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"There is nothing impossible to they who will try."

GATE 2024

प्रचण्ड Batch

PRODUCTION

CASTING

LEC-09

Mechanical Engineering


ONLINE TEST
1.
a
b
c
2.
a
b
c

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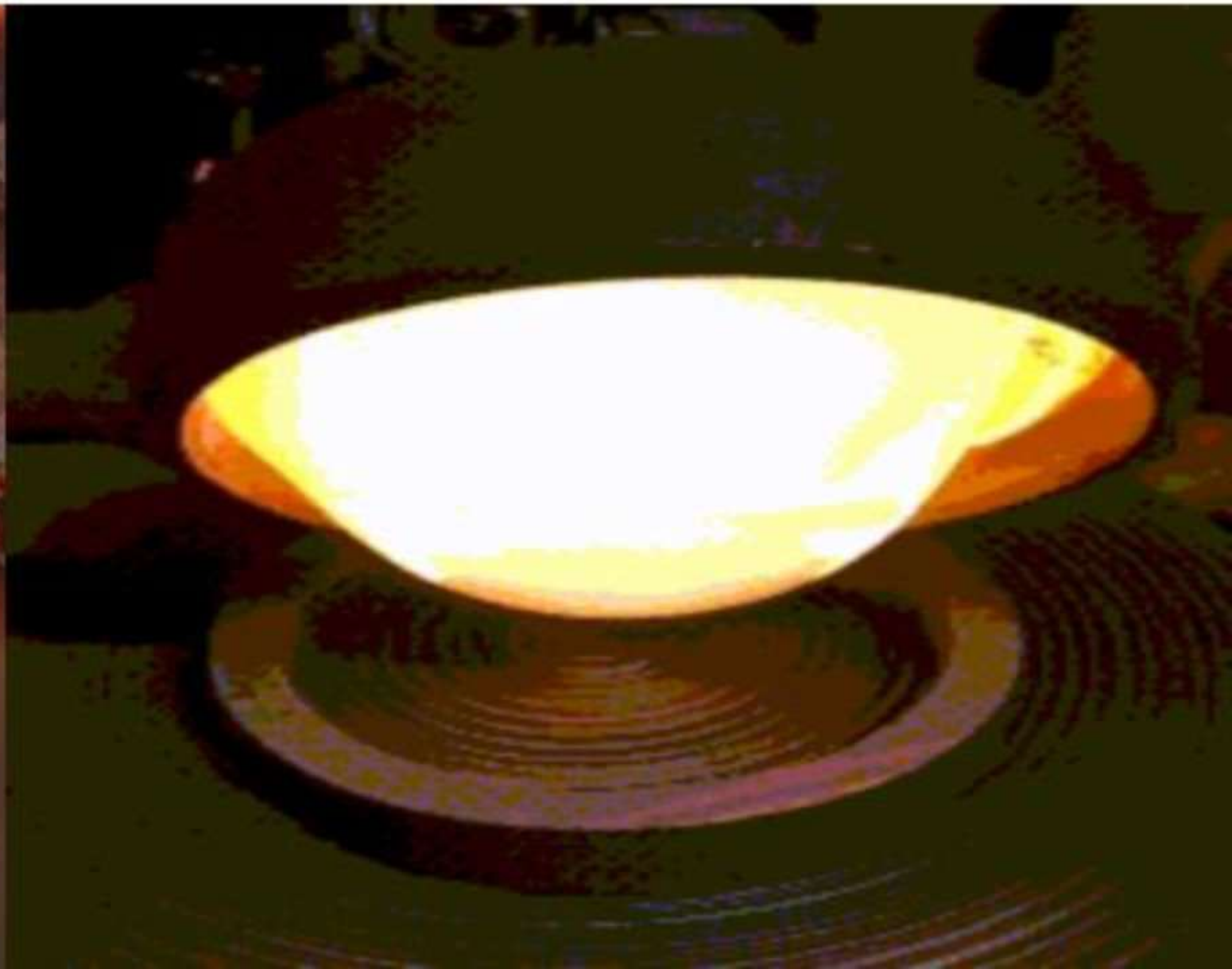
GATE 2024
GATE
प्रचण्ड Batch
MECHANICAL ENGINEERING
MON/ TUE/ WED- 9PM
THEORY OF MACHINE (TOM)
THUR/ FRI/ SAT- 6PM
PRODUCTION ENGINEERING

CASTING



INDEX

Introduction of Casting

Broad Steps in Sand Casting

Cooling Curve for Sand Casting

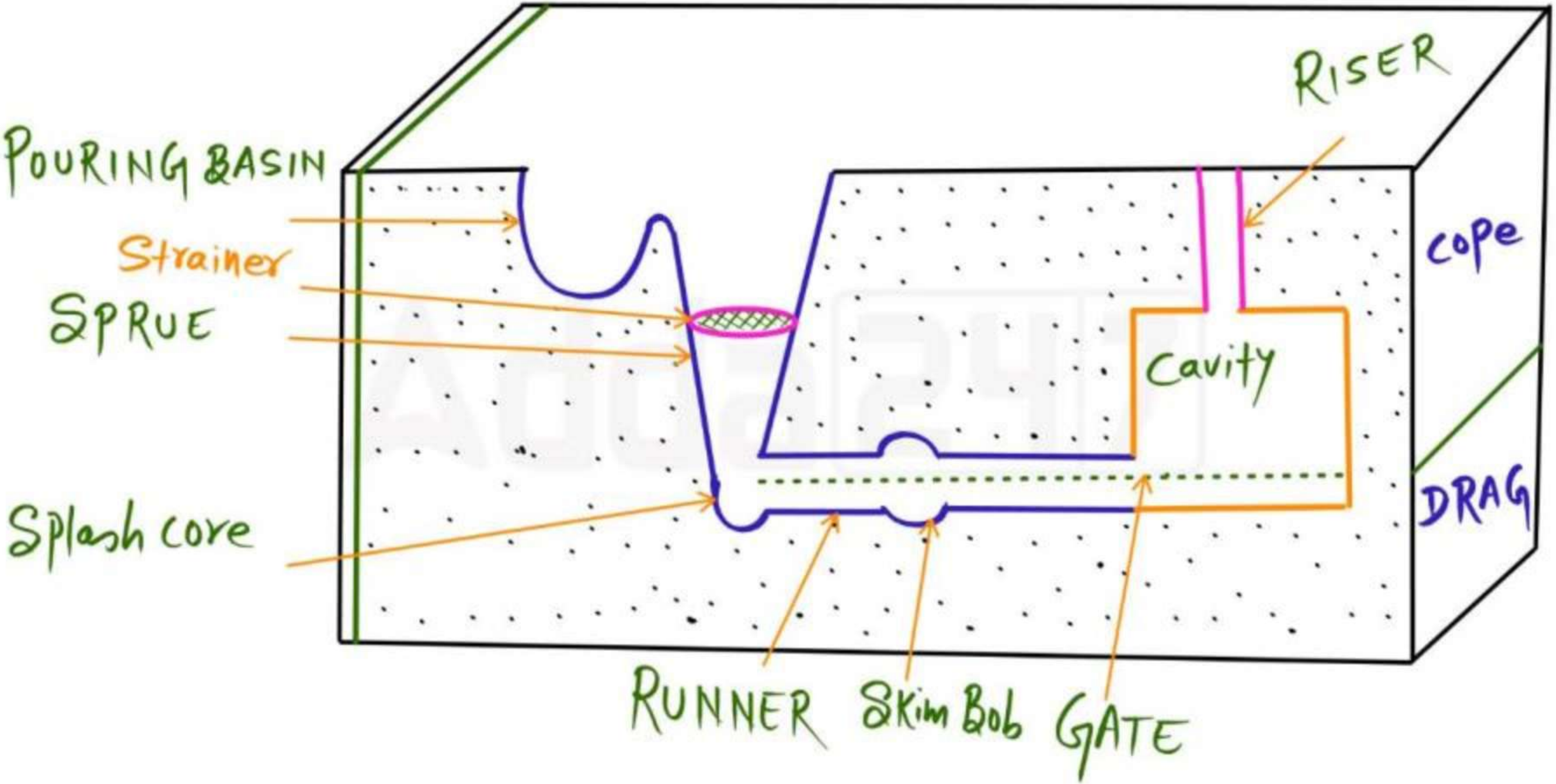
Types of allowances

Types of pattern

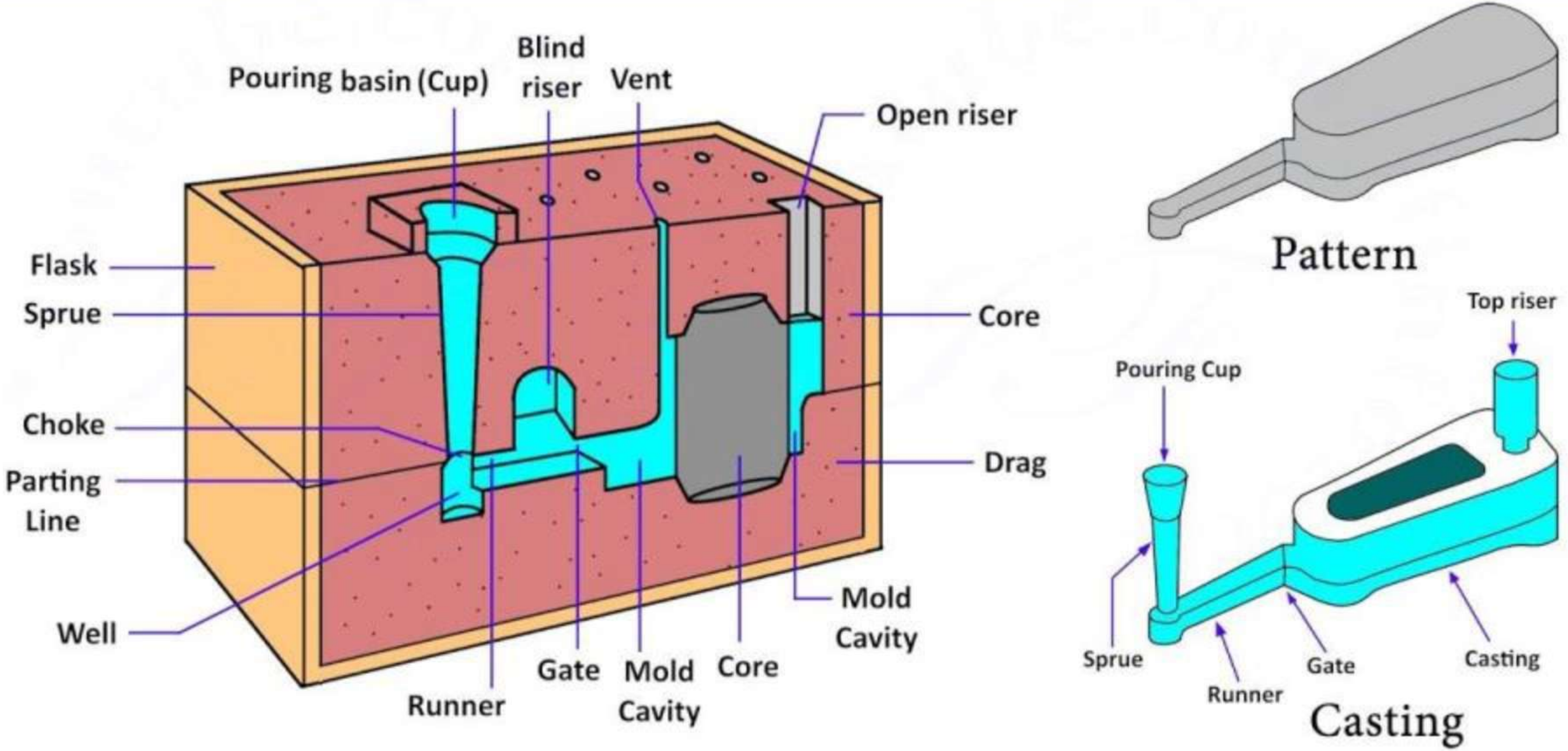
Moulding sand and its properties

Elements of Gating Design

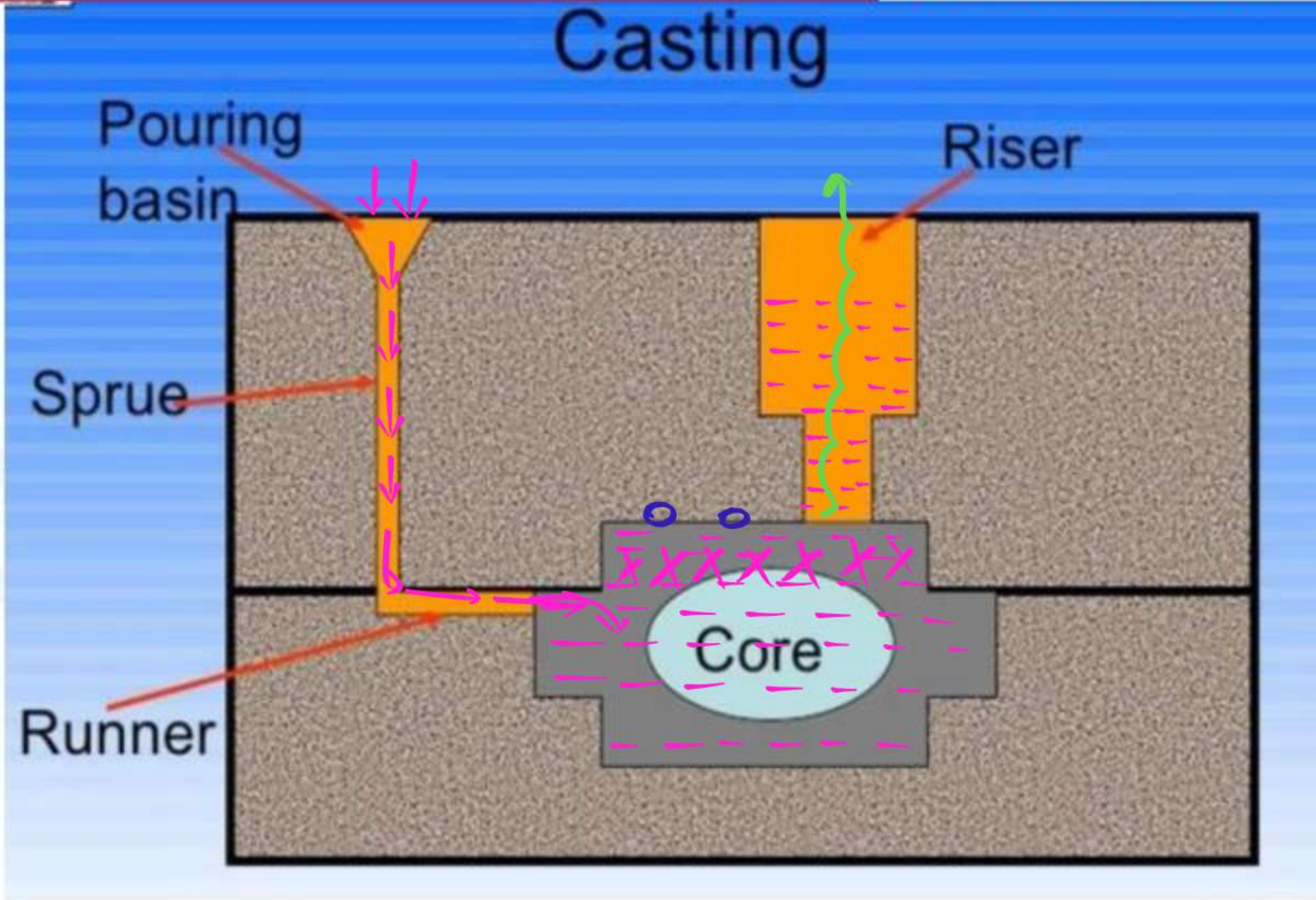
Riser and Riser Design

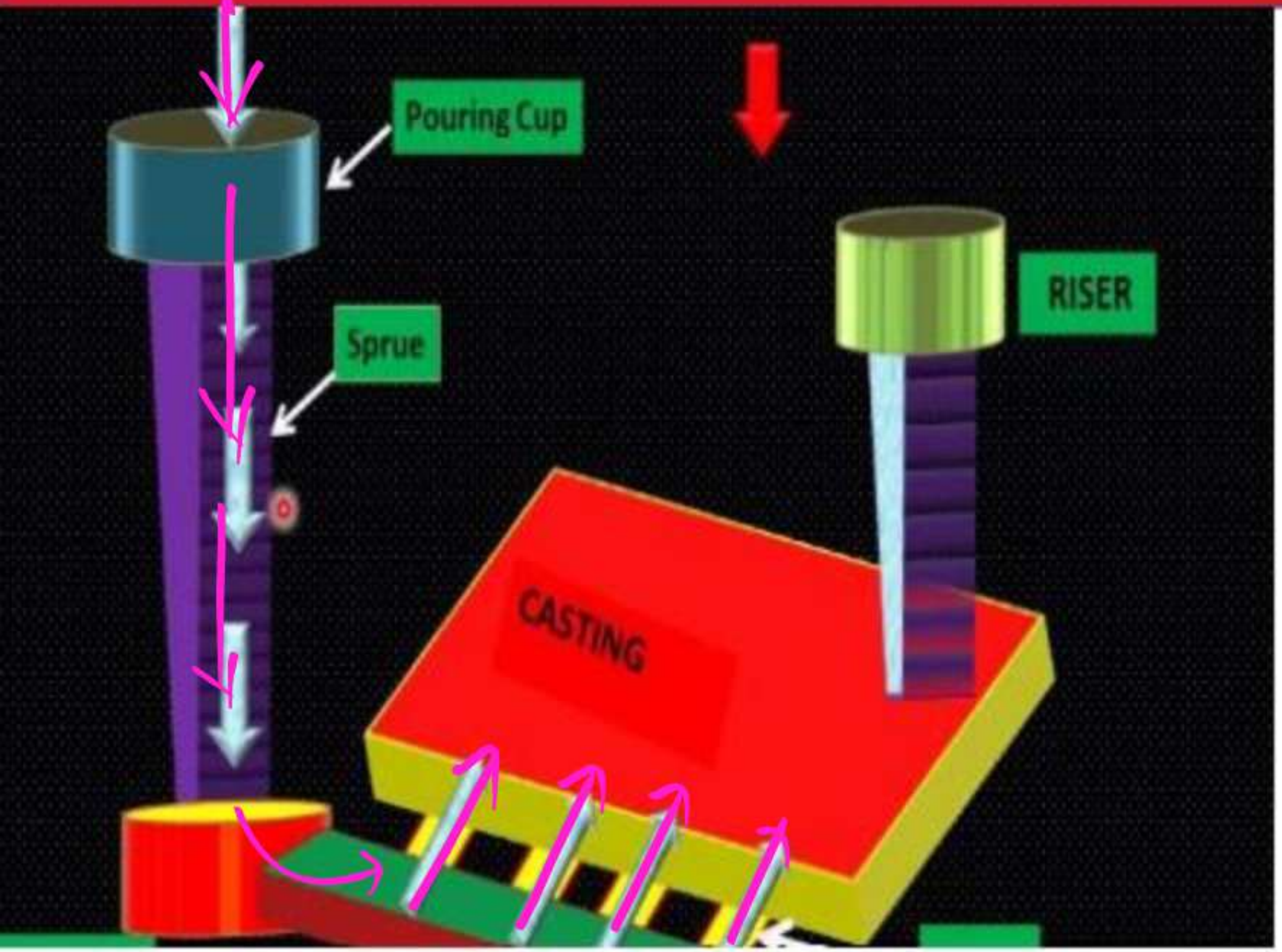

POURING BASIN
Strainer
SPRUE
Splash core
RISER
cope
Cavity
DRAG
RUNNER
Skim Bob
GATE

Gating System (Metal Casting Process)



Riser




Pouring Cup
RISER
Sprue
CASTING

Function of Riser

① To Escape the Gas oR Air which is Generated inside the cavity.

② It Componsate the Liquid And Solidification Shrinkage.

③ It Shows that whether the casting is full oR not. → Top Riser → Side Riser

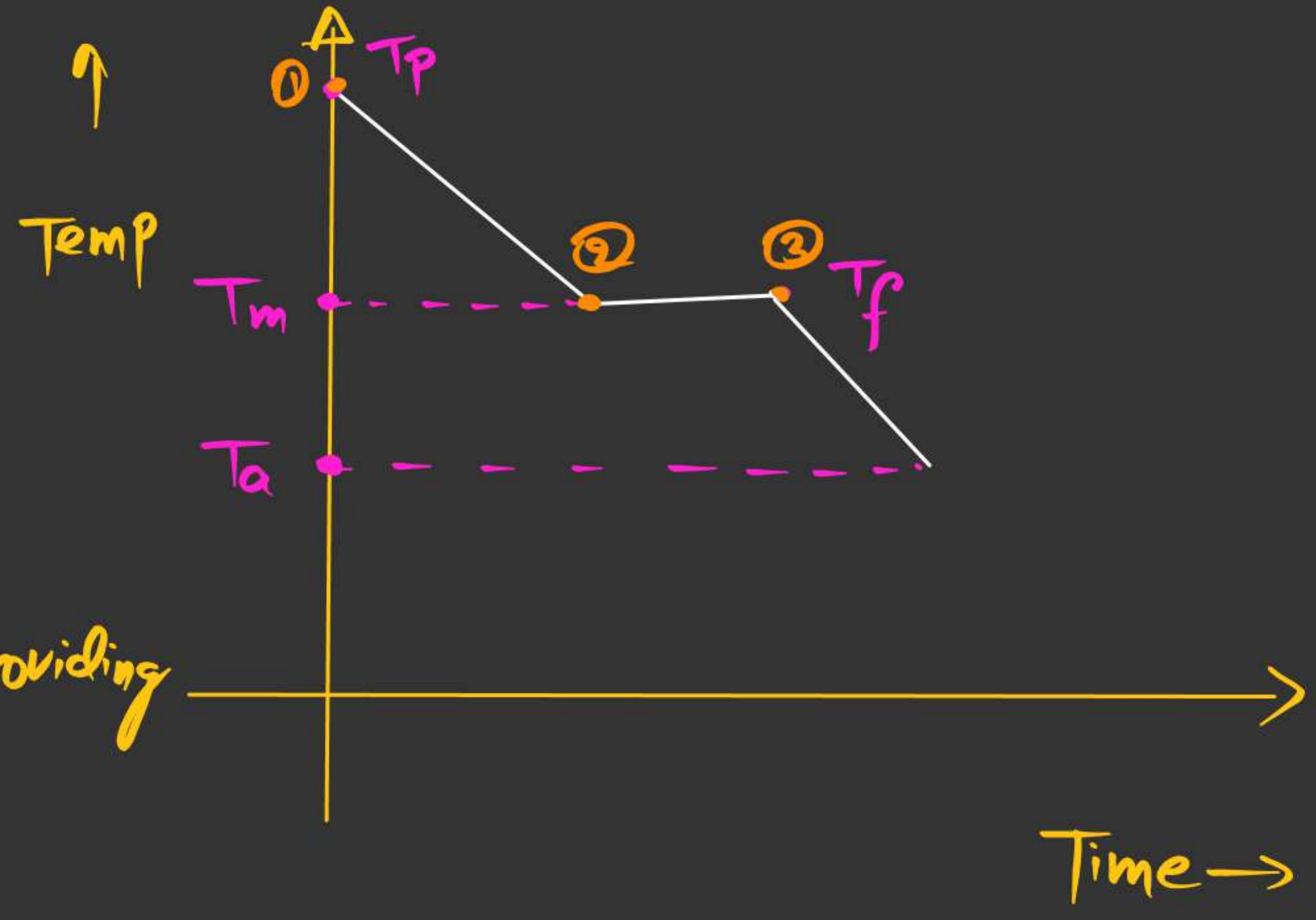
Blind Riser ⇒ Perform only Above function ① And function ②

* open Riser perform function ① And function ② And function ③

* 1 → 2 → Liquid Shrinkage

* 2 → 3 → Solidification Shrinkage

Componsated by Providing Riser

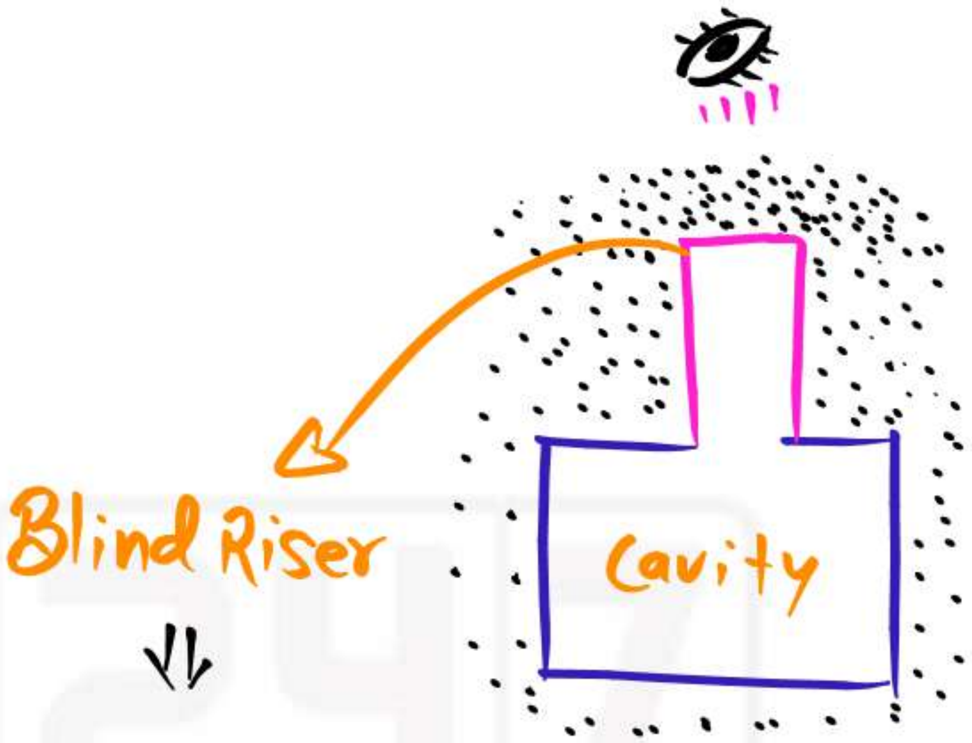


Types of Riser

1.Side Riser

2.Top Riser

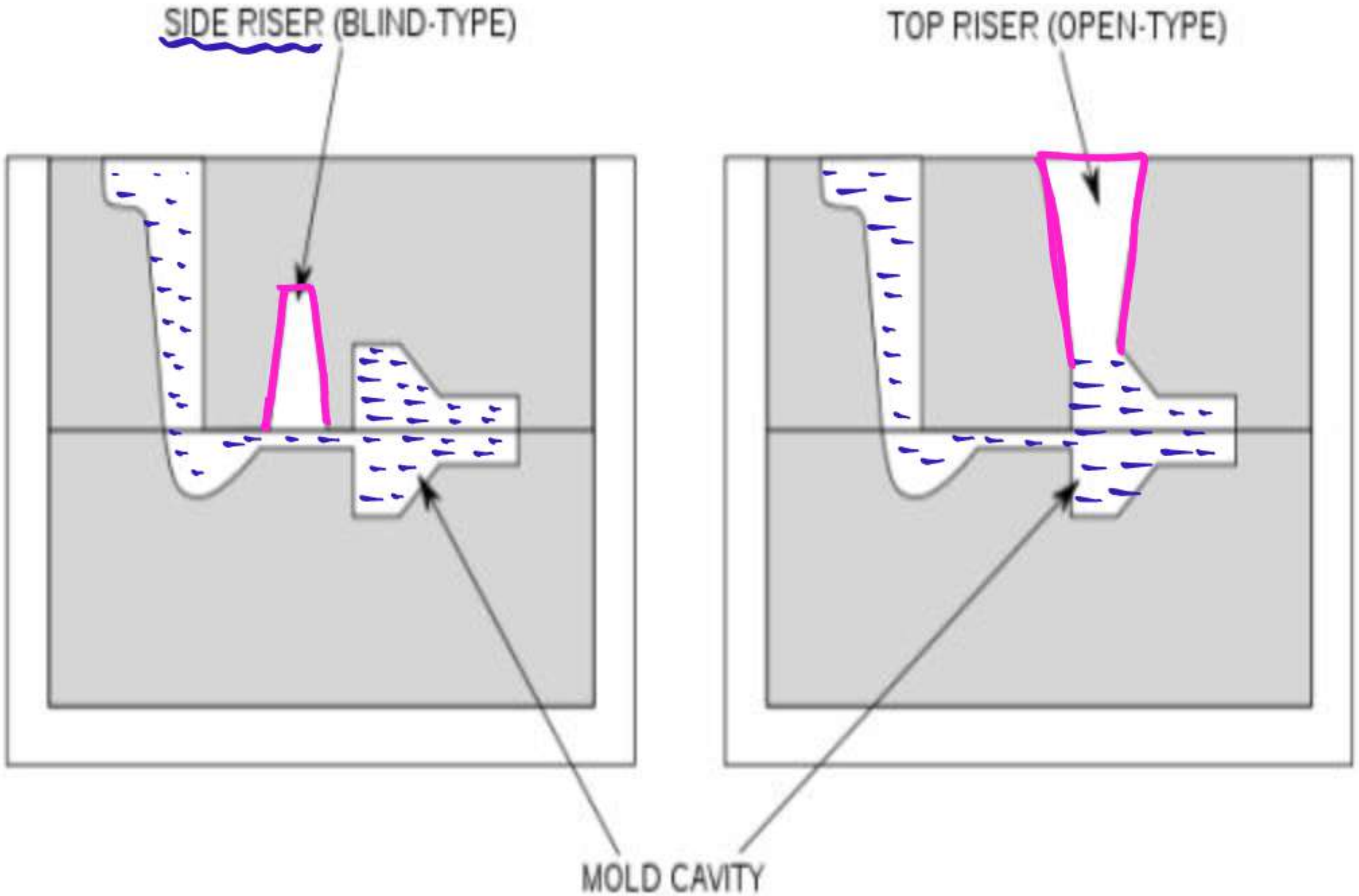
③ Blind Riser



⇓

Riser covered by Moulding Sand

Riser → open Riser
Riser → Blind Riser

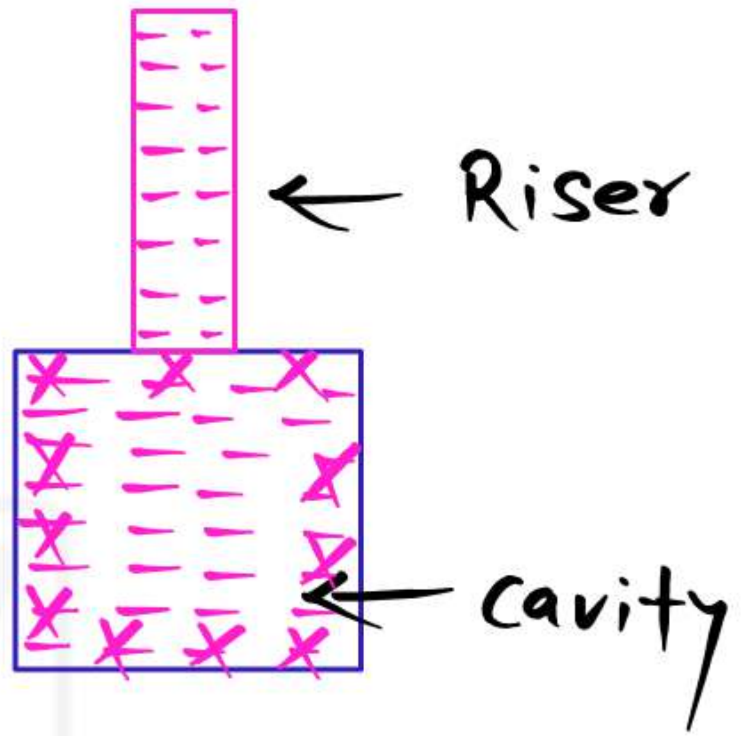

SIDE RISER (BLIND-TYPE)
TOP RISER (OPEN-TYPE)
MOLD CAVITY

Solidification Time (t_s)

For Directional Solidification

⇓

$$(t_s)_{Riser} > (t_s)_{cavity}$$



* $t_s \propto \left(\frac{V}{SA}\right)^2$

* $t_s = K\left(\frac{V}{SA}\right)^2$

* V → Volume of casting
* SA → Surface Area of cavity
* K → Solidification factor (s/m^2)

K → Solidification factor
⇓
Depends of Properties of Material.

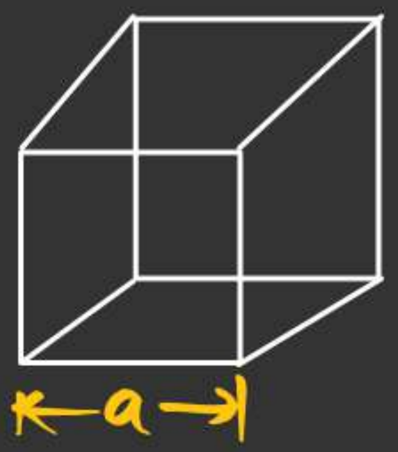
* $t_s \propto \dfrac{1}{\text{Thermal conductivity}}$

* $t_s \propto \dfrac{1}{\text{Thermal Diffusibility}}$

* $t_s \propto \text{Specific Heat}$

$* \; t_s = K\left(\frac{V}{SA}\right)^2$

① cube

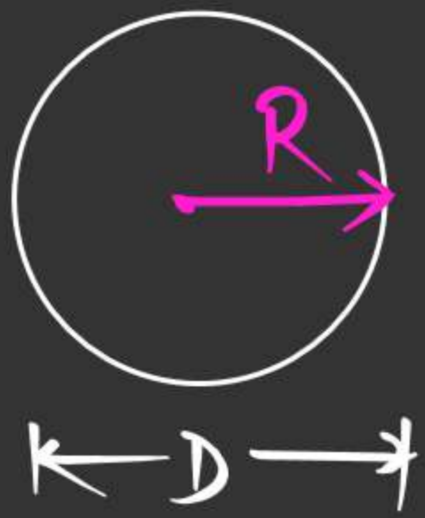


$$* \; \frac{V}{SA} = \frac{a^3}{6a^2} = \frac{a}{6}$$

② Sphere

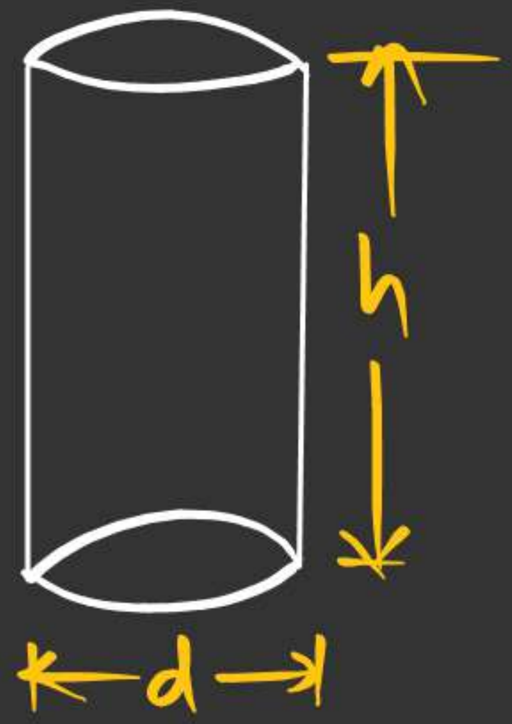
$$* \; \frac{V}{SA} = \frac{\frac{4}{3}\pi R^3}{4\pi R^2}$$

$$* \; \frac{V}{SA} = \frac{R}{3} = \frac{D}{6}$$



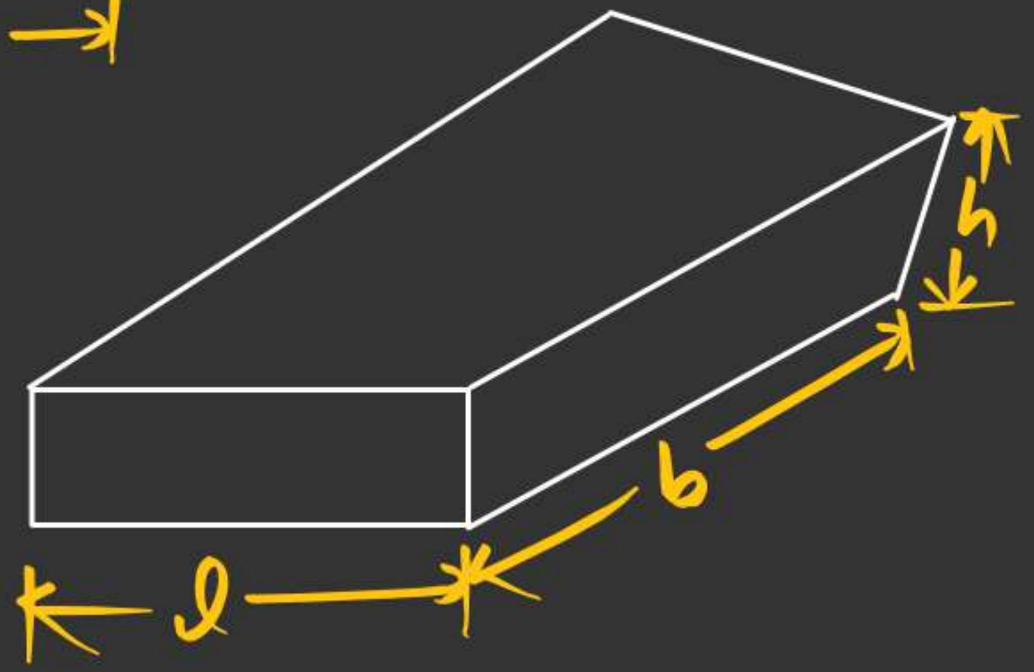
③ cylinder

$$* \ \frac{V}{SA} = \frac{\left(\frac{\pi}{4}d^2\right)\cdot h}{2\times\frac{\pi}{4}d^2 + \pi d h}$$



④ Slab

$$* \ \frac{V}{SA} = \frac{l\cdot b\cdot h}{2(lb+bh+hl)}$$



Q.

A molten drop of liquid metal which is in spherical form with 2mm radius will solidify in 10 second .what is the solidification time of same molten drop with double the radius.

Given Data :→ Sphere

$* \frac{V}{SA} = \frac{\frac{4}{3}\pi r^3}{4\pi r^2} = \frac{r}{3}$

$* r_1 = 2mm \Rightarrow t_{s_1} = 10 sec$

$* r_2 = 4mm \Rightarrow t_{s_2} = ?$

Solution :→

$* t_s = K\left(\frac{V}{SA}\right)^2$

$* t_s = K\left(\frac{r}{3}\right)^2$

* $t_s = K\left(\frac{r}{3}\right)^2$

* $t_{s_1} = K_1\left(\frac{r_1}{3}\right)^2$ — ①

* $t_{s_2} = K_2\left(\frac{r_2}{3}\right)^2$ — ②

$\frac{t_{s_1}}{t_{s_2}} = \frac{K_1(r_1/3)^2}{K_2\left(\frac{r_2}{3}\right)^2}$

* $\frac{t_{s_1}}{t_{s_2}} = \frac{\cancel{K_1}}{\cancel{K_2}}\left(\frac{r_1}{r_2}\right)^2$

* $\frac{t_{s_1}}{t_{s_2}} = \left(\frac{r_1}{r_2}\right)^2$

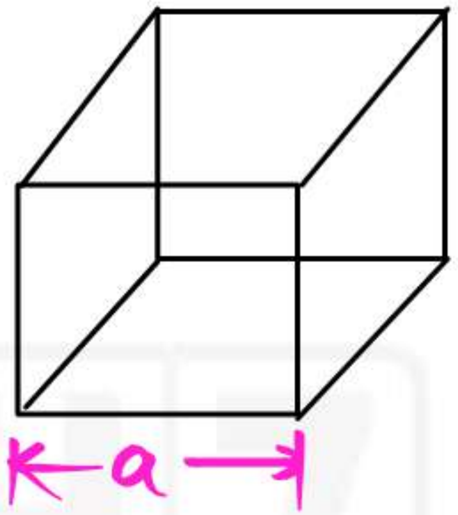
* $\frac{10\ sec}{t_{s_2}} = \left(\frac{2}{4}\right)^2$

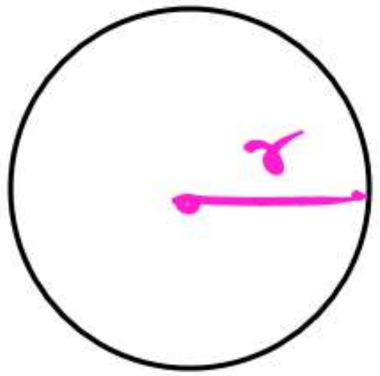
* $t_{s_2} = 40\ Sec$

Q.
Two casting one is cube another is a sphere both are made up of same material and having the same volume .what is the ratio
Of solidification time of cube to the sphere.

Given Data :→

* cube, Sphere → Same Material
* $(Vol)_{cube} = (Vol)_{sphere}$
* $\frac{(t_s)_c}{(t_s)_s} = ?$





Solution :→

$$* \frac{(t_s)_c}{(t_s)_s} = \frac{K_c \left(\frac{V}{SA}\right)_c^2}{K_s \left(\frac{V}{SA}\right)_s^2}$$

$$* \frac{(t_s)_c}{(t_s)_s} = \left(\frac{V_c \times SA_s}{SA_c \times V_s}\right)^2$$

$$* \frac{(t_s)_c}{(t_s)_s} = \left(\frac{V_c}{V_s}\right)^2 \times \left(\frac{SA_s}{SA_c}\right)^2$$

$$* \frac{(t_s)_c}{(t_s)_s} = \left(\frac{SA_s}{SA_c}\right)^2$$

$$* \frac{(t_s)_c}{(t_s)_s} = \left(\frac{4\pi r^2}{6a^2}\right)^2$$

$$* \frac{(t_s)_c}{(t_s)_s} = \left(\frac{4\pi}{6}\right)^2 \times \left(\frac{r}{a}\right)^4 \text{ — (1)}$$

$$* \frac{(t_s)_c}{(t_s)_s} = \left(\frac{4\pi}{6}\right)^2 \times \left(\frac{3}{4\pi}\right)^{4/3}$$

$$= 0.649$$

$V_s = V_c$

$\downarrow \qquad \downarrow$

* $\frac{4}{3}\pi r^3 = a^3$
* $\left(\frac{r}{a}\right)^3 = \frac{3}{4\pi}$
* $\left(\frac{r}{a}\right) = \left(\frac{3}{4\pi}\right)^{1/3}$ — (2)

Q=

A cube casting will solidify in 5 minutes another cube casting with same material is 8 times heavier than original casting .

What is the solidification time of second cubical casting.

Given Data :→ cube

* t_{s_1} = 5 Minute
* 8 times Heavier ($m_2 = 8m_1$)
* t_{s_2} = ?

* $V_2 = 8V_1$ ✗

* $m_2 = 8 m_1$

$\downarrow$

* $V_2 \cdot \cancel{\rho_2} = 8 \cdot V_1 \cancel{\rho_1}$

* $V_2 = 8 V_1$

* $(a_2)^3 = 8 (a_1)^3$

* $(a_2)^3 = (2 a_1)^3$

* $a_2 = 2 a_1$

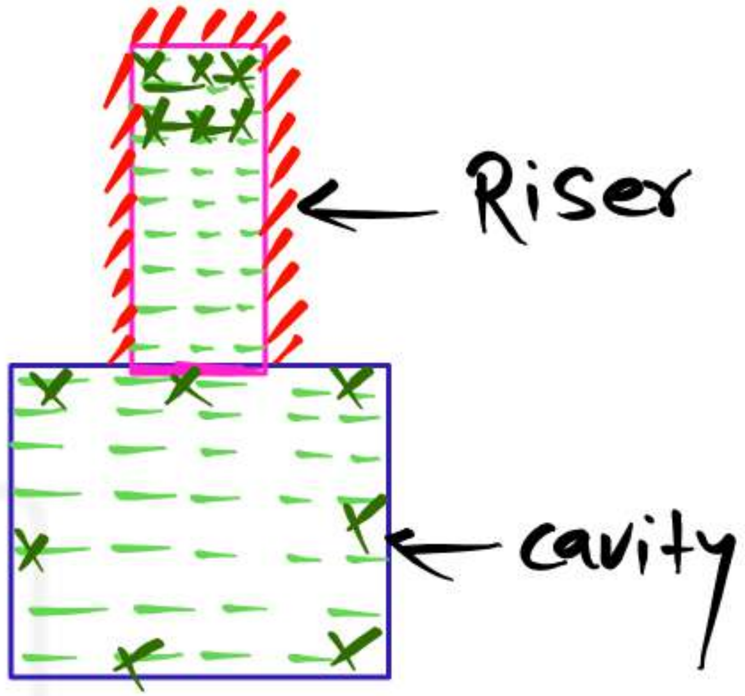
Solution :→

* $ts = K\left(\frac{V}{SA}\right)^2$
* $ts = K\left(\frac{a^3}{6a^2}\right)^2$
* $ts = K\left(\frac{a}{6}\right)^2$
* $\frac{ts_1}{ts_2} = \frac{K_1}{K_2}\left(\frac{a_1}{a_2}\right)^2$
* $\frac{ts_1}{ts_2} = \left(\frac{a_1}{a_2}\right)^2$
* $\frac{5 \text{ minute}}{ts_2} = \left(\frac{a_1}{2a_1}\right)^2$
* $\frac{5 \text{ min}}{ts_2} = \left(\frac{1}{2}\right)^2$
* $ts_2 = 20 \text{ min}$

Riser Design

$Q_s = hA_s\Delta T$

* $(t_s)_{Riser} > (t_s)_{cavity}$ ⟹ Directional Solidification



① Apply Insulating Material all over the Surface of Riser

② Done Exothermic Reaction inside the Riser

③

③ $(t_s)_{Riser} > (t_s)_{cavity}$

* $t_s = K\left(\frac{V}{SA}\right)^2$

⇓

$t_s \propto \frac{1}{(SA)}$

☺ * $(t_s)_{Riser} \longrightarrow$ Max

⇓

$SA \longrightarrow$ Min

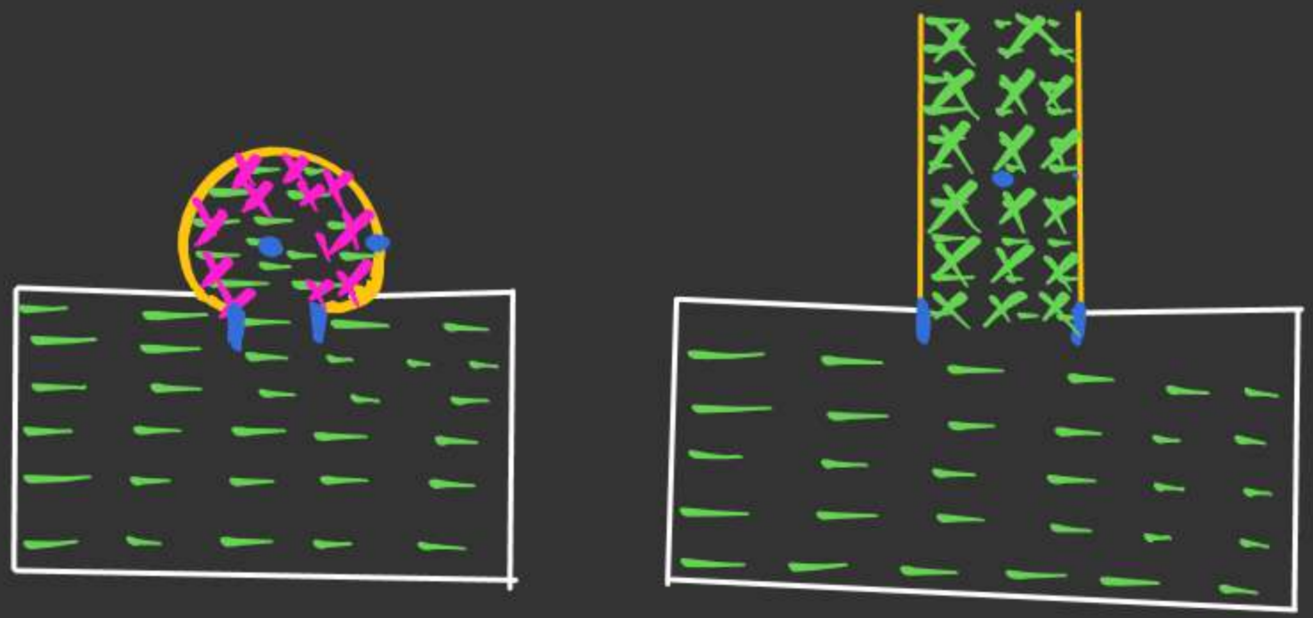
Shape of Riser

* $(t_s)_{Riser} \rightarrow Max$

  $\Downarrow$

* $(SA) \rightarrow Min$

* Sphere → (SA) → Min

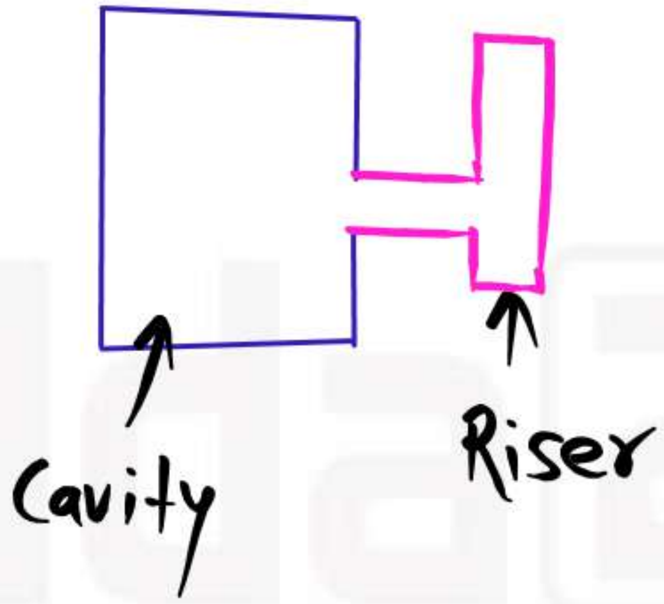


* Cylinder will be the shape of Riser

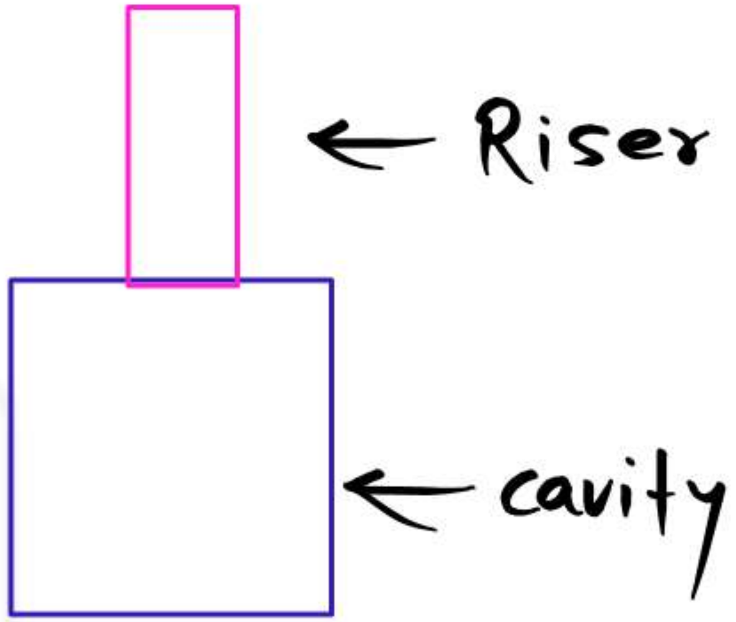
Types of Riser

1. Side Riser

2. Top Riser



① Side Riser



② Top Riser

Optimum condition in SIDE RISER

Optimum condition of Riser

⇓

* $(t_s)_{Riser} \rightarrow Max$

⇓

$(S.A) \rightarrow Min$

Optimum condition in TOP RISER

Methods of Riser Design

1.Canes Method

2.Modified canes Method

3.Modulus Method