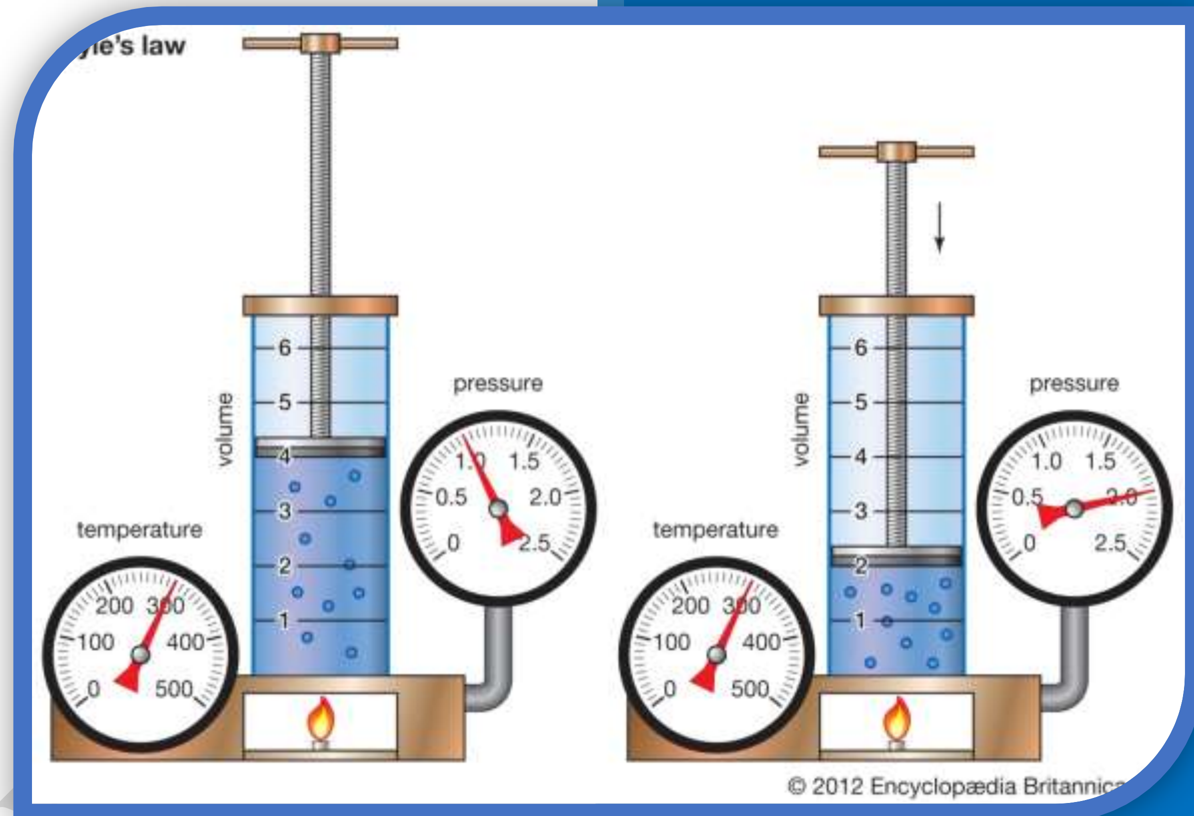
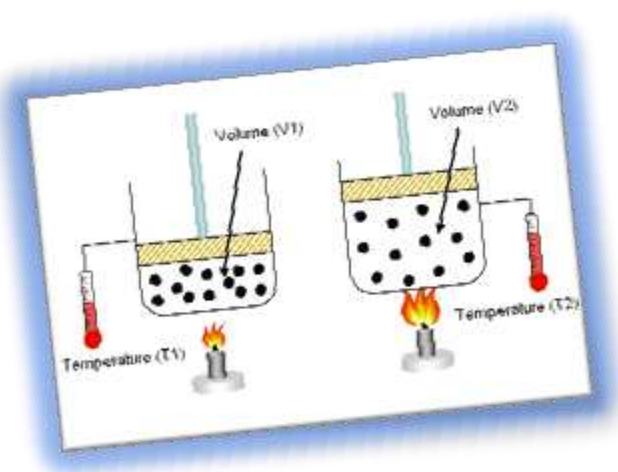
2020

GAS LAWS





TEACHERS OF PHYSICS

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8/12/2020

BOYLE'S LAW.

1. State Boyle's Law

- ✓ *The pressure of a fixed mass of a gas is inversely proportional to its volume at a constant temperature.*

2. State how the pressure of a fixed mass of gas can be increased at constant temperature. (1mk)

- ✓ When the volume is decreased (the gas is compressed), the spacing between the molecules is decreased, and therefore the rate at which they collide with the walls of the container is increased – so the pressure increases.

3. An air bubble expands as it rises to the surface of water in a deep pond. State the cause of this given that the temperature remains constant. (1mk)

- ✓ Decrease in pressure due to water as the bubbles rises to the top it expand since pressure increases with depth.

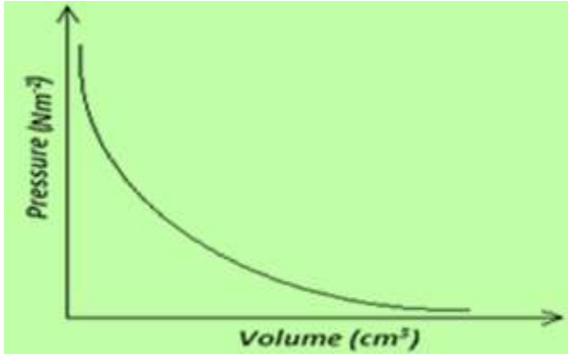
4. When an inflated balloon is placed in a refrigerator, it is noted that its volume reduces. Use kinetic theory to explain this observation. (1mk)

- ✓ Low temperature reduces the kinetic energy of molecules which lead to lower rate of collision which results to reduction of pressure.

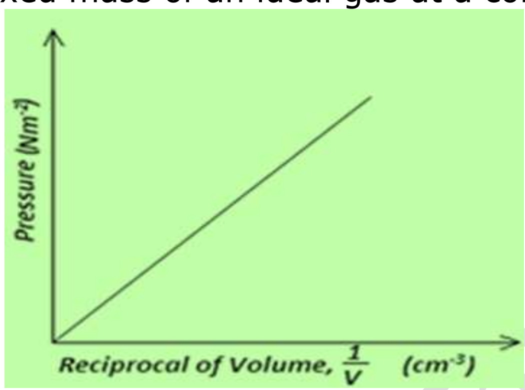
5. Show that the density of a fixed mass of gas is directly proportional to the pressure at constant temperature.

- ✓ Ideal gas Equation is given in the form PV=ηRT……(i)
- ✓ Where moles of the gas (η) = $\frac{mass\ of\ gas\ (m)}{molecular\ weight\ (M)}$
- ✓ Using η=$\frac{m}{M}$ and rearranging equation (i) yields
- ✓ $\frac{m}{V} = \frac{M}{RT}p$
- ✓ But $\frac{m}{V}$ = ρ (Density)
- ✓ Then, ρ=$\frac{M}{RT}p$ …………….(ii)
- ✓ Equation (ii) implies that ρ is directly proportional to p at constant T since M and R are constants.

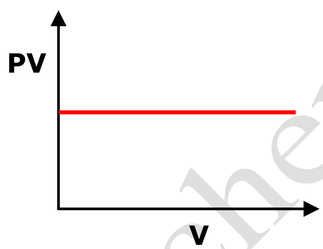
6. Draw axes and sketch the **P – V** graph for a gas obeying Boyle's Law.



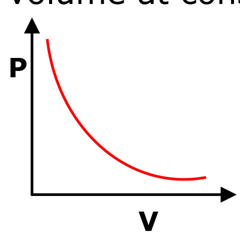
7. Draw axes and sketch a graph of pressure **(P)** against reciprocal of volume **(1/v)** for a fixed mass of an ideal gas at a constant temperature.



8. On the axes provided, sketch a graph of **PV** against **V** for ideal gas in which Boyle's law is obeyed. (1mk)



9. On the axis below, sketch a graph to show how the pressure of a fixed mass of a gas varies with volume at constant temperature. (1mk)



10. A diver at the bottom of a swimming pool releases an air bubble of volume **2cm^3**. As the air bubble rises, its volume increases to 5cm^3 at the surface of the pool. Explain this observation.

- ✓ Liquid pressure decreases as the bubble rises to the top causing increase in its volume.

11. A bubble at the bottom of a pond rises to the surface of the pond. If the volume, as it just reaches the surface is double that at the bottom of the pond; estimate the depth of the pond. (Assume uniform pond temperature Atmospheric pressure **100kPa**) (5mk)

Solution

Let assume the pond contain water.

Let V_1 (at the bottom)=X

Density of water $1000kg/m^3$

V_1= X

P_1=?

P_2=100KPa=100,000Pa

V_2=2X

$P_1V_1=P_2V_2$

$P_1\times X= 100{,}000\times 2X$

$P_1=\frac{100{,}000\times 2X}{X}$

P_1=200,000 Pa

Pressure=ρhg

200,000=1000×h×10

H=20 m

12. A bubble of air of volume $1cm^3$ is released by a deep-sea diver at a depth where the pressure is 30 atmospheres. Assuming its temperature remains constant (T_1 = T_2) **what** is its volume just before it reaches the surface where the pressure is 1.5 atmosphere? (3mks)

Solution

$V_1=1cm^3$

P_1=30 atm

P_2=1.5 atm

V_2=?

$P_1V_1=P_2V_2$

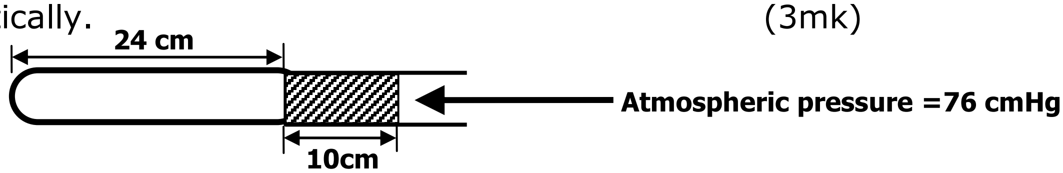
$1.5\times V_1=1\times 30$

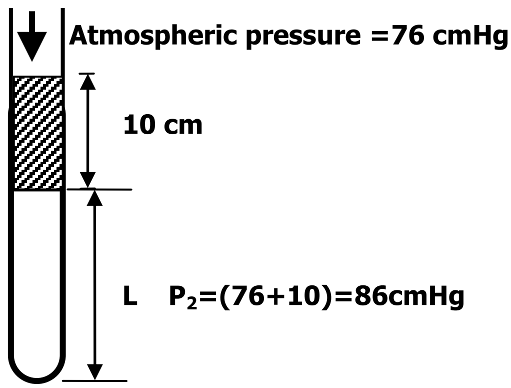
$V_1=\frac{1\times 30}{1.5}$

V_1=20 cm^3

13. An empty barometer tube of length **90cm** is lowered vertically with its mouth downwards into a tank of water. What will be the depth at the top of the tube when the water has risen **15cm** inside the tube, given that the atmospheric pressure is 10m head of water?

14. A column of air **24cm** long is trapped by a column of mercury 10cm long in a horizontal tube with uniform cross-sectional area. If the atmospheric pressure is **76cm Hg**. Determine the new height of air trapped in the tube when the tube is placed vertically. (3mk)





$P_1V_1=P_2V_2$

$76\times24=86\times L$

$L=\frac{76\times24}{86}$

L=21.21 cm

15. A hand pump suitable for inflating a football has a cylinder which is 0.24m in length and an internal cross-sectional area of **5.0×10^{-4} m^2**. To inflate the football the pump handle is pushed in and air is pumped through a one-way valve. The valve opens to let air in to the ball when the air pressure in the pump has reached **150 000Pa**. (Assume the air temperature remains constant}

a) If the pressure in the pump is initially **100 000 Pa**, calculate how far the piston must be pushed inwards before the one way valves opens.

Let the initial length of hand pump be Y

$V_1=0.24 \times 5.0 \times 10^{-4}\ m^3$

$P_1=100{,}000$ Pa

$P_2= 150{,}000$Pa

$V_2= (Y \times 5.0 \times 10^{-4})\ m^3$

By boyle's law: $P_1V_1=P_2V_2$

$100{,}000 \times (0.24 \times 5\times10^{-4})=150{,}000 \times (Y \times 5.0 \times 10^{-4})$

$Y=\frac{10\cancel{0,000} \times (0.24 \times \cancel{5.0\times10^{-4}})}{15\cancel{0,000} \times \cancel{5.0 \times 10^{-4}})}$

Y= 0.16

Length piston moved inwards=0.24-0.16=0.08 m

(b) When the one-way valve opens the total pressure in the cylinder will be **150 000 Pa**. What force will be exerted on the piston by the air in the cylinder?

Pressure= 150,000 Pa
Area =5.0 x 10^{-4} m^2

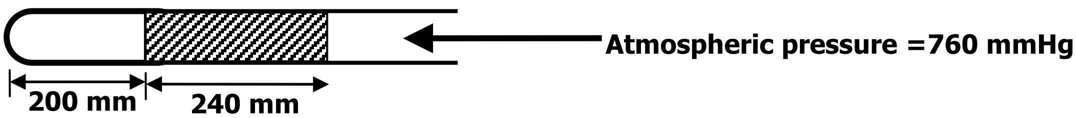
$$\text{Pressure}=\frac{Force}{Area}$$

$$150{,}000 = \frac{\textbf{Force}}{\mathbf{5.0\times10^{-4}}}$$

Force =150,000 x 5.0 x 10^{-4} m^2

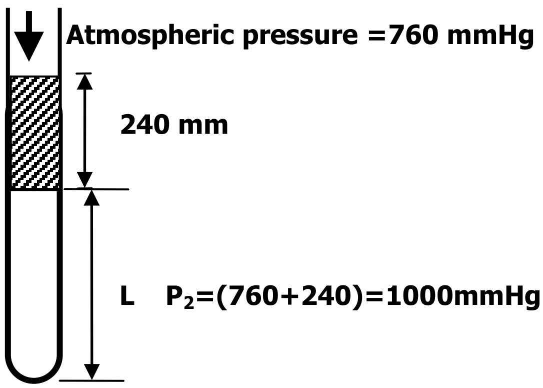
Force =75N

16. Air is trapped inside a glass tube by a thread of mercury 240mm long. When the tube is held horizontally, the length of the air column is 200mm.



Given that the atmospheric pressure is 760mmHg and the temperature is kept constant, calculate the length of air column when the tube is held;

(i) Vertical with the open end up (3mk)



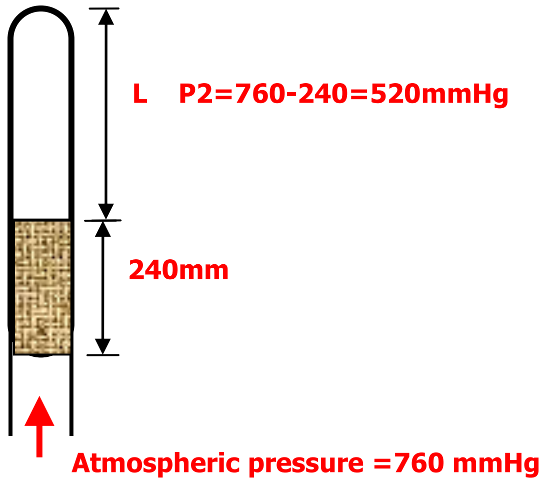
$P_1V_1=P_2V_2$

$760\times200=1000\times L$

$L=\frac{760\times200}{1000}$

L=153 mm

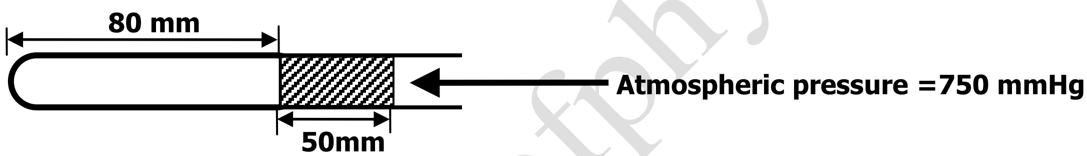
(ii) Vertical with the open end down (inverted) (2mk)



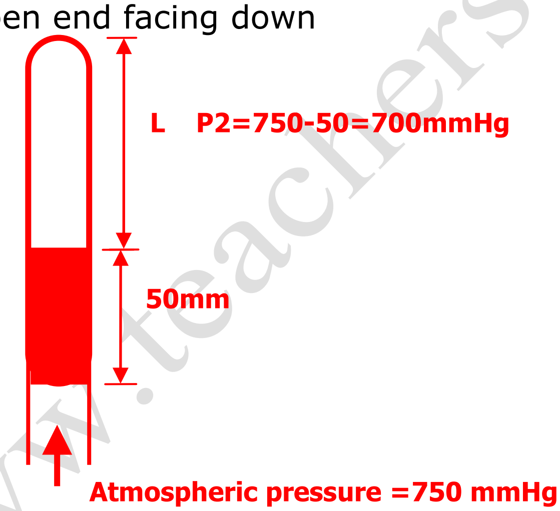
$P_1V_1=P_2V_2$
$760\times200=520\times L$
$L=\frac{760\times200}{520}$

L=292.3 mm

17. Air is trapped in a tube of uniform cross-action using mercury as shown



(a) Determine the length of the air column when the tube is kept vertical with the open end facing down (3mks)



$P_1V_1=P_2V_2$
$750\times80=700\times L$
$L=\frac{750\times80}{700}$

L=85.71 mm
Length of air column =**85.71mm**

(b) State the assumptions made in the above calculation (1mk)

- ✓ Temperature is kept constant throughout the air column.

18. The pressure of helium gas of volume $10cm^3$ decreases to one third of its original value at a constant temperature. Determine the final volume of the gas.

Solution
$V_1=10\ cm^3$
Let initial pressure=P
New value of pressure= 1/3P
By boyle's law: $P_1V_1=P_2V_2$
$10\times P=1/3P\times V_2$
$V_2=30\ cm^3$

19. A balloon seller has a cylinder of helium gas which he uses to blow up his balloons. The volume of the cylinder is $0.10m^3$. It contains helium gas at a pressure of $1.0 \times 10^7 Nm^{-2}$. The balloon seller fills each balloon to a volume of $1.0 \times 10^{-2} m^3$ and a pressure of $2.0 \times 10^5 N/m^2$

(a) Explain in terms of particles how the helium in the cylinder produces a pressure (1mk)

- ✓ Pressure is produced when particles collide with each other and with the wall of the cylinder.

(b) Calculate the total volume that the helium gases occupy at a pressure of **$1.2 \times 10^5\ N/m^2$**. Assume the temperature of the helium does not change. (3mk)

Solution
$V_1=1.0 \times 10^{-2}\ m^3$
$P_1=2.0 \times 10^5\ N/m^2$
$P_2=1.2 \times 10^5\ N/m^2$
$V_2=?$
By boyle's law: $P_1V_1=P_2V_2$
$2.0 \times 10^5 \times 1.0 \times 10^{-2}=1.2 \times 10^5 \times V_2$
$V_2=\frac{2.0 \times 10^5 \times 1.0 \times 10^{-2}}{1.2 \times 10^5}$

$V_2= 1.667 \times 10^{-2}\ m^3$

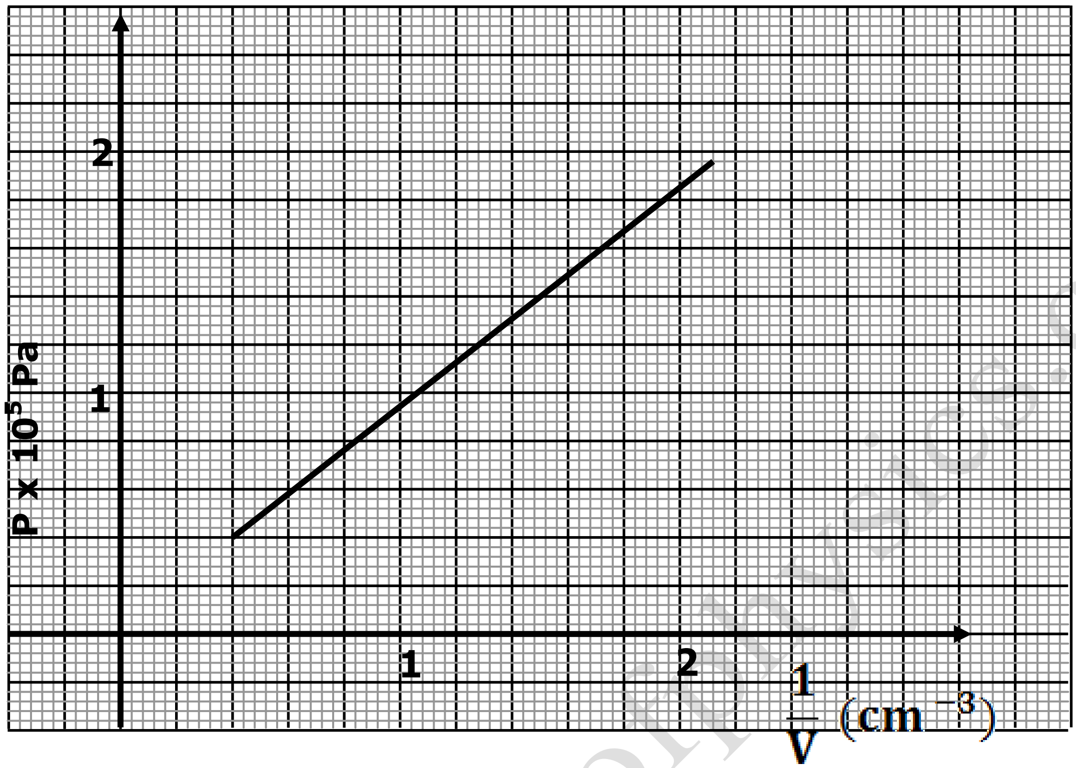
(c) Calculate the number of balloons of volume $1.0 \times 10^{-2} m^3$ that the balloon seller can fill using the gas (2mk)

Solution
Let the number = n
$V_1=0.10m^3$
$P_1= 1.0 \times 10^7 Nm^{-2}$
$P_2=2.0 \times 10^5\ N/m^2$
$V_2=1.0 \times 10^{-2}\ m^3$
By boyle's law: $P_1V_1=n(P_2V_2)$
$1.0 \times 10^7 \times 0.10=n(2.0 \times 10^5 \times 1.0 \times 10^{-2})$
$n=\frac{1.0 \times 10^7 \times 0.10}{2.0 \times 10^5 \times 1.0 \times 10^{-2}}$

n= 500

20. An air bubble is released at the bottom of a tall jar containing a liquid. The height of the liquid column is 80cm. The volume of the bubble increase from

0.5cm^3 at the bottom of the liquid to 1.15cm^3 at the top. The figure below shows the variation of pressure **P**, on the bubble with the reciprocal of volume **1/V** as it rises in the liquid.



(a) State the reason why the volume increases as the bubble rises in the liquid column. (1mk)

- ✓ Decrease in pressure exerted on the bubbles by the liquid column as it rises to the top.

(b) From the graph, determine the pressure on the bubble.

(i) At the bottom of the liquid column; (2mk)

- ✓ $(1.8+0.16) \times 10^5$ **$=1.96\times10^5$ Pa**

(ii) At the top of the liquid column. (1mk)

- ✓ 0.4×10^5 **$=4.0\times10^4$ Pa**

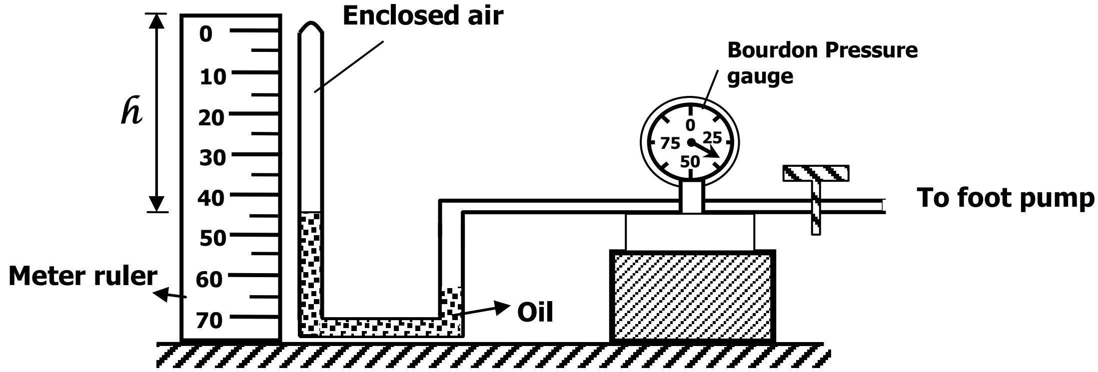
(iii) Hence determine the density of the liquid in kgm^{-3}(3mk)

- ✓ Height = 80 cm, g=10,
- ✓ Pressure of the air bubble at the bottom=1.96×10^5 Pa
- ✓ Pressure $=\rho hg$
- ✓ $1.96\times10^5=\rho\times0.8\times10$
- ✓ **$\rho=2.45\times10^3$ kg/m^3**

(iv) What is the value of the atmospheric pressure of the surrounding? (1mk)

- ✓ (1.96×10^5 Pa-4.0×10^4 Pa)=**1.56×10^5 Pa**

21. Set up in figure is used to verify Boyle's law

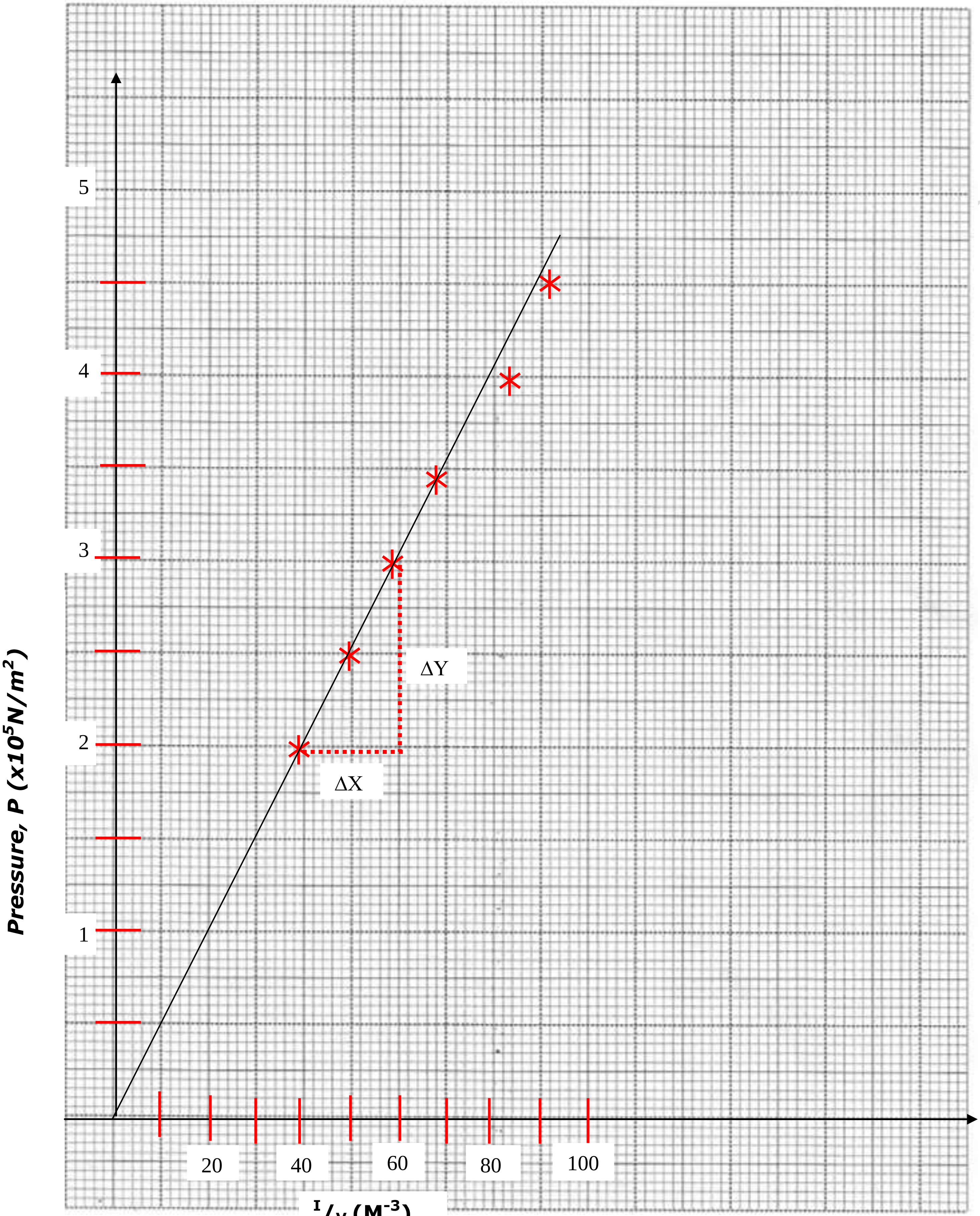


The pressure, P of a fixed mass of a gas at a constant temperature T = 300K is varied continuously. The corresponding values of P and the volume (V) of the gas are shown in the table below.

Pressure, P ($x10^5 N/m^2$)	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**
Volume, V(M^3)	**0.025**	**0.02**	**0.017**	**0.014**	**0.012**	**0.011**
$^I/_V$ (M^{-3})	**40**	**50**	**58.8**	**71.4**	**83.3**	**90.9**

(i) Complete the table above by filling in the values of $^I/_V$ (1mk)

(ii) Plot a graph of pressure (y – axis) against $^I/_V$ (5mk)



(iii) Determine th... the graph (3mks)

$$\text{Slope} = \frac{\Delta P}{\Delta 1/V}$$

$$\text{Slope} = \frac{\{(3\times10^5)-(2\times10^5)\}}{(58.8-40)}$$

$$= \frac{1\times10^5}{18.8}$$

$= 5.3191 \times 10^3$ N/m

(iv) Given that the equation of the graph is PV = 2RT where R is a constant, use your graph to determine the value of R. (3mks)

From the graph, it is a straight line, Y=mx+c

$$P=\frac{2RT}{V}$$

2RT= Slope/Gradient

$2\times300K\times R=5.3191 \times 10^3$ N/m

$600K\times R=5.3191 \times 10^3$ N/m

$R=8.8652Nm^{-1}k^{-1}$ or J/K

(v) State the unit of R. (1mk)

✓ $Nm^{-1}k^{-1}$ or J/K

(vi) Estimate the pressure of the air column when the length of the air is zero (2mk)

Pressure =0 Pa

(vii) From the graph, calculate the volume when the pressure 380,000N/m^2 (2mks)

3.8×10^5 N/m^2=70.1 m^{-3} =0.01426m^3

(viii) State the two physical quantities which were kept constant (2mks)

✓ Mass and temperature

CHARLE'S LAW.

1. State Charles law for an ideal gas. (1mk)

- ✓ *The volume of a fixed mass of a gas is directly proportional to the absolute temperature(Kelvin) at constant pressure.*

2. When an inflated balloon is placed in a refrigerator it is noted that its volume reduces.

Low temperature reduces the kinetic energy of molecules, and therefore the rate at which they collide with the walls of the container is reduces which results to reduction of volume.

3. Define absolute zero temperature for an ideal gas (1mk)

- ✓ *Absolute zero temperature refers to the lowest temperature a gas can fall to. It is -273^{0}celcius (0 Kelvin).*

4. The pressure of the air inside a car tyre increases if the car stands out in the sun for some time on a hot day. Explain the pressure increase in terms of the kinetic theory of gases. (3mk)

When the temperature of the air inside the tyre increase the kinetic energy of air particles increases and therefore the rate at which they collide with the walls of the tyre is increased – so the pressure increases.

5. Using the kinetic theory of gases, explain the behaviour of gas particles in accordance with Charles Law. (2mk)

- ✓ When the temperature of a gas rises, its particles move faster and exert a larger force on the wall of the container when they collide with it.
- ✓ The frequency of collisions also increases.
- ✓ If the pressure is to remain constant, the volume must increases.

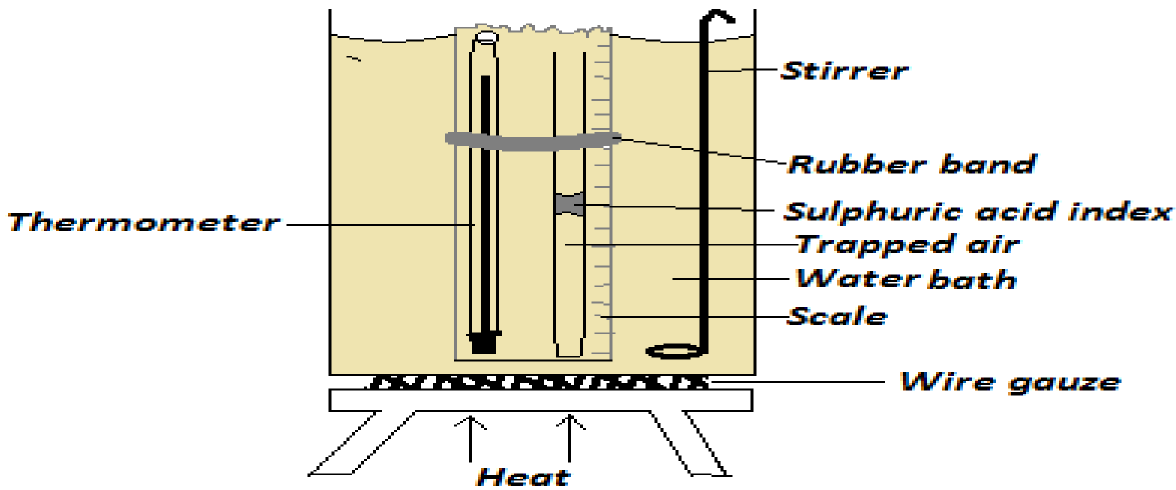
OR

- ✓ *When a gas is heated the kinetic energy of its molecules increases.*
- ✓ *If the volume remains constant the pressure at the walls would increase due to a greater rate of change of momentum per unit time.*
- ✓ *Since Charles law is done at constant pressure, and then the volume increases.*

6. You are provided with the following

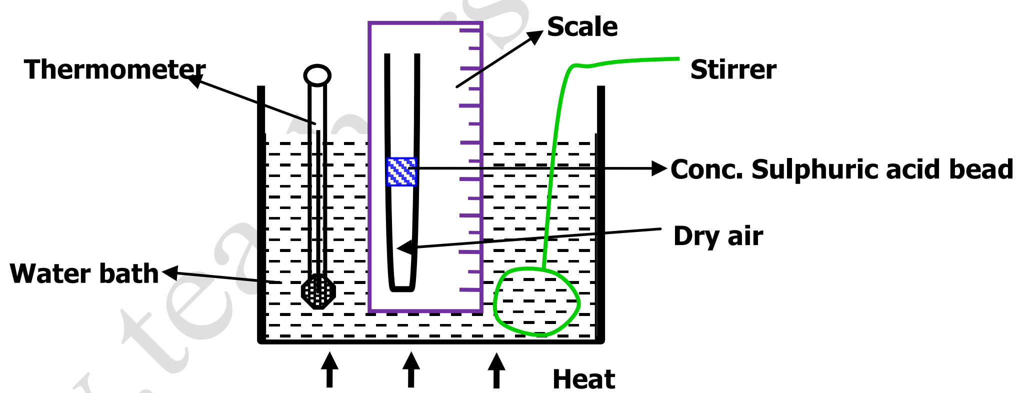
- A uniform glass tube
- An index of sulphuric acid
- A thermometer
- A stirrer
- A meter scale (Ruler)
- Water bath and a source of heat

Using a suitable diagram, explain how the above may be used to verify Charles' law.



- ✓ *The initial length of the air column is taken and recorded as well as the initial thermometer reading.*
- ✓ *The water bath is heated and new height (column) of air is taken and recorded with its corresponding temperature reading*
- ✓ *This is repeated several times at suitable temperature intervals to get several pairs of results*
- ✓ *A graph of volume (height, h (cm)) against absolute temperature is plotted. It is a straight line with positive gradient.*
- ✓ *This shows that the volume is directly proportional to absolute temperature.*

7. The diagram in figure below shows an experiment to investigate the relationship between volume and temperature of a fixed mass of gas at constant pressure.



(a) Explain the function of:

(i) Concentrated sulphuric acid (2mk)

- *Used as a pointer to volume of the gas on the scale*
- *Used as a drying agent for the air*
- *Used to trap air*

(ii) Stirrer (1mk)

To stir the water bath for uniform distribution of heat

(b) Which measurements are taken in the above experiment (2mk)

- *Air column height which corresponds to volume*
- *Temperature*

(c) State law being investigated in the experiment above.(1mk)

✓ *Charles' law*

(d) Describe how the experiment above is used to verify the law. (3mk)

- *The initial length of the air column is taken and recorded as well as the initial thermometer reading.*
- *The water bath is heated and new height (column) of air is taken and recorded with its corresponding temperature reading*
- *This is repeated several times at suitable temperature intervals to get several pairs of results*
- *A graph of volume (height, h (cm) against absolute temperature is plotted.*
- *It is a straight line with positive gradient.*
- *This shows that the volume is directly proportional to absolute temperature.*

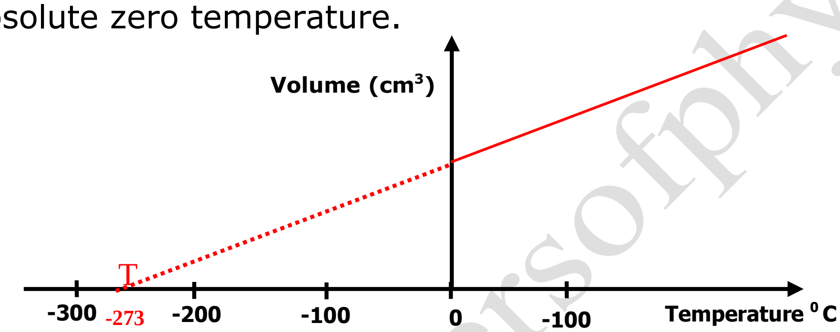
(e) What physical property of the gas is kept constant in this experiment? (1mk)

✓ Pressure

(f) Why is the atmospheric pressure not taken into account in this experiment? (1mk)

✓ Atmospheric pressure is also constant.

(g) On the grid shown in figure below sketch a graph of volume (cm^3) against temperature (^0C) for the experiment above. Clearly mark with the letter T the absolute zero temperature. (2mk)

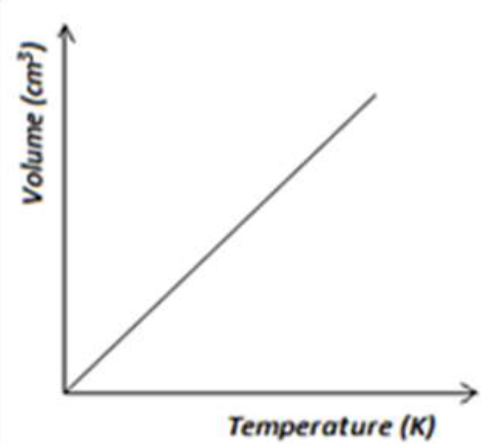


(h) What two assumptions are made in the experiment (2mk)

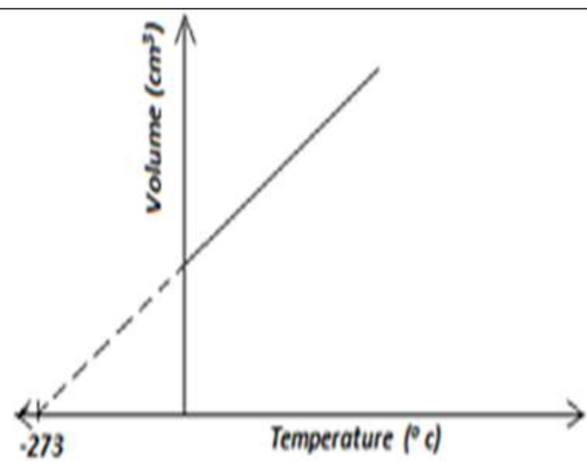
✓ Pressure is kept constant throughout the experiment.
✓ Uniform distribution of heat.

8. Sketch a graph of volume against absolute temperature for an ideal gas.(2mk)

ANS



OR



9. A gas has a volume of $20cm^3$ at 27^0C and normal atmospheric pressure. Calculate the new volume of the gas if it is heated to 54^0C at the same pressure.

Solution

$V_1=20cm^3$

$T_1=27+273=300K$

$T_2=54+273=327K$

$V_2=?$

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

$\frac{20}{300}=\frac{V_2}{327}$

$V_2=21.8cm^3$

10. On a certain day when the temperature is 37^0c, the pressure in an open gas jar is 640mm of mercury. The jar is then sealed and cooled to the temperature of 17^0c. Calculate the final pressure.

Solution

$T_1=37+273=310K$

$P_1=640mmHg$

$T_2=17+273=290K$

$P_2=?$

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

$\frac{640}{310}=\frac{P_2}{290}$

$P_2=598.71$ mmHg

11. A constant mass of hydrogen gas occupies a volume of $4.0cm^3$ at a pressure of 2.4×10^5 Pa and temperature of 288K. Find its volume at a pressure of 1.6×10^5 Pa when the temperature is 293K.

Solution

$V_1=4.0cm^3$

$T_1=288K$

$P_1=2.4 \times 10^5$ Pa

$T_2=293K$

$P_2=1.6 \times 10^5$ Pa

$V_2=?$

$\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$

$\frac{2.4\times10^5\times4.0}{288}=\frac{1.6\times10^5\times V_2}{293}$

$V_2=6.104$ cm^3

12. A balloon is filled with air to a volume of 200ml at a temperature of 293 K. Determine the volume when the temperature rises to 353 k at the same pressure (3mk)

Solution

V_1=200ml

T_1=293K

T_2=353K

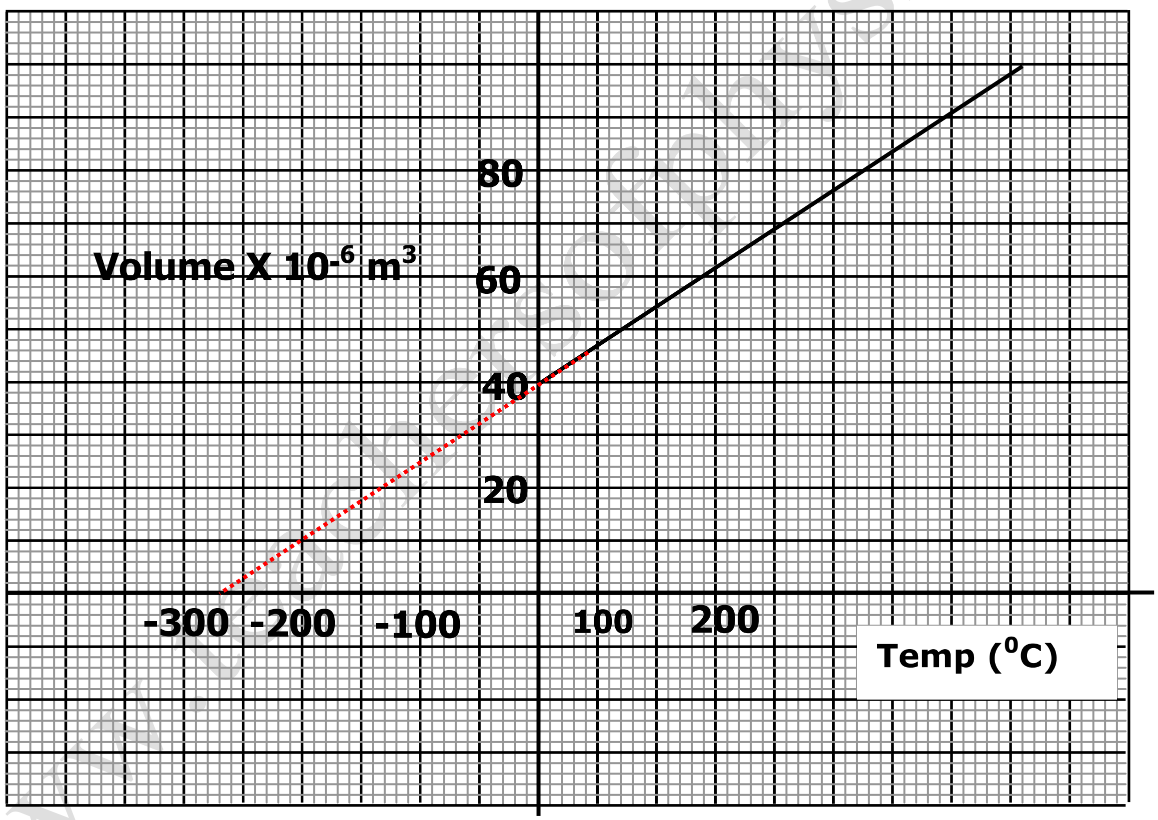
V_2=?

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

$\frac{200}{293}=\frac{V_2}{353}$

V_2=240.9556 ml

13. (a) The graph shows the relationship between volume and temperature for an experiment.



(i) What was the volume of the gas at 0^oC (1mk)

$=40\times10^{-6}\ m^3$

(ii) At what temperature would the volume of the gas be Zero (1mk)

$=-275^0C$

(iii) Explain why the temperature is part (ii) above cannot be achieved. (1mk)

✓ It liquefies at higher temperatures than OK or -273^0C.

PRESSURE LAW.

1. State the pressure law for an ideal gas (1mk)

- ✓ *The pressure of a fixed mass of a gas is directly proportional to the absolute temperature(Kelvin) at a constant volume.*

2. A gas is enclosed in a glass container and the container is heated. Explain why the pressure of the gas increases. (1**mk**)

- ✓ Raising the temperature increases the average speed of particles so they collide more vigorously and more frequently with container walls. If the volume does not increase the pressure must rise.

3. Explain why gas cylinders are likely to expand incase of a fire out break(2mk)

- ✓ *When a gas is heated, Temperature of a gas rises, its particles move faster and exert a larger force on the wall of the cylinder.*
- ✓ *If the pressure remain constant, the volume must increase thus expand.*

4. Using Kinetic theory of Gases, explain how the rise in temperature of a gas causes rise in the pressure of a gas if the volume is kept constant.(3mk)

- ✓ Raising the temperature increases the average speed of particles so they collide more vigorously and more frequently with container walls.
- ✓ If the volume does not increase, pressure increases.

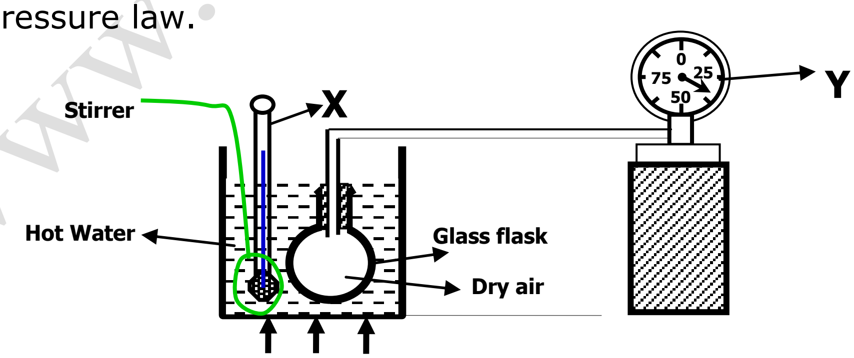
5. A house in which a cylinder containing cooking gas is kept unfortunately catches fire. The cylinder explodes. Give a reason for the explosion.

- ➢ From pressure law, *when a gas is heated due to fire Temperature increases which led to increase in pressure at constant volume, when pressure increases it can led to explosion.*

6. Define the absolute zero temperature (1mk)

- ➢ *Absolute zero temperature refers to the lowest temperature a gas can fall to. It is -273^{0}celcius (0 Kelvin).*

7. The diagram below shows a set up that a student used to investigate the pressure law.



a) Name the parts (2mks)

X ……………………Thermometer…………………………………………………..

Y ……………………Pressure gauge……………………………………………..

b) What are the functions of (2mks)

(i) the stirrer

- *To stir the water for uniform distribution of heat*

(ii) Part Y.

- *To measure pressure*

c) At what Kelvin temperature will the pressure of the air theoretically be zero. (1mk)

- $-273^0C = 0$ K

d) What name is given to this temperature?

- *Absolute zero temperature*

(i) State the measurements that should be taken in the experiment(3mk)

a) Temperature

b) Pressure

(ii) Explain how the measurement in (i) above may be used to verify Pressure law (3mk)

- *The initial temperature and pressure reading are taken and recorded*
- *The water bath is heated gently and some more pairs of pressure and temperature readings are taken and recorded at suitable temperature intervals*
- *A graph of pressure against temperature is plotted.*
- *It is a straight line with positive gradient.*
- *This shows that the pressure is directly proportional to absolute temperature.*

(iii) Name one limitation of the gas laws. (1mk)

- *Real gases liquefy before the volume of the gas reduces to zero.*

8. A gas is put into a container of fixed volume at a pressure of 2.1×10^5 Nm^{-2} and temperature 27^0C.The gas is then heated to a temperature of 327^0C. Determine the new pressure.

$T_1=27+273=300K$

$P_1=2.1 \times 10^5\ Nm^{-2}$

$T_2=327+273=600K$

$P_2=?$

$$\frac{P1}{T1}=\frac{P2}{T2}$$

$$\frac{2.1\times10^5}{300}=\frac{P2}{600}$$

$$\mathbf{V_2=4.2\times10^5Nm^{-2}}$$

9. At the start of the journey, the temperature and pressure of inside a car tyre were 17^0c and 300 Pa

i) Calculate the temperature during the journey (3mk)

$T_1=17+273=290K$

$P_1=300$ Pa

$T_2=?$

$P_2=?$

$$\frac{P1}{T1}=\frac{P2}{T2}$$

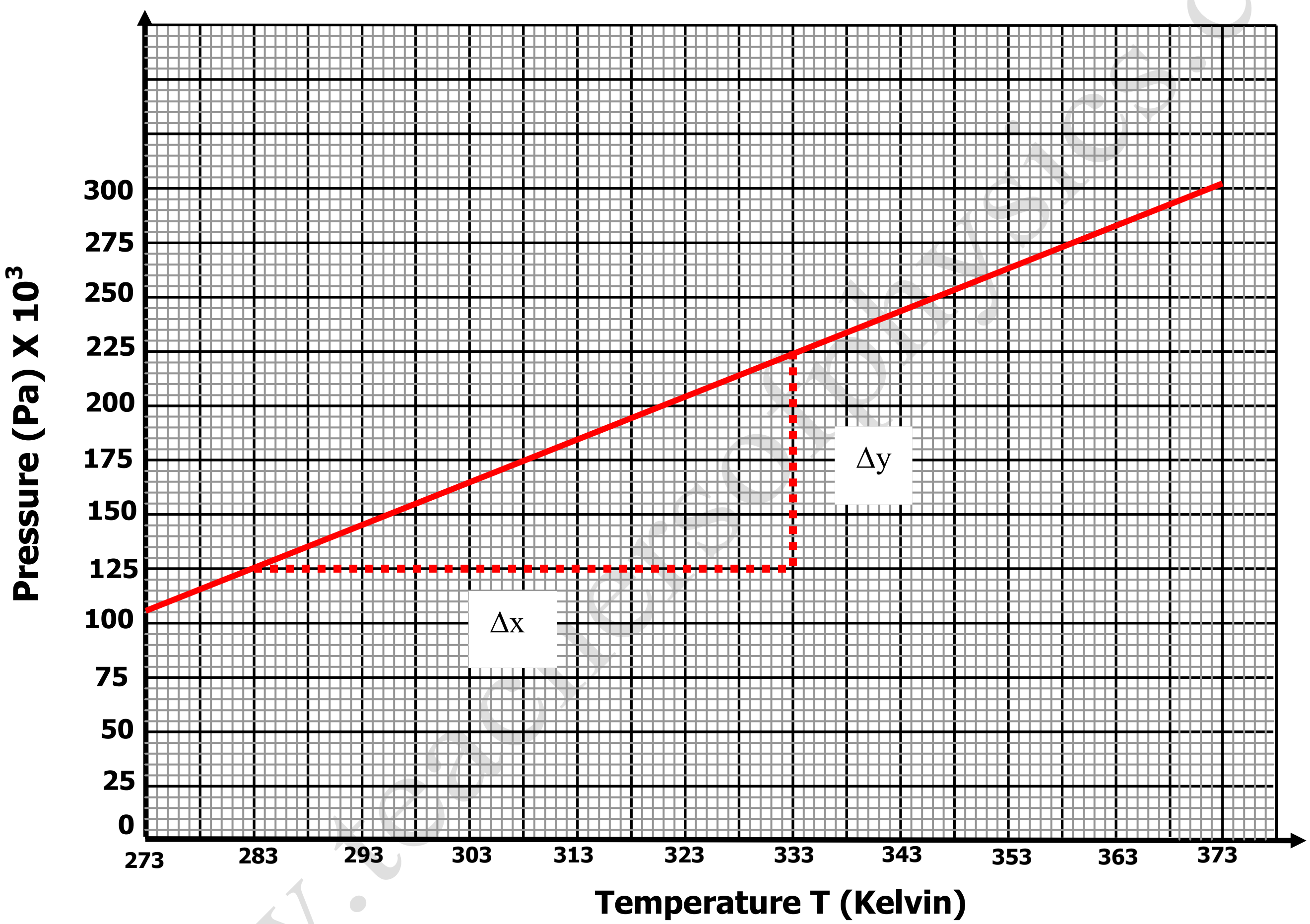
$$\frac{300}{290}=\frac{P_2}{T_2}$$

$T_2=(290P_2)/300$

ii) State assumption you have considered answering (ii) a above (1mk)

✓ Constant volume

10. The graph in the figure below shows the relationship between the pressure and temperature for a fixed mass of an ideal gas at constant volume.



i) Determine the slope of the graph

$$\text{Slope} = \frac{\Delta P}{\Delta T}$$

$$\text{Slope} = \frac{\{(225\times10^3)-(125\times10^3)\}}{(333-283)}$$

$$= \frac{100\times10^3}{50}$$

$$\mathbf{= 2.0 \times 10^3\ Pa/K}$$

ii) Given that the relationship between pressure, **P**, and temperature, **T** in Kelvin is of the form **P=kT + A**, where **K** and **A**are constants, determine from the graph, values of **k** and **A**.

From the graph, it is a straight line, Y=mx+c

P=kT+A

Hence A= y intercept

$A=1.05\times10^{5}$

K= Slope/Gradient

$K=2.0 \times 10^{3}$ Pa/K

iii) Why would it be impossible for pressure of the gas to be reduced to zero in practice?

- ✓ Gas liquefies at high temperatures before reaching O Kelvin.
- ✓ High pressure may liquefy the gas even before reaching 0°C

UNIVERSAL GAS FORMULAR

From General Equation $\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}=$Constant

Where

- P is pressure of the gas
- V is Volume of the gas
- T is Temperature of the gas

1. A balloon filled with organ gas a volume of 200 cm^3 at the earth's surface where the temperature is20^0C, and the pressure 760mm of mercury. If it is allowed to ascend to a height where the temperature is 0^0C and the pressure 100mm of mercury, calculate the volume of the balloon.

Solution

$V_1=200cm^3$
$T_1=20+273=293K$
$P_1=760mmHg$
$T_2=0+273=273K$
$P_2=100mmHg$

$V_2=?$

$$\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$$

$$\frac{200\times760}{293}=\frac{V2\times100}{273}$$

$V_2=144.14cm^3$

2. A gas occupies a volume of 4.0 liters when its temperature is 20°C and its pressure is 76cmof mercury. It the temperature of the gas is raised to 80°C and its pressure is increased to180cm of mercury. Calculate the new volume occupied by the gas.

Solution

$V_1=4$ liters
$T_1=20+273=293K$
$P_1=76cmHg$

$T_2=80+273=353K$

$P_2=180cmHg$
$V_2=?$

$$\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$$

$$\frac{4\times76}{293}=\frac{V2\times180}{353}$$

$V_2=2.034$ Liters

3. A car tyre is at an air pressure of 4.0 x 10^5 Pa. at a temperature of 27 ^{0}C. While it is running, the temperature rises to 75 ^{0}C. What is the new pressure in the tyre? (Assume the tyre does not expand) (3mk)

Solution

V= Constant i.e $V_1=V_2$

$T_1=27+273=300K$

$P_1=4.0 \times 10^5$ Pa

$T_2=75+273=348K$

$P_2=?$

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

$$\frac{4.0\times10^5}{300}=\frac{P2}{348}$$

$P_2=4.63\times10^5$ Pa

4. A given mass of hydrogen gas occupies a volume of 1.6m^3 at a pressure of 1.5 x 10^5 Pa and 12^{0}C temperature. What volume will it occupy at s.t.p?(3mk)

Solution

$V_1=1.6$ m^3

$T_1=12+273=285K$

$P_1=1.5\times10^5$ Pa

$T_2=0+273=273K$

$P_2=1.0 \times 10^5$ Pa

$V_2=?$

$$\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$$

$$\frac{1.5\times10^5\times1.6}{285}=\frac{V2\times1.0\times10^5}{273}$$

$V_2=2.299$ m^3

5. A rubber tube is inflated to a pressure of 2.7 x 10^5 pa and volume 3800cm^3 at a temperature of 25^{o}c. It is then taken to another place where the temperature is 15^{o}c and the pressure 2.5 x 10^5 pa. Determine the new volume. (3mk)

Solution

$V_1=3800$ cm^3

$T_1=25+273=298K$

$P_1=2.7\times10^5$ Pa

$T_2=15+273=288K$

$P_2=2.5 \times 10^5$ Pa

$V_2=?$

$$\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$$

$$\frac{2.7\times10^5\times3800}{298}=\frac{V2\times2.5\times10^5}{288}$$

$V_2=3966.289$ cm^3

6. A container holds 80cm^3 of air. the pressure is 100KPa and the temperature 7.5^{0}C. What is the final pressure when the air is compressed to 30cm^3 and the temperature is 29^{0}C

Solution

$V_1=80$ cm^3

$T_1=7.5+273=280.5K$

$P_1=100K$ Pa

$T_2=29+273=302K$

$P_2=?$

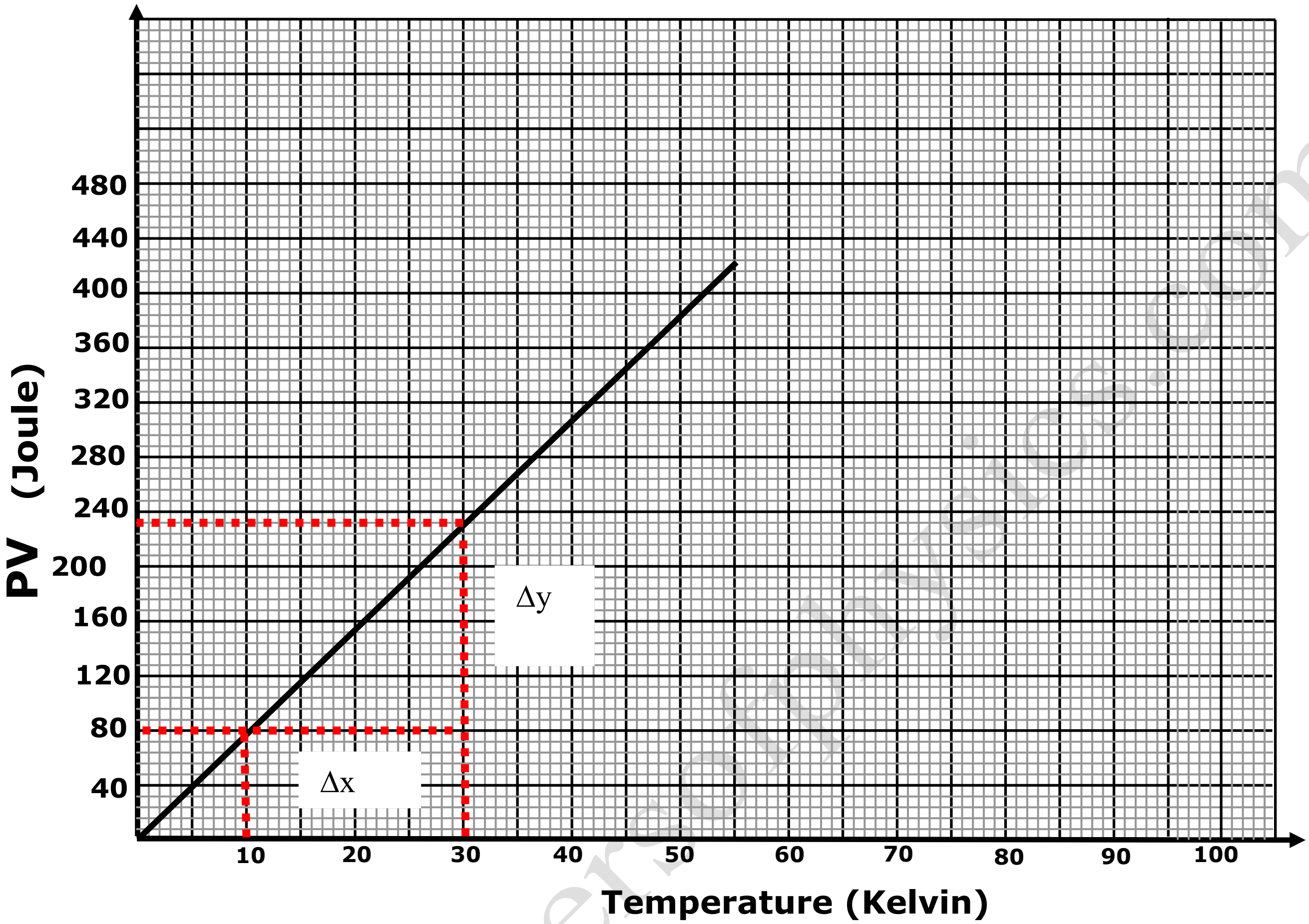
$V_2=30$ cm^3

$$\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$$

$$\frac{100\times80}{280.5}=\frac{P2\times30}{302}$$

$P_2=287.106$ KPa

7. The graph in figure shows the relationship between the product of pressure and volume(PV) and the absolute temperature for a given mass of a gas. From the graph determine;



(i) The gas constant. (2mks)

Gas constant =Slope = $\frac{\Delta PV}{\Delta T}$

Constant= $\frac{(232-80)}{(30-10)}$

=7.6 J/K

(ii) The volume that the fixed mass of the gas would occupy at a temperature of **-248^{0}C** and a pressure of **104kPa**. (3mk)

$\frac{PV}{T}$=K=7.6

7.6= $\frac{104KPa \times V}{(-248+273)}$

7.6=$\frac{104V}{25}$

V=1.8269 Volumes

(iii) The pressure necessary for **40m^3** of the gas to attain a temperature of 0^{0}C. (3mk)

7.6=$\frac{P \times 40\ m^3}{(0+273)K}$

7.6=$\frac{40P}{273}$

P=51.377 Pa