تفريغ فيزيكال

اسم الموضوع: Gaseous state

إعداد الصيدلاني/ـة: ياسمين خليل

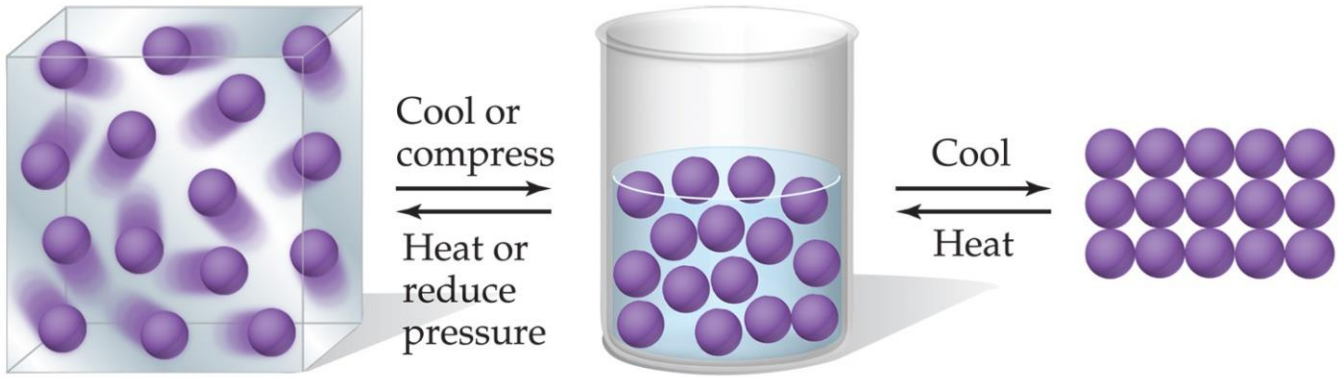
Soul Academy

لجان الدُّفعات

States of Matter

- Three primary state of matter

1) Gaseous state 2) Liquid state 3) Solid state



Gas

Total disorder; much empty space; particles have complete freedom of motion; particles far apart

مساحة فارغة
حرية الجزيئات
صرة تماما
الجزيئات متباعدة

Liquid

Disorder; particles or clusters of particles are free to move relative to each other; particles close together

Crystalline solid

Ordered arrangement; particles are essentially in fixed positions; particles close together

الجزيئات في وضعية ثابتة

- Other mesophases:

Liquid crystals, Supercritical fluids

رَبِّ اشْرَحْ لِي صَدْرِي
وَيَسِّرْ لِي أَمْرِي وَاحْلُلْ عُقْدَةً
مِّن لِّسَانِي يَفْقَهُوا قَوْلِي)

We can get liquid from gas by : Cool , comperss
We can get liquid from solid by : Heat
We can get solid from liquid by : Cool
We can getgas from liquid by : Heat , reduce pressure

- Heating is the way / process
  Convert solid to liquid

بصيغة أخرى :-

The gaseous state

طاقة حركية عالية والسبب أنه الجزيئات حرة الحركة و بينها فراغات بالتالي حركتها سريعة

- Gases are described as molecules that have high kinetic energy → rapid motion of molecules.
- Gas molecules exert relatively small forces on each other (molecules try to act independently of one another).

نفرض انه عندنا غازين ، هدول الغازين بختلطوا مع بعض بسهولة و سرعة عادي ومن أسباب ذلك ان الجزيئات متباعدة.

General properties

- A gas mixes rapidly and completely with any other gas.
- A gas uniformly fills any container and assumes its shape (volume).

بأخذ الغاز شكل الوعاء الحتواجد فيه

- Gas is the only state that is compressible.

الحالة الوحيدة: قابل للضغط

- The vigorous motion produces a pressure called **vapor pressure**.

vapor pressure : حركة الجزيئات القوية تنتج ضغط اسمه

Pressure units

International system of units

- The SI unit is the Pascal (Pa) where:

$$1\ Pa = 1\ N\ m^{-2}$$

Newton

- The relationship of other commonly used pressure units to the Pascal is as follows:
  - ❑ 1 bar = 10^5 Pa
  - ❑ 1 mmHg = 1 torr = 133.32 Pa
  - ❑ 1 atm = 1.013×10^5 Pa
  - ❑ 1 psi = 6894.76 Pa

• هدول مش حفظ الدكتور بجيبهم في الامتحان آخر ورقة ☺

- Standard atmospheric pressure is 760 mmHg = 760 torr = 1.013 bar = 1.013×10^5 Pa

احفظوها !

Ideal gas

الغاز يكون مثالي لما ما يكون في قوة بين الجزيئات

- Ideal gas is a gas where no intermolecular interactions exist and collisions are perfectly elastic, and thus no energy is exchanged during collision.

في حالة اصطدام الجزيئات المفروض تفقد جزء من طاقتها صح ؟ صح ؛ بس في الحالة الغازية بسبب خاصية المرونة صار رح تفقد الجزيئات طاقتها ولا تتبادلها مع بعضها (elastic) .

- The properties of the ideal gas can be described by the general ideal gas law, which is derived from Boyle, Charles and Gay-Lussac laws

general ideal gas laws

1. Boyle

Volume (V) + pressure (P)

inversely : علاقتهم عكسية

$P \propto \frac{1}{V}$ ، $PV = k$ ثابت

$P_1 V_1 = P_2 V_2$

2. charles

Volume (V) + temp (T)

علاقة طردية

$V = kT$

- الحرارة لازم تكون بوحدة كيلفن Kelvin

3. gay-lussac

pressure (P) + temp (T)

علاقتهم طردية في حال الحجم ثابت

$\frac{P}{T} = k$

سنتعلم الـ 3 سلايدات الجاية

Ideal gas

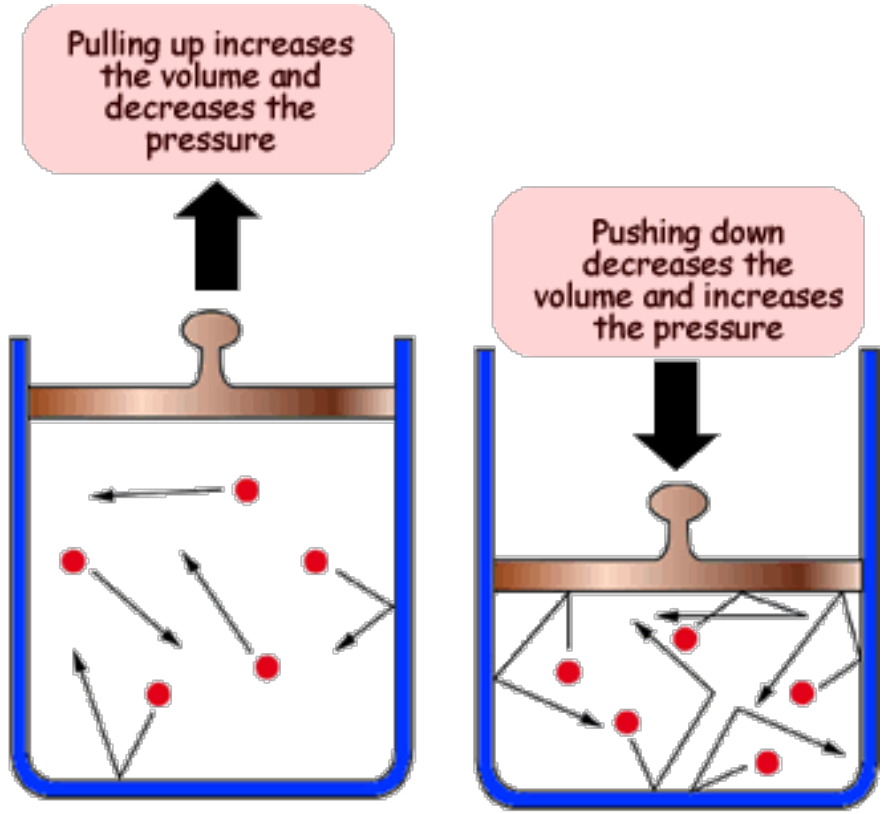
- **Boyle's law** states that the volume and pressure of a given mass of gas is inversely proportional at a constant temperature (i.e. when the pressure of a gas increases, its

$$P \alpha \frac{1}{V} \quad or \quad PV = k$$

$$P_1V_1 = P_2V_2$$

P: pressure, K: constant,

V: volume



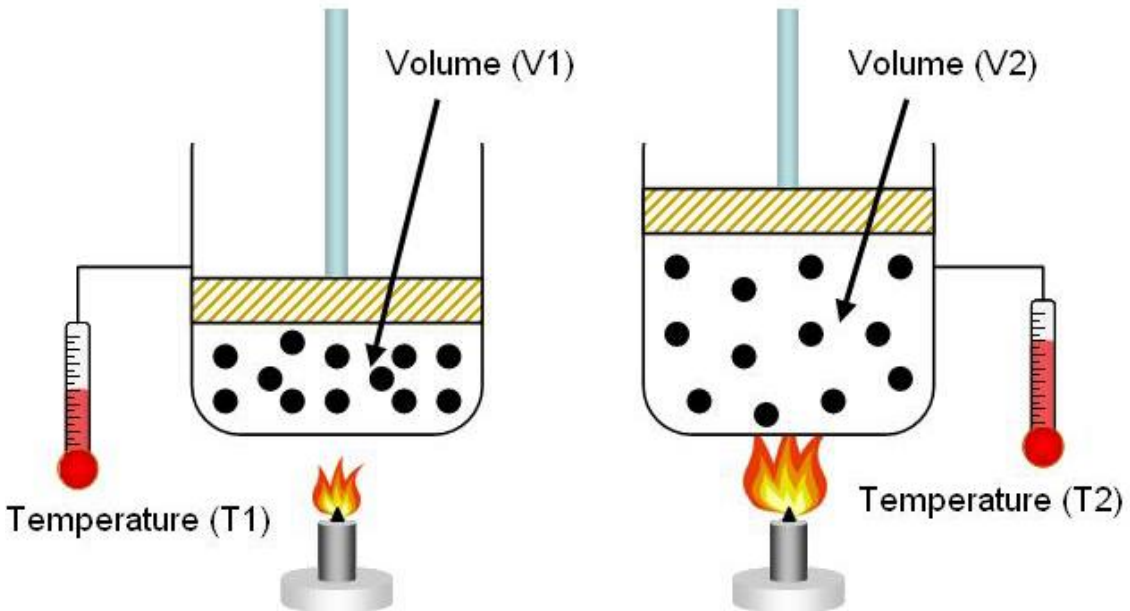
ضغط عالي رح تقلل من حجم الغاز

Ideal gas

- The **Charles** law states that the volume and absolute temperature of a given mass at constant pressure are directly proportional:

$$V \propto T \quad \text{or} \quad V = kT$$

طردية
بسبب زيادة الطاقة الحركية للجزيئات



Ideal gas

- **Gay-Lussac's law** states that the pressure of a given mass of gas varies directly with the absolute temperature of the gas, when the volume is kept constant:

$$P/T = k$$

رَبِّ إِنِّي لِمَا أَنزَلْتَ
إِلَيَّ مِنْ خَيْرٍ فَقِير

Avogadro's law

جمع الثلاثة قوانين السابقة بقانون واحد.

- Equal volumes of gas at the same temperature and pressure contain the same number of molecules.

$$V1/n1 = V2/n2$$

- 1 mole of ideal gas occupies 22.4 L regardless the identity of the gas under standard temperature and pressure.
- The volume of gas is directly proportional to the number of moles

$$V \propto n \quad \text{at constant T and P}$$

في حال ثبوت الضغط والحرارة، تكون العلاقة بين الحجم وعدد المولات شو؟ طردية

Ideal gas

- Boyle, Gay-Lussac and Charles law can be combined to obtain the familiar relationship:

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

هاد القانون الجامع لثلاثة قوانين

- T: kelvin scale (0 ºC=273.15 K)

ملاحظة :- التحويل من °C إلى K بس بنزيد الحرارة بالسيليسوس 273. مثال: الحرارة 53°C سيليسوس كيلفن

53°C + 273 = 326 K

Ideal gas

Example

- In the assay of ethylnitrite spirit, the nitric oxide that is librated from a definite quantity of spirit and collected in a gas burette occupies a volume of 30.0 ml, (V_1) at a temperature of 20 °C (T_1) and a pressure of 740 mm Hg. (P_1) Assuming the gas is ideal, what is the volume at 0 °C (T_2) and 760 mm Hg? (P_2) ($V_2 = ?$)

طيب هون عنا كل المعلومات ومطلوب V_2 ، بس ننتبه للحرارة بأي وحدة! ونحولها لكيلفن

$T_1 = 20 + 273 = 293\ K$

$T_2 = 0 + 273 = 273\ K$

بعدين نبدأ حل ✓

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \longrightarrow \frac{740 \times 30}{293} = \frac{760 \times V_2}{273} \longrightarrow V_2 = 27.2\ ml$$

General ideal gas law

- General ideal gas law (also called equation of state) relates the **pressure**, **volume**, and **temperature** of a given mass of gas.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad \Longrightarrow \quad \frac{P V}{T} = R$$

ثابت
= 0.08205
atm L/mole k

- **R:** the molar gas constant value for the PV/T ratio of an ideal gas.

- For n moles the equation becomes:

$$\mathbf{PV = nRT}$$

ممكن سؤال امتحان!!

في قانون $PV=nRT$ كل الارقام متغيرة ماعدا؟ (R) ثابت بثلاث وحدات مختلفة

General ideal gas law

- The volume of 1 mole of an ideal gas under standard conditions of temperature and pressure (i.e., at 0° C and 1 atm) has been found by experiment to be 22.414 liters.
- Substituting this value in general ideal gas law:

$$R = \frac{P\,V}{T} = \frac{1 \times 22.414}{273.16} = 0.08205 \text{ atm L/mole K}$$

- The molar gas constant can also be expressed by energy units:
- **R = 8.314 Joules/mole K or**
- **R = 1.987 cal/mole deg**

1 atm = 1.0133×10^6 dynes/cm^2
1 Joule = 1 N.m = 1 Pa.m^3
1 cal = 4.184 Joule

شرح التحويلات السابقة

0.08205 atm L / mol K

× 101.325

8.314 Joules / mole K

1 cal ⟶ 4.184 Joules

!؟ ⟶ 8.314 Joules

$= \frac{8.314}{4.184} = 1.987$ cal / mole K

اللَّهمَّ اكْفِني بحلالِكَ عَن
حَرَامِكَ، وَاغْنِني بِفَضلِكَ
عَمَّن سِوَاك

General ideal gas law

Example: Calculation of volume using the ideal gas law

- **What is the volume of 2 moles of an ideal gas at 25°C and 780 mm Hg?**

atm= 760 mmHg

$P = \frac{780\ mmHg}{760\ mmHg} = 1.0263\ atm$

$T = 273 + 25^{\circ}C = 298\ K$

$PV = nRT \qquad V = \frac{2 * 0.08205 * 298}{1.026} = 47.65\ L$

ممكن حد يسأل ليه استخدمنا قيمة R = 0.08205 و استخدمناها بعد ما حولنا ها لوحدات ثانية (اللي بدها بعد)؟

لأنه بدأنا الحل بوحدة atm بالتالي نختار قيمة R وحدتها atm

General ideal gas law: Molecular weight of gas

The approximate molecular weight of a gas can be determined by use of the ideal gas law:

مش مطلوبة بس حكا
فيها الكتير عن المبيدات كمان حسب حجم الرذاذ الخارج من العبوة زي مثلاً مبيد الحشرات الزراعة كبيرة أما رذاد الحشرات المنزلية صغيرة وميل

PV = nRT

since **n=g/M** then:

$$PV = \frac{g}{M} RT$$

$$M = \frac{gRT}{PV}$$

General ideal gas law: Molecular weight of gas

Example: Molecular weight determination using the ideal gas law

If 0.30 g of ethyl alcohol in the vapor state occupies 200 mL at a pressure of 1 atm and a temperature of 100 °C, what is the molecular weight of ethyl alcohol?

100 °C + 273 = 373 K

200 mL ÷ 1000 mL =0.2 L

$$\mathbf{M} = \frac{\mathbf{gRT}}{\mathbf{PV}} = \frac{0.3 \times 0.082 \times 373}{1 \times 0.2} = 46 \frac{\text{g}}{\text{mole}}$$

Ideal gas

Kinetic Molecular Theory

Kinetic molecular theory explains the behavior of gases according to the ideal gas law and to lend additional support to the validity of the gas law:

- Gases are composed of particles called atoms or molecules, the total volume of which is so small (negligible) in relation to the volume of the space in which the molecules are confined.
- Gas molecules exert neither attractive nor repulsive forces on one another
- The particles exhibit continuous random motion. The average kinetic energy, E, is directly proportional to the absolute temperature of the gas, or **E=(3/2)RT.**
- The molecules exhibit perfect elasticity; there is no net loss of speed or transfer of energy after they collide with one another and with the walls of the confining vessel.

Real gas

طريقة معرفة إذا كان الغاز Real أو لا هو انه الغازات الحقيقية تتعامل الطاقة أثناء الاصطدام بالتالي هي خاضعة للثلاث قوانين السابقة

لا تتفاعل

- Real gases do not interact without energy exchange, and therefore do not follow the laws of Boyle, Charles, and Gay-Lussac.
- Real gases are not composed of infinitely small and perfectly elastic non-attracting spheres.

نفي

إثبات

- They are composed of molecules of a finite volume that tend to attract one another.
- The significant molecular volume and the intermolecular attractions between gas molecules affect both the volume and the pressure of a real gas respectively.

Volume and pressure of real gas are effected by
- significant molecular volume
- intermolecular attraction between gas molecules.

Real gas: van der Waals equation

- The van der Waals equation is a modified ideal gas equation that takes into account the factors that affect the volume and pressure of a real gas.

For n mole of gas:

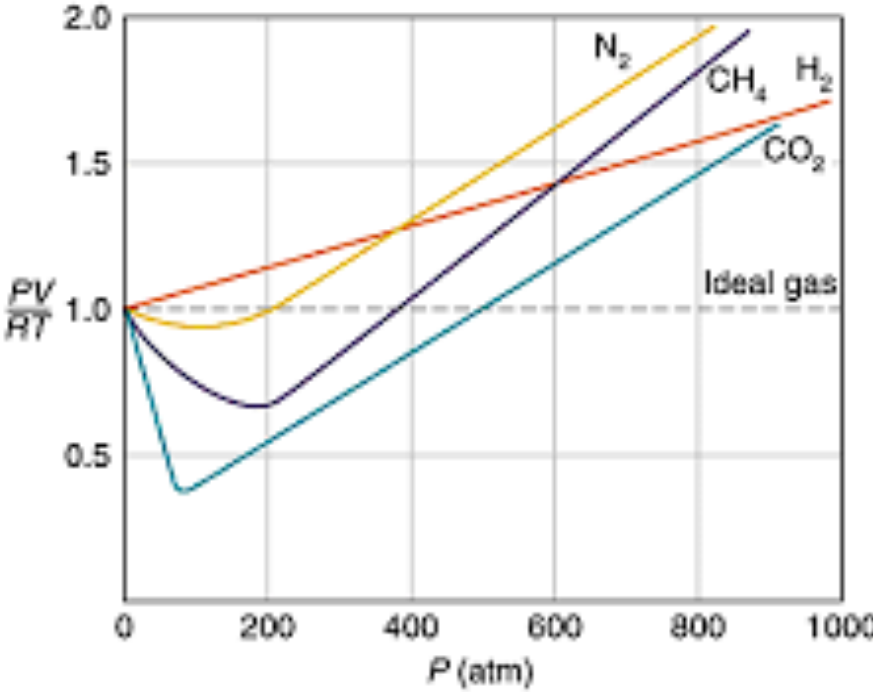
$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

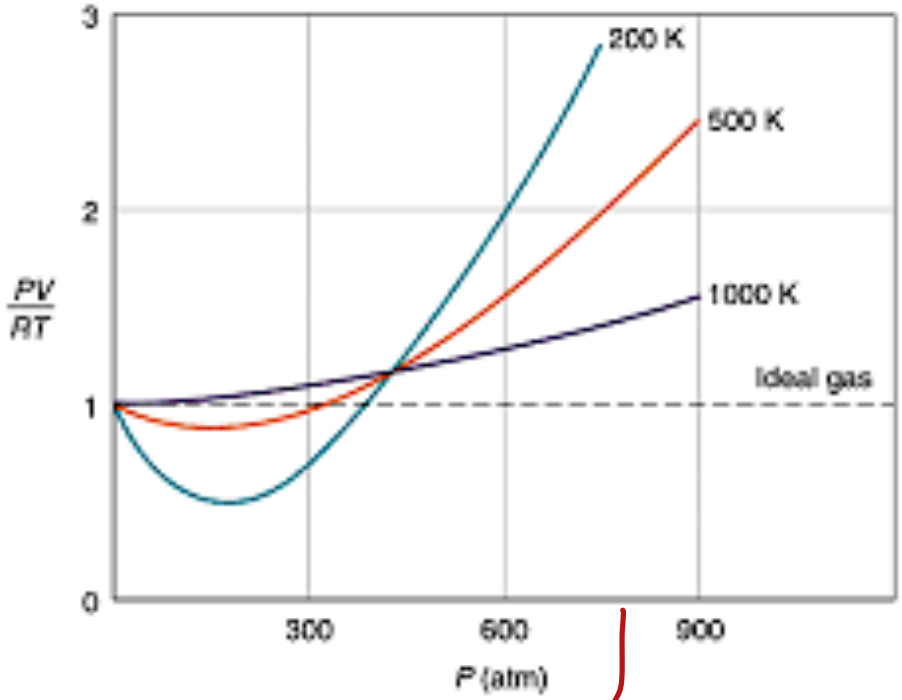
- where *a and b are constants for a particular* gas.
- Around each molecule of a gas is a particular volume from which other molecules are excluded for purely physical reasons. The bulk molar volume, *V, of the gas is consequently an* overestimation of the true molar volume.

Real gas: van der Waals equation

- The influence of non-ideality is greater when the gas is compressed (At high pressure and low temperature).
- When the volume of a gas is large (At low pressure and high temperature), the molecules are well dispersed and far apart. Under these conditions, $\mathbf{a/V^2}$ and **b** become insignificant with respect to **P** and **V**, respectively, and the van der Waals equation for the real gas reduces to the ideal gas equation: $\mathbf{PV = nRT}$
- At these conditions, real gases behave in an ideal manner.
- A convenient means of expressing departure from ideality is by a plot of PV/RT as a function of pressure for 1 mole of each gas

لا إلهَ إلاّ أنتَ
سبحانَك إنِّي
كنتُ من
الظالمينَ

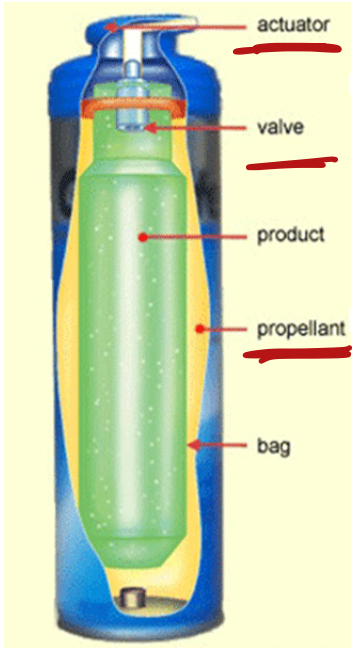




كلما زيادة الحرارة
يزيد حيود الغاز للـ
Real
gases

Aerosols and ideal gas law

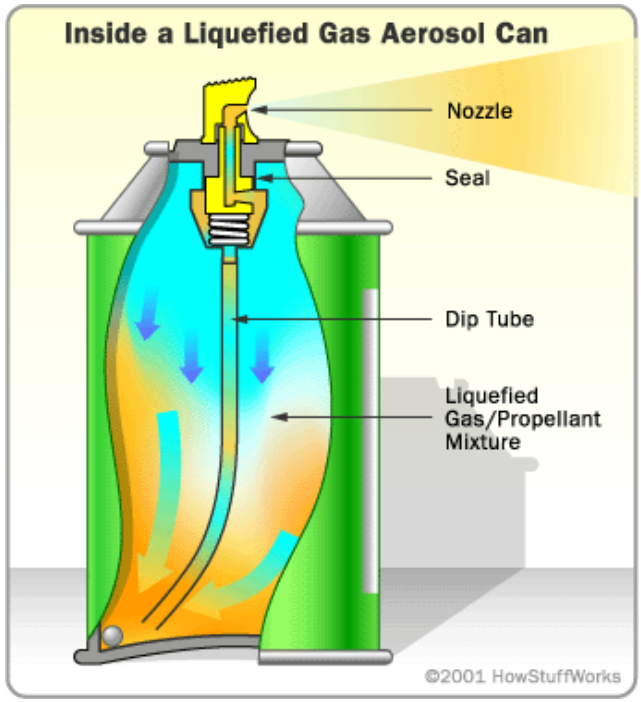
- An Aerosol product consists of the following component parts:
  1) product concentrate
     - active ingredient &
     - Additives (such as, antioxidants, surface- active agents, and solvents)
  2) Propellant
     - liquefied gas or a mixture of liquefied gases or
     - compressed gases (carbon dioxide, nitrogen, and nitrous oxide)
- The drug is dissolved or suspended in a propellant
- *Propellant*, a material that is liquid under the pressure conditions existing inside the container but that forms a gas under normal atmospheric conditions
- Part of the propellant exists as a gas and exerts the pressure necessary to expel the drug, whereas the remainder exists as liquid and provides a solution or suspension vehicle for the drug.
- When the propellant is a liquefied gas or a mixture of liquefied gases, it frequently serves the dual role of propellant and solvent or vehicle for the product concentrate.



3) Container

4) Valve and actuator

- By depressing a valve on the container, some of the drug–propellant mixture is expelled owing to the excess pressure inside the container.
- Outside the container, the liquid propellant reverts to gas and vaporizes off, while the drug forms a fine spray



عند الضغطة الاولى يخرج الرذاذ بحجم كبير بعد أكثر من ضغطة يصير fine spray حجم الرذاذ صغير

Aerosols and ideal gas law

مطلوبة

- The propellant is responsible for developing the proper pressure within the container, and it expels the product when the valve is opened and its ,in the atomization or form production of the product.

Types of propellants:

1) Liquefied gases

a. Fluorinated hydrocarbons

b. Hydrocarbons (propane, butane, and isobutane)

بغيبو

2) Compressed gases → Can be determined by ideal gas law

Carbon dioxide, nitrogen and nitrous oxide.

CO_2 N N_2O

- The pressure in the case of compressed gas propellants can be determined by ideal gas law assuming ideal gas behavior.

General ideal gas law

Example: Calculation of pressure using the ideal gas law

Calculate the pressure at 25°C within an aerosol container of internal volume 250 cm³ containing 160 cm³ of concentrate above which has been introduced 0.04 mol of nitrogen gas. Assume ideal behavior.

n

$T = 25 + 273 = 298\ K$

$$PV = nRT$$

$$P = \frac{0.04 * 8.314 * 298}{(250 - 160) * 10^{-6}}$$

$$= 1.01 \times 10^{6}\ Pa\ (or\ N\ m^{-2})$$

صممها صفقها للامتحان

البادئة	رمزها	قيمتها الاسية
كيكا	G	10^{9}
ميكا	M	10^{6}
كيلو	k	10^{3}
ديسي	d	10^{-1}
سنتي	c	10^{-2}
ملي	m	10^{-3}
مايكرو	μ	10^{-6}
نانو	n	10^{-9}
بيكو	p	10^{-12}