How Metals Are Produced

Steel Alloy Iron

First produced 5000 - 3000 BC

Iron ore

Crush

5% of earth's crust

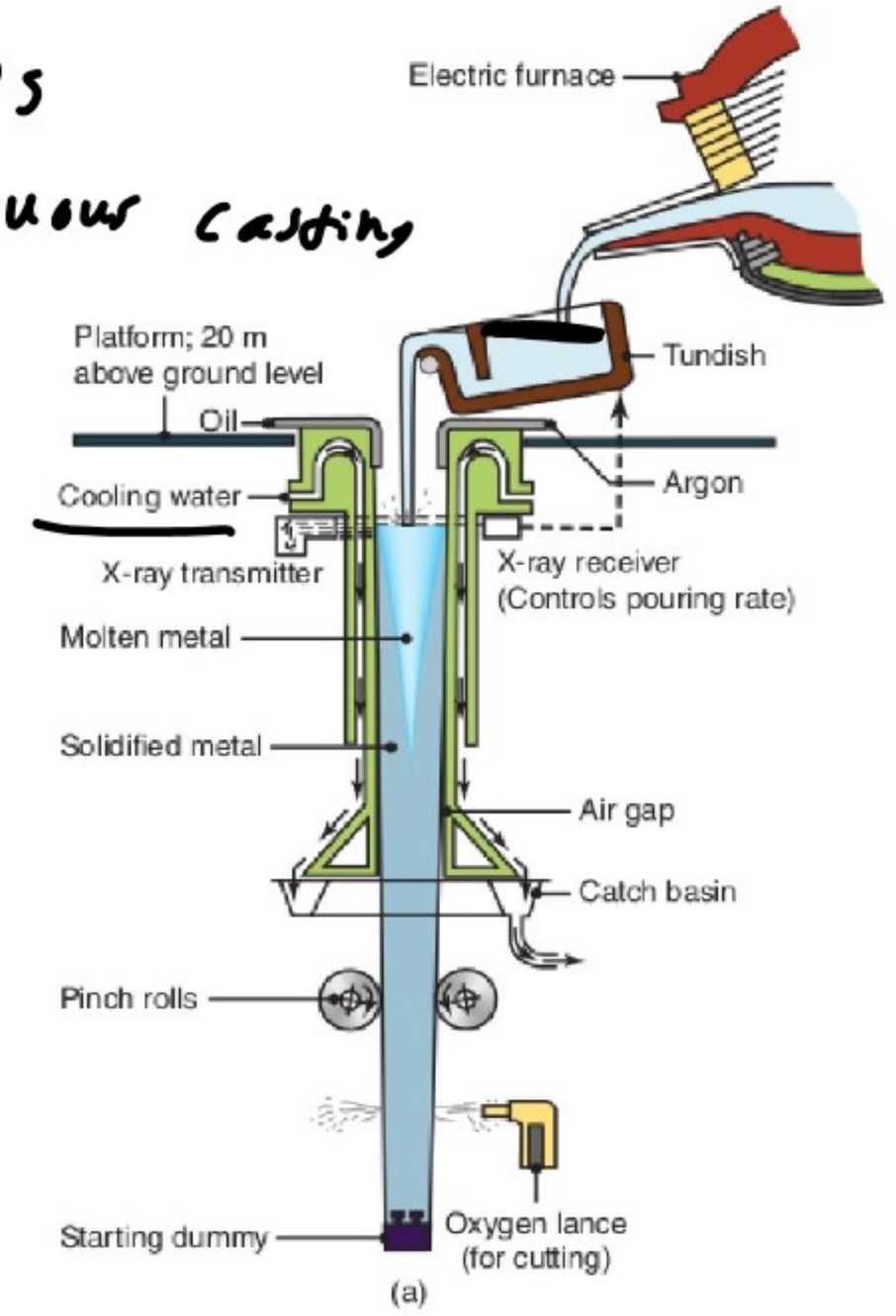
Iron melts at 1650°C

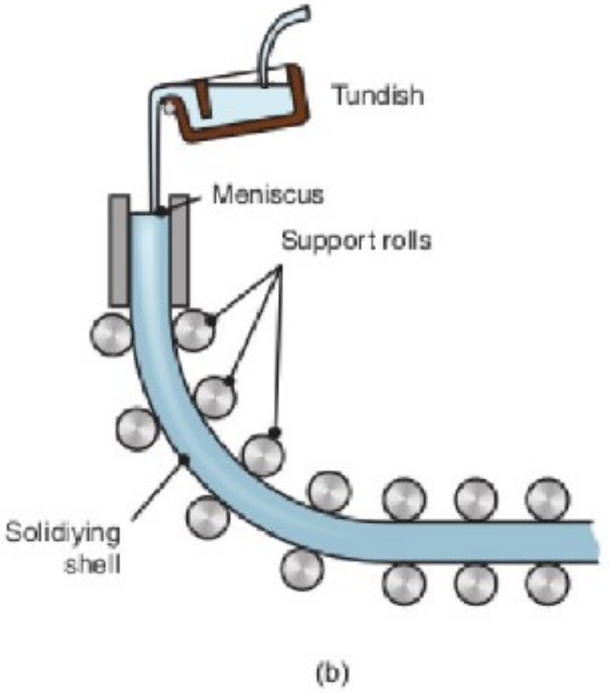
Blast furnace

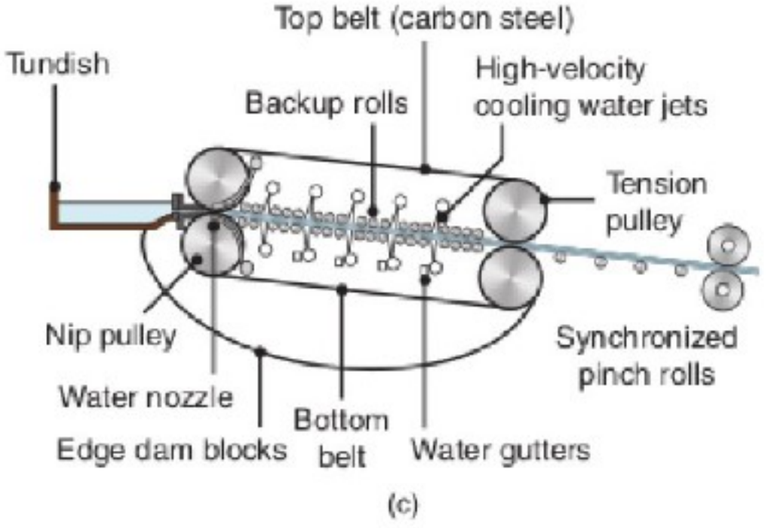
Slag

1960s

Continuous casting








Aluminium 1825
bauxite
8% crust
crush

heat to 150-200°C in sodium hydroxide

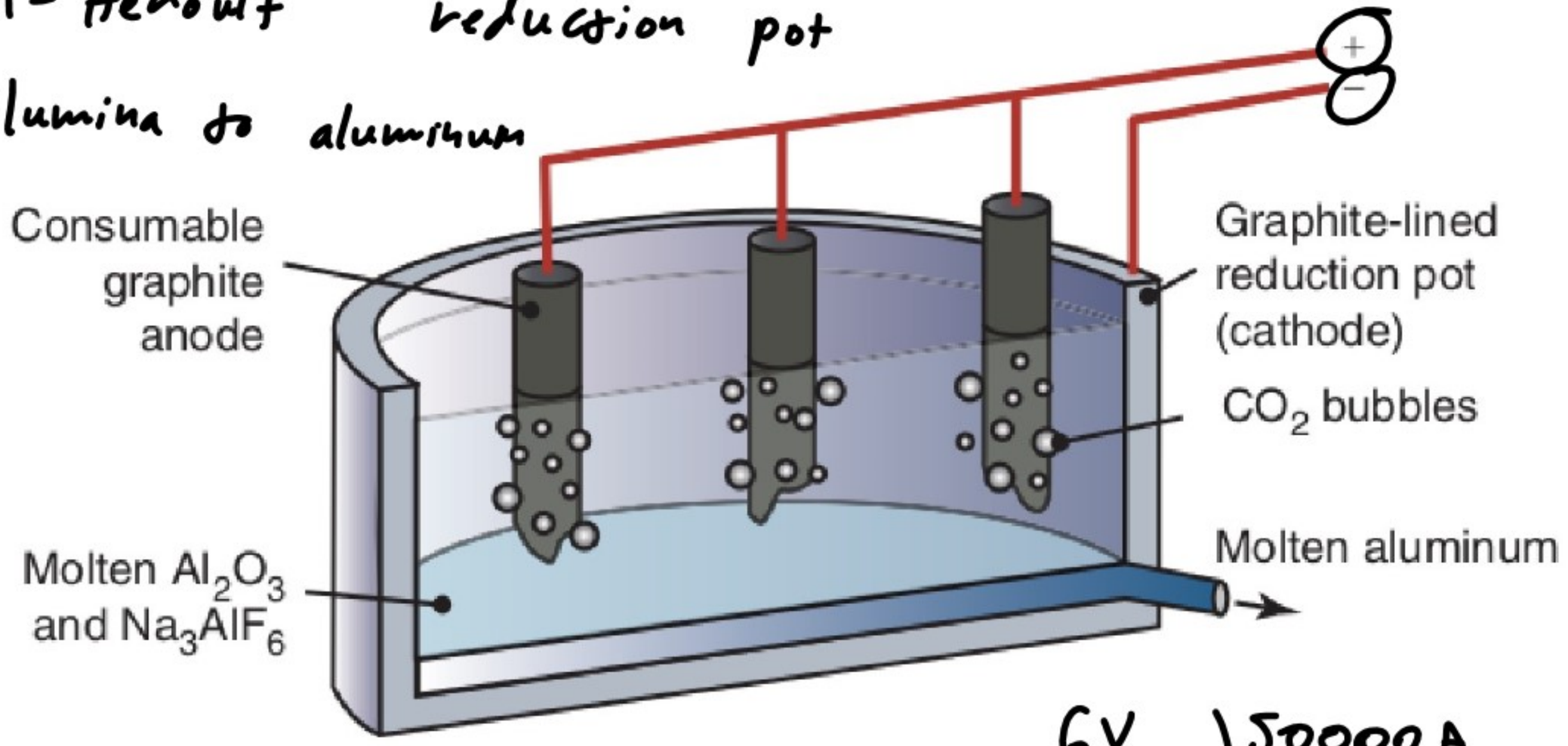
produces sodium aluminate

convert to aluminum hydroxide

heat 1000°C alumina

Hall-Heroult reduction pot

Alumina to aluminum



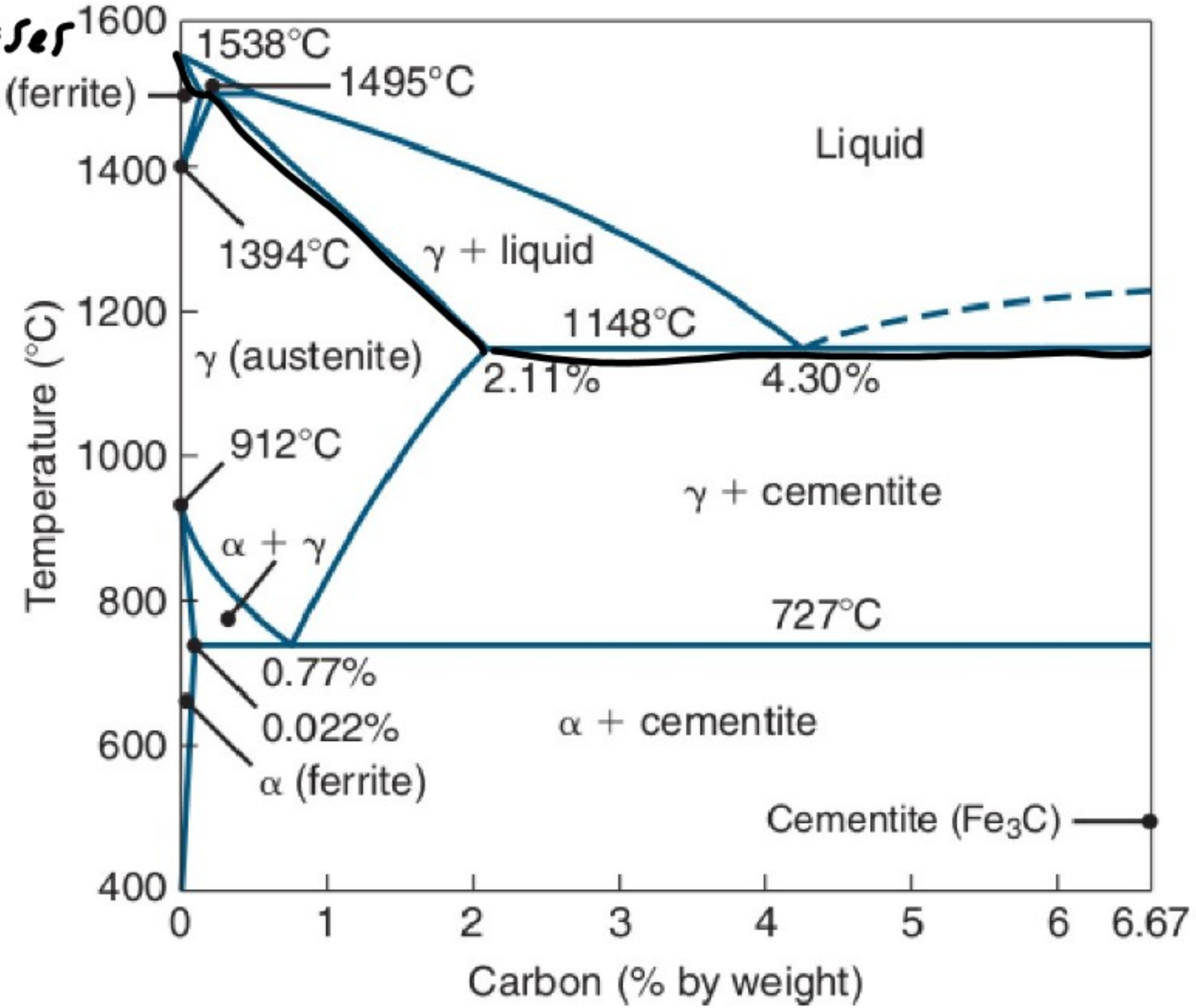
5% of US electricity

6V 150000A

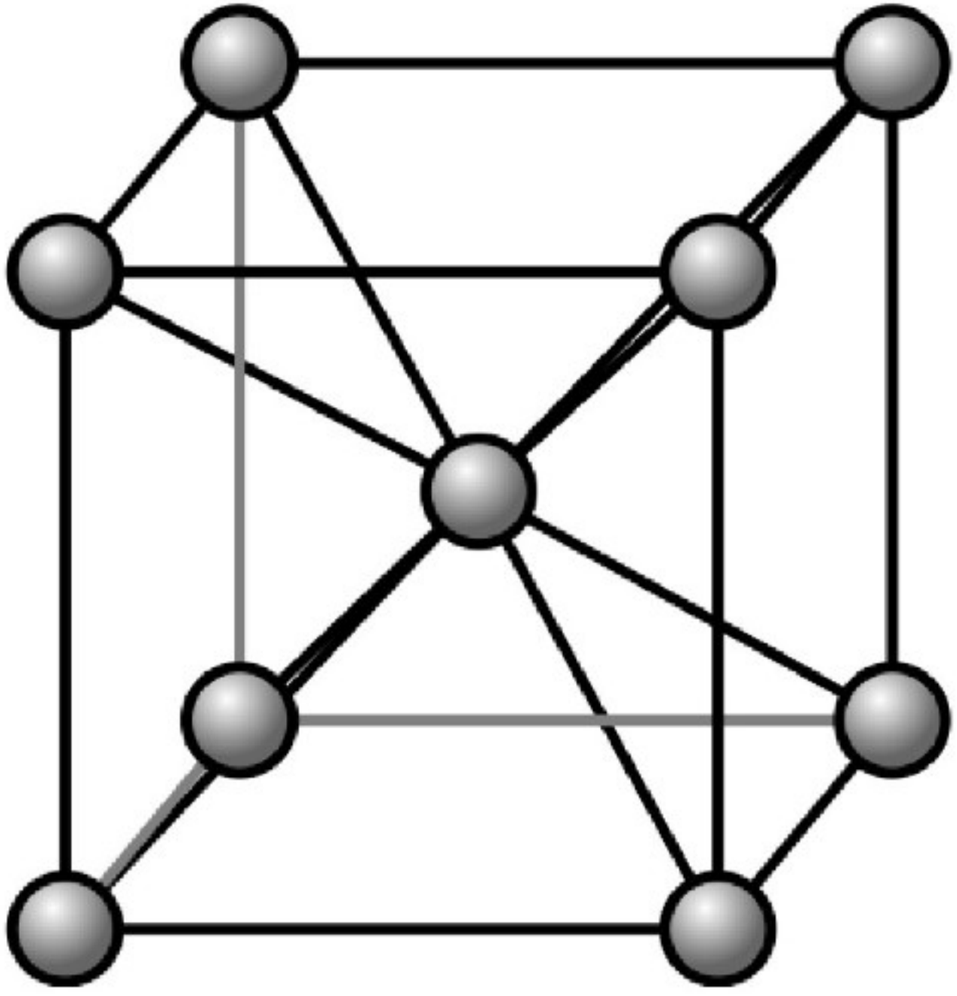
~1MW

Iron Phases

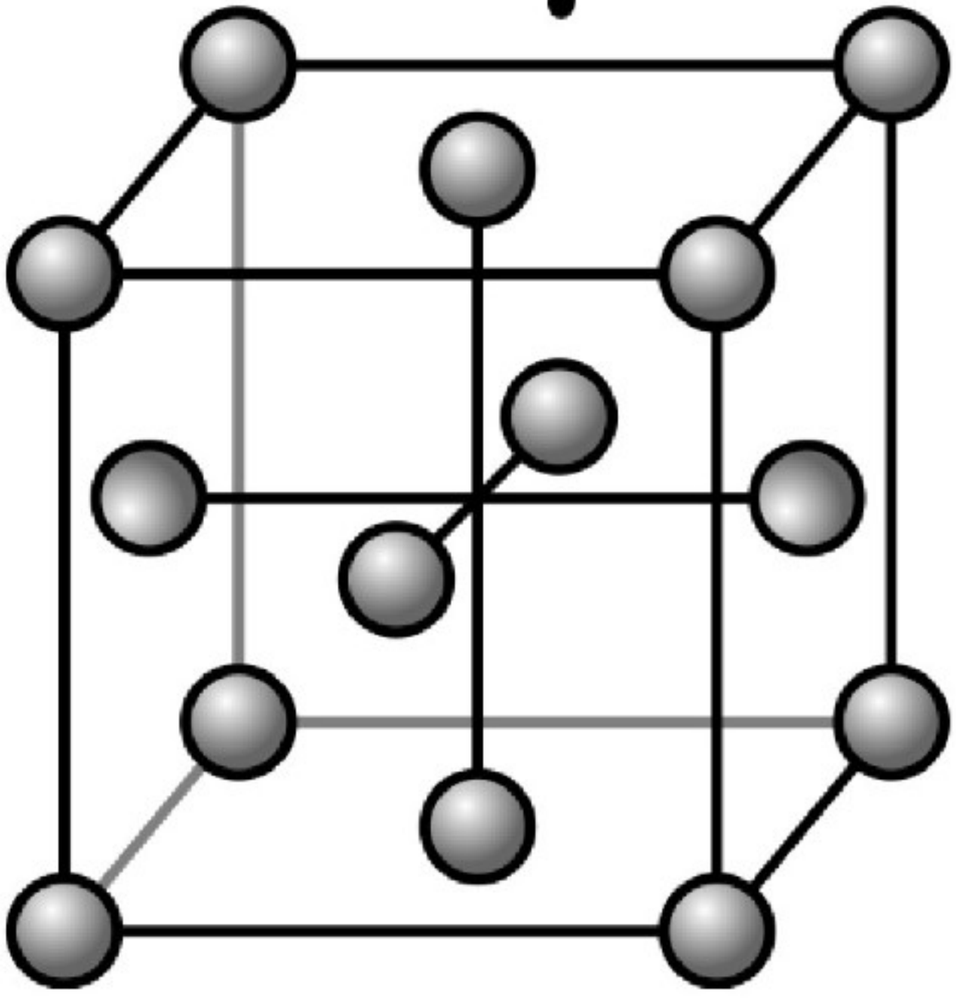
Water
Steam
Ice

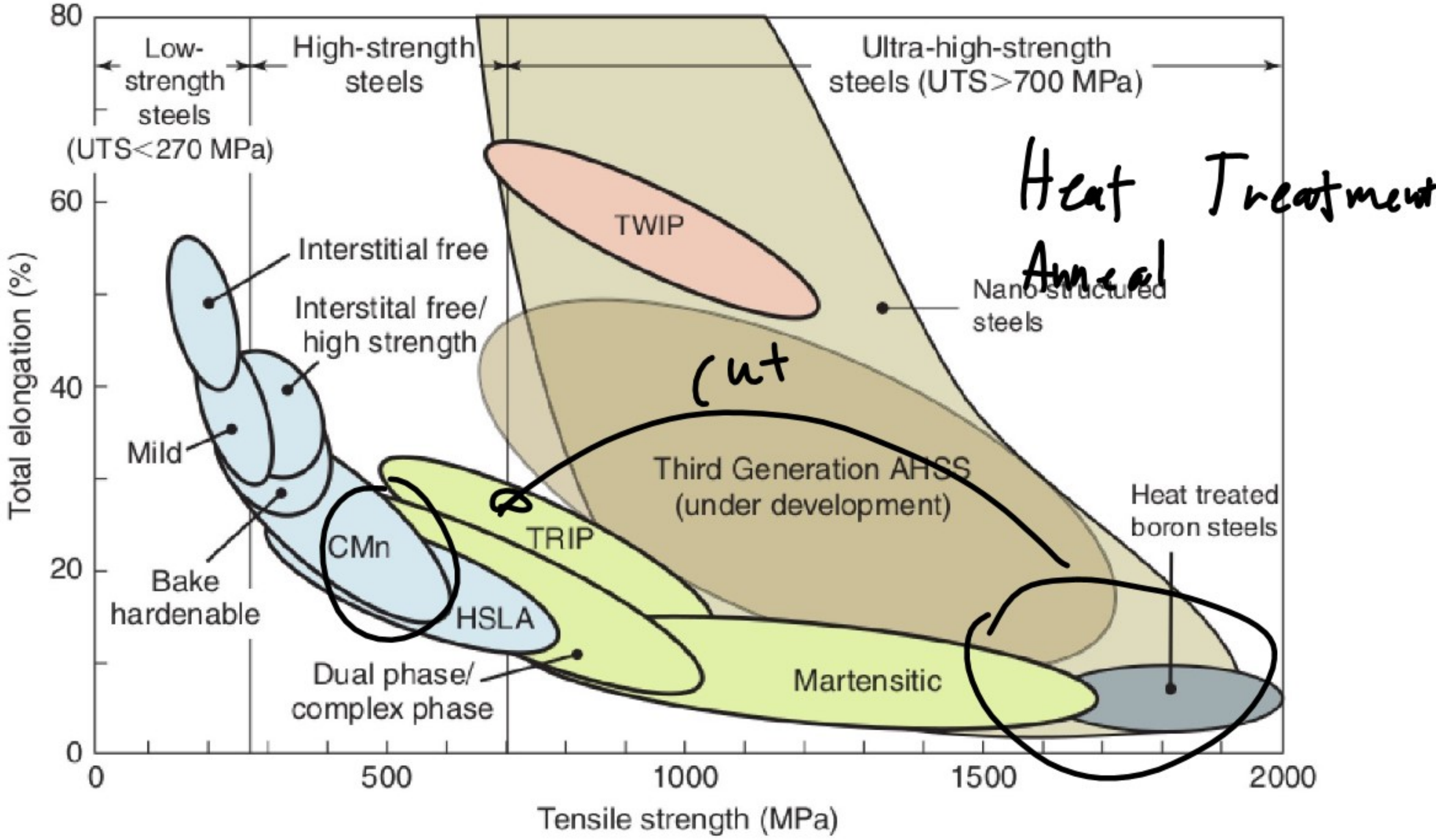


α



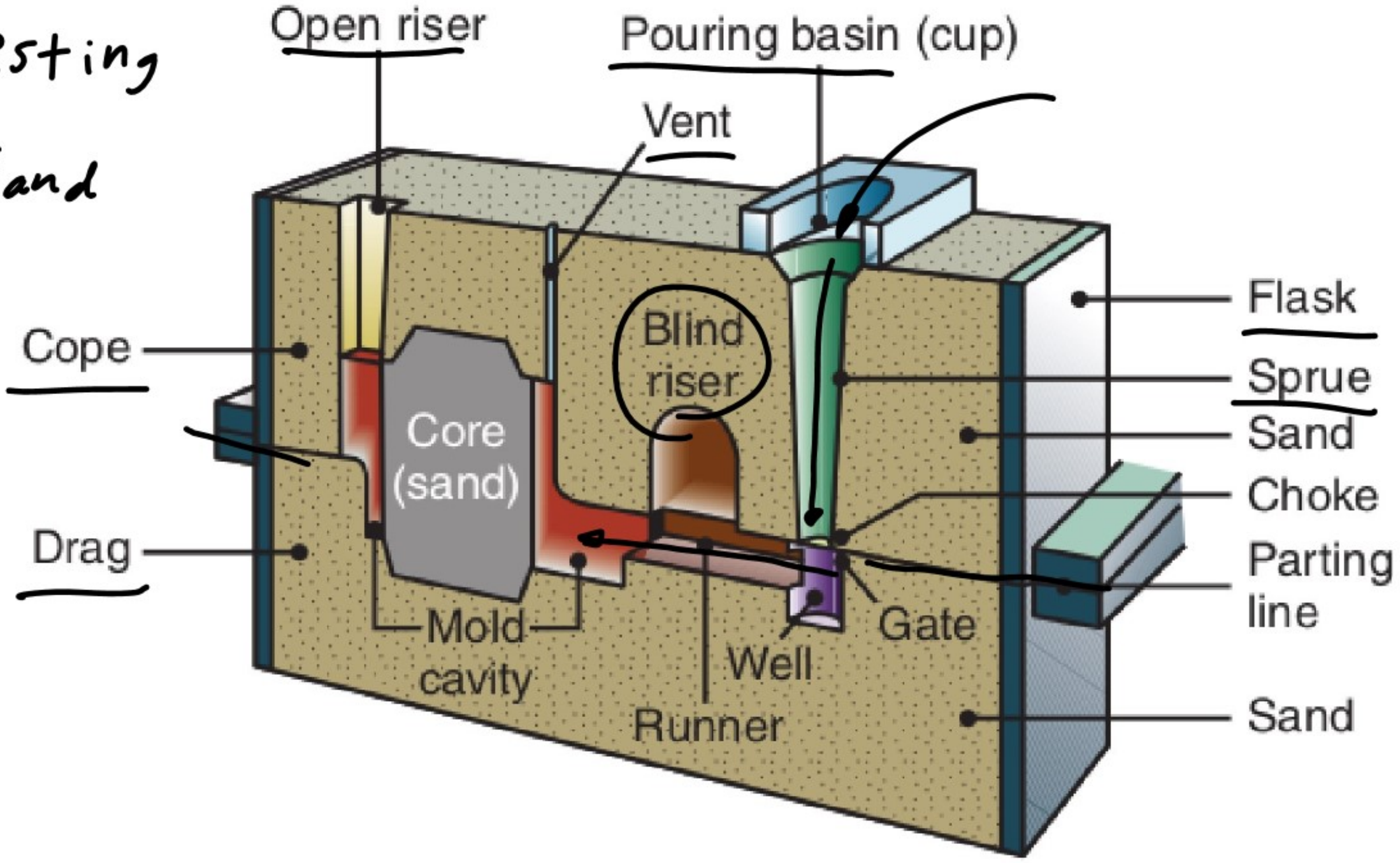
γ




Low-strength steels (UTS<270 MPa)
High-strength steels
Ultra-high-strength steels (UTS>700 MPa)
Heat Treatment
Anneal
Cut
TWIP
Interstitial free
Interstital free/ high strength
Nano structured steels
Mild
Third Generation AHSS (under development)
Heat treated boron steels
CMn
TRIP
Bake hardenable
HSLA
Dual phase/ complex phase
Martensitic
Total elongation (%)
Tensile strength (MPa)
0
20
40
60
80
0
500
1000
1500
2000

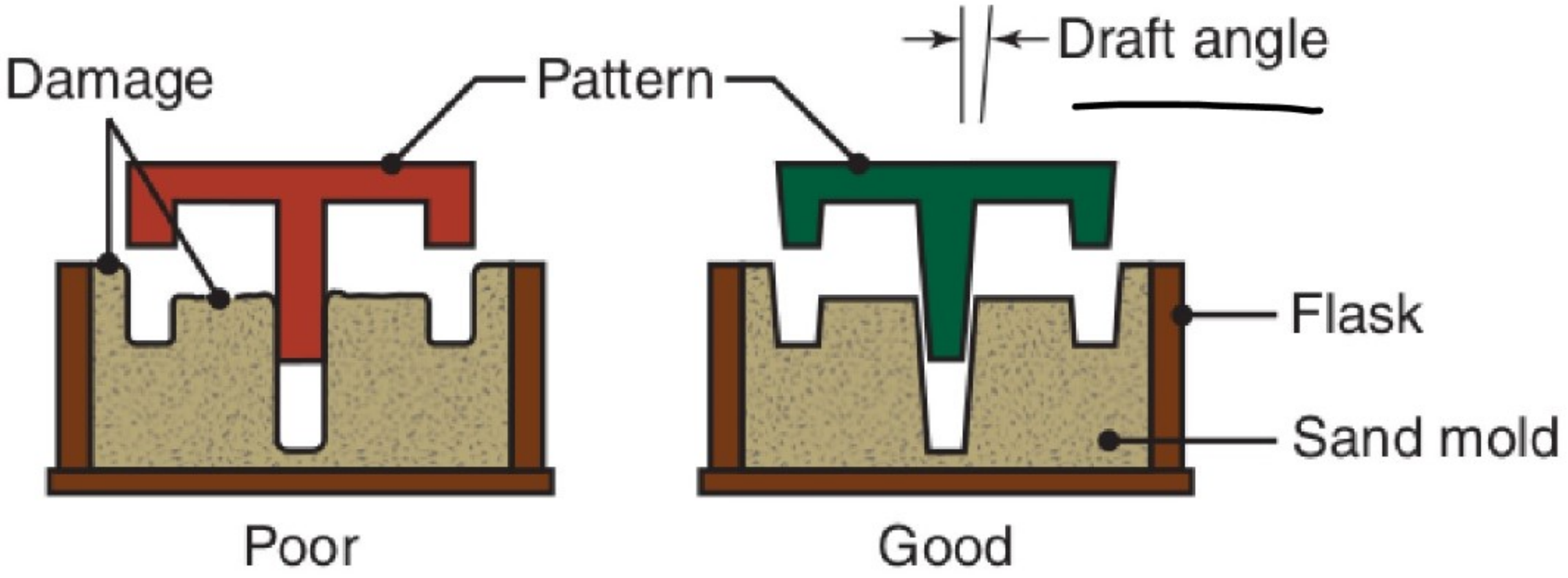
Case Hardening

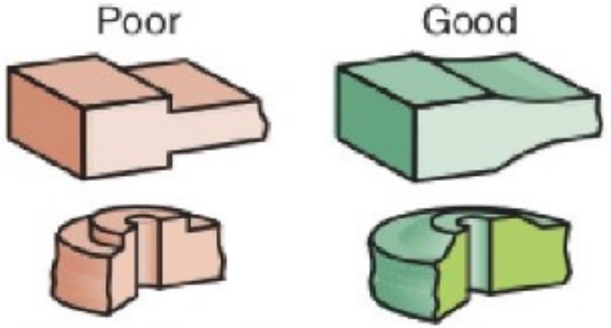
Casting Sand



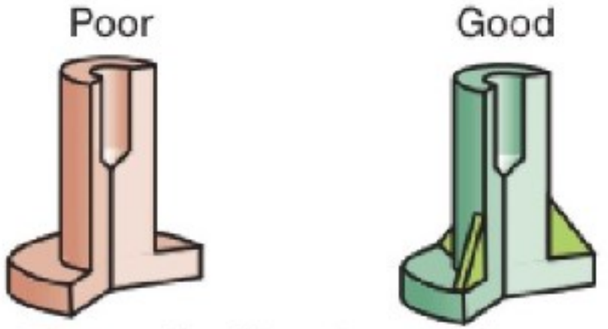

Pluk


flask

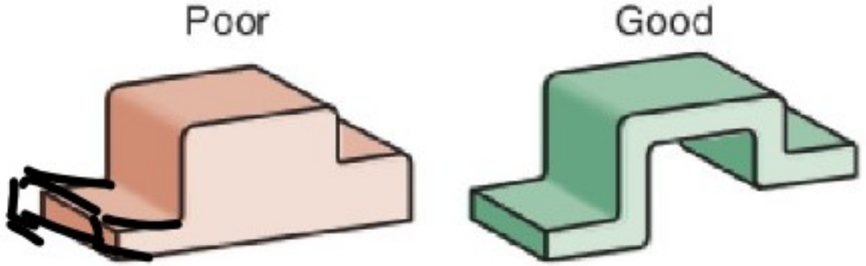

Damage
Pattern
Draft angle
Flask
Sand mold
Poor
Good



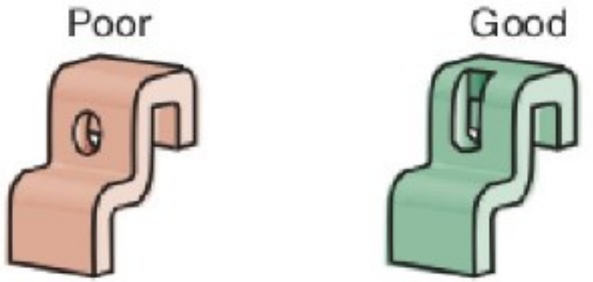
Use radii or fillets to avoid corners and provide uniform cross-section.



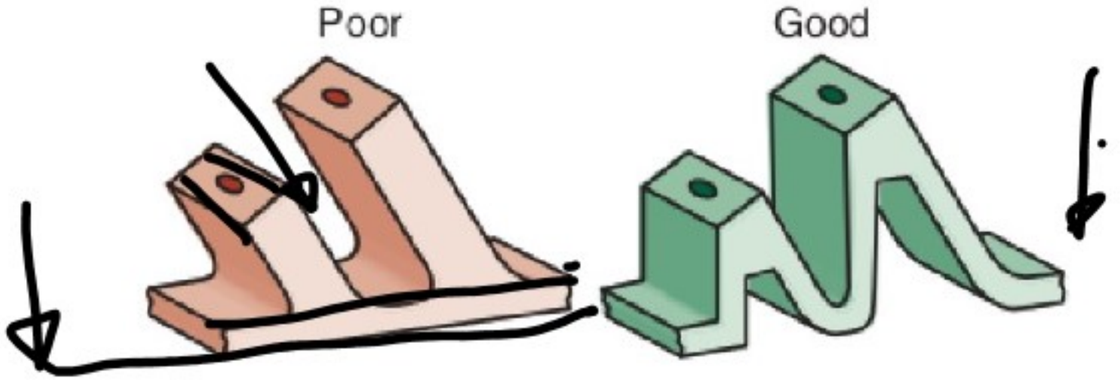
Ribs and/or fillets improve bosses.



Wall sections should be uniform.



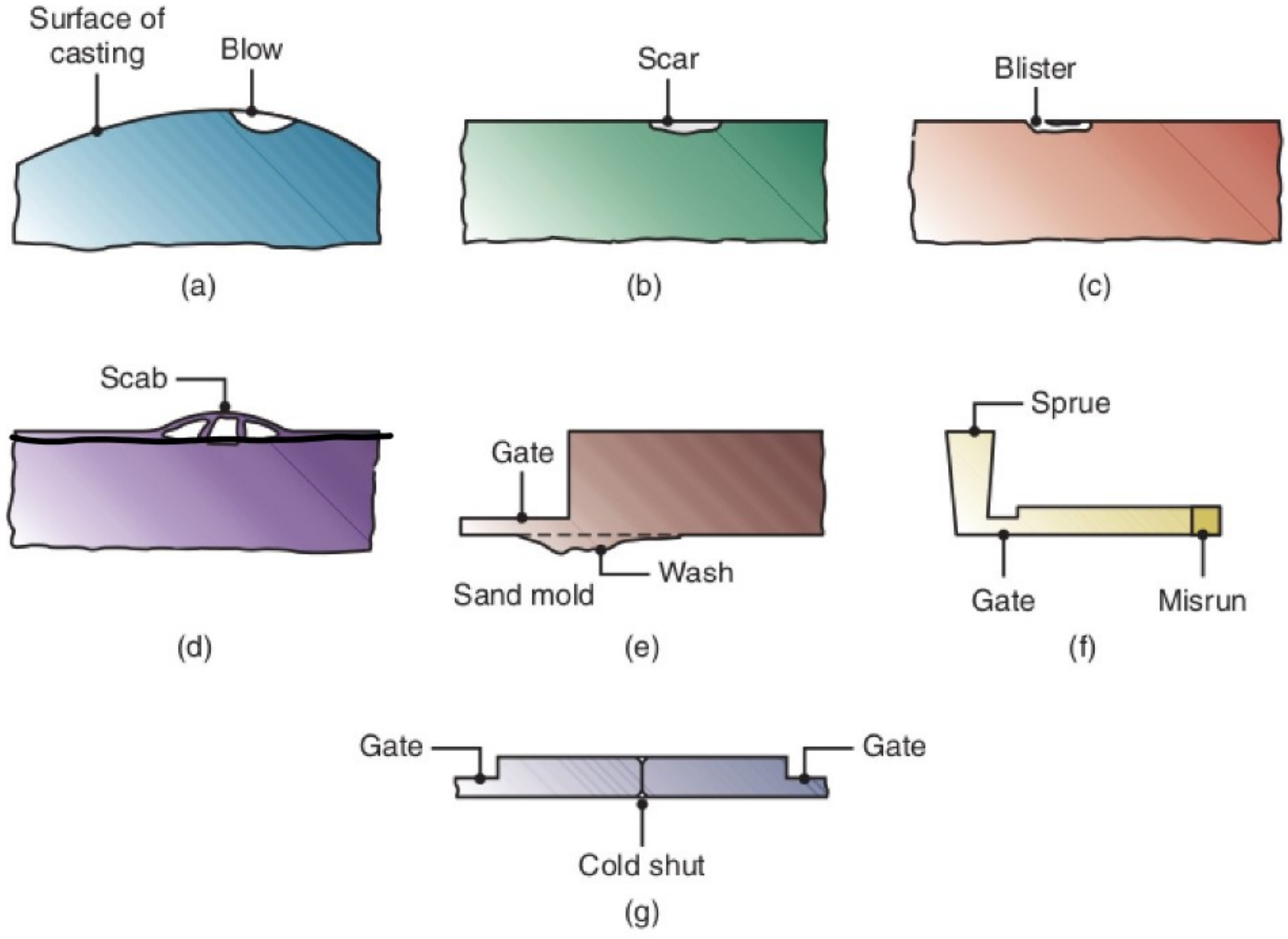
Side cores can be eliminated with this hole design.

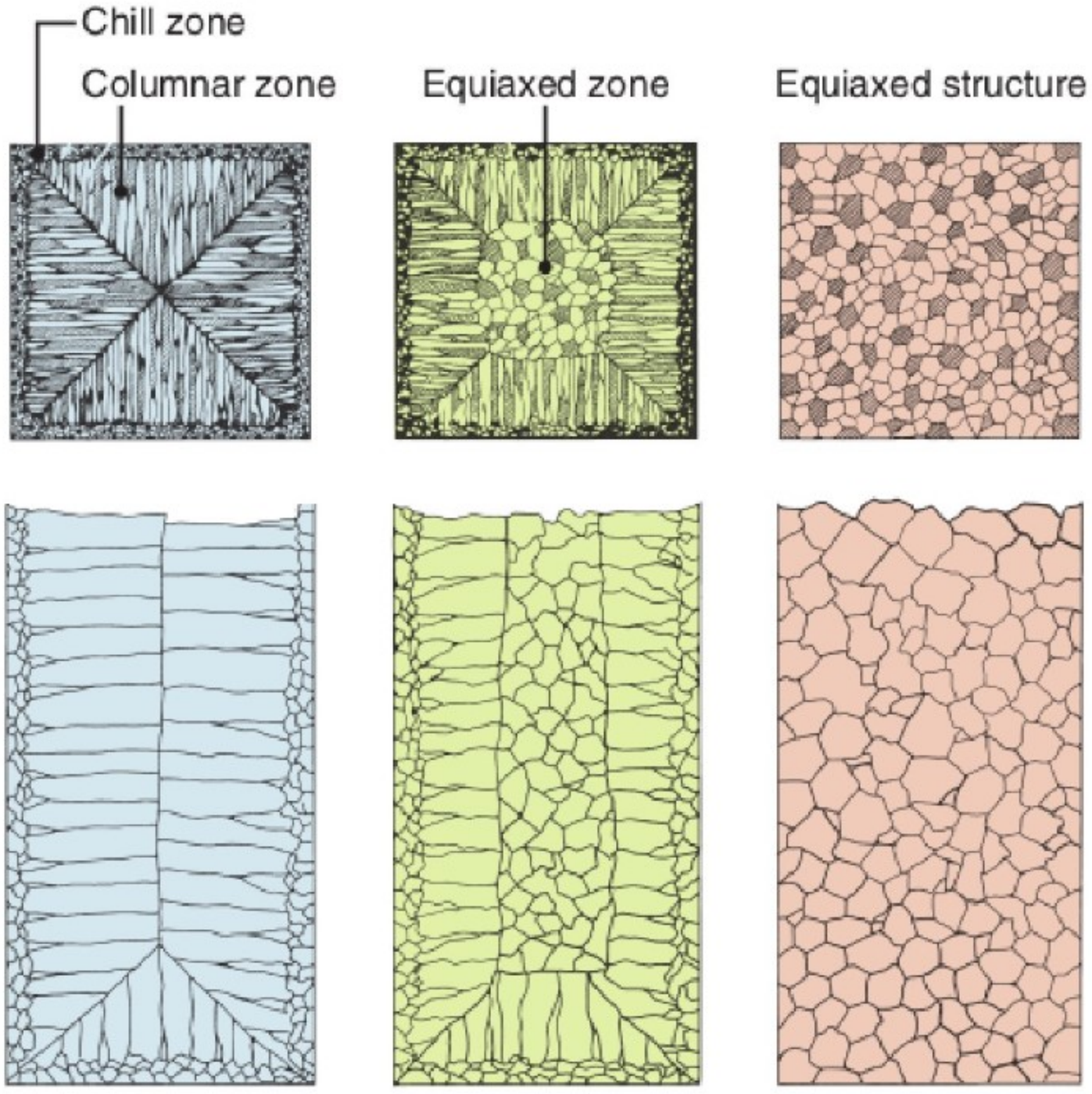


Sloping bosses can be designed for straight die parting to simplify die design.


SOAR
GPRV HYDROTURBINE

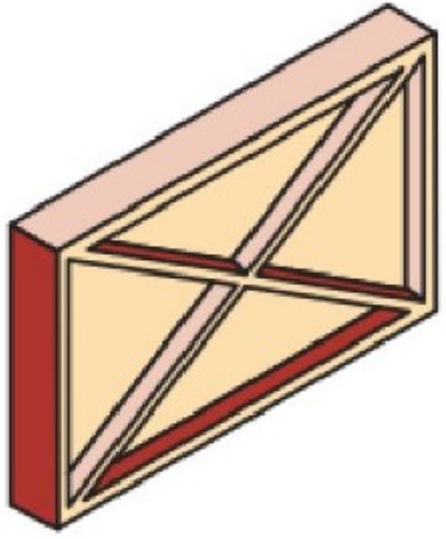

SOAR


Surface of casting
Blow
(a)
Scar
(b)
Blister
(c)
Scab
(d)
Gate
Wash
Sand mold
(e)
Sprue
Gate
Misrun
(f)
Gate
Gate
Cold shut
(g)


Chill zone
Columnar zone
Equiaxed zone
Equiaxed structure

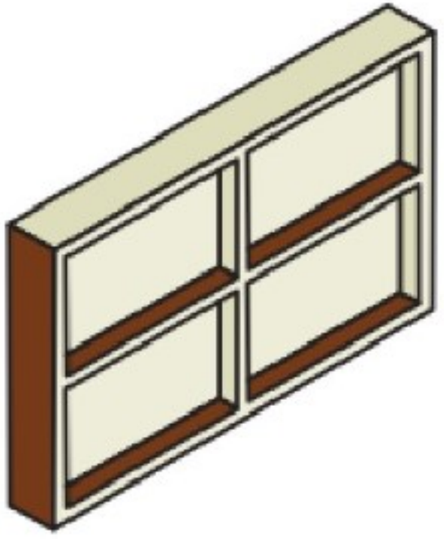
Metal	Shrinkage allowance (%)
Cast Irons	
Gray cast iron	0.83–1.3
White cast iron	2.1
Malleable cast iron	0.78–1.0
Aluminum alloys	1.3
Magnesium alloys	1.3
Copper alloys	
Yellow brass	1.3–1.6
Phosphor bronze	1.0–1.6
Aluminum bronze	2.1
High-manganese steel	2.6

Poor



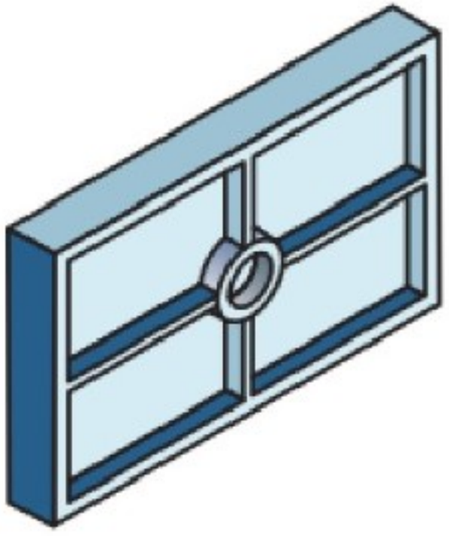
(a)

Poor



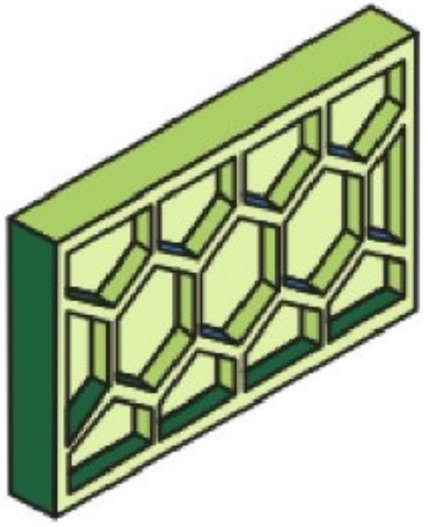
(b)

Good



(c)

Best



(d)