



AYALMWARA
VITREOAVI

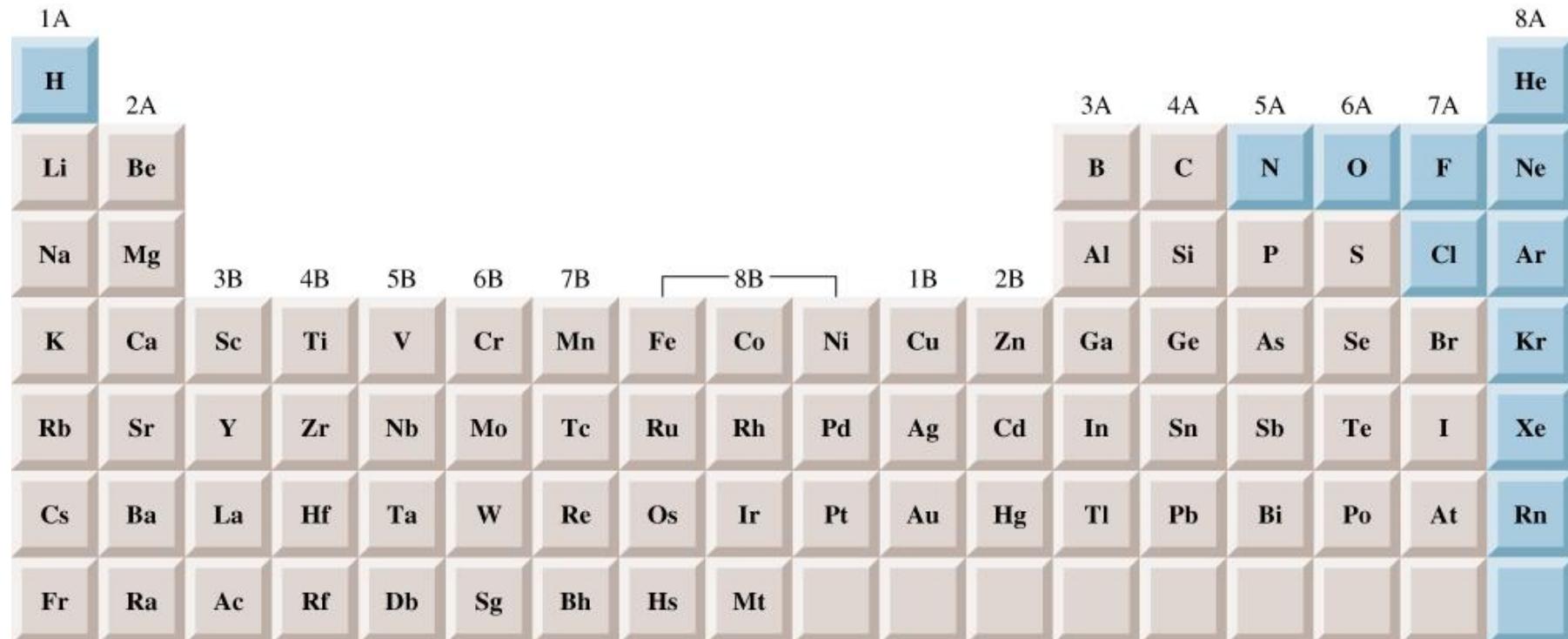
G A S

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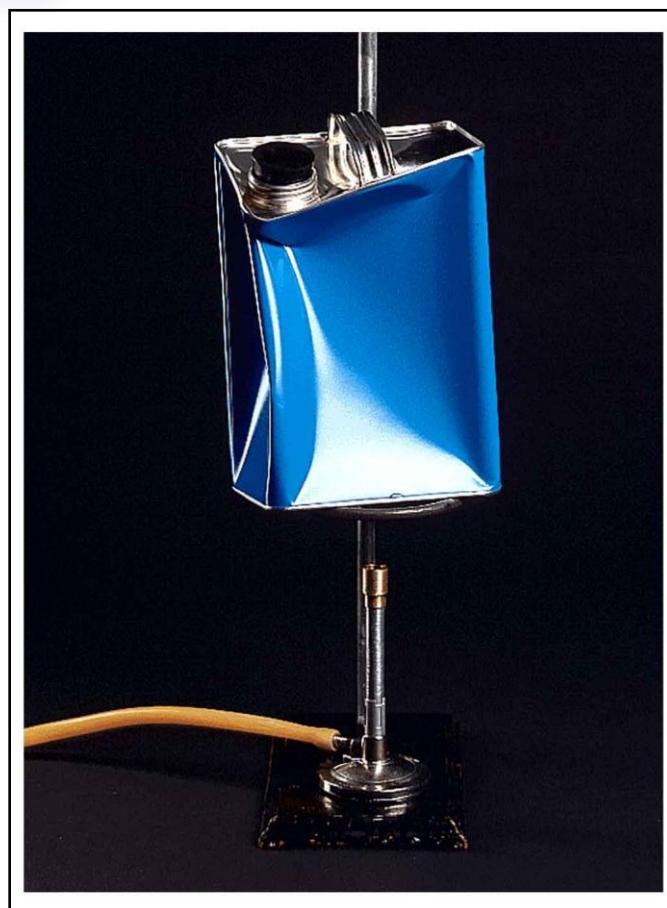
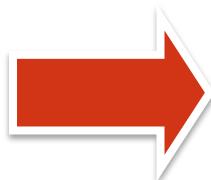
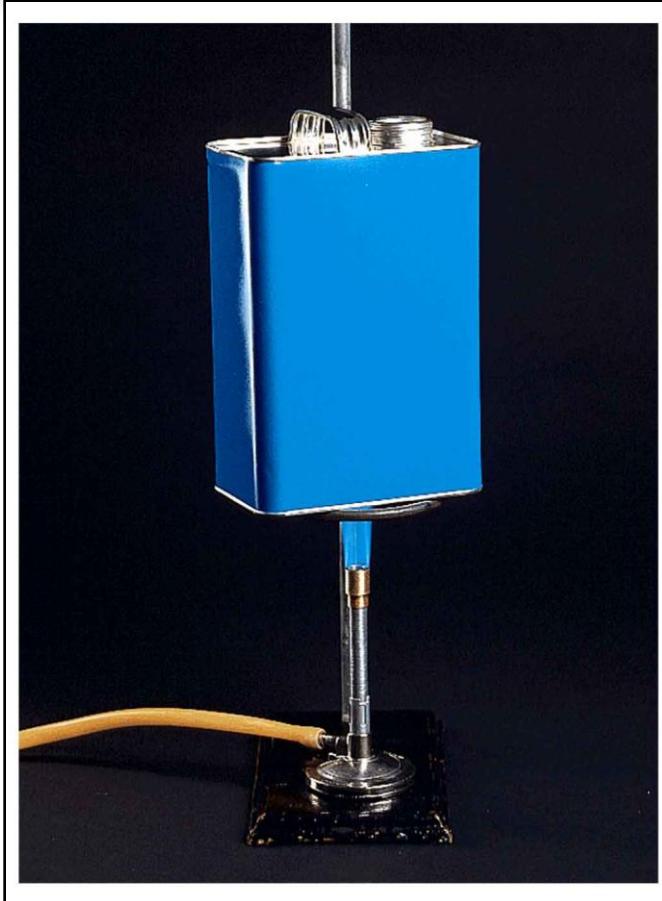
Elemen Berwujud Gas pada 25°C dan 1 atm



Karakteristik Fisika dari Gas

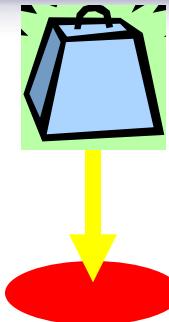
- Gas diasumsikan mempunyai volume dan bentuk sesuai tempatnya.
- Gas adalah wujud materi yang (paling) dapat terkompresi (mendapat variasi tekanan) untuk mampat (atau memuai).
- Gas akan bercampur jika tergabung dalam satu tempat.
- Gas mempunyai kerapatan dan berat jenis lebih ringan dibandingkan wujud cair atau padat.
- Terpengaruh tekanan pada lingkungannya.

Perubahan Tekanan



Satuan Tekanan

$$\text{Tekanan} = \frac{\text{Gaya}}{\text{Area}}$$

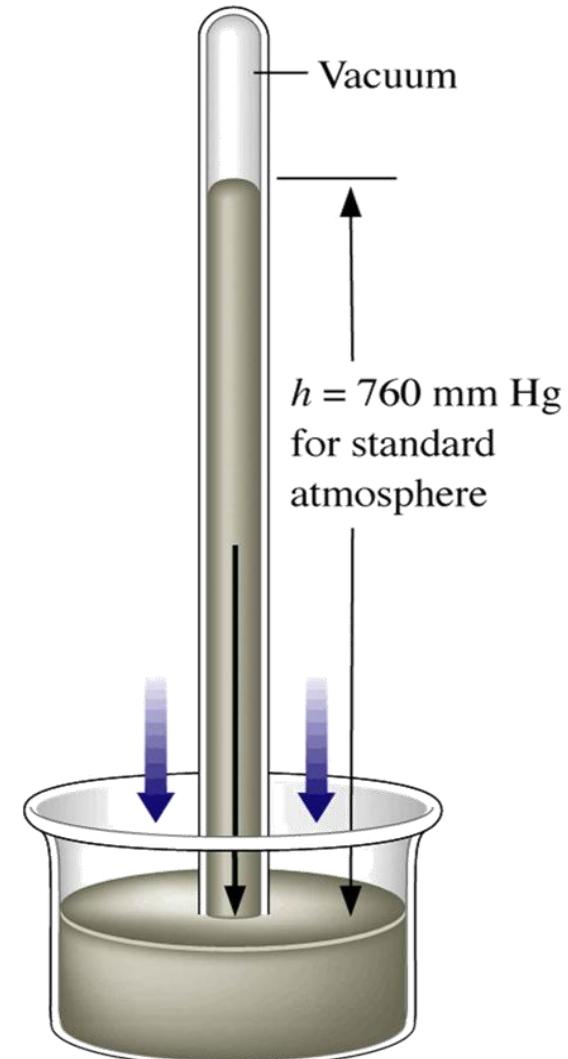


Satuan Tekanan

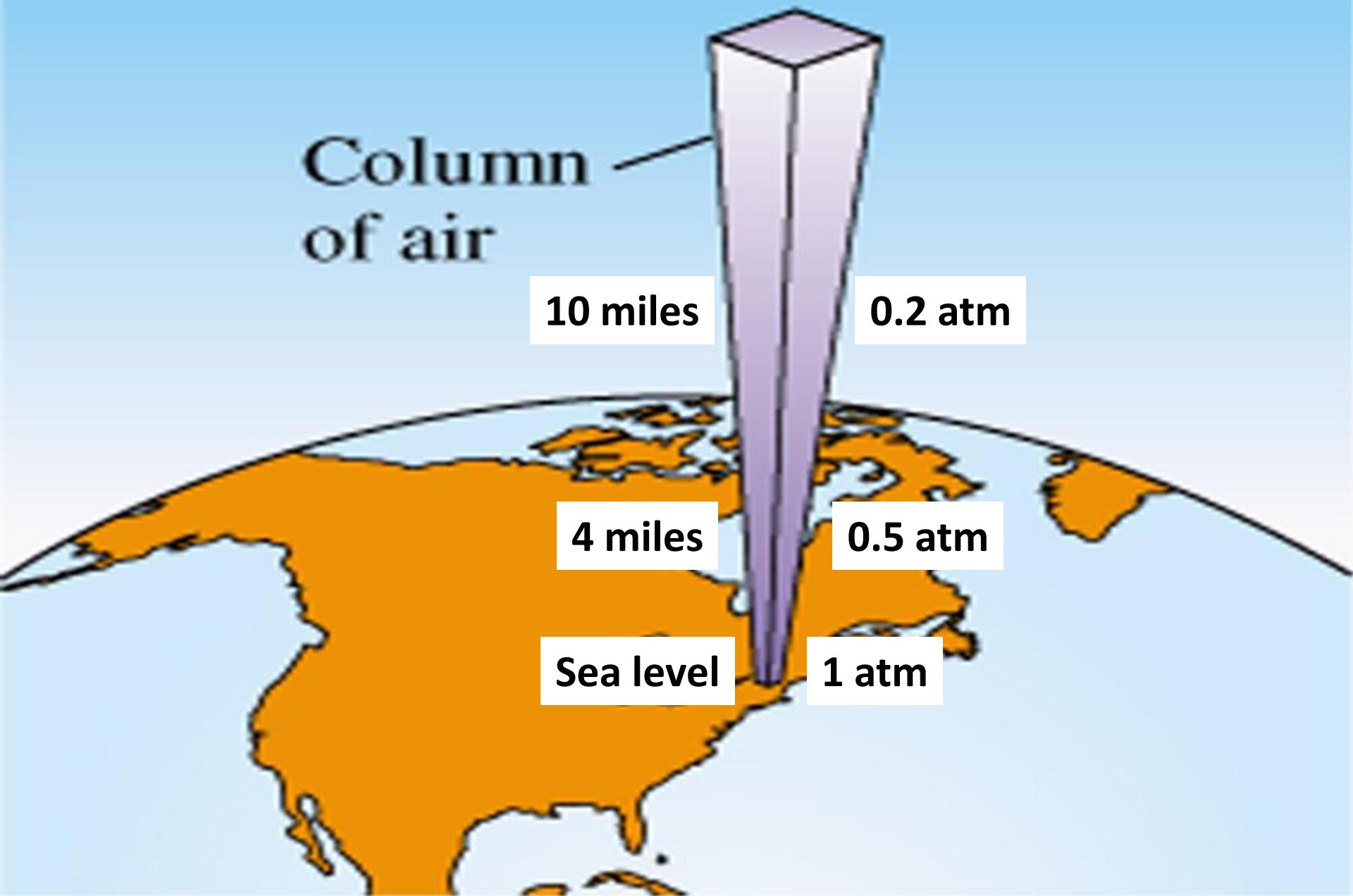
$$1 \text{ pascal (Pa)} = 1 \text{ N/m}^2$$

$$1 \text{ atm} = 760 \text{ mmHg} = 760 \text{ torr}$$

$$1 \text{ atm} = 101.325 \text{ Pa}$$



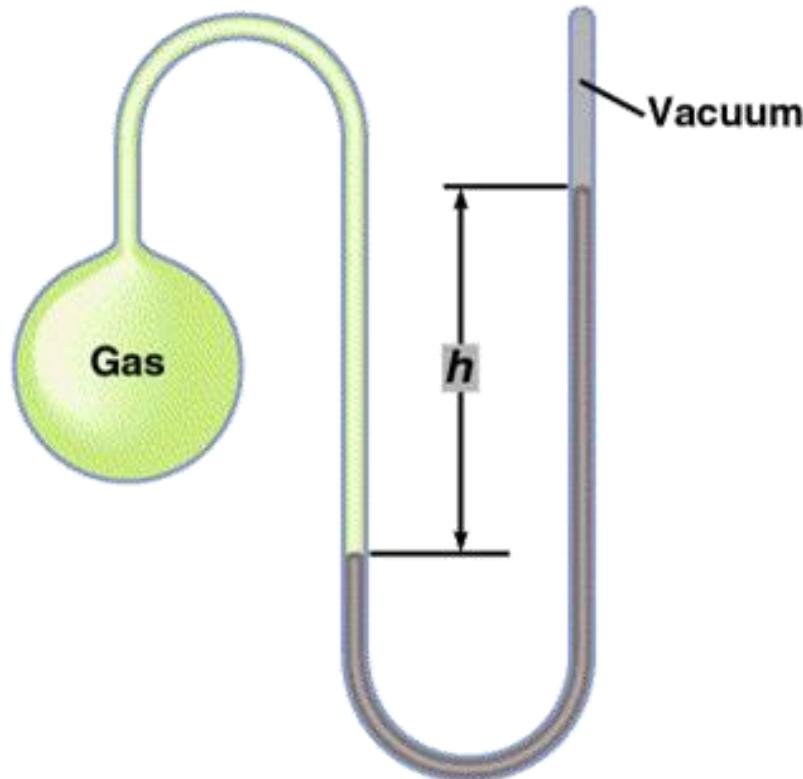
Tekanan Udara



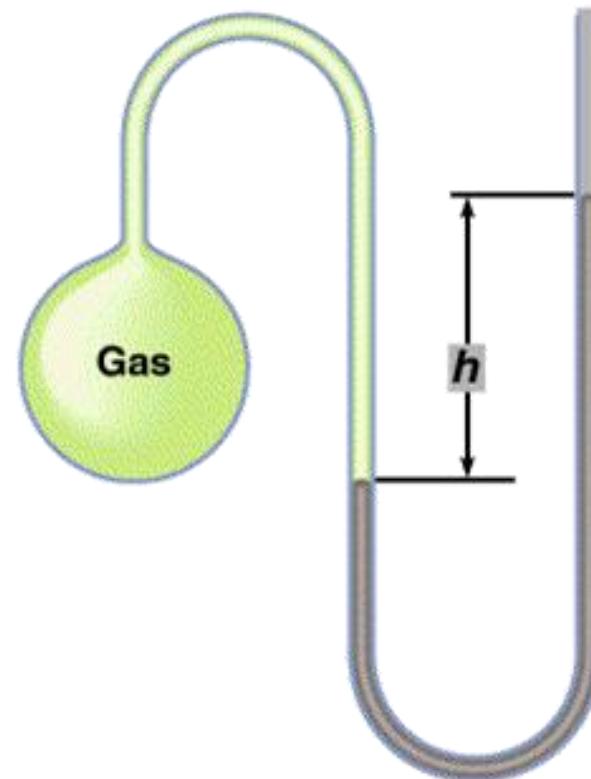
Manometer



Manometers Used to Measure Gas Pressures

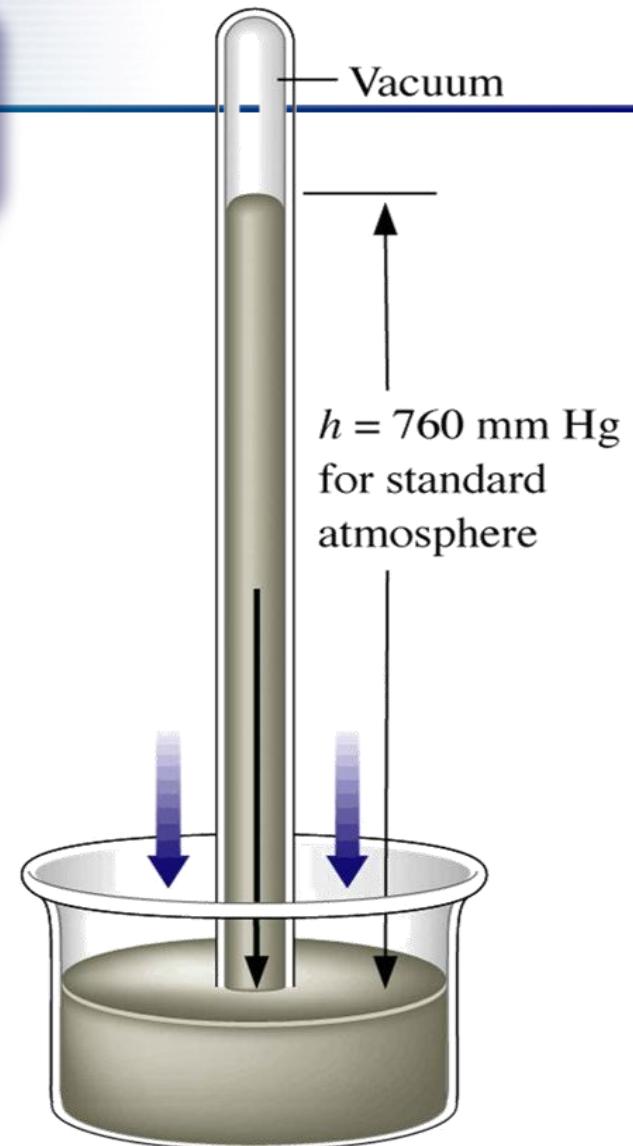
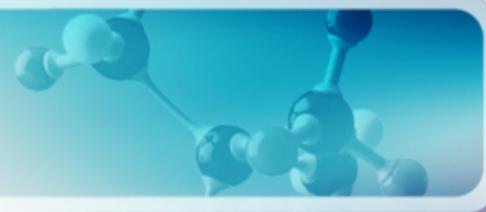


$$P_{\text{gas}} = P_h$$



$$P_{\text{gas}} = P_h + P_{\text{atm}}$$

Barometer



$h = 760 \text{ mm Hg}$
for standard
atmosphere

Hukum Boyle (Boyle's Law)

- Dikemukakan pada 1660 oleh Robert Boyle
- Jika temperatur tetap konstan, volume suatu gas dengan massa tertentu, berbanding terbalik dengan tekanan

$$V \propto 1/P$$

$$P \cdot V = \text{konstan}$$

$$V_1/V_2 = P_2/P_1$$

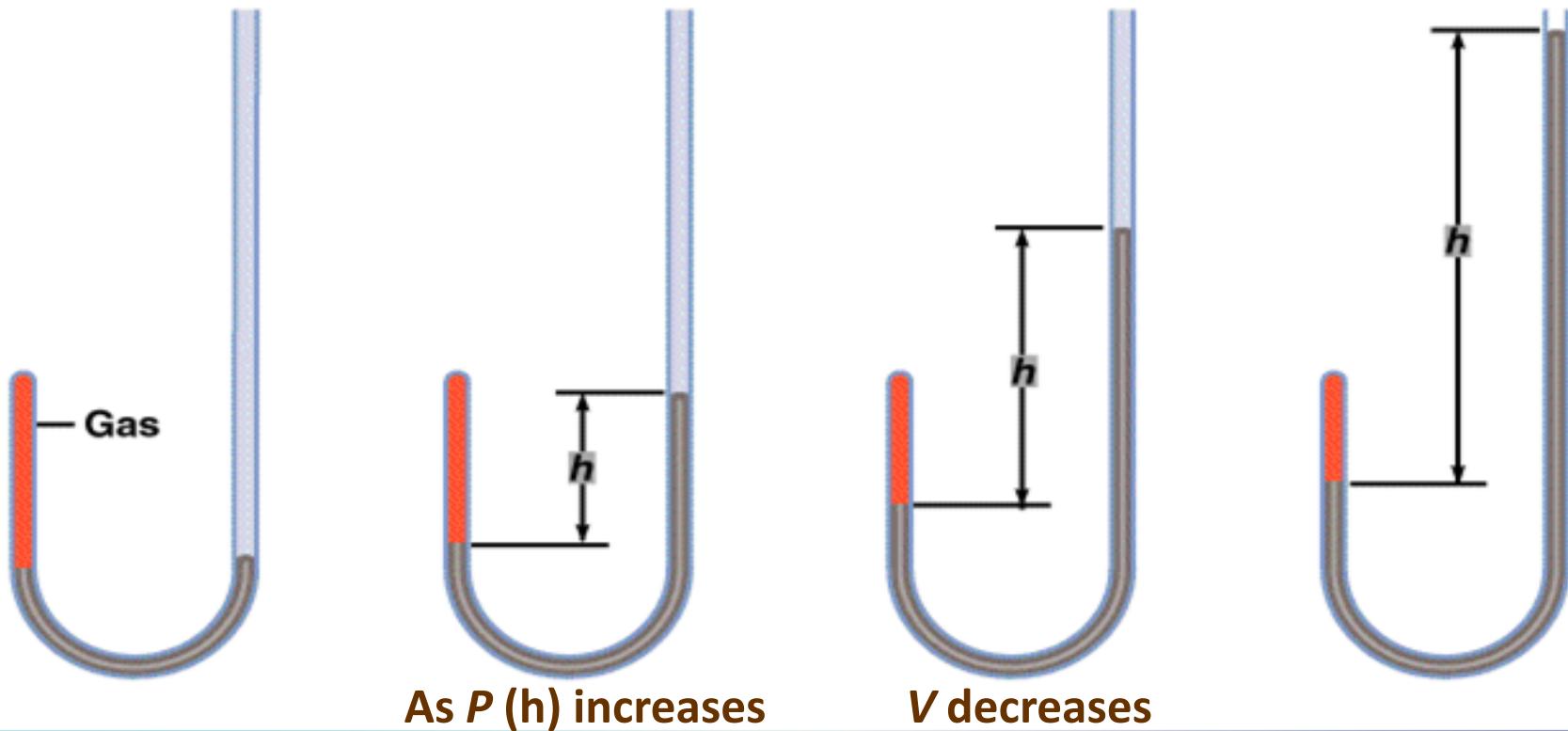
Hukum Boyle (Boyle's Law)

TABLE 5.1 Actual Data from Boyle's Experiment

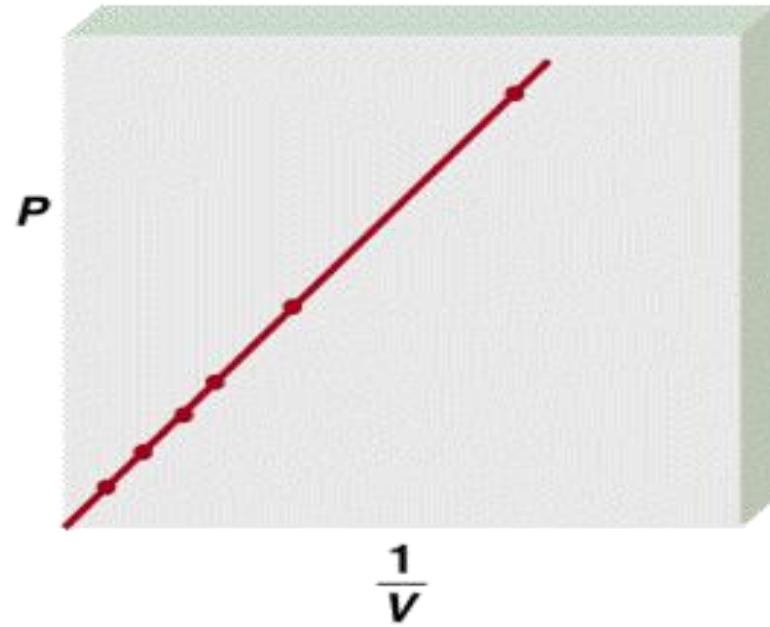
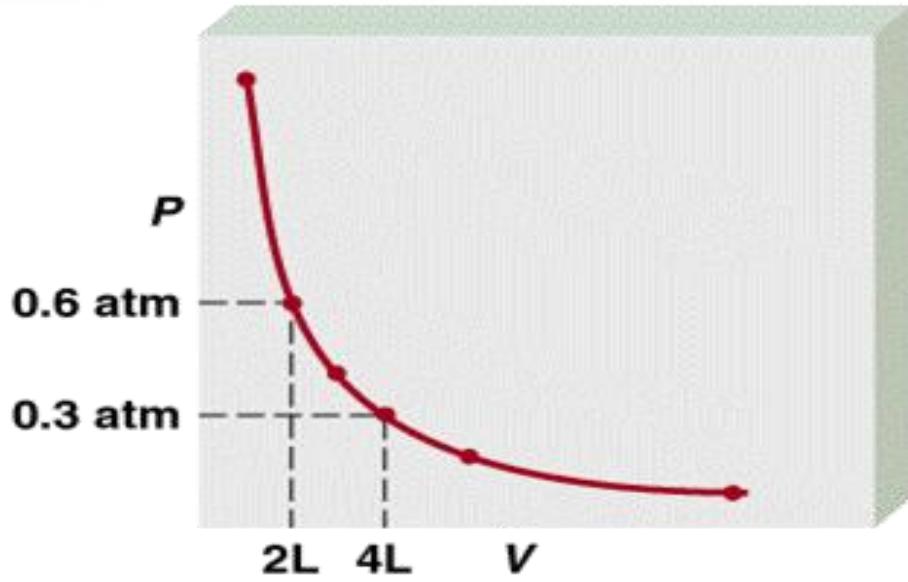
Volume (in ³)	Pressure (in Hg)	Pressure × Volume (in Hg × in ³)
117.5	12.0	14.1×10^2
87.2	16.0	14.0×10^2
70.7	20.0	14.1×10^2
58.8	24.0	14.1×10^2
44.2	32.0	14.1×10^2
35.3	40.0	14.1×10^2
29.1	48.0	14.0×10^2

Hukum Boyle (Boyle's Law)

Apparatus for Studying the Relationship between Pressure and Volume of a Gas



Hukum Boyle (Boyle's Law)



$$P \propto 1/V$$

$$P \times V = \text{constant}$$

$$P_1 \times V_1 = P_2 \times V_2$$



Constant temperature
Constant amount of gas

Hukum Boyle (Boyle's Law)

Pressure x Volume = Constant ($T = \text{constant}$)

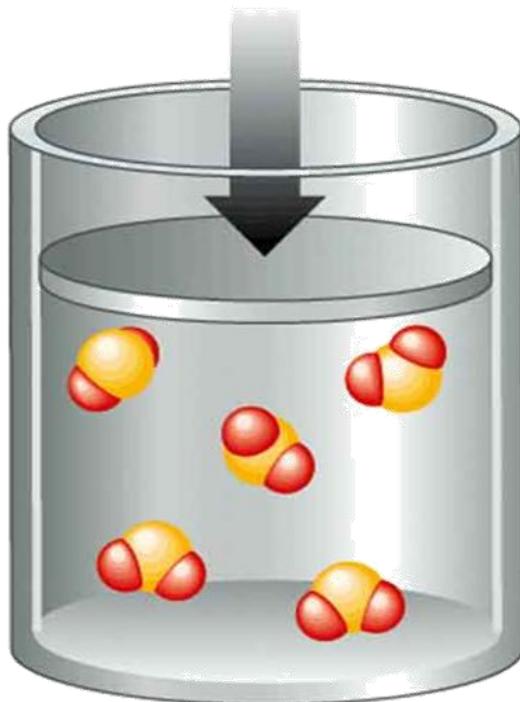
$$P_1 V_1 = P_2 V_2 \quad (T = \text{constant})$$

$$V \propto 1/P \quad (T = \text{constant})$$

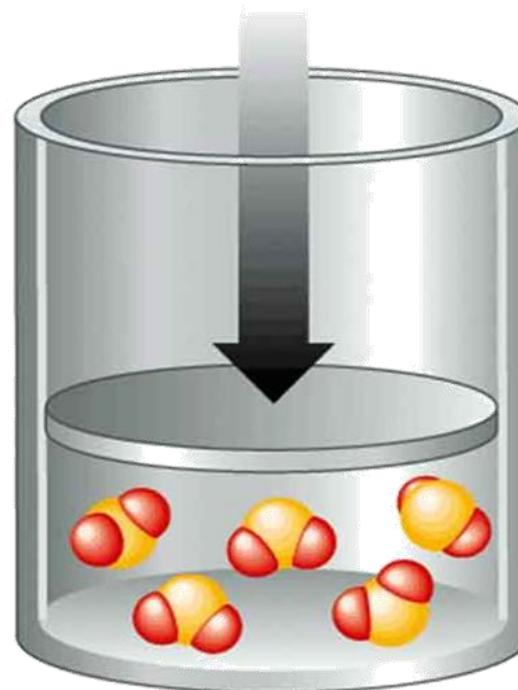
(*Holds *precisely* only at very low pressures.)

Tekanan ditambah, volume SO_2 menurun

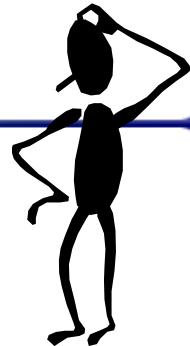
$5.6 \times 10^3 \text{ Pa}$



$1.5 \times 10^4 \text{ Pa}$



Contoh Perhitungan



A sample of chlorine gas occupies a volume of 946 mL at a pressure of 726 mmHg. What is the pressure of the gas (in mmHg) if the volume is reduced at constant temperature to 154 mL?

$$P_1 \times V_1 = P_2 \times V_2$$

$$P_1 = 726 \text{ mmHg}$$

$$V_1 = 946 \text{ mL}$$

$$V_2 = 154 \text{ mL}$$

$$P_2 = \frac{P_1 \times V_1}{V_2} = \frac{726 \text{ mmHg} \times 946 \text{ mL}}{154 \text{ mL}} = 4460 \text{ mmHg}$$

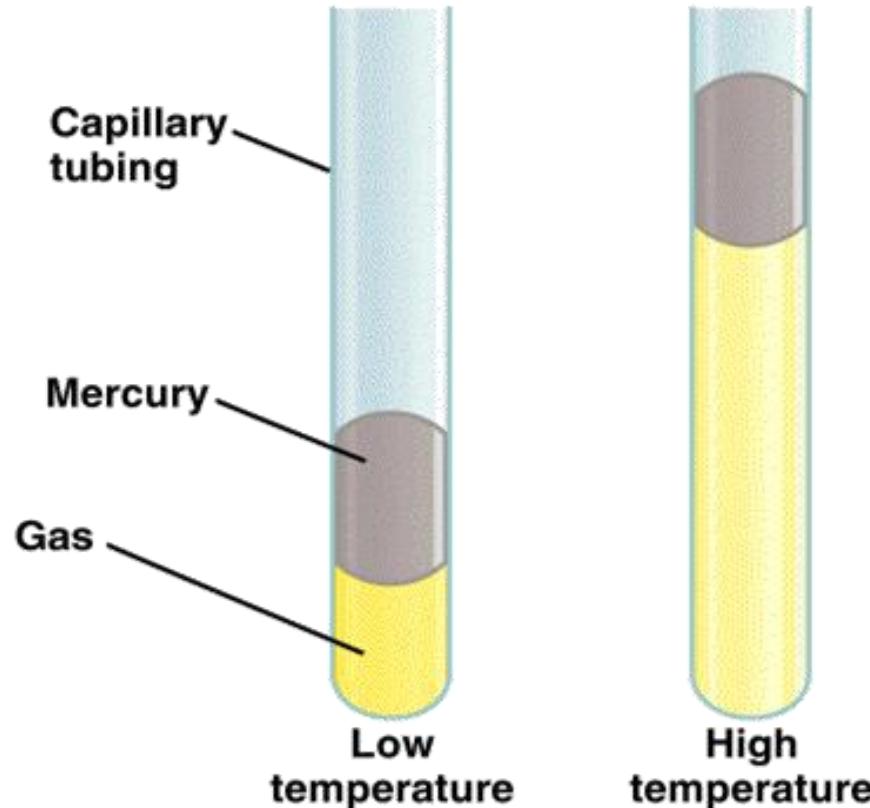
Hukum Charles (Charles's Law)

- Dikemukakan pada 1787 oleh Jacques Charles dan dirumuskan pada 1802 oleh Joseph L. Gay Lussac
- Jika tekanan tak berubah, volume gas dengan massa tertentu, berbanding lurus dengan temperatur

$$\Delta V \propto \Delta T$$

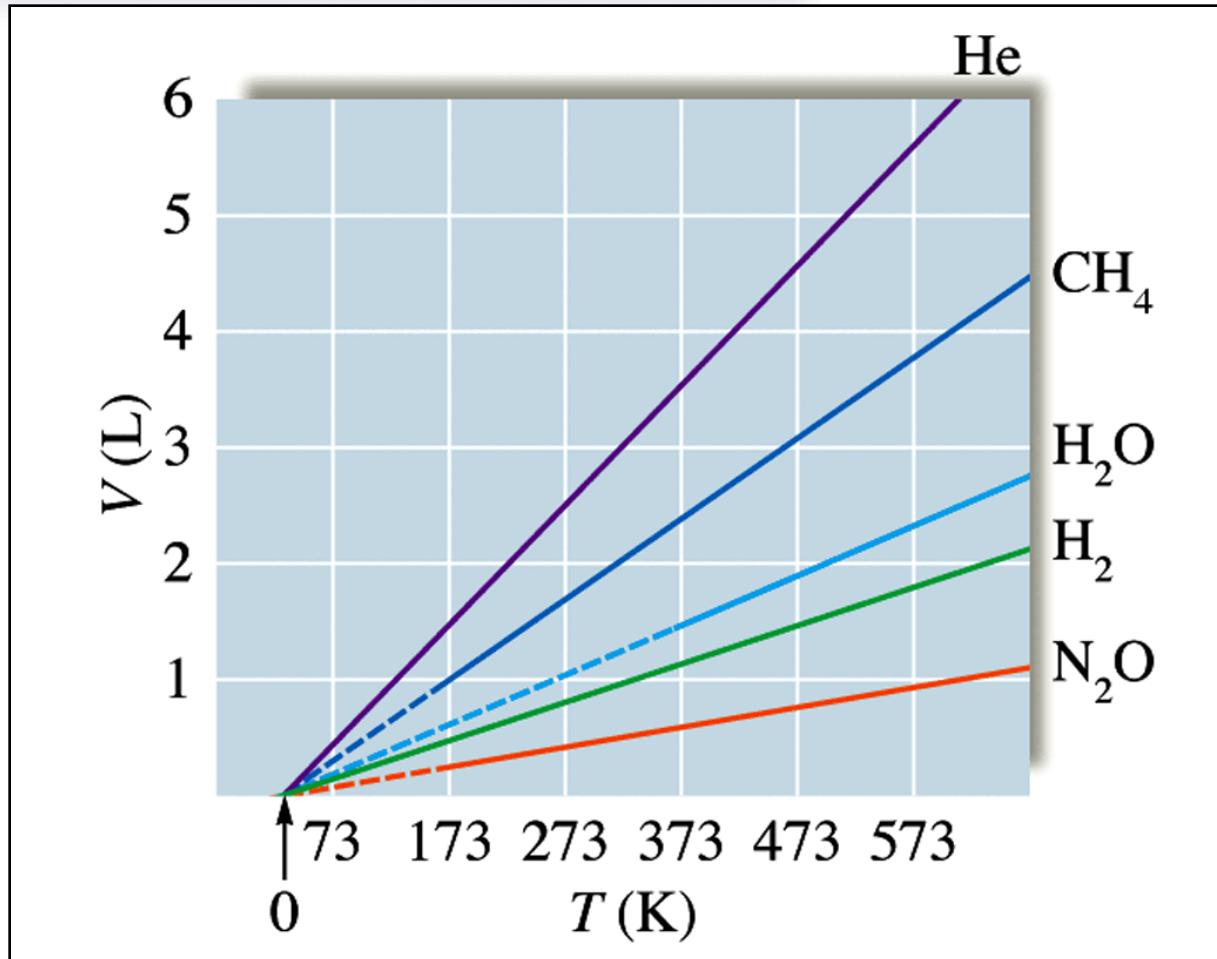
Hukum Charles (Charles's Law)

Gas Expanding and Contracting



As T increases V increases

Hukum Charles (Charles's Law)



Hukum Charles (Charles's Law)

- The volume of a gas is directly proportional to temperature, and extrapolates to zero at zero Kelvin.

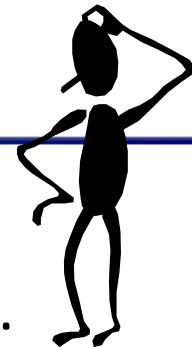
$$V = bT \quad (P = \text{constant})$$

b = a proportionality constant

Hukum Charles (Charles's Law)

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad (P = \text{constant})$$

Contoh Perhitungan



A sample of carbon monoxide gas occupies 3.20 L at 125 °C. At what temperature will the gas occupy a volume of 1.54 L if the pressure remains constant?

$$V_1/T_1 = V_2/T_2$$

$$V_1 = 3.20 \text{ L}$$

$$V_2 = 1.54 \text{ L}$$

$$T_1 = 398.15 \text{ K}$$

$$T_2 = ?$$

$$T_2 = \frac{V_2 \times T_1}{V_1} = \frac{1.54 \text{ L} \times 398.15 \text{ K}}{3.20 \text{ L}} = 192 \text{ K}$$

Hukum Gay Lussac

- Dikemukakan pada 1703 oleh Joseph L. Gay Lussac dan Guillaume Amontons
- Tekanan suatu gas dengan massa tertentu berbanding lurus dengan temperatur

$$\Delta P \propto \Delta T$$

Hukum Avogadro

- Dikemukakan pada 1811 oleh Amadeo Avogadro
- Molekul yang sama banyak terdapat dalam gas-gas berlainan yang volumenya sama, jika tekanan dan temperaturnya sama

$$V \propto n$$

Hukum Avogadro



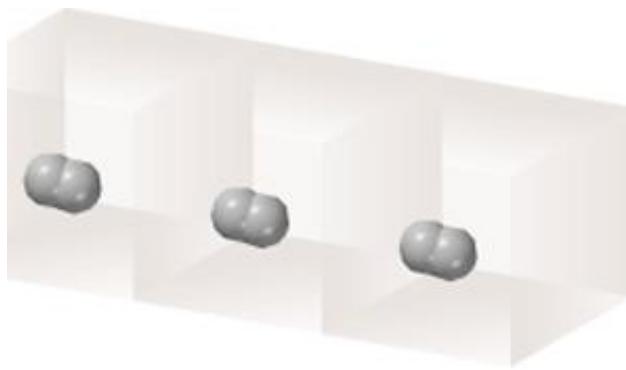
$V \propto$ number of moles (n)

$V = \text{constant} \times n$

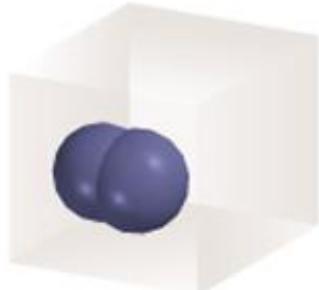
$$V_1/n_1 = V_2/n_2$$



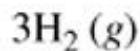
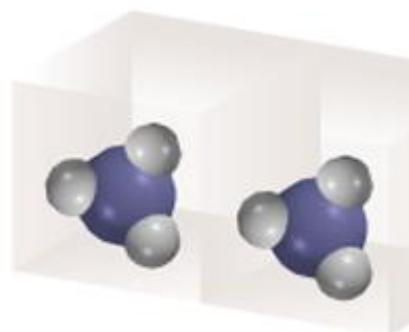
Constant temperature
Constant pressure



+



→



3 molecules

3 moles

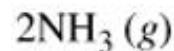
3 volumes



1 molecule

1 mole

1 volume

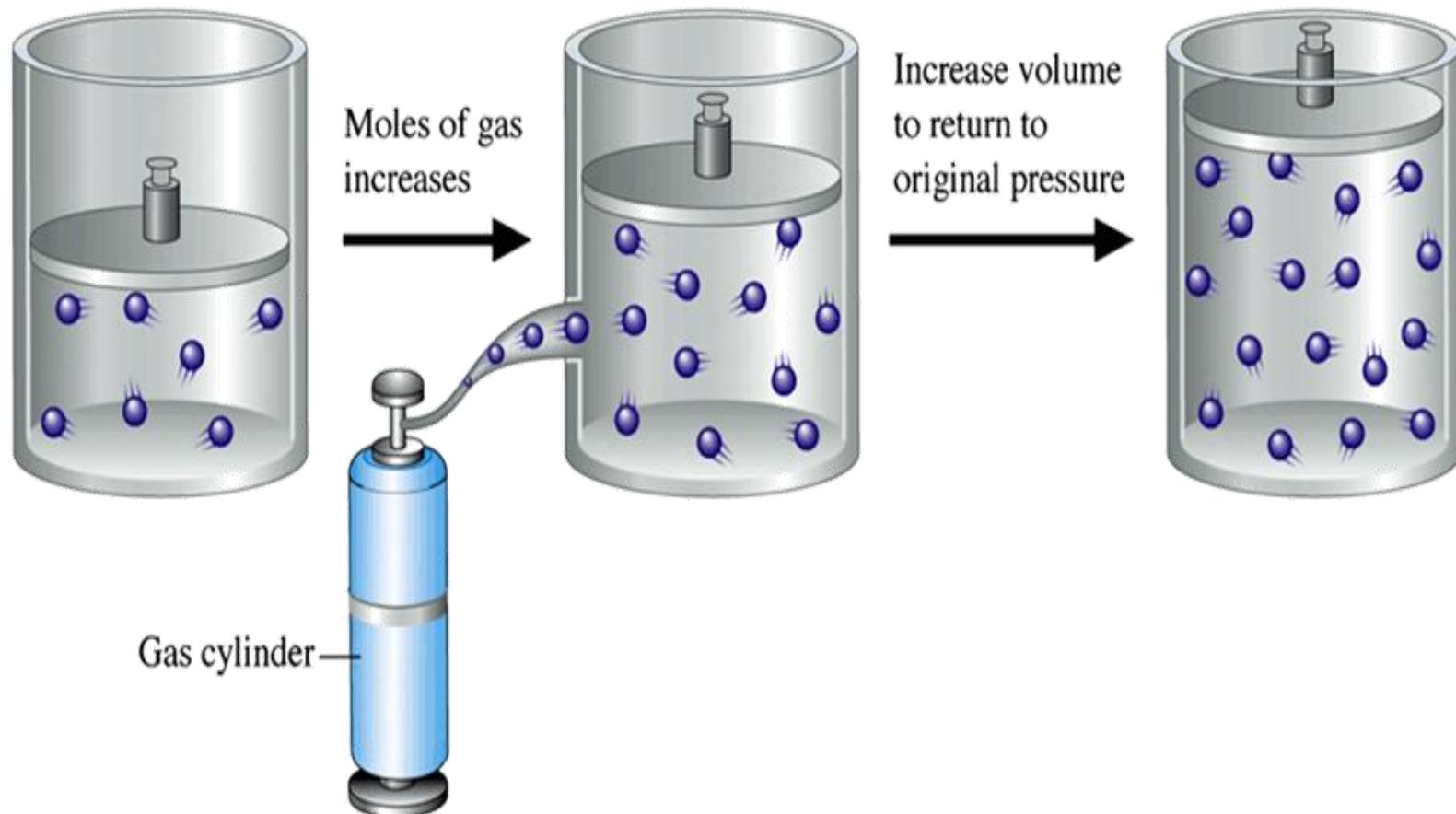


2 molecules

2 moles

2 volumes

Efek penambahan mol partikel gas pada temperatur dan tekanan konstan.



Persamaan Gas Ideal

Boyle's law : $V \propto \frac{1}{P}$ (at constant n and T)

Charles' law : $V \propto T$ (at constant n and P)

Gay Lussac' law : $P \propto T$ (at constant n and V)

Avogadro's law : $V \propto n$ (at constant P and T)

$$V \propto \frac{nT}{P}$$

$$V = \text{constant} \times \frac{nT}{P} = R \frac{nT}{P}$$

R is the gas constant

$$PV = nRT$$

Hukum Gas Ideal

$$PV = nRT$$

P = pressure in atm

V = volume in liters

n = moles

R = proportionality constant

= 0.08206 L atm K⁻¹ mol⁻¹

T = temperature in Kelvins

Holds closely at P < 1 atm

Tetapan R



Gas	Rumus	Volume	Tetapan R	Gas	Rumus	Volume	Tetapan R
Ideal		22,414	0,082057	Nitrogen Oxyde	NO	22,389	0,081966
Hydrogen	H ₂	22,428	0,082109	Methane	CH ₄	22,360	0,081860
Helium	He	22,426	0,082101	Carbon Dioxide	CO ₂	22,256	0,081845
Neon	Ne	22,425	0,082098	Hydrogen Chloride	HCl	22,249	0,081453
Nitrogen	N ₂	22,404	0,082021	Ethilene	C ₂ H ₄	22,241	0,081424
Carbon Monoxide	CO	22,403	0,082017	Asetilene	C ₂ H ₂	22,190	0,081240
Oxygen	O ₂	22,394	0,081984	Ammonia	NH ₃	22,094	0,080870
Argon	Ar	22,393	0,081981	Chloride	Cl ₂	22,063	0,080760

Tetapan R



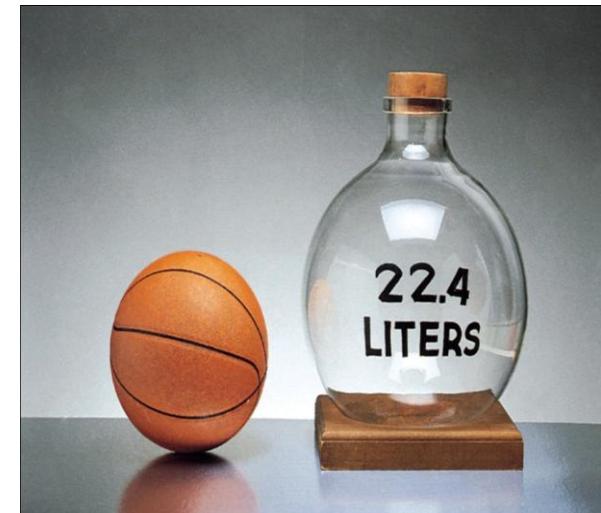
The conditions 0°C and 1 atm are called **standard temperature and pressure (STP)**.

Experiments show that at STP, 1 mole of an ideal gas occupies 22.42 L.

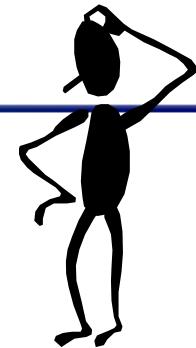
$$PV = nRT$$

$$R = \frac{PV}{nT} = \frac{(1 \text{ atm})(22.42\text{L})}{(1 \text{ mol})(273.15 \text{ K})}$$

$$R = 0.082067 \text{ L} \cdot \text{atm} / (\text{mol} \cdot \text{K})$$



Contoh Perhitungan



What is the volume (in liters) occupied by 49.8 g of HCl at STP?

$$T = 0^{\circ}\text{C} = 273.15 \text{ K}$$

$$P = 1 \text{ atm}$$

$$PV = nRT$$

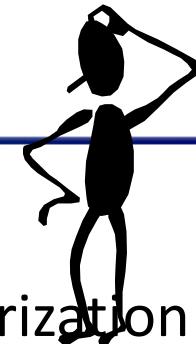
$$V = \frac{nRT}{P}$$

$$n = 49.8 \text{ g} \times \frac{1 \text{ mol HCl}}{36.45 \text{ g HCl}} = 1.37 \text{ mol}$$

$$V = \frac{1.37 \text{ mol} \times 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \times 273.15 \text{ K}}{1 \text{ atm}}$$

$$V = 30.6 \text{ L}$$

Contoh Perhitungan



Argon is an inert gas used in lightbulbs to retard the vaporization of the filament. A certain lightbulb containing argon at 1.20 atm and 18 °C is heated to 85 °C at constant volume. What is the final pressure of argon in the lightbulb (in atm)?

$$PV = nRT \quad n, V \text{ and } R \text{ are constant}$$

$$\frac{nR}{V} = \frac{P}{T} = \text{constant}$$

$$P_1 = 1.20 \text{ atm}$$

$$P_2 = ?$$

$$T_1 = 291 \text{ K}$$

$$T_2 = 358 \text{ K}$$

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

$$P_2 = P_1 \times \frac{T_2}{T_1} = 1.20 \text{ atm} \times \frac{358 \text{ K}}{291 \text{ K}} = 1.48 \text{ atm}$$



Thank You !

