lower number of atoms than in the grains

IES-33. Ans. (b)

Grain boundary

IES-34. What is a surface imperfection, which separates crystals of different orientations in a poly-crystalline aggregate, called? **[IES-2008]**

(a) Edge dislocation (b) Stacking fault
(c) Grain boundary (d) Screw dislocation

IES-34. **Ans. (c)** There are several types of planar (or surface) defects that occur from a change in the orientation of crystallographic planes across a surface boundary. The most important planar defect is the *grain boundary,* which is the imperfect plane surface that separates two crystals of different orientation in a polycrystalline solid. Grain boundaries originate when the last few remaining atoms of a liquid freeze onto the meeting faces of two adjacent crystals that have grown from the melt or, similarly, when two adjacent crystals that grow by re-crystallization meet each other.

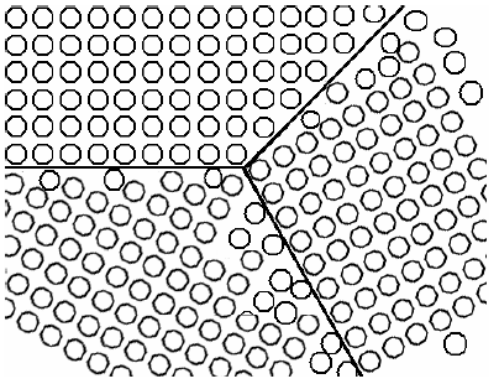


Fig. Grain boundaries

Twin boundary

IES-35. **What is the movement of block of atoms along certain crystallographic planes and directions, termed as?** **[IES 2007]**
(a) Glide (b) Twinning (c) Slip (d) Jog

IES-35. **Ans. (c)**

IES-36. **The B.C.C. and H.C.P. metals undergo plastic deformation by:** **[IES-2005]**
(a) Slip (b) Twinning
(c) Edge dislocation (d) Twinning in combination with slip

IES-36. **Ans. (d)**

Other

IES-37. **Which one of the following is correct for 'Climb'?** **[IES-2009]**
(a) Dislocation moves parallel to the slip plane
(b) Dislocation moves perpendicular to the slip plane
(c) Sliding of one plane of atoms over the other plane
(d) Dislocation moves from a slip plane to another slip plane

IES-37. **Ans. (b)** Climb is a dislocation movement in which dislocation moves from one slip plane to another slip plane. Where as Glide is a dislocation movement in which dislocation moves within the same slip plane.

IES-38. **Assertion (A): Plastic deformation in metals and alloys is a permanent deformation under load. This property is useful in obtaining products by cold rolling.** **[IES-1998]**
Reason (R): Plastic or permanent deformation in metal or alloy is caused by movement or dislocations.
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-38. **Ans. (c)** The deformation of metals, which is caused by the displacement of the atom is achieved by one or both of the processes called slip and twinning.

Plain Carbon Steel

Objective Questions (GATE, IES & IAS)

Previous 20-Years GATE Questions

GATE-1. **The true strain for a low carbon steel bar which is doubled in length by forging is**
(a) 0.307 (b) 0.5 (c) 0.693 (d) 1.0 **[GATE-1992]**

GATE-1. **Ans. (c)**

Previous 20-Years IES Questions

IES-1. **Consider the following statements about medium carbon steel:** **[IES-2005]**
1. It can be quench-hardened but not case-hardened.
2. It cannot be quench-hardened but case-hardening can be done.
3. It exhibits distinct yield point under tension test.

Which of the following statements given above are correct?
(a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) 1, 2 and 3

IES-1. **Ans. (c)** Low carbon steels (less than 0.3%C) cannot be quench hardened but case hardening can be done.

IES-2. **Match List I with List II and select the correct answer using the codes given below the lists:** **[IES-1995]**

List I (Alloy)	**List II (Use)**
A. Low carbon steel	1. Bearing
B. Hadfield manganese steel	2. Thermocouple
C. Constantan	3. Wire nails.
D. Babbitt alloy	4. Bulldozer blades.

Code:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	1	2	3	4	(b)	3	4	1	2
(c)	3	2	1	4	(d)	3	4	2	1

IES-2. **Ans. (d)**

IES-3. **Match List I (Steel) with List II (Application) and select the correct answer using the code given below the Lists:** **[IES-2005]**

List I	**List II**
A. Mild Steel	1. Ball bearing
B. Tool Steel	2. Cold chisels
C. High Carbon Steel	3. Shaft and axles
D. Medium Carbon Steel	4. Rolled steel sections

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	2	1	4	3	(b)	4	3	2	1
(c)	2	3	4	1	(d)	4	1	2	3

IES-3. **Ans. (d)**

IES-4. **In case of power screws, what is the combination of materials used for the screw and the nut?** **IES-2006]**
a) Cast iron screw and mild steel nut
(b) Carbon steel screw and phosphor bronze nut
(c) Cast iron screw and cast iron nut
(d) Aluminium screw and alloy steel nut

IES-4. **Ans. (b)**

IES-5. **Hot cracks occur in the weld and fusion zone as the metal solidifies. Which of the following are the causes for hot cracks?** **[IES-2005]**

1. Presence of sulphur and phosphorus in the base metal
2. High carbon or alloy content of the base metal
3. Moisture in the joint or electrode
4. Joint restraint

Select the correct answer using the code given below:

(a) 1, 2 and 4 (b) 1, 2 and 3 (c) 3 and 4 (d) 1, 2, 3 and 4

IES-5. **Ans. (d)**

IES-6. **Match List I (Alloy) with List II (Application) and select the correct answer using the codes given below the Lists:** **[IES-2004]**

	List I		**List II**
A.	Silicon steel	1.	Marine bearings
B.	High carbon steel	2.	Cutting tools
C.	High speed steel	3.	Springs
D.	Monel metal	4.	Transformer laminations

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	1	2	3	4	(b)	4	3	2	1
(c)	4	2	3	1	(d)	1	3	2	4

IES-6. **Ans. (b)**

IES-7. **For the pipe fitting like elbow, tee, union etc. which of the following is preferred?**

(a) Pig iron (b) Malleable iron **[IES-1992]**

(c) Spheroidal graphite cast iron (d) High carbon steel

IES-7. **Ans. (b)**

IES-8. **Which of the following factors influence in a plain carbon steel?** **[IES 2007]**

1. Percentage carbon
2. Quenching media
3. Work size

Select the correct answer using the code given below:

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

IES-8. **Ans. (d)**

IES-9. **Consider the following statements:** **[IES-2005]**

Strength of steel increases with carbon content.

Young's Modulus of steel increases with carbon content.

Young's Modulus of steel remains unchanged with variation of carbon content.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only (c) 1 and 2 (d) 1 and 3

IES-9. **Ans. (c)**

IES-10. **Presence of hydrogen in steel causes** **[IES-1992]**

(a) Reduced neutron absorption cross-section (b) improved weldability

(c) Embrittlement (d) corrosion resistance

IES-10. **Ans. (c)**

Previous 20-Years IES Questions

IAS-1. **Match List I (Percentage of carbon content in plain carbon steel) with List II (Application) and select the correct answer using the codes given below the lists:** **[IAS-2002]**

List I (Percentage of carbon content in plain carbon steel)	**List II (Application)**
A. 0·10 - 0·20	1. Drop hammers
B. 0·30 - 0·40	2. Razors
C. 0·60 - 0·70	3. Structures
D. 1·10 - 1·40	4. Crane hooks

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	3	4	2	1	(b)	4	3	1	2

(c) 3 4 1 2 (d) 4 3 2 1

IES-1. Ans. (a)

Iron Carbon Equilibrium Diagram

Objective Questions (IES, IAS, GATE)

Previous 20-Years GATE Questions

GATE-1. **Match the terms used in connection with heat-treatment of steel with the micro structural/physical characteristics:** **[GATE-1992]**

Terms	**Characteristics**
(A) Pearlite	(P) Extremely hard and brittle phase
(B) Martensite	(Q) Cementite is finely dispersed in ferrite
(C) Austenite	(R) Alternate layers of cementite and ferrite
(D) Eutectoid	(S) Can exist only above 723°C
	(T) Pertaining to state of equilibrium between three solid phases
	(U) Pertaining to state of equilibrium between one liquid and two solid phase

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	R	P	S	T	(b)	R	S	P	T
(c)	T	R	P	S	(d)	T	R	S	P

GATE-1. **Ans. (a)**

GATE-2. **Match the terms used in connection with heat-treatment of steel with the micro structural/physical characteristics:** **[GATE-1992]**

Terms	**Characteristics**
(A) Pearlite	(P) Extremely hard and brittle phase
(B) Martensite	(Q) Cementite is finely dispersed in ferrite
(C) Austenite	(R) Alternate layers of cementite and ferrite
(D) Eutectoid	(S) Can exist only above 723°C
	(T) Pertaining to state of equilibrium between three solid phases
	(U) Pertaining to state of equilibrium between one liquid and two solid phase

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	R	P	S	T	(b)	R	S	P	T
(c)	T	R	P	S	(d)	T	R	S	P

GATE-2. **Ans. (a)**

Previous 20-Years IES Questions

IES-1. **Match List-I (Fe-Fe_3C Phase Diagram Characteristic) with List-II (Phase) and select the correct answer using the code given below the Lists:** **[IES-2006]**

List-I	**List-II**
A. Alpha (α) iron	1. δ iron
B. Iron carbide having crystal lattice with 3 iron and 1 carbon atom	2. Eutectic
C. BCC pure allotrope of iron is stable between 1388 °C and is melting point at 1535°C	3. Ferrite
	4. Cementite

Codes:	**A**	**B**	**C**		**A**	**B**	**C**
(a)	4	2	3	(b)	3	4	1
(c)	4	2	1	(d)	3	1	2

IES-1. **Ans. (b)**

IES-2. **Match List I with List II and select the correct answer:** **[IES-2002]**

List I (Phase diagram)	**List II (Characteristic)**
A. Isomorphous system	1. One liquid decomposes into another liquid and solid
B. Eutectic system	2. One liquid and another solid combine to form a new solid
C. Peritectic system	3. Two metals are completely soluble in liquid state And completely insoluble in solid state
D. Monotectic system	4. Two metals, soluble in solid and liquid state

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	2	3	4	1	(b)	4	1	2	3
(c)	2	1	4	3	(d)	4	3	2	1

IES-2. **Ans. (d)** Two metals are completely soluble in liquid state and completely insoluble in solid state. i.e. $Liquid \rightarrow Solid_1 + Solid_2$

IES-3. **According to Gibbs' phase rule, the number of degrees of freedom of an eutectic point in a binary system is** **[IES-2003]**

(a) 1 (b) 2 (c) 0 (d) 3

IES-3. **Ans. (a)**

According to Gibb's phase rule,

Number of degree of freedom, F = C - P + 2

where, C = number of components; P = number of phases

For binary system, C = 2 and for entectic point, P = 3

$\therefore$ F = 2- 3 + 2 = 1

IES-4. **In a eutectic system, two elements are completely** **[IES-1999]**

(a) Insoluble in solid and liquid states (b) Soluble in liquid state
(c) Soluble in solid state (d) Insoluble in liquid state

IES-4. **Ans. (b)** In eutectic system, two elements are completely soluble in liquid state.

IES-5. **Eutectic reaction for iron-carbon system occurs at** **[IES-1993]**

(a) 600°C (b) 723°C (c) 1147°C (d) 1493°C

IES-5. **Ans. (c)**

IES-6. **During peritectic solidification, one liquid** **[IES-2000]**

(a) Combines with one solid to form a second new solid
(b) Solidifies into two different solids
(c) Forms one solid
(d) Forms one solid and another liquid

IES-6. **Ans. (a)** $L + S_1 = S_2$

IES-7. **Which one of the following is the correct statement?** **[IES 2007]**

Pearlite in iron-carbon system is a

(a) Phase consisting of ferrite and cementite at room temperature
(b) Mechanical mixture of ferrite and cementite at room temperature
(c) Eutectic mixture ferrite and cementite at room temperature
(d) All the above three are correct

IES-7. **Ans. (b)** Since the chemical separation occurs entirely within crystalline solids, the resultant structure is a five mechanical mixture of ferrite & cementite.
Pearlite is a eutectoid mixture of ferrite and cementite.

IES-8. **Match List I with List II and select the correct answer using the code given below the Lists:** **[IES 2007]**

List I (Name of the Invariant Reaction)	**List II (Invariant Reaction during cooling)**
A. Monotectic	1. LIQUID….SOLID1 + SOLID2

B. Eutectic — 2. LIQUID1.....LIQUID2 + SOLID
C. Eutectoid — 3. SOLID1.....SOLID1 + SOLID2
D. Peritectic — 4. LIQUID + SOLID1.....SOLID2

Code:	A	B	C	D		A	B	C	D
(a)	3	1	2	4	(b)	2	4	3	1
(c)	3	4	2	1	(d)	2	1	3	4

IES-8. Ans. (d)

IES-9. Increase of ferrite phase in steel increases: [IES-2005]
(a) Strength (b) Hardness (c) Ductility (d) Brittleness

IES-9. Ans. (a)

IES-10. A 60 C-plain carbon steel has, approximately: [IES-2005]
(a) 75% of pearlite and 25% of ferrite
(b) 25% of pearlite and 75% of ferrite
(c) 75% of cementite and 25% of ferrite
(d) 75% of pearlite and 25% of cementite

IES-10. Ans. (a) pearlite contain 0.8% carbon
Ferrite contain 0.006% carbon
60C plain carbon steel $\equiv 75\% \times 0.8 + 25\% \times 0.006 \approx 0.6\%$ carbon

IES-11. Pearlite consists of [IES-2000]
(a) 6.67% C and 93.33% ferrite (b) 13% Fe and 87% cementite
(c) 13% C and 87% ferrite (d) 13% cementite and 87% ferrite

IES-11. Ans. (d) 13% x 6.67 + 87% x 0.02 = 0.8

IES-12. A given steel test specimen is studied under metallurgical microscope. Magnification used is 100 X. In that different phases are observed. One of them is Fe_3C. The observed phase Fe_3C is also known as [IES-1997]
(a) Ferrite (b) Cementite (c) Austenite (d) Martensite

IES-12. Ans. (b)

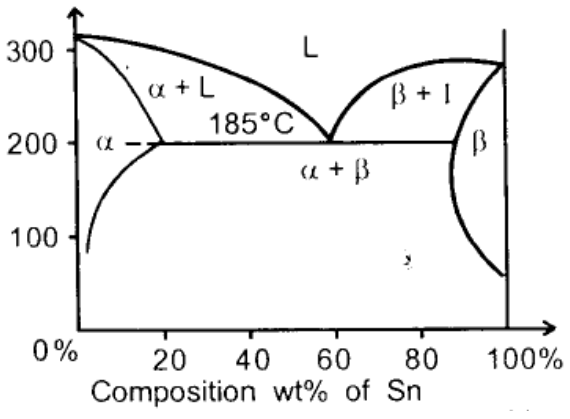
IES-13. Which one of the following sets of constituents is expected in equilibrium cooling of a hypereutectoid steel from austenitic state? [IES-1995]
(a) Ferrite and pearlite (b) Cementite and pearlite
(c) Ferrite and bainite (d) Cementite and martensite

IES-13. Ans. (b)

IES-14. Martensite is a super-saturated solution of carbon in [IES-2001]
(a) Alpha iron (b) Beta iron (c) Gamma iron (d) Delta iron

IES-14. Ans. (a)

IES-15. Consider the following lead-tin phase diagram given below:



For which one of the following alloy compositions, the alloy will have the lowest melting point at 185°C
(a) 20% Sn and 80% Pb by weight
(b) 60% Sn and 40% Pb by weight
(c) 97% Sn and 3% Pb by weight
(d) 40% Sn and 60% Pb byweight

[IES-2004]

IES-15. Ans. (b)

Cast Iron

Objective Questions (IES, IAS, GATE)

Previous 20-Years GATE Questions

GATE-1. The percentage of carbon in gray cast iron is in the range of **[GATE-2004]**
(a) 0.25 to 0.75 percent (b) 1.25 to 1.75 percent
(c) 3 to 4 percent (d) 8 to 10 percent

GATE-1. Ans. (c)

Previous 20-Years IES Questions

IES-1. Vibration damping in machinery is best achieved by means of base structures made of which one of the following materials? **[IES 2007]**
(a) Low carbon steel (b) Nodular iron
(c) Grey cast iron (d) White cast iron

IES-1. Ans. (c) Carbon is in a flake like shape as in grey cast iron; the graphite breaks up the continuity of iron and greatly weakens it. But it also helps in absorbing vibrational energy, as a result of which grey cast iron is normally used for the beds of machine tools.

IES-2. Which of the following materials is used in the manufacture of extrusion nozzles?
(a) Grey cast iron (b) Malleable cast iron **[IES-2005]**
(c) White cast iron (d) Nodular cast iron

IES-2. Ans. (c)

IES-3. Which one of the following cast irons consists of carbon in rosette form? **[IES-2009]**
(a) White cast iron (b) Gray cast iron
(c) Malleable cast iron (d) Nodular cast iron

IES-3. Ans. (d)

IES-4. Consider the following statements: **[IES-2005]**
1. Cast Iron has poor ability to damp vibrations.
2. Cast Iron has higher compressive strength compared to that of steel.
3. Cast Iron parts are suitable where permanent deformation is preferred over fracture.

Which of the statements given above is/are correct?
(a) 1, 2 and 3 (b) 1 and 3 (c) 3 only (d) 2 only

IES-4. Ans. (d)

IES-5. Which of the following pairs are correctly matched? **[IES-2005]**

(Designation of Steel/Cast Iron)		**(Description)**
1. Fe E 250	:	Minimum tensile strength of 250 N/mm2
2. 40 C 8	:	Percentage of Manganese is 0.7% - 0.9%
3. FG 200	:	Grey cast iron with ultimate tensile strength of 200 N/mm^2

Select the correct answer using the code given below:
(a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) 1, 2 and 3

IES-5. Ans. (c)

IES-6. **Machine tool manufacturers prefer grey cast-iron grade 40 for producing machine columns and tables because grey cast-iron is** **[IES-2003]**
1. Heavy
2. Easily castable
3. Easily weldable
4. Having good damping capacity

Select the correct answer using the codes given below:
Codes:
(a) 1 and 2 (b) 2 and 4 (c) 1 and 3 (d) 3 and 4

IES-6. **Ans. (b)**

IES-7. **Piston compression rings are made of which one of the following** **[IES 2007]**
(a) Cast iron (b) Bronze (c) Aluminium (d) White metal

IES-7. **Ans.(a)** They are subjected to wear, to minimize they are made of wear resisting material, high quality grey cast iron casting and coated with Nitride or Chrome by PVD.

IES-8. **Nodular grey cast iron is obtained from the grey cast iron by adding a small amount of** **[IES-2001]**
(a) Manganese (b) Phosphorus (c) Magnesium (d) Chromium

IES-8. **Ans. (c)**

IES-9. **Cast iron is used for machine beds because of its high** **[IES-1999]**
(a) Tensile strength
(b) Endurance strength
(c) Damping capacity
(d) Compressive strength

IES-9. **Ans. (c) & (d)**

IES-10. **Assertion (A): Cast iron is generally hard, brittle and wear resistant.** **[IES-1998]**
Reason (R): Cast iron contains more than 2% carbon and as such the percentage cementite in it is higher.
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-10. **Ans. (a)**

IES-11. **Assertion (A): The notch sensitivity of cast iron component is zero.**
Reason (R): Cast iron does not have a yield point. **[IES-1997]**
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-11. **Ans. (a)**

IES-12. **Consider the following statements:** **[IES-1995]**
Addition of silicon to cast iron
1. Promotes graphite module formation.
2. Promotes graphite flake formation.
3. Increases the fluidity of the molten metal.
4. Improves the ductility of cast iron.

Select the correct answer using the codes given below:
(a) 1and 4 (b) 2 and 3 (c) 1and 3 (d) 3 and 4

IES-12. **Ans. (b)**

IES-13. **Match List I with List II and select the correct answer using the codes given below the lists:** **[IES-1995]**

List I (Name of Material)	List II (% Carbon Range)
A. Hypo-eutectoid steel	1. 4.3 - 6.67
B. Hyper-eutectoid steel	2. 2.0 - 4.3
C. Hypo-eutectic cast iron	3. 0.8 - 2.0
D. Hyper-eutectic cast iron	4. 0.008 - 0.8

Codes:	A	B	C	D		A	B	C	D
(a)	4	3	2	1	(b)	1	3	2	4
(c)	4	1	2	3	(d)	1	2	3	4

IES-13. Ans. (a)

IES-14. An iron-carbon binary alloy has 0.5% C by weight. What is this alloy called? **[IES-2004]**
(a) Eutectoid alloy (b) Eutectic alloy
(c) Hypo-eutectoid alloy (d) Hypereutectoid alloy

IES-14. Ans. (c)

IES-15. Eutectoid reaction occurs at **[IES-1995]**
(a) 600°C (b) 723°C (c) 1147°C (d) 1493°C

IES-15. Ans. (b)

IES-16. The eutectoid of carbon in iron, above lower critical temperature, when cooled, results in: **[IES-2005]**
(a) Ferrite and austenite (b) Ferrite and cementite
(c) Cementite and austenite (d) Ferrite, cementite and austenite

IES-16. Ans. (b)

IES-17. Consider the following work materials: **[IES-1995]**
1. Titanium 2. Mild steel 3. Stainless steel 4. Grey cast iron.
The correct sequence of these materials in terms of increasing order of difficulty in machining is
(a) 4,2,3,1 (b) 4,2, 1,3 (c) 2,4,3,1 (d) 2, 4, 1, 3.

IES-17. Ans. (a) Titanium high cost and need 10 times much energy than steel to produce.
Light weight, strong, corrosion resistant, properties between steel and aluminium.

IES-18. Addition of magnesium to cast iron increases its **[IES-1995]**
(a) Hardness (b) Ductility and strength in tension
(c) Corrosion resistance (d) Creep strength.

IES-18. Ans. (b)

IES-19. Assertion (A): Machine tool beds are generally made of grey cast iron.
Reason (R): Cast iron possesses good self-lubricating properties. **[IES-1994]**
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-19. Ans. (a) Both A and R are true and R provides correct explanation for A.

IES-20. Which of the following pairs are correctly matched? **[IES-1994]**
1. Lead screw nut…… Phosphor bronze
2. Piston…….. Cast iron.
3. Cam ……..EN-31 steel
4. Lead screw ……..Wrought iron.

Select the correct answer using the codes given below:
Codes:
(a) 2, 3 and 4 (b) 1, 3 and 4 (c) 1, 2 and 4 (d) 1, 2 and 3

IES-20. Ans. (d)

IES-21. **Assertion (A): Fracture surface of grey cast iron is dark.** **[IES-1993]**
Reason (R): Failure takes place along the weak cementite plates.
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-21. **(a)** Both A and R are true. Also R gives satisfactory explanation for A.

IES-23. **Which of the following display properties similar to that of steel** **[IES-1992]**
1. Black-heart cast iron
2. White-heart cast iron
3. Gray cast iron
4. Pig iron

(a) 1 and 2 only (b) 3 and 4 only (c) 2 and 4 only (d) 1 and 3 only

IES-23. **Ans. (a)**

IES-24. **Which of the following metal shrinks most from molten state to solid state?**
(a) Cast iron (b) Cast steel **[IES-1992]**
(c) Brass (d) Admiralty metal

IES-24. **Ans. (b)**

Previous 20-Years IAS Questions

IAS-1. **Consider the following statements:** **[IAS-2003]**
1. From design considerations, it is always advantageous to place cast iron ribs on the tension side rather than on the compression side.
2. Cast iron is an excellent choice for machine tool guides and frames.
3. Cast iron parts have low notch sensitivity.

Which of these statements are correct?
(a) 1, 2 and 3 (b) 2 and 3 (c) 1 and 3 (d) 1 and 2

IES-1. **Ans.** ***(b)***
Since cast iron is strong in compression and weak in tension. Therefore, statement 1 is wrong.

IAS-2. **A cast iron specimen in a torsion test gives a** **[IAS-2002]**
(a) Cup-and-cone fracture
(b) Fracture along a plane normal to the axis of the specimen
(c) Fracture along a helix of approximately 45°
(d) Fracture along a plane inclined at 60° to the axis

IAS-2. **Ans. (b)** cast iron brittle fracture.

Alloying Element of Steel and alloy Steel

Objective Questions (GATE, IES & IAS)

Previous 20-Years GATE Questions

GATE-1. **The alloying element mainly used to improve the endurance strength of steel materials is** **[GATE-1997]**
(a) Nickel (b) Vanadium (c) Molybdenum (d) Tungsten

GATE-1. **Ans. (b)**

Previous 20-Years IES Questions

IES-1. **Alloy steel which is work hardenable and which is used to make the blades of bulldozers, bucket wheel excavators and other earth moving equipment contain iron, carbon and**
(a) Chromium (b) Silicon (c) Manganese (d) Magnesium.

IES-1. **Ans. (c)** Manganese increases toughness and ductility.

IES-2. **The alloy steel designated as 40 Cr18 Ni 2 by Bureau of Indian Standards contains**
(a) 0.4% C, 18% Cr and 2% Ni (b) 4.0% C, 1.8% Cr and 0.2% Ni **[IES-2001]**
(c) 0.4% C, 1.8% Cr and 2% Ni (d) 0.4% C, 1.8% Cr and 0.2% Ni

IES-2. **Ans. (a)**

IES-3. **Match List I (Name of alloy) with List II (Major alloying elements) and select the correct answer using the codes given below the Lists:** **[IES-2004]**

List I	**List II**
A. Invar	1. Manganese
B. Hadfield steel	2. Chromium
C. Stellite	3. Nickel
D. Stainless steel	4. Tungsten
	5. Molybdenum

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	5	1	4	2	(b)	3	2	5	1
(c)	5	2	4	1	(d)	3	1	5	2

IES-3. **Ans. (d)** Invar 64% Fe + 36% Ni
Hadfield steel 12 – 14 % Manganese increases toughness and ductility.

IES-5. **Match List I (Alloying Element) with List II (Effect on Steel) and select the correct answer using the code given below the Lists:** **[IES-2005]**

List I	**List II**
A. Vanadium	1. Increases endurance strength
B. Molybdenum	2. Improves creep properties
C. Silicon	3. Increases hardness
D. Chromium	4. Increases resistance to high temperature oxidation

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	2	1	3	4	(b)	1	3	2	4

(c)	2	1	4	3	(d)	1	2	3	4

IES-5. Ans. (d)

IES-6. Match List-I (Alloying element in steel) with List-II (Property conferred on steel by the element) and select the correct answer using the codes given below the lists:

List-I	**List-II**
A. Nickel	1. Corrosion resistance
B. Chromium	2. Magnetic permeability
C. Tungsten	3. Heat resistance
D. Silicon	4. Hardenability

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	4	1	3	2	(b)	4	1	2	3
(c)	1	4	3	2	(d)	1	4	2	3

IES-6. Ans. (a)

IES-7. Consider the following statements in respect of austenitic stainless steels:
1. Austenitic stainless steels are hardened and strengthened by cold working. **[IES-2008]**
2. Austenitic stainless steels cannot be quenched and tempered.

Which of the statements given above is/are correct?
(a) 1 only (b) 2 only (c) Both 1 and 2 (d) Neither 1 nor 2

IES-7. Ans. (c)

- Austenitic stainless steels usually contain 18% Cr and 8% Ni in addition to other minor alloying elements. Ni stabilizes the austenitic phase assisted by C and N. Other alloying additions include Ti, Nb, Mo (prevent weld decay), Mn and Cu (helps in stabilizing austenite).
- These steels are very tough and can be forged and rolled but offer great difficulty in machining.
- These steels cannot be hardened by quenching, in fact they are softened by rapid cooling from about 1000°C.

IES-8. Assertion (A): Austenitic stainless steel contains 18% chromium and 8% nickel. Since it retains its austenitic structure at room temperature, it is called austenitic stainless steel.
Reason (R): Chromium present in the steel improves its corrosion resistance by forming a thin film of chromium oxide on the surface. **[IES-1997]**
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-8. Ans. (a)

IES-9. 18/8 stainless steel contains [IES-1996]
(a) 18% stainless, 8% chromium. (b) 18% chromium, 8% nickel.
(c) 18% tungsten, 8% nickel. (d) 18% tungsten, 8% chromium.

IES-9. Ans. (b)

IES-10. Match List-I with List-II and select the correct answer using the codes given below the lists: [IES-1998]

List-I (Material)	**List-II (Structure)**
A. Charcoal	1. F.C.C
B. Graphite	2. H.C.P
C. Chromium	3. Amorphous
D. Copper	4. B.C.C

Code:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	3	2	1	4	(b)	3	2	4	1
(c)	2	3	4	1	(d)	2	3	1	4

IES-10. Ans. (b)

IES-11. **Match List I (Alloy) with List II (Major Constituent) and select the correct answer using the code given below the Lists:** **[IES-2005]**

List I	List II
A. Babbitt	1. Nickel
B. Invar	2. Tin and lead
C. Gun Metal	3. Aluminium
D. Duralumin	4. Copper

Code:	A	B	C	D		A	B	C	D
(a)	2	4	1	3	(b)	3	1	4	2
(c)	2	1	4	3	(d)	3	4	1	2

IES-11. **Ans. (c)** A. Babbitt - 85% lead, 5% tin, 10% antimony, and 0.5% copper
B. Invar - 64% Fe, 36% Ni
C. Gun metal is a type of bronze: 83% Cu 14% Tin, 3% Zinc, 0.8% Phosphorus.
D. Duralumin - Al 94%, Cu 4%, other(Si, Mn, Mg) 2%

IES-12. **Monel metal is an alloy of** **[IES-2003]**
(a) Iron and carbon (b) Copper and zinc
(c) Aluminium and copper (d) Copper and nickel

IES-12. **Ans. (d)** Monel metal is an allow of Ni - 63-67% , Cu - 30% (rest)

IES-13. **Invar is used or measuring tapes primarily the to its**
(a) Non-magnetic properties
(b) High nickel content
(c) Low coefficient of thermal expansion
(d) Hardenability

IES-13. **Ans. (c)**

IES-14. **Coefficient of Expansion is practically nil in a particular alloy. What is this alloy?**
(a) Hadfield Manganese Steel (b) Invar **[IES-2008]**
(c) Vitallium (d) Stellite

IES-14. **Ans. (b)** A nickel steel alloy containing 36% of nickel is known as ***invar.*** It has nearly zero coefficient of expansion. So it is in great demand for measuring instruments and standards of lengths for everyday use. (Invar - 64% Fe, 36% Ni)

IES-15. **For improving the strength of steel at elevated temperatures, which one of the following alloying element is used?** **[IES-2004]**
(a) Copper (b) Tungsten (c) Aluminium (d) Zinc

IES-15. **Ans. (b)**

IES-16. **Addition of vanadium to steel results in improvement of** **[IES-2000]**
(a) Heat-treatability by quenching (b) Hardenability
(c) Fatigue strength (d) Resistance to oxidation at elevated temperature

IES-16. **Ans. (b)**

IES-17. **Addition of which of the following improves machining of copper?** **[IES-1992]**
(a) Sulphur (b) Vanadium (c) Tin (d) Zinc

IES-17. **Ans. (d)**

IES-18. **Which of the following pairs are correctly matched?** **[IES-1994]**
1. Silicon steels ……Transformer stampings
2. Duralumin ……Cooking utensils.
3. Gun metal..... Bearings

Select the correct answer using the codes given below.
Codes:
(a) 1, 2 and 3 (b) 1 and 2 (c) 1 and 3 (d) 2 and 3

IES-18. Ans. (c)

IES-19. Consider the following statements: An increase in the cobalt content in the straight carbide grades of carbide tools [IES-2005]
1. Increases the hardness.
2. Decreases the hardness.
3. Increases the transverse rupture strength
4. Lowers the transverse rupture strength.

Which of the statements given above are correct?
(a) 1 and 3 (b) 2 and 4 (c) 1 and 4 (d) 2 and 3

IES-19. Ans. (d)

IES-20. Disruptive strength is the maximum strength of a metal, when [IES-2006]
(a) Subjected to 3 principal tensile stresses at right angles to one another and of equal magnitude
(b) Loaded in tension
(c) Loaded in compression
(d) Loaded in shear

IES-20. Ans. (a)

IES-21. Which one of the following elements is an austenitic stabilizer? [IES-2009]
(a) Chromium (b) Tungsten (c) Nickel (d) Molybdenum

IES-21. Ans. (c) Nickel and Manganese are Austenitic stabilizers.

IES-22. Which one of the following elements is a ferritic stabilizer? [IES-2009]
(a) Nickel (b) Manganese (c) Copper (d) Chromium

IES-22. Ans. (d) Chromium, Tungsten and Molybdenum are ferritic stabilizer.

IES-23. Which of the following elements given below determine(s) the maximum attainable hardness in steel? [IES-2008]
1. Chromium 2. Manganese 3. Carbon 4. Molybdenum

elect the correct answer using the code given below:
a) 1 only (b) 1 and 2 (c) 3 only (d) 2 and 4

IES-23. Ans. (c) Molybdenum – Because of this lowering of the transformation point, molybdenum is most effective in producing desirable oil-hardening and air-hardening properties. Except for carbon, it has the greatest hardening effect.

Ni, Cr and Mo alloying additions improve hardenability of Medium carbon steels.
Therefore 1 and 4 is correct but we have forgotten the effect of carbon on steel.

IES-24. Small percentage of boron is added to steel to [IES-1992]
(a) Increases hardenability (b) Reduce machinability
(c) Increases wear resistance (d) Increase endurance strength

IES-24. Ans. (a)

Boron improves the deep hardening of constructional steels and produces therefore core hardness steels. With austenitic 18/8 crome-nickel, steels can achieve higher elastic limits by the process or precipitation hardening, but the corrosion resistance is lowered.

IES-25. Match the following: [IES-1992]

List I (Alloying element in steel)	**List II (Effect)**
A. Lead	1. Restricts grain growth
B. Aluminium	2. Raises yield point
C. Copper	3. Reduces strength to impact
D. Phosphorus	4. Free machining

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	1	2	3	4	(b)	2	3	4	1

(c) 3 4 1 2 (d) 4 1 2 3

IES-25. Ans. (d)

Previous 20-Years IAS Questions

IAS-1. Assertion(A): In high speed steels, alloying elements tungsten, chromium and vanadium are added to make them suitable to work at higher speeds than tool steel or low alloy steels.
Reason(R): Vanadium adds to the property of red hardness and tungsten and chromium add to high wear resistance. [IAS-1995]
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IAS-1. Ans. (a) Both A and R are true and R is the correct explanation of A

IAS-2. Watch List I (Alloying elements for tool steel) with List II (Improved mechanical property) and select the correct answer using the codes given below the Lists

List I (Alloying elements for tool steel)	**List II (Improved mechanical property)**
A. Carbon	1. Hardness
B. Manganese	2. Hot Hardness
C. Chromium	3. Lower Critical Temp
D. Vanadium	4. Toughness

[IAS-2002]

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	1	3	4	2	(b)	2	4	3	1
(c)	1	4	3	2	(d)	2	3	4	1

IAS-2. Ans. (c)

IAS-3. Match List I with List II and select the correct answer using the codes given below the lists: [IAS-1996]

List I (Cutting tools)	**List II (Major constituent)**
A. Stellite	l. Tungsten
B. H.S.S.	2. Cobalt
C. Ceramic	3. Alumina
D. DCON	4. Columbium
	5. Titanium

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	5	1	3	4	(b)	2	1	4	3
(c)	2	1	3	4	(d)	2	5	3	4

IAS-3. Ans. (c)

IAS-4. Which of the following methods are suitable for the production of super alloys?
1. Atomization from molten state using inert gas. **[IAS-1998]**
2. Atomization using plasma arc and rotating electrode.
3. Reduction and crushing.

Select the correct answer using the codes given below:
Codes:
(a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) 1, 2 and 3

IAS-4. Ans. (b)

High Speed Steel

Objective Questions (IES, IAS, GATE)

Previous 20-Years IES Questions

IES-1. **Cutting tool material 18-4-1 HSS has which one of the following compositions?** **[IES 2007]**
(a) 18% W, 4% Cr, 1% V (b) 18% Cr, 4% W, 1% V
(c) 18% W, 4% Ni, 1% V (d) 18% Cr, 4% Ni, 1% V
IES-1. **Ans. (a)**

IES-2. **The correct sequence of elements of 18-4-1 HSS tool is** **[IES-2003]**
(a) W, Cr, V (b) Mo, Cr, V (c) Cr, Ni, C (d) Cu, Zn, Sn
IES-2. **Ans. (a)**

IES-3. **The limit to the maximum hardness of a work material which can be machined with HSS tools even at low speeds is set by which one of the following tool failure mechanisms?** **[IES-1996]**
(a) Attrition (b) Abrasion
(c) Diffusion (d) Plastic deformation under compression.
IES-3. **Ans. (a)**

IES-4. **The blade of a power saw is made of** **[IES-1993]**
(a) Boron steel (b) High speed steel
(c) Stainless steel (d) Malleable cast iron
IES-4. **Ans. (b)** The blade of a power saw is made of high speed steel.

IES-5. **The compositions of some of the alloy steels are as under:** **[IES-1995]**
1. 18 W 4 Cr 1 V 2. 12 Mo 1 W 4 Cr 1 V
3. 6 Mo 6 W 4 Cr 1 V 4. 18 W 8 Cr 1 V
The compositions of commonly used high speed steels would include
(a) 1 and 2 (b) 2 and 3 (c) 1 and 4 (d) 1 and 3
IES-5. **Ans. (d)**

IES-6. **Percentage of various alloying elements present in different steel materials are given below:** **[IES-2000]**
1. 18% W; 4% Cr; 1% V; 5% Co; 0.7% C
2. 8% Mo; 4% Cr; 2% V; 6% W; 0.7% C
3. 27% Cr; 3% Ni; 5% Mo; 0.25% C
4. 18% Cr; 8% Ni; 0.15% C
Which of these relate to that of high speed steel?
(a) 1 and 3 (b) 1 and 2 (c) 2 and 3 (d) 2 and 4
IES-6. **Ans. (b)**

IES-7. **Match List-I (Alloys) with List-II (Applications) and select the correct answer using the codes given below the lists:** **[IES-1998]**

List-I	**List-II**
A. Chromel	1. Journal bearing
B. Babbit alloy	2. Milling cutter
C. Nimonic alloy	3. Thermocouple wire

D. High speed steel 4. Gas turbine blades

Code:	A	B	C	D		A	B	C	D
(a)	3	1	4	2	(b)	3	4	1	2
(c)	2	4	1	3	(d)	2	1	4	3

IES-7. Ans. (a)

IES-8. The main alloying elements in high speed Steel in order of increasing proportion are [IES-1992]

(a) Vanadium, chromium, tungsten
(b) Tungsten, titanium, vanadium
(c) Chromium, titanium, vanadium
(d) Tungsten, chromium, titanium

IES-8. Ans. (a)

Previous 20-Years IAS Questions

IAS-1. Assertion (A): The characteristic feature of High speed Steel is its red hardness. Reason (R): Chromium and cobalt in High Speed promote martensite formation when the tool is cold worked. [IAS 1994]

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IAS-1. Ans. (b)

IAS-2. Assertion (A): For high-speed turning of magnesium alloys, the coolant or cutting fluid preferred is water-miscible mineral fatty oil. [IAS-2001]
Reason (R): As a rule, water-based oils are recommended for high-speed operations in which high temperatures are generated due to high frictional heat. Water being a good coolant, the heat dissipation is efficient.

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IAS-2. Ans. (a)

IAS-3. Which of the following processes can be used for production thin, hard, heat resistant coating at TiN, on HSS? [IAS-1997]

1. Physical vapour deposition.
2. Sintering under reducing atmosphere.
3. Chemical vapour deposition with post treatment
4. Plasma spraying.

Select the correct answer using the codes given below:
Codes:
(a) 1 and 3 (b) 2 and 3 (c) 2 and 4 (d) 1 and 4

IAS-3. Ans. (a)

Cutting Tool Materials

Objective Questions (GATE, IES & IAS)

Previous 20-Years IES Questions

IES-1. **Match List I with List IT and select the correct answer using the codes given below the lists:** **[IES-1993]**

List - I (Cutting tool Material)	**List - I I(Major characteristic constituent)**
A. High speed steel	1. Carbon
B. Stellite	2. Molybdenum
C. Diamond	3. Nitride
D. Coated carbide tool	4. Columbium
	5. Cobalt

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	2	1	3	5	(b)	2	5	1	3
(c)	5	2	4	3	(d)	5	4	2	3

IES-1. **Ans. (b)** High speed steel, in addition to W, Cr & V, has Mo as the most influencing constituent. Thus A matches with 2.
Non ferrous alloys (stellites) are high in cobalt. Thus B matches with 5.
The major constituent of diamond is carbon. Thus C matches with 1.
Coated carbide tools are treated by nitriding. Thus D matches with 3.

IES-2. **Which one of the following is the hardest cutting tool material next only to diamond?** **[IES-2002]**

(a) Cemented carbides (b) Ceramics
(c) Silicon (d) Cubic boron nitride

IES-2. **Ans. (d)**

IES-3. **The straight grades of cemented carbide cutting tool materials contain** **[IES-1995]**

(a) Tungsten carbide only (b) Tungsten carbide and titanium carbide
(c) Tungsten carbide and cobalt (d) Tungsten carbide and cobalt carbide.

IES-3. **Ans. (c)**

IES-4. **Which of the following given the correct order of increasing hot hardness of cutting tool material?** **[IES-1992]**

(a) Diamond, Carbide, HSS (b) Carbide, Diamond, HSS
(c) HSS, carbide, Diamond (d) HSS, Diamond, Carbide

IES-4. **Ans. (d)**

IES-6. **Match List-I with List-II and select the correct answer using the codes given below the Lists:** **[IES-1999]**

List I (Materials)	**List II (Applications)**
A. Tungsten carbide	1. Abrasive wheels
B. Silicon nitride	2. Heating elements
C. Aluminium oxide	3. Pipes for conveying liquid metals
D. Silicon carbide	4. Drawing dies

Code:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	3	4	1	2	(b)	4	3	2	1

(c) 3 4 2 1 (d) 4 3 1 2

IES-6. **Ans. (d)** WC is used for drawing dies, silicone nitride for pipes to carry liquid metal, Al_2O_3 for abrasive wheels, and silicon carbide for heating elements.

IES-7. **Cubic boron nitride** **[IES-1996]**
(a) Has a very high hardness which is comparable to that of diamond.
(b) Has a hardness which is slightly more than that of HSS
(c) Is used for making cylinder blocks of aircraft engines
(d) Is used for making optical glasses.

IES-7. **Ans. (a)** Hardness of CBN is comparable to diamond

IES-8. **Cubic boron nitride is used** **[IES-1994]**
(a) As lining material in induction furnace
(b) For making optical quality glass.
(c) For heat treatment
(d) For none of the above.

IES-8. **Ans. (d)** None of the uses is true for CBN.

IES-9. **Which one of the following is not a synthetic abrasive material?** **[IES-2003]**
(a) Silicon Carbide (b) Aluminium Oxide
(c) Titanium Nitride (d) Cubic Boron Nitride

IES-9. **Ans. (b)**
$Alu\min ium\, oxide (Al_2O_3)$ This is one of the natural abrasives found, and is also called corundum and emery. However, the natural abrasives generally have impurities and, as a result, their performance is inconsistent. Hence the abrasive used in grinding wheels is generally manufactured from the aluminium ore, bauxite,
Silicon carbide (SiC) Silicon carbide is made from silica sand and coke with small amounts of common salt.

IES-10. **Which one of the following is not a ceramic?** **[IES 2007]**
(a) Alumina (b) Porcelain (c) Whisker (d) Pyrosil

IES-10. **Ans. (d)**

IES-11. **Consider the following tool materials:** **[IES-2000]**
1. HSS 2. Cemented carbide
3. Ceramics 4. Diamond
The correct sequence of these materials in decreasing order of their cutting speed is
(a) 4, 3, 1, 2 (b) 4, 3, 2, 1
(c) 3, 4, 2, 1 (d) 3, 4, 1, 2

IES-11. **Ans. (c)** Why Diamond is not used in high speed? Diamond has a tendency to revert at high temperatures (700°C) to graphite and/or to oxidize in air. But ceramics are applicable upto 1300°C. So highest cutting speed with ceramics.

IES-12. **Cermets are** **[IES-2000]**
(a) Metals for high temperature use with ceramic like properties
(b) Ceramics with metallic strength and luster
(c) Coated tool materials
(d) Metal-ceramic composites

IES-12. **Ans. (d)**

IES-13. **Assertion (A): Ceramic tools are used only for light, smooth and continuous cuts at high speeds.** **[IES-1997]**
Reason (R): Ceramics have a high wear resistance and high temperature resistance.
(a) Both A and R are individually true and R is the correct explanation of A

(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-13. Ans. (b)

IES-14. A machinist desires to turn a round steel stock of outside diameter 100 mm at 1000 rpm. The material has tensile strength of 75 kg/mm². The depth of cut chosen is 3 mm at a feed rate of 0.3 mm/rev. Which one of the following tool materials will be suitable for machining the component under the specified cutting conditions? [IES-1996]

(a) Sintered carbides (b) Ceramic
(c) HSS (d) Diamond.

IES-14. Ans. (b) Cutting speed in this case is 314 m / min, at which ceramic is suited.

IES-15. Consider the following tool materials: [IES-1994]

1. Carbide 2. Cermet
3. Ceramic 4. Borazon.

Correct sequence of these tool materials in increasing order of their ability to retain their hot hardness is

(a) 1,2,3,4 (b) 1,2,4,3 (c) 2, 1, 3, 4 (d) 2, 1, 4, 3

IES-15. Ans. (a)

IES-16. Assertion (A): Diamond tools can be used at high speeds. [IES-2001]
Reason (R): Diamond tools have very low coefficient of friction.

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-16. Ans. (c)

IES-17. Match List-I (ISO classification of carbide tools) with List-II (Applications) and select the correct answer using the codes given below the Lists: [IES-1999]

List-I	**List-II**
A. P-10	1. Non-ferrous, roughing cut
B. P-50	2. Non-ferrous, finishing cut
C. K-10	3. Ferrous material, roughing cut
D. K-50	4. Ferrous material, finishing cut

Code:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	4	3	1	2	(b)	3	4	2	1
(c)	4	3	2	1	(d)	3	4	1	2

IES-17. Ans. (c)

IES-18. Assertion (A): Non-ferrous materials are best machined with diamond tools.
Reason (R): Diamond tools are suitable for high speed machining. [IES-1995]

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-18. Ans. (b)

Previous 20-Years IAS Questions

IAS-1. Match. List I (Cutting tool materials) with List II (Manufacturing methods) and select the correct answer using the codes given below the Lists: [IAS-2001]

List I **List II**

A. HSS					1. Casting				
B. Stellite					2. Forging				
C. Cemented carbide					3. Rolling				
D. UCON					4. Extrusion				
					5. Powder metallurgy				
Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	3	1	5	2	(b)	2	5	4	3
(c)	3	5	4	2	(d)	2	1	5	3

IAS-1. Ans. (c)

IAS-2. Consider the following cutting tool materials used for metal-cutting operation at high speed: [IAS-2000]

1. Tungsten carbide
2. Cemented titanium carbide
3. High-speed steel
4. Ceramic

The correct sequence in increasing order of the range of cutting speeds for optimum use of these materials is

(a) 3,1,4,2 (b) 1,3,2,4 (c) 3,1,2,4 (d) 1,3,4,2

IAS-2. Ans. (c) H.S.S < Cast alloy < Carbide < Cemented carbide < Cermets < ceramics

IAS-3. Which of the following tool materials have cobalt as a constituent element? [IAS-1998]

1. Cemented carbide
2. CBN
3. Stellite
4. UCON

Select the correct answer using the codes given below:

Codes:

(a) 1 and 2 (b) 1 and 3 (c) 1 and 4 (d) 2 and 3

IAS-3. Ans. (b)

IAS-4. At room temperature, which one of the following is the correct sequence of increasing hardness of the tool materials? [IAS-2003]

(a) Cast alloy-HSS-Ceramic-Carbide (b) HH-Cast alloy-Ceramic-Carbide
(c) HSS-Cast alloy-Carbide-Ceramic (d) Cast alloy-HSS-Carbide-Ceramic

IAS-4. Ans. (d)

IAS-5. The coating materials for coated carbide tools, includes [IAS-1999]

(a) TiC, TiN and NaCN (b) TiC and TiN
(c) TiN and NaCN (d) TiC and NaCN

IAS-5. Ans. (b)

Heat Treatment of Metals

Objective Questions (IES, IAS, GATE)

Previous 20-Years GATE Questions

GATE-1. **The ductility of a material with work hardening** **[GATE-2002]**
(a) Increases (b) Decreases
(c) Remains unaffected (d) Unpredictable
GATE-1. **Ans. (b)**

GATE-2. **Cast steel crankshaft surface is hardened by** **[GATE-2000]**
(a) Nitriding (b) Normalising
(c) Carburising (d) Induction heating
GATE-2. **Ans. (d)**

GATE-3. **From the lists given below, choose the most appropriate set of heat treatment process and the corresponding process characteristics** **[GATE-2004]**

Process	**Characteristics**
P. Tempering	1. Austenite is converted into bainite
Q. Austempering	2. Austenite is converted into martensite
R. Martempering	3. Cementite is converted into globular structure
	4. Both hardness and brittleness are reduced
	5. Carbon is absorbed into the metal

(a) P-3 Q-1 R-5 (b) P-4 Q-3 R-2
(c) P-4 Q-1 R-2 (d) P-1 Q-5 R-4
GATE-3. **Ans. (c)**

GATE-4. **Hardness of steel greatly improves with** **[GATE-2003]**
(a) Annealing (b) Cyaniding
(c) Normalising (d) Tempering
GATE-4. **Ans. (b)**

GATE-5. **On completion of heat treatment, the resulting structure will have retained Austenite if** **[GATE-1997]**
(a) Rate of cooling is greater than the critical cooling rate
(b) Rate of cooling is less than the critical cooling rate
(c) Martensite formation starting temperature is above the room temperature
(d) Martensite formation finish temperature is below the room temperature
GATE-5. **Ans. (c)**

GATE-6. **Carburized machine components have high endurance limit because carburization** **[GATE-1992]**
(a) Raises the yield point of the material
(b) Produces a better surface finish
(c) Introduces a compressive layer on the surface
(d) Suppresses any stress's, concentration produced in the component.
GATE-6. **Ans. (c)**

GATE-7. **During heat treatment of steel, the hardness of various structures in increasing order is** **[GATE-2003]**
(a) Martensite, fine pearlite, coarse pearlite, spherodite

(b) Fine pearlite, coarse pearlite, spherodite, martensite
(c) Martensite, coarse pearlite, fine pearlite, spherodite
(d) Spherodite, coarse pearlite, fine pearlite, martensite

GATE-7. Ans. (d)

GATE-8. The iron-carbon diagram and the TTT curves are determined under [GATE-1996]
(a) Equilibrium and non-equilibrium conditions respectively
(b) Non-equilibrium and equilibrium conditions respectively
(c) Equilibrium conditions for both
(d) Non-equilibrium conditions for both.

GATE-8. Ans. (a)

Previous 20-Years IES Questions

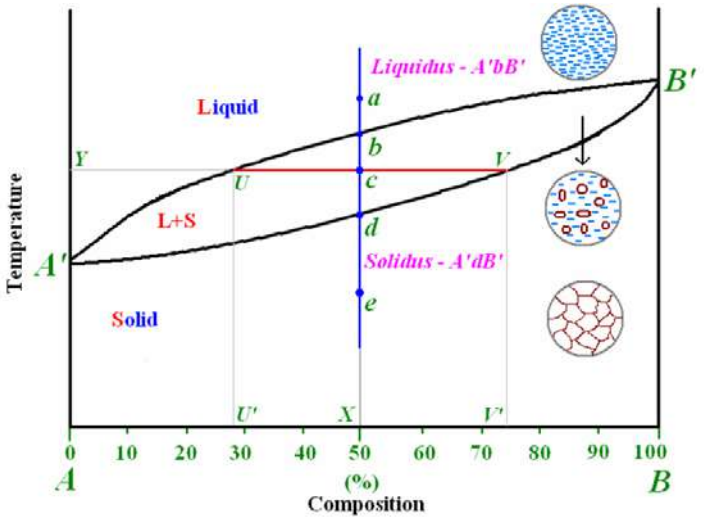
Transformation Curves

IES-1. TTT diagram indicates time and temperature transformation of [IES-2002]
(a) Cementite (b) Pearlite
(c) Ferrite (d) Austenite

IES-1. Ans. (d)

IES-2. Assertion (A): Lever Rule can be applied to determine relative amounts of phases present at any temperature. [IES-2008]
Reason (R): Lever Rule is restricted to estimate relative phases, only if they are solid phases.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-2. Ans. (c)



- At a point in a phase diagram, phases present and their composition (tie-line method) along with relative fraction of phases (lever rule) can be computed.
- Relative amount of liquid and solid phases is given respectively by:

$$C_L = \frac{cV}{UV} \qquad C_S = \frac{Uc}{UV} \qquad C_L + C_S = 1$$

Therefore it is not restricted to solid phases only.

Hardening or Quenching

IES-3. **Consider the following treatments:** **[IES-1994]**
1. Normalizing 2. Hardening
3. Martempering 4. Cold working
Hardness and tensile strength in austenitic stainless steel can be increased by
(a) 1, 2 and 3 (b) 1 and 3 (c) 2 and 4 (d) 4 alone

IES-3. **Ans. (d)** Hardness and tensile strength in austenitic steel can be increased by cold working alone.

IES-4. **Quenching in not necessary when hardening is done by** **[IES-1992]**
(a) Case carburizing (b) Flame hardening
(c) Nitriding (d) Any of the above processes

IES-4. **Ans. (d)**

IES-5. **Which of the following generally decreases in the steel after quench-hardening?**
1. Brittleness 2. Percentage elongation **[IES-1992]**
3. Impact strength
(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

IES-5. **Ans. (b)**

IES-6. **Consider the following quenching media:** **[IES-2001]**
1. Oil 2. Water 3. Water + NaOH 4. Brine
The correct sequence of these media in order of increasing hardness of steel undergoing heat treatment is
(a) 1, 3, 2, 4 (b) 2, 1, 3, 4 (c) 1, 2, 3, 4 (d) 4, 3, 2, 1

IES-6. **Ans. (c)**

IES-7. **Which one of the following mediums is used for the fastest cooling rate of steel quenching?** **[IES-2009]**
(a) Air (b) Oil (c) Water (d) Brine

IES-7. **Ans. (d)** Comparative cooling rates

Brine	1.20 to 1.30
Water	1
Oil	0.40 to 0.50
Forced air	0.03
Still air	0.02

Brine has fastest cooling rate of steel quenching and is also used as secondary refrigerant.

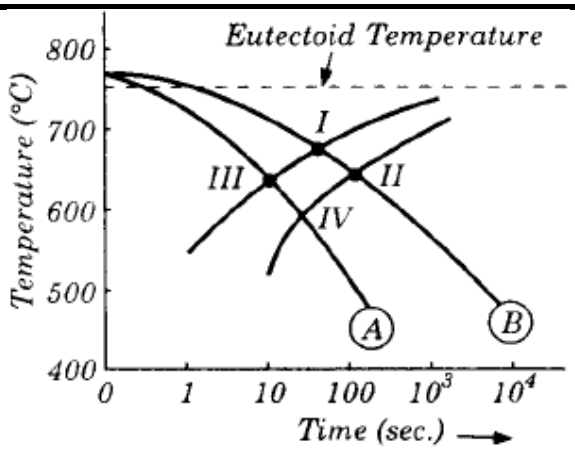
IES-8. **Match List-I (Effect of Cooling) with List-II (Cooling Medium) and select the correct answer using the code given below:** **[IES-2006]**

List -I	**List - II**
A. Martensite	1. Water quenched
B. Very fine pearlite	2. Air cooled
C. Fine pearlite	3. Furnace cooled
D. Coarse pearlite	4. Oil quenched

	A	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	1	4	2	3	(b)	2	3	1	4
(c)	2	3	4	1	(d)	1	2	3	4

IES-8. **Ans. (a)**

IES-9. **Two cooling curves A and B for a eutectoid iron-carbon alloy are superimposed on a continuous cooling transformation diagram as shown in the given figure. Fine pearlite microstructure is represented by the points labelled [IES-1998]**



(a) I and III
(b) II
(c) IV
(d) I

IES-9. **Ans. (c)** Fine pearlite structure is formed below eutectoid temperature and on moderate cooling.

IES-10. **Which one of the following materials can be subjected to an age hardening process? [IES-2009]**

(a) HSS (b) Aluminium (c) Pure iron (d) Stellite

IES-10. **Ans. (b)**

- Precipitation hardening is also called age hardening because strength increases with time.
- Requisite for precipitation hardening is that second phase must be soluble at an elevated temperature but precipitates upon quenching and aging at a lower temperature.
- E.g.: Al-alloys, Cu-Be alloys, Mg-Al alloys, Cu-Sn alloys
- If aging occurs at room temperature – Natural aging
- If material need to be heated during aging – Artificial aging.

Tempering

IES-11. **Tempering is a process of annealing [IES-2006]**

(a) Martensite at low temperatures (b) Martensite at higher temperatures
(c) Bainite at low temperatures (d) Bainite at higher temperatures

IES-11. **Ans. (a)**

IES-12. **Austempering is employed to obtain: [IES-2005]**

(a) 100% martensitic structure
(b) 100% bainitic structure
(c) 50% martensitic and 50% bainitic structure
(d) 100% pearlitic structure

IES-12. **Ans. (b)**

IES-13. **Consider the following pairs: [IES-2004]**

Heat treatment	Effect on medium carbon steel
1. Normalizing	: Grain refinement
2. Full annealing	: Uniform grain structure
3. Martempering	: Decreased ductility
4. Spheroidizing	: Maximum softness

Which of the pairs given above are correctly matched?

(a) 1 and 2 (b) 2 and 3 (c) 3 and 4 (d) 1, 2, 3 and 4

IES-13. **Ans. (d)**

IES-14. **'Tempering' of quenched martensitic steel is necessary to improve the [IES-2001]**

(a) Hardness of the metal (b) Surface texture or the metal
(c) Corrosion resistance of the metal (d) Ductility or the metal

IES-14. Ans. (d)

IES-15. Match List I with List II and select the correct answer using the codes given below the lists: [IES-1995]

List I (Heat treatment)	List II (Effect on the properties)
A. Annealing	1. Refined grain structure
B. Nitriding	2. Improves the hardness of the whole mass
C. Martempering	3. Increases surface hardness
D. Normalising	4. Improves ductility

Codes:	A	B	C	D		A	B	C	D
(a)	4	3	2	1	(b)	1	3	4	2
c)	4	2	1	3	(d)	2	1	3	4

IES-15. Ans. (a)

Annealing and Normalising

IES-16. The pattern known as Widmanstatten structure is encountered in: [IES-2006]
(a) Tempering (b) Normalizing
(c) Spheroidizing (d) Annealing

IES-16. Ans. (a)

IES-17. The complete phase recrystallization and fine grain structure is obtained in casting, forging and rolled parts by: [IES-2005]
(a) Recrystallization annealing (b) Normalizing
(c) Spheroidizing (d) Austenising

IES-17. Ans. (a)

IES-18. Heating the hypoeutectoid steels to 30°C above the upper critical temperature line, soaking at that temperature and then cooling slowly to room temperature to form a pearlite and ferrite structure, is known as [IES-1999]
(a) Hardening (b) Normalizing
(c) Tempering (d) Annealing

IES-18. Ans. (d) The process described is annealing.

IES-19. Which of the following statements are true of annealing of steels? [IES-1993]
1. Steels are heated to 500 to 700°C. 2. Cooling is done slowly and steadily.
3. Internal stresses are relieved. 4. Ductility of steel is increased.

Select the correct answer using the codes given below:
Codes:
(a) 2, 3 and 4 (b) 1, 3 and 4
(c) 1, 2 and 4 (d) 1, 2 and 3

IES-19. Ans. (a) Steels are heated to 30 to 50°C above the upper critical temperature.

IES-20. Temperature required for full annealing in hyper-eutectoid steel is [IES-1992]
(a) 50°C above upper critical temperature (AC_3)
(b) 50°C below upper critical temperate (AC_3)
(c) 50°C above lower critical temperature (AC_1)
(d) 50°C below lower critical temperature (AC_1)

IES-20. Ans. (c)

IES-21. Assertion (A): Normalized steel will have lower hardness than annealed steel.
Reason (R): The pearlite of normalized steel is finer and has lower intermolecular space. [IES-2000]
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A

(c) A is true but R is false
(d) A is false but R is true

IES-21. Ans. (d)

Spheroidising

IES-22. Globular form of cementite in the structure of steel is obtained through [IES-2003]
(a) Normalizing (b) Malleabilising
(c) Spheroidizing (d) Carbonizing

IES-22. Ans. (c)

Case Hardening

IES-23. In case carburising Carbon is introduced to form a high carbon layer at the surface. The carbon is introduce in the form of [IES-1992]
(a) Graphite flakes (b) Pearlite
(c) Cementite (d) Free carbon

IES-23. Ans. (d)

IES-24. Match List I (Name of treatment) with List II (Media used) and select the correct answer using the codes given below the Lists [IES-2004]

List I	**List II**
A. Pack carburizing	1. Ammonia gas
B. Gas carburizing	2. Sodium cyanide
C. Cyaniding	3. Carburizing compound
D. Nitriding	4. Ethane

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	3	4	2	1	(b)	2	1	3	4
(c)	3	1	2	4	(d)	2	4	3	1

IES-24. Ans. (a)

IES-25. Induction hardening is basically a [IES-1992]
(a) Carburising process (b) Surface hardening process
(c) Core-hardening process (d) None of the above

IES-25. Ans. (b)

IES-26. Guideways of lathe beds are hardened by [IES-1996; 1997]
(a) Carburising (b) Cyaniding
(c) Nitriding (d) Flame hardening

IES-26. Ans. (d)

Heat Treatment of Non-Ferrous Alloys

IES-27. Which one of the following elements/ alloy exhibits season cracking? [IES 2007]
(a) Iron (b) Brass (c) Aluminium (d) Steel

IES-27. Ans. (b)
i. Copper alloys cracks in ammonaical solution (Season Cracking)
ii. Stainless steel and Aluminium cracks in the presence of chlorides, Steel cracks in the presence of alkali (Boiler Cracking) or Caustic Cracking.

IES-28. Which one among the following is the most effective strengthening mechanism of non-ferrous metal? [IES 2007]
(a) Solid solution hardening (b) Strain hardening
(c) Grain size refinement (d) Precipitation hardening

IES-28. Ans. (d)

IES-29. Which one of the following pairs is correctly matched? [IES-2001]
(a) Solid solution strengthening… Increasing density of dislocations
(b) Dispersion hardening ……..Creating strained region in the crystal
(c) Strain-hardening ……....Creating particles to resist the movement of dislocations
(d) Precipitation-hardening….. Creating particles by decreasing solubility of one phase in another

IES-29. Ans. (d)

IES-30. Assertion (A): Carburizing is done on non-ferrous alloys to increase the surface hardness. [IES-1994; 2005]
Reason (R): Precipitation hardening of non-ferrous alloys involves solution heat treatment followed by precipitation heat treatment.
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-30. Ans. (d) *A is false.* Carburizing is done only on ferrous alloys to increase the surface hardenss but it is not done on non-

IES-31. If the surface of a component is heavily stressed while the stresses in the core are of comparative small magnitude, which one of the following heat treatment methods is employed? [IES-2005]
(a) Annealing (b) Tempering
(c) Quenching (d) Case hardening

IES-31. Ans. (c) case carburizing if they do not respond to quenching process.

Previous 20-Years IAS Questions

IAS-1. Major operations in the manufacture of steel balls used for Ball bearings are given below [IAS 1994]
1. Oil lapping 2. Cold heading
3. Annealing 4. Hardening
5. Rough grinding

The correct sequence of these operations is
(a) 3,2,4,1,5 (b) 3,2,1,4,5 (c) 2,3,4,5,1 (d) 2,3,5,4,1

IAS-1. Ans. (c)

IAS-2. Two plain carbon steel specimens having 0·8% carbon content are welded. If we observe the weldment under Metallurgical Microscope from centre towards either side, the following structures are observed at different zones: [IAS-2002]
1. Fine Pearlite
2. Coarse Pearlite
3. Martensite

Select the correct sequence using the codes given below:
Codes:
(a) 1, 2, 3 (b) 1, 3, 2 (c) 2, 1, 3 (d) 3, 1, 2

IAS-2. Ans. (d)
Maximum cooling rate produces Martensite
Medium cooling rate produces Fine pearlite
Low cooling rate produces coarse pearlite.

Plastics

Objective Questions (IES, IAS, GATE)

Previous 20-Years IES Questions

IES-1. **Structure of a polymer is:** **[IES-2008]**

(a) Long chain (b) Rhombic (c) Cubic (d) Closed pack hexagonal

IES-1. **Ans. (a) Polymers:**

- Commercially called *plastics*; noted for their low density, flexibility and use as insulators.
- Mostly are of organic compounds i.e. based on carbon, oxygen and other nonmetallic elements.
- Consists large molecular structures bonded by covalent and van der Waals forces.
- That is why structure of polymer is long chain.

IES-2. **Assertion (A): Linear polymers are rigid at low temperatures but soft and mouldable at elevated temperatures.** **[IES-1992]**

Reason (R): Linear polymers are thermo-setting.

(a) Both A and R are individually true and R is the correct explanation of A

(b) Both A and R are individually true but R is **not** the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true

IES-2. **Ans. (c)** A is true but R is false

IES-3. **Teflon is a** **[IES-2003]**

(a) Thermosetting fluorocarbon polymer

(b) Thermo-plastic fluorocarbon polymer

(c) Inorganic compound of fluorine and carbon

(d) Laminated phenolic material

IES-3. **Ans. (b)** Remember it.

Thermoplast: Thermoplast have the property of increasing plasticity that is increasing ability to deform plastically with increasing temperature.

Thermosets: It has a three dimensional network of primary bonds. They are relatively hard and rigid at room temperature and do not soften on heating.

IES-4. **Match List I with List II and select the correct answer using the code given below the Lists:** **[IES 2007]**

List I **(Material)**	**List II** **(Application)**
A. Fibre reinforced plastics	1. Automobile tyres
B. Acrylics	2. Aircraft
C. Phenolics	3. Lenses
D. Butadiene rubber	4. Electric switch cover

Code:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	1	4	3	2	(b)	2	3	4	1
(c)	1	3	4	2	(d)	2	4	3	1

IES-4. **Ans. (b)**

IES-5. **Phenol formaldehyde is a/an** **[IES-2006]**

(a) Thermoplastic polymer (b) Thermoset polymer

(c) Elastomer (d) Rubber

IES-5. **Ans. (b)**

IES-6. **Thermoplastic materials cannot be produced by:** **[IES-2005]**

(a) Injection moulding process (b) Extrusion process

(c) Blow moulding process (d) Both (a) and (b) above

IES-6. **Ans. (b)** For thermoplastic extrusion we have to feed thermoplastic pellets or powders through a hoper into a barrel chamber of a screw extruder. So it is not conventional extrusion process.

IES-7. **Which of the following are fabricated using engineering plastics?** **[IES-2002]**

1. Surface plate
2. Gears
3. Guide ways for machine tools
4. Foundry patterns

Select the correct answer using the codes given below:

(a) 1, 2 and 3 (b) 1 (c) 2, 3 and 4 (d) 1, 2, 3 and 4

IES-7. **Ans. (c)**

IES-8. **Consider the following statements:** **[IES-2002]**

Polytetrafluoroethene is

1. A thermoplastic material
2. Having high friction coefficient
3. A thermosetting material
4. Having low friction coefficient
5. An electric insulator
6. Non sticking to surfaces

Which of the above statements are correct?

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

IES-8. **Ans. (a)**

IES-9. **The molecular weight of vinyl chloride is 62.5. Thus the molecular weight or a polyvinyl chloride with a degree of polymerization of 20000 is** **[IES-2001]**

(a) $\frac{20000}{62.5}$ (b) $\frac{62.5}{20000}$ (c) 62.5×20000 (d) 20000

IES-9. **Ans. (c)**

IES-10. **Consider the following pairs of plastics and their distinct characteristics:**

1. Acrylics ..... Very good transparency to light **[IES-1999]**
2. Polycarbonate….. Poor impact resistance
3. PTFE ... ……Low coefficient of friction.
4. Polypropylene…. .Excellent fatigue strength

Which of these pairs are correctly matched?

(a) 2 and 3 (b) 1 and 3 (c) 1 and 4 (d) 2 and 4

IES-10. **Ans. (c)** PTFE is used for high temperature applications. Polycarbon has good impact resistance.

IES-11. **Consider the following statements:**

Thermosetting plastics are

1. Formed by addition polymerisation.
2. Formed by condensation polymerisation.
3. Softened on heating and hardened on cooling for any number of times
4. Moulded by heating and cooling.

Select the correct answer using the codes given below:

(a) 1 and 3 (b) 2 and 4 (c) 1 and 4 (d) 2 and 3

IES-11. **Ans. (b)**

IES-12. **Match List I with List II and select the correct answer**

List I (Material)	**List II (Nature of product)**
A. Polyethylene	1. Adhesive
B. Polyurethane	2. Film
C. Cyano-acrylate	3. Wire
D. Nylon	4. Foam

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	2	4	3	1	(b)	4	2	3	1
(c)	2	4	1	3	(d)	4	2	1	3

IES-12. Ans. (c)

IES-13. Consider the following statements:
Fibre Reinforced Plastics are
1. Made of thermosetting resins and glass fibre
2. Made of thermoplastic resins and glass fibre
3. Anisotropic 4. isotropic

Select the correct answer using the codes given below:
(a) 1 and 4 (b) 1 and 3 (c) 2 and 3 (d) 2 and 4

IES-13. Ans. (b)

IES-14. Which of the following pairs of plastics and their modes of formation are correctly matched? [IES-1994]
1. Polythene…….. Condensation polymerization.
2. Polycarbonate .....Addition polymerisation.
3. Polystyrene…….. .Addition polymerisation.
4. Polyamide ……Either by addition or by condensation polymerisation.

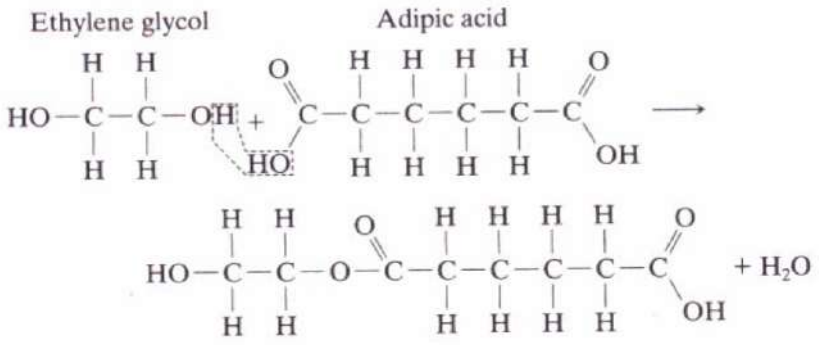
Select the correct answer using the codes given below:
(a) 1 and 2 (b) 2 and 4 (c) 1 and 4 (d) 3 and 4

IES-14. Ans. (d)

IES-15. What is the process by which two or more chemically different monomers are polymerised to form a cross link polymer together with a by-product such as water or ammonia, known as? [IES-2008]
(a) Addition polymerization (b) Co-polymerisation
(c) Linear polymerisation (d) Condensation polymerization

IES-15. Ans. (d)
- Condensation polymerization process involves more then one monomer species. This process is also known as step growth polymerization.
- In condensation polymerization, smaller macromolecule by-product such as water is eliminated.
- No resultant product has the chemical formula of mere one monomer.
- Repeat unit in condensation process itself is product of polymerization involving basic constituents.
- Reaction times for condensation polymerization are usually longer than those for additional polymerization.

E.g.: Formation of a polyester from Ethylene glycol and Adipic acid



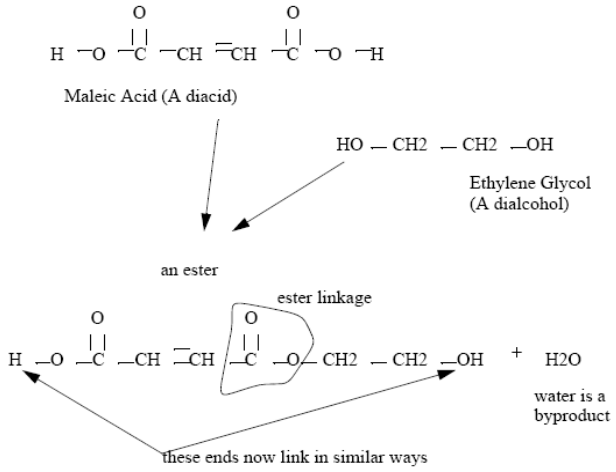
E.g. : Formation of a polyester from Ethylene glycol and Adipic acid

IES-16. Polyamides are characterized by [IES-1992]
(a) Flexible chain (b) Rigid chain
(c) Amorphous structure (d) Crystalline structure

IES-16. Ans. (d)

IES-17. **Polyesters can be defined as the condensation products of** **[IES-2003]**
(a) Dicarboxylic acids with dihydroxy alcohols
(b) Bisphenol-A and epichloro-hydrin
(c) Phenol and formaldehyde
(d) Benzene and toluene

IES-17. **Ans. (a)** Polyester resins are quite common. The process often begins with molecules like a dialcohol, and diacid. These then cure into a solid polymer.



IES-18. **Assertion (A) In Addition Polymerization method, polymer is produced by adding a second monomer to the first, then a third monomer to this dimmer and so on.**
Reason (R): There must exist at least one double bond in the monomer for Addition Polymerization reaction. **[IES-2006]**
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-18. **Ans. (a)**

IES-19. **Assertion (A): Addition polymerization is a primary summation of individual molecules into long chains,** **[IES-2000]**
Reason (R): In addition polymerization, the reaction produces a small molecule as by-product.
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is **not** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

IES-19. **Ans. (c)**

IES-20. **Match List I (materials) with List II (applications) and select the correct answer using the codes given below the Lists:** **[IES-1994]**

List I	**List II**
A. Engineering ceramics	1. Bearings
B. Fibre reinforced plastics	2. Control rods in nuclear reactors
C. Synthetic carbon	3. Aerospace industry
D. Boron	4. Electrical insulator

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	1	2	3	4	(b)	1	4	3	2
(c)	2	3	1	4	(d)	4	3	1	2

IES-20. **Ans. (d)**

IES-21. **Fillers are added to plastics to** **[IES-1992]**

(a) Improve flow
(b) Reduce brittleness
(c) Facilitate process ability
(d) Reduce cost

IES-21. Ans. (d)

IES-22. Match List I (Type of moulding) List II (Mechanism involved) and select the collect answer using the codes given below the Lists: [IES-2004]

List I
A. Compression moulding
B. Injected moulding
C. Jet moulding
D. Extrusion moulding

List II
1. Mould cavity must be heated to cure the plastic forced into it.
2. Similar to Hydraulic extrusion
3. Analogous to the hot pressing of powered metals
4. Analogous to die casting of metals

	A	B	C	D		A	B	C	D
(a)	2	4	1	3	(b)	3	1	4	2
(c)	2	1	4	3	(d)	3	4	1	2

IES-22. Ans. (d)

IES-23. Match List-I with List-II and select the correct answer using the code given below the Lists: [IES-2009]

List-I (Article)
A. Disposable coffee cups
B. Large water tanks
C. Plastic sheets
D. Cushion pads

List-II (Processing Method)
1. Rotomoulding
2. Expandable bead moulding
3. Thermoforming
4. Blow moulding

IES-24. Match List I (Type of moulding) List II (Mechanism involved) and select the collect answer using the codes given below the Lists: [IES-2004]

List I
A. Compression moulding
B. Injected moulding
C. Jet moulding
D. Extrusion moulding

List II
1. Mould cavity must be heated to cure the plastic forced into it.
2. Similar to Hydraulic extrusion
3. Analogous to the hot pressing of powered metals
4. Analogous to die casting of metals

Codes:	A	B	C	D		A	B	C	D
(a)	2	4	1	3	(b)	3	1	4	2
(c)	2	1	4	3	(d)	3	4	1	2

IES-24. Ans. (d)

IES-25. Match List-I with List-II and select the correct answer using the code given below the Lists: [IES-2009]

List-I (Article)
A. Disposable coffee cups
B. Large water tanks
C. Plastic sheets
D. Cushion pads

List-II (Processing Method)
1. Rotomoulding
2. Expandable bead moulding
3. Thermoforming
4. Blow moulding
5. Calendering

Code:	A	B	C	D		A	B	C	D
(a)	3	5	1	2	(b)	4	5	1	2
(c)	4	3	2	1	(d)	3	1	5	2

IES-25. Ans. (d)

Plastics

S K Mondal's

Previous 20-Years IAS Questions

IAS-1. **Which one of the following are the processes for thermosetting materials?** **[IAS-1999]**

1. Compression
2. Transfer moulding
3. Injection moulding
4. Extrusion

Select the correct answer using the codes given below:

(a) 1 and 4 (b) 1 and 2 (c) 2 and 3 (d) 2, 3 and 4

IAS-1. **Ans. (b)**

IAS-2. **Which one of the following statements is *not* correct?** **[IAS-2007]**

(a) In injection die moulding, exact amount of material to fill the cylinder is delivered
(b) Injection die moulding is generally limited to forming thermoplastic material
(c) Thermosetting plastics are more suitable for extrusion moulding
(d) Extrusion moulding process is used for giving shapes, such as rods, tubes, pipes, ropes etc.

IAS-2. **Ans. (c)** Thermoplastics are made suitable for extrusion moulding.

IAS-3. **Match List I with List II and select the correct answer using the code given below the Lists:** **[IAS-2007]**

List I (Additive for Polymers)	**List II (Purpose)**
A. Plasticizer	1. Allows polymerization to begin
B. Filler	2. Colours the material
C. Initiator	3. Acts as internal lubricants
	4. Improves strength

Code:	**A**	**B**	**C**		**A**	**B**	**C**
(a)	1	4	3	(b)	3	2	1
(c)	1	2	3	(d)	3	4	1

IAS-3. **Ans. (d)** **IAS-4.** **Ans. (a)**

IAS-4. **Which of the following are the characteristics of the injection moulding of plastics?** **[IAS-2004]**

1. It is the most economical method of mass producing a single item
2. In most cases finished products are obtained
3. There is lot of waste of thermoplastic since the runners and sprues can not be reused.

Select the correct answer by using the following codes:

(a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) 1, 2 and 3

IAS-5. **Consider the following statements:** **[IAS-2003]**

1. Thermoplastics possess a strong intermolecular bonding compared to that of thermosetting plastics.
2. Plastics have a high creep under continuous loading.
3. Embrittlement occurs in plastics at low temperature.

Which of these statements are correct?

(a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) 1, 2 and 3

IAS-5. **Ans. (b)**

IAS-6. **Weldable type plastic(s) include (s)** **[IAS-2000]**

(a) Thermosets alone
(b) Thermoplastics alone
(c) Both thermosets and thermoplastics
(d) Neither thermosets and thermoplast

IAS-6. **Ans. (b)** only the thermoplastic polymers can be welded, since these materials can be melted or softened by heat without degradation. The thermosetting polymers do not soften with heat but tend only to char or burn.

IAS-7. **Match List- I (Name of moulding composition to prepare plastics) with List-II (Property of moulding composition) and select the correct answer using the codes given below the lists:** **[IAS-1998]**

List - I
A. Binder
B. Filler
C. Plasticizer
D. Lubricant

List – II
1. Reduce cost, shrinkage
2. Make the moulding of plastic easier
3. Cellulose derivatives
4. Accelerate condensation and polymerization
5. Toughness and resistance to temperature.

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	3	1	2	5	(b)	3	1	5	2
(c)	5	3	1	4	(d)	3	5	l	4

IAS-7. **Ans. (b)**

IAS-8. **Consider the following statements in respect of fabrication of plastic products:**
1. Compression moulding is analogous to hot pressing of powdered metals. **[IAS-2003]**
2. Jet moulding is a modification of compression moulding.
3. Injection moulding is analogous to die casting of metals
4. Transfer moulding is similar to hydraulic extrusion.

Which of these statements are correct?
(a) 1 and 2 (b) 1 and 3 (c) 1, 2 and 4 (d) 2, 3 and 4

IAS-8. **Ans. (c)**

IAS-9. **Which of the following processes can be used for mass production of plastic containers (with lid) of 5 liter capacity?** **[IAS-1997]**
1. Injection moulding
2. Jolt moulding
3. Blow moulding

Select the correct answer using the codes given below:
Codes:
(a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) 1, 2 and 3

IAS-9. **Ans. (c)**

IAS-10. **To reduce the consumption of synthetic resins, the ingredient added is** **[IAS 1994]**
(a) Accelerator (b) Elastomer (c) Modifier (d) Filler

IAS-10. **Ans. (d)**

IAS-11. **Consider the following:** **[IAS-2007]**
Which of the following properties are possessed by plastics?
1. Good resistance to corrosive atmosphere
2. Ease of fabrication into complex shapes.
3. Good resistance to shocks and vibrations.

Select the correct answer using the code given below:
(a) 1, 2 and 3 (b) 2 and 3 only (c) 1 and 3 only (d) 1 and 2 only

IAS-11. **Ans. (a)**

Elastomer

Objective Questions (IES, IAS, GATE)

Previous 20-Years IES Questions

IES-1. **In the case of rubber, vulcanization refers to the process of producing a** **[IES-2003]**
(a) Linear polymer (b) Branched polymer
(c) Cross-linked polymer (d) Net-work polymer

IES-1. **Ans. (c)** An elastomer is produced by heating raw rubber with sulphur. Sulphur forms covalent bonds with the carbon, by saturating the remaining double bond in each monomer. This reaction, known as vulcanization, produces additional link between chains called cross links.

Ceramics

IES-2. **Consider the following statements relating to mechanical properties of ceramics:**
1. Tensile strength is theoretically high but in practice quite low. **[IES-2008]**
2. Compressive strength is many times lower than tensile strength.
3. Shear strength is high.
4. Transverse strength is easy to ascertain.

Which of the statements given above are correct?
(a) 1 and 3 (b) 1 and 4 (c) 2 and 3 (d) 2 and 4

IES-2. **Ans. (a)** 2. Compressive strength is many times *higher* than tensile strength.
Ceramics
1. They contain both metallic and non-metallic elements.
2. Characterized by their higher resistance to high temperatures and harsh environments than metals and polymers.
3. Typically good insulators to passage of both heat and electricity.
4. Less dense than most metals and alloys.
5. They are harder and stiffer, but brittle in nature.
6. They are mostly oxides, nitrides, and carbides of metals.
7. Wide range: traditional (*clay, silicate glass, cement*) to advanced (*carbides, pure oxides, non-silicate glasses*).

IES-3. **Match List I with List II and select the correct answer:** **[IES-2002]**

List I (Material)	**List II (Application)**
A. Ceramics	1. Construction of chemical plants
B. Refractory	2. Columns and pillars
C. Stones	3. Lining of furnaces
D. High silica glass	4. Tiles

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	4	3	2	1	(b)	2	1	4	3
(c)	4	1	2	3	(d)	2	3	4	1

IES-3. **Ans. (d)**

IES-4. **Which one of the following is true?** **[IES-2002]**
(a) Structure of metallic materials consists of atoms having valence of 5, 6 or 7
(b) Ceramic materials have long range electron matrix bond
(c) Polymers are composed of long chain of repeating molecules
(d) Ceramics are weaker than metals because of weak electrostatic bond

IES-4. **Ans. (c)**

IES-5. **Which one of the following is correct?** **[IES-2008]**
When "devitrification" of inorganic glasses is done,
(a) Glass transforms from crystalline to non-crystalline state

(b) Glass transforms into a fully transparent material
(c) Glass transforms from non-crystalline state to poly-crystalline state
(d) Glass is relieved of internal stresses

IES-5. **Ans. (c)** Inorganic glasses can be made to transform from a non crystalline state to one that crystalline by the proper high – temperature heat treatment which is called devitrification.

Composite Materials

IES-6. **Which of the following fibre materials are used for reinforcement in composite materials?** **[IES-2002]**
1. Glass 2. Boron carbide 3. Graphite
Select the correct answer using the codes given below:
(a) 1 and 2 (b) 1 and 3 (c) 2 and 3 (d) 1, 2 and 3

IES-6. **Ans. (d)**

IES-7. **Consider the following statements:** **[IES-1999]**
The strength of the fibre reinforced plastic product
1. Depends upon the strength of the fibre alone
2. Depends upon the fibre and plastic
3. Is isotropic
4. Is anisotropic
Which of these statements are correct?
(a) 1 and 3 (b) 1 and 4 (c) 2 and 3 (d) 2 and 4

IES-7. **Ans. (d)** Fibre Reinforced plastics are composite materials possessing additional and/or superior properties to individual components.

IES-8. **Wood is a natural composite consisting of which of the following?** **[IES 2007]**
(a) Lignin fibres in collagen matrix
(b) Lignin fibres in apatite matrix
(c) Cellulose fibres in apatite matrix
(d) Cellulose fibres in lignin matrix

IES-8. **Ans. (d)**

IES-9. **Nano composite materials are highly preferable in design consideration for their**
(a) High resistance to crack propagation **[IES-2009]**
(b) Vibration resistance
(c) Impact resistance
(d) High resilience

IES-9. **Ans. (b)**

IES-10. **Which one of the following materials is not a composite?** **[IES-2009]**
(a) Wood (b) Concrete (c) Plywood (d) Sialon

IES-10. **Ans. (d) SIALON:** Hot pressing and sintering of an appropriate mix of Al_2O_3 and Si_3N_4 powders yielded an excellent composite ceramic tool called SIALON which are very hot hard, quite tough and wear resistant. These tools can machine steel and cast irons at high speeds (250 – 300 m/min). But machining of steels by such tools at too high speeds reduces the tool life by rapid diffusion.

IES-11. **Which of the following composites are 'dispersion-strengthened composites'?**
(a) Particulate composites (b) Laminar composites **[IES-2009]**
(c) Fiber reinforced composites (d) Short-fiber discontinuous composites

IES-11. **Ans. (a)**
1. Particulate composites consist of discrete particles of one material surrounded by a matrix of another material.

2. Dispersion-strengthened materials are particulate composites where a small amount of hard, brittle, small particles (typically, oxides or carbides) are dispersed through-out a softer, more ductile matrix.

Use of Materials

Objective Questions (IES, IAS, GATE)

Previous 20-Years GATE Questions

GATE-1. **Machine tool structures are made .....for high process capability. (tough/strong/rigid)** **[GATE-1995]**

GATE-1. **Ans. Rigid**

Previous 20-Years IES Questions

IES-1. **Match List I with List II and select the correct answer using the code given below the Lists:** **[IES 2007]**

List I **(Component)**	**List II** **(Required Property)**
A. Blades of bulldozer	1. High wear resistance and high toughness
B. Gas turbine blades	2. Low Young's modulus and high fatigue strength
C. Drill bit	3. High wear and abrasion resistance
D. Springs of automobiles	4. High creep strength and good corrosion resistance

Code:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	3	2	1	4	(b)	1	4	3	2
(b)	3	4	1	2	(d)	1	2	3	4

IES-1. **Ans. (c)**

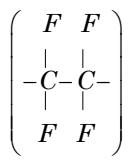
IES-2. **Match List-I (Composition) with List-II (Application) and select the correct answer using the code given below the Lists:** **[IES-2006]**

List- I	**List -II**
A. Commercial bronze (10% Zn)	1. Radiator
B. Red brass (15% Zn)	2. Spring metal
C. Aluminium brass (22% Zn, 2% Al)	3. Forging and stamping
D. P-bronze (11 % tin) small amount of P)	4. Power plant and chemical equipment

Codes:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	2	4	1	3	(b)	3	1	4	2
(c)	2	1	4	3	(d)	3	4	1	2

IES-2. **Ans. (b)**

IES-3. **The structure of a polymer is shown in the given figure. This polymer**



Finds special application in **[IES-1995]**

(a) Packaging (b) Adhesives (c) Bearings (d) Fertilizer

IES-3. **Ans. (c)**

IES-4. **Which one of the following possesses the property of nonsparking character?**

(a) Hadfield's manganese steel (b) Spring steel **[IES-2009]**

(c) Stellite (d) Invar

IES-4. **Ans. (b)**

IES-5. **Match List I (Material) with List II (Typical use) and the correct answer using the codes given below the Lists:** **[IES-2004]**

List I	**List II**
A. Branched polyethylene	1. Bottles
B. Polyester	2. Textile fibres
C. Polyvinylidene chloride	3. Films for packaging
D. Linear Polyethylene	4. Transparent film

	A	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	2	3	4	1	(b)	3	2	1	4
(c)	2	3	1	4	(d)	3	2	4	1

IES-5. **Ans. (b)**

IES-6. **Gunmetal, which is used in journal bearings, contains** **[IES-2003]**

(a) 88% Cu, 10% Sn, 2% Zn (b) 80% Cu, 10% Zn, 10% Al
(c) 85% Cu, 5% Mg, 10% Al (d) 85% Cu, 5% Sn, 10% Pb

IES-6. **Ans. (a)** 83% Cu + 14% Sn + 3% Zinc + 0.8 Phosphorus

IES-7. **The correct composition of austenitic stainless steel used for domestic utensils is**

(a) 0.08% C, 18% Cr, .8% Ni, 2% Mn, 1% Si **[IES-2002]**
(b) 0.08% C, 24% Cr, 12% Ni, 2% Mn, 1% Si
(c) 0.15% C, 12% Cr, 0.5% Ni, 1% Mn, 1% Si
(d) 0.30% C, 12% Cr, 0.4% Ni, 1% Mn, 1% Si

IES-7. **Ans. (a)** 18/8 austenitic stainless steel

IES-8. **Quartz is a** **[IES-1993]**

(a) Ferroelectric material (b) Ferromagnetic material
(c) Piezoelectric material (d) Diamagnetic material

IES-8. **Ans. (c)** Quartz is a piezoelectric material.

IES-9. **Duralumin Alloy contains aluminium and copper in the ratio of** **[IES-1993]**

%Al	%Cu
(a) 94	4
(b) 90	8
(c) 88	10
(d) 86	12

IES-9. **Ans. (a)** Duralumin alloy contains aluminium and copper in the ratio of 94% aluminium and 4% copper.

IES-10. **Which one of the following is correct?** **[IES-2008]**

Babbitt are used for

(a) Gears (b) Bearings (c) Bolts (d) Clutch liners

IES-10. **Ans. (b)** A tin base alloy containing 88% tin, 8% antimony and 4% copper is called ***babbit metal.*** It is a soft material with a low coefficient of friction and has little strength. It is the most common bearing metal used with cast iron boxes where the bearings are subjected to high pressure and load.

Note: Those alloys in which lead and tin are predominating are designated as ***white metal bearing alloys.*** This alloy is used for lining bearings subjected to high speeds like the bearings of aero-engines.

IES-11. **Babbit lining is used on brass/bronze bearings to** **[IES-1995]**

(a) Increase bearing resistance (b) Increase compressive strength
(c) Provide anti-friction properties (d) Increase wear resistance.

IES-11. Ans. (c)

IES-12. Why are babbit alloys used for bearing material? **[IES-2009]**
(a) They have excellent embeddability
(b) They are relatively stronger than other bearing materials
(c) They do not lose strength with increase in temperature
(d) They have high fatigue strength

IES-12. Ans. (a) A tin base alloy containing 88% tin, 8% antimony and 4% copper is called *babbit metal*. It is a soft material with a low coefficient of friction and has little strength. It is the most common bearing metal used with cast iron boxes where the bearings are subjected to high pressure and load. A babbit overlay to enhance surface conformability and corrosion resistance, makes an excellent bearing.

IES-13. Match List-I with List-II and select the correct answer using the codes given below the Lists: **[IES-1997]**

List-I	**List-II**
A. Neoprene	1. Electric switches
B. Bakelite	2. Adhesive
C. Foamed polyurethane	3. Thermal insulator
D. Araldite	4. Oil seal

Code:	**A**	**B**	**C**	**D**		**A**	**B**	**C**	**D**
a)	4	1	2	3	(b)	1	4	2	3
c)	4	1	3	2	(d)	1	4	3	2

IES-13. Ans. (c)

IES-14. Which one of the following materials is used for car tyres as a standard material?
(a) Styrene-butadiene rubber (SBR) **[IES-1997]**
(b) Butyl rubber
(c) Nitrile rubber
(d) Any of the above depending upon the need

IES-14. Ans. (a)

IES-15. Which material is used for bushes in the bushed-pin type of flexible coupling?
(a) Gun metal (b) Plastic **[IES-2008]**
(c) Rubber (d) Aluminium

IES-15. Ans. (c) Rubber is used for bushes in the bushed pin type flexible coupling.

IES-16. The percentage of phosphorous in phosphor bronze is **[IES-1992]**
(a) 0.1 (b) 1 (c) 11.1 (d) 98

IES-16. Ans. (a)

IES-17. Tin base white metals are used where the bearings are subjected to
(a) Large surface wear (b) Elevated temperatures.
(c) Light load and pressure (d) High pressure and load.

IES-17. Ans. (d)

IES-18. Machine tool frame should have **[IES-1992]**
(a) High rigidity to weight ratio (b) Graphite in the form of nodules
(c) Low hardness (d) High work hardness

IES-18. Ans. (a)

IES-19. Which of the following statement is incorrect about duralumin? **[IES-1992]**
(a) It is prone to age hardening (b) It can be forged
(c) It has good machining properties (d) It is lighter than pure aluminium

IES-19. Ans. (c)

IES-20. Cartridge brass can be **[IES-1992]**

(a) Cold rolled into sheets
(b) Drawn into wires
(c) Formed into tubes
(d) Any of the above.

IES-20. Ans. (d)