AL-Ayen University
College of Health and Medical Technology
Department of Anesthesia

Properties of gases ,temperature and flow of fluid through the tubes and orifice

Lecture (3) theoretical
Basics of Anesthetic Equipment (1)
2nd Stage
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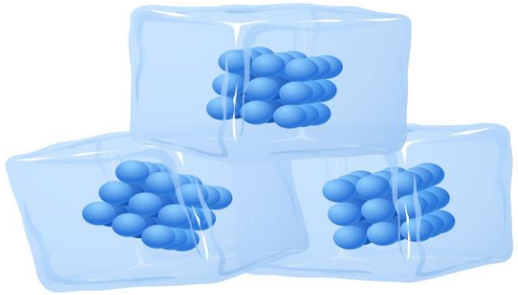
PROPERTIES OF GASES

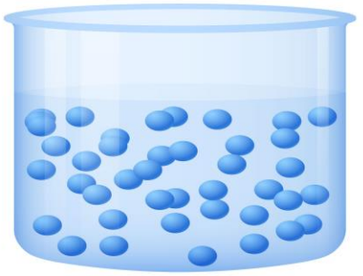
1. Gases may be compressed
2. Gases expand when less pressure is applied.
3. Gases can be mixed
4. Gases exert a constant pressure on its container walls.
5. Gases have low densities.

SOLID



- Rigid
- Fixed Shape
- Fixed Volume
- Cannot be squashed

LIQUID



- Not Rigid
- No Fixed Shape
- Fixed Volume
- Cannot be squashed

GAS

- Not Rigid
- No Fixed Shape
- No Fixed Volume
- Can be squashed

KINETIC MOLECULAR THEORY OF GASES:

1. Gases always move in straight lines and in constant motion
2. Gases are widely spaced
3. Gases collide with each other and with their container walls without loss of kinetic energy
4. Gases behave as individual particles.
5. The actual volumes of gases are insignificant compared to the space they previously.

PARAMETERS OF GASES:

- ✓ • Pressure- chaotic movement of gases make pressure measurement important
- ✓ 1 atm. = 760 mmHg = 760 torr
- ✓ • Temperature = gases expand when heated, contract when cooled
- ✓ K = 0C + 273
- ✓ • Volume = mL, liter 1 liter = 1000 mL
- ✓ • Quantity= grams and or moles

GAS LAWS:

• Mathematical statements of the properties and behavior of gases

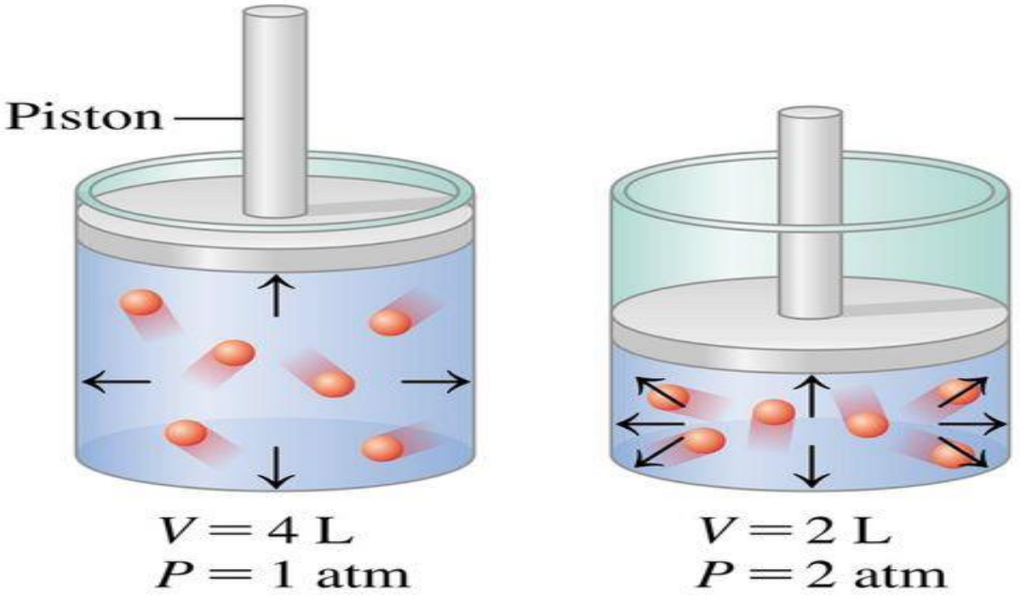
1- Boyle's Law= At constant temperature, the volume of a gas is inversely proportional to its pressure $VP = K$ $P1V1=P2V2$

Boyle's Law

Boyle's law states that

- the pressure of a gas is inversely related to its volume when T is constant.
- the product $P \times V$ is constant when temperature and amount of a gas is held constant
- if volume decreases, the pressure increases.

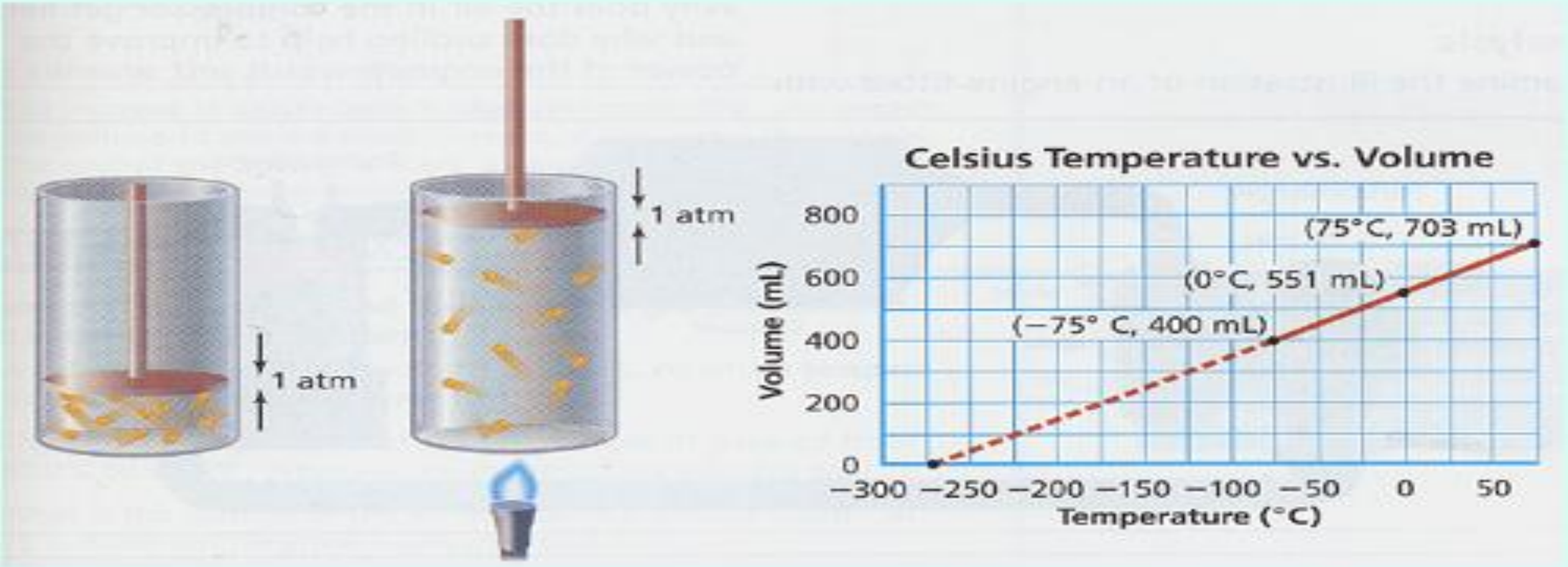
$$P_1V_1 = P_2V_2$$



2- Charles' Law= At constant pressure, the volume of a gas is directly proportional to its absolute temperature

$V/T = K$ $V_1/T_1 = V_2/T_2$

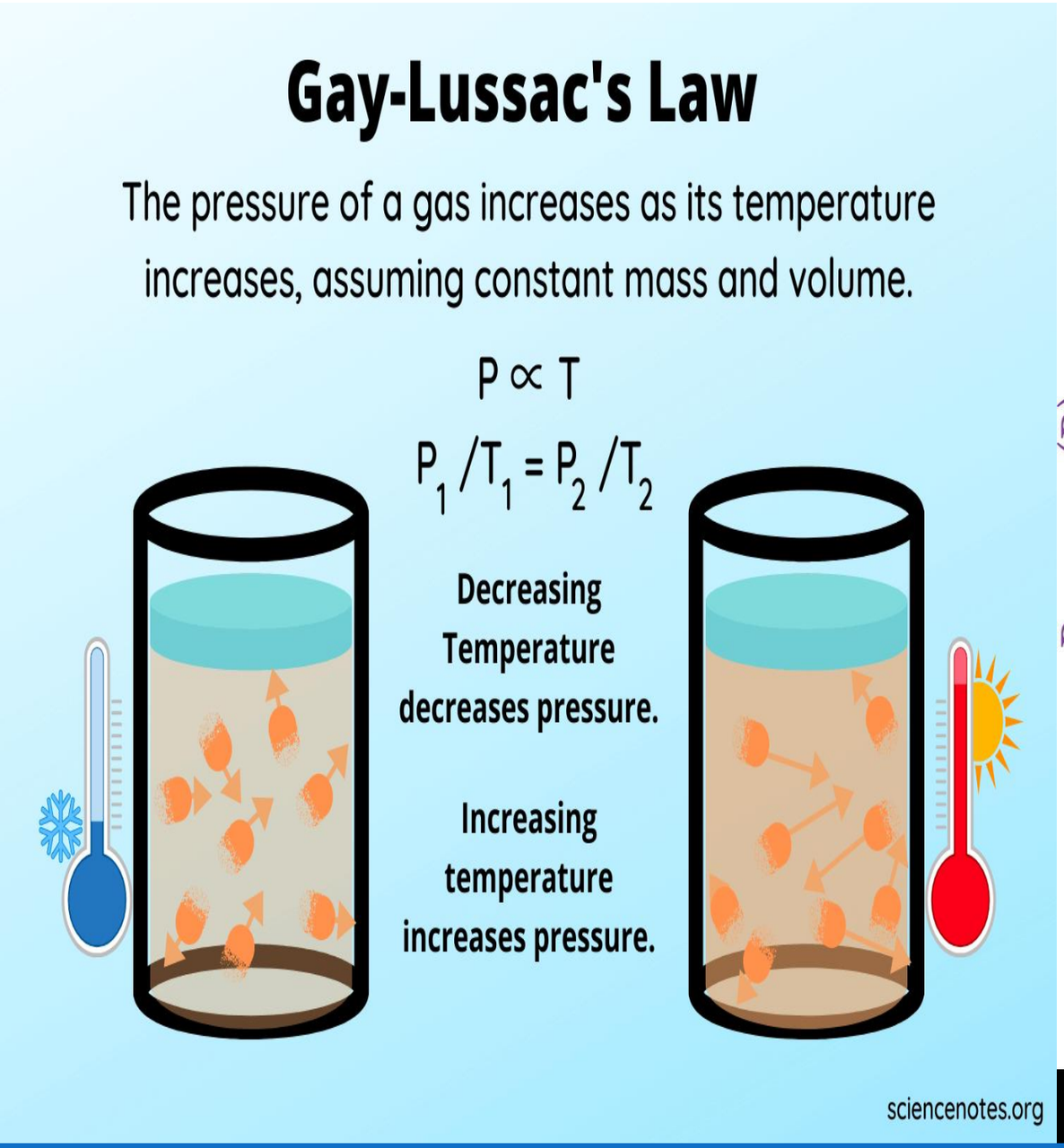
Charles's Law

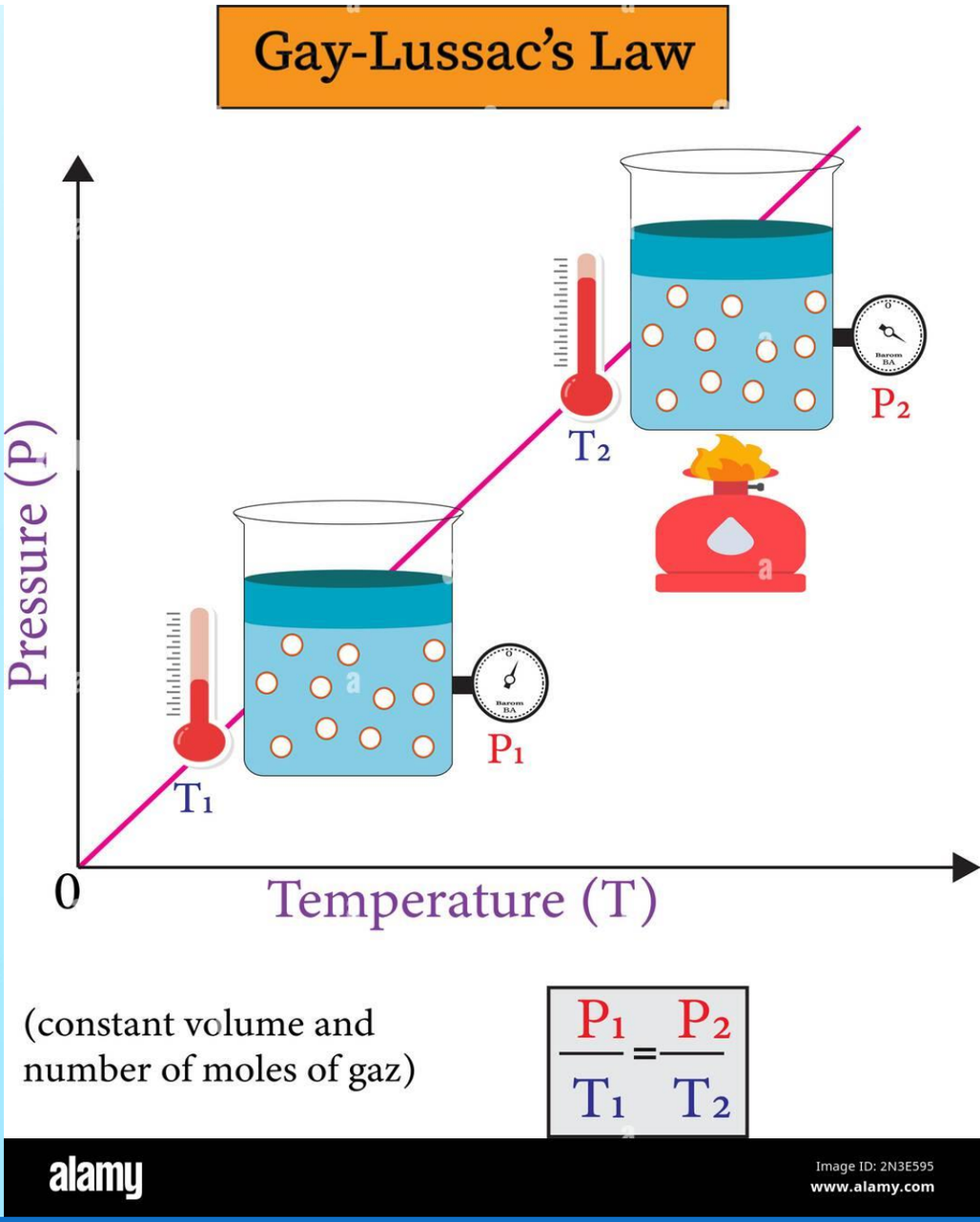


As the temperature increases, the volume increases because the faster molecules collide harder and push each other farther apart.

Gay Lussac's Law = At constant volume, the pressure of a gas is directly proportional to its absolute temperature

P/T = K





Combined Gas Law:

- For a given amount of the gas, any change in the condition of one of the variables will also cause a change in the other two variables in accordance to Boyle's Law and Charles' law. For this reason we can combine the 2 gas laws into one mathematical equation called combined gas law.
- $VP/T = K$

Ideal Gas Law:

- $PV = nRT$
- Where P=pressure in atm.
- V= volume in liter
- T = absolute temperature
- n = moles of gas
- R = 0.082

• P V = K Boyle’s law

• V/T = K Charle’s law

• P/T = K Gay Lussac’s Law

•• Combining the 3 laws • PV/nT = K • PV = nKT • • PV = nRT •

1 mole = 22.4 liters that molar gas volume

0 C = 273 K at 1 atm

under standard conditions of temperature and pressure

Avogadro’s Law:

• Equal volumes of gases under same conditions of temperature and pressure contain equal number of molecules

• Means Mole Ratio = Volume Ratio •

Example :

$$CH_4 + {}_2O_2 >>>>> CO_2 + {}_2H_2O$$

mole ratio

$$\frac{1 \text{ mole } CH_4}{2 \text{ moles } O_2}$$

at STP volume ratio

$$\frac{1 \text{ mole } CH_4 \times 22.4 \text{ liters}}{2 \text{ moles } O_2 \times 22.4 \text{ liters}} = \frac{1}{2}$$

Gas Law	*Formula*
Boyle's law	$P_1V_1 = P_2V_2$
Charles's law	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
Gay-lussac's law	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$
Combined law	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
Ideal gas law	$PV = nRT$

Temperature:

Definition

Temperature is the degree of sensible heat or cold, expressed in terms of a specific scale.

Several scales and units exist for measuring temperature, the most common being Celsius, Fahrenheit, and especially in science Kelvin.

Celsius Scale:

- The Celsius scale is used for common temperature measurements in most of the world.
- It is an empirical scale.
- Its zero point is 0 oC being defined by the freezing point of water, and 100 oC was the boiling point of water, both at sea level atmospheric pressure.
- Because of the hundred degree interval, it is called a centigrade scale.

Fahrenheit Scale:

The United States commonly uses the Fahrenheit scale, on which water freezes at 32oF and boils at 212oF at sea level atmospheric pressure.

Kelvin Scale:

- Many scientific measurements use the Kelvin temperature scale.
- It is a thermodynamic or absolute temperature scale.
- Its zero point 0K, is defined to coincide with coldest physically-possible temperature.
- The temperature of absolute zero occurs at 0K= -273.15oC and the freezing point of water at sea level atmospheric pressure occurs at 273.15K=0oC.

FLUID FLOW

- A fluid is a substance that continually deforms (flows) under an applied shear stress.
- Fluids are a subset of the phases of matter and include liquids, gases.
- Fluid flow may be defined as the flow of substances that do not permanently resist distortion

Types Of Fluid Flow:-

1) Steady & Unsteady Flows.
2) Uniform & Non-uniform Flows.
3) Laminar & Turbulent Flows.
4) Compressible & Incompressible Flows.
5) Rotational & Irrotational Flows.
6) One , Two & Three Dimensional Flows.

1-Steady & Unsteady Flows:-

- ✓ Steady Flows:- In which the fluid Characteristics Like velocity, pressure, density , etc. At a Point do not change with time.
- ✓ Unsteady Flow:- In which the fluid velocity , pressure or density at a point changes with respect to time.

2-Uniform & Non-uniform Flow :-

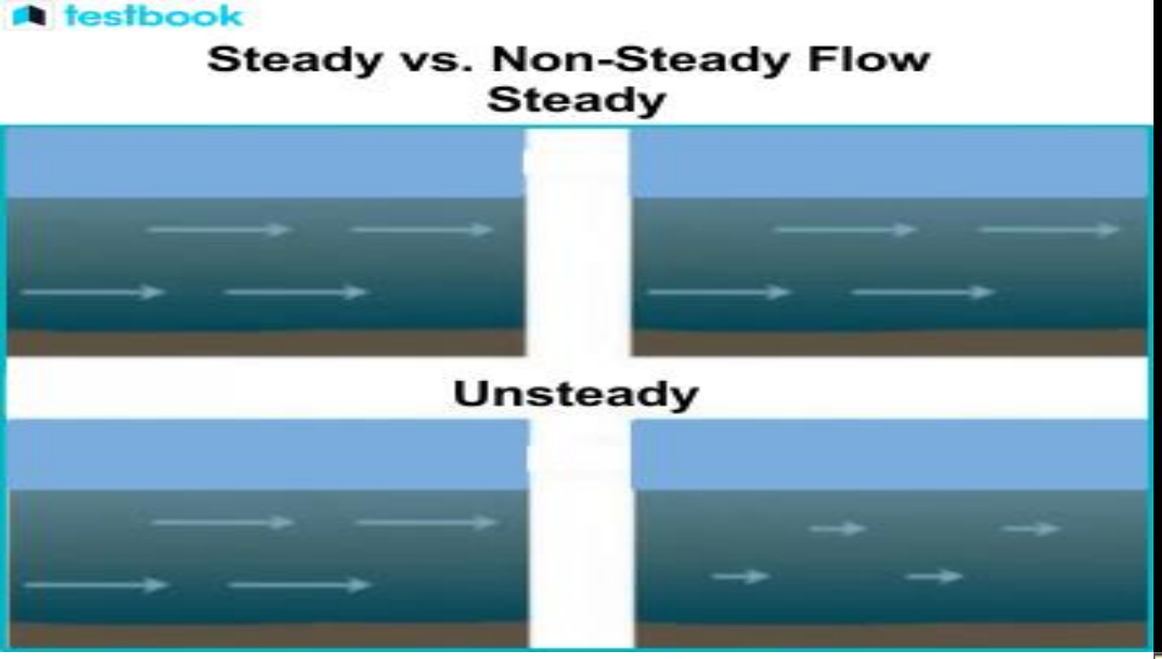
- ✓ Uniform Flow:- In which the velocity at given time does not change with respect to space.
- ✓ Non-Uniform Flow:- In which the velocity at any time changes with respect to space.

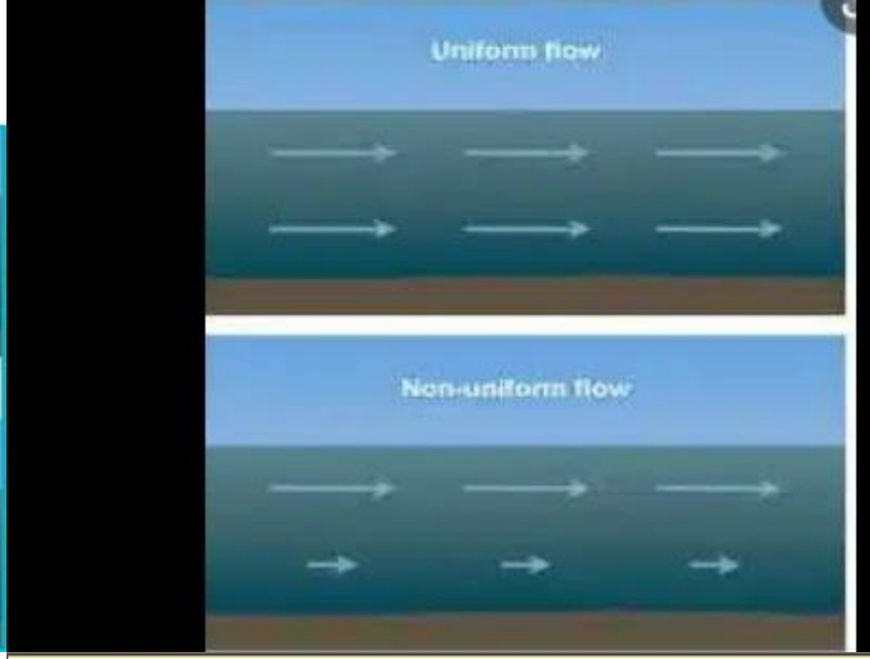
3-Laminar & Turbulent flows:-

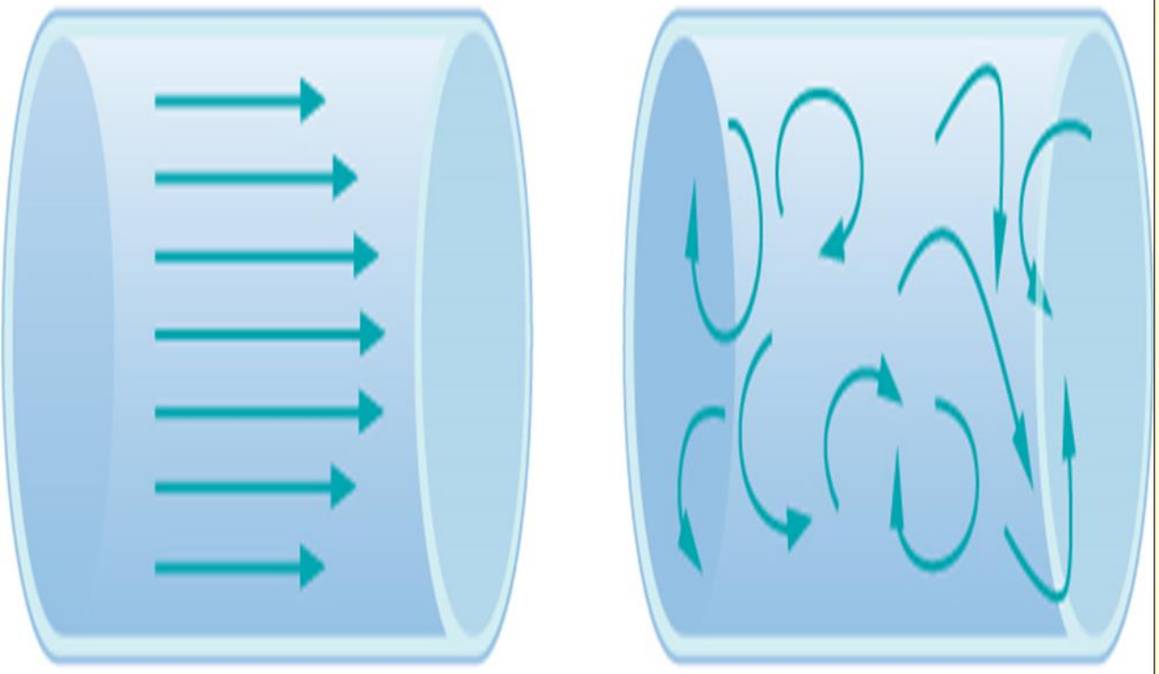
- ✓ Laminar Flow:- in which the fluid particles move along well defined paths or stream line.
- ✓ Turbulent Flow:- fluid moves in very irregular paths or zig – zag Way.

4-Compressible & Incompressible Flows:-

- ✓ Compressible Flows:- In which the density of the fluid changes from point to point.The density is not constant for the fluid.
- ✓ Incompressible Flows:- In which the density of fluid not changes from point to point. the density is constant for the fluid.

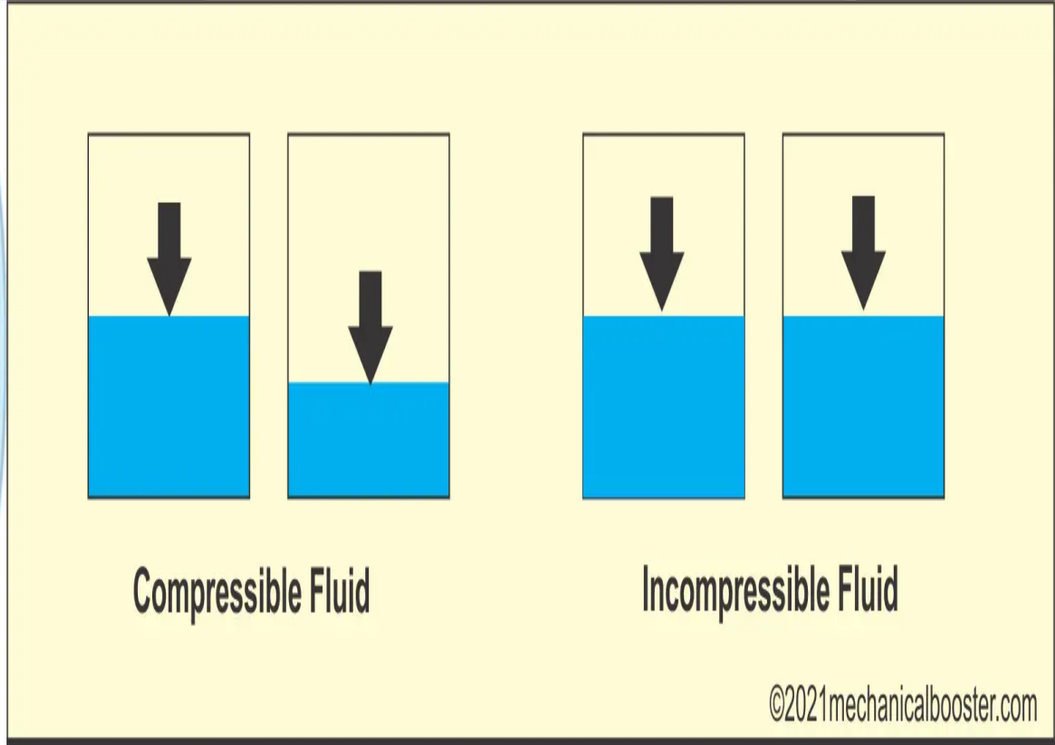






(a) Laminar Flow

(b) Turbulent Flow

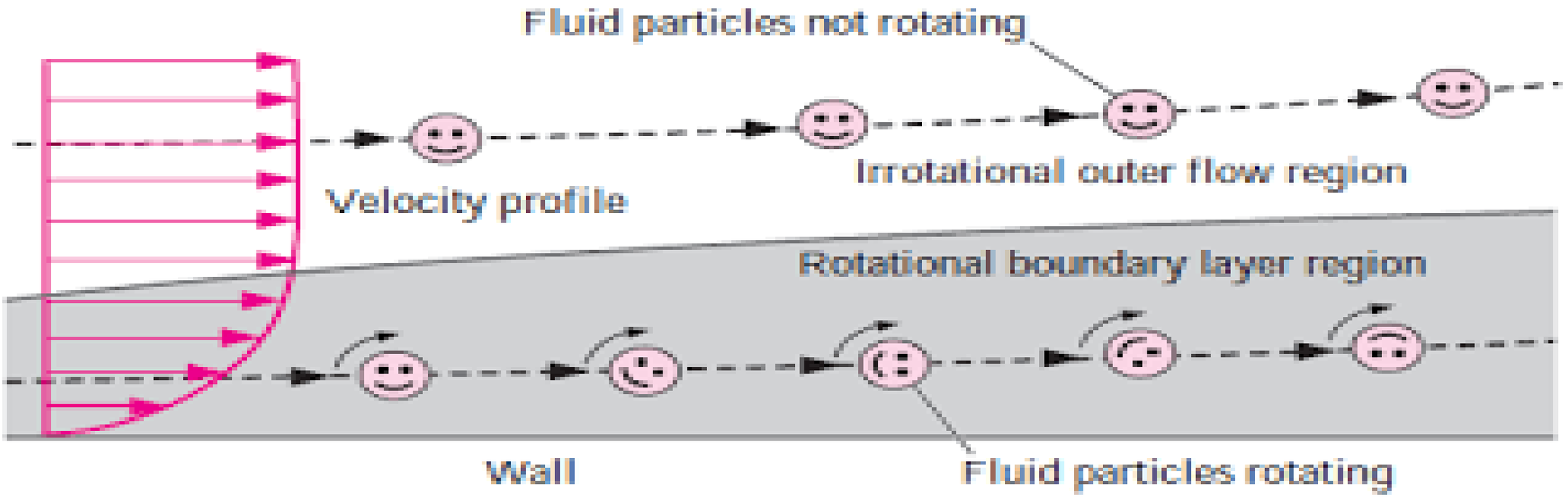


Compressible and Incompressible Fluid Flow

5-Rotational & Irrotational Flows:-

- ✓ Rotational Flow :- In which the fluid particles while flowing along stream lines, Also rotate about their own axis.
- ✓ Irrotational Flow:- In which the fluid particles while flowing along stream lines, do not rotate about their own axis.

6-One , Two & Three Dimensional Flows:-



Thank you for listening