1. Hardness of a material is the measure of its
   A) Resistance to corrosion
   B) Resistance to indentation or scratching
   C) Resistance to fatigue failure
   D) Thermal conductivity
   Answer: B
2. Hardenability is the ability of steel to
   A) Harden only at surface
   B) Harden in depth under quenching
   C) Become soft during cooling
   D) Resist crack formation
   Answer: B
3. Hardness is a _____ property.
   A) Surface
   B) Core
   C) Electrical
   D) Thermal
   Answer: A
4. Hardenability is measured using
   A) Rockwell test
   B) Izod test
   C) Jominy test
   D) Vickers test
   Answer: C
5. In Jominy test, water stream is applied
   A) Over full length
   B) Only at one end
   C) Only at center
   D) To both ends
   Answer: B
6. The hardness in Jominy test is measured
   A) At top only
   B) At quenched end only
   C) At intervals from quenched end
   D) On unquenched face only
   Answer: C
7. Grossmann method determines
   A) Grain size number
   B) Critical diameter
   C) Impact strength
   D) Hardness number
   Answer: B

8. Quench severity is highest in
   A) Still oil
   B) Water
   C) Brine
   D) Air
   Answer: C
9. In hardness vs hardenability, the correct pair is
   A) Hardness = depth of hardness
   B) Hardenability = surface indentation resistance
   C) Hardness = surface resistance
   D) Hardenability = electrical resistance
   Answer: C
10. Core hardness means hardness at
   A) Immediate surface
   B) Outer layer
   C) Centre of the material
   D) Heat-affected zone only
   Answer: C
11. Quenching oil is mainly used for
   A) Fastest cooling
   B) Moderate cooling
   C) Slowest cooling
   D) No cooling
   Answer: B
12. Air cooling is used in
   A) Hardening
   B) Annealing
   C) Normalizing
   D) Carbonitriding
   Answer: C
13. The purpose of annealing is to
   A) Increase brittleness
   B) Increase grain size non-uniformity
   C) Soften material
   D) Harden surface
   Answer: C
14. In annealing cooling occurs
   A) In furnace slowly
   B) In quench tank
   C) In air forcefully
   D) In liquid nitrogen
   Answer: A

15. Normalising improves
    A) Wear resistance only
    B) Grain refinement & stress relief
    C) Case depth
    D) Colour of steel
    Answer: B
16. Normalising cooling takes place in
    A) Oil
    B) Furnace
    C) Air
    D) Water
    Answer: C
17. High distortion is expected in
    A) Furnace cooling
    B) Air cooling
    C) Water quenching
    D) No cooling
    Answer: C
18. Hardening temperature corresponds to
    A) Austenitic region
    B) Ferritic region
    C) Cementite region
    D) Room temperature
    Answer: A
19. Which one produces martensite?
    A) Slow cooling
    B) Step cooling
    C) Fast quenching
    D) No cooling
    Answer: C
20. Best quench medium for **die steel like H13**
    A) Water
    B) Brine
    C) Polymer / air blast
    D) Mercury
    Answer: C
21. A quenchant must be selected considering
    A) Only cost
    B) Only colour
    C) Steel grade & hardenability
    D) Melting point
    Answer: C

22. Overheating during heat treatment leads to
    A) Strength increase
    B) Finer grains
    C) Coarse grains & brittleness
    D) Higher ductility
    Answer: C
23. Burning defect occurs due to
    A) Under-heating
    B) Heating near melting temperature
    C) Low carburization
    D) High quenching oil viscosity
    Answer: B
24. Decarburization is loss of carbon from
    A) Core
    B) Surface of steel
    C) Internal voids
    D) Grain boundaries only
    Answer: B
25. Cracks in heat treatment increase with
    A) Lower carbon
    B) Smooth corners
    C) Higher cooling rate
    D) Polishing
    Answer: C
26. Warpage results due to
    A) Symmetrical heating
    B) Very slow cooling
    C) Uneven quenching & overheating
    D) CNC machining
    Answer: C
27. For through hardening of medium carbon steel, best quenchant
    A) Still air
    B) Water
    C) Oil
    D) Furnace cooling
    Answer: C
28. Microstructure of normalized steel is mainly
    A) Pearlite + ferrite
    B) Pure martensite
    C) Pure austenite
    D) White cast iron
    Answer: A

29. Hardness test scale for steels widely used
    A) HRB
    B) HRC
    C) Shore scale
    D) Moh’s scale
    Answer: B
30. Hardenability curve shows hardness on Y-axis and _____ on X-axis
    A) Time only
    B) Carbon percentage
    C) Distance from quenched end
    D) Quench medium name
    Answer: C
31. Case hardening produces
    A) Hard core, soft surface
    B) Soft surface, soft core
    C) Hard surface, tough core
    D) Full hardness throughout
    Answer: C
32. Carburizing is generally applicable to
    A) Low carbon steels
    B) High carbon steels
    C) Aluminium alloys
    D) Cast iron
    Answer: A
33. Carbon absorption during carburizing occurs due to
    A) Diffusion
    B) Melting
    C) Electrical breakdown
    D) Shrinkage
    Answer: A
34. Gas carburizing atmosphere controls
    A) Carbon potential
    B) Annealing rate
    C) Welding speed
    D) Nitrogen diffusion only
    Answer: A
35. Effective case depth in carburized parts is evaluated by
    A) Impact testing
    B) Hardness profile
    C) Chemical corrosion test
    D) Thermal imaging
    Answer: B

36. Carbonitriding adds
    A) Carbon only
    B) Nitrogen only
    C) Carbon and nitrogen both
    D) Oxygen and nitrogen
    Answer: C
37. Carbonitriding is generally conducted at
    A) 500–600°C
    B) 700–750°C
    C) 850–880°C
    D) 1100–1200°C
    Answer: C
38. A major advantage of carbonitriding is
    A) High case depth for heavy sections
    B) It reduces surface wear resistance
    C) Low cost + high hardenability
    D) No heat treatment required later
    Answer: C
39. Nitriding temperature range is
    A) 200–300°C
    B) 450–500°C
    C) 540–570°C
    D) 900–1100°C
    Answer: C
40. Nitriding achieves surface hardness
    A) 200–300 Hv
    B) 400–500 Hv
    C) >1000 Hv
    D) <300 Hv
    Answer: C
41. A nitrided surface contains
    A) Ferrite only
    B) Pearlite only
    C) Compound (white) layer + diffusion zone
    D) Austenite only
    Answer: C
42. Nitriding is preferred when
    A) Minimum distortion is desired
    B) Full martensite is required
    C) Recrystallization needs to be avoided
    D) Component must be soft
    Answer: A

43. Induction hardening works using
    A) Convection
    B) Conduction
    C) Electromagnetic induction (eddy currents)
    D) Plastic deformation
    Answer: C
44. Induction hardening increases
    A) Only ductility
    B) Surface hardness + case depth
    C) Only machinability
    D) Melting point
    Answer: B
45. In induction hardening, higher frequency generates
    A) Deeper case
    B) Shallow case
    C) No case
    D) Surface softening
    Answer: B
46. Suitable steel for induction hardening must have minimum carbon
    A) <0.05%
    B) <0.20%
    C) >0.37%
    D) >2.0%
    Answer: C
47. Tempering is done after hardening to
    A) Increase brittleness
    B) Reduce internal stresses and improve toughness
    C) Remove carbon completely
    D) Eliminate surface hardness
    Answer: B
48. Tempering temperature for carburized parts is usually
    A) 50–100°C
    B) 160–180°C
    C) 400–500°C
    D) 700–800°C
    Answer: B
49. Higher tempering temperature generally
    A) Increases hardness
    B) Decreases toughness
    C) Reduces hardness but increases toughness
    D) Softens completely
    Answer: C

50. Stress relieving is performed to
    A) Increase case depth
    B) Improve plasticity
    C) Remove residual stresses without major microstructural change
    D) Increase carbon content
    Answer: C
51. Stress relieving temperature typically ranges
    A) 150–650°C
    B) 900–1100°C
    C) 1200–1400°C
    D) 50–200°C
    Answer: A
52. Complete through hardening aims at
    A) Soft surface
    B) Fully martensitic structure
    C) Fully ferritic structure
    D) No phase change
    Answer: B
53. Case depth in induction hardening depends on
    A) Only quenching medium
    B) Only tempering time
    C) Frequency and power of coil
    D) Colour of steel
    Answer: C
54. Nitriding requires steels containing
    A) Cu & Pb
    B) Al, Cr, Mo, Ni, V
    C) Mg & Si
    D) Sn & Co
    Answer: B
55. Advantage of nitriding over carburizing
    A) Higher distortion
    B) No quenching required
    C) Lower hardness
    D) White layer is unwanted only
    Answer: B
56. In case hardened parts, failure generally initiates from
    A) Surface only
    B) Core only
    C) Transition region
    D) Outer coating
    Answer: C

57. Ideal process for gear teeth wear resistance + tough core
    A) Normalizing
    B) Carburizing + hardening
    C) Cold working
    D) Shot blasting
    Answer: B
58. Ideal process for crankshaft pin
    A) Annealing
    B) Induction hardening
    C) Brine quenching
    D) Case carburizing
    Answer: B
59. Induction hardening cracks increase with
    A) Higher carbon content
    B) Lower carbon content
    C) Lower hardness
    D) Higher machining allowance
    Answer: A
60. For only a particular region of part to be hardened, preferred method
    A) Nitriding
    B) Induction hardening
    C) Full annealing
    D) Normalizing
    Answer: B
61. Austenite is stable at
    A) Room temperature
    B) Below 200°C
    C) High temperature region
    D) Freezing temperature
    Answer: C
62. Martensite is formed by
    A) Slow cooling
    B) Air cooling
    C) Rapid quenching
    D) Furnace cooling
    Answer: C
63. Microstructure formed by slow furnace cooling is mostly
    A) Martensite
    B) Pearlite + ferrite
    C) Austenite
    D) Bainite
    Answer: B

64. Bainite forms at
    A) Higher temperature than pearlite
    B) Lower temperature than martensite
    C) Temperature between pearlite and martensite
    D) Melting temperature
    Answer: C
65. Martensite is
    A) Very soft
    B) Very hard and brittle
    C) Very ductile
    D) Corrosion-proof layer
    Answer: B
66. Critical cooling curve on a TTT diagram is one that
    A) Avoids martensite formation
    B) Just touches the nose of TTT curve
    C) Goes below Ms line directly
    D) Avoids austenite formation
    Answer: B
67. On a TTT diagram, transformation begins when the cooling path
    A) Touches the start curve
    B) Touches the finish curve
    C) Touches Ms
    D) Touches Mf
    Answer: A
68. The transformation to martensite starts at
    A) A1 temperature
    B) Ms temperature
    C) A3 temperature
    D) Solidus temperature
    Answer: B
69. Ms is
    A) Minimum softening temperature
    B) Martensite start temperature
    C) Metal solidification temperature
    D) Matrix shrinking temperature
    Answer: B
70. In Iron–Carbon diagram, eutectoid reaction occurs at
    A) 0.8% C and 727°C
    B) 4.3% C and 1147°C
    C) 2.11% C and 950°C
    D) 6% C and 700°C
    Answer: A

71. Pearlite forms from austenite at
    A) High cooling rate
    B) Slow cooling rate
    C) No cooling
    D) Sub-zero treatment
    Answer: B
72. The structure 100% martensite means
    A) Maximum strength but low toughness
    B) High ductility
    C) No brittleness
    D) Poor hardenability automatically
    Answer: A
73. A grain-refined structure results in
    A) Lower strength
    B) Higher strength and toughness
    C) Colour change
    D) Poor machinability always
    Answer: B
74. Bainite compared to pearlite has
    A) Lower toughness
    B) Higher toughness
    C) Same hardness
    D) No carbon present
    Answer: B
75. The A1 temperature line represents
    A) Eutectoid temperature
    B) Liquidus
    C) Solidus
    D) Melting point
    Answer: A
76. Increasing grain size
    A) Increases toughness
    B) Decreases brittleness
    C) Decreases tensile strength
    D) Improves fatigue life
    Answer: C
77. Ideal quenchant for minimizing cracking while still achieving full hardness
    A) Brine
    B) Water
    C) Polymer / oil
    D) Air
    Answer: C

78. A fully tempered martensite structure gives
    A) Low strength & high brittleness
    B) Balanced hardness + toughness
    C) No microstructure change
    D) No wear resistance
    Answer: B
79. During heat treatment, phase transformation starts during
    A) Heating only
    B) Cooling only
    C) Both heating and cooling
    D) No transformation occurs
    Answer: C
80. Carbide particles in tempered martensite improve
    A) Strength and wear resistance
    B) Ability to melt easily
    C) Electrical resistance
    D) Magnetic resistance
    Answer: A
81. The eutectoid composition of steel is
    A) 0.2%
    B) 0.45%
    C) 0.8%
    D) 2.11%
    Answer: C
82. Retained austenite is
    A) Austenite that did not transform during quenching
    B) Austenite formed during tempering
    C) Austenite present only in cast iron
    D) Corrosion layer on gear teeth
    Answer: A
83. Austenite transforms to pearlite at
    A) High cooling rate
    B) Moderate cooling rate
    C) Extremely rapid cooling
    D) Very high temperature only
    Answer: B
84. Increasing alloying elements such as Cr & Mo
    A) Decrease hardenability
    B) Increase hardenability
    C) Remove hardenability
    D) Cause corrosion
    Answer: B

85. Temper embrittlement is caused by
    A) Incorrect tempering temperature selection
    B) High carbon potential
    C) Low case depth
    D) Improper machining
    Answer: A
86. Pearlite is a combination of
    A) Ferrite + Bainite
    B) Ferrite + Cementite
    C) Austenite + Martensite
    D) Cementite + Graphite
    Answer: B
87. Transformation to martensite is
    A) Diffusion-controlled
    B) Non-diffusion (shear) transformation
    C) Liquid-state transformation
    D) No transformation
    Answer: B
88. The TTT “nose” represents
    A) Fastest transformation point
    B) Highest hardness region
    C) Corrosion-resistant zone
    D) Lowest toughness region
    Answer: A
89. Bainite microstructure gives
    A) Higher brittleness than martensite
    B) Higher strength + toughness balance
    C) Zero hardness always
    D) Softest steel
    Answer: B
90. A fully annealed steel shows
    A) Coarse pearlite
    B) 100% martensite
    C) 100% bainite
    D) Very fine martensite
    Answer: A
91. Overheating during heat treatment results in
    A) Finer grains
    B) Coarse grains and reduced toughness
    C) Higher ductility
    D) Lower distortion
    Answer: B

92. Burning is caused by
    A) Low quenching rate
    B) Heating near melting temperature for long duration
    C) Excessive machining
    D) Welding only
    Answer: B
93. Decarburization is removal of carbon from
    A) Entire cross-section
    B) Only the surface layer
    C) Only the core
    D) Steel grain boundaries
    Answer: B
94. Quench cracks occur due to
    A) Slow cooling
    B) High cooling rate + high carbon
    C) No heat treatment
    D) Removing machining allowance
    Answer: B
95. Distortion / warpage results from
    A) Uniform quenching
    B) Uneven heating / uneven quenching
    C) Slow annealing
    D) Use of nitriding steels
    Answer: B
96. A steel with carbon below 0.37% is not suitable for
    A) Induction hardening
    B) Welding
    C) Annealing
    D) Stress relieving
    Answer: A
97. Steel with high carbon & sharp corners is more prone to
    A) Softening
    B) Cracking
    C) Decarburization only
    D) No change
    Answer: B
98. To reduce distortion during quenching
    A) Use brine
    B) Use severe water spray
    C) Use polymer / oil quench
    D) Increase quench speed
    Answer: C

99. ASTM grain size 6–8 refers to
A) Very coarse grains
B) Fine to medium fine grains
C) No grains present
D) Cast-iron structure
Answer: B

100. Grain refinement in steels leads to
A) Increase in brittleness
B) Decrease in fatigue life
C) Increase in toughness and strength
D) Zero hardness
Answer: C

101. A bolt requires core hardness 32–39 HRC → best process
A) Nitriding
B) Normalizing only
C) Through hardening (Hardening + tempering)
D) Tempering only
Answer: C

102. A gear requires very high surface hardness + wear resistance + tough core
A) Normalizing
B) Carburizing + Hardening
C) Stress relieving
D) Annealing
Answer: B

103. A rear axle requires hard teeth on surface + soft core
A) Nitriding
B) Annealing
C) Case carburizing + hardening
D) Normalizing
Answer: C

104. Shock-loaded component requiring low distortion & high wear resistance → preferred
A) Case carburizing
B) Nitriding
C) Carbonitriding
D) Shot peening
Answer: B

105. For large components where deep hardness is needed → best property
A) High hardness
B) High hardenability
C) High machinability
D) High electrical resistance
Answer: B

106. For cheap surface hardening of low-carbon steel → preferred
A) Annealing
B) Carbonitriding
C) Nitriding
D) Laser hardening
Answer: B
107. For spot hardening of a single region (e.g., cam lobe)
A) Full carburizing
B) Induction hardening
C) Annealing
D) Normalizing
Answer: B
108. To obtain 50% martensite at centre of a bar, we refer to
A) Jominy test
B) Grossmann's critical diameter method
C) Izod impact test
D) Rockwell test
Answer: B
109. Hardenability differs from hardness because it measures
A) Hardness of the surface only
B) Hardness value during machining
C) Depth up to which hardness is achieved
D) Machinability
Answer: C
110. The heat treatment process that produces lowest distortion
A) Carburizing
B) Nitriding
C) Induction hardening
D) Brine quenching
Answer: B
111. Low hardness after quenching may be due to
A) Low carbon
B) Under-austenitizing
C) Too slow quench cooling
D) All of the above
Answer: D
112. Tooth pitting failure in gears can be minimized by
A) Increasing case depth
B) Using air cooling
C) Full annealing
D) Removing core strength
Answer: A

113. After carburizing, tempering is done to
A) Remove case
B) Soften core
C) Reduce brittleness and stabilize case
D) Convert martensite to ferrite fully
Answer: C
114. After induction hardening, tempering is done to
A) Reduce brittleness of surface layer
B) Remove compound zone
C) Remove case depth
D) Increase annealing
Answer: A
115. Carbon content increases hardenability until approx.
A) 0.2%
B) 0.4%
C) 0.8%
D) 2.1%
Answer: C
116. The best quenchant for minimum cracks + controlled cooling
A) Water
B) Brine
C) Oil / Polymer
D) Air
Answer: C
117. Heat-treatment defect NOT caused by quenching
A) Cracking
B) Warpage
C) Decarburization
D) Distortion
Answer: C
118. The very fast transformation time is indicated on TTT curve at
A) Far right
B) Centre
C) “Nose”
D) End of curve
Answer: C
119. The best process when both surface and core must be hardened
A) Through hardening
B) Annealing
C) Stress relieving
D) Normalizing
Answer: A

120. The best method to harden only outer 1–2 mm without affecting core

A) Nitriding

B) Induction hardening

C) Annealing

D) Air cooling

Answer: B