Multiple-Choice Questions

1. Break-even analysis classifies the various costs as
   (a) fixed costs and indirect costs
   (b) fixed costs and variable costs
   (c) variable costs and indirect costs
   (d) variable costs and direct costs
2. For a typical manufacturing operation, the variable cost may include the following costs:
   (a) Cost of the die
   (b) Tooling cost
   (c) Part-material cost
   (d) Setup cost
3. For a typical manufacturing operation, the fixed cost may include the following costs:
   (a) Overhead cost
   (b) Tooling cost
   (c) Part material cost
   (d) Running cost

Answers to Multiple-Choice Questions

1. (b) 2. (c) 3. (b)

Multiple-Choice Questions

1. Strength of a material can be defined as the
   (a) resistance offered to indentation
   (b) resistance offered on application of external force
   (c) resistance offered to impact forces
   (d) resistance offered to sudden application of impact forces
2. Strain in a given material is the ratio of
   (a) applied load to the area of cross-section opposing the load
   (b) change in dimension to original dimension
   (c) applied load to original dimension
   (d) change in dimension to the area of cross-section opposing the load
3. Brinell hardness test uses an indenter that is a
   (a) sphero-conical diamond
   (b) sphere made of steel or tungsten carbide
   (c) square-base pyramid diamond
   (d) rectangular-base pyramid diamond
4. Vicker's hardness test uses an indenter that is a
   (a) sphero-conical diamond
   (b) sphere made of steel or tungsten carbide
   (c) square-base pyramid diamond
   (d) rectangular-base pyramid diamond
5. Ductility of a material can be defined as the
   (a) resistance offered to indentation
   (b) ratio of elongation of the material at fracture during the tensile test to the original length
   (c) resistance offered to impact forces
   (d) resistance offered to sudden application of impact forces
6. Pig iron is
   (a) pure iron with no carbon
   (b) iron with 0.40% carbon
   (c) iron with 4.0% carbon
   (d) iron with 2.40% carbon
7. In a face-centred cubic (FCC) cell, atoms are present
   (a) at all eight corners of the cube and at the centre of each face.
   (b) at all eight corners of the cube and at the body centre.
   (c) at all eight corners of the cube, at the centre of each face and at the body centre.
   (d) none of the above
8. Fine grain size during the solidification of a metal is achieved by
   (a) lower nucleation rate
   (b) higher nucleation rate with lower growth rate
   (c) higher nucleation rate with higher growth rate
   (d) lower growth rate
9. Maximum carbon contained in steels is up to
   (a) 0.2%
   (b) 6.67%
   (c) 2%
   (d) 1.2%
10. Austenite is the
    (a) BCC form of iron
    (b) FCC form of iron
    (c) pure iron without any carbon
    (d) inter metallic compound iron carbide
11. Ferrite is the
    (a) BCC form of iron
    (b) FCC form of iron
    (c) pure iron with very low carbon
    (d) inter-metallic compound iron carbide
12. Grey cast iron is
    (a) iron with the colour gray
    (b) iron where all the carbon is in combined form
    (c) iron where part of the carbon is in graphite form
    (d) graphite present is in spherical form
13. Ductile iron is
    (a) iron with the colour gray
    (b) iron where all the carbon is in combined form
    (c) iron where part of the carbon is in graphite form

(d) graphite present is in spherical form

14. Chromium as an alloying element in alloy steels is used principally to
    (a) improve hardenability
    (b) improve mechanical properties at low or elevated temperatures
    (c) improve the corrosion and oxidation resistance
    (d) increase the machinability
15. Tungsten as an alloying element in alloy steels is used principally to
    (a) improve hardenability
    (b) improve mechanical properties at elevated temperatures
    (c) improve the corrosion and oxidation resistance
    (d) increase the machinability
16. Aluminium alloys are generally used for their
    (a) low thermal conductivity
    (b) low electrical conductivity
    (c) excellent corrosion resistance
    (d) high mass density
17. Martensite is
    (a) BCC form of iron
    (b) body centred tetragonal form of iron
    (c) pure iron with very low carbon
    (d) intermetallic compound iron carbide
18. Tempering process is used in steels to achieve
    (a) lower hardness by transforming austenite to pearlite
    (b) lower hardness by transforming martensite to pearlite
    (c) high hardness by transforming austenite to martensite
    (d) high hardness by transforming martensite to pearlite
19. Normalising process is used in steels to achieve
    (a) improve ductility by transforming austenite to martensite
    (b) improve mechanical properties by transforming austenite to fine grain pearlite
    (c) increase hardness by transforming austenite to martensite
    (d) decrease hardness by transforming martensite to pearlite
20. Nitriding process is used to increase surface hardness for
    (a) low-carbon steels
    (b) alloy steels
    (c) medium-carbon steels
    (d) high-carbon steels

Answers to Multiple-Choice Questions

1. (b)	2. (b)	3. (b)	4. (c)	5. (b)	6. (c)	7. (a)	8. (b)	9. (c)
10. (b)	11. (c)	12. (c)	13. (d)	14. (c)	15. (b)	16. (c)	17. (b)	18. (b)
19. (b)	20. (b)							

12. The volume of a sand core is 160 cm^3. Find the buoyant force on the core if poured with the following alloys:
    (a) Cast iron
    (b) Cast steel
    (c) Aluminium

    Note the density of molten metal must be obtained by taking the density at room temperature and correcting for expansion by using the volumetric coefficient or expansion applied to the solid. The error in neglecting the liquid expansion is not large because most foundry alloys are poured at only 50 to 100 degrees superheat.

    [8.336 N, 9.696 N, 1.6 N]

Multiple Choice Questions

1. Sandcasting is preferred mainly because
   (a) good dimensional accuracy can be achieved
   (b) molten material flows into any small section in the mould cavity and as such any intricate shapes internal or external can be obtained
   (c) better surface finish is achieved
   (d) thin sections can be easily cast.
2. The upper moulding flask used in sandcasting is called
   (a) cope
   (b) cheek
   (c) drag
   (d) core
3. Solid shrinkage in a metal during the solidification is
   (a) reduction in volume when liquid metal temperature is reduced from pouring temperature to liquidus temperature
   (b) reduction in volume when solid metal temperature is reduced from solidus to room temperature
   (c) reduction in volume when solid metal temperature is reduced from liquidus to room temperature
   (d) reduction in volume when the metal changes from liquid to solid state at the solidus temperature
4. Shrinkage allowance is added to pattern dimensions to take care of
   (a) liquid shrinkage
   (b) liquid shrinkage or solid shrinkage
   (c) solid shrinkage
   (d) liquid shrinkage and solid shrinkage
5. In sandcasting, draft allowance is added to
   (a) all linear dimensions
   (b) only the interior dimensions
   (c) only the exterior dimensions
   (d) only to the dimensions that are perpendicular to the parting plane
6. The following pattern allowance can be specified quantitatively:
   (a) Machining allowance
   (b) Shake allowance
   (c) Draft allowance
   (d) Shrinkage allowance
7. Main disadvantage of aluminium as a pattern material for making the master pattern is
   (a) high strength
   (b) low cost
   (c) low density
   (d) high cost
8. Grey cast iron is used as pattern material for making the master pattern because of
   (a) high corrosion resistance
   (b) low cost
   (c) low density
   (d) none of the above
9. The main disadvantage of wood when used as pattern material for sandcasting is
   (a) long life
   (b) difficult to shape
   (c) distortion due to moisture absorption
   (d) high density
10 Brass is used as pattern material for making the master pattern because of

(a) low cost
(b) low density
(c) high corrosion resistance
(d) none of the above

11. Permeability of a moulding sand is increased with
(a) increasing the moisture content
(b) coarse grain size
(c) increasing the compacting pressure
(d) fine grain size

12. Refractoriness of moulding sand is increased with
(a) increasing the moisture content
(b) coarse grain size
(c) increasing the compacting pressure
(d) fine grain size

13. Permeability of a moulding sand is increased with
(a) increasing the clay content
(b) decreasing the clay content
(c) increasing the compacting pressure
(d) fine grain size

14. To improve the surface finish of sandcasting, the following is applied to the mould cavity:
(a) Coal dust
(b) Facing sand
(c) Sawdust
(d) Iron oxide

15. Problem with the green-sand moulds is
(a) the process is more expensive
(b) the process produces sound castings without any defects
(c) erosion of the mould takes place
(d) none of the above

16. Problem with the skin-dried sand moulds is
(a) mould distortion takes place
(b) the process produces sound castings without any defects
(c) erosion of the mould takes place
(d) none of the above

17. In a squeeze moulding machine, the sand in the moulding flask is compacted by
(a) a plate that rams the sand thoroughly
(b) impact force by dropping the flask on the machine table
(c) combining the above two (a) and (c)
(d) throwing sand into the flask with high force

18. In a sand-slinging moulding machine, the sand in the moulding flask is compacted by
(a) a plate that rams the sand thoroughly
(b) impact force by dropping the flask on the machine table
(c) combining the above two (a) and (c)
(d) throwing sand into the flask with high force

19. The binder that is more commonly used in core sands is
(a) clay
(b) bentonite
(c) linseed oil
(d) starch

20. A chaplet is used in a sand mould to
(a) support the core during the molten metal pouring
(b) support the mould from breaking
(c) support the mould from moving mould walls
(d) prevent the formation of cold shuts

Answers Multiple Choice Questions

1. (b) 2. (a) 3. (b) 4. (c) 5. (d) 6. (b) 7. (d) 8. (b) 9. (c)
10. (c) 11. (b) 12. (b) 13. (b) 14. (b) 15. (c) 16. (d) 17. (a) 18. (d)
19. (c) 20. (a)

Metal	No treatment	Insulating sleeve	Radiation shield	Insulation shield
Steel	5	7.5	13.4	43.0
Copper	8.2	15.1	14.0	45.0
Aluminum	12.3	31.1	14.3	45.6

(a) Determine the effective constant for Chvorinov's rule from the data for each of the metals listed above.

(b) Discuss the relative effect of radiation shielding for each metal listed, in terms of specific heat, latent heat of fusion and pouring temperature.

(c) Repeat item (b) in terms of using an insulating sleeve only.

(d) Discuss why the solidification times for steel and aluminium risers are about the same when they have both insulating sleeves and radiating shielding.

Multiple-Choice Questions

1. Pouring basin is used in sandcastings to
   (a) reduce the momentum of the molten metal as it enters the sprue
   (b) remove the slag and dirt present in the molten metal
   (c) reduce the mould erosion
   (d) all of the above
2. The best shape for sprue in sandcasting is
   (a) straight cylindrical
   (b) tapered
   (c) either straight cylindrical or tapered
   (d) shape will not matter
3. To reduce the mould erosion in a sandcasting,
   (a) sprue is tapered
   (b) cylindrical sprue is used
   (c) sprue base well is provided
   (d) runner is made trapezoidal
4. The preferred shape of a runner in sandcasting is
   (a) spherical (b) cylindrical
   (c) trapezoidal (d) rectangular
5. Advantage of providing a top gate in a sandcasting is
   (a) favourable temperature gradient is achieved
   (b) slow filling of the mould cavity
   (c) smooth flow of metal into the mould cavity
   (d) none of the above
6. The advantage of providing a bottom gate in a sandcasting is
   (a) favourable temperature gradient is achieved
   (b) fast filling of the mould cavity
   (c) smooth flow of metal into the mould cavity
   (d) none of the above
7. The advantage of providing a parting gate in a sandcasting is
   (a) favourable temperature gradient is achieved
   (b) best gating with minimum defects
   (c) smooth flow of metal into the mould cavity
   (d) none of the above
8. Riser is used in a sandcasting to
   (a) reduce the slag inclusion
   (b) reduce defects due to air aspiration
   (c) reduce mould erosion
   (d) reduce shrinkage cavities
9. To improve the directional solidification for difficult casting geometries, use a
   (a) chill
   (b) parting gate
   (c) step gate
   (d) runner extension
10. Pouring time for a given casting is increased by
    (a) using green sand mould
    (b) using sprue base well

(c) increased section thickness of the casting
(d) using wide runners

11. The following is a point to be considered during the design of in-gate in a sand mould:
    (a) In-gate should not be located near a protruding part of the mould to avoid the striking of vertical mould walls by the molten metal stream.
    (b) In-gates should preferably be placed along the longitudinal axis of the mould wall.
    (c) In-gates should not be placed near a core print or a chill.
    (d) All of the above
12. The following type of gate is used for trapping the slag in a sand mould:
    (a) Bottom gate
    (b) Whirl gate
    (c) Parting gate
    (d) Step gate
13. Shrinkage cavity in a sandcasting can be reduced by
    (a) using a riser
    (b) pouring more molten metal into the mould cavity
    (c) pouring just sufficient molten metal into the mould cavity
    (d) using a runner extension
14. Riser for a sandcasting can be designed using
    (a) Caine's method
    (b) naval research laboratory method
    (c) modulus method
    (d) all of the above
15. To reduce the risering requirement in a sandcasting,
    (a) use a runner extension
    (b) use a strainer core
    (c) use a riser sleeve
    (d) none of the above

Answers to Multiple-Choice Questions

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

	Charge kg	Carbon %	Silicon %	Manganese %	Sulphur %	Phosphorous %
Pig iron A	250	3.82	3.17	0.90	0.01	1.40
Pig iron B	250	3.50	2.50	0.60	0.04	0.80
Scrap 1	500	3.30	2.50	0.60	0.08	1.00

Assuming a carbon pick-up of 0.30%, sulphur pick-up of 0.03%, 10% loss of silicon, 25% loss of manganese and no change in phosphorous, calculate the final melt composition.

Multiple-Choice Questions

1. The charge of a cupola contains
   (a) pig iron, coal and lime stone
   (b) pig iron and coke
   (c) pig iron, coke and lime stone
   (d) none of the above
2. During the cupola melting of cast iron, the following element is lost due to oxidation:
   (a) Carbon
   (b) Phosphorous
   (c) Silicon
   (d) All of the above
3. The most economical furnace to melt cast iron in large volume is
   (a) reverberatory furnace
   (b) cupola furnace
   (c) induction furnace
   (d) electric furnace
4. Inoculation is done in foundry to help in
   (a) improving the mechanical strength of steel
   (b) producing changes in graphite distribution in the case of ductile iron
   (c) reducing the slag from molten metal
   (d) improving the flow characteristics of copper alloys
5. The type of inoculation method is practiced in automatic pouring lines:
   (a) Ladle inoculation
   (b) In-mould inoculation
   (c) In-stream inoculation
   (d) In-furnace inoculation
6. Blowholes in sandcasting are caused by
   (a) poor casting design
   (b) lower strength of the solidified metal
   (c) higher moisture in the moulding sand
   (d) faulty moulding flask
7. Air inclusions in sandcasting are caused by
   (a) poor casting design
   (b) faulty moulding flask
   (c) lower strength of the solidified metal
   (d) higher pouring temperature
8. Pinhole porosity in sandcasting is caused by
   (a) poor casting design
   (b) faulty moulding flask
   (c) lower strength of the solidified metal
   (d) higher pouring temperature
9. Cuts and washes in sandcasting are caused by
   (a) poor casting design
   (b) lower strength of the solidified metal
   (c) lower strength of the moulding sand
   (d) higher pouring temperature
10. Fusion in sandcasting is caused by
    (a) lower refractoriness of the moulding sand
    (b) lower strength of the solidified metal
    (c) lower strength of the moulding sand
    (d) lower hardness of the moulding sand

11. Rat tails and buckles in sandcasting are caused by
    (a) lower refractoriness of the moulding sand
    (b) lower strength of the solidified metal
    (c) lower strength of the moulding sand
    (d) lower hardness of the moulding sand
12. Misruns and cold shuts in sandcasting are caused by
    (a) lower pouring temperature
    (b) faulty moulding flask
    (c) lower strength of the solidified metal
    (d) higher pouring temperature
13. Parting line in sandcastings should be
    (a) any type will not make a difference
    (b) simple and straight
    (c) irregular parting line decreases casting cost
    (d) multiple parting lines decrease casting cost
14. A hot spot in sandcasting is caused by
    (a) pouring hot metal into the mould
    (b) the higher concentration of metal in the joints
    (c) poor refractory property of the moulding sand
    (d) low thermal conductivity of the moulding sand
15. Hot tear in sandcasting is caused by
    (a) pouring hot metal into the mould
    (b) non uniform thickness of walls joining in a casting
    (c) poor refractory property of the moulding sand
    (d) low thermal conductivity of the moulding sand

Answers to Multiple-Choice Questions

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

- Vacuum die-casting ensures the removal of entrapped air in the die inside the casting, thereby ensuring a sound casting.
- In centrifugal casting, the mould is rotated at high speed, which ensures that the slag and impurities in the molten metal are separated and removed effectively. This ensures that the casting produced is sound. There are other variations in this process to cater to the different types of casting sizes and geometries produced.
- Continuous casting allows for the fast production of constant cross-sectional shapes in large volume.

Questions

1. Compare precision-investment casting and shell moulding from the standpoint of process, product and applications.
2. "Although sandcasting is the most widely used process judging from the tonnage of castings produced, there are instances where one would choose die casting in preference to sandcasting." Discuss the statement.
3. Give examples of the typical products of the following processes: die casting, centrifugal casting, permanent-mould casting, shell moulding.
4. Specify the advantages of the precision investment casting process over other casting processes.
5. Describe the composition of the mould material in the shell-moulding process.
6. What is the main difference in quality between a sandcasting and a casting in a metal mould?
7. Why are most die castings not made out of high-strength materials?
8. Is it possible to obtain a sound casting of a solid bar by centrifugal casting? Give reasons in support of your answer.
9. State the difference between centrifuging and true centrifugal casting.
10. What are the typical situations in which the following casting processes are used?
    (a) Precision investment casting
    (b) Shell moulding
    (c) True centrifugal casting
    (d) Pressure die casting
11. Give advantages and disadvantages of permanent-mould casting compared to that of sandcasting.
12. How is a semipermanent mould different from a permanent mould?
13. Why is aluminium preferred to be done by cold-chamber die casting than hot chamber die casting?
14. "Large parts cannot be manufactured by the centrifuging process". Comment on the statement.
15. How will you compare a cold-chamber die-casting process with that of a hot-chamber process?
16. Outline the precision investment casting process giving typical applications of the process.
17. Briefly enumerate the steps in sequence for producing castings from shell moulding.

Multiple-Choice Questions

1. The type of binder that is commonly used in shell moulding is
    (a) linseed oil
    (b) thermosetting resin
    (c) thermoplastic resin
    (d) core oil

2. Type of sand that is normally used in shell moulding:
   (a) Synthetic sand (b) River sand
   (c) Dry and fine sand (d) Moulding sand
3. The most widely used casting process for industrial components:
   (a) Squeeze casting
   (b) Pressure die casting
   (c) True centrifugal casting
   (d) Vacuum-pressure die casting
4. Pattern used in shell moulding is normally made of
   (a) wood (b) metal
   (c) plastic (d) wax
5. Main advantage of using a shell moulding is
   (a) any complex shape can be obtained
   (b) cost of the pattern is low
   (c) very thin sections (upto 0.25 mm) can be readily made
   (d) any size of casting can be obtained
6. Pattern used in precision investment casting is normally made of
   (a) wood (b) metal
   (c) plastic (d) wax
7. Pattern used in permanent-mould casting is normally made of
   (a) wood (b) metal
   (c) plastic (d) none of the above
8. Cores used in permanent-mould casting are normally made of
   (a) sand (b) metal
   (c) collapsible metal (d) all of the above
9. Coatings are normally used in permanent-mould casting moulds to
   (a) improve the appearance of the mould cavity
   (b) improve the surface finish of the mould cavity
   (c) prevent the soldering of metal to the mould
   (d) improve the flow of the molten metal inside the mould cavity
10. Pattern used in pressure die-casting is normally made of
    (a) wood (b) metal
    (c) plastic (d) none of the above
11. Main advantage of using a pressure die casting is
    (a) economical even in small quantities
    (b) any complex shape can be obtained
    (c) any size of casting can be obtained
    (d) any material can be used
12. Hot-chamber die-casting process is used for
    (a) aluminium (b) zinc
    (c) cast iron (d) steel
13. Hot-chamber die-casting process when compared to cold-chamber die-casting process is
    (a) faster
    (b) more expensive
    (c) more versatile for the range of materials used
    (d) can use stronger materials
14. The main difference between hot-chamber die-casting process and cold-chamber die-casting process is
    (a) cold chamber process utilises low-melting-temperature alloys compared to hot-chamber process
    (b) Hot-chamber process utilises a ladle to inject molten metal into the die
    (c) Hot-chamber process utilises an integral furnace with the machine
    (d) Cold-chamber process utilises an integral furnace with the machine
15. The casting process that does not require a core to produce a hollow casting is
    (a) shell moulding
    (b) permanent-mould casting
    (c) hot-chamber die casting
    (d) true centrifugal casting

Answers to Multiple-Choice Questions

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

71. What are the specific applications of hydrostatic extrusion?
72. Explain how the variables that affect the extrusion pressure.
73. Briefly describe the method of swaging giving the main applications for the process.
74. What do you understand by the term 'roll piercing'? Explain with a simple sketch.
75. Is rolling useful for making tubes? Explain your answer with proper sketches.
76. Briefly explain the thread-rolling operation.
77. Describe the explosive forming process. Give its applications.

Multiple Choice Questions

1. Fibre-flow lines seen in the products produced by metal-working processes are
   (a) the obstruction that was provided during the deformation process
   (b) the direction in which the metal has actually moved during the deformation
   (c) not really related to metal deformation process
   (d) present in the metal before the deformation process
2. Hot working of metal in metal-forming processes is
   (a) working below the melting temperature
   (b) working below the recrystallisation temperature
   (c) working above the recrystallisation temperature
   (d) working above the ambient temperature
3. Recrystallisation temperature of an alloy is
   (a) the approximate minimum temperature at which complete recrystallisation of a cold-worked metal occurs within a specified time
   (b) the approximate maximum temperature at which complete recrystallisation of a cold-worked metal occurs within a specified time
   (c) the approximate minimum temperature at which complete recrystallisation of a hot-worked metal occurs within a specified time
   (d) the approximate maximum temperature at which complete recrystallisation of a hot-worked metal occurs within a specified time
4. Recrystallisation temperature of a metal is
   (a) decreased by an increase in solute concentration in solid solution
   (b) increases by an increase in original grain size before cold working
   (c) increased by decreasing temperature of cold working
   (d) decreases by a decrease in original grain size before cold working
5. A disadvantage of hot working of metals is
   (a) any amount of working can be done
   (b) surface finish obtained is poor
   (c) it requires less force
   (d) brittle metals can be worked
6. A disadvantage of cold working of metals is
   (a) maximum deformation that can be given is limited
   (b) dimensional accuracy obtained is less
   (c) surface finish obtained is poor
   (d) none of the above
7. Smaller diameter rolls in rolling are used to
   (a) smaller reduction in cold rolling
   (b) smaller reduction in hot rolling
   (c) larger reduction in cold rolling
   (d) for any reduction
8. The following steel section is generally a square cross section:
   (a) Slab (b) Billet
   (c) Bloom (d) Ingot
9. For effective descaling the following pass is suitable:
   (a) Finishing pass
   (b) Box pass

(c) Diamond-square pass
(d) Oval-square pass

10. Drawing out is a forging operation used to
(a) reduce the cross-section of a part
(b) increase the cross-section of a part
(c) finish the part
(d) flatten the part

11. Drop forging is used to make parts in
(a) open-impression dies that involves only upsetting operation
(b) closed-impression dies that involves only upsetting operation
(c) closed-impression dies that involves only drawing out operation
(d) open-impression dies that involves only drawing out operation

12. Machine forging is used to make parts in
(a) open-impression dies that involves only upsetting operation
(b) closed-impression dies that involves only upsetting operation
(c) closed-impression dies that involves only drawing out operation
(d) open-impression dies that involves only drawing out operation

13. Edging impression is an operation in drop forging used to
(a) increase the material cross section and decrease the length
(b) gather the exact amount of material required at each cross-section
(c) decrease the material cross section and increase the length
(d) acquires the shape very near to the final one

14. Press forging operation is characterised by
(a) larger draft angles than drop forging
(b) use of larger presses compared to drop forging
(c) no tong holds are required compared to drop forging
(d) poor surface finish compared to drop forging

15. Counterlocking of dies becomes a necessity
(a) in all press-forging dies
(b) in all drop-forging dies
(c) in all drop-forging dies that have irregular parting line
(d) in all drop-forging dies that have sectional-die construction

16. Extrusion is used to manufacture
(a) constant cross sections over its entire length
(b) any object
(c) only some complex cross sections
(d) none of the above

17. A lubricant used in forward hot extrusion of steels is
(a) soap solution (b) linseed oil
(c) molten glass (d) copper sulphate

18. The process used to make the aluminium collapsible tube used to keep the toothpaste is
(a) cold-extrusion forging
(b) impact extrusion
(c) forward hot extrusion
(d) forward cold extrusion

19. The following is always a cold-working operation:
(a) Rolling (b) Wire drawing
(c) Forging (d) Extrusion

20. The lubricant commonly used in wire-drawing operation is
(a) soap solution after lime coating
(b) linseed oil
(c) molten glass
(d) copper sulphate

Answers Multiple Choice Questions

1. (b)	2. (c)	3. (a)	4. (a)	5. (b)	6. (a)	7. (c)	8. (c)	9. (b)
10. (a)	11. (c)	12. (b)	13. (b)	14. (b)	15. (c)	16. (a)	17. (c)	18. (b)
19. (b)	20. (a)							

Multiple-Choice Questions

1. The following sheet-metal operation induces both compression and tensile stresses in the part:
   (a) Blanking (b) Piercing
   (c) Drawing (d) Trimming
2. The following sheet-metal operation induces only compressive stresses in the part:
   (a) Blanking (b) Coining
   (c) Drawing (d) Trimming
3. The following sheet-metal operation induces only tensile stresses in the part:
   (a) Stretch forming (b) Coining
   (c) Drawing (d) Trimming
4. The following sheet-metal operation induces shear stresses in the part:
   (a) Stretch forming
   (b) Coining
   (c) Drawing
   (d) Blanking
5. The following sheet-metal operation induces shear stresses in the part:
   (a) Stretch forming (b) Piercing
   (c) Drawing (d) Coining
6. The following sheet-metal operation induces only compressive stresses in the part:
   (a) Stretch forming (b) Ironing
   (c) Drawing (d) Coining
7. Spring back during the sheet-metal operation is caused because of the
   (a) release of the stored energy during the elastic and plastic deformation
   (b) release of the stored energy during the plastic deformation
   (c) release of the stored energy during the elastic deformation
   (d) excess energy that was utilised during the forming process
8. Compared to brittle materials, ductile materials require for shearing operation
   (a) clearance based on material thickness only
   (b) lower clearances
   (c) higher clearances
   (d) same clearance
9. In a blanking die, to reduce the possibility of slug clinging to the die, the following provision is made:
   (a) Shear on the punch
   (b) Shear on the die
   (c) Angular clearance in the die
   (d) Cutting land on the die
10. Find the correct statement below:
   (a) The clearance in a piercing die applied on the die while in a blanking die, it is applied on the punch.
   (b) The clearance in a piercing die applied on the punch while in a blanking die, it is applied on the die.
   (c) The clearance in a piercing die applied on the die while in a blanking die, it is applied on the die.
   (d) The clearance in a piercing die applied on the punch while in a blanking die, it is applied on the punch.
11. To reduce the required shearing force on the punch, to accommodate a large component on a smaller capacity punch press, shear is applied. In a blanking operation, shear is applied on the
   (a) punch (b) die
   (c) die or punch (d) die and punch
12. To reduce the required shearing force on the punch, to accommodate a large component on a smaller capacity punch press, shear is applied. In a piercing operation, shear is applied on the
   (a) punch (b) die
   (c) die or punch (d) die and punch
13. The operation to be used to remove the burr produced during the blanking operation is
   (a) nibbling (b) trimming
   (c) shaving (d) notching
14. Sheet-metal drawing operation is used to make
   (a) wire (b) cup shaped parts
   (c) tubes (d) rods
15. Blank holding is normally required in
   (a) blanking (b) shallow drawing
   (c) deep drawing (d) piercing

16. Only axisymmetric cup shapes are produced by this process:
    (a) Blanking (b) Spinning
    (c) Deep drawing (d) Shallow drawing
17. Bending produces the following types of stresses in the parts:
    (a) Tensile
    (b) Compressive
    (c) Tensile and compressive
    (d) Shear
18. For making a bend of 90 degrees, the part should be bent
    (a) more than 90 degrees
    (b) less than 90 degrees
    (c) exactly 90 degrees
    (d) none of the above
19. The following sheet-metal-manufacturing process does not experience any spring back:
    (a) Blanking (b) Shallow drawing
    (c) Deep drawing (d) Stretch forming
20. The following sheet-metal process requires a large press:
    (a) Embossing (b) Coining
    (c) Trimming (d) Blanking

Answers to Multiple-Choice Questions

1. (c)	2. (b)	3. (a)	4. ( )	5. (b)	6. (b)	7. (c)	8. (c)	9. (c)
10. (b)	11. (b)	12. (a)	13. (c)	14. (b)	15. (c)	16. (b)	17. (c)	18. (b)
19. (d)	20. (b)							

7. Calculate the size of the heat affected zone with the same parameters as in problem 9.5, and discuss the likely metallurgical structures in HAZ.
8. It is necessary to design the weldment using the Shielded Metal Arc Welding (SMAW) process for the following plates (i) 15 mm, and (ii) 25 mm. The following parameters are obtained from previous experience:

   Voltage = 25 V

   Current = 250 A

   Heat transfer efficiency = 0.85

   Electrode travel speed = 8 mm/s

   Cooling rate = 6°C/s

   Temperature for cooling rate calculation = 550°C

   Calculate the necessary preheating temperature of the base metal to reduce the residual stresses. Comment on the results.

Multiple-Choice Questions

1. Welding is a
   (a) permanent joint
   (b) semipermanent joint
   (c) temporary joint
   (d) temporary or semi-permanent joint
2. Mechanical fastening is a
   (a) permanent joint
   (b) fusion joint
   (c) temporary joint
   (d) temporary or semi-permanent joint
3. Soldering is a
   (a) permanent joint
   (b) fusion joint
   (c) leakproof joint
   (d) temporary or semi-permanent joint
4. For very thick plates, the following edge preparation is preferable:
   (a) Single v
   (b) Single u
   (c) Double u
   (d) Double v
5. The fuel gas that has highest flame temperature (heat capability) in gas welding is
   (a) propylene
   (b) propane
   (c) acetylene
   (d) hydrogen
6. The flame type that is normally used to weld cast iron in oxy-oxy-acetylene welding method is
   (a) carburising flame
   (b) neutral flame
   (c) oxidising flame
   (d) natural flame
7. The flame type that is normally used to weld copper base alloys in oxy-oxy-acetylene welding method is
   (a) carburising flame
   (b) neutral flame
   (c) oxidising flame
   (d) reducing flame
8. Filler metal is not required in the following type of welding process:
   (a) Oxy-oxy-acetylene welding
   (b) Arc welding
   (c) Resistance welding
   (d) Oxy-oxy-hydrogen welding
9. Drag in oxy-oxy-acetylene cutting can be reduced by
   (a) increasing the travel speed of the torch
   (b) decreasing the travel speed of the torch
   (c) using a larger hole in the torch for the oxy-oxy-acetylene jet
   (d) using a larger hole in the torch for the oxygen jet
10. Straight polarity in arc welding is obtained with
    (a) alternating current electrode with electrode being positive
    (b) direct current electrode with electrode being positive
    (c) direct current electrode with electrode being negative
    (d) alternating current electrode with electrode being negative

11. Consumable electrode for manual metal arc welding of steel is made of
    (a) tungsten
    (b) steel
    (c) copper
    (d) cadmium copper
12. Electrode for gas metal arc Welding of steel is made of
    (a) tungsten
    (b) steel
    (c) copper
    (d) cadmium copper
13. For welding thin workpieces of aluminium sheet, the following welding process is preferred:
    (a) Manual metal arc welding
    (b) Gas-metal arc welding
    (c) Gas tungsten arc welding
    (d) Submerged arc welding
14. Advantage of coated electrode for shielded metal arc welding process is
    (a) gives off inert gases and protect the molten weld pool
    (b) provides arc stabilizing compounds
    (c) provides flux to remove oxide from the weld joint
    (d) all of the above
15. Arc blow in manual metal arc welding is caused by
    (a) the use of ac welding with non consumable electrodes
    (b) the use of dc welding with consumable electrodes
    (c) the use of ac welding with consumable electrodes
    (d) none of the above
16. Argon is the most widely used inert gas in gas tungsten arc welding because
    (a) it requires a lower arc voltage, allows for easier arc starting and provides a smooth arc action.
    (b) it provides a short arc
    (c) it is lighter compared to other inert gases
    (d) it can withstand higher arc voltage
17. Filler rod used in welding mild-steel plates using gas-metal arc welding is made of
    (a) mild steel
    (b) low-carbon steel
    (c) medium-carbon steel
    (d) no filler rod is used
18. For overhead welding of thin plates in gas-metal arc welding, the preferred metal transfer should be
    (a) short circuit or dip transfer
    (b) globular transfer
    (c) spray transfer
    (d) pulsed spray transfer
19. The welding process preferred to weld ship hulls is
    (a) manual metal arc welding
    (b) gas-metal arc welding
    (c) submerged arc welding
    (d) flux cored arc welding
20. In resistance-spot welding, the heat required to melt the joint is mainly because of the resistance of the
    (a) electrodes
    (b) workpiece joint
    (c) contact resistance of the electrode with workpiece
    (d) all of the above

Answers to Multiple-Choice Questions

1. (a)	2. (d)	3. (c)	4. (c)	5. (c)	6. (a)	7. (d)	8. (c)	9. (b)
10. (c)	11. (b)	12. (b)	13. (c)	14. (d)	15. (b)	16. (a)	17. (d)	18. (d)
19. (c)	20. (d)							

6. Compare electro-slag welding process with that of submerged-arc welding from the standpoint of heat liberated, joint preparation and welding position.
7. Describe the electron-beam welding process.
8. Explain how the atmosphere around the workpiece affects the weld obtained in electron-beam welding.
9. What do you understand by laser-beam welding?
10. Explain various types of lasers used in the laser-beam welding process.
11. Write a short note on laser-beam welding detailing the applications.
12. What are the advantages claimed of friction welding?
13. Describe briefly about forge welding.
14. Explain the reasons why forge-welding process is not commercially used.
15. Explain the process of friction welding, giving the applications.
16. Is it possible to use a centre lathe for friction welding? Support your answer with reasons.
17. What applications would require diffusion welding?
18. Explain the process of diffusion welding.
19. Write a brief note on explosion welding.
20. How is brazing different from welding?
21. Why is brazing more extensively used in industrial practice?
22. What filler metals are generally used in brazing?
23. Explain what you understand by silver soldering or silver brazing.
24. What is the requirement of fluxes in brazing? Give details of some of the fluxes used in brazing with their applications.
25. Explain briefly how brazing is carried out.
26. What do you understand by braze welding?
27. Compare brazing and braze welding.
28. What are the typical applications of soldering?
29. Distinguish between brazing and soldering from the point of view of the filler metals used, applications and the strength of the joint obtained.
30. What fluxes are generally used in soldering?
31. Give the typical compositions of the filler metals used in soldering with their applications.

Multiple-Choice Questions

1. Thermit welding is used for welding
   (a) thin plates in a single pass
   (b) very thick plates in a single pass
   (c) very thick plates in two passes
   (d) very thick plates in multiple passes
2. Thermit welding utilises the heat liberated from the
   (a) chemical reaction between two compounds
   (b) burning of a solid fuel along with the filler material in the joint
   (c) burning of a liquid fuel along with the filler material in the joint
   (d) electric induction of the joint
3. Thermit mixtures used in thermit welding normally use the following metal:
   (a) Manganese (b) Magnesium
   (c) Aluminium (d) Alum
4. Electro-slag welding utilises the heat liberated from the
   (a) chemical reaction between two compounds
   (b) resistance heating of the slag in the joint

(c) electric arc between the electrode and the filler material in the joint
(d) electric induction of the joint

5. Electro-slag welding is used for welding
(a) rolling mill frames
(b) ship hulls
(c) frames of heavy mechanical and hydraulic presses
(d) all of the above

6. Electron-beam welding is used for welding
(a) high depth-to-width ratios
(b) low depth-to-width ratios
(c) depth-to-width ratios equal to one
(d) with large heat-affected zone due to large heat generated

7. Filler metal or flux is not required for the following process:
(a) Thermit welding
(b) Electron-beam welding
(c) Electro-slag welding
(d) Arc welding

8. Welding process that requires no direct heat application in the joint:
(a) Thermit welding
(b) Electron-beam welding
(c) Friction welding
(d) Laser-beam welding

9. Welding process that requires no direct heat application in the joint:
(a) Thermit welding
(b) Diffusion bonding
(c) Friction welding
(d) Laser-beam welding

10. Filler metal or flux is not required for the following process:
(a) Thermit welding
(b) Laser-beam welding
(c) Electro-slag welding
(d) Arc welding

Answers to Multiple-Choice Questions

1. (b) 2. (a) 3. (c) 4. (b) 5. (d) 6. (a) 7. (b) 8. (c) 9. (b) 10. (b)

Summary

Powder metallurgy is unique in providing exceptional properties that cannot be achieved by other manufacturing processes.

- The starting point of powder metallurgy is the metal powder, which is generally obtained by atomisation from liquid metal. A number of methods are possible for this.
- Different metal/alloy powders will be mixed with additives and then blended to ensure uniform properties and appropriate lubrication.
- Metal powder is then placed in the die and then compacted with appropriate tooling to achieve the necessary density for the green compact. To get uniform density, it is necessary to use multiple punches in a double-acting press.
- The green compact is heated in a furnace with a protective environment to expel all the lubricants and then to achieve the metallurgical bonding of the powder particles.
- Some secondary operations such as repressing, sizing, plating, etc. may be performed to achieve the requisite properties on the sintered product.
- It is necessary to follow the guidelines for designing the powder-metallurgy parts, so that the process is exploited to its best advantage.

Questions

1. Briefly explain the powder-metallurgy process with a block diagram.
2. What are the various methods available for making the metal powder?
3. Explain any one of the atomisation process used for preparing the metallic powder.
4. What do you understand by mixing and blending with reference to powder metallurgy?
5. Describe the movement of powder particles during compaction in powder-metallurgy process. What features are responsible for the fact that powder does not flow and transmit pressure like a liquid?
6. Explain sintering process in connection with the powder metallurgy.
7. Explain the following terms with reference to the powder-metallurgy process: Sintering, Infiltration, and Impregnation.
8. Give the advantages of powder-metallurgy parts.
9. Give a brief account of cold isostatic pressing.

Multiple-Choice Questions

1. Powder-metallurgy process involves the following operations in sequence:
   (a) Powder mixing, sintering, compacting, and finishing
   (b) Powder mixing, sintering and finishing
   (c) Powder mixing, compacting, sintering and finishing
   (d) Powder mixing, compacting, and sintering
2. Metal powder particle size is reduced during atomisation by
   (a) decreasing gas velocity
   (b) increasing gas velocity
   (c) decreasing gas pressure
   (d) decreasing metal volume

3. Identify the correct statement among the following:
   (a) Blending and mixing refer to the same process of mixing different types of metal or alloy powders of different size distributions.
   (b) Blending is mixing the different metal or alloy powders of different size distributions, while mixing is mixing same types of metal or alloy powders.
   (c) Blending is mixing the same metal or alloy powders of different size distributions, while mixing is mixing different types of metal or alloy powders.
   (d) Blending and mixing refer to the same process of mixing same types of metal or alloy powders of different size distributions.
4. Identify the correct statement among the following:
   (a) Single punch is sufficient to achieve uniform compacting of powder-metallurgy parts.
   (b) Multiple punches are required to achieve uniform compacting of powder-metallurgy parts.
   (c) Any type (single or multiple) of punch will be able to achieve good compacting of the powder-metallurgy parts.
   (d) Punching with variable pressure will be able to achieve good compacting of the powder-metallurgy parts.
5. Green density of the powder-metallurgy part will be increased by
   (a) increasing the sintering temperature
   (b) decreasing the sintering temperature
   (c) increasing the compacting pressure
   (d) decreasing the compacting pressure
6. Final strength of a powder-metallurgy part can be increased by
   (a) increasing the sintering temperature
   (b) decreasing the sintering temperature
   (c) increasing the lubricant in the powder mix
   (d) decreasing the compacting pressure
7. To improve the mechanical properties of a powder-metallurgy part, the following finishing operation is used:
   (a) Repressing (b) Sizing
   (c) Coining (d) Impregnation
8. To improve the dimensional accuracy of a powder-metallurgy part, the following finishing operation is used:
   (a) Repressing (b) Sizing
   (c) Coining (d) Impregnation
9. To improve the self lubricating capacity of a powder-metallurgy part, the following finishing operation is used:
   (a) Repressing (b) Sizing
   (c) Infiltration (d) Impregnation
10. To improve the strength of a powder-metallurgy part, the following finishing operation is used:
   (a) Coining (b) Sizing
   (c) Infiltration (d) Impregnation

Answers to Multiple-Choice Questions

1. (c) 2. (b) 3. (c) 4. (b) 5. (c) 6. (a) 7. (a) 8. (b) 9. (d) 10. (c)

5. Explain the various methods (only the principle) available for injection moulding of plastics. Give the comparative advantages and applications for the same.
6. What are the different types of moulds used in injection moulding? Give their relative applications.
7. Explain reaction injection-moulding process.
8. Explain co-injection moulding process.
9. Explain the various methods (only the principle) available for blow moulding of thermoplastics giving their relative applications.
10. Mame the processes used for making of (a) plastic bottles such as those used for storing 1 litre shampoo, (b) plastic top cover of a plain paper copier (photostat machine), and (c) plastic buckets of 20 litre capacity.
11. Explain injection blow-moulding process.
12. Explain stretch blow-moulding process with applications.
13. Describe the thermoforming process. What are its applications?
14. Give a brief account of some salient points to be considered for designing parts for plastic processing.

Multiple-Choice Questions

1. Polyvinyl chloride is a
   (a) thermoplastic material
   (b) thermosetting material
   (c) elastomeric material
   (d) epoxy resin
2. Phenol-formaldehyde is a
   (a) thermoplastic material
   (b) thermosetting material
   (c) elastomeric material
   (d) epoxy resin
3. Identify the material produced by addition polymerisation:
   (a) Epoxy
   (b) Phenol-formaldehyde
   (c) Polyamide (Nylon)
   (d) Polyvinyl acetate
4. Identify the material produced by condensation polymerisation:
   (a) Polystyrene (b) Polyamide (Nylon)
   (c) Polypropylene (d) Polyvinyl chloride
5. Extrusion is generally used for
   (a) thermosetting materials
   (b) thermoplastic materials
   (c) elastomers
   (d) phenol-formaldehyde
6. The advantage of using plastic-extrusion process is
   (a) equipment is simple and relatively inexpensive
   (b) short lead times
   (c) relatively low tooling costs
   (d) all of the above
7. The most widely used plastic-processing method in the industry is
   (a) extrusion (b) injection moulding
   (c) blow moulding (d) thermo forming
8. The mould that provides highest productivity in injection moulding is
   (a) two-plate mould (b) three-plate mould
   (c) hot-runner mould(d) single-plate mould
9. To make complex parts in thermosetting materials the following process is used:
   (a) Extrusion
   (b) Injection moulding
   (c) Reaction injection moulding
   (d) Blow moulding
10. For making hollow parts with thin sections the following process is used:
   (a) Extrusion
   (b) Injection moulding
   (c) Reaction injection moulding
   (d) Blow moulding

Answers to Multiple-Choice Questions

1. (a) 2. (b) 3. (d) 4. (b) 5. (b) 6. (d) 7. (b) 8. (c) 9. (c) 10. (d)