VIVEKANAND EDUCATION SOCIETY'S POLYTECHNIC

Study Material

Program Code: Common to all 1st semester

Semester: 1

Course Name: Basic Science (Physics)

Course Code: 22102

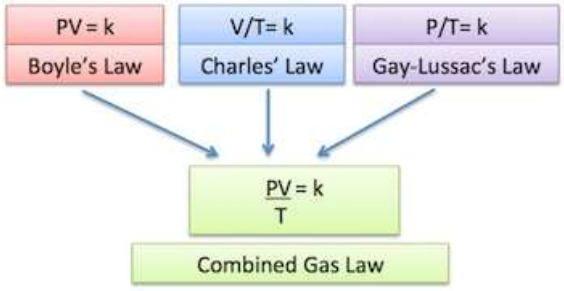
Topic Name: Heat and optics

UO3C:Relate the properties of three gas laws .

LO3: Students will be able to explain the three gas laws and general gas equation

Course Expert: Mrs. Deepa Gupte	**Date: 21/9/2020**

Concept Map:



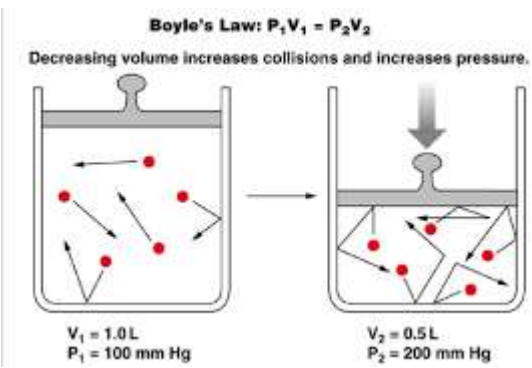
Key words: Boyle's law, Charle's law, Gay Lussac's law, general gas equation

Key Questions:

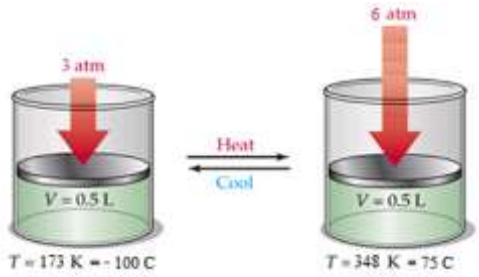
Key Definition/Formula: PV=RT

Diagram /Picture:

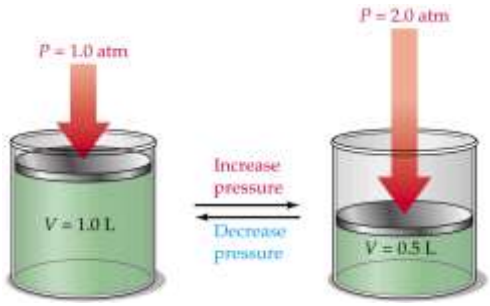
Boyle's Law



Gay Lussac's Law



Charle's law



Note:

Like solids and liquids, gases also expand on heating and expansion in case of gases is very large and hence the expansion of containers of gases is considered as negligible. In case of gases the volume of a gas depends not only on temperature of the gas but also on the pressure to which gas is subjected. Thus in case if gases we have three variables the volume (v), temperature (T) and pressure (P). All these three variables are mutually dependent upon one another. To study the variation of any two, the third one should be kept constant. The inter relationship between the three variables are known as gas laws.

Hence we have the following three gas laws.

Gas laws:

Boyle's law: At constant temperature, the pressure exerted by a fixed mass of the gas is inversely proportional to its volume.

If the pressure of a gas is increased, keeping the temperature constant, the volume will decease and if the pressure is decreased keeping the temperature constant, the volume of the gas will increase.

If P is the pressure and V is the volume at constant temperature, then $P\alpha 1/V$ or PV= constant.

In general if V1, V2 and V3 are volumes at pressures P1, P2 and P3 respectively at constant temperature of a given mass of a gas, we have P 1V1= P2V2=P3V3=constant

Charle's law: At constant pressure, the volume of a fixed mass of a gas is directly proportional to the absolute temperature.

If the temperature of a gas is increased keeping the pressure constant, the volume of the gas will also increases. If the temperature is reduced the volume will also be reduced. If V is the volume and T is the temperature at constant pressure, then $V\alpha T$

V/T=constant

In general if V1, V2 and V3 are the volume at temperature T1, T2 and T3 respectively at constant pressure of a given mass of a gas, V1/T1= V2/T2=V3/T3=constant

Gay lussac's law: At constant volume, the pressure of a fixed mass of a gas is directly proportional to the absolute temperature.

If the temperature of a gas is increased keeping the volume constant, the pressure of the gas will also increases. If the

temperature is reduced the pressure will also be reduced. If P is the pressure and T is the temperature at constant volume, then PαT

In general if P1, P2 and P3 are the pressure at temperature T1, T2 and T3 respectively at constant volume of a given mass of a gas, we have P1/T1=P2/T2=P3/T3=constant

Gas equation:

The state of fixed mass of gas can be described completely by starting the pressure, volume and temperature of the gas. The equation of the state of a gas gives the relationship between these three quantities for fixed mass of a gas.

This gas equation is described by combining gas laws, i.e,

P α 1/V (T constant)–––––––––––––– according to Boyle's law,

Vα T (P = constant) ---------- -------- according to Charle's law,

V α T/P PV α T

∴ PV = KT (where K is constant for a fixed mass of a gas and called specific gas

constant)

PV = KT is called the ideal **gas equation.**

Now if we consider a unit mass of gas (i.e. one mole of a gas), then K is replaced by R

i.e. PV = RT (where R is universal gas constant)

For 'n' number of moles of gas, the equation is written as PV = nRT and is called

General gas equation.

Universal gas constant (R): We know for one gram mole of a gas the general gas equation is given as PV = RT, where R is a universal gas constant.

R is called universal gas constant because value of R is same for all gases (R = 8314.91

J/°K-kg-mole). The reason is that one gram molecule of any gas occupies some volume under normal temperature pressure (NTP) condition.

NTP stands for normal temperature and pressure of the gas it denotes the temperature of

0°C or 273 K and pressure of one atmosphere or 76 cm of Hg.

One atmosphere is defined as normal pressure of gas exerted by a column of mercury exactly 76 cm high at 0°C and is equal to the average pressure of the atmosphere at sea level.

Unit of R: We know PV = RT,

∴ PV /T= R

Now for n moles of a gas, the gas equation is given as PV = nRT is called **molar gas equation**.

Link to YouTube/ OER/ video/e-book:

Key Take away: Three gas laws, General gas equation

Formative Assessments

<22102>: < Common to all 1st semester>: <Common to all>: <Heat and Optics>: <UO3c: Relate the properties of three gas laws>: <Assessments>: <Formative>

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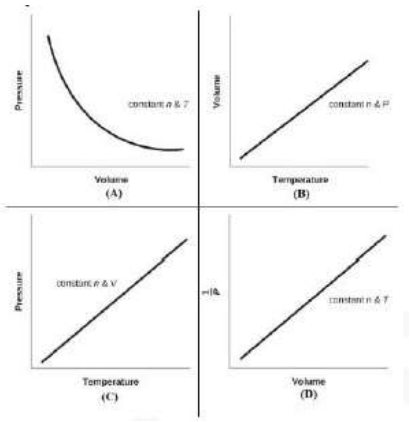
Assessment Type: Formative Assessments:

Set 1: Question No 1	Set 1: Question No 2	Set 1: Question No 3
SI unit of pressure is	As per Boyle's law, if P is the pressure and V is the volume at constant temperature, then	A gas at 76 cm of mercury occupies a volume of 50 cc at constant temperature. If the pressure of the gas changes to 60 cm of mercury, find the volume occupied by the gas at constant temperature.
a) N/m2	a) PV = constant	a) 75 cc
b) Pa	b) P/V = constant	b) 72.56 cc
c) atm	c) V/P = constant	c) 69.34 cc
d) All of the above	d) 1/PV = constant	d) 63.33 cc
Ans: <d>	Ans: <a>	Ans: <d>

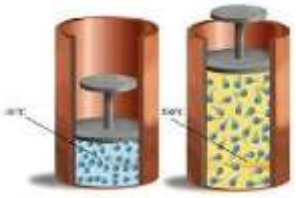
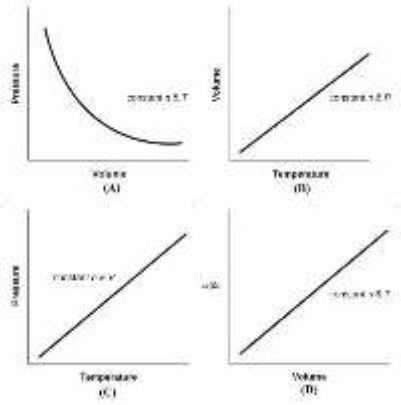
Set 2: Question No 1	Set 2: Question No 2	Set 2: Question No 3
P1V1 = P2V2 = P3V3 = ... = PnVn is the general equation of -	Which of the following is the graphical representation of Charle's Law? 	A gas at 10°C has its temperature raised so that its volume is doubled, What is its final temperature, if pressure is same?
a) Boyle's law	a) (A) only	a) 93°C
b) Charles's law	b) (B) only	b) 193°C
c) Gay-Lussac's law	c) (C) only	c) 293°C
d) Avogadro's law	d) (D) only	d) 393°C
Ans: <a>	Ans: ~~<c>~~ <b>	Ans: ~~<b>~~ <c>

Practice Worksheet

<22102> : <Common to all 1st Semester> : < Common to all 1st Semester>: <Heat and optics>: <UO1c> : <Assessments> : <Worksheet>

< Mrs. Deepa Gupte >

Assessment Type: Practice Worksheets:

A) PV = RT is called as ..... a. gas equation b. general gas equation c. ideal gas equation d. state of gas	B) At constant temperature, the pressure of gas is inversely proportional to volume of the gas. Identify the correct gas law - a. Boyle's law b. Charles's law c. Gay-Lussac's law d. Avogadro's law
Ans A: b	Ans B: a
C) V1/T1 = V2/T2 = ... = Vn/Tn is the general equation of - a. Boyle's law b. Charle's law c. Gay-Lussac's law d. Dalton's law	D) Figure represents –  a. Boyle's law b. Charle's law c. Gay-Lussac's law d. Avogadro's law
Ans C: b	Ans D: b
E) Which of the following is the graphical representation of Boyle's Law?  a. Both (A) and (B) b. Both (A) and (C) c. Both (A) and (D) d. Only Fig (A)	F) Figure represents –  a. Boyle's law b. Charle's law c. Gay-Lussac's law d. Avogadro's law
Ans E: c	Ans F: a