



**POSTAL
BOOK PACKAGE**

2025

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**MECHANICAL
ENGINEERING**

Objective Practice Sets

Material Science

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Structures of Metals and Alloys

MCQ and NAT Questions

- Q.1** For Molybdenum, which has a body centered cubic lattice structure, the number of atoms per unit cell is
 (a) 1 (b) 2
 (c) 4 (d) 6
- Q.2** A plane intersects the coordinate axes at $x = \frac{2}{3}, y = \frac{1}{3}, z = \frac{1}{2}$, then its miller indices is
 (a) (932) (b) (452)
 (c) (413) (d) (364)
- Q.3** Assuming atoms to be perfect spheres, what is the value of the highest possible atomic packing factor (APF) in metals?
 (a) 0.95 (b) 0.74
 (c) 0.66 (d) 0.5
- Q.4** An infinite array of points in three-dimensional space in which each point is identically located with respect to the other is known as
 (a) space lattice (b) Basis
 (c) Unit cell (d) Crystal
- Q.5** Atomic packing factor for chromium will be equal to
 (a) 0.523 (b) 0.68
 (c) 0.74 (d) 0.84
- Q.6** Miller indices (101) is
 (a) parallel to x-axis (b) parallel to y-axis
 (c) parallel to z-axis (d) None of the above
- Q.7** When a pair of one cation & one anion are absent from an ionic crystal, the defect is called as
 (a) Substitutional impurity
 (b) Interstitial impurity
 (c) Frenkel's defect
 (d) Schottky's defect
- Q.8** Match **List-I** (Crystal structure) with **List-II** (Atomic packing factor) and select the correct answer using the codes given below the lists:

List-I

- A. Simple cubic
 B. Body-Centred cubic
 C. Face-Centred cubic
 D. Hexagonal close packed

List-II

1. 74%
 2. 74%
 3. 52%
 4. 68%

Codes:

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

- Q.9** The ratio of long and short unit cell dimensions of ideal HCP crystal structure should be
 (a) 1.56 (b) 1.89
 (c) 1.633 (d) 1.59
- Q.10** Phenomenon of cross-slip occurs in
 (a) edge dislocation
 (b) screw dislocation
 (c) mixed dislocation
 (d) edge & mixed dislocation
- Q.11** Which one of the following is not correct about the characteristics of dislocation?
 (a) Edge dislocations travel much faster than screw dislocations
 (b) Two edge dislocations of opposite sign, of equal Burgers vector & on the same slip plane cancel out.
 (c) The elastic strain energy per unit length of a dislocation is directly proportional to the burgers vector 'b'
 (d) The sum of Burgers vectors meet at a point called nodal point, inside the crystal remains zero.
- Q.12** A miller indices of the diagonal plane of cube is
 (a) (200) (b) (111)
 (c) (010) (d) $(\bar{1}10)$
- Q.13** The crystal structure of austenite is
 (a) body centered cubic

Q.55 For BCC-iron, for the (2 2 0) set of planes, the lattice parameter for Fe is 0.29 nm and a monochromatic radiation having a wavelength of 0.18 nm is used, and the order of reflection is 1. Which of the following statements is(are) correct?
 (a) Interplanar spacing for given plane is 0.1025 nm.
 (b) The diffraction angle is 122.80°.
 (c) Atomic radius of BCC-iron is 0.1256 nm.
 (d) If everything else remains same except the plane, then the interplanar spacing for (1 1 1) set of planes will be 0.1674 nm.

Q.56 Iodine has an orthorhombic unit cell for which the *a*, *b* and *c* lattice parameters are 0.479 nm, 0.725 nm and 0.978 nm, respectively. The atomic packing factor and atomic radius are 0.547 and 0.177 nm, respectively. Atomic weight of Iodine is 126.9 g/mol. Which of the following statements is(are) correct?
 (a) Number of atoms in each unit cell is 8.
 (b) Number of atoms in each unit cell is 4.
 (c) The density of Iodine is 4.96 g/cm³.
 (d) The density of Iodine is 3.96 g/cm³.

Q.57 Which of the following statements is(are) correct?
 (a) Unit plastic deformation is called slip and it always appear in the direction of applied load.
 (b) In edge dislocation Burger vector is perpendicular to the dislocation line.
 (c) In screw dislocation movement of dislocation is referred as climb.
 (d) If dislocation comes out of the material, it is termed as failure of material.

Q.58 An alkali halide is having NaCl structure and having density as 2.1145 g/cm³. Which of the following statements is(are) correct?
 (a) If it contain 0.1% Schottky defect then its density will be 2.11239 g/cm³.
 (b) If it contain 0.1% Frenkel defect then its density will be 2.11239 g/cm³.
 (c) If it contain 0.1% Frenkel defect then its density will be 2.1145 g/cm³.
 (d) If it contain 0.1% Schottky defect then its density will be 2.1145 g/cm³.



Answers Structures of Metals and Alloys

- | | | | | | | |
|------------------|------------|---------|---------------|---------------|------------------|------------|
| 1. (b) | 2. (d) | 3. (b) | 4. (a) | 5. (b) | 6. (b) | 7. (d) |
| 8. (a, c) | 9. (c) | 10. (b) | 11. (c) | 12. (b) | 13. (b) | 14. (b) |
| 15. (c) | 16. (a) | 17. (b) | 18. (d) | 19. (c) | 20. (b) | 21. (b) |
| 22. (d) | 23. (d) | 24. (a) | 25. (b) | 26. (a) | 27. (b) | 28. (a) |
| 29. (c) | 30. (b) | 31. (b) | 32. (c) | 33. (a) | 34. (c) | 35. (d) |
| 36. (c) | 37. (a) | 38. (d) | 39. (d) | 40. (a) | 41. (c) | 42. (c) |
| 43. (a) | 44. (d) | 45. (d) | 46. (0.68) | 47. (a, c, d) | 48. (a, b, d) | 49. (a, d) |
| 50. (a, d) | 51. (c, d) | 52. (c) | 53. (b, c, d) | 54. (a, c) | 55. (a, b, c, d) | 56. (a, c) |
| 57. (a, b, c, d) | 58. (a, c) | | | | | |

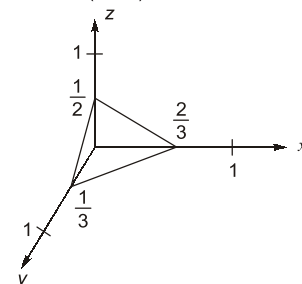
Explanations Structures of Metals and Alloys

1. (b)

Crystal structure	Effective No. of atoms in unit cell
* Diamond cubic	8
* Simple cubic	1
* Face centered	4
* HCP	6
* BCC	2

2. (d)

Taking reciprocal of intercepts on *x*, *y* and *z* axis, we have $\left(\frac{3}{2}, 3, 2\right)$ and forming fractions into integer, we have (364) as miller indices of this plane.



Corrosion and Its Control

- Q.1** Which of the following are types of dry or chemical corrosion?
1. Oxidation corrosion
 2. Dry corrosion by Gases other oxygen
 3. Liquid-metal corrosion
- Choose the correct option:
- (a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3
- Q.2** Corrosion of iron articles, called rusting, is an example of
- (a) Dry or chemical corrosion
 - (b) Pitting corrosion
 - (c) Intergranular corrosion
 - (d) Fretting corrosion
- Q.3** Addition of which softening agent for internal treatment of water in steam boilers causes caustic embrittlement?
- (a) NaCl (b) Na_2SO_4
 - (c) Na_2CO_3 (d) KMnO_4
- Q.4** Arrange the following in increasing order of passivity:
1. Al 2. Ni
 3. Mg 4. Cu
 5. Fe
- (a) $\text{Mg} < \text{Cu} < \text{Ni} < \text{Fe} < \text{Al}$
 - (b) $\text{Al} < \text{Mg} < \text{Ni} < \text{Fe} < \text{Cu}$
 - (c) $\text{Al} < \text{Cu} < \text{Ni} < \text{Fe} < \text{Mg}$
 - (d) $\text{Cu} < \text{Fe} < \text{Ni} < \text{Mg} < \text{Al}$
- Q.5** Galvanisation is the process of coating iron with
- (a) tin (b) nickel
 - (c) zinc (d) copper
- Q.6** Electrochemical corrosion occurs due to
- (a) dissimilarity of a solution
 - (b) when a conducting liquid is in contact with metal.
 - (c) Two dissimilar metals are electrically connected and exposed to an electrolyte.
 - (d) existence of separate anodic and cathodic areas
- Q.7** The rate of metallic corrosion increases with
- (a) increase in temperature
 - (b) increase in percent of oxygen
 - (c) increase in moisture content
 - (d) decrease in temperature
- Q.8** Consider the following measures for reducing fretting corrosion:
1. Reducing coefficient of friction between mating parts
 2. Use of solid lubricants such as molybdenum sulphide
- Which of these measure are beneficial for reducing fretting corrosion?
- (a) 1 only (b) 2 only
 - (c) Both 1 and 2 (d) None of these
- Q.9** Which one of the following metal can be used as anode to reduce corrosion when brass is acting as cathode?
- (a) Cu (b) Ni
 - (c) Bronze (d) Pb
- Q.10** **Statement (I):** In the case atmospheric corrosion, humidity in the air does the job of an electrolyte.
Statement (II): Rusting in desert type atmosphere is low, because of low humidity and dry being a poor electrolyte.
- (a) Both Statement (I) and Statement (II) are true and Statement (II) is the correct explanation of Statement (I).
 - (b) Both Statement (I) and Statement (II) are true but Statement (II) is not a correct explanation of Statement (I).
 - (c) Statement (I) is true but Statement (II) is false.
 - (d) Statement (I) is false but Statement (II) is true.

Q.11 Consider the following:

1. Presence of moisture in atmosphere
2. Presence of impurities in atmosphere
3. Presence of suspended particles in atmosphere

Which of these enhance the corrosion rate?

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

Q.12 Consider the following statements regarding dry corrosion:

1. Occurs in dry state due to gases and liquid metals.
2. It follow adsorption mechanism
3. Corrosion is non-uniform
4. It takes place due to formation of various tiny electrochemical cells.

Which of these statements are correct?

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

Q.13 Consider the following statements:

1. Coating of zinc on iron is a common example of anodic coating.
2. Coating of tin (Sn) on iron is common example of cathodic coating.

Which of these statements are correct?

- (a) 1 only (b) 2 only
(c) Both 1 and 2 (d) None of these

Q.14 The thickness, uniformity and adhesion of dipped coating depends on

1. Viscosity of the both
2. Rate of immersion and withdrawal
3. Temperature of bath
4. Number of dips
5. Material of substrate (base metal)

Choose the correct option:

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

Q.15 Which of the following elements are added to iron to improve its oxidation resistance?

1. Zinc 2. Chromium
 3. Magnesium 4. Aluminium
- (a) 1 and 3 (b) 2 and 4
(c) 1 and 4 (d) 2 and 3

Q.16 Which of the following materials are protected by passivation (i.e. formation of a thin adherent film on the surface) from corrosion?

1. Aluminium alloys
 2. Mild steel
 3. Stainless steel
 4. Silver
- (a) 1 and 2 (b) 2 and 3
(c) 2 and 4 (d) 1 and 3

Q.17 Match **List I** with **List II** and answer the correct using the codes given below:

List I

- A.** Dry corrosion
B. Wet corrosion
C. Galvanic corrosion
D. Concentration cell corrosion

List II

1. Dissimilarity of the solution
2. Chemical corrosion
3. Electrochemical corrosion
4. Dissimilarity of metals in contact with solution

Codes:

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



Answers Corrosion and Its Control

1. (d) 2. (b) 3. (c) 4. (d) 5. (c) 6. (d) 7. (a) 8. (c) 9. (d)
10. (b) 11. (c) 12. (a) 13. (c) 14. (d) 15. (b) 16. (d) 17. (d)

Explanations Corrosion and Its Control

1. (d)

Dry corrosion occurs when metals come in contact directly with the gases like chlorine, hydrogen sulphide, sulphur dioxide, etc. or when exposed to atmosphere contains oxygen, carbon dioxide, moisture etc.

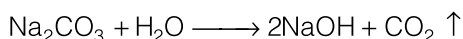
All three above are types of dry or chemical corrosion.

2. (b)

The corrosion of iron articles is best described by electrochemical corrosion. However, pitting corrosion occurs when protective film breakdown concentration cells are set up resulting in rust of iron.

3. (c)

In boilers, sodium carbonate (Na_2CO_3) is added as softening agent for internal treatment.



This NaOH makes the water alkaline which cracks the metal by penetrating into cracks (pits).

4. (d)

Passivation of certain metal follows this order:

$\text{Ti} > \text{Al} > \text{Cr} > \text{Be} > \text{Mo} > \text{Mg} > \text{Ni} > \text{Co} > \text{Fe} > \text{Mn} > \text{Zn} > \text{Cd} > \text{Sn} > \text{Pb} > \text{Cu}$

5. (c)

Galvanization is the process of applying a protective zinc coating to steel or iron to prevent rusting. The most common method is hot-dip galvanizing, in which the parts are submerged in a bath of molten zinc.

6. (d)

The electrochemical corrosion occurs due to existence of separate anodic and cathodic area having conducting medium like water, acids for conduction of electrons and ions.

7. (a)

Increase of temperature increases diffusion of ions in the corrosive medium and thus serves to increase corrosion rate. Further, increase of temperature decrease the solubility of gases in

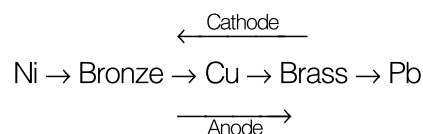
the aqueous medium. Decrease of dissolved oxygen in a region may render the adjacent metal anodic.

8. (c)

Fretting is the surface damage, when two surfaces in contact, experience slight relative motion. Fretting cannot be completely prevented. However, if all relative motions are prevented, fretting will not occur, so both these measures reduce fretting corrosion.

9. (d)

Galvanic series order of given materials:



10. (b)

In atmospheric environments, corrosion is often approximated as a discontinuous process reliant on the availability of electrolyte to provide ionic conduction between cathodic and anodic sites for damage to develop at a considerable rate.

Rusting of iron occurs only if iron comes in contact with moist air. In coastal areas, air contains high percentage of moisture because of sea or ocean, while in deserts air is dry and hot. As the percentage of moisture in air is less in desertic environment therefore chance of rusting is also low.

11. (c)

- Presence of moisture in air act as electrolyte for CO_2 , O_2 etc. It cause electrochemical corrosion.
- Presence of corrosive gases like SO_2 , CO_2 , H_2S , HCl and H_2SO_4 in atmosphere increases high corrosion.
- Presence of active particles like NaCl , $(\text{NH}_4)_2\text{SO}_4$, increases corrosion as they absorb moisture and behaves as strong electrolyte.

12. (a)

In dry corrosion, corrosion is uniform and it takes place by direct chemical attack of environment on the metal.