POSTAL Book Package 2022

Mechanical Engineering

Objective Practice Sets

Material Science

Contents

MADE EASY Publications

4 CHAPTER
Plastics, Ceramics and Composite Materials

Q.1 Refractory material can withstand
(a) abrasion (b) high temperature
(c) low temperature (d) corrosion

Q.2 Bakelite is an example of
(a) an elastomer (b) a fibre
(c) a thermoset (d) a thermoplast

Q.3 Cermets are
(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

Q.4 Select the true statements among the following:
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
(a) 1 and 3 (b) 2 and 4
(c) 1, 2 and 4 (d) 1, 2 and 3

Q.5 Which one is not a characteristics of plastics?
(a) Low density
(b) Machinability
(c) High strength
(d) Large plastic deformation

Q.6 Consider the following statements relating to mechanical properties of ceramics:
1. Tensile strength is theoretically high but in practice quite low.
2. Compressive strength is many times lower than tensile strength
3. Shear strength is high
4. Transverse strength is easy to ascertain.
Which of these statements are correct?
(a) 1 and 3 (b) 1 and 4
(c) 2 and 3 (d) 2 and 4

Q.7 The hardest known material is
(a) ceramic (b) high speed steel
(c) diamond (d) cemented carbide

Q.8 The chemical name of teflon is
(a) polytetra-fluoroethylene
(b) urea formaldehyde
(c) polystyrene
(d) phenol acetaldehyde

Q.9 Which of the following polymers produces HCl as condensate?
(a) Phenol formaldehyde
(b) Poly carbonate
(c) Urea formaldehyde
(d) Nylon-6, 6

Q.10 The fibres which resemble wool are known as
(a) Terylene (b) Acrylon
(c) Polyester (d) Nylon

Q.11 The main constituents of plastics are
(a) carbon, hydrogen, nitrogen and oxygen
(b) carbon, sulphur, hydrogen and oxygen
(c) carbon, phosphorus, hydrogen and oxygen
(d) carbon, sulphur, phosphorus and hydrogen

Q.12 The modulus of elasticity of nonporous ceramic material is 100 GPa. Then the modulus of elasticity of a ceramic material having volume fraction porosity of 10% is:
(a) 81.9 GPa (b) 90 GPa
(c) 94 GPa (d) 87.6 GPa

Q.13 Match **List-I** (Composites) with **List-II** (Application) and select the correct answer using the codes given below the lists:

List-I
A. Glass Fibre-Reinforced Polymer
B. Carbon Fibre-Reinforced Polymer
C. Aramid Fibre-Reinforced Polymer
D. Metal Matrix Composites

List-II

1. Ballistic products
2. Aerospace industry
3. Fishing rods
4. Industrial flooring

Codes:

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

Q.14 Consider the following polymers:

1. Nylon-6
2. Nylon-6, 6
3. Polyvinyl chloride
4. Poly styrene polyamide

includes:

(a) 1 only
(b) 1 and 2
(c) 1, 3 and 4
(d) All of the above

Q.15 Weldable type plastic(s) include(s):

(a) thermosets alone
(b) thermoplastics alone
(c) both (a) and (b)
(d) neither (a) and (b)

Q.16 Match the **List-I** (Polymers) with **List-II** (Application):

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

Codes:

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

Q.17 Whiskers are

(a) very thin wires
(b) very thin copper wires
(c) very thin single crystal
(d) none of these

Q.18 A continuous and aligned glass fibre-reinforced composite consists of 40 vol% of glass fibres modulus of elasticity 69 GPa and 60 vol% of a polyester resin that, when hardened, displays a modulus of 3.4 GPa. What is the modulus of elasticity of this composite in the longitudinal direction?

(a) 15 GPa (b) 30 GPa
(c) 45 GPa (d) 60 GPa

Q.19 A continuous and aligned glass fibre-reinforced composite consists of 40 vol% of glass fibres having a modulus of elasticity 80 GPa and remaining volume of a polyester resin that, when hardened, displays a modulus of 4 GPa. What is the elastic modulus of composite material when the stress is applied perpendicular to the direction of fibre alignment?

(a) 2.45 GPa (b) 6.25 GPa
(c) 7 GPa (d) 8.25 GPa

Q.20 Parachutes are made from which fibre?

(a) Nylon (b) Terylene
(c) Plastic (d) Rayon

Q.21 Which of the following composites are 'dispersion-strengthened composites'?

(a) Particulate composites
(b) Laminar composites
(c) Fiber reinforced composites
(d) Short-fiber discontinuous composites

Q.22 The molecular weight of vinyl chloride is 62.5. Thus the molecular weight of a polyvinyl chloride with a degree of polymerization of 20000 is

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

Q.23 Which of the following is not an example of laminar composite?

(a) Wood (b) Bimetallic
(c) Coatings/Paints (d) Claddings

Q.24 Wood is

(a) homogeneous material
(b) granular material
(c) amorphous material
(d) cellular material

Q.25 **Statement (I):** Steel reinforcing bars are used in reinforced cement concrete.

Statement (II): Concrete is weak in compression.

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)

(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is NOT the 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.26 Match **List-I** with **List-II** and select the correct answer using the code given below the lists:

List-I

A. Car dashboard

B. Aircraft windows

C. Conduit pipes

D. Bearing and gears

List-II

1. Poly vinyl chloride (PVC)

2. TEFLON

3. Polyacrylonitrile

4. Polymethylmethacrylate

Codes:

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

Q.27 Consider the following statements pertaining to composite materials:

1. The mechanical characteristics of a fibre-reinforced composite depend only on the properties of the fibre.
2. Prestressed concrete should be of a high quality with a low shrinkage and a low creep rate.
3. Whiskers are very thin single crystals that have extremely large length-to-diameter ratio.

Which of the above statements are valid?

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

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

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Answers **Plastics, Ceramics and Composite Materials**

1. (c)	**2.** (b)	**3.** (d)	**4.** (c)	**5.** (c)	**6.** (b)	**7.** (b)	**8.** (b)	**9.** (c)
1. (b)	**2.** (c)	**3.** (d)	**4.** (b)	**5.** (c)	**6.** (a)	**7.** (c)	**8.** (a)	**9.** (b)
10. (b)	**11.** (a)	**12.** (a)	**13.** (a)	**14.** (b)	**15.** (b)	**16.** (c)	**17.** (c)	**18.** (b)
19. (b)	**20.** (a)	**21.** (a)	**22.** (c)	**23.** (a)	**24.** (d)	**25.** (c)	**26.** (a)	**27.** (d)

Explanations Plastics, Ceramics and Composite Materials

1. (b)

Refractory is defined as the quality of a material to retain its strength at higher temperature, hence these materials are used in linings for furnace, kilns, incinerators and reactors.

2. (c)

The earliest synthetic polymer was a phenol-formaldehyde, a thermoset developed & called Bakelite.

3. (d)

Cermets are metal-ceramic composites, and are used in cutting tools, or high-temperature applications such as nozzles for jet engines and brakes for aircrafts.

4. (b)

It is a plastic which once set or moulded does not become soft on further heating.

Instead of melting, it degrades on further heating.

These are formed by condensation polymerisation.

6. (a)

Mechanical properties of ceramics are:

1. They have theoretically high tensile strength but practically low.
2. Shear strength is high.
3. Lack of plasticity due to ionic and covalent bond.
4. They are relatively brittle.

7. (c)

Diamond is hardest known material.

8. (a)

Teflon is a thermoplastic polymer. Its chemical name is polytetra fluoroethylene. It finds applications in nonlubricating bearings, because of its very low coefficient of friction.

9. (b)

The main polycarbonate material is produced by the reaction of bisphenol A(BPA) and phosgene $COCl_2 \cdot HCl$ is final by product.

10. (b)

We wear sweaters and use shawls or blankets in the winter. Many of these are actually not made from natural wool, though they appear to resemble wool. These are prepared from another type of synthetic fibre called acrylic. They are available in range of colors.

11. (a)

Carbon, hydrogen, nitrogen and oxygen are the main constituents of plastics.

12. (a)

Given, Nonporous ceramic material modulus of elasticity, E_o = 100 GPa

Volume fraction porosity, P = 10%

We know that,

Modulus of elasticity of porous ceramic material,

$$E = E_0(1 - 1.9P + 0.9P^2)$$
$$= 100(1 - 1.9 \times 0.1 + 0.9 \times 0.1^2)$$
$$= 100(1 - 0.19 + 0.009)$$
$$= 100 \times 0.819$$
$$E = 81.9 \text{ GPa}$$

13. (a)

Various applications of different composites

1. Glass fibre reinforced polymer - under water application submarines, industrial flooring.
2. Carbon fiber - Reinforced polymer - Aerospace structure, fishing rods.
3. Aramid fibre - Reinforced polymer - Ballistic products
4. Metal matrix composites - Aerospace industry.

14. (b)

Material type	Trade names	Major application characteristics	Typical applications
ABS	Abson (Cycolac Kralastic Lustran Novodur Tybrene)	Outstanding strength and toughness, resistance to heat distortion, good electrical properties, flammable and soluble in some organic solvents	Refrigerator linings, lawn and garden equipment, toys, highway safety devices
Acrylics	Acrylite (Diakon Lucite Plexiglas)	Outstanding light transmission and resistance to weathering	Lenses, transparent aircraft enclosures, drafting equipment, outdoor signs
Flurocarbons (PTFE or TFE)	Teflon (Fluon Halar Hastaflon TF Neoflon)	Chemically inert in almost all environments, excellent electrical properties, low m, poor cold-flow properties	Anticorrosive seals, chemical pipes and valves, bearings, antiadhesive coatings
Polyamides (Nylons)	Nylon (Baylon Durethan Herox Nomex)	Good mechanical strength, abrasion and toughness, low m, absorbs water and some other liquids	Bearings, cams, gears, bushings, handles and jacketing for wires and cables
Polytheylene	Alathon (Alkathene Fortiflex Hi-fax)	Chemically resistant and electrically insulating; tough and relatively low coefficient of friction	Flexible bottles, toys, tumblers, battery parts ice trays, film wrapping materials

15. (b)

Weldable plastics are: Polypropylene, Polycarbonate, Acrylic, Nylon, ABS.

16. (c)

1. Neoprene - oil seal
2. Bakelite - electrical parts, switches, handles and knobs of utensils, thermal insulators etc.
3. Formed polyurethane - thermal insulators
4. Araldite - Adhesives

17. (c)

Whiskers are very thin filaments, hair-like single crystals of about 13 mm length and 10^{-4} cm diameter (approx). These are produced as dislocations of free crystals and are without any structural defect. Whiskers are far stronger than polycrystals of same materials.

18. (b)

$$E_{CL} = E_m V_m + E_f V_f$$
$$= 3.4 \times 0.6 + 69 \times 0.4$$
$$= 2.04 + 27.6 = 30 \text{ GPa}$$

19. (b)

$$E_{CL} = \frac{E_m E_f}{V_m E_f + V_f E_m}$$
$$= \frac{4 \times 80}{0.6 \times 80 + 0.4 \times 8}$$
$$= \frac{320}{48 + 3.2} = 6.25 \text{ GPa}$$

20. (a)

Nylon is used to make parachute.

21. (a)

The dispersion - strengthened composites contain small particulate/dispersions, which increases the strength of composite by blocking the movement of dislocations. There are various examples of dispersion-strengthened composites like particulate composites.

22. (c)

$$D.P. = \frac{\text{Molecular weight of macromolecule}}{\text{Weight of monomer}}$$
$$20000 = \frac{x}{62.5}$$
$$x = 62.5 \times 20000$$

23. (a)

When multidirectional stresses are imposed within a single plane, aligned layers that are fastened together one on top of another at different orientations are frequently utilized. These are called laminar composites. These are generally designed to provide high strength and low cost at a lighter weight.

24. (d)

Wood is a natural polymer composite with principal polymeric molecules being those of cellulose. It is composed of cell resembling long tubes with tapered ends.

25. (c)

Concrete is weak in tensile strength and hence it is reinforced with steel bars for better tensile strength.

26. (a)

- Car dashboard is made by polyacrylonitrile
- Aircraft windows are made by polymethylmethacrylate
- Polyvinyl chloride (PVC) is used to make cable jackets, piping, ceiling paneling, fibre coating etc
- Teflon is used to make bearing bushes, piston rings, anticorrosion seals, gaskets etc.

27. (d)

The mechanical characteristics of a fiber-reinforced composite depend not only on the properties of the fiber, but also on the degree to which an applied load is transmitted to the fibers by the matrix phase.

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