اجهزة التخدير النظري
المرحله الثانيه

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Physical principles : behavior of molecules of soild and liquid , heat and temperature. part 1

three states of matter: solid, liquid, and gas.

1. Solids:

Molecules are closely packed in a fixed, orderly arrangement They vibrate in place but do not move freely, leading to a definite shape and volume.Strong forces (like ionic or covalent bonds) hold the molecules together.these intermolecular forces cause the molecules to maintain a fairly fixed position relative to each other.
When a solid is heated, the kinetic energy of the molecules increases, so the range of movement increases and the volume of the solid increases. As more heat is added to the solid, the range of movement of the molecules eventually becomes sufficiently great to disrupt the fixed structure and the molecules are able to move past each other. The solid has changed state to become a liquid.

2. Liquids:

Molecules are close together but not in a fixed arrangement, allowing them to flow.Molecules can slide past one another, leading to a definite volume but no fixed shape.
Intermolecular Forces:Weaker than in solids, these forces allow for greater movement while still keeping the molecules relatively close.
heat is added to the liquid, the kinetic energy of the molecules increases until the intermolecular forces are no longer sufficient to hold the molecules near each other.
The state changes to the gaseous state, in which the molecules move freely throughout the volume in which they are contained.

Heat and Temperature

1. Temperature:

A measure of the average kinetic energy of the molecules in a substance.
Scale: Commonly measured in Celsius (°C), Fahrenheit (°F), or Kelvin (K).
Higher temperatures indicate greater molecular motion.

$K = °C + 273.15$

$F = (9/5 \times °C) + 32$.

Units =0°C= 32°F = 273K

2. Heat:

Definition: The energy transferred between substances or systems due to a temperature difference.
The SI unit of energy is the joule (J), although an alternative unit, the calorie (cal) is sometimes used specifically for heat energy.
1 calorie (cal) = 4.187 joule (J)

melting point,In the case of the transition from solid to liquid
latent heat..The energy is needed to increase the kinetic energy of the molecules sufficiently to overcome the forces of attraction between them These processes occur in reverse when heat energy is removed from a substance.
dew point The transition from gas to liquid
freezing point : the transition from liquid to solid.

Transfer Methods of heat:

Conduction: Direct transfer of heat through contact. there is an energy transfer from the high-temperature region to the low-temperature region.

Convection: is the mode of energy transfer between a solid surface and the adjacent liquid or gas that is in motion, and it involves the combined effects of conduction and fluid motion. The faster the fluid motion, the greater the convection heat transfer. Transfer of heat through fluid movement.

Radiation: refer to the net transfer of thermal energy between two surfaces at different temperature levels, in the absence of an intervening medium between them. This occurs due to electromagnetic waves emitted from a hot body.

properties and laws of the gases

Properties of Ideal Gases
Gas molecules are in constant motion, moving in all directions and rebounding from each other and from the walls of the space in which they are confined. It is the collisions of gas molecules with the walls that appears as the pressure of the gas

Gas concentration
Two methods are commonly used to express the concentration of a gas or vapor.
➢ Partial pressure
➢ Volumes percent (Vol%)

Volumes percent expresses the relative ratio of gas molecules in a mixture, whereas partial pressure expresses an absolute value.

Volumes percent = Partial pressure/ Total pressure

GAS LAWS

Why Learn Gas laws as Anaesthesiologists?
Gas laws and physics play a crucial role in our practice.
They are needed in a wide variety of situations in the OT as well as the ICU
For better induction of anaesthesia
For appropriate use of Boyle's Machine
To better understand the mechanics behind using Nitrous Oxide and volatile anesthetics
To prevent Hazards in the hospital.

Gas laws describe the behavior of gases in relation to pressure, volume, temperature, and quantity. **Here are the key laws:**

1-Boyle's Law:

Boyle's Law: P ⬇️, V⬆️ (at constant T)
the pressure-volume law states that the volume of a given amount of gas held at constant temperature varies inversely with the applied pressure .
When pressure goes up, volume goes down.

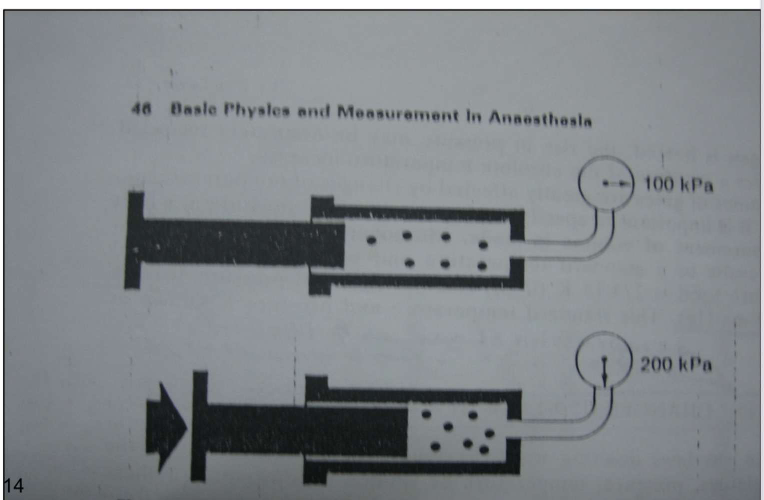


Figure 4.3 Effect of volume change at constant temperature.

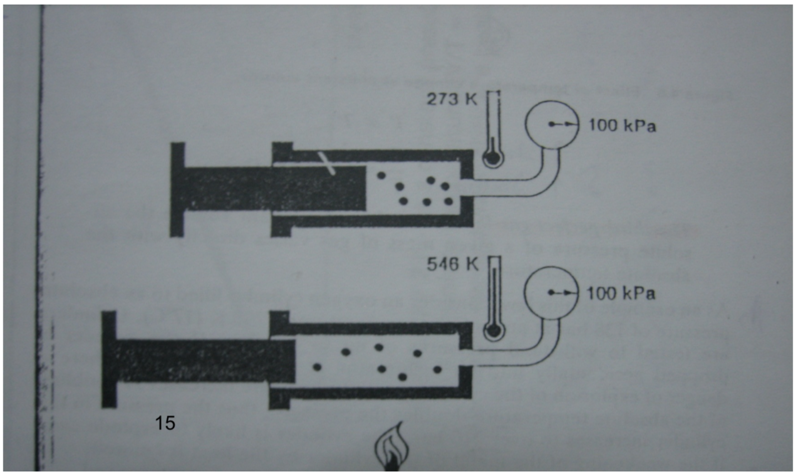
P1V1 = P2V2 = P3V3 etc.

For example, if the initial volume was 500 mL at a pressure of 760 torr, when the volume is compressed to 450 mL, what is the pressure?
Plug in the values:
P1V1 = P2V2
(760 torr)(500 mL) = P2(450 mL)
760 torr x 500 mL/450 mL = P 844 tort = P2
The pressure is 844 torr after compression.

2-Charles's Law:

T⬆️, V⬆️ (at constant P)

At constant pressure, the volume of a gas is directly proportional to its absolute temperature (V1/T1 = V2/ T2).
As the temperature also goes up, the volume goes up and vice-versa.
V1/ T2 =V2 / T2 =V3/ T3 ...etc



ex: If 1ml halothane gives 207mL vapour at 273K how much vapour is present at 293K?
V1/T1,=V2/T2
V2 = 207x 293/273 =221mL vapour

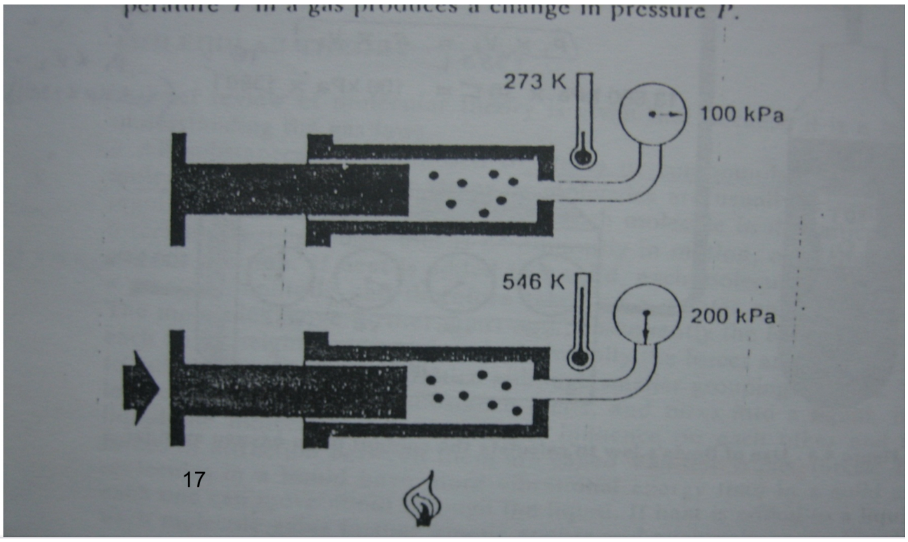
4-Gay-Lussac's Law: The Pressure Temperature Law ,This law states that the pressure of a given amount of gas held at constant volume is directly proportional to the Kelvin temperature.

$P \propto T$

As the temperature also goes up,the pressure goes up and vice-versa.
P1/T1= P2/ T2 = P3/ T3 etc.

ex: An 02 cylinder indicates a pressure of 132 atm while being transported in hot weather when the temp is 44C. What pressure will be indicated when it is placed in a cool operation theatre when the temp is 20C?

P1/T1=P2/T2
132/44=P1/22
P1 = 132x22/44
P1=66



4-Avogadro's Law: At constant temperature and pressure, the volume of a gas is directly proportional to the number of moles of the gas (V1/n1 = V2/n2).
Gives the relationship between volume and amount when pressure and temperature are held constant
V1/ n1 =V2/ n2 = V3 / n3 etc.

5-The Combined Gas Law

The Combined gas law or General Gas Equation is obtained by combining Boyle's Law, Charles's law, and Gay-Lussac's Law.

It shows the relationship between the pressure, volume, and temperature for a fixed mass (quantity) of gas:

$V \propto T/P$

Its The volume of a given amount of gas is proportional to the ratio of its Kelvin temperature and its pressure.

$P_1V_1/T_1 = P_2V_2/T_2 = P_3V_3/T_3$ etc.

the combined gas law develops into the ideal gas law:

6-Ideal Gas Law:

The previous laws all assume that the gas being measured is an ideal gas, a gas that obeys them all exactly. But over a wide range of temperature, pressure, and volume, The idea gas law is:

expressed as $PV = nRT$, describes the behavior of ideal gases. Where n is the number of moles and R is a constant called the universal gas constant and is equal to approximately 0.0821 L-atm / mole-K, temperature in Kelvin.

7-Graham's law

This law states that the rate at which gas molecules diffuse is inversely proportional to the square root of the gas density at a constant temperature.

Daltons Law of Partial Pressures

Dalton's Law of Partial Pressures states that the total pressure of a mixture of nonreacting gases is the sum of their individual partial pressures.

$P_{total} = P_a + P_b + P_c + ..$