Some Basic Concepts of Chemistry

Nature of Matters

- Anythings that has mass and occupies space is called matter

- Matter can be classified into two ways
A) Physical classification of matter
B) chemical classification of matter

A) Physical Classification of matter
Depending upon the Physical state of matter, it can be classified into three states, namely, solid, liquid and gaseous state.

i) Solid state :- A solid has a definite shape and possesses definite volume.
Thus, solids are generally hard and rigid
eg - Wood, table, copper rod, common salt etc.

ii) Liquid state ⇒ A liquid as a definite volume but not definite shape, They take the shape of the container
eg - water, milk, oil etc.

iii) Gaseous states ⇒ A gas neither possesses a definite volume nor a definite shape.
It occupies the whole of the volume of the vessel in which it is Placed
eg - air, oxygen, hydrogen, water dioxide etc.

Chemical Classification of Matter

Matter

Mixture

eg - Sugar solution in water, air, tea, brass, soft drink, soil etc.

Pure Substance

eg - copper, silver, gold, water, glucose, sodium chloride

homogenous mixture

eg - Sugar solution, milk air etc.

heterogenous mixture

eg - mixtures of salt and sugar, undissolved sugar in water, smoke mixture of sand and water

Elements

eg ⇒ hydrogen, oxygen, nitrogen, sulphur, iron, lead, gold etc.

Compounds

eg ⇒ (i) water always contains hydrogen and oxygen in the ratio of 1 : 8 by mass

(ii) carbon dioxide always contains carbon and oxygen in the ratio 3 : 8

Inorganic compound

eg ⇒ common salt, marble, washing soda etc.

organic compound

eg - Carbohydrates, oils, fats, waxes, Protein etc.

Properties of Matter and their Measurement

Every substance has unique or characterstic properties. These properties may be classified as Physical properties and chemical properties

- Physical properties are those properties which can be measured or observed without changing the identity or composition of the substance
eg- colour, odour, melting point, boiling point, density, etc.

- Chemical properties are those in which a chemical change in the substance take place
eg- acidity, basicity, combustibility ~~and~~ etc

Date
Page

* Satalight

~~having~~ heavenly body that ~~arom~~ revolve around the Planate are called satalight

- There are two types of satalight
1) Natural satalight
11) Artificial satalight

* Orbital velocity of satalight

The velocity required to put a satalight into its orbit around the earth (Planate) called orbital velocity

- Expration of orbital velocity

Let a satalight of mass 'm' Placed at a hight of 'h' from the earth surface earth having mass ~~M~~ and radius 'M' and 'R'

Since, satalight revolves around the earth
gravitational force = centripetal force

$$\frac{GMm}{(R+h)^{\cancel{2}}} = \frac{mV_0^2}{\cancel{(R+h)}}$$

$$\frac{GMm}{(R+h)} = mV_0^2$$

$$\boxed{V_0 = \left[\frac{GM}{R+h}\right]^{\frac{1}{2}}} \quad \text{——— (1)}$$

we know that

$$g = \frac{GM}{R^2}$$

$$GM = gR^2$$

Putting this value in eq^n (1)

$$v_0 = \left[\frac{gR^2}{R+h}\right]^{\frac{1}{2}}$$

Time period

$$T = \frac{\text{Circumference}}{\text{velocity}}$$

$$= \frac{2\pi(R+h)}{\left[\frac{gR^2}{R+h}\right]^{\frac{1}{2}}}$$

$$= \frac{2\pi(R+h) \times (R+h)^{\frac{1}{2}}}{g^{\frac{1}{2}} R}$$

$$= \frac{2\pi (R+h)^{\frac{3}{2}}}{R g^{\frac{1}{2}}}$$

$$\boxed{T = \frac{2\pi}{R}\left[\frac{(R+h)^3}{g}\right]^{\frac{1}{2}}}$$

* Height

$$T = \frac{2\pi}{R}\left[\frac{(R+h)^3}{g}\right]^{\frac{1}{2}}$$

squaring both side

$$T^2 = \frac{4\pi^2}{R^2}\left[\frac{(R+h)^3}{g}\right]$$

$$\frac{(R+h)^3}{g} = \frac{T^2R^2}{4\pi^2}$$

$$(R+h)^3 = \frac{T^2R^2g}{4\pi^2}$$

Taking cubic root both side

$$R+h = \left(\frac{T^2R^2g}{4\pi^2}\right)^{\frac{1}{3}}$$

$$\boxed{h = \left(\frac{T^2R^2g}{4\pi^2}\right)^{\frac{1}{3}} - R}$$

* Total energy of satalight

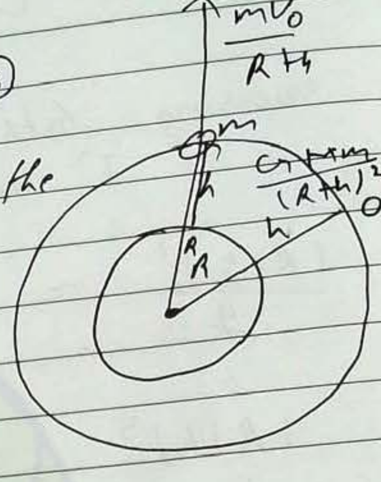
Since satalight revolve around a Planate at a ~~sertan~~ certian height so it posses the kinetic energy as well as potential energy

total energy of satalight is given by

$$TE = KE + PE \quad \text{——— (1)}$$

Potential energy ~~Placed~~ of satalight Placed at a height of $(R+h)$ is given by

$$PE = \frac{-GMm}{R+h} \quad \text{——— (2)}$$



Kinetic energy is given by

$$KE = \frac{1}{2} m v_0^2 \quad \text{——— (3)}$$

Since, gravitational force provide the neassary centripetal force

$$\frac{GMm}{(R+h)^{\cancel{2}}} = \frac{mv_0^2}{\cancel{R+h}}$$

$$mv_0^2 = \frac{GMm}{R+h}$$

Putting this value in eqn (3)

$$KE = \frac{GMm}{2(R+h)} \quad \text{——— (4)}$$

Putting value of potential energy and kinetic energy in eqn (1)

$$TE = \frac{GMm}{2(R+h)} - \frac{GMm}{(R+h)}$$

$$TE = \frac{GMm - 2GMm}{2(R+h)}$$

$$\boxed{TE = \frac{-GMm}{2(R+h)}}$$

A negative sin so that satalight bonded with the earth surface

* Relation between the total energy and total potential energy of a satalight

$$\frac{TE}{PE} = \frac{-\frac{GM\cancel{m}}{2(R+h)}}{-\frac{GM\cancel{m}}{(R+h)}}$$

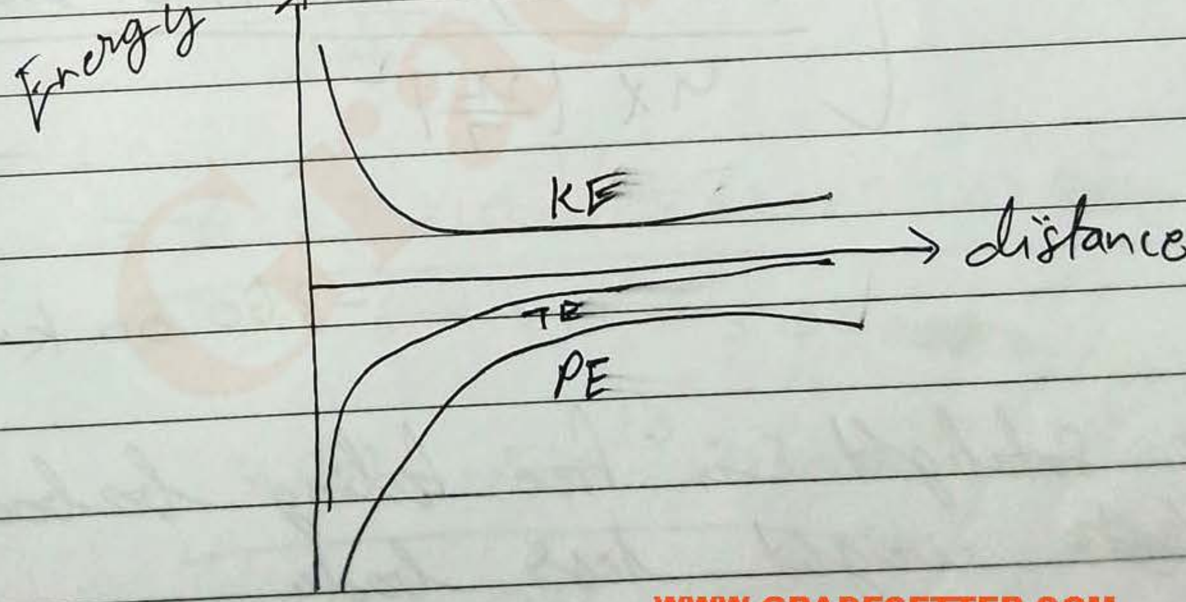
$$\frac{TE}{PE} = \frac{1}{2}$$

$$TE = \frac{1}{2} PE$$

$$KE = \frac{GMm}{2(R+h)}$$

~~$PE = \frac{-GMm}{(R+h)}$~~ $PE = \frac{-GMm}{(R+h)}$

$$TE = \frac{-GMm}{2(R+h)}$$



* Geo ~~stationary~~ stationary Satalight :-

A satalight which apears at rast with respect to the earth is know as the Geo stationary satalight.

- Properties of Geo stationary satallight

1) Time Period of Geo stationary satalight is same Period of the time Period is same revolution

11) Geo stationary satalight moves in a same direction of the earth ervolution west to east

111) the height of Geo ~~satinonar~~ stationary satalight moust be above the 36 thousand (36000 km)

$$h = \left[\frac{T^2R^2g}{4\pi^2}\right]^{\frac{1}{3}} - R$$

$$T = 24\,hr = 24 \times 3600 \text{ sec}$$
$$R = 6.4 \times 10^6 m$$
$$g = 9.8$$

$$h = \left[\frac{(24 \times 3600)^2 \times (6.4 \times 10^6)^2 \times 9.8}{4 \times \left(\frac{22}{7}\right)^2}\right]^{\frac{1}{3}} - 6.4 \times 10^6$$

$$= 36000 \text{ km}$$

Note => since ~~satalight~~ is free faling babody so it is a ~~body~~ weight less body

Q A satalight orbits the earth at a height 500 km from its surface calucate

i) Kinetic energy

ii) Potentail "

iii) Total energy of a satalight

If its mass is 300 kg and wats hapens when earth ~~weight~~ get same suddenly $\frac{1}{2}$ of the size

$M = 6\times10^{24}$ kg

$R = 6.4\times10^{6}$ m

$G = 6.67\times10^{-11}$ Nm^2kg^{-2}

i) Kinetic energy $= \frac{-GM}{2(R+h)^2}$

$= \frac{2\times6\times10^{24}\times6.67\times10^{-11}}{6.4\times10^{6}\times10+500}$

$= \frac{400.2\times10^{13}}{6.4\times46.96\times10^{11}}$

$= \frac{6.67\times6\times3\times10^{9}}{2\times6.9}$

$= 8.7\times10^{9}$ J

$PE = \frac{-GMm}{R+h}$

$= \frac{-6.67\times10^{-11}\times6\times10^{24}\times300}{6.4\times10^{6}+500}$

$= \frac{40.02\times10^{13}\times300}{320.0\times10^{6}}$

$PE = -2(KE)$

6.67 × 6 = 400 2

6.4 × 6.4 = 40.96

6.67 × 18

8.7 × 2 = 17.4×10^{18}

40.02 × 3 = 120.06

6.67 × 6 = 2

6.4 × 5 = 320

classmate
Date
Page

17.4×10^{9} J

iii) $TE = KE + PE$
$= 8.7 \times 10^{9} + 17.4 \times 10^{9}$
$= -8.7 \times 10^{8}$ J

above resul is same because radius of the earth surface the gate radius but distane of satallite is ~~also~~ is remins of (R+h) mass of satallight ~~is~~ earth is also same

Q. you are given the following date $g = 9.81 ms^{-2}$
$RE = 6.37 \times 10^{6} m$ distance of the moon
$R = 3.84 \times 10^{8} m$ and the time Period of the moon's revolution is 27.3 day
obtand the mass of the earth in two different ways

Date ______
Page ______

Bulk Properties of matter

* Machenical Properties of solid
* Deforming force → A force that apply on the body and change its configuration (shape and size) called deforming force
* Restoring force → A force store in a body that have tendency to return there original configuration after removal of applied force (deforming force) is know as the restoring force

* elasticity → the Properties of a body by virtue of which body regains there original configuration after removal of deforming force is know as elasticity

* Perfectly elasticity → the properties of a body by virtue of which body completely regain there original configuration after the removal of deforming force is known as the Perfectly elasticity
  eg → Quartz
  Phosphor bronze

* Inelasticity → the properties of the body by virtue of which body does not regain there original configuration after removal of deforming force is know as ~~Ind~~ Inelasticity

Stress

The Restoring force acts on a body Perpendicularly per unit area is know as the stress

$$\text{Stress} \rightarrow \frac{\text{Restoring force}}{\text{Area}}$$

Restoring force = Deforming force

$$\text{Stress} \Rightarrow \frac{\text{deforming force}}{\text{area}}$$

It is the scaler quantity

SI unit → Nm^{-2}

Dimensional formula $\frac{[MLT^{-2}]}{[L^2]}$

$$= [ML^{-1}T^{-2}]$$

* Type of stress

i) Normal stress and longitudinal stress

ii) Tangential stress and shearing stress

iii) Bulk stress

I Normal stress ⇒ the Restoring force acts on a body perpendicularly per unit area is know as the normal stress.

- Type of Normal stress

i) Tensile stress → the Restoring force or deforming force acts on a body perpendicularly per unit area of ~~crossation~~ crossaction is know as tensile stress

$$\text{Tenile stress} = \frac{F}{A}$$

(ii) Compressive stress → the restoring or deforming force acts on a body perpendicularly per unit area of crossaction and decreasing its length is know as the compressive stress

$$\text{compressive stress} = \frac{F}{A}$$

II Tangential stress and shearing stress ⇒ the ratio of the force acting tangent to the surface to the area of the surface is known as tangential and shearing stress.

$$\text{Tangential stress} = \frac{F}{A}$$

III Bulk stress → the Restoring or deforming force acts on the body perpendicularly per unit surface area is known as bulk stress and hydrolic stress.

$$\text{Bulk stress} = \frac{F}{A}$$

* Strain → the ratio of the change in configuration (shape and size) to the original configuration of a body is know as strain

$$\text{strain} = \frac{\text{change in configuration}}{\text{original configuration}}$$

- Strain is unitless and dimensionless physical quantity
- Type of strain

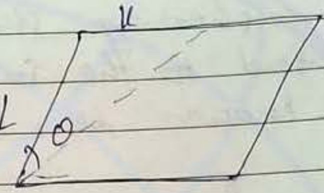
(i) longitudinal strain → the ratio of the change in length to the original length is know as the longitudinal strain

$$= \frac{\Delta L}{L}$$

(ii) Bulk strain and hydralic strain → the ratio of the change in volume to the original volume is know as the bulk strain and volume strain

$$\text{Bulk strain} = -\frac{\Delta V}{V}$$

(iii) Tangential and shearing stress → the angle through which the face of the body originally perpendicular to the fixed face is turned when tangential force applied on the face



$\boxed{\theta = \frac{x}{L}}$ $\boxed{\theta = \frac{x}{L}}$

* Hook's law → According to hook's law a stress of a body is directly proportional to the strain with in its elastic limit

stress ∝ strain

stress = constant × strain

$$\boxed{\text{constant} = \frac{\text{stress}}{\text{strain}}}$$

here, constant is know as modulus of elasticity

* Modulus of elasticity → the ratio of the stress to the strain of a body with in its elastic limit is know as modulus of elasticity

S-I unit is Nm^{-2}

dimensional formula $[ML^{-1}T^{-2}]$

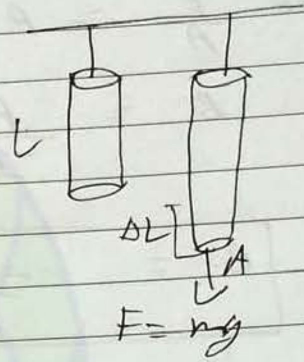
- Type of modulus of elasticity
  - (i) young's modulus of elasticity (Y)
  - (ii) bulk modulus of elasticity (B)
  - (iii) Modulus of rigidity (η)

1) ~~A~~ young's models of elasticity (Y) →

The Ratio of the normal stress to the longitudinal strain ~~straigh is know as the young's~~ with in its elastic limit is know as the young's model's of elasticity

Normal stress = $\frac{F}{A}$

longitudinal strain = $\frac{\Delta L}{L}$



$$Y = \frac{\text{Normal stress}}{\text{longitudinal strain}}$$

$$Y = \frac{\frac{F}{A}}{\frac{\Delta L}{L}}$$

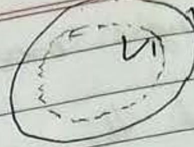
$$\boxed{Y = \frac{FL}{A\Delta L}}$$

~~F=mg~~ $F = mg$

$A = \pi r^2$

$$\boxed{y = \frac{mgL}{\pi r^2 \Delta L}}$$

A Bulk models of elasticity (B) – The ratio of the Bulk stress ~~strains~~ to the Bulk strian with in a elastic unit is know as the Bulk model's of elasticity



$= -\Delta V$

$$B = \frac{\text{Bulk stress}}{\text{Bulk strain}}$$

$$B = \frac{\frac{F}{A}}{\frac{-\Delta V}{V}}$$

where $\frac{F}{A} = P$ (Pressure)

$$B = \frac{P}{\frac{-\Delta V}{V}}$$

$$\boxed{B = \frac{-PV}{\Delta V}}$$

(ii) * ~~Compes~~ ~~complacom~~ Compressibility :-
compresibility is reciprocal of the bulk models of elasticity

$$\boxed{K = \frac{1}{B}}$$

SI unit of k is $N^{-1}m^2$

Dimentional formula $= \frac{A}{F} = \frac{L^2}{[MLT^{-2}]}$

$$[M^{-1}LT^2]$$

* Models of regidity ⟹ Ratio of the tangential ~~trangisitaly~~ stress to the or saring stress with in elastic limit is know as the models of regidity

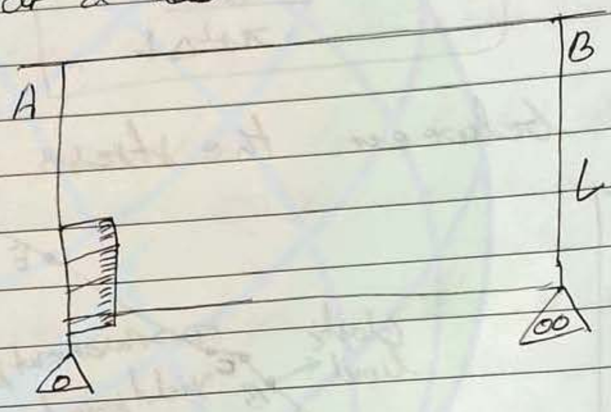
Models of rigidity → ratio of the tangential stress to the tangential strain or shearing strain with in its elastic limit is know as the modulus of rigidity

$$\eta = \frac{\text{tangential stress}}{\text{shearing strain}}$$

$$\eta = \frac{\frac{F}{A}}{\frac{x}{L}}$$

$$\boxed{\eta = \frac{FL}{Ax}}$$

* Exbrimental determinition of youns models of elasticity of a wire



$= \frac{mgL}{...}$ $\boxed{Y = \frac{mgL}{\pi r^2 \Delta L}}$

to determin the youngs models of elasticity appratodas of arrange as show in a given figure
two wire A and B nearlay of same length and area of crossection and made up of the ~~same~~ material suspende from the common rigid body both having a pen in required wire a pan acts as a lod load pan is used for the weight
A burner ~~o~~ kaliperi main scale fixied ~~on~~ a wire A

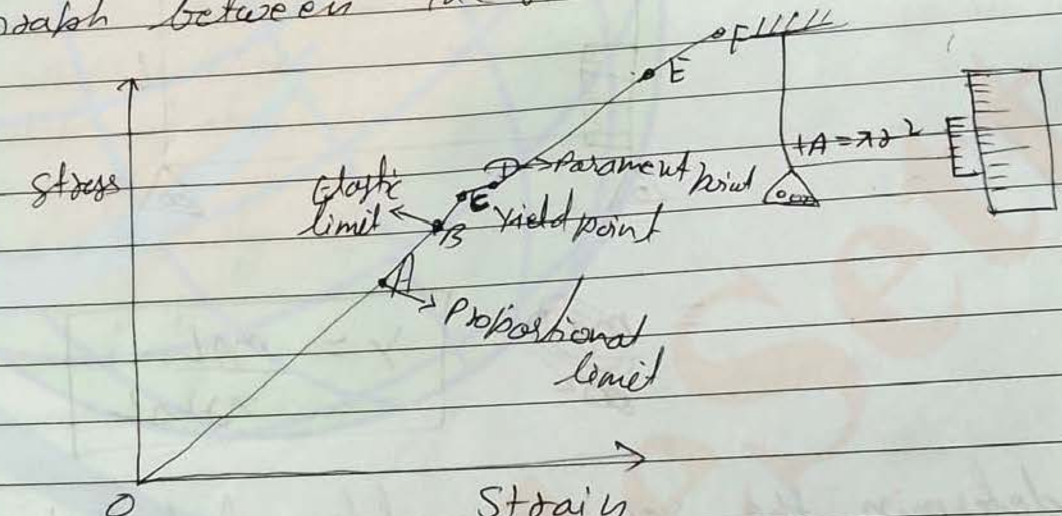
A pointer connected 2nd at B at the lowest point

first determin the original length of B small and main scale of verinal callipers

Gradually know mass placed on the pair of the B wire of to the elastic unit and take the megurment of length of the exterier wire B and calculate the young's models of elasticity by given formula

$$\boxed{Y = \frac{mgL}{\pi r^2 \Delta L}}$$

A Graph between the stress and strain



Graph between the stress and strain Plotes as show the given figure

O is Straight graph know as the proportional graph and point A is called proportional limit on further of ~~lig~~ ling force up to point B and OB graph is known as elastic rigion and point B is know as

classmate
Date
Page

elastic region ~~upton~~ further negative stress at point get Parament set ~~D~~ is know as point C get parament so point C is know as yield point on further increasing beyond C up to point D wire it self get stress up to point D. beyond D up to point E graph D is shows elastic plastic region and point E is know as plastic limit on further incrising beyond E up to point F and EF graph is know as fracture region and F graph is know as fracture point or Breaking point

Application of the elastic behaver of the substance

- By gloling this properties to decated the brize, bulding round are ~~so~~ shapes or unshape to be use
- By this elasticity radius of the wire use in a crane

$$Y = \frac{mgl}{\pi r^2 \Delta l}$$

$$r^2 = \frac{\pi \Delta l Y}{mgl} \qquad r^2 = \frac{mgl}{\pi Y \Delta l}$$

$$r = \sqrt{\frac{\pi \Delta l Y}{mgl}} \qquad r = \boxed{\sqrt{\frac{mgl}{\pi Y \Delta l}}}$$

- By using elasticity behaves macaniary part can be are sutable or not sutatable can be ~~decat doco~~ dicated

- By using this width and thickness of the Pilar can be determine

- By doing this height of the ~~mainted~~ mountain can be determine

* Lateral strain → The ratio of the change in diameter to the origanal diameter is know as the lateral strain

* Posisson's ratio → The ratio of the lateral strain to the ~~logino~~ longitudinal strain is know as Possion's ratio

$$\text{laeral strain} = \frac{-\Delta D}{D}$$

$$\text{longitudinal strain} = \frac{\Delta L}{L}$$

~~Poss~~ Posisson's ratio $(\sigma) = \dfrac{\frac{-\Delta D}{D}}{\frac{\Delta l}{l}}$

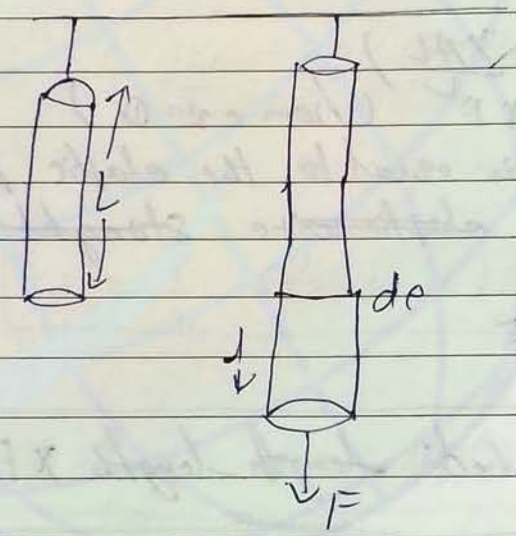
$$= -\frac{\Delta D}{D} \times \frac{l}{\Delta l}$$

$$\boxed{\sigma = \frac{-\Delta D l}{D \Delta l}}$$

* Elastic after effect ⇒ The dialy in regaining the origanal configuration by the body after removel of deforming force is know as Elastic after effect

* elastic Fatigue ⇒ lose of strength of the body by the body due to rebated strain on the body is called elastic Fatigue.

* elastic potential energy stored in a stratch wire



Let a wire of length 'L' having young models of elasticity is Y area of crosation of the wire and force applied of area of crosation of wire is F then youngs models is given by

$$Y = \frac{FL}{A\Delta L}$$

$$F = \frac{YA\Delta L}{L} \quad \text{———} (1)$$

work done to displace the wire through distance ΔL is given by

$dw = F\,dl \cos 0$
$dw = \frac{YA\cancel{\Delta L}}{2}\,dl$ (from eqn ①)

Total work done from 0 to l

$\int dw = \frac{YA\cancel{\Delta L}}{L} \int_0^l dl$

$w = \frac{YA\cancel{\Delta L}}{L}\left[\frac{l^2}{2}\right]_0^l$

$w = \frac{YA}{2L} l^2$ ——— ②

$w = \frac{1}{2}\left(\frac{YAl}{L}\right)$ (from eqn ①)

$w = \frac{1}{2} l \times F$

this work done is equal to the elastic potential energy stored in a ~~elastic wire~~ straight stretch wire

$U = \frac{1}{2} lF$

$\boxed{U = \frac{1}{2} \text{ stretched } \cancel{\text{length}} \text{ length} \times \text{Force}}$

from eqn ②

$w = \frac{YAl^2}{2L}$

This workdone is equal to elastic potential energy

$U = \frac{YAl^2}{2L}$

$U = \frac{YAl^2 \times L}{2L \times L}$

classmate
Date
Page

were $AL = V$ (volume)

$$u = \frac{Y l^2}{2L^2} V$$

$$\frac{u}{V} = \frac{Y}{2}\left[\frac{l}{L}\right]^2$$

where, $Y = \frac{stress}{strain}$

$\frac{l}{L} = strain$

$$\frac{u}{V} = \frac{1}{2}\frac{stress}{strain} \times (Strain)^2$$

$\frac{u}{V} \rightarrow$ called density of elastic potential energy

$$\boxed{U = \frac{1}{2}\ stress \times strain}.$$

A <u>factor affecting the elasticity</u>

elasticity of the matterial can be ures by continious ~~oo~~ hamring

• ~~effect of Alieming~~ Annealing

→ effect of tempetature
→ effect of Anneling

Q A copper wire of length 2.2m and a stail wire of length 1.6m both of diameter of 3mm are conacated end to end when stracted ~~wire~~ by a lode the net elogation is foom to be 0.7mm of obtained the load applied. Youngs models of copper is $1.1 \times 10^{11}\ Nm^{-2}$

$Y_s = 2 \times 10^{11}\ Nm^{-2}$

Soln length of the copper wire = 2.2m

" " " Stail " = 1.6m

$$\Delta L_{cu} + \Delta L_s = 0.7 \times 10^{-3} m \qquad (1)$$

$$r = \frac{3}{2} = 1.5\,mm$$

$$= 1.5 \times 10^{-3} m$$

$$Y = \frac{FL}{A\Delta L}$$

$$\Delta L = \frac{FL}{AY}$$

$$\Delta L_{cu} = \frac{FL_{cu}}{AY_{cu}}$$

$$\Delta L_s = \frac{FL_s}{AY_s}$$

Putting this value in eqn (1)

$$\frac{FL_{cu}}{AY_{cu}} + \frac{FL_s}{AY_s} = 0.7 \times 10^{-3}$$

$$\frac{F}{A}\left(\frac{L_{cu}}{Y_{cu}}+\frac{L_s}{Y_s}\right)=0.7\times10^{-3}$$

$$\frac{F}{A}\left(\frac{2.2}{1.1\times10^{11}}+\frac{1.6}{2\times10^{11}}\right)=0.7\times10^{-3}$$

$$\frac{F}{A\times10^{11}}(2+0.8)=0.7\times10^{-3}$$

$$F=\frac{0.7\times10^{-3}A\times10^{11}}{2.8}$$

$$=\frac{3.14\times(1.5\times10^{-3})^2\times10^{8}}{4}$$

$$=\frac{3.14\times2.25\times10^{-6}\times10^{8}}{4}$$

$$=3.14\times2.25\times25\ N$$

$$=176.625$$

Q8 The average depth of Indian ocane is abord 3000 m cA calculate fractional exbressition $\frac{\Delta V}{V}$ of water at the botum of the occaue given that the bulb models of w

$$B=2.2\times10^{9}\ Nm^{-2}$$

Sol $B=\frac{P}{\frac{\Delta V}{V}}$

Page

$\frac{\Delta V}{V} = \frac{P}{B}$

$P = \frac{F}{A}$

$P = \frac{mg}{A}$

$P = \frac{\rho V g}{A}$

$P = \frac{\rho A h g}{A}$

$P = h \rho g$

$P = 3000 \times 1000 \times 10$

$= 3 \times 10^7$ Pascale

$\frac{\Delta V}{V} = \frac{3 \times 10^7}{2.2 \times 10^{9}}$

$$\boxed{\frac{\Delta V}{V} = \frac{3 \times 10^{-2}}{2.2}}$$

Q which is more elasticity rubber or ~~stile~~ steel
explaine

A steel is more elastic than rubber

let consider equal length 'l' and ~~equal~~ area of consturction 'A'

A steel and rubber

whe appling the same force 'f' change a distan in steel and rubber be ΔL_S and ΔL_R respectively

youngs modulus of steel

$$Y_S = \frac{FL}{A\Delta L_S} \quad \text{——— (1)}$$

Young's modulus of rubber is given by

$$Y_R = \frac{FL}{A\Delta L_R} \quad \text{——— (2)}$$

eqn (1) by eqn (2)

$$\frac{Y_S}{Y_R} = \frac{\frac{FL}{A\Delta L_S}}{\frac{FL}{A\Delta L_R}}$$

$$\frac{Y_S}{Y_R} = \frac{\Delta L_R}{\Delta L_S} \quad \text{——— (3)}$$

but

$\Delta L_R > \Delta L_S$ (since the longing in rubber is more than the steel)

$$\frac{\Delta L_R}{\Delta L_S} > 1 \quad \text{——— (4)}$$

from eqn (3) and (4)

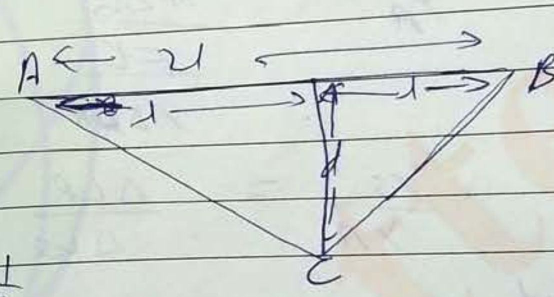
$$\frac{Y_S}{Y_R} > 1$$

$$\boxed{Y_S > Y_R}$$

Since young's models of steel is grater than the models of rubber ~~that~~ thats ~~rubber is~~ is more elastic than rubber

Q A wide of radius 'a' stoach without tension along a straight line is tightly fixed at A and B what is the tension in the wire when it is fade in the A, C shalse of A, C, B assume youngs models of the wire be 'Y'

soln let wire of length $2l$ and with got dipeces 'd' (d is very will less than l)



$AC = BC = (l^2+d^2)^{\frac{1}{2}}$

$\Delta L = ACB - AB$

$= (AC+BC) - AB$

$= 2(l^2+d^2)^{\frac{1}{2}} - 2l$

$= 2l\left(1+\frac{d^2}{l^2}\right)^{\frac{1}{2}} - 2l$

By binomial theorem

$(1+x)^n = 1+nx \quad x \ll 1$

$= 2l\left(1+\frac{d^2}{2l^2}\right) - 2l$

$\Delta L = \cancel{2l} + \frac{\cancel{2}\cancel{l}d^2}{\cancel{2}l^{\cancel{2}}} - \cancel{2l}$

$\Delta L = \frac{d^2}{l}$

$$Y = \frac{Fl}{A \Delta L}$$

$$Y = \frac{F \cdot 4l \times l}{\pi r^2 \times d^2}$$

$$\boxed{F = \frac{Y \pi r^2 d^2}{2l^2}}$$

$$F = T$$

$$T = \frac{Y \pi r^2 d^2}{2l^2}$$

Ch => 10

MACHENICAL Properties of Fluids

* ~~Machenical~~ Fluids :-> that those substance ~~depth~~ ~~dots~~ ~~[illegible]~~ fluids under the action of applied force and donot have the fixed shape called fluids

* Pressure - force acts on a body per unit area is know as the pressure

$$\boxed{\text{Pressure} = \frac{\text{force}}{\text{Area}}}$$

It is scalar quantity
S.I unit of pressure Nm^{-2} called Pascal
Dimensional formula of [Pressure] $= \frac{[MLT^{-2}]}{[L^{2}]}$

$= [ML^{-1}T^{-2}]$

* Relative ~~velocity~~ density :-> The ratio of the density of substance to the density of water at 4°c is know as the relative density

$$\text{Relative density} = \frac{\text{Density of substance}}{\text{Density of water at } 4°c}$$

It is unit less and dimensional less Physical quantity

eg -> density of ice = ~~920~~ ~~920kg~~ 0.92
Glass = 2.5
Mercury = ~~1.3.6~~ 13.6

Q Relative density of the mercury at 13. the 13.6 find the density of the mercury

soln

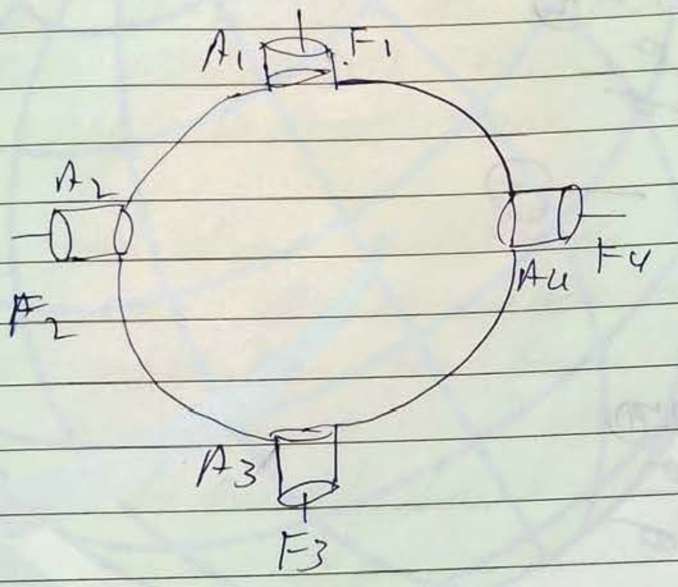
Desity of substance = R.D × Density of water at 4°c

$= 13.6 \times 1000\ kg\ m^{-3}$

$= 13600\ kg\ m^{-3}$

$\boxed{D = 13.6 \times 10^3\ kg\ m^{-3}}$

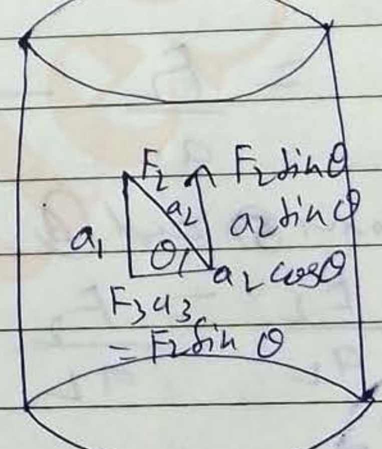
* Pascale law :⇒ According to Pascal law the pressure applied to an enclosed liquid is transmeted undemishist to every portion of the liquid and the wall of conting vessel

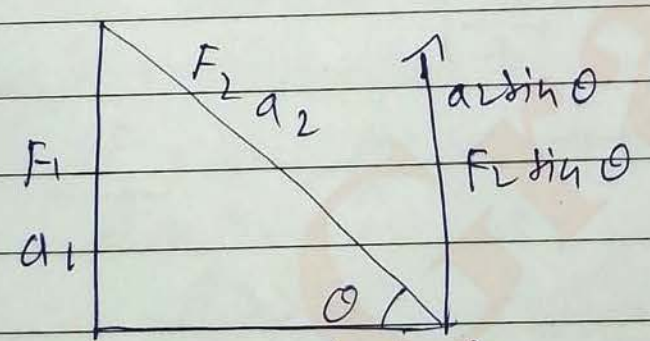


$P_1 = P_2 = P_3 = P_4$

$\frac{F_1}{A_1} = \frac{F_2}{A_2} = \frac{F_3}{A_3} = \frac{F_4}{A_4}$

Proof





$a_3 = F_2 \cos\theta$

$a_3 = F_2 \cos\theta$

a triangular shape of area crossation ~~area~~ a_1, a_2, a_3 on which force F_1, F_2 and F_3 respectively they are two component ~~of~~ of area a_2
~~co~~ $\sin\theta$ $a_2 \sin\theta$
which are

$$a_3 = a_2 \cos\theta \quad \text{——} (1)$$

$$a_1 = a_2 \sin\theta \quad \text{——} (2)$$

they are two componals of the force $F_2 \sin\theta$ and $F_2 \cos\theta$

$$F_3 = F_2 \cos\theta \quad \text{——} (3)$$

$$F_1 = F_2 \sin\theta \quad \text{——} (4)$$

eqn (4) by eqn (2)

$$\frac{F_1}{a_1} = \frac{F_2 \cancel{\sin\theta}}{a_2 \cancel{\sin\theta}}$$

$$\frac{F_1}{a_2} = \frac{F_2}{a_2} \quad \text{——} (5)$$

eqn (3) by eqn (1)

$$\frac{F_3}{a_3} = \frac{F_2 \cancel{\cos\theta}}{a_2 \cancel{\cos\theta}}$$

$$\frac{F_3}{a_3} = \frac{F_2}{a_2} \quad \text{——} (6)$$

from eqn (5) and (6)

$$\frac{F_2}{a_2} = \frac{F_2}{a_2}.$$

* Application of pascal law
i) Hadrolice lift
ii) Hadrolice Brack

i) Hadrolic lift ⇒ A divice which used to lift the Small object by applying the

Principle ⇒ ~~Hardoco~~ Hadrolic lift lest on the principle of the Pascal law

construction ⇒ Hadrolic lift is consists of the to cylinder of different are of crossation a and A ~~asmall~~ is very-very A | both ~~cy~~ cylinder attached ~~to~~ the at in of the master cylinder all the cylinder are field with the in comercial in liquid and highly ~~discres~~ viscus

working ⇒ where small force f applied at the small area of crossation of cylinder than resultend force F applied on the load

According to pascal law

$$\frac{F}{A} = \frac{f}{a}$$

$$F = \frac{f}{a} A$$

$$F = \left(\frac{A}{a}\right) f$$

$$\frac{F}{f} = \frac{A}{a} \quad \text{—— (1)}$$

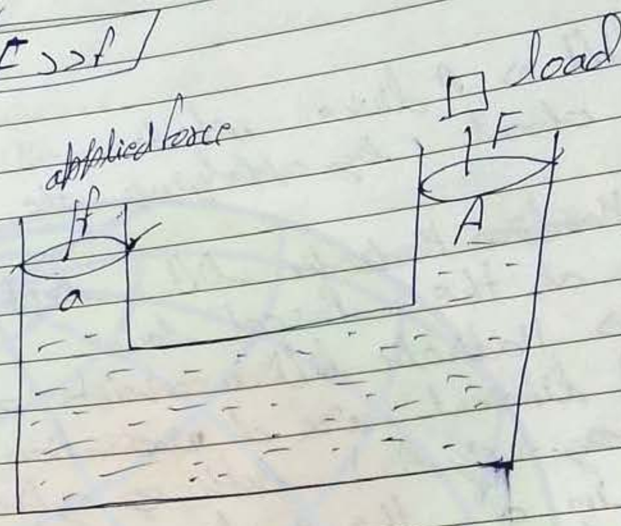
$$A >> a$$

$$\frac{A}{a} >> 1$$

(from eq^n ①)

$\frac{F}{f} >> 1$

$\boxed{F >> f}$



By appling the small force on the lift ~~s~~ obtained the more force that applied on the load

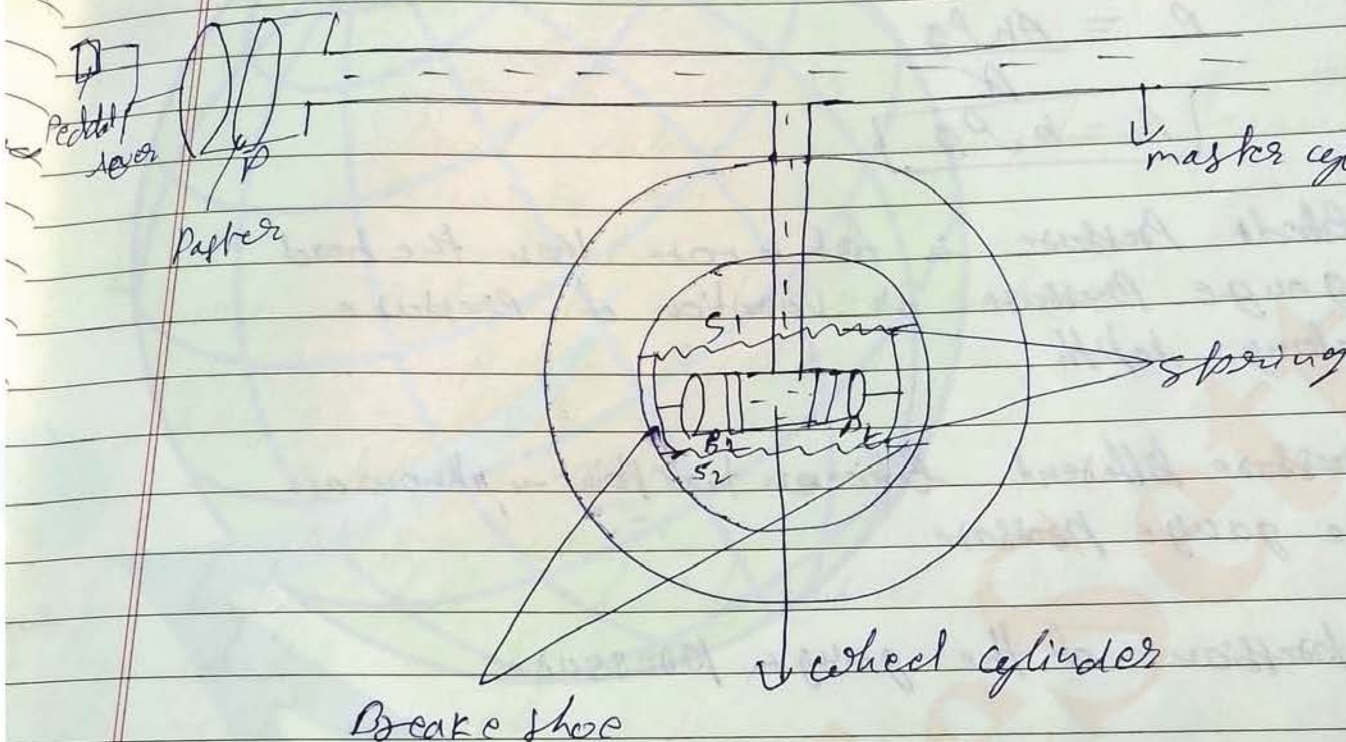
ii) Hadrolice brack ⇒ A device which used to ~~applied~~ ~~p~~ applying on the moving vacille

Principle ⇒ It is best on the Principle of the Pascal law

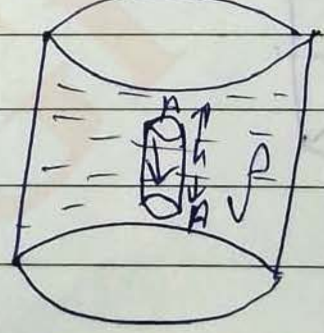
construction ⇒ Hadrolice break consists of the master cylinder at the one end of the master cylinder ~~be~~ pester P is connacted ~~paddle~~ throw the liver and another end of the master ~~D~~ cylinder is connected to the will cylinder through the conacative ~~pain~~ pipe. ~~will f~~ wheel cylinder has the two pister P_1 and P_2 pressed again the Break Shoe with break shoe is also conacative to the spring

all the cylinder fied with the highly viscal liquid working → when the small force 'f' applied on the padel according to pascal law effect of the pressure transmite ~~a~~ undiminesd through ~~of~~ the out the liquid.

Result → the pistel P_1 and P_2 gets move and push the break the rime of the ~~wool~~ wheel and retard the speed of ~~vechoud~~ vechilles when applied force is remove than pistons P_1 and P_2 comes on original position with the help on the spring



expression for Pressure by the liquid colamn



consider the imagenary cylinder of the liquid of heigh 'h' area of crossation 'a' densicity of the liquid is ρ.

To weight of liquid coloum is given by

$$w = mg$$
$$= V\rho g \quad (mass = volume \times density)$$
$$= Ah\rho g \quad (V = Ah)$$

pressure exerted by liquid coloum is given by

$$P = \frac{w}{A}$$

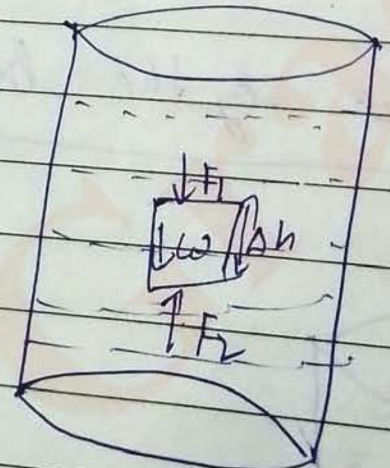
$$P = \frac{Ah\rho g}{A}$$

$$\boxed{P = h\rho g}$$

* Blood Pressure is feet is more than the head gauge Pressure or varation of Pressure along depth

- Pressure different between two point is know as the gauge pressure

expression of the gauge pressure



let a liquid fiel in a containar having dencity ρ
consider small height liquid coloum Δh

There are three forces ats on the imagenery liquid coloum F_1 weight w down words direction F_2 ats upward in the lower in of liquid coloum

Pressure ats a force is given by

$$P_1 = \frac{F_1}{A}$$

$$F_1 = P_1 A \quad \text{——— (1)}$$

~~fraction~~ Pressure ates ~~force~~ ~~at~~ on botame

$$F_2 = P_2 A \quad \text{——— (2)}$$

Since liquid coloum is in ~~incuteberium~~ equilibrium

$$F_1 + w - F_2 = 0$$

$$w = F_2 - F_1$$

$$mg = P_2 A - P_1 A \quad (\text{from eqn (1) and (2)})$$

$$V \rho g = A(P_2 - P_1)$$

$$\cancel{A} \Delta h \rho g = \cancel{A}(P_2 - P_1)$$

$$\Delta h \rho g = P_2 - P_1$$

$$\Delta h \rho g = \Delta P$$

diviling both side by Δh

$$\frac{\cancel{\Delta h} \rho g}{\cancel{\Delta h}} = \frac{\Delta P}{\Delta h}$$

$$\frac{\Delta P}{\Delta h} = \rho g$$

when $\Delta h \to 0$

$$\lim_{\Delta h \to 0} \frac{\Delta P}{\Delta h} = \rho g$$

$$\frac{dP}{dh} = \rho g$$

$dP = \rho g\, dh$

where $h = 0$, $P = P_a$ (air pressure)

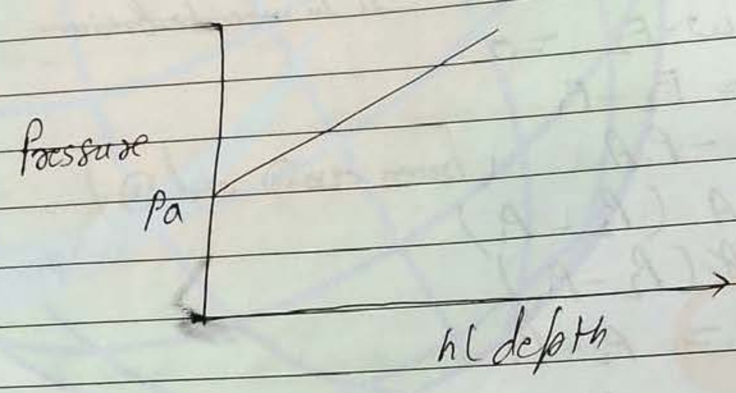
$h = h \Rightarrow P = P$

$$\int_{P_a}^{P} dP = \rho g \int_0^h dh$$

$$[P]_{P_a}^{P} = \rho g\, [h]_0^h$$

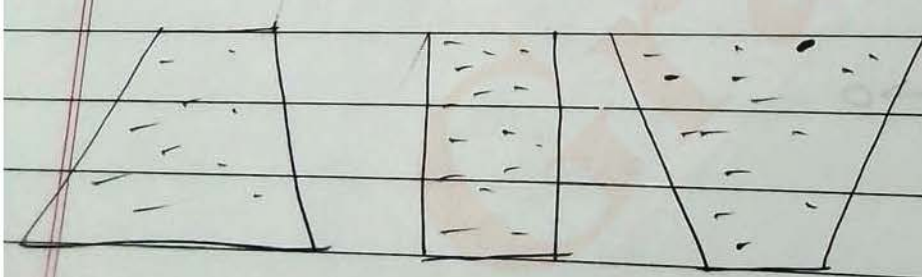
$$\boxed{P - P_a = \rho g h}$$

$$\boxed{P = P_a + \rho g h}$$



* hydrostatick paradure

liquid pressure does not depends on the sape and size only depend on the dencity hight and acceleration due to gravaity is know as the hydrostatick paradu



$P = h\rho g$

classmate
Date
Page

* atmospheric pressure = atmospheric pressure at any point is numerecaly equation of the weight of a coloum of air of unit crossaction area extending foram that point to the top of the atmospherie

* Air pressure => At acts STP or a sea level
Air pressure can be measure by the mercury barrometer

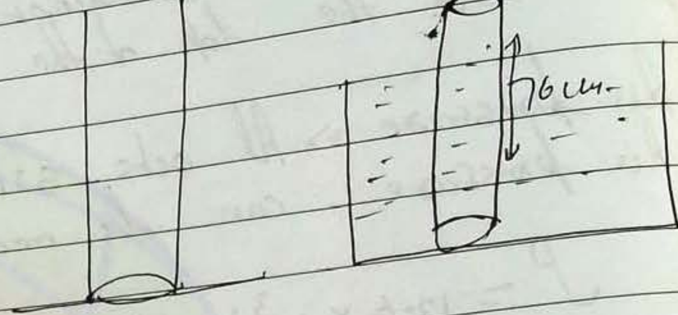
$\rho = 13.6 \times 10^{3}\, kg m^{-3}$
$h = 76 cm = 76 \times 10^{-2} m$
$g = 9.8 ms^{-2}$
$P = h\rho g$
$= 76 \times 10^{-2} \times 13.6 \times 10^{3} \times 9.8$
$= 1.013 \times 10^{5} Nm^{-2}$ (Pascal)

76
9.8
608
684 x
6444.8

height of the water in a barrometer
$P = 1.013 \times 10^{5} Nm^{-2}$
$\rho = 1000\, kg m^{-3}$
$h = ?$
$g = 9.8$
$P = h\rho g$
$h = \frac{P}{\rho g} = \frac{1.013 \times 10^{\cancel{5}\,2}}{1000 \times 9.8}$
$= \frac{\cancel{1.013} \times 10}{9.8} = \frac{101.3}{9.8}$
$= 10.34 m$

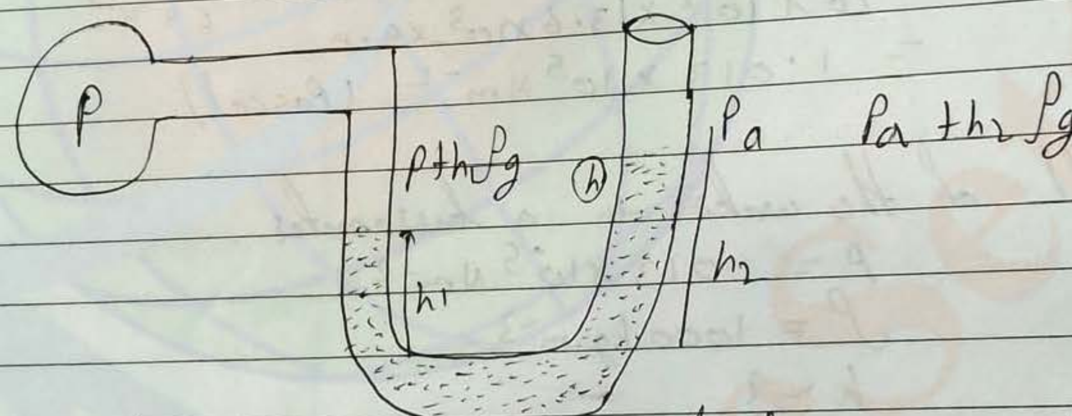
height of the water in a tube is 10 m ~~that~~ is in convenient ~~that~~ to be ~~under~~ used barrometer water liquid is not used barrometer => A device which is used to measure the air pressure acts on a body is know as the barrometer

meacurry barrometer -



$P = h\rho g$

* open to manometer



open tube manometer is used to measure the Pressure goes it consists of U shape tube field with meacury for measuring a high goeas pressure
One end of the tube is open while the other end is conceted to the balloons

At equilibrium

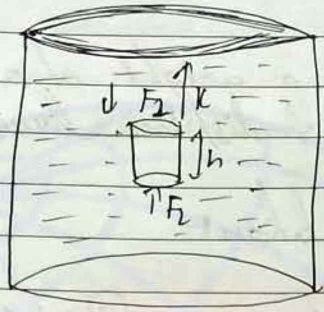
$P + h_1\rho g = P_a + h_2\rho g$

$P - P_a = h_2\rho g - h_1\rho g$

$P - P_a = g\rho\,(h_2 - h_1)$

$\boxed{P - P_a = h\rho g}$

* ~~Ask~~ Archamading principle
According to principle in object, parsialy or fuly in
mores in liquid that than ~~apero~~ lose aparent lose in weight
may be object is equal to the weight of the distplace
liquide



Expression of Archamading principle

let a insoluble body of mass 'M' and height 'h' fuly
in must in a liquid. liquid have density ρ and
object Emerged at the depth acts on the liquid surface

- Area of crossation of the body A
force adjected at the tope and buttume F_1 and F_2 are
given by

$$F_1 = P_1 A$$
$$F_1 = x\rho g A \quad \text{--- (1)}$$
$$F_2 = P_2 A$$
$$F_2 = (x+h)\rho g A \quad \text{--- (2)}$$

Net ~~up~~thrust force ats on a body in up ward direction
is given by

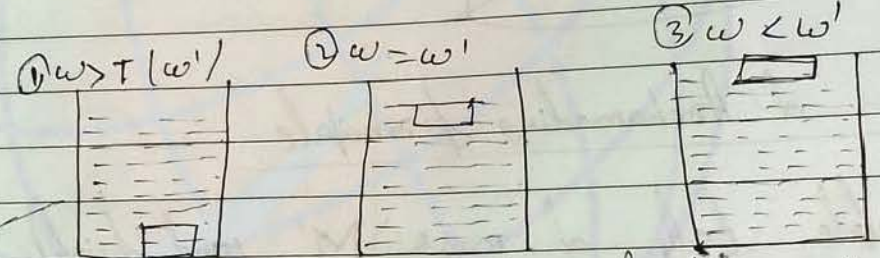
$$\text{upthrust force } (F) = F_2 - F_1$$
$$= (x+h)\rho g A - x\rho g A$$
$$= \cancel{x\rho g A} + h\rho g A - \cancel{x\rho g A}$$
$$F = h\rho g A$$
$$F = V\rho g \quad (V = hA)$$

$F = mg$ $(m = V\rho$ = mass of displace liquid)
upthrust force = weight of displace liquid

conclusion:-
upthrust force = apparent loss in weight of the body

Therefore apparent loss in a weight of a body equal to weight dis weight of displace liquid

* law of Rotation floatation:



i) body flodes on the surface of the liquid when weight of the body is equal to the weight of the displace liquid

ii) when weight of the body greater than the grater than the displace of liquid is get fully imerged in a liquid

when weight of the body is less than the weight of the displaced liquid i-e flowed on the liquid surface with small part in a liquid

→ Sea figure

Q At depth of 1000m in an ocian
i) what is the absolute pressure
ii) what is the gaug's pressure
iii) find the force at acting on the windo of area 20cm of a summerian at depth dase the interior of which is drented at sea level atmospheric pressure densicity of sec water is $1.03 \times 10^3 m^{-3}$
$g = 10 m/s$ $\quad$ apa $= 1.01 \times 10^5$ Pascal

soln given

$h = 1000m$
$g = 10 ms^{-2}$
$P_a = 1.01 \times 10^5$ Pascal
$\rho_s = 1.03 \times 10^3 m^{-3}$

i) $P = P_a + h\rho g$
$= 1.01 \times 10^5 + 1000 + 1.03 \times 10^3 \times 10$
$= 1.01 \times 10^5 + 103 \times 10^5$
$P = 104.01 \times 10^5$ Pascal

ii) $P - P_a = h\rho g$
$= 1000 \times 1.03 \times 10^3 \times 10$
$= 1.03 \times 10^7$ Pascal

Out side pressure
$P = P_a + h\rho g$
Inside pressure $= P_a$
Net pressure
$= P_a + h\rho g - P_a$
$= h\rho g$
$= 1.03 \times 10^7$ Pascal

$P = \frac{F}{A}$
$F = PA \quad = 1.03 \times 10^7 \times 400 \times 10^{-2}$ N
41.2×10^4 N

Q In a car lift Compressed air exerts a force F_1 on a small cristane having a radius 5cm this pressure is transmeted to a second pristalo of radius 10 cm if the mass of the car to a lefter as 1350 kg calculate F_1 what is the pressure of neaccarary a combrers this part $g = 9.8$

Soln Given

$r_1 = 5\,cm = 5 \times 10^{-2}\,m$

$m_c = 1350\,kg$

$r_2 = 10\,cm = 10 \times 10^{-2}\,m$

A/c Principle of hydrolic lift

$$\frac{F_1}{a_1} = \frac{F_2}{a_2}$$

$$F_1 = \frac{F_2}{a_2} a_1$$

$$= \frac{mg\,\cancel{\pi} r_1^2}{\cancel{\pi} r_2^2}$$

$$= \frac{1350 \times 9.8 \times 25 \times 10^{-4}}{100 \times 10^{-4}}$$

9 Q you to contain water and sprite saparated by mercury the mercury coloum in the two arm level with 10cm of water in 1 arm and 11.5cm and of sprite in the other. what is the relative dencity of the sprite

Soln At eqilibrium

$$h_1 \rho g = h_2 \rho_2 g$$

$$\frac{h_1}{h_2} = \frac{\rho_2}{\rho_1}$$

$$\frac{10\,cm}{11.5\,cm} = \frac{\rho_2}{\rho_1}$$

$= 0.87$

* Types of flow of liquid

i) ~~stame~~ strime lime flow
ii) Lemener flow
iii) Termenent flow

1) Strime lime flow - A flow of liquid in such that the velocity direction of avery particles at any point of the flude is constant is know as the strime line flow

• Properties of strime lime flow :-

(i) Tengent ~~of any~~ at any point of a strime line flow gives the direction of the velocity of strime line

(ii) To strime line flow cannot be the each other because at the point of intersection there are two direction which show the two diff. direction of liquid that is not possible

(2) Lemener flow ⇒ In a liquid flow over a horizontal surface in the from of layers of different velocity than the flowes of the liquid is called Lemener flow

• Note ⇒ each layer of the lamener flow is consider as a strime line flow

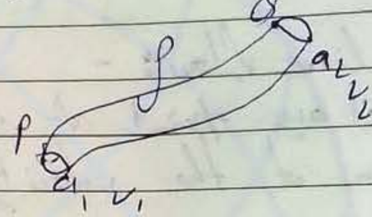
(3) Tarmenent flow ⇒ A flow of liquid in which par[illegible] of the liquid as not a fixed direction and veloc[illegible] each know as the tarment flow

* equation of conduanity

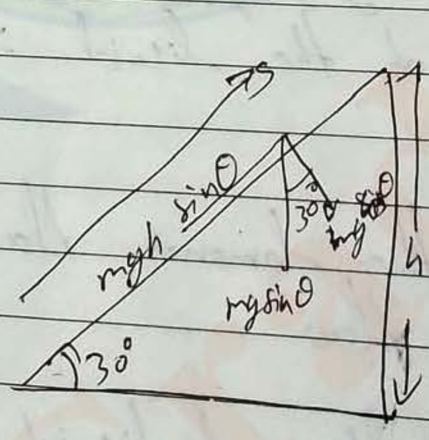
According to eqn of conduanity product of the area of crossation of the close pipe and velocity of the liquid for a strim.lin flow each constant

$$\boxed{av = \text{constant}}$$

eqn of conduanity best on the low of consurcation of mass



Q A solid cylinder role on an Inclined plane of inclination 30° at the bottom of the inclind plane



$$\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = mgh$$

$$\frac{1}{2}mv^2 + \frac{1}{2}I\frac{v^2}{r^2} = mgh$$

$$\frac{1}{2}mv^2\left(1+\frac{I}{mr^2}\right)=mgh$$

$$\frac{v^2}{2}\left(1+\frac{\frac{1}{2}\cancel{mr^2}}{\cancel{mr^2}}\right)=gh$$

$$\frac{v^2}{2}\times\frac{3}{2}=gh$$

$$h=\frac{3v^2}{4g}$$

$$=\frac{3\times25}{4\times9.8}$$

$$=\frac{75}{39.2}\ m$$

and

$$\sin\theta=\frac{h}{s}$$

$$\sin 30°=\frac{75}{39.2s}$$

$$\sin 30°=\frac{75}{39.2s}$$

$$\frac{1}{2}=\frac{75}{39.2s}$$

$$\boxed{s=\frac{150}{39.2}\ m}$$

$$s=\frac{150}{39.2}\ m$$

$$a=g\sin30=g\times\frac{1}{2}$$

$$=\frac{9.8}{2}=4.9\ m/s^2$$

$u = 0$

$t = 2$

$g = ut + \frac{1}{2}at^2$

$s = 0 + \frac{1}{2} 4 g t^2$

$29 = 4.9 t^2$

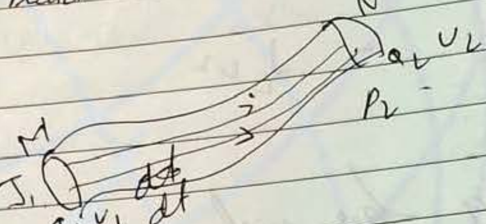
$t = \sqrt{\frac{2 \times 150}{39.2 \times 4.9}}$

Total time $= 2 \sqrt{\frac{2 \times 150}{39.2 \times 4.9}}$

* eqn of continuity based on the law of conservation of mass

let a pipe having area of crossation a_1 and a_2 and flow of the liquid through it v_1 and v_2 respectively

mass of the fluid intersect at point M in time dt



distance travel
$= v_1 dt$

volume $= a_1 v_1 dt$

Mass = volume x density

$M_m = a_1 v_1 dt \rho_1$ —— (1)

similiarly
mass of fluid comes out from N

$M_n = a_2 v_2 dt \rho_2$ —— (2)

when there is no change in mass of fluid between M an N

A/c ~~Now~~ law conservation of mass

$M_m = M_n$

$a_1 v_1 dt \rho_1 = a_2 v_2 \rho_2$

but the liquid is incompressible

$\rho_1 = \rho_2 = \rho$

$a_1 v_1 \cancel{\rho} = a_2 v_2 \cancel{\rho}$

$$\boxed{a_1 v_1 = a_2 v_2}$$

$\therefore a v = \text{constant}.$

* Kinetic energy per unit mass

$$\frac{\frac{1}{2} \cancel{m} v^2}{\cancel{m}} = \frac{1}{2} v^2$$

* Potential energy per unit mass

$$= \frac{\cancel{m} g h}{\cancel{m}} = g h$$

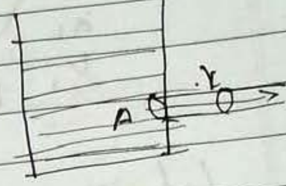
* Pressure energy ⇒ work done by the liquid pressure is know as the ~~pressure~~ pressure energy

Let a frictional less piston of area crosssection A contacted at the bottom of the container when liquid of densicity low fall in a container then it moves through distance x

$$P = \frac{F}{A}$$

$$F = PA \quad \text{——} (1)$$

work done to displace the piston through distance x is given by



$\omega = Fx$

$\omega = PAx$ (from eq $= ①$)

$\omega = PV$ $(V = Ax)$

This work done is equal to pressure energy

$U = PV$

pressure energy per unit mass $= \frac{PV}{m}$

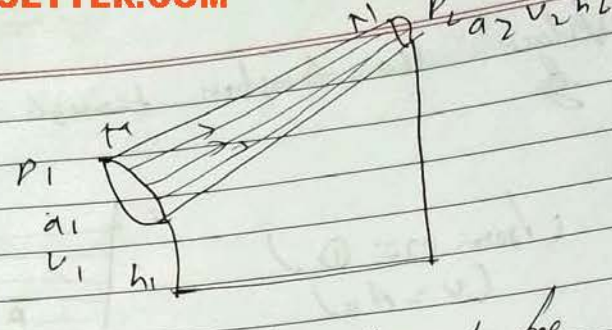
$= \frac{PV}{V\rho}$ $(m = V\rho)$

$= \frac{P}{\rho}$

Bernoulli's theorem

According to the bernoulli's theorem sum of the kinetic energy potential energy and pressure energy per unit mass for a ideal fluid in a streamline flow is constant

$\frac{1}{2}v^2 + gh + \frac{P}{\rho} = \text{constant}$



Let in compressible liquid be through a close pipe of densicity ρ pressure a speed of flue hight and are of crossation acts M ($P_1 v_1 h_1 a_1$) and N ($P_2 v_2 h_2 a_2$) respectively

work done by the pressure energy at point m is given by
distance covered by fluid in unit time $= v_1 \times 1$
$= v_1$

force at M $= P_1 a_1$
work done $= F \times d$
$= P_1 a_1 v_1$

similarly
work done by liquid pressure at N
$= P_2 a_2 v_2$

change in pressure energy $= P_1 a_1 v_1 - P_2 a_2 v_2$ — (1)

~~change in mechanical energy~~ = ~~ME_N − ME_M~~

from eqn of continuity
mass per unit time is given by

$$a_1 v_1 \rho = a_2 v_2 \rho = m$$
$$a_1 v_1 = \frac{m}{\rho}$$

Date
Page

$a_2 v_2 = \frac{m}{\rho}$

Putting this value in eq^n (1)

change in pressure energy $= \frac{P_1 m}{\rho} - \frac{P_2 m}{\rho}$ — (2)

change in Mechanical energy $= ME_n - ME_m$
$= \left(\frac{1}{2} m v_2^2 + mgh_2\right) - \left(\frac{1}{2} m v_1^2 + mgh_1\right)$ — (3)

According to law of conservation of energy
~~the~~ change in pressure energy = change in Mechanical energy

$$\frac{P_1 m}{\rho} - \frac{P_2 m}{\rho} = \left(\frac{1}{2} m v_2^2 + mgh_2\right) - \left(\frac{1}{2} m v_1^2 + mgh_1\right)$$

$$\cancel{m}\left(\frac{P_1}{\rho} + \frac{1}{2} v_1^2 + gh_1\right) = \cancel{m}\left(\frac{P_2}{\rho} + \frac{1}{2} v_2^2 + gh_2\right)$$

$$\boxed{\frac{P_1}{\rho} = \frac{1}{2} v_1^2 + gh_1 = \frac{P_2}{\rho} + \frac{1}{2} v_2^2 + gh_2}$$

$$\boxed{= \frac{P}{\rho} + \frac{1}{2} v^2 + gh = \text{constant}}$$

$$\frac{P}{\rho} + \frac{1}{2} v^2 + gh = \text{constant}$$

Dividing all the term by ~~ρ~~ g

$$\frac{P}{\rho g} + \frac{v^2}{2g} + h = \text{constant}$$

∴ all term have the same dimentional length, meter call head

$\frac{P}{\rho g}$ is called pressure head

$\frac{v^2}{2g}$ is called velocity head

h is called gravitational head

$$\frac{P_1}{\rho} + \frac{1}{2}v_1^2 + gh_1 = \frac{P_2}{\rho} + \frac{1}{2}v_2^2 + gh_2$$

when $h_1 = h_2$

$$\frac{P_1}{\rho} + \frac{1}{2}v_1^2 = \frac{P_2}{\rho} + \frac{1}{2}v_2^2$$

∴ $v_1 > v_2$

$P_1 < P_2$

1) It is ~~dangers~~ dangerous to a stand ~~of a~~ on the age of Plateform while fast moving train crosses the Plateform, when the fast moving train cross a person standing near traik then velocity air between the Person and train is greater than the velocity of air behind the person according to Bhoanolise theorem pressure between the ~~person~~ person and the train is less than the pressure behind the Person due to Pressure differnce Person fals the towards the train

during ~~coit~~ when stoke rise of houses ~~of~~ are blow u

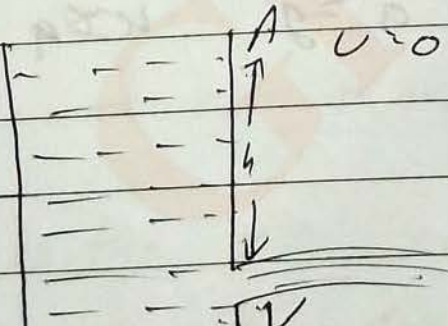
- when pristen of the a spre moves forward then air molecule velocity with grater than the velocity of air inside the bottel according to bornalise theorem pressure at ~~mouth~~ pristen is lower than the Pressure inside the botel as result due to pressure difference liquid fill in a botel comes

* A spaning of ball and magnus effect

when speed baller through the balls ~~from~~ during that ballers natch the velocity diffe rece at tope and bubome through the finger according to bornalise theorem pressure difference created at tope and bottom ~~and~~ as result ~~bad~~ ball skine this effect is know as the maganes effect

- A fling ~~form~~ / Pong / ball

- Torricelli's law
speed of or effects
According to torricelli's law speed of the liqu through the emitter is equal to the a speed the liquid falls from the same height under action of the gravaity



Let a liquid of density ρ fille ... the liquid ... at the depth of h from the liquid comes out velocity through the inffles liquid 'v'

At point A
$P_1 = P_1 \quad v = 0 \quad h = 0$

At point B
$P_2 = P \quad V_2 = v \quad h_2 = 0$

A/c Bernoullis theorem

$$\frac{P_1}{\rho} + \frac{1}{2} v_1^2 + gh_1$$

$$= \frac{P_2}{\rho} + \frac{1}{2} v_2^2 + gh_2$$

$$\frac{P}{\rho} + 0 + gh = \frac{P}{\rho} + \frac{v^2}{2} + 0$$

$$gh = \frac{v^2}{2}$$

$$v^2 = 2gh$$

$$v = \sqrt{2gh} \quad \text{——— (1)}$$

when liquid fall from same height under the gravity

$u = 0 \quad s = h \quad a = g \quad \text{req} \quad v = v'$

$$v'^2 = u^2 + 2gh$$

$$v'^2 = 0 + 2gh$$

$$v' = \sqrt{2gh} \quad \text{——— (2)}$$

Date
Page

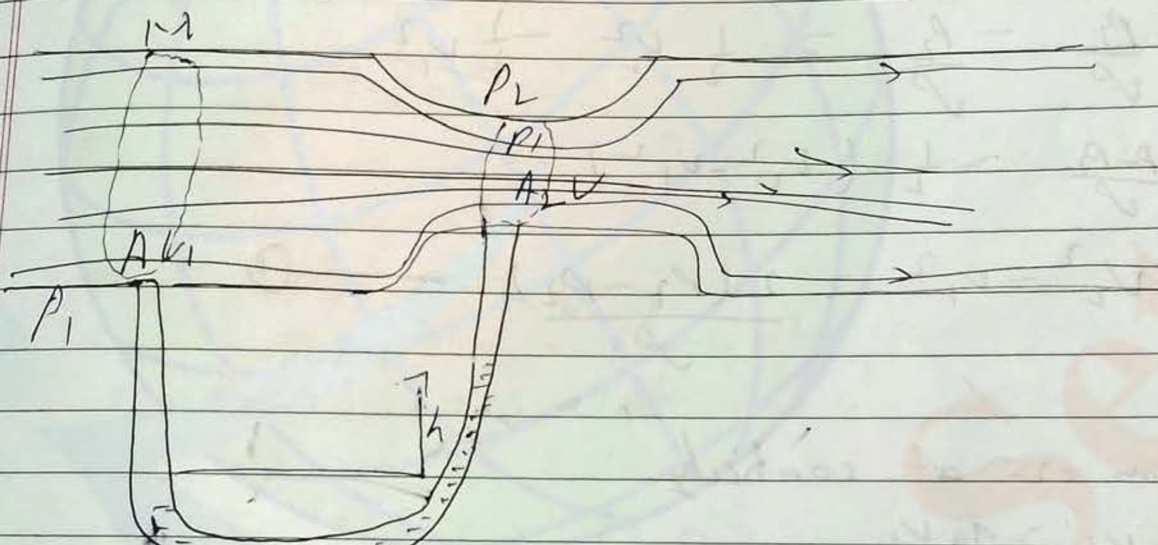
from eqn (1) and (2)

$\boxed{v' = v}$

* ~~Vectory~~

* Venturimeter

A device is used to measure the speed of flow at liquid ~~is a at~~ is know as venturimeter



Venturimeter is consistes of the pipe in which a gaug is attach at point M area of corraction of Pipe p A_1 and out of area of cross section A

velocity ~~at~~ at M and N v_1 and v_2 respectively

A/c to the eqn contuinity

v_2 is grater than p_1

liquid flow in a pipe in a streamline flow

~~At M~~
According to Bernoulli's theorem

$$\frac{P_1}{\rho} + \frac{1}{2}v_1^2 + gh_1 = \frac{P_2}{\rho} + \frac{1}{2}v_2^2 + gh_2$$

$h_1 = h_2$

$$\frac{P_1}{\rho} + \frac{1}{2}v_1^2 = \frac{P_2}{\rho} + \frac{1}{2}v_2^2$$

$$\frac{P_1}{\rho} - \frac{P_2}{\rho} = \frac{1}{2}v_2^2 - \frac{1}{2}v_1^2$$

$$\frac{P_1 - P_2}{\rho} = \frac{1}{2}(v_2^2 - v_1^2)$$

$$v_2^2 - v_1^2 = \frac{2(P_1 - P_2)}{\rho} \text{ --- (1)}$$

from eqn of continuity

$$a_1 v_1 = a_2 v_2$$

$$v_2 = \frac{a_1}{a_2} v_1$$

Putting value of v_2 in eqn (1)

$$\left(\frac{a_1}{a_2} v_1\right)^2 - v_1^2 = \frac{2(P_1 - P_2)}{\rho}$$

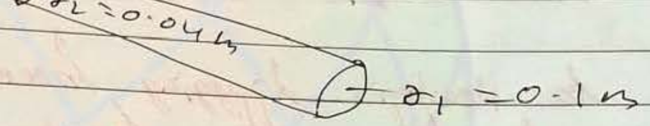
$$v_1^2\left[\left(\frac{a_1}{a_2}\right)^2 - 1\right] = \frac{2(P_1 - P_2)}{\rho}$$

$$\boxed{v_1 = \left[\frac{2(P_1 - P_2)}{\rho\left[\left(\frac{a_1}{a_2}\right)^2 - 1\right]}\right]^{\frac{1}{2}}}$$

Similarly

$$\boxed{v_2 = \left[\frac{2(P_1 - P_2)}{\rho\left[1 - \left(\frac{a_2}{a_1}\right)^2\right]}\right]^{\frac{1}{2}}}$$

Q. Find the rate of flow of gasoline of density 1.25×10^3 kg/m^3 through a conical tap hole with in radius 0.1m and 0.04 m respectively and with pressure differce across the ring $10 N/m^2$



$a_1 = \pi r_1^2 = \pi (0.1)^2$

$a_2 = \pi r_2^2 = \pi (0.04)^2$

$P_1 - P_2 = 10 N/m^2$

$\rho = 1.25 \times 10^3 \ kg\ m^{-3}$

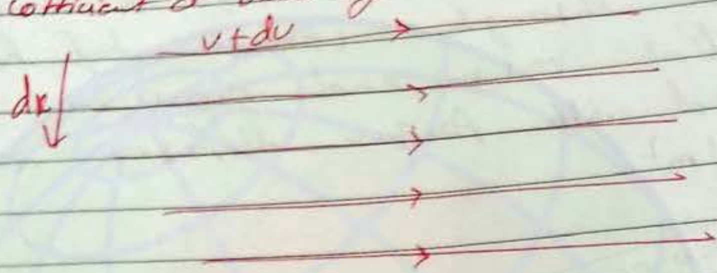
$$v_1 = \sqrt{\frac{2(P_1 - P_2)}{\rho\left[\left(\frac{a_1}{a_2}\right)^2 - 1\right]}}$$

$$= \sqrt{\frac{2 \times 10}{1.25 \times 10^3\left[\left(\frac{\pi(0.1)^2}{\pi(0.04)^2}\right)^2 - 1\right]}}$$

$$v_2 = \sqrt{\frac{2 \times 10}{1.25 \times 10^3\left[1 - \left(\frac{\pi(0.04)^2}{\pi(0.1)^2}\right)^2\right]}}$$

* Visco city ⇒ the property of liquid by which opposing force comes into play between the different layers of the liquid when there over the is relative motion between the layer is know as the visco city

cofficient of viscocity ⇒



$$F \propto A \frac{dv}{dx}$$

$$F = -\eta A \frac{dv}{dx}$$

According to Newton's dragging force or viscous force 'F' act between the layers of the liquid

i) directly proportional to the velocity gradient

$$F \propto \frac{dv}{dx} \quad \text{—— (1)}$$

ii) directly proportional to the area of contact between the layer

$$F \propto A \quad \text{—— (2)}$$

combaning eqn (1) and (2)

$$F \propto A \frac{dv}{dx}$$

$$F = -\eta A \frac{dv}{dx}$$

wher η is constant of proportionalaty is know as cofficient of viscocity

A negative sing show that F is the opposing force

cofficient ... city —

Coefficient of visco city is numeracaly equal to the viscoes direct or force acting for unit surface area and for unit lessecrating velocity gradient

S.I unit of coffiaient of viscocity

$$\eta = \frac{-F}{A\frac{dy}{dx}}$$

$$\frac{N}{M^2 \times \frac{\cancel{M}s^{-1}}{\cancel{M}}}$$

$$Ns\,m^{-2}$$

$Ns\,m^{-2}$ called ~~deca~~poise deca poise

- C.G.S unit of η is ~~deca~~ poise

$\boxed{10\text{ poise} = 1\text{ deca poise}}$

- dimensional formula

$$[\eta] = \frac{[MLT^{-2}]}{L^2 \frac{LT^{-1}}{[L]}}$$

$$[\eta] = [ML^{-1}T^{-1}]$$

effect of the temperature on the visco city :→

on increasing temperature viscocity of the liquid decreasi and vice versa

on increasing temperature visco city of gas increases and vice versa

$$\boxed{\eta \propto \frac{1}{\sqrt{T}}}$$

$$\boxed{\eta \propto \sqrt{T}}$$

$$\sqrt{\frac{T_2}{T_1}}$$

Forses

* application of visco city

i) by using a proper lubricant can be made for different season and temperature of.

ii) It is use in baker in a trais

iii) the fuomena of visco city of air and liquid is used to ~~of~~ refer to motion of the moving

iv) the noulare of visco city of organic liquid is used to determine the molecular weight and shape and size of the molecule

v) It find a important use in the circulation of blood through arteries and veins

* comparision of the visco city and solid fraction

similarity

i) both are opposing the relative motion

" " causes due to the inter molecular force

difference ⇒

(i) solid freaction does not depent on care and contact but viscatecat depends on the area of layer contact

Page

ii) solid reaction depends on the normal reaction where as visco city or viscous does not depends on the normal reaction

* Stokes law

When a solid sphere radius r falls in a liquid having cofficient of viscocity η than it attend the terminal velocity 'v'
according to stokes law viscous depends on the radius of solid spheres cofficient of viscocity 'η' and terminal velocity 'v'

$$F \propto r^a \eta^b v^c$$

where a, b, c are dimension

$$F = k r^a \eta^b v^c \quad \text{---} (1)$$

where k dimensionless constant

$$[MLT^{-2}] = [L^a][ML^{-1}T^{-1}]^b[LT^{-1}]^c$$

$$[MLT^{-2}] = [M^b L^{a-b+c} T^{-b-c}]$$

A/c to principle of homogenous

$$b = 1 \quad \text{---} (2)$$

$$a - b + c = 1 \quad \text{---} (3)$$

$$-b - c = -2$$

$$b + c = 2 \quad \text{---} (4)$$

from eq^n (2) and (4)

$$c = 1$$

Putting c = 1, b = 1 in eq^n (3)

$$a - \cancel{1} + \cancel{1} = 1$$

$$a = 1$$

Putting a = 1, b = 1, c = 1 in eq^n (1)

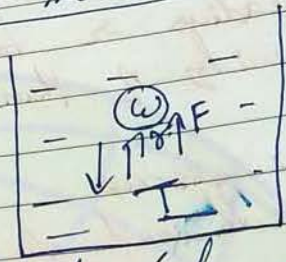
$$F = k r \eta v$$

where $k = 6\pi$

$$\boxed{F = 6\pi r \eta v}$$

* terminal velocity ⇒ when a body liquid 1st it accelerated and after sarting a time interval with required constant velocity is ~~called~~ known as the terminal velocity

- expression of the terminal velocity



Let a spherical body of ~~mass~~ radius 'r' and density ρ droper in a viscous fluid having dencity sigma (σ)

There are three forc acts on a body apteres force 'f' and viscous direct acts in a upward direction were as wight 'ω' the body acts ~~on in down a~~ in a down ward direction

when body required the terminal velocity then ($a = 0$)

$$\omega - T - F = m \times 0 \quad (a = 0)$$

$$\omega - T - F = 0 \quad \text{———} \quad (1)$$

weight of the body $\omega = mg$

$$= V\rho g$$

$$= \frac{4}{3}\pi r^3 \rho g$$

upthrust force T = weight of the liquid displa

$$= m'g$$

$$= V\sigma g$$

Date
Page

A/c stokes $= \frac{4}{3}\pi r^3 \sigma g$

viscous drag $f = 6\pi \eta r v$

Putting value of ω, T and F in eq^n ①

$$\frac{4}{3}\pi r^3 \rho g - \frac{4}{3}\pi r^3 \sigma g = 6\pi\eta r v$$

$$\frac{\frac{4}{3}\pi r^3 g (\rho-\sigma)}{6\pi\eta r} = v$$

$$v = \frac{2}{9}\frac{r^2 g}{\eta}(\rho-\sigma)$$

* ~~Cristal~~ <u>Critical velocity :-</u> the maximum velocity attend by the in a strime line flow after that it ~~can~~ convered or terminate flow is know as the ~~crit~~ critical velocity.

* <u>expression of critical velocity</u>

critical velocity in a strime line flow (v) is defend on the flowing

1) Radius of the dore ~~pipe~~ 'r'
2) density of the fludes 'ρ'
3) ~~the~~ coficient viscocity of the flude η

$$v \propto r^a \rho^b \eta^c$$

where a b c ar dimintion

$$v = k r^a \rho^b \eta^c \quad \text{—— (1)}$$

Date
Page

where 'k' is dimensionless constant

$[M^0 L T^{-1}] = [L]^a [ML^{-3}]^{-b} [ML^{-1}T^{-1}]^c$

$[M^0 L T^{-1}] = M^{b+c} L^{a-3b-c} T^{-c}]$

A/c principle of homogeneity

$b+c=0$

$b=-c$ — (2)

$a-3b-c = 1$ — (3)

$-c=-1$

$c=1$

$b=-1$ (from eqn (2))

Putting the value of ~~...~~ b and c in eqn (3)

$a+3-1=1$

$a=1-2$

$a=-1$

Putting the value of a, b and c in eqn (1)

~~Putting the value of a, b and c in eqn (1)~~

$v = K r^{-1} \rho^{-1} \eta^{1}$

$$\boxed{v = \frac{k\eta}{r\rho}}$$

Reynolds number

According to Reynolds critical velocity in a narrow ~~...~~ tube is ~~...~~

(1) directly proportion to the ~~...~~ coefficient of velocity and invertial proportional to the

Date
Page

radius of the tube and denity of flude
from above eq:

$$V_c \propto \frac{\eta}{r\rho}$$

$$V_c = \frac{N_R \eta}{r\rho}$$

wher N_R is the Reynols number
when $N_R = \frac{V_c r\rho}{\eta}$

it is unit less and dimension less

case I when N_R less than $N_R < 1000$
the flude of liquid in a strian flow

case II whe N_R between 1000 to 3000 it is in
unistable condition some times in a laminar
flow and terminated flow

case III when N_R is grater than 3000 ($N_R < 3000$)
than flow ~~of~~ a liquid is a traminal flow

V.V.I Poiseuilles equation

Rate of flow of fluids to a closed tube (V)
it depend on the flowing

) Pressure gradient $\left(\frac{P}{L}\right)$

) Radius of the tube 'r' and coefficient of
viscosity η

$V \propto \left(\frac{P}{l}\right)^a r^b \eta^c$

wher a, b and c are ~~pressure~~ dimension ~~gradient~~

(volume) $V = \left(\frac{P}{l}\right)^a r^b \eta^c$

(volume of liquid per unit time)

where 'k' is dimension less constant

$V = k\left(\frac{P}{l}\right)^a r^b \eta^c$ —— 1

$[M^0 L^3 T^{-1}] = [ML^{-2}T^{-2}]^a [L]^b [ML^{-1}T^{-1}]$

$[M^0 L^3 T^{-1}] = [M^{a+c} L^{-2a+b-c} T^{-2a-c}]$

A/c Principle of homogeneity.

$a+c=0$

$a = -c$ —— 2

$-2a+b-c = 3$ —— 3

$-2a-c=-1$

$2a+c=1$ —— 4

$2\times -c+c=1$ (from eqn 2 and eqn 4)

$-c=1$

$c=-1$

$a=1$ (from eqn 2)

Putting $a=1$ $c=-1$ in eqn 3

$-2\times 1+b+1=3$

$b=4$

Putting $a=1 \quad b=4$
$c=-1$ in eq (1)

$$V = k \frac{P}{l} r^4 \eta^{-1}$$

$$V = \frac{k P r^4}{l \eta}$$

where $k = \frac{\pi}{8}$

$$\boxed{V = \frac{\pi P r^4}{8 \eta l}}$$

Force required to maintain the laminar or stream line flow

~~We know that~~

we know that

$$V = \frac{\pi P r^4}{8 \eta l}$$

$$P = \frac{8 \eta l v}{\pi r^4}$$

$$P = \frac{F}{A} \Rightarrow A = \pi r^2$$

$$F = PA = \frac{8 \eta l v}{\pi r^{4}} \times \pi r^2$$

$$\boxed{F = \frac{8 \eta l v}{r^2}}$$

Q the terminal velocity of a copper ball of radius 2 mm ~~flowing~~ falling through ~~altered~~ oil at 20°c is 6.5 cm/s ~~calculate~~ combute the visco city of the oil at 20°c

dencity of oil = 1.5×10^3 kg m^{-3}

ρ of copper = 8.9×10^2 kgm^{-3}

soln $r = 2mm = 2 \times 10^{-3}$ m

$v = 6.5$ cm/s

$= 6.5 \times 10^{-2}$ ms^{-1}

$\eta = ?$

$\sigma = 1.5 \times 10^3$ kg m^{-3}

$\rho = 8.9 \times 10^3$ kgm^{-3}

$$v = \frac{2}{9}\frac{r^2 g}{\eta}(\rho - \sigma)$$

$$\eta = \frac{2r^2 g}{9v}(\rho - \sigma)$$

$$= \frac{2 \times (2 \times 10^{-3})^2 \times 9.8}{9 \times 6.5 \times 10^{-2}}(8.9 \times 10^3 - 1.5 \times 10^3)$$

$= 0.99$ Pa.s

Q the flow rate of water from a tape of diameter 1.25 cm is 0.48 l/min the cefficient of visco-city of water is 10^{-3} Pascal second after some time the flow rate incrise 3 l/min characterise the flow for both the flow rates

Soln $D = 1.25\,cm = 1.25 \times 10^{-2}\,m$

$V = 0.48\ L/min$

$= \cancel{\dfrac{0.48 \times 10^{-3}}{60 \times 100}}$

$= \cancel{0.48 \times}$

$= \cancel{8\,m^3 s^{-1}}$

$\dfrac{0.48 \times 10^{-3}}{60 \times 100}$

$= 8 \times 10^{-6}\ m^3 s^{-1}$

$V' = 3\ L/min$

$= \dfrac{3 \times 10^{-3}}{60}$

$= 0.5 \times 10^{-4}$

5×10^{-6}

$\eta = 10^{-3}$ Pascal

$V = 3\ L/min$

$= \cancel{\dfrac{3 \times 10^{-3} L}{60}} = \cancel{50\,m^3 s^{-1}}$

$\eta = 10^{-3}$

$N_R = \dfrac{V_c \rho D}{\eta} \times \dfrac{A}{A}$

$= \cancel{50\,m^3 s^{-1} \times 1.25 \times 10^{-2}\,m}$

$= \dfrac{V \rho D}{\eta A}$ (volume $= v \times A$)

$= \dfrac{V \rho D}{\eta \pi \left(\frac{D}{2}\right)^2}$

$= \dfrac{4 V \rho D}{\eta \pi D^2}$

$N_R = \dfrac{4 V \rho}{\eta \pi D}$

$\cancel{N_R = 4 \times 8 \times 10^3 \times 7}$

$N_R = \dfrac{4 V \rho}{\eta \pi D}$

$$= \frac{4 \times 8 \times 10^{-6} \times 10^{3} \times 7 \times 100^{4}}{10^{-3} \times 22 \times \frac{1.25}{5} \times 10^{-2}}$$

$$= \frac{128 \times 7 \times 10^{2}}{110}$$

$$= 8.145 \times 10^{2}$$

$$= 814.5$$

In first case flow at skim line

$$N_R = \frac{4 V \rho}{\eta \times D}$$

$$= \frac{\cancel{4} \times \cancel{5} \times 10^{-\cancel{5}\,-2} \times 10^{3} \times \cancel{0}7 \times 100^{4}}{10^{-3} \times 2\cancel{2} \times 1.\cancel{2}5 \times 10^{-2}}$$

$$\frac{2\cancel{0}}{\cancel{5}} \quad 50$$

$$= \frac{56 \times 10^{3}}{11}$$

$$= 5.0909 \times 10^{3}$$

$$= 5090.9$$

Ex 10.13 $L = 1.5\ m$

$R = 1cm \qquad r = 1 \times 10^{-2} m$

$\frac{m}{t} = 4 \times 10^{-3} kg / second$

$P = ?$

$\rho_g = 1.3 \times 10^{-3}\ m^{-3}$

$\eta = 0.083\ Nsm^{-2}$

$V = \frac{\pi P r^4}{8 \eta l}$

$\frac{volume}{time} = \frac{\pi}{8} \frac{P r^4}{\eta l}$

$\frac{m}{\rho t} = \frac{\pi}{8} \frac{P r^4}{\eta l}$

$=$

$P = \frac{m}{t} \times \frac{8 \eta l}{\pi \rho r^4}$

$= \frac{7 \times 4 \times 10^{-3} \times 8 \times 0.83 \times 1.5}{22 \times (10^{-2})^4 \times 1.3 \times 10^3}$

$= 975.37$ Pascal

Ex 10.14

$V_u = 70 m/s$

$V_l = 63$ m/s respectively

$A = 2.5 m^2$

$\rho = 1.3 kg/m^3$

$V_1 > V_2 \quad V_2 = P_2$

63 ms^{-1}

$P_1 < P_2$

$(P_2 - P_1)$

A/C Bernoulli's theorem

$\frac{P}{\rho} + \frac{1}{2} v_1^2 + gh_1 = \frac{P_2}{\rho} + \frac{1}{2} v_2^2 + gh_2$

$h_1 = h_2$

$$\frac{P_1}{\rho} + \frac{1}{2}v_1^2 = \frac{P_2}{\rho} + \frac{1}{2}v_2^2$$

$$\frac{1}{2}v_1^2 - \frac{1}{2}v_2^2 = \frac{P_2}{\rho} - \frac{P_1}{\rho}$$

$$\frac{1}{2}v_1^2 - \frac{1}{2}v_2^2 = \frac{1}{1.3}(P_2 - P_1)$$

$$\frac{1}{2}70^2 - \frac{1}{2}63^2 = \frac{1}{1.3}(P_2 - P_1)$$

$$\frac{1}{2} \times 7 \times 133 \times 1.3 = P_2 - P_1$$

$$F = (P_2 - P_1)A$$

$$= \frac{1}{2} \times 7 \times 133 \times 1.3 \times 1.5 \text{ N}$$

$$= 1512.875 \text{ N}$$

Ex 10.17 Q

$A_1 = 8\ cm^2$ $\quad 8 \times 10^{-4}\ m^2$

$d = 1\ mm$ $\quad \frac{1}{2} \times 10^{-3}\ m$

$V_1 = 1.5 m/min$ $\quad 1.5m/600s = \frac{1}{4}\ ms^{-1}$

$V_2 = ?$

Area of 1 hole $= \pi r^2$

$$= \frac{22}{7} \times \frac{1}{4} \times 10^{-6}$$

Total area of 40 hole

$$a_2 = \cancel{40}^{10} \times \frac{22}{7} \times \frac{1}{\cancel{4}} \times 10^{\cancel{-6}\,-5}$$

$$= \frac{22}{7} \times 10^{-5}$$

From eq^n of continuity

$$a_1 v_1 = a_2 v_2$$

$$v_2 = \frac{a_1 v_1}{a_2}$$

$$= \frac{7 \times \cancel{8}^{2} \times 10^{\cancel{-4}} \times 1}{\frac{\cancel{22}}{11} \times 10^{\cancel{-3}} \times \cancel{40}} = \frac{7}{11}\ ms^{-1}$$

classmate
Date
Page

* Molecular force :- the force of attraction acts between the two molecule is know as the molecular force

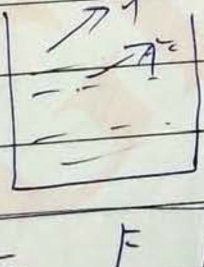
- There are two types of molecular force
i) ~~corent~~ cohesive force
ii) Adhesive force

i) cohesive force :- A molecular force acts between the ~~tight~~ like molecule is know as the cohesive force
eg => the force between the molecules of water

ii) Adhesive force => the force of attraction acts between the two different kinds of molecule is know as the adhesive force
eg -> The force of attraction between the water and finger

* Surface tension :=> The properties of a liquid at rest by virtue of wich the liquid surface have to acquire minimum surface area and behaves ~~life~~ like a strach membrane is know as the surface tension

- Surface tension is ~~numerically to the~~ equal to the force per unit length



$$\boxed{T = \frac{F}{l}}$$

S-I unit = N/m

Dimension formula = $\{ML^0T^{-2}\}$

- Some phenomenon observed due to the surface tension of flowing

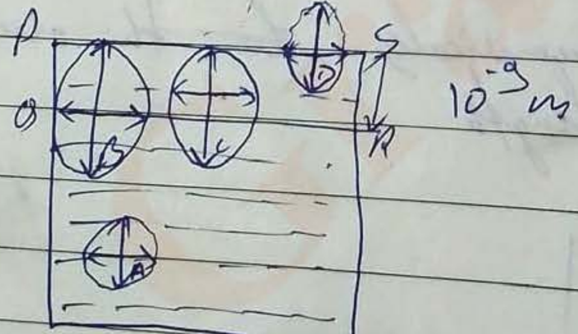
i) lide bulb are spherical in of shape
ii) Rain drops are ~~in~~ spherical in shape
iii) hair of shaving bru brues staraght in a water but as an ~~soon~~ as stricks together

* molecular Range → The maximum distance between the molecule force can be ~~expreccen~~ exprence is know as the molecular range

Molecular range is a oder of 10^{-9} m

* sphere of influence :→
A sphere whose radius is a molecular range and 1 molecule acts at a centre is know as the spher of influrence.

* Molecular theory of surface tension



Consider ~~rectangular~~

consider fill in a container having receht rectangular liquid field P, Q, R, and S

consider four liquid molecules A, B, C, D

molecule A inside the liquid on which molecular force of attraction acts from all direction and net resultant force is zero

- Same fenomene occurs in molecules B in a molecule C and D

~~sphere of fluence pa~~

parsel sphere of influence part lige in a air so nake resultant force is act in down ward direction and form a strach membrance in air liquid surface called <u>surface tension</u>

- Surface energy :→ The potential energy per unit of the surface area of a liquid is know as the surface energy

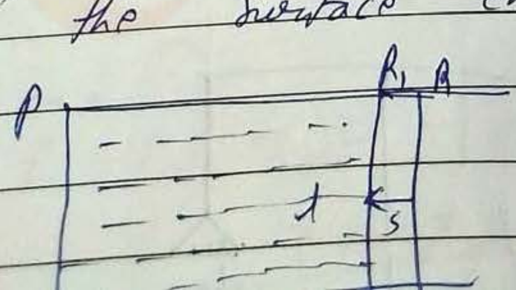
$$\text{Surface energy (s)} = \frac{\text{Potential energy}}{\text{Area}}$$

S.I unit $\quad Jm^{-2}$

Dimensional formul $= \frac{[ML^2T^{-2}]}{[L^2]}$

$$= [ML^0T^{-2}]$$

expression of the surface energy



Consider rectangular from P, Q, S, R in which RS is frassible it moves through distance acts due to surface tension 'T'

$$T = \frac{F}{l}$$

$$F = T2l \quad \text{—— (1)}$$

Work done by the surface tension

$$\omega = Fx$$

$$\omega = T \times 2lx$$

This work done is equal two P.E

$$U = T2lx \quad \text{—— (2)}$$

change in area $(A) = 2lx$

$$S = \frac{U}{A}$$

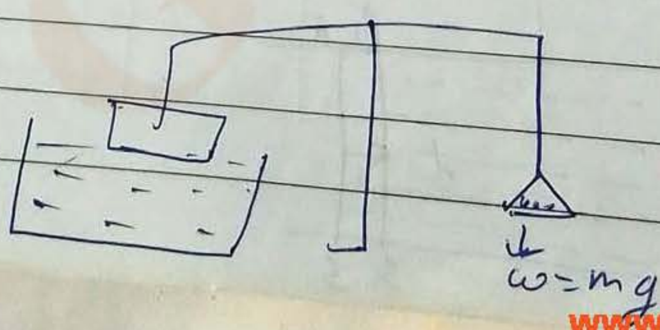
$$= \frac{}{2} 2lx$$

$$= \frac{T\, 2\cancel{lx}}{\cancel{2lx}}$$

$$= T$$

Surface energy = Surface tension

Measurement of surface tension



$$F = \omega = mg$$

$$\boxed{T = \frac{F}{2l}}$$

$$\boxed{T = \frac{mg}{2l}}$$

Date
Page

let a liquid field in a glass
take a physical blance through which a glass planch of length 'l' suspandend and 1 end another 2 end have the pen
liquid fiel glass place just below surface of the glass plate which attract glass plate down ward that force is blance by the putting the non weight of the pen and determin the surface tension by using flowing formula

$$\omega = mg$$

$$F = \omega = mg$$

$$\boxed{T = \frac{F}{2l}}$$

$$\boxed{T = \frac{mg}{2l}}$$

* excesses pressure inside the liquid bubble

let a liquid bubble of radius 'r' inside pressure 'P' and out side atmospheric pressure 'Pa' then pressure difference is given by

$$F = (P - P_a)$$

Force adjected on the surface of liquid bubble due to pressure difference is given by

$$P \cdot F = P - P_a \text{ ——— } (1)$$

If surface tension acts on the liquid bubble 'D t'

$$T = \frac{F}{2 \times 2\pi r}$$

$$F = T \times 4\pi r \text{ ——— } (2)$$

from eq^n (1) and (2)

$$(P - P_a)\pi r^2 = T \times 4\pi r$$

$$P - P_a = \frac{T \times 4\cancel{\pi}\cancel{r}}{\cancel{\pi} r^{\cancel{2}}}$$

$$\boxed{P - Pa = \frac{4T}{r}}$$

- Axies pressure inside the liquid forms

Let a liquid drop of spherical in shape having inside presser 'P' out side presser Pa (Pa grater than Pa) the pressure difference is given by P − Pa the force adjected due to pressure difference is given by

$$T = \frac{F}{2\pi r} \quad \text{—— (2)}$$

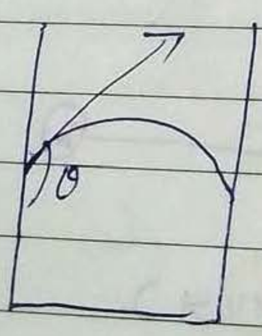
$$F = 2 \times L \pi r$$

$$(P - Pa)\,\pi r^2 = T \times 2\pi r$$

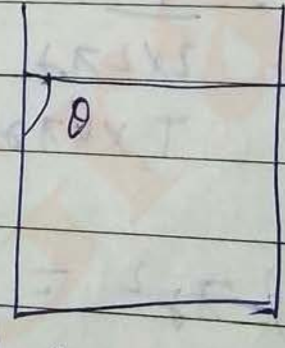
$$\therefore P - Pa = \frac{T \times 2 \cancel{\pi} \cancel{r}}{\cancel{\pi} r \cancel{r}}$$

$$\boxed{P - Pa = \frac{2T}{r}}$$

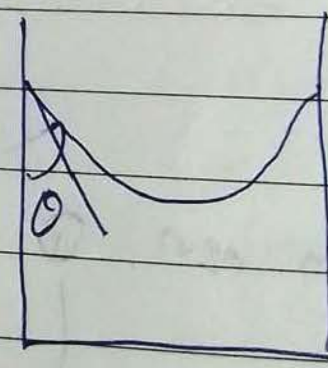
* Angle of contact
The angle between the tangent on the liquid surface at the point of contact and inear surface of the container in side the liquid is know as angle of contact



meniscus



Plane meniscus



concave menisu

1) convex meniscus => When angle of contact is obtuse than convex meniscus is form

convex surface is form because cosiceve force acts between the liquid is grater than the addisive force eg - meacury

2) Plane meniscus => When angle of contact is 90° then Plane meniscus is form

The cohessive force acts between the liquid molecules is equal to the addisive force
eg - cold water

3) Concave meniscus => when angle of contact is actue then concave meniscus is form

The addisive force is more than the cohessive force acts between the like molecule
eg - hote water

· In hote water and sope and detergent water addisive force incrases

* Kapelary => The fenomenan of rise and fale of a liquide in a kapalerie tube is called kapaleries

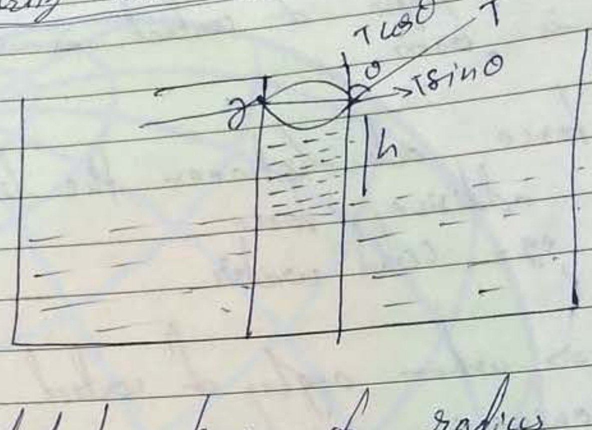
· kapelaries in tube - A fine board glass in which a liquid in rase of fale is know as the kapaleries tube

* Application of kapelarity
1) Water rast a cotten cloth, paper etc due of kabalearaj action

ii) Ink drops through the tea reaf due the kapaleary action

- Water transmeated all the leaves from the rood on a plant and tree by kapalarity

* Kapalarity rise or Ascent formula



$F = T\cos\theta \times 2\pi r$

Let a kapalarity tube of radius 'r' pararely emegous in a lequid which having density ρ due to the kaparaleary action liquid range height and form the concave viscures of the tube

- There are two components of the $T\cos\theta$ and $T\sin\theta$ in which $T\sin\theta$ components can and due to $T\cos\theta$ component lequid raired to the lequid in caballary tube $F = T\cos\theta \times 2\pi r$ then force due to the $T\cos\theta$ is given by volume of the raste lequidi in a capallary tube $V = \pi r^2 h + \left(\pi r^2 \cdot r - \frac{2}{3}\pi r^3\right)$

$$= \pi r^2 h + \frac{1}{3}\pi r^3$$

$$= \pi r^2\left(h + \frac{r}{3}\right)$$

mass $= V\rho$

Date
Page

$$= \pi r^2 \left(h + \frac{r}{3}\right)\rho$$

weight of raised liquid $= mg$

$$= \pi r^2 \left(h + \frac{r}{3}\right)\rho g \quad — ②$$

from eqn ① and ②

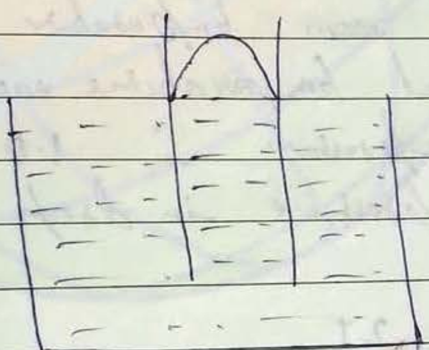
$$\cancel{\pi} r^{\cancel{2}} \left(h + \frac{r}{3}\right)\rho g = T \cos\theta \, 2\cancel{\pi} \cancel{r}$$

$$\boxed{h + \frac{r}{3} = \frac{2T\cos\theta}{r\rho g}}$$

$r \ll h$

$$\therefore \boxed{h = \frac{2T\cos\theta}{r\rho g}}$$

* decant formula



$$\boxed{h = \frac{2T}{r\rho g}}$$

Q The lower end of a cappilearly tube of dimeter 2mm is dept 8 cm below the surface of water in a bigger, what is the pressure required in the tube in order to below a hemisphe-rical bubble at ends in water the surface tension of water at temperature of the expriment is 7.3×10^{-2} N/m atmospherice pressure 1.01×10^5 Pasc density of water 1000 kg/m³ $g = 9.8 m/s^2$

also calculate the axis pressure

soln Pressure $= P_a + h\rho g \quad \frac{2T}{r}$

$= 1.03 \times 10^5 + 8 \times 10^{-2} \times 1000 \times 9.8 + \frac{2 \times 7.3 \times 10^{-2}}{1 \times 10^{-3}}$

$= \frac{2 \times 7.3 \times 10^{-2}}{1 \times 10^{-3}}$

Excess pressure $= \frac{2T}{r}$

$= \frac{2 \times 7.3 \times 10^{-2}}{1 \times 10^{-3}}$ Pascal

$= 14.6 \times 10^{-2}$

$7.3 \times 2 = 14.6$

Q 10.20

Q what is the pressure inside a drope of mercuary of radius 3 mm at room temperature surface tension of mearcuary at that temperature each 4.65×10^{-1} N/m that atmospheric pressure is 1.01×10^5 Pascal also give axis pressure in drop

sol-n radium = 3mm

Excess pressure $= \frac{2T}{r}$

$= \frac{2 \times 4.65 \times 10^{-1}}{300}$

$= \frac{4 \times 4.65 \times 10^{-1}}{300}$

$P - P_a = \frac{2T}{r}$

$= \frac{2 \times 4.65 \times 10^{-1}}{10 \times 10^{-3-2}}$

= 310 Pascal

Date
Page

$$P = P_a + 310$$
$$= 1.01 \times 10^5 \times 310$$
$$= 101000 + 310$$
$$= 101310 \text{ Pascal}$$

Q. What is the excess pressure inside the bubble of shope solution of radius 5mm given that the surface tension of shope solution at temperature 20°C each 2.5×10^{-2} N/m. If an air bubble of mass the same dimension where from a depth of 40 cm inside a container containing shope solution of relative velocity 1.2 what would be pressure inside the bubble ; atomsphoric pressure = 1.01×10^5 pascal

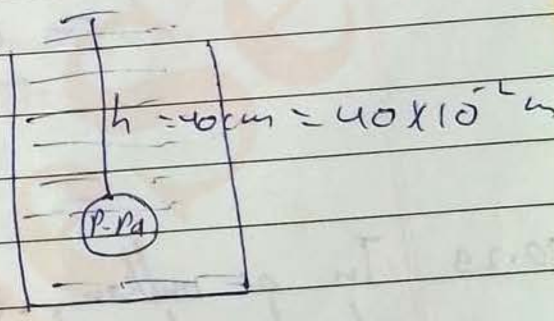
Ans. Radius = 5mm $= 5 \times 10^{-3}$ m

Excess pressure $= \dfrac{4T}{r}$

$$= \frac{4 \times 2.5 \times 10^{-2}}{5 \times 10^{-3}}$$

$$= \frac{20}{\cancel{08}} \text{ pascal}$$

$$= 2$$



$$P - P_a = \frac{2T}{r} + h\rho g$$

$$P = P_a + \frac{2T}{r} + h\rho g$$

$$= 1.01 \times 10^5 + \frac{2 \times 2.5 \times 10^{-2}}{5 \times 10^{-3}} + 40 \times 10^{-2} \times 1.2 \times 10^3 \times 9.8$$

$$= 1.06 \times 10^5 \text{ Pascal}$$

Q 10.30 ⇒ Mercury ~~as~~ has an angle of contact equal to 140 with soda lime glass a narrow tube of radius 1mm made ~~up~~ of this glass is dipped in a trough containing mercury by in the tube relative to the mercury surface out side - surface tension of mercury at the temperature of the experiment is 0.465 N/m density of mercury 13.6×10^3 kg/m³

$\boxed{(\cos 140) = -0.7660}$

soln $\theta = 140$

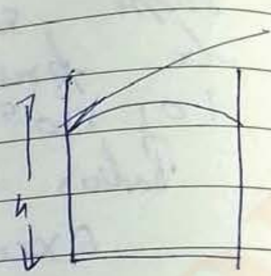
$T = 0.465$

$r = 1mm = 1 \times 10^{-3} m$

density of mercury $= 13.6 \times 10^3 \, kg/m^3$

$g = 9.8 \, m/s$

$h = ?$



$$h = \frac{2T\cos\theta}{r\rho g}$$

$$= \frac{2 \times 0.465 \times \cos 140}{10^{-3} \times 13.6 \times 10^3 \times 9.8}$$

$$= \frac{0.930 \times 0.766}{13.6 \times 9.8}$$

$$= -5.34$$

0930
0.766
5580
5580
6510
.712380

Q 10.29 In a millikan oil drop of experiment what is the terminal speed of a drope of radius 2×10^{-5} m and density $1.2 \times 10^3 kg/m^3$ take the viscuos city of air at the temperature of the expremment to be 1.8×10^{-5} Ns/m²

how much is the viscus force on drop at the ~~may~~ Neglect of the drope due to air

soln $R = 2 \times 10^{-5}$ m

$\rho = 1.2 \times 10^3 \, kg/m^3$

WWW.GRADESETTER.COM

$F_g = \sqrt{N^2 + F_f^2} = \sqrt{(196)^2 + (24.5)^2}$

$= \sqrt{34116} -$

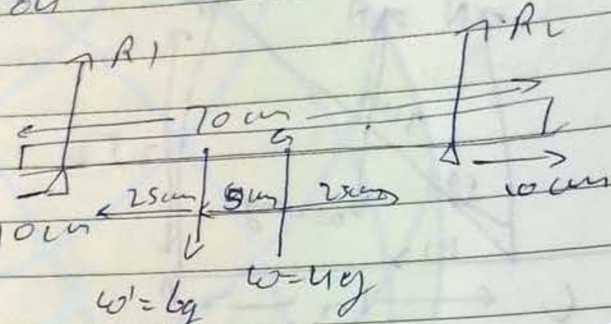
196
196

1176
1764
196 x

34116

Q A metal part 70 cm long and 4 kg in mass is supported on 2 wire age placed 10 cm from each end it, 6 kg weight is suspended at 30 kg cm from end, find the ~~weight is suspended at 200mm at the~~ reaction and the wire age a ~~200mm at the~~ cross-section of age assume the bar to be uniform cross-section of age assume the bar to be homogeneous

Sol



$R_1 + R_2 = 4g$ ——— ① $= R_1 + R_2 = 39.2$ ——— ①

A/c principle of moment

total moment at G

$= -R_1 \times 25 + w' \times 5 + w \times 0 + R_2 \times 25$

$= 0$

$= 25R_2 - 25R_1 = -w'5$

$= R_2 - R_1 = \dfrac{-6 \times 9.8 \times 5}{25}$

1.96 × 6 = 11.76

$R_2 - R_1 = -11.76$

$R_1 - R_2 = 11.76$ ——— ②

eq ① + eq ②

$R_1 + R_2 = 39.20$

$R_1 - R_2 = 11.76$

$2R$

WWW.GRADESETTER.COM

$$R_1 = \frac{50.96}{2}$$

$$= 25.48$$

$R_2 = $ ef. Puthin

ch-

Thermal Properties of the matter

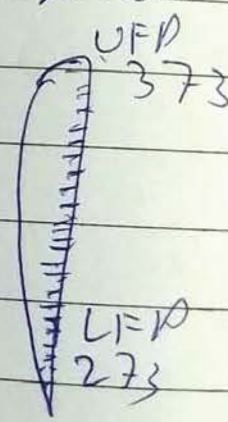
* heat - heat is a form of energy that gives a sensation of hoteness and coldness of a body
  Its S.I unit is Joule
  another unit calorie
  - 1 calorie = 4.186 J
    = 4.2 J
    1 k calorie = 10^3 cal
    KJ = 10^3 J
    Dimensional formula of heat = $[ML^2T^{-2}]$

* Temperature - the Measurment of degree hoteness and coldness of a body is know as the temperature

* Temperature Scale
  1) Upper fixed point (UFP) ⇒ boiling point of the water
  2) lower fixed point (LFP) → Melting point of Ice

1) Calvine ⇒ It. calvine is the S.I unit of temperature

UFP = 373 k
LFP = 273 k
Difference = (373 − 273) K
= 100 k



II) Degree Calcies
UFP = 100°C
LFP = 0°C
Difference = 100 − 0
= 100

* Degree in Farenhight

$UFP = 212^\circ F$

$LFP = 32^\circ F$

Difference $= 212 - 32$

$= 180$

* Reaumer Scale

$UFP = 80^\circ R$

$LFP = 0^\circ R$

Difference $= 80 - 0$

$= 80$

Relation between the Scale

$$\frac{^\circ C - LFP}{UFP - LFP} = \frac{K - LFP}{UFP - LFP} = \frac{^\circ F - LFP}{UFP - LFP} = \frac{^\circ R - LFP}{UFP - LFP}$$

$$\therefore \frac{^\circ C - 0}{100 - 0} = \frac{K - 273}{373 - 273} = \frac{^\circ F - 32}{212 - 32} = \frac{^\circ R - 0}{80 - 0}$$

$$\frac{^\circ C}{\cancel{100}\,5} = \frac{K - 273}{\cancel{100}\,5} = \frac{^\circ F - 32}{\cancel{180}} = \frac{^\circ R}{\cancel{80}\,4}$$

$$\boxed{\frac{^\circ C}{5} = \frac{K - 273}{5} = \frac{^\circ F - 32}{9} = \frac{^\circ R}{4}}$$

$$\frac{^\circ C}{\cancel{5}} = \frac{K - 273}{\cancel{5}}$$

$$\boxed{^\circ C = K - 273}$$

$$\boxed{K = {}^\circ C + 273}$$

Q At ~~∞~~ 1 temperature degree are equal

$$\frac{°C}{5} = \frac{°F-32}{9}$$

$$\frac{x}{5} = \frac{x-32}{9}$$

$$9x = 5x - \cancel{32}\,160$$

$$9x - \cancel{4}5x = -160$$

$$\cancel{5}4x = -160$$

$$x = \frac{-160}{\cancel{4}} \; 40$$

$$\boxed{x = \cancel{20}-40}$$

Putting $-40°C$

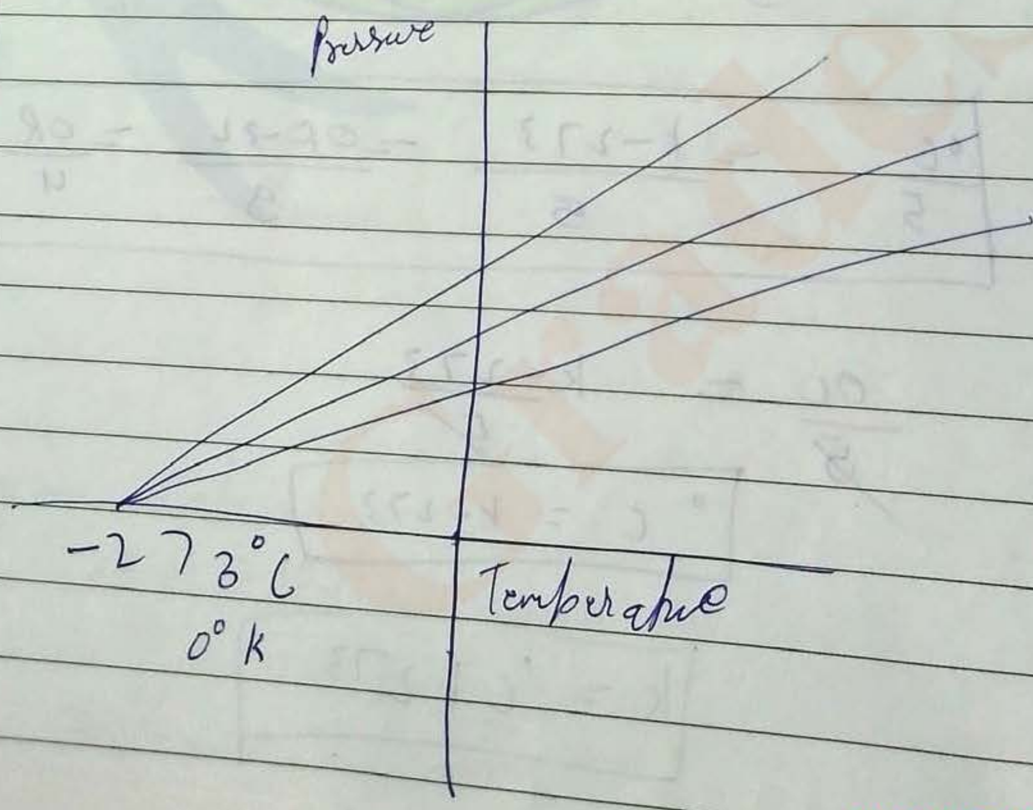
Faranhite degree salicus are equal

Ideal gas equation and absolute temperature

$$PV = nRT$$

$$P = \left(\frac{nR}{V}\right)$$

$$P \propto T$$



classmate
Date
Page

- absolute temper ⟹ the temperature at which pressure of the all ideal gas as 0 then temperature is know as absolute temperature

- Triple point ⟹ the temperature at which all the three state of substance are exist is know as the triple point

- triple point of water is 273.16k

Note ⟹ triple point of the substance cannot be change by ~~all~~ adding impurities that way triple point of water is use for the calibration of to fixed the upper and lower fixed point

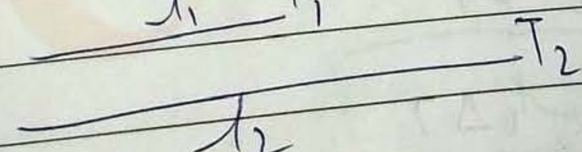
- Thermal Expansion - when a temperature of substance increases then ~~a~~ calfusation of substance also increases is know as the thermal expension

- There are three types of the expension
  - i) linear expention
  - ii) Area expention or Superficial expension
  - iii) ~~Cubical~~ expension
  - (iii) Cubical expresion

i) linear expention ⟹ thermal expension in which length of the substance ~~it~~ increases is know as the linear expention

- expression of the linear expention

Let



$(T_2 > T_1)$

let length of a substance be l_1 at temperature t_1 and l_2 at temp t_2 $(t_2 > t_1)$

change in length $= l_2 - l_1$

change in temperature $= t_2 - t_1 = \Delta T$

- change in length is
  i) directly proportional to the origanal length — (1)
  $$(l_2 - l_1) \propto l_1$$
  ii) directly proportional to the change in temperature — (2)
  $$(l_2 - l_1) \propto \Delta T$$

combining eqn (1) and (2)

$$l_2 - l_1 \propto l_1 \Delta T$$

$$l_2 - l_1 = \alpha l_1 \Delta T \quad \text{— (3)}$$

where α is constant the proportionality called temperature cofficient of linear expension

$$l_2 = l_1 + \alpha l_1 \Delta T$$

$$\boxed{l_2 = l_1 (1 + \alpha \Delta T)}$$

from eqn (3)

$$l_2 - l_1 = \alpha l_1 \Delta T$$

$$\alpha = \frac{l_2 - l_1}{l_1 \Delta T}$$

$$\alpha = \frac{\text{change in length}}{\text{original length} \times \text{change in temperature}}$$

change in length per unit original length and per unit change in temperature is know as the temperature coefficient of linear expension

S.I unit of $\alpha = \frac{m}{m\,K} = K^{-1}$ or $°C^{-1}$

Area of superfesical expension
In expension in which area of the body increase on is know as the superfesical expension or area expension

expression of the superfesical expansion
let Area A_1 and A_2 at temperature T_1 and T_2 respectively $(T_2 > T_1)$

change in area $= A_2 - A_1$

change " temperature $= T_2 - T_1 = \Delta T$

change in area
i) Directly proportional to the original area A_1

$$(A_2 - A_1) \propto A_1 \text{ ——— (1)}$$

ii) change in Area is directly proportional to the change in temperature

$$A_2 - A_1 \propto \Delta T \text{ ——— (2)}$$

combining eqn ① and ②

$$A_2 - A_1 \propto A_1 \Delta T \quad \text{——} \ ③$$

$$A_2 - A_1 = \beta A_1 \Delta T$$

Where β is constant to proportionality called cofficient of thermal the superfisical thermal expention or area expenssion

$$A_2 = A_1 + \beta A_1 \Delta T$$

$$\boxed{A_2 = A_1 (1 + \beta \Delta T)}$$

* temperature cofficient of superfesical expenssion or Area expenssion

from eqn ③

$$A_2 - A_1 = \beta A_1 \Delta T$$

$$\beta = \frac{A_2 - A_1}{A_1 \Delta T}$$

$$\beta = \frac{\text{change in area}}{\text{original area} \times \text{change in temperature}}$$

change in Area per unit original area and per unit change in temperature is ~~then~~ temperature cofficient of superfisical expenssion know as

S.I unit = $\frac{\cancel{m^2}}{\cancel{m^2} \times K} = K^{-1}$ or $°C^{-1}$

Dimension of formula = $\frac{\langle L^2 \rangle}{[L^2][K]}$ = K^{-1}

Volume extenssion or cubical extenssion

an expenssion in which volume of a body increases on heating is know as the volum or cubical expansion

expression of cubical expension

let volume of a body V_1 and V_2 at temperature T_1 and T_2 $(T_2 > T_1)$

change in volume = $V_2 - V_1$

change in temperature = $T_2 - T_1 = \Delta T$

change in volume $V_2 - V_1$ is

i) directly proportional to original volume

$$(V_2 - V_1) \propto V_1$$

ii) directly proportional to change in temperature

$$V_2 - V_1 \propto \Delta T$$

Combining above eqn ——— (1)

$$V_2 - V_1 \propto V_1 \Delta T$$

$$V_2 - V_1 = \gamma V_1 \Delta T$$

where γ is temperature cofficient of cubical expenssion

$$\boxed{V_2 = V_1 + \gamma V_1 \Delta T}$$

temperature cofficient of cubical expension

from eqn (1)

$$V_2 - V_1 = \gamma V_1 \Delta T$$

$$\gamma = \frac{V_2 - V_1}{V_1 \Delta T}$$

γ = change in volume

* $\gamma \rightarrow$ change in volume per unit ... unit change in temperature is ... coefficient of cubical expansion

S.I unit of $\gamma = \frac{m^3}{m^3 k} = k^{-1}$

Dimensional formula $= \theta k^{-1}$

* expression of change in dencity in a thermal expansion

from the cubical expansion

$V_2 = V_1 (1 + \gamma \Delta T)$ ——— ①

$\rho = \frac{M}{V}$

let mass of the substance be 'm' and dencity ρ_1 and ρ_2 at temperature T_1 and T_2

$$V_1 = \frac{M}{\rho_1}$$

$$V_2 = \frac{M}{\rho_2}$$

Putting this value in eqn ①

$$\frac{M}{\rho_2} = \frac{M}{\rho_1}(1 + \gamma \Delta T)$$

$$\frac{1}{\rho_2} = \frac{1}{\rho_1}(1 + \gamma \Delta T)$$

classmate Date Page

$$\rho_2 = \frac{\rho_1}{(1+\gamma\Delta T)}$$

$$\rho_2 = \rho_1 (1+\gamma\Delta T)^{-1}$$

By binomial exbension

$$(1+x)^n = 1+nx$$

$$(1+x)^n = 1+nx$$

when $x << 1$

$$\rho_2 = \rho_1 (1-\gamma\Delta T)$$

~~Anmo~~balaus exbension of water

On increasing temperature from $0°c$ to $4°c$ it contract contract this anamolies of water

~~Thus~~ thats soil ice surface of the water

Q. How equatic ~~molecule~~ animal survice in a winter areas

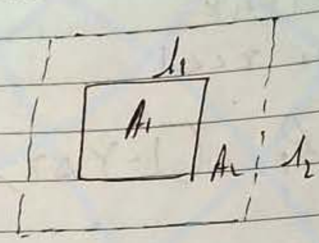
Ans Only the top layer of the lake or river freeze Under beneath the frozen upper layer, the water remain in its liquid form and does not freeze

Also, oxygen is trapped beneath the layer of ice as a result fish and other aquatic animals find it possible to ~~the~~ live comfortably in the winter Areas

Ans → The Icy waters of the water / Areas Ocean Support of great amount of / maine / life for millions of year has remained Unchanged only the top layer of the lake / or river freeze under breath the frozen

\# Relation between α, β and γ

case I Relation between α and β



consider a Square of length l_1 Area A_1 at temperature T_1 on increasing at temperature T_2 its length become l_2 Area A_2

$$A_1 = l_1^2 \quad \text{———} \quad (1)$$
$$A_2 = l_2^2 \quad \text{———} \quad (2)$$

from linear ~~ex~~ thermal

$$l_2 = l_1 (1 + \alpha \Delta T)$$

Putting value of l_2 in eq^n (2).

$$A_2 = [l_1 (1+\alpha\Delta T)^2]$$

$$A_2 = l_1^2 \ (1+\alpha\Delta T)^2$$

$$A_2 = A_1 \ (1+\alpha^2\Delta T^2 + 2\alpha\Delta T) \quad (\text{from eq}^n\ (1))$$

classmate
Date
Page

where $\alpha^2 \Delta T^2$ is very-very small so this term can be neglected

$$A_2 = A_1 (1 + 2\alpha \Delta T) \text{ --- } (3)$$

from superficial expansion

$$A_2 = A_1 (1 + \beta \Delta T) \text{ --- } (4)$$

from eqn (3) and (4)

$$\cancel{A_1} (1 + 2\alpha \Delta T) = \cancel{A_1} (1 + \beta \Delta T)$$

$$\cancel{1} + 2\alpha \Delta T = \cancel{1} + \beta \Delta T$$

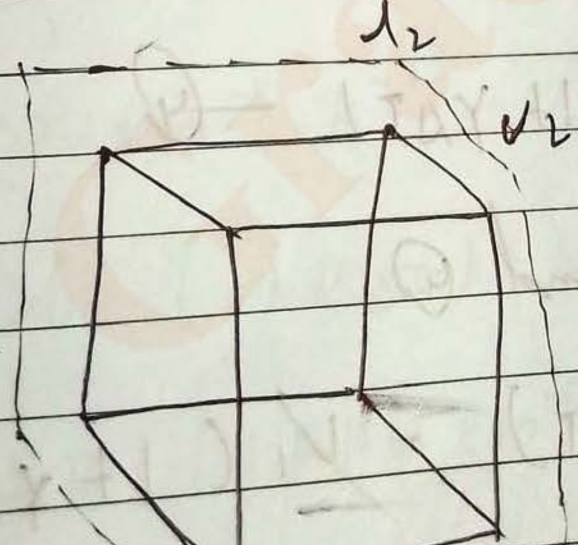
$$2\alpha \Delta \cancel{T} = \beta \Delta \cancel{T}$$

$$2\alpha = \beta$$

$$\frac{\alpha}{\beta} = \frac{1}{2}$$

$$\boxed{\alpha : \beta = 1 : 2}$$

Relation between the α and γ



$(T_2 > T_1)$

Let, side and volume of cube at temperature T_1 be l_1 and V_1 and at temperature T_2 $(T_2 > T_1)$ be l_2 and V_2 respectively

$$V_1 = l_1^3 \text{ --- } (1)$$

$$V_2 = l_2^3 \text{ --- } (2)$$

Again from linear thermal expansion

$$l_2 = l_1 (1 + \alpha \Delta T)$$

Putting value of l_2 in eqn (2)

$$V_2 = [l_1 (1 + \alpha \Delta T)]^3$$

$$V_2 = l_1^3 (1 + \alpha \Delta T)^3$$

$$V_2 = l_1^3 [1 + 3\alpha \Delta T + 3(\alpha \Delta T)^2 + (\alpha \Delta T)^3]$$

where $3\alpha^2 \Delta T^2$ and $\alpha^3 \Delta T^3$ are very - very small so these term can be neglected

$$V_2 = V_1 (1 + 3\alpha \Delta T) \text{ --- } (3) \quad (\text{from eqn } (1))$$

from cubical thermal expansion

$$V_2 = V_1 (1 + \gamma \Delta T) \text{ --- } (4)$$

from eqn (3) and (4)

$$\cancel{V_1} (1 + 3\alpha \Delta T) = \cancel{V_1} (1 + \gamma \Delta T)$$

$$\cancel{1} + 3\alpha \Delta T = \cancel{1} + \gamma \Delta T$$

Date
Page

$3\cdot\alpha\Delta T = \gamma\Delta T$

$3\alpha = \gamma$

$\frac{\alpha}{\gamma} = \frac{1}{3}$

$\alpha : \gamma = 1 : 3$

Now

$\alpha : \beta = 1 : 2$

$\alpha : \gamma = 1 : 3$

$$\boxed{\alpha : \beta : \gamma = 1 : 2 : 3}$$

Q A black smith fixes iron drim ring on the ~~ring~~ rime of the woden wind or block chard the diameter of the ~~ring on~~ rime and the ring are 5.243 m and 5.231 m respectively at 27°C to what temp. should the ring, ~~as to~~ be heated so as to feath the rime of the well cofficient of linear expension of ~~a~~ iron is $1.2 \times 10^{-5} K^{-1}$

Sol $l_1 = 5.243$ m

$l_2 = 5.231$ m

$T_1 = 27°C$

$T_2 = ?$

$\alpha = 1.2 \times 10^{-5} k^{-1}$

$l_2 = l_1(1+\alpha\Delta T)$

$5.243 = 5.231(1+1.2\times10^{-5}\Delta T)$

$\frac{5.243}{5.231} = 1 + 1.2\times10^{-5}\Delta T$

~~1.002 = 1+1.25 x~~

$1.002 = 1 + 1.2 \times 10^{-5} \Delta T$

$0.002 = 1.2 \times 10^{-5} \Delta T$

$\Delta T = \frac{0.002}{1.2 \times 10^{-5}} \times 10^{3}$

$= \frac{200}{1.2}$

$T_2 - T_1 = 166.67$

$T_2 = 166.67 + 27$

$T_2 = 193.67^\circ C$

effect of temperature on the resistance on heating resistance of the conductor is increases

$$\boxed{R_2 = R_1 (1 + \alpha \Delta T)}$$

$\alpha \Rightarrow$ temperature coefficient of resistance

effect of temperature on the resistivity

similarly

$$\boxed{\rho_2 = \rho_1 (1 + \alpha \Delta T)}$$

thermal ~~states~~ stresses

Thermal ~~strime~~ strain

$l_2 = l_1 (1 + \alpha \Delta T)$

$l_2 = l_1 + l_1 \alpha \Delta T$

$l_2 - l_1 = l_1 \alpha \Delta T$

$\Delta l = l_1 \alpha \Delta T$

$\boxed{\frac{\Delta l}{l_1} = \alpha \Delta T}$ —— (1)

called thermal strain

* youngs models of elasticity is given by

$y = \frac{\text{Thermal stress}}{\text{thermal strain}}$

Thermal stress $= y \times$ Thermal strain

thermal stress $= y \alpha \Delta T$

$\frac{F}{A} = y \alpha \Delta T$

$\boxed{F = y A \alpha \Delta T}$

$w = F \Delta l$

$\boxed{w = y A \alpha \Delta T \Delta T}$

11.9 A brash wire 1.8 m long at 27°c is health ~~tote~~ taut with tension between 2 rigid support ~~el~~ in the wire is could to a temperatures ~~of~~ -39°c what is the tension developed in wire it dim. is 2mm coefficient of linear expansion of brass $\alpha = 2 \times 10^{-5}\ °c^{-1}$

and younges models of brass 0.91×10^{11} Nm^{-2}

Sol:- $l_1 = 1.8m$

$T_1 = 27°c$

$T_2 = -39°c$

$\alpha = 2 \times 10^{-5} °c^{-1}$

$Y = 0.9 \times 10^{11} Nm^{-2}$

$r = 1mm$

$= 10^{-3} m$

$A = \pi r^2 = 3.14 \times 10^{-6}$

27
39
76

$F = YA\alpha\Delta T$

$= 0.9 \times 10^{11} \times 3.14 \times 10^{-6} \times 2 \times 10^{-5} \times (27+39)$

$= 0.9 \times 10^{\cancel{11}} \times 3.14 \times 10^{-6} \times 2 \times 10^{-5} \times 76$

0.9
3.14

=

3.14
0.9

$= 3.77 \times 10^{2} N$

Q 11.8 A hole is drile in a copper seath the diameter of the hole is 4.24 cm at 27°c what is the change in diameter of the hole when the seat is heated 227°c cofficient of linear exbention of copper is $1.7 \times 10^{-5} °c^{-1}$

Sol:- $l_1 = 4.24$

$T_1 = 27°c$

$T_2 = 227°c$

$\frac{\alpha}{\beta} = \frac{1}{2}$

$\beta = 2\alpha$

$= 2 \times 1.7 \times 10^{-5}$

$= 3.4 \times 10^{5}\ °C^{-1}$

$r_1 = 2.12\ cm$

$= 2.12 \times 10^{-2}\ m$

$r_2 = ?$

$A_2 = A_1 (1 + \beta \Delta T)$

$\frac{227}{27}{200}$

$\cancel{\pi} r_2^2 = \cancel{\pi} r_1^2 (1 + \beta \Delta T)$

$r_2^2 = (2.12 \times 10^{-2}) [1 + 3.4 \times 10^{5} \times (227 - 27)]$

$r_2^2 = (2.12 \times 10^{-2}) [1 + 3.4 \times 10^{-5} \times 200]$

$r_2^2 = 2.12 \times 10^{-7}$

$=$

Q 11.11 The cofficient of volume expension of ~~glas~~ glasies $49 \times 10^{-5}\ °C^{-1}$ what is the fraction change in density for a 30°C ~~range~~ rise in temperature

Sol-4 $\alpha = 49 \times 10^{-5}\ °C^{-1}$

$T_1 = 30°C$

$V_2 = V_1 (1 + \gamma \Delta T)$

$V_2 = V_1 + V_1 \gamma \Delta T$

$V_2 - V_1 = V_1 \gamma \Delta T$

$\frac{\Delta V}{V_1} = \gamma \Delta T$

$\rho = 49 \times 10^{-5} (30 -)$

$= 49 \times 10^{-5} \times 30)$

$= 49 \times 30 \times 10^{-5}$

$\frac{}{}(\Delta \rho) = 1470 \times 10^{5}$

$\frac{\Delta P}{P_1} = 1470 \times 10^5$

* Heat Capacity ⇒ Amount of heat energy required to rast the temperature of a given mass through 1°c, is know as the Heat capacity or thermal capacity

* Specific Heat capacity ⇒ The amount of heat energy required to rased the temp. of 1g of substance through 1°c is know as the specific heat capacity

It is denoted by (S) or (C)

- Expression of the specific heat capacity

Amount of heat energy ~~required~~ is

(i) directly proportional to the amount of substance

$Q \propto m$

(ii) directly proportional to the change in temperat

$Q \propto m$

$Q \propto \Delta T$

combining above eqn

$Q \propto m\Delta T$

$Q = Cm\Delta T$

where C is constant of proportionality called specific heat capacity

$$C = \frac{Q}{m\Delta T}$$

when $m = 1$

$\Delta T = 1$

$$C = \frac{Q}{1 \times 1}$$

$$\boxed{C = Q}$$

The amount of heat energy reqired to rised the temprature through unit °c of unit mass

$$S.I \text{ unit of } C = \frac{Q}{m\Delta T}$$

$$= \frac{J}{kg\,°C}$$

$$= J\,kg^{-1}\,°C^{-1}$$

$$\text{or } J\,kg^{-1}\,K^{-1}$$

$$\text{dimensional formula of } (C) = \frac{[ML^2T^{-2}]}{[M]\,[K]}$$

$$[C] = [M^0 L^2 T^{-2} K^{-1}]$$

C.G.S unit of specific heat capacity

$$= \text{Calori}/kg/°C$$

$$C\,kg^{-1}\,°C^{-1}$$

- Specific heat capacity of a give a substance is a fixed value

Molar specific heat capacity =>

Molar specific the amount of heat energy required to ra[ise] a temp. of 1 moles of a given substan[ce] through 1°C is know as the Molar specific [heat] calori

$$~~Q = nC\Delta T~~$$

$$Q = nC\Delta T$$

$$n = \frac{\text{given mass}}{\text{molar mass}}$$

$$n = \frac{m}{M} \quad \text{—— (1)}$$

$$Q = \frac{mC\Delta T}{M}$$

$$Q = mc\Delta T$$

$$m\Delta T = \frac{Q}{c}$$

Putting this value in eq^n (1)

$$\cancel{Q} = \frac{C\cancel{Q}}{Mc}$$

$$\boxed{C = Mc}$$

S.I unit of molar ~~heat~~ specific heat capacity

$$Q = nC\Delta T$$

$$C = \frac{Q}{n\Delta T}$$

$$= J\,mol^{-1}\,°C^{-1}$$

* There are two types of the molar specific heat capacity

(1) Molar specific heat capacity at constant pressure (CP) ⇒ the amount of heat energy required to raised the tempe of 1 mole of substance through 1°C at a constant pressure is know as the molar spe

classmate Date Page

(iii) Molar specific heat capacity at constant volume ⇒ The amount of heat energy required to rased the temperature of 1 mole of substance through 1°c is kno at constant volume is know as the specific heat capacity at constant volume

CP is gratethan CV or CP > CV

Note ⇒ When a gas is heated at constant volume no heat is ~~axbe~~ expend in the expansion of gas hole, ~~heat~~ amount of heat is used to rest the tem. of the gas but incase of the constant pressure heat energy expend in two ways To rest the temp. and Work done to expen the gas that show as CP > CV

~~Calorie meter ⇒~~

Specific heat capacity of water 4200 J/kg/mole
4.2 kg/ ~~kg~~/k
4.2 kg kJ^{-1} °C^{-1}

C.G.S = 1 cal g^{-1} °c^{-1}

water euvalent ⇒ the mass of water which woud absorbe or evolve the same amount of heat as is done by the body in rising or folowing through the same range of tempetature

It is numericaly equal to product of specific heat capacity ~~of mass~~ and mass of the body

It is denoted by the (W)

J kg^{-1} °c^{-1} kg

CM

$= J\,°C^{-1}$

* Relegation :- When a matelick wire ~~sp~~ suspended to the ice labo where one is in havy weight done to increasing the pressure melting point decreases ~~at~~ as a result wire passes through the Ice slabe be weighed ~~co~~ looking the this phenoment of refrezing is know as Relegation

* laten heat ⇒ the amount of heat energy required to ~~Φ~~ change the state of the substance from one state to another state weighout changing is temp. is know as laten heat

$$Q \propto m$$

$$Q = Lm$$

where L is laten heat

$$\boxed{L = \frac{Q}{m}}$$

S.I unit of $L = J\,kg^{-1}$

Dimensional formula of $L = \frac{[ML^2T^{-2}]}{[M]}$

$$= [M^0L^2T^{-2}]$$

* i) latent heat of fusion - The heat energy required to convert the solid state into liquid state by ~~boghout~~ without is riting it temp. it is know as latent heat of fusion

$$\boxed{Q = L_f\,m}$$

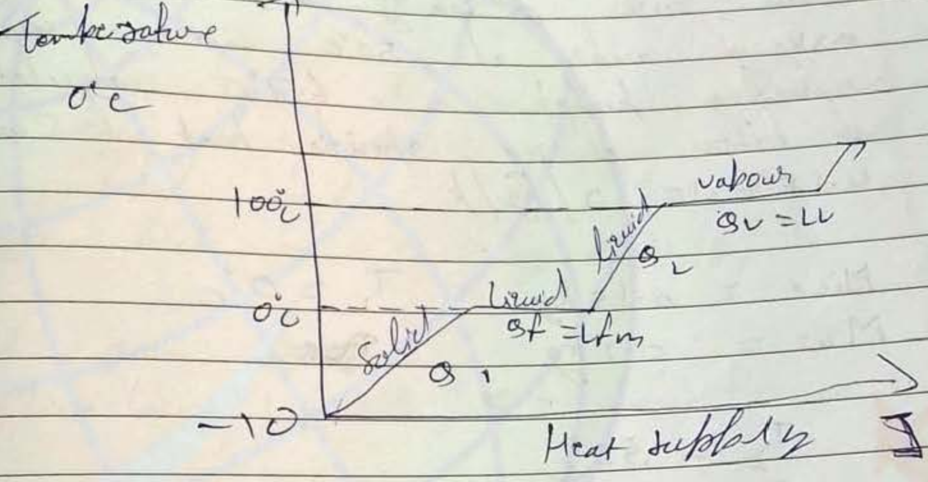
ii) Latent heat of vaporation ⇒ The amount of heat

classmate
Date
Page

energy required convert the solid state of the substance into gases state without rasinin in temp. this known as the latent heat of vaporation

$$\boxed{QV = Lvm}$$

Q Graphical relation between the temp. and heat supplied



- Vapour cautes more sivear boom then boling water at 100°c boil

- Vapour or stime poses more energy in form of lantent heat compare then the boling water at 100°c is thas boil stem co caule siniear boom than boling water

Q What is meaning of the latent heat of water 2.262×10^5 J/kg

latent heat of fusion of water 2.262×10^5 J/kg per means water poses the 2.262×10^5 J energ to convert into liquid state to gases state without rasing it temperature

* Principle of calorimeatry

According to principle of calorimetry loss of the heat energy by the substance must be equal to the heat energy gain by the substance

$\boxed{\text{heat lost} = \text{heat gain}}$

Q When 0.15 ice kg of ice 0°c is mixed with 0.3kg of water at 50°c in a containear the resulting temperature is 6.7°c calculate the heat of fusion of ice, specific heat of water is 4.186 x10³ J/kg/k

$M_{ice} = 0.15 kg$ $T_1 = 0°c$
$M_w = 0.3 kg$

$T_2 = 50°c$
$T = 6.7°c$

Heat lose by water

$= m_w C_w \Delta T$

$= \frac{0.3}{10} \times 4.186 \times 10^{\cancel{3}\,2} \times (50-6.7)$

$Q_2 = 3 \times 4.186 \times 10^2 \times 43.3$

Heat gain by ice

$= Qf + Q$

$= Lfm + mc\Delta T$

$= Lf \times 0.15 + 0.15 \times 4.186 \times 10^3 \; (6.7-0)$

$= Lf \times 0.15 + 0.15 \times 4.186 \times 10^3 \times 6.7$

A/c Principle of calorimeter

Heat lost = Heat gain

$L_f \times 0.15 + 0.15 \times 4.180 \times 10^3 \times 6.7$

$= 3 \times 4.186 \times 10^2 \times 43.3$

$0.15 L_f = 3 \times 4.186 \times 10^3 \times 4.33 - 0.15 \times 4.186 \times 10^3 \times 6.7$

$0.15 L_f = 0.15 \times 4.186 \times 10^3 (2 \times 4.33 - 6.7)$

$= 4.180 \times 10^3 \times 1.96$

$= 3.34 \times 10^5 \; J\,kg^{-1}$

Q. The water of mass 75g at 100°c is added to ice of mass 20g at ice −15°c what is the resulting temperature, latent heat of ice 80 calorie/g and specific heat of ice 0.5 calorie/g/°c

Sol^n Heat gain by ice

$m_{ice} c_{ice} (0° + 15) + L_f m + m_{ice} c_w (T - 0°)$

$= 20 \times 0.5 \times 15 + 80 \times 20 + 20 \times 1T$

$= 150 + 1600 + 20T$

~~Heat~~ $= 1750 + 20T$

~~Heat lost at~~

Heat lost by water

$m_w c_w (100 - T)$

$= 75 \times 1 (100 - T)$

A/c Principle of calorimeter

Heat lost = heat gain

$1750 + 20T = 7500 - 75T$

$95T = 7500 - 1750$

$T = \left(\frac{5700}{95}\right)$

$= 60.5°C$