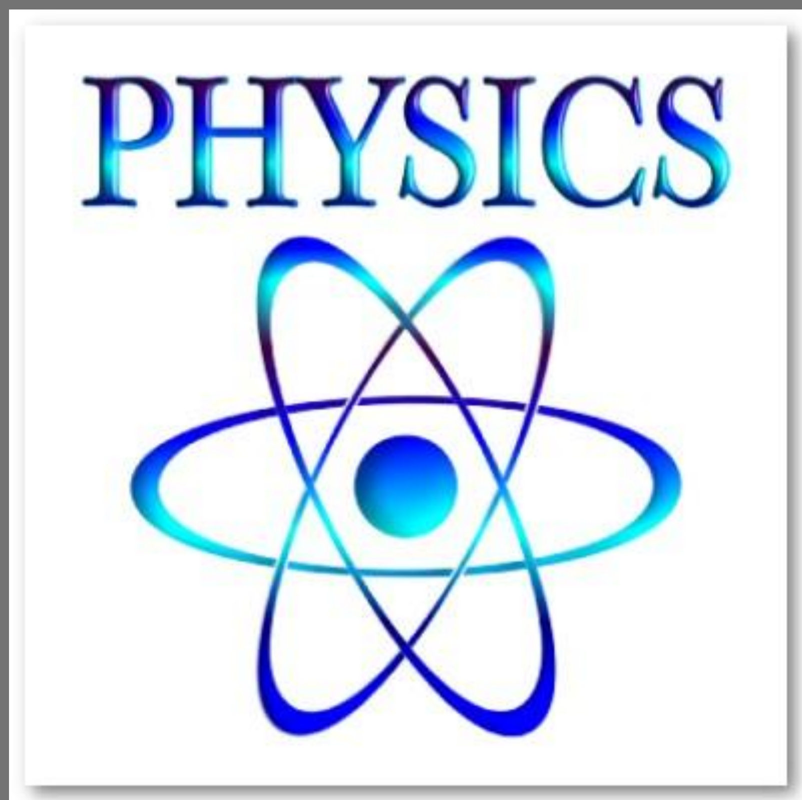
1st Edition

PHYSICS - I



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INTRODUCTION TO THIS DOCUMENT

Assalam U Alaikum..!

Entry tests are very important for the admission in Engineering University. Almost every good and well known university like UET, NUST, PIEAS, GIKI etc. conduct entry tests. So you should have the quality which differs between you and rest of the candidates. You should be hard working and your self confidence should be very high and you should have a firm faith on ALLAH. Many students think that getting admission in UET is first and last thing. No doubt, UET has a name in engineering but there are many other options for you. Apply in every university, appear in all the entry tests, keep your hard work continue and In sha ALLAH you will get what you deserved.

This document contains important points for Physics. In Entry test, you don't have to solve the question and show the solution as in board exams. Entry test is different. You have to guess the right option and you will get full marks. If you have good concepts then there will be no difficulties for you.

Before reading, we will suggest you to first study the text book very carefully. Take a highlighter and study the theory of the chapter. Highlight important points and If you have any confusion then make it clear. This document will only help you if you have studied the text book very carefully.

Always remember "PRACTICE MAKES A MAN PERFECT". So, do maximum practice of mcq's. There are lot of mcq books available in the market. ILMI is very good and there are many others also. Buy the one you like.

If you find any error in this document or if you know any trick then send us . We will update this document and add your tricks. Have a good time and many best wishes. Thank You

Regards,

Talha Syed Naqvi

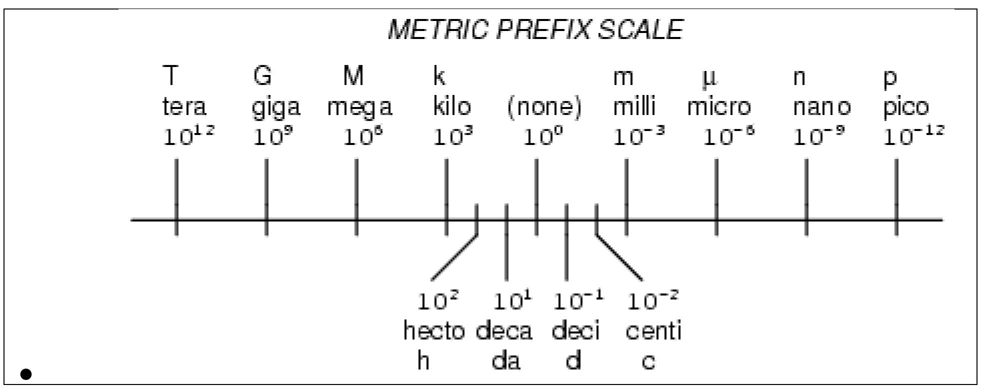
Attiqa Nasir

Muhammad Talha

Chapter 1:

Important key point to remember

- Physics deal with the study of matter and energy and relationship between them.
- There are seven base unit
  Meter(m), mass(kg), second(s) ,ampere(A),Kelvin(K),candela(cd),mole(mol)
- Only thermodynamic temperature is base unit. Temperature in Celsius or Farenhieght is not base units.
- Two Supplementary unit 1)Radian 2)Steradian
  Radian is plane angle having unit rad
  Steradian is solid angle having unit r^2
- Unit of Light intensity is Candela.
- Derived units are derived from the base and supplementary units.
- Number expressed in ten raise to power are in standard form known as Scientific Notations. There should be only one digit left to the decimal



- Uncertainty
  For addition and subtraction absolute uncertainties added
  for example x1=13.4±0.1 cm and x2=15.6±0.2 where 0.1 and 0.2 are uncertainties then there difference is x2-x1=2.2±0.3
  >>For Multiplication and division percentage uncertainties are added .
- All formula which we are using are dimensionally correct
  >>All formula which have same dimension may have different SI unit For example Torque and work
  >> Torque, work, energy have same dimension

>>Force and impulse per unit time have same dimension

>>Angular Momentum and Planks Constant have same dimension

- Memorize the dimension of force
  F=[MLT^{-2}] then you will easily find the dimension of different formula (work, power, momentum, torque, pressure)
- Quantities with different dimension can't be added or subtract they can be multiply or divide
  for example 3kg-2N $\Longrightarrow$ Not possible 3kg/2N=1.5(sec^2/m) >>>unit change

Example of some Dimension of physical Quantities

S. No.	Physical quantity	Dimensional formula	M.K.S. units
1.	Area	$[M^0L^2T^0]$	m^2
2.	Volume	$[M^0L^3T^0]$	m^3
3.	Density=mass/volume	$[ML^{-3}T^0]$	$kg\ m^{-3}$
4.	Speed or velocity $= \frac{dx}{dt}$	$[M^0LT^{-1}]$	$m\ s^{-1}$
5.	Acceleration $= \frac{dv}{dt}$	$[M^0LT^{-2}]$	$m\ s^{-2}$
6.	Force=mdv/dt=ma	$[MLT^{-2}]$	$kg\ m\ s^{-2}$ or N
7.	Linear Momentum (p=mv)	$[MLT^{-1}]$	$kg\ m\ s^{-1}$ or Ns
8.	Impulse $= F.\Delta t$	$[MLT^{-1}]$	$kg\ m\ s^{-1}$ or $N\ s$
9.	Power=work/time	$[ML^2T^{-3}]$	$J\ sec^{-1}$ or watt or kg
10.	Work or Energy =force× displacement	$[ML^2T^{-2}]$	$N\ m$ or J or $kg\ m^2\ s^{-2}$
11.	Pressure or Stress =force/area	$[ML^{-1}T^{-2}]$	$N\ m^{-2}$ or $kg\ m^{-1}\ s^{-2}$

Significant Number

1. All non zero numbers are significant.
   Example: 4.543 ( )

2. Zeros between significant nonzero digits are significant.
   Examples: 50006 ( ) 5.0006 ( )

3. Zeros to the right of a decimal point but to the left of all non zero digits are not significant.
   Example: .0077 ( )

These zeros are not significant because they just mark the decimal point. The number can be written as 7.7×10^{-3}.

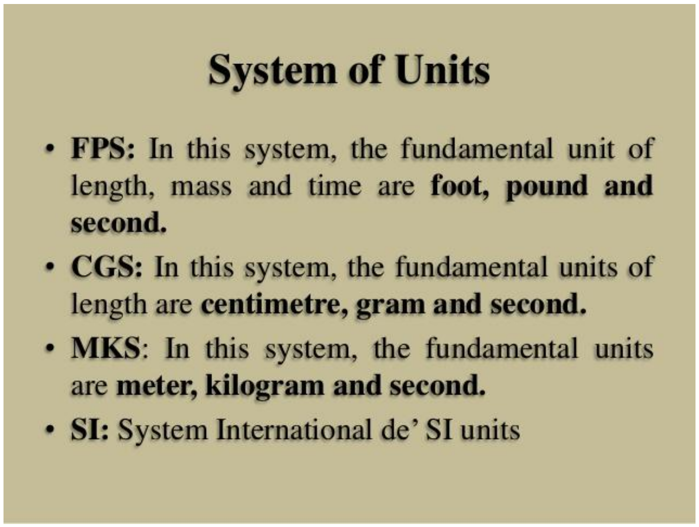
4. Zeros to the right of a decimal point and to the right of nonzero digits are significant.
   Examples: .600 ( )
   .0060700 ( ) these zeros show exactness.

5. Zeros to the left of a decimal point with no non zero digits preceding it are not significant.
   Example: 0.55 ( )

6. Any zeros to the right of non zero digits and not followed by non zero digits are not significant unless followed by zeros after the decimal point.
   Example 1: 100 ( )

These zeros are not significant because they just mark the decimal point. The number can be written as 1×10^2.

Example 2: 10.0 ( ) These zeros show exactness.



- Trick For chapter Number 1 :

Baaz owqat examination hall k bachon ko numerical ki smjh nhi ati... statement kuch aisi hoti hy k yeh pta nhi lgta k find kia krna hay... ya formula bhol jata hay....

Or question hath sy nikalta nazr Ata hay....

Isi conditions main student ko chahey k answer main given unit ko daikhy

For example unit hay

A) 15kwh b) 16kwh etc.....

Ab is sy pta chalta hay k hamin energy find out krni ya koi bhi Chez jo k p.t k barabr Hay ab apko given conditions sy p ya t nikalna bhi prh skta etc...

Ya for example answer main unit hay

a) 4N/m^2 b) 3N/m^2

Its mean apko pressure find out krna hay ya koi bhi chez jo k F/A sy nikalti hay

Ab may be given conditions sy apko F ya A nikalna prhy pehly...

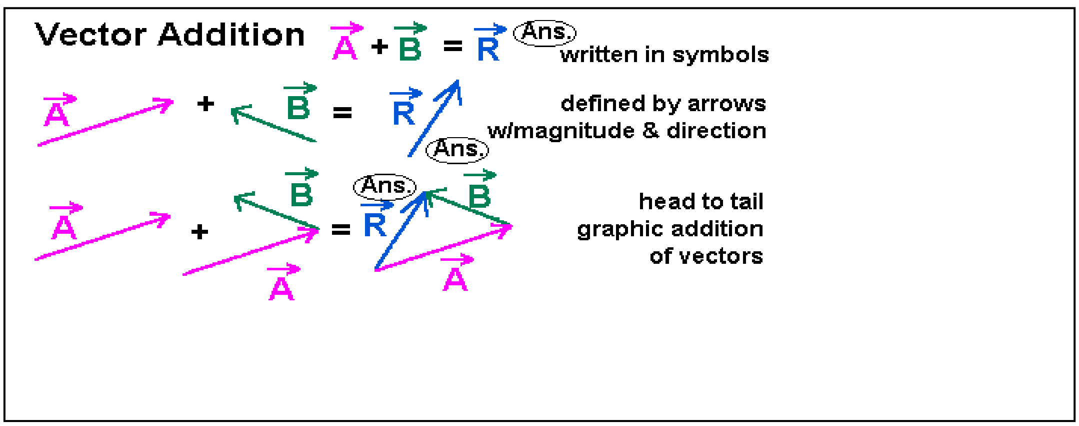
This trick will help you in Sha Allah

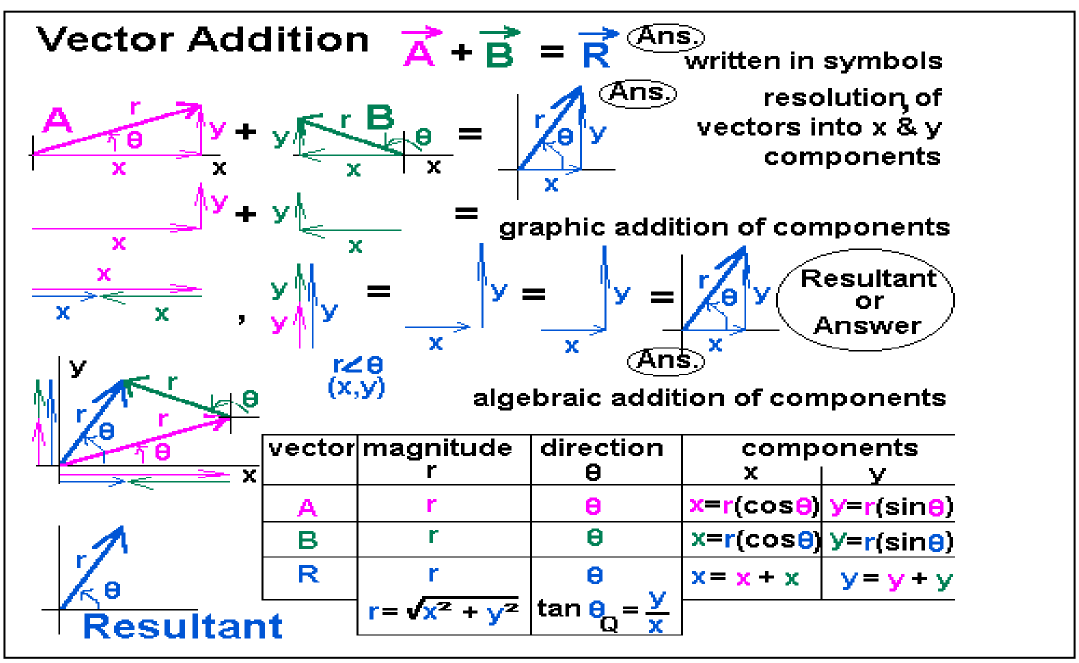
Best Regards :

- Talha naqvi

PHYSICS CHAPTER 2:

- Quantities which required both magnitude and direction for complete their complete description are known as vector
- Vectors can be represent in two or three dimensional plane.
- The Reverse process of addition of a vector is resolution of vector. Subtraction of vector is not a reverse process of vector
- Unit vector have magnitude one in given direction .Null vector have zero magnitude and its direction is Undefined..
  >>Position vector of null vector is undefined
- VECTOR ADDITON AND RECTANGULAR COMPONENT





Dot or scalar product: a•b

The *dot* or *scalar product* of two vectors, **a** and **b**, is the product of their lengths times the cosine of the angle between them.
This is usually written as either **a**•**b** or (**a**, **b**).
Thus if we take **a**•**a** we get the square of the length of **a**.
This product (and the next as well) is linear in either argument (**a** or **b**), by which we mean that for any number c we have

$$c(\mathbf{a}, \mathbf{b}) = (c\mathbf{a}, \mathbf{b}) = (\mathbf{a}, c\mathbf{b})$$

and for any vectors **a**, **d** and **b** we have

$$(\mathbf{a} + \mathbf{d}, \mathbf{b}) = (\mathbf{a}, \mathbf{b}) + (\mathbf{d}, \mathbf{b})$$

and

$$(\mathbf{a}, \mathbf{b} + \mathbf{d}) = (\mathbf{a}, \mathbf{b}) + (\mathbf{a}, \mathbf{d})$$

This innocent looking fact is very important; it means that if we know all the dot products among some set of vectors, say **i**, **j** and **k**, and can express **a** and **b** each as sums of these, then we can read off the dot product of **a** and **b**.In particular, if we choose **i**, **j** and **k** to be mutually perpendicular and each of unit length, then

$$\mathbf{i}\bullet\mathbf{i} = \mathbf{j}\bullet\mathbf{j} = \mathbf{k}\bullet\mathbf{k} = 1$$

and

$$\mathbf{i}\bullet\mathbf{j} = \mathbf{j}\bullet\mathbf{k} = \mathbf{k}\bullet\mathbf{i} = 0$$

For real vectors, **a**•**b** is always the same as **b**•**a**. (when complex vectors are defined this is not usually so; instead these two products are complex conjugates of one another.)
We get

$$\mathbf{a} = (\mathbf{a}, \mathbf{i})\mathbf{i} + (\mathbf{a}, \mathbf{j})\mathbf{j} + (\mathbf{a}, \mathbf{k})\mathbf{k}$$

$$\mathbf{b} = (\mathbf{b}, \mathbf{i})\mathbf{i} + (\mathbf{b}, \mathbf{j})\mathbf{j} + (\mathbf{b}, \mathbf{k})\mathbf{k}$$

$$(\mathbf{a}, \mathbf{b}) = (\mathbf{a}, \mathbf{i})(\mathbf{b}, \mathbf{i}) + (\mathbf{a}, \mathbf{j})(\mathbf{b}, \mathbf{j}) + (\mathbf{a}, \mathbf{k})(\mathbf{b}, \mathbf{k})$$

The square of the magnitude of **a** is $\mathbf{a} \bullet \mathbf{a}$, and the direction between two segments can be read off from the fact that the cosine of the angle between them is their dot product divided by the product of their magnitudes, if you know their dot product and their magnitudes.

Cross Product: a × b

1. Its magnitude is area of parollelogram determined by vectors = $|\mathbf{a}||\mathbf{b}|\sin\theta_{ab}$

2. Its sign changes if the order is reversed: thus

$$\mathbf{a} \times \mathbf{b} = -\,\mathbf{b} \times \mathbf{a} \text{ and so } \mathbf{a} \times \mathbf{a} = 0$$

3.Conventionally defined so that

$$\mathbf{i} \times \mathbf{j} = \mathbf{k}$$

and cyclically:

$$\mathbf{j} \times \mathbf{k} = \mathbf{i},$$

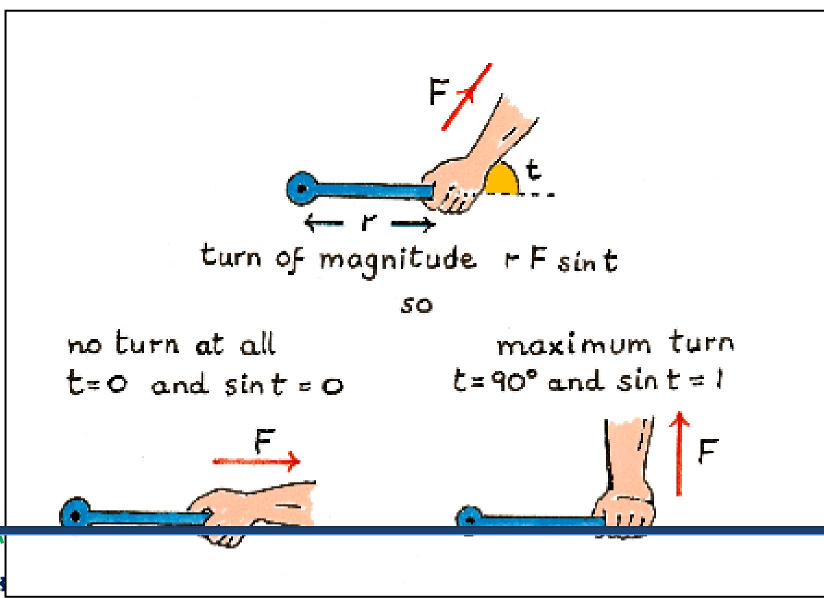
$$\mathbf{k} \times \mathbf{i} = \mathbf{j} \text{ (and so } \mathbf{j} \times \mathbf{i} = -\,\mathbf{k}\text{, etc...)}$$

4. The vector product is orthogonal to either factor:

$$\mathbf{a} \times \mathbf{b} \bullet \mathbf{a} = \mathbf{a} \times \mathbf{b} \bullet \mathbf{b} = 0$$

5. The same result comes from computing the determinant of the matrix for which the components of **a** are the first row, those of **b** the second, and **i**, **j**, **k** the third.

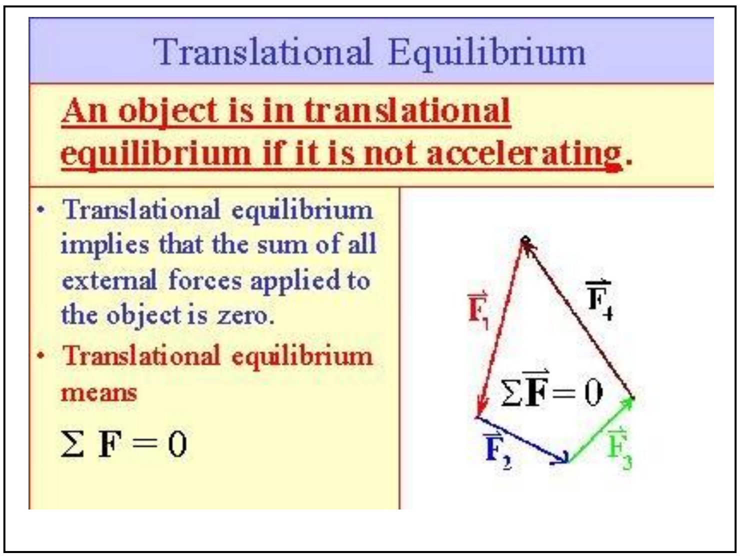
Torque

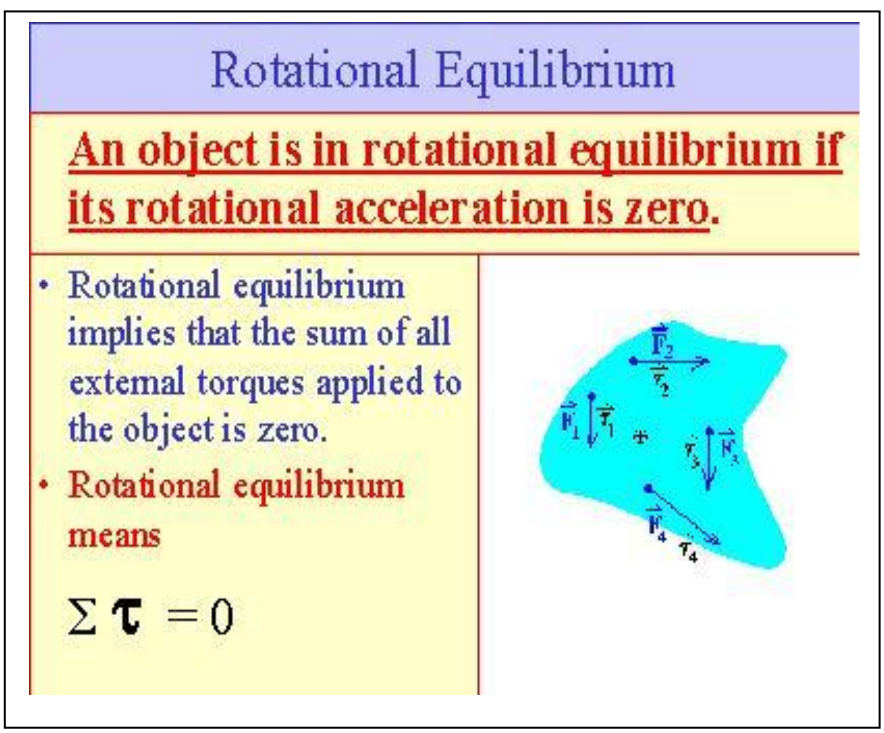


- Torque plays same rule in angular motion as force in linear motion (i.e analogous to force in angular motion)

Torque have same dimension as work and energy
torque=rxF

Equilibrium

- A body is said to be in complete equilibrium if summation of all forces and torques acting on it is equal to zero
- 



Trick for finding torque and all cross product

The solution of vector product is comparatively tough.... determinant method and other method are very long...

As we know the result of vector product is also a vector and its perpendicular tu both vector..

So in m.c.q we can take dot product of any one given vector to the option... the option in which we get 0 result is the right answer as both are perpendicular i.e theeta=90 Cos90=0

for example....

given force F=2i+j-3k acting at a point A(1,-2,1) find moment of force about point B(2,0,-2)

A) 3i+4j+3k b) 3i+3j+5k c) ans3i+3j+3k d) none

As we know tourqe = rxF

is question main abhi r nhi given points given hain ab aik tu yeh method k pehly r nikalin phr torque using determinant

Lekin mcq main waqt kyu zaya karin solution thori check krwana.....

Ab ap option k sath dot laen force ka... ya r nikal kr uska u r free....

Taking dot of mcq with

For a) 1

for b) -6

for c) 0

so c is the answer

This technique apply on every cross product

Also

F=ILxB

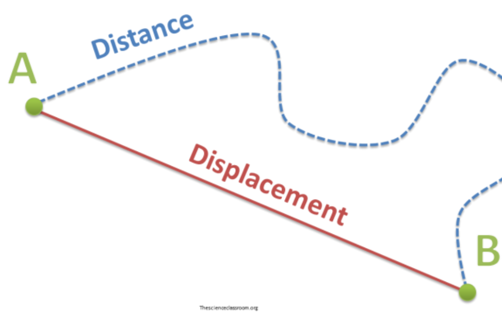
F=q(vxB)

Use this and enjoy

Chapter : 3 " Motion and Force "

Distance and Displacement

- **Distance** is a scalar quantity that refers to "how much ground an object has covered" during its motion.
- **Displacement** is a vector quantity that refers to "how far out of place an object is"; it is the object's overall change in position.



Speed and Velocity

- Speed is a scalar quantity that refers to "how fast an object is moving."
- Velocity is a vector quantity that refers to "the rate at which an object changes its position."

Acceleration

- **Acceleration** is the rate of change of velocity of an object.
- An object's **acceleration** is the net result of any and all forces acting on the object, as described by Newton's Second Law.

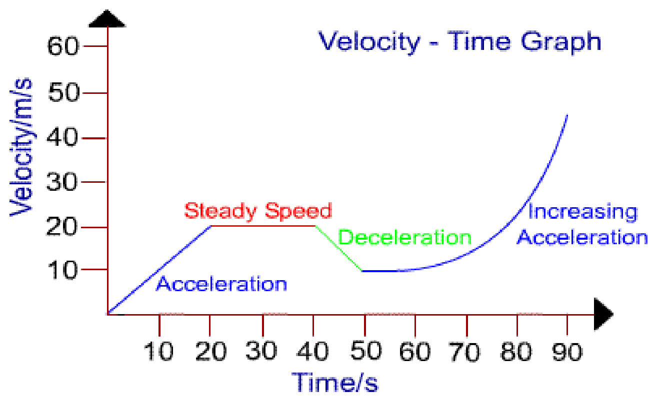
Key points

- As average velocity is disp/time so if d=0, average velocity will be 0
- If velocity is increasing,acceleration is positive
- If velocity is decreasing,acceleration is negative
- If velocity is uniform,acceleration is zero
- For uniform acceleration, average velocity = instantaneous velocity

Velocity-Time graph

The graphs which illustrate the variation of velocity with time

- **When velocity is constant :**
  The graph is horizental straight line
  Area of the graph=area of rectangle=vt= distance covered by object
- **When acceleration is constant :**
  The graph is straight line
  Area of the graph=area of triangle=1/2 vt= distance ccovered
- **The slope of this graph will give average acceleration**
- **When acceleration is increasing :**
  The graph is a curve
  Area of graph will give the distane covered



Equations of Motion

$$v = u + at$$

$$s = \left(\frac{u+v}{2}\right) t$$

$$v^2 = u^2 + 2as$$

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

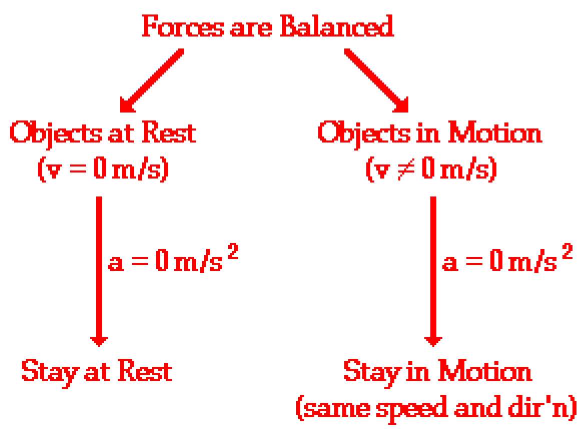
$$s = vt - \frac{1}{2}at^2$$

- Initial Velocity is taken as reference

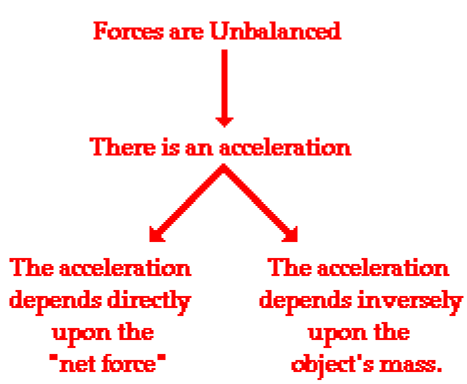
Quantities with same direction as that of initial velocity are taken positive and others are taken negative

Newton's Law of Motion

1st law..



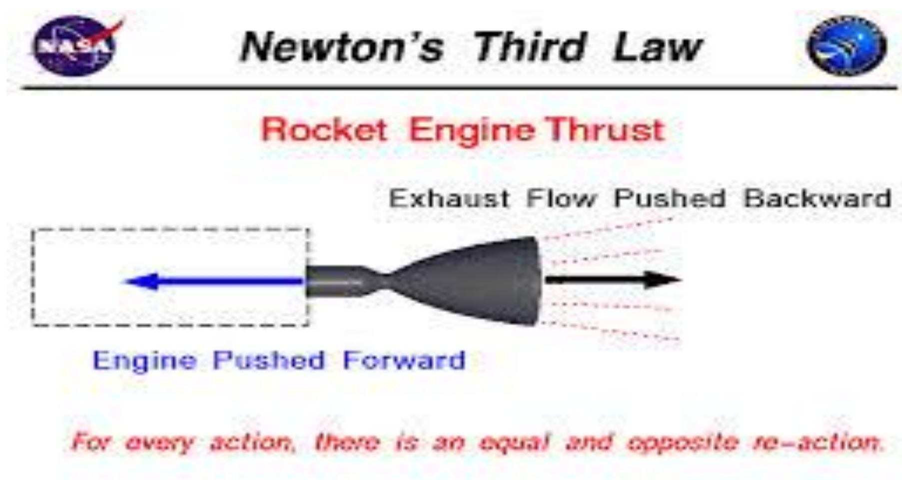
2nd law..



3rd law..

Action and Reaction are equal in magnitude but opposite in reaction

- Action and reaction act on same body



- An accelerated frame is called non inertial frame while an non accelerated frame is called inertial frame
- Newton first law are valid in inertial frame only

Momentum and impulse

MOMENTUM

Definition: Momentum of an object is the product of the mass and velocity of a moving object i.e. momentum of a moving object is simply defined as it's mass times the velocity at which it's moving.

$$\text{momentum} = \text{mass} \times \text{velocity}$$
$$p = m \times v$$

- Momentum is a vector quantity
- The SI unit for momentum: kg·m·s^{-1} (no special name).
- A net force is required to change a body's momentum.
- Momentum is directly proportional to both mass and speed.
- Something big and slow could have the same momentum as something small and fast.

$$\textbf{Impulse} = F\,\Delta t$$

$$F = ma = m\left(\Delta v/\Delta t\right)$$

$$F\,\Delta t = m\,\Delta v = \Delta(mv) = \Delta p$$

$$\textbf{Impulse} = \underline{\text{change}} \text{ in } \textbf{momentum} = \Delta p$$

Law of conservation of momentum:

The total momentum of the body remains the same

Elastic and Inelastic Collision

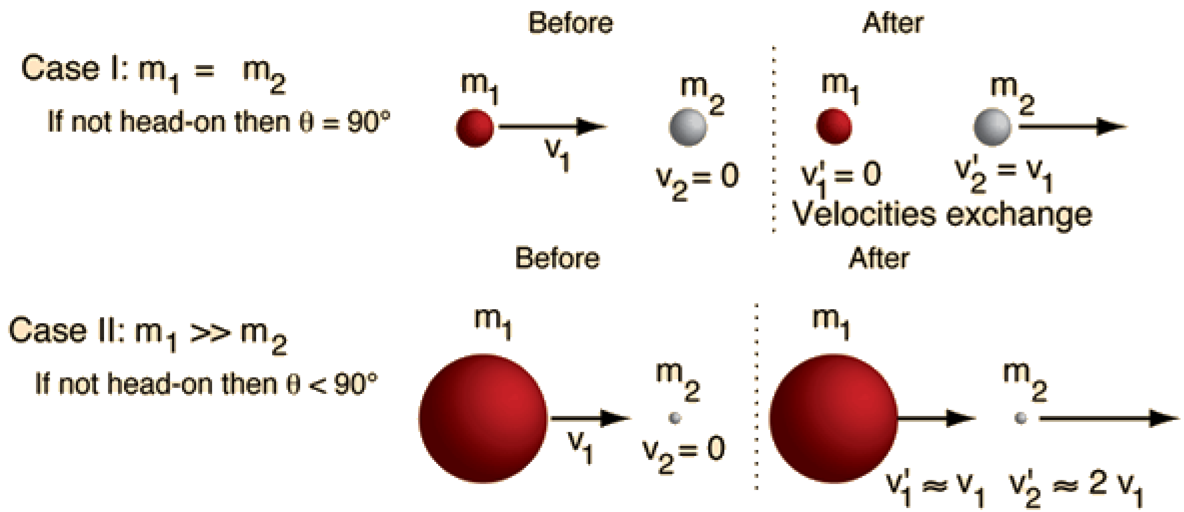
- The collision in which K.E is not conserved is an inelastic collision
- The collision in which K.E remains consered is an elastic collision-ideal case
- Total energy and momentum remains conserved in every type of collision

Elastic Collision in one dimension

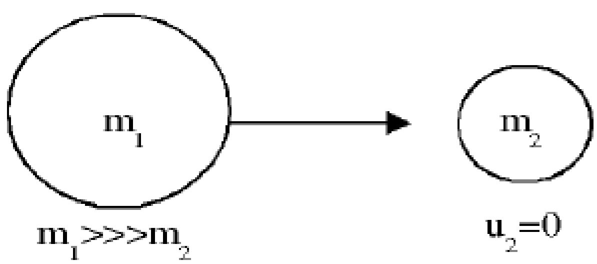
$$v_{1f} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_{1i} + \left(\frac{2m_2}{m_1 + m_2}\right)v_{2i}$$

$$v_{2f} = \left(\frac{2m_1}{m_1 + m_2}\right)v_{1i} + \left(\frac{m_2 - m_1}{m_1 + m_2}\right)v_{2i}$$

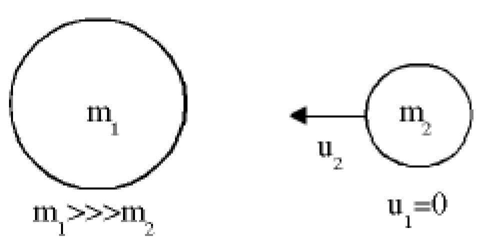
Special cases



Case 3 :



Case 4 :



Projectile Motion

- x=(v0cosθ0)t
- y=(v0sinθ0)t-gt2/2
- vx= v0cosθ0

and

- vy= v0sinθ0t-gt ,

where

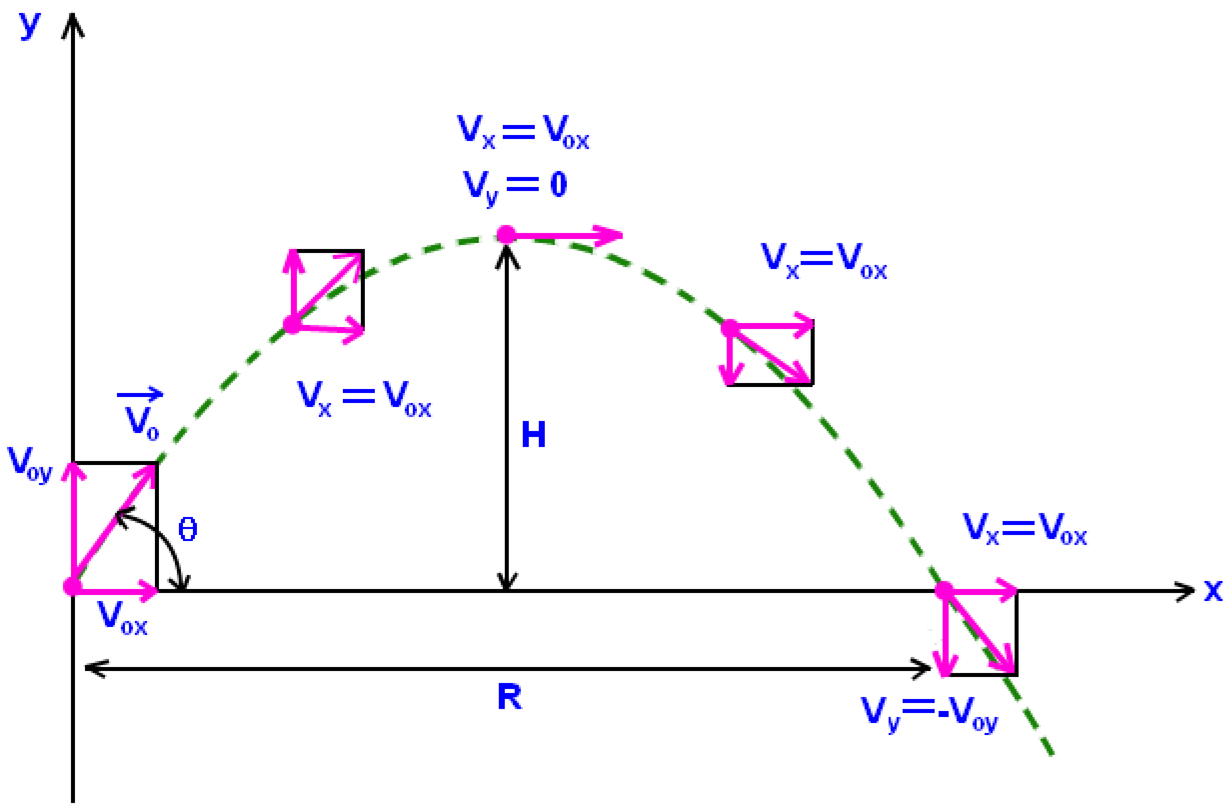
θ0 is the angle initial velocity makes with the positive x axis

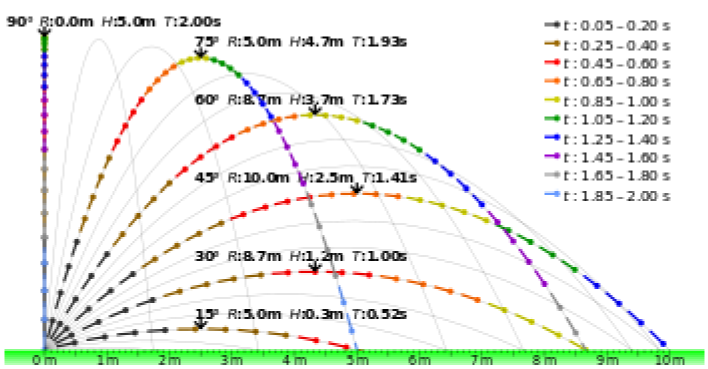
Height,Time and Range of Projectile

$$\text{Time of flight, } t = \frac{2v_0 \sin\theta}{g}$$

$$\text{Maximum height reached, } H = \frac{v_0^2 \sin^2\theta}{2g}$$

$$\text{Horizontal range, } R = \frac{v_0^2 \sin 2\theta}{g}$$





From above figures

- The y component of a velocity is 0 at max height
- The range of a projectile is max at 45 degree

Application to Ballistic Missiles

- For short ranges and flat Earth,the trajectory is parabolaic
- For spherical Earth,trajectory is elliptical

- The ballistic missiles are useful only for short ranges

Best Regards

☺

Chapter : 4 " Work and Energy "

Work

Work done by the force is defined as dot product of force and displacement vector.

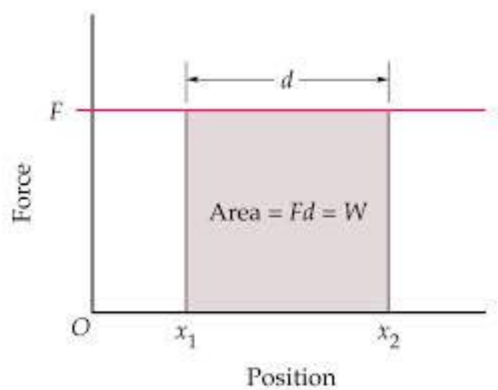
Work done by a constant for Force

For constant Force

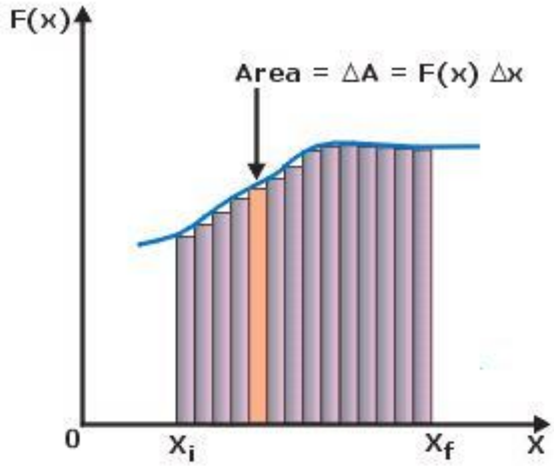
$$W = \mathbf{F} \cdot \mathbf{d}$$

$$= F\cos\theta\, d$$

- If angle is 90 degree, work done is zero
- If angle is less than 90, work done is positive
- If angle is greater than 90,work done is negative



Work done by a variable Force



(a)

$$W_{total} = \Delta W_1 + \Delta W_2 \dots\dots\dots. + \Delta W_n$$

$$= F_1 cos\theta_1\, \Delta d_1 + F_2\, cos\theta_2\, \Delta d_2 + \dots\dots\dots.. + F_n\, cos\theta_n\, d_n$$

$$W_{total} = \sum_{i=1}^{n} F_i\, cos\theta_i\, \Delta d_i \quad \dots\dots\dots.. \quad (4.2)$$

Work done in a closed path

- The field in which work done is independent of path followed or work done in a closed path is zero is called conservative field
- The field in which work done by force is not zero is called non-conservative field
- Conservative forces
  - Gravitational force
  - Elastic spring force
  - Elastic force
- Non-conservative forces
  - Frictional force
  - Air resistance
  - Tension in a spring
  - Normal force
  - Propulsion forces

Power

Power is rate of doing work

i.e., P=work/time.

- SI unit of power is Watt.
- 1W=1Js-1

. In terms of force

P= **F.v**

Energy

Kinetic Energy: Energy due to motion of body

K.E=(1/2)mv^2

Potential Energy: Energy due to position of body

P.E=mgh

Elastic Potential Energy Energy stored due to compressed state of spring

Gravitational Potential Energy Energy stored due to position of body in a gravitational field

Work-Energy Principle

W=Kf-Ki

Absolute Potential Energy

Ug= -GMm/R

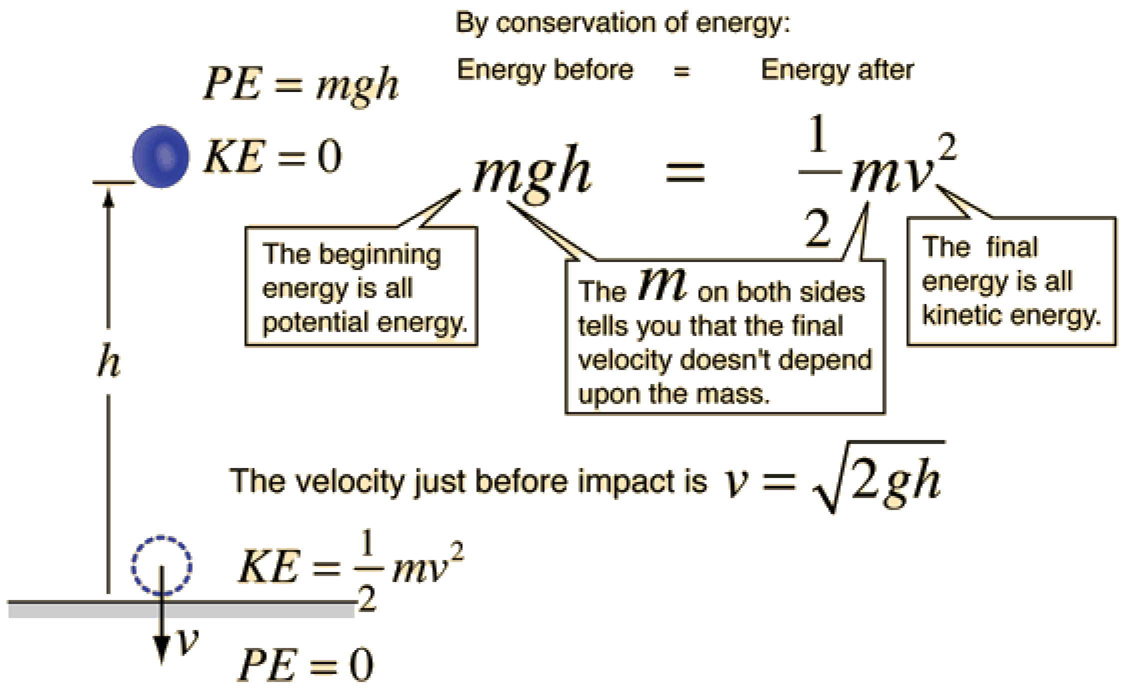
Gravitational Force= GMm/r^2

Acceleration due to gravity= GM/R^2

Escape Velocity

Vesc=√2gR

Interconversion of Energy



- Loss in P.E=Gain in K.E

In the presence of friction

Loss in P.E=Gain in K.E+work done against friction

Conservation of Energy

Energy can neither be created nor be destroyed it can just be converted from one form to another form

The total energy of the universe remains constant

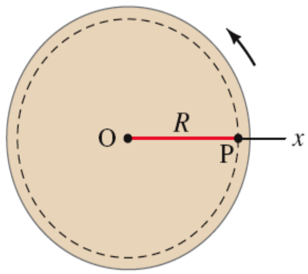
Non-conventional Energy Sources

- Energy from tides
- Solar Energy
- Energy from Waste products
- Energy from Waves
- Energy from Biomass
- Geothermal Energy

Best Wishes ☺

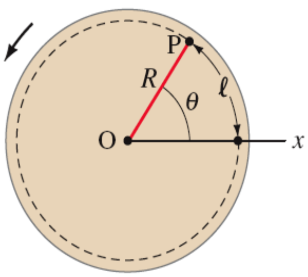
CH 5 “CIRCULAR MOTION”

Angular Quantities

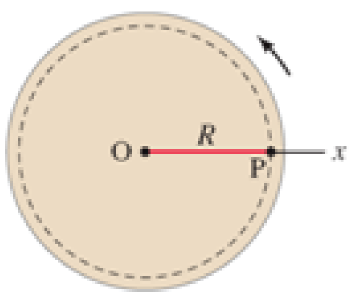


Rigid object – shape doesn’t change

In purely rotational motion – an object move in rotation motion with (“*O*”) as the *axis of rotational*

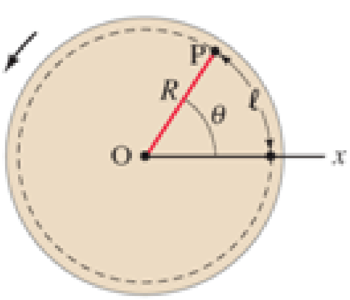


Point P - distance R from the center
- move in a circle (same as all other point in the object)



All points on a straight line drawn through the axis move through the same angle in the same time.

X-axis as a reference frame
- can indicate the angular position of point P
- θ usually in degree
- radian is use for mathematical purposes



The angle θ in radians is defined:

$$\theta = \frac{l}{R}, \quad \text{[dimensionless]}$$

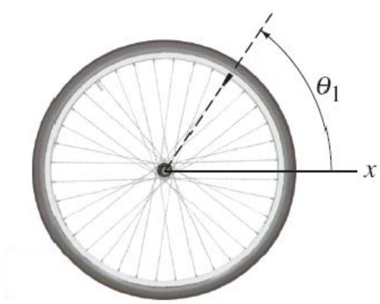
l - is the arc length.
R - distance from the *axis of rotational*

To define linear motion of an object we use quantities such as displacement, velocity and acceleration of the object

For rotational motion, we will make use angular quantities such as angular displacement, angular velocity and angular acceleration

The concept is similar to linear motion.

Angular Displacement

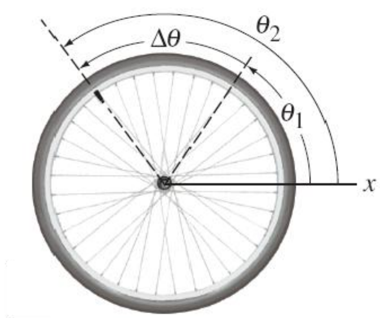


A wheel rotating – some point initially specified by θ_1 move to point θ_2

Angular displacement:

$$\Delta\theta = \theta_2 - \theta_1. \qquad \text{[rad]}$$

The average angular velocity (omega, ω) is defined as the *total angular displacement divided by time*:



$$\bar{\omega} = \frac{\Delta\theta}{\Delta t}. \qquad \text{[rad/s]}$$

The instantaneous angular velocity:

$$\omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt}. \qquad \text{[rad/s]}$$

It is not only the point (we measure) move in that angular velocity, all point in the object rotate with the same angular velocity – every position in the object move through the same angle in the same time interval

By convention – object moving counterclockwise has + value and
object moving clockwise has – value.

Angular Acceleration:

The angular acceleration (alpha, α) is the *rate at which the angular velocity changes with time*:

$$\bar{\alpha} = \frac{\omega_2 - \omega_1}{\Delta t} = \frac{\Delta \omega}{\Delta t}. \qquad [\mathrm{rad/s^2}]$$

The instantaneous acceleration:

$$\alpha = \lim_{\Delta t \to 0} \frac{\Delta \omega}{\Delta t} = \frac{d\omega}{dt}. \qquad [\mathrm{rad/s^2}]$$

All points in the object have the same angular acceleration

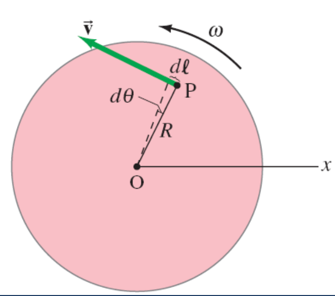
Linear velocity and Angular velocity

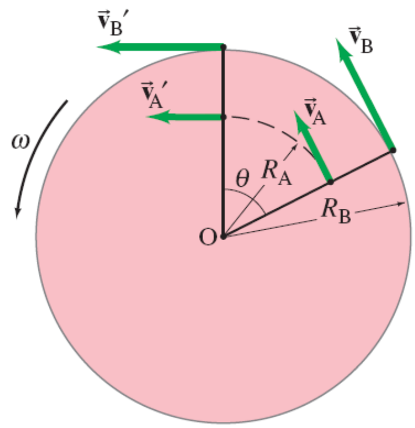
Every point on a rotating body has, at any instant a linear velocity v and a linear acceleration.

We can relate the linear quantities (v and a) to the angular quantities (ω and α)

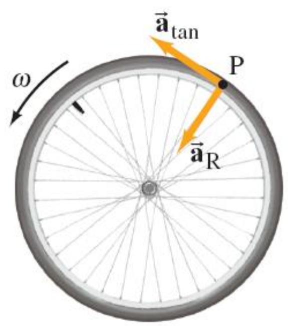
Linear velocity and angular velocity are related:

$$v = R\omega.$$





Points farther from the axis of rotation will move faster (linear velocity) but the angular velocity for all points is the same.

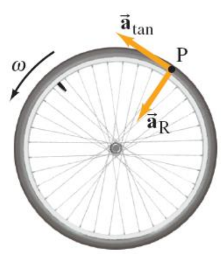


If the angular velocity of a rotating object changes, it has a tangential acceleration:

$$a_{tan} = \frac{dv}{dt} = R\frac{d\omega}{dt} = R\alpha.$$

Even if the angular velocity is constant, each point on the object has a centripetal acceleration:

$$a_R = \frac{v^2}{R} = \frac{(R\omega)^2}{R} = \omega^2 R.$$



Total acceleration of the object:

$$\vec{a} = \vec{a}_{tan} + \vec{a}_R$$

$$a = \sqrt{a_{tan}^2 + a_R^2}$$

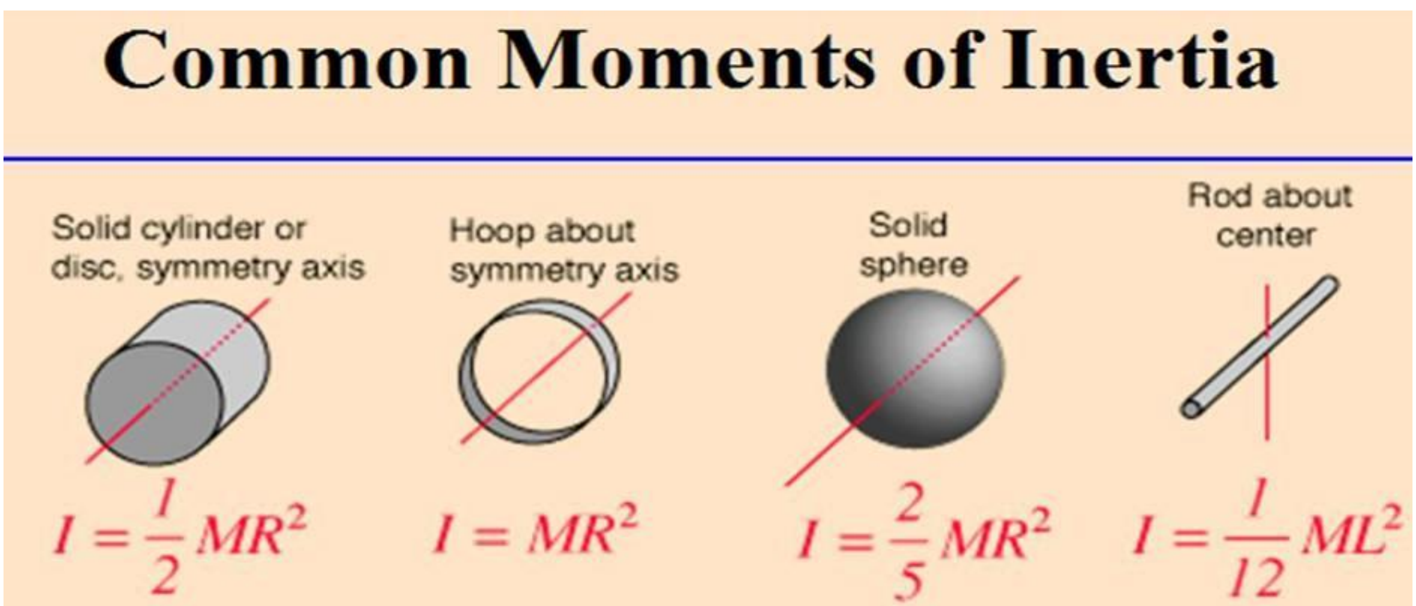
	Displacement	Velocity	Acceleration
Translational motion	S	V	a
Rotational motion	θ	ω	α
Relationship	S = rθ	V = rω	a = rα

MOMENT OF INERTIA:

It is the inertia of rotating body and is given by,

$$I = mr^2$$

Units are kgm^2.



Angular Momentum:

The rotational analog of linear momentum is angular momentum,

$$L = I\omega. \qquad \text{[unit: kg m}^2\text{/s]}$$

Conservation of Angular Momentum

In the absence of an external torque, angular momentum is conserved:

$$L = I\omega = \text{constant.}$$

This is the law of conservation of angular momentum,

The total angular momentum of a rotating object remains constant if the net external torque acting on it is zero.

This means, the value of angular momentum is conserved:

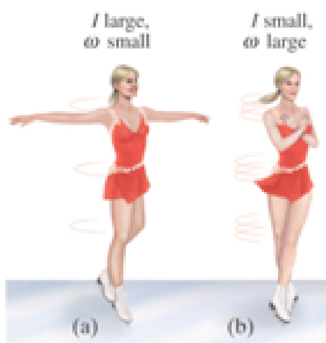
$$I\omega = I_0\omega_0 = \text{constant.}$$

Where I_o – moment of inertia at (t=0)

ω_o – angular velocity at (t=0)

Therefore, if an object's moment of inertia changes, its angular speed changes as well.

Object change their shape – alter their moment of inertia (I), angular velocity (ω) change as well so $I\omega$ remain constant

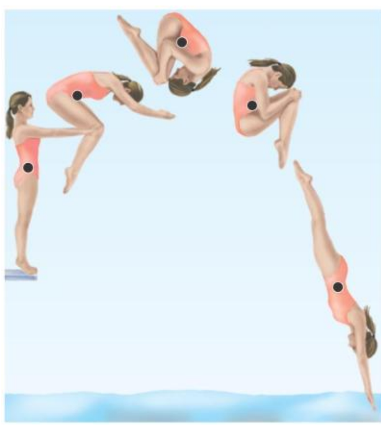


Skater start spinning at low angular velocity with arm outstretched

Bring her arm close to her body, decreasing her moment of inertia

For $I\omega$ to remain constant, ω increases

She will spin more faster



Diver leaves the board with an angular momentum, L = $I\omega$, with small angular velocity.

Curls herself, rotates more quickly

Stretch out again, moment of inertia increase, angular velocity decrease

Enter the water with small angular velocity, ω

Rotational Kinetic Energy:

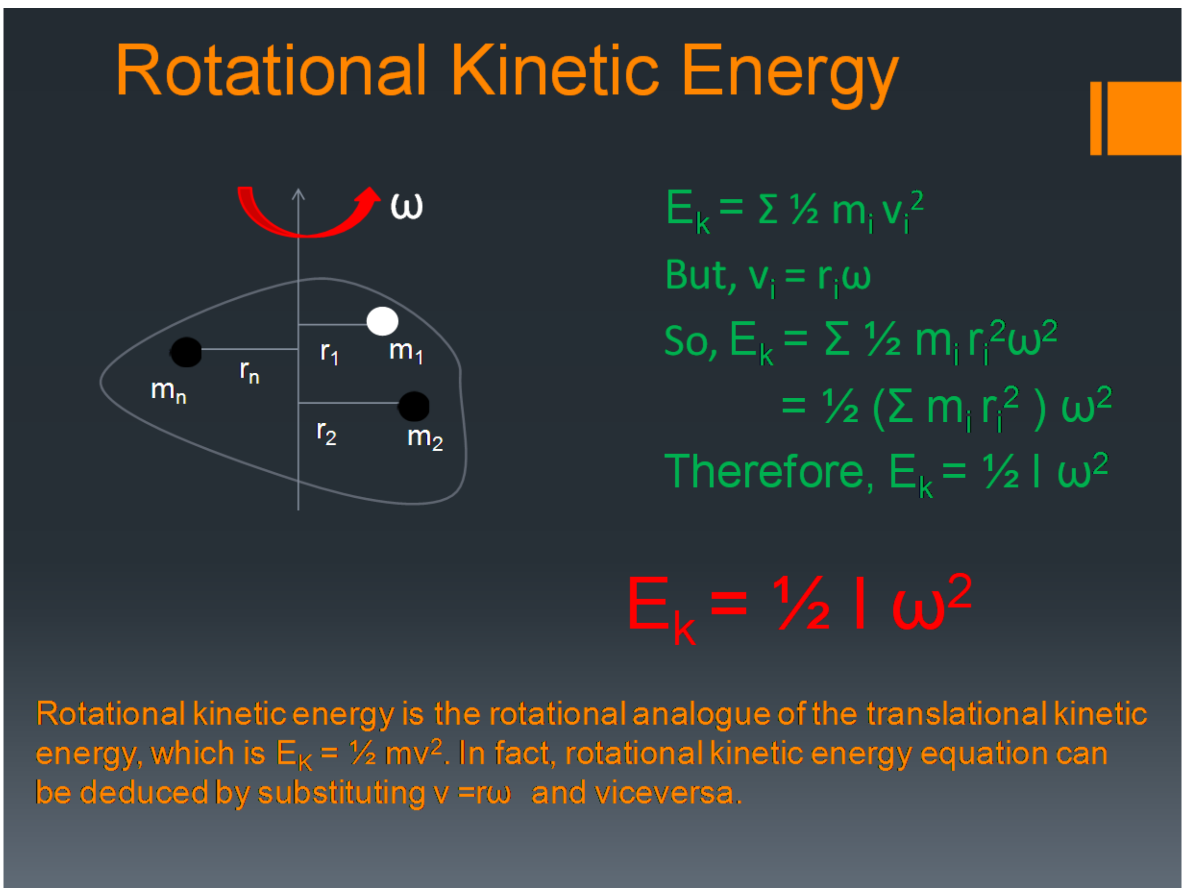
The kinetic energy of a rotating object is given by:

$$K = \Sigma\left(\tfrac{1}{2} m v^2\right).$$

By substituting the rotational quantities, we find that the rotational kinetic energy can be written:

$$\text{rotational } K = \tfrac{1}{2} I \omega^2.$$

or



See book for Kinetic energy of disc and hoop.

Satellites:

A satellite is any object that is orbiting the earth, sun or other massive body. Satellites can be categorized as natural satellites or man-made satellites. The moon, the planets and comets are examples of natural satellites. Accompanying the orbit of natural satellites are a host of satellites launched from earth for purposes of communication, scientific research, weather forecasting, intelligence, etc. Whether a moon, a planet, or some man-made satellite, every satellite's motion is governed by the same physics principles and described by the same mathematical equations.

A Satellite is a Projectile

The fundamental principle to be understood concerning satellites is that a satellite is a projectile. That is to say, a satellite is an object upon which the only force is gravity. Once launched into orbit, the only force governing the motion of a satellite is the force of gravity.

Important Points:

1) $g = v^2/R$ and so $v = \sqrt{gR}$. It is known as critical velocity and by putting R=6400km, we get v = 7.9km/s

2) $T = \frac{2\pi R}{v}$ = 5060sec = 84 min approximately

REAL & APPARENT WEIGHT:

Real Weight:

It is the pull of earth on body i.e. W = mg

Apparent Weight:

It is the reading of any weight measuring instrument.

In Inertial Frame: Apparent Weight = Real Weight
In Non-Inertial Frame: Apparent Weight depends on acceleration of frame.

Apparent Weight: Person on Scale in Elevator

A person with mass, *m*, who is located at or near the surface of the Earth will always have some weight *W=mg*. When a person stands on a scale, the reading (the number of pounds or newtons) on the scale is actually the Normal Force that the scale exerts back towards the person to support the person's weight. (Note that the person and the scale are stationary relative to each other, in other words they are always in contact with each other, so they always have equal and opposite action and reaction forces acting between them.)

Things get complicated, though, when the scale and the person experience acceleration. This will change the contact force (the Normal Force) between the person and the scale.

Let's look at several cases.

Case 1: No acceleration of elevator

Apparent weight = Real Weight

Case 2: Elevator moves upward

In this case Apparent weight > Real Weight

Case 3: Elevator moves downward

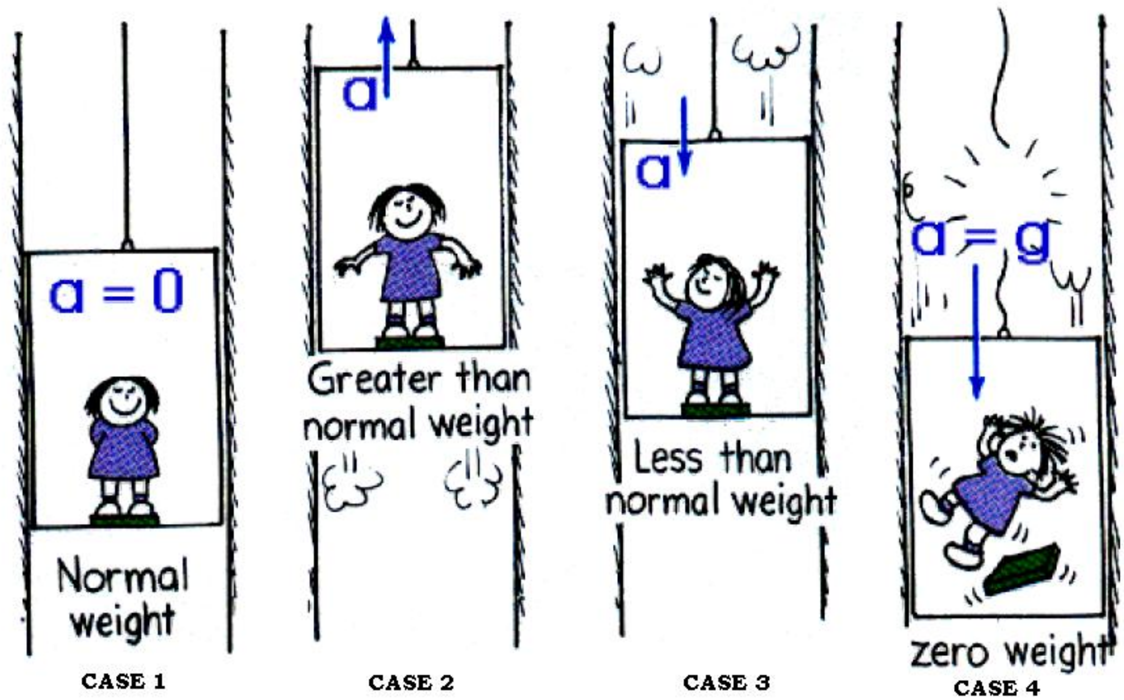
In this case Apparent weight < Real Weight

Case 4: Elevator falls freely

In this case, Apparent weight = 0

See textbook page number 116-117

A pictorial summary of apparent weight:



ORBITAL VELOCITY(page 119)

$$V = \sqrt{\frac{GM}{R}}$$

Artificial Gravity:

As a satellite orbiting around the earth is a freely falling object, so satellite and everything in it are in the state of weightlessness. In order to remove the weightlessness condition, an artificial gravity is created by spinning the satellite about its axis with frequency given by:

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{R}}$$

Geo-Stationary Satellites:

1) h = 36000 km from earth

2) Its orbital motion is synchronized with spin motion, so they appear stationary w.r.t Earth.

3) T = 1 day = 24 Hours

4) $r = [\frac{GMT^2}{4\pi^2}]^{1/3} = 4.23 \times 10^4$ km

Chapter 6

FLUID DYNAMICS

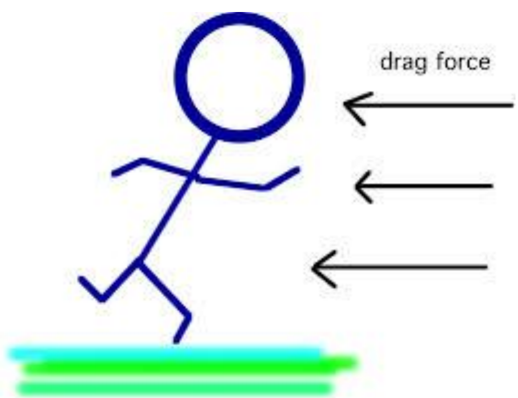
Drag force:

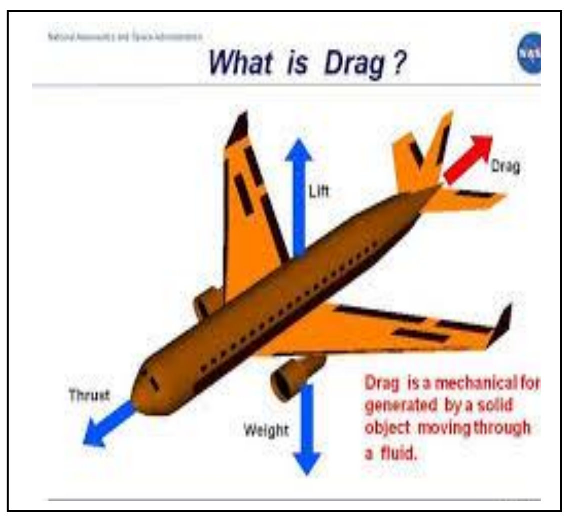
"An object moving through a fluid experience retarding force called drag force. This drag force increases as the speed of object increases"

The drag force is explained by stoke's law:

$$F = 6\pi\eta r v$$

- F is drag force or retarding force
- V is speed of object moving through fluid medium
- R is radius of object
- η is viscosity and its units are kg/ms or $[ML^{-1}T^{-1}]$





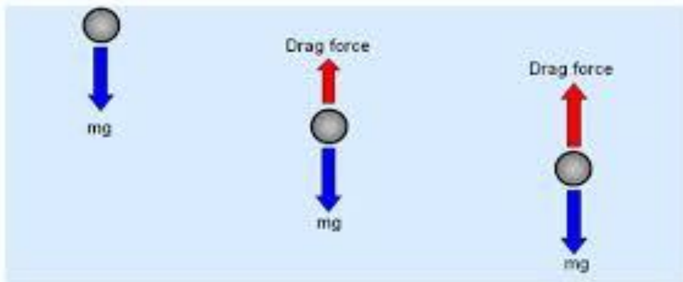
Terminal velocity:

"When the magnitude of drag force becomes equal to the weigh, the net force acting on the droplet is zero. The droplet will fall with constant speed called terminal velocity"

Terminal velocity can be understood by:

$$mg = 6\pi\eta rv$$

$$v_t = \frac{mg}{6\pi\eta r}$$



Body released from rest

Forces on body during acceleration

Forces on body at terminal velocity

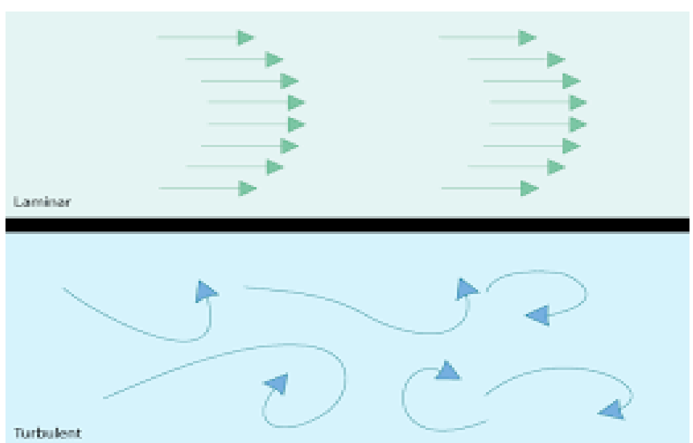
Fluid flow:

Laminar flow:

If every particle that passes particular point, moves along exactly the same path, as followed by particles which passed that point earlier.

Turbulent flow:

The irregular or unsteady flow of fluid is called turbulent flow.



Equation of continuity:

"The product of cross sectional area of the pipe and the fluid speed at any point along the pipe Is a constant. This constant equals the volume flow per second of fluid or simply flow rate"

$$A_1 v_1 = A_2 v_2$$

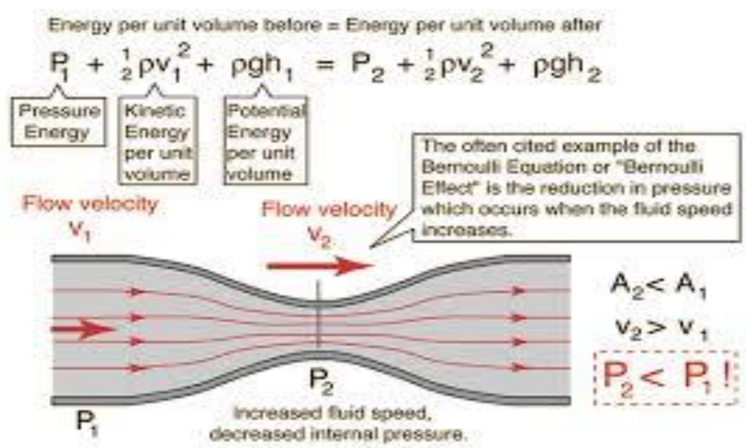
- This is mother equation in fluid dynamics; it serves as a base for all other important equations in fluid dynamics.
- This holds for ideal conditions, that is fluid should be frictionless.

The flow entering and leaving the pipe is same.

Bernoulli's equation:

"When incompressible and frictionless fluid is passing through pipe, the sum of total pressure, kinetic energy and potential energy is constant"

$$P + \frac{1}{2}\rho v^2 + \rho g h = const$$

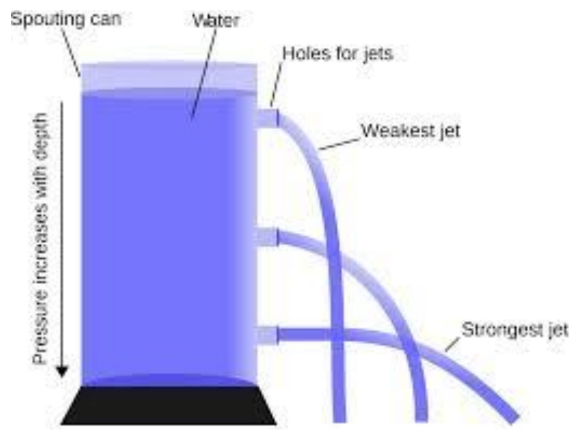


Applications of Bernoulli's equation:

Torricelli's theorem:

"The speed of efflux is equal to the velocity gained by the fluid in falling through the distance (h_1-h_2) under the action of gravity"

$$v_2 = \sqrt{2g(h_1 - h_2)}$$

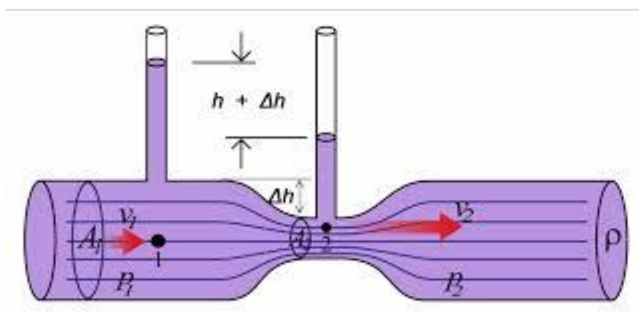


- Where the speed is high, the pressure will be lower.

Venture relation:

Venture meter is a device used to measure the speed of liquid flow.

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



Change in pressure in middle is measured by manometer and speed is measured.

Chapter 7:

OSCILLATIONS

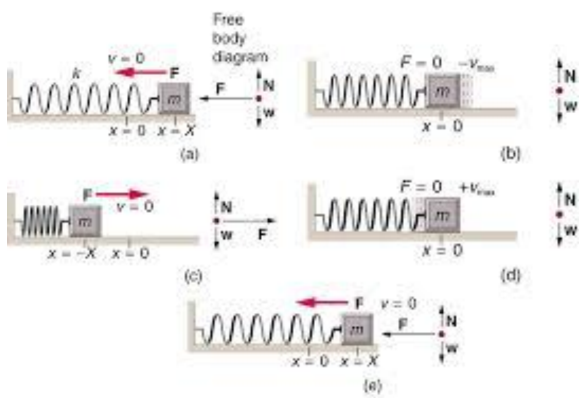
Simple harmonic motion:

"The acceleration at any instant of a body executing SHM is proportional to displacement and is always directed towards the mean position"

By hooke's law:

$$F = -Kx$$

K is spring constant, -ve sign is that the force is restoring force and always acts backward.



Amplitude:

The maximum value of displacement is called amplitude.

Vibration:

The motion of body from one extreme position to same extreme position is called one vibration.

Time period:

The time required to complete one vibration

Frequency:

This is the number of vibrations executed by a body in one second.

- By multiplying frequency and time period, the answer is one.

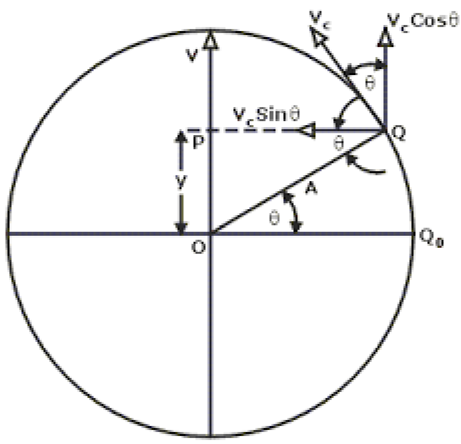
Angular frequency:

It is basically the characteristics of circular motion. By this value, instantaneous displacement and instantaneous velocity of body can be calculated.

$$\omega = \frac{2\pi}{T} = 2\pi f$$

Displacement:

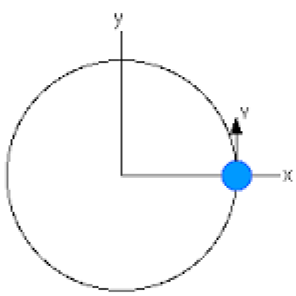
After one quarter of vibration is completed, phase is 90. After that phase of SHM will be changed. This is related to displacement like this:

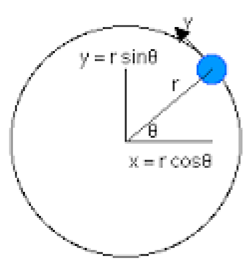


$$\boxed{x = x_0 \sin \omega t}$$

Instantaneous velocity:

The velocity of point P at any instant t, will be directed along the tangent to the circle at P and its magnitude is given as:

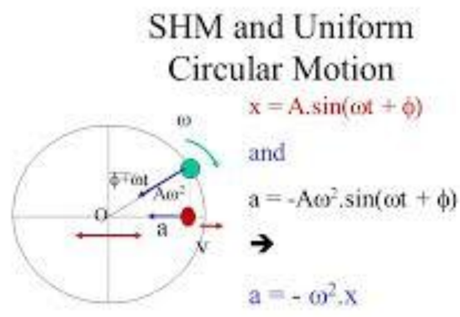




$$\boxed{V = \omega\sqrt{x_0^2 - x^2}}$$

Acceleration:

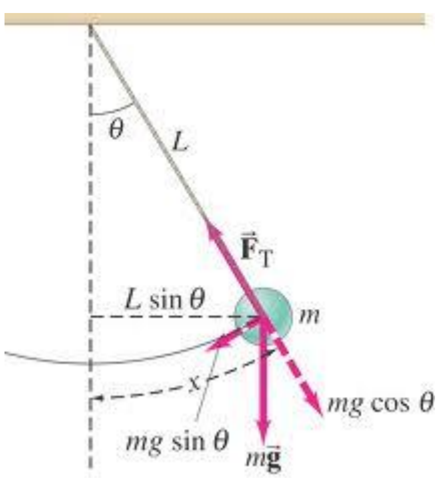
When the point is moving in circle, it has some acceleration that acceleration is measured as:



Simple pendulum:

The time period of simple pendulum depends upon the length of pendulum and the acceleration due to gravity. It is independent of mass.

- At the center of earth, grasvity is zero, so vibrations and time period will be infinity.
- Time period of first pendulum is 1 sec and frequency is 1 Hz
- Time period of second pendulum is 2 sec and frequency is 0.5 Hz

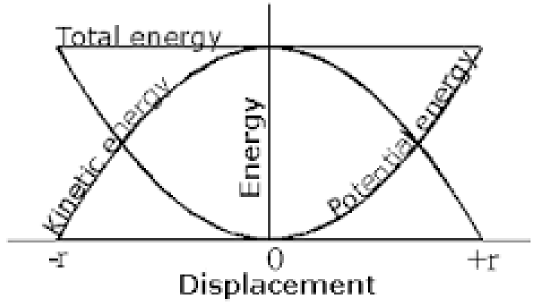


$$\boxed{T = 2\pi\sqrt{\frac{l}{g}}}$$

Energy conservation in SHM:

Total energy is conserved in SHM:

- At x=0 K.E is maximum i.e. when the mass in at equilibrium or mean position.
- For any displacement x, the energy is partly P.E and partly K.E.
- T.E=K.E+P.E

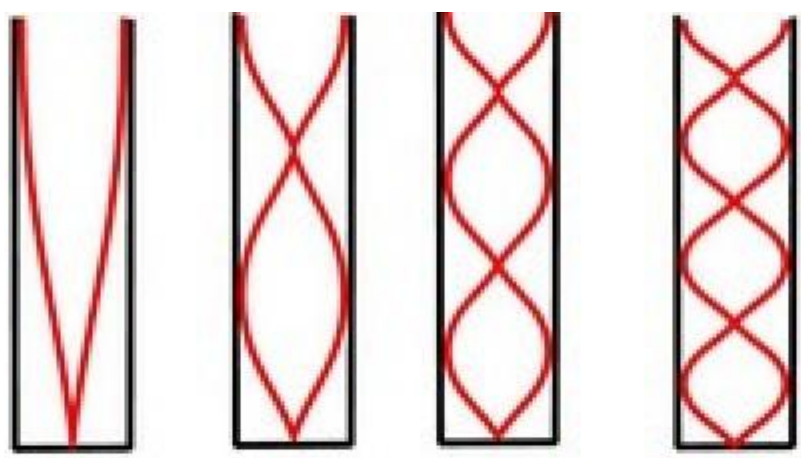


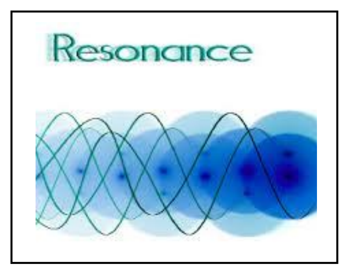
Free and forced oscillations:

- If anybody is oscillating naturally, the amplitude will start decreasing reaching to zero called as free oscillations
- If amplitude is required to constant, we force the oscillation by external source, called as forced oscillations
- The physical system that undergoes forced vibrations is known as driven harmonic oscillator.

Resonance:

"Resonance occurs when the frequency of applied force is equal to one of the natural frequencies of vibrations of the forced or driven harmonic oscillator"

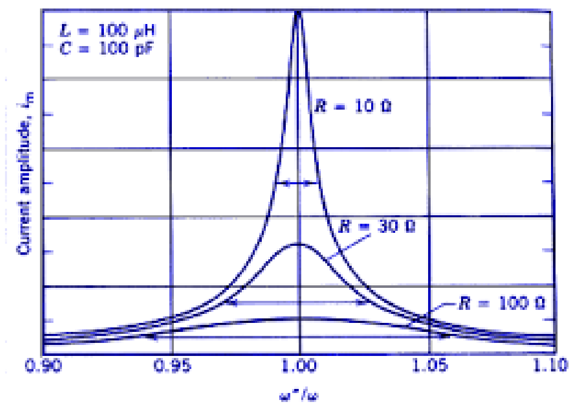




- In first tube, frequency is 1, in second the frequency is 2, in 3rd its 3, in 4th its 4

Sharpness of resonance:

A heavily damped system has a fairly flat resonance curve.

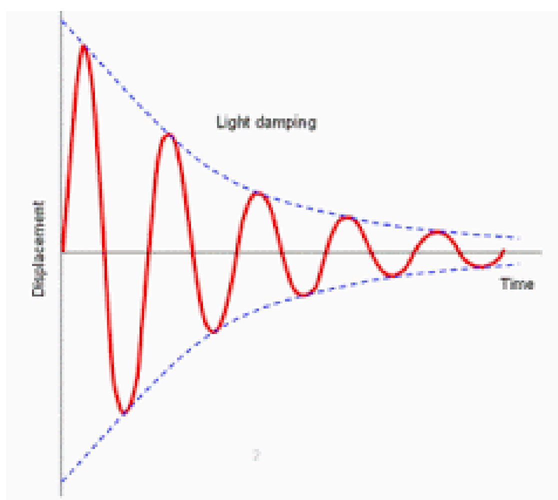


The effect of damping can be observed by attaching a pendulum of light mass such as pith ball as its bob and another of same length carrying a heavy mass such as lead bob of equal size, to a rod. They are set into vibration by third pendulum of equal length, attached to same rod.

- It is observed that the amplitude of lead bob is much greater than that of pith ball.
- The damping effect for pith ball due to air resonance is much greater than for lead ball.

Damped oscillations:

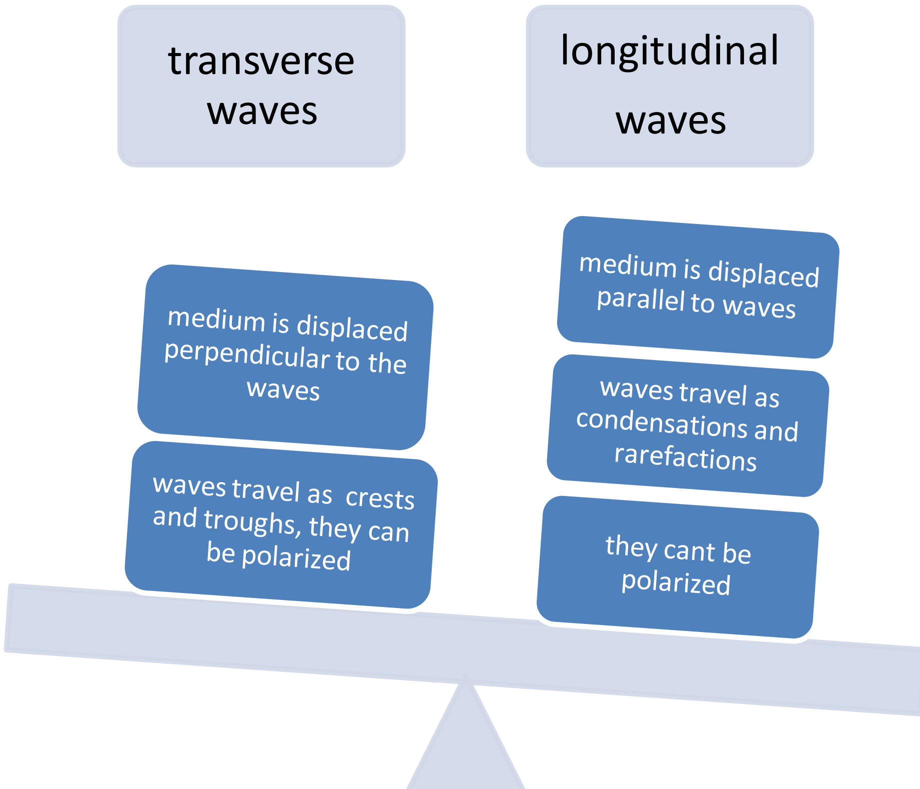
It is process whereby energy is dissipated from the oscillating system.



- Applications of damped oscillations is the shock absorber of a car which provides damping force to prevent excessive oscillations

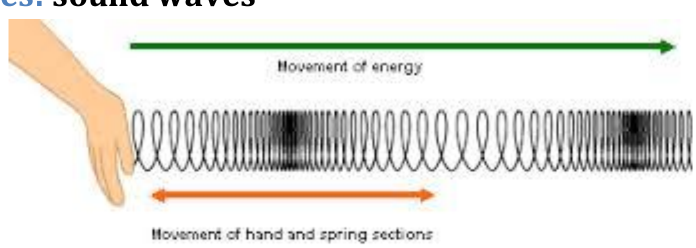
Chapter 8:

WAVES

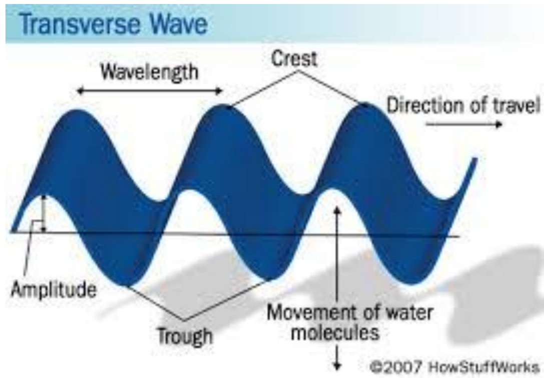


Examples:

Longitudinal waves: sound waves



Transverse waves: a mass attached with spring showing SHM



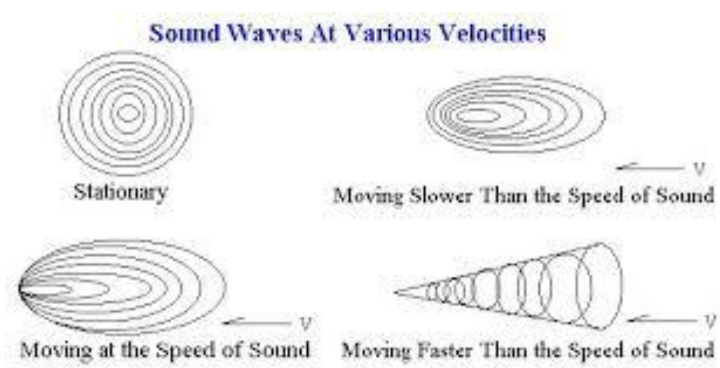
Speed of sound in air:

Sound waves are the most important examples of longitudinal or compression waves. The speed of sound waves depends upon the ***compression and inertia of the medium*** through which they are travelling.

The expression is:

$$v = \sqrt{\frac{E}{\rho}}$$

- E is elastic modulus of the medium
- P is the density of medium
- Speed of sound is much higher in solids than in gases



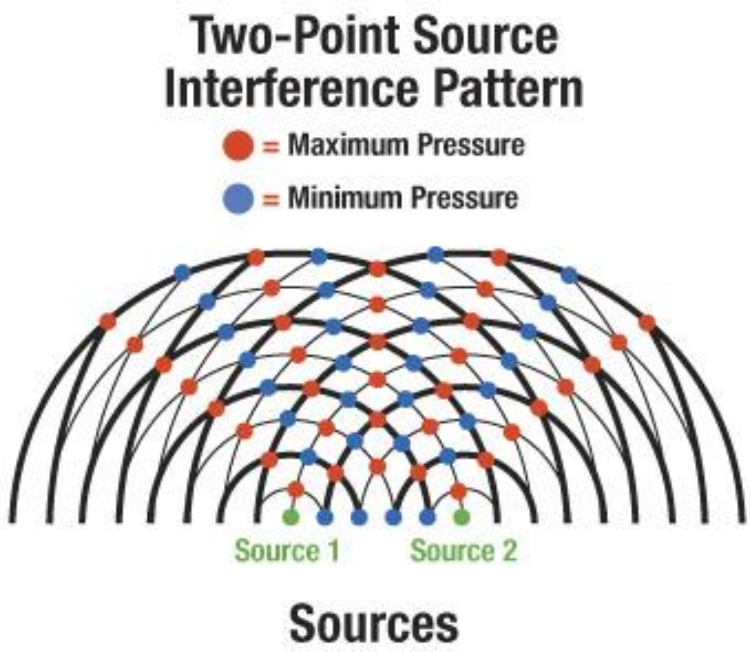
Moving slower than sound waves=***subsonic waves***

Same speed as sound waves=***sonic waves***

Greater speed than sound waves=***supersonic waves***

Principles of superposition:

- Two waves having same frequency and travelling in same direction (***Interference***)



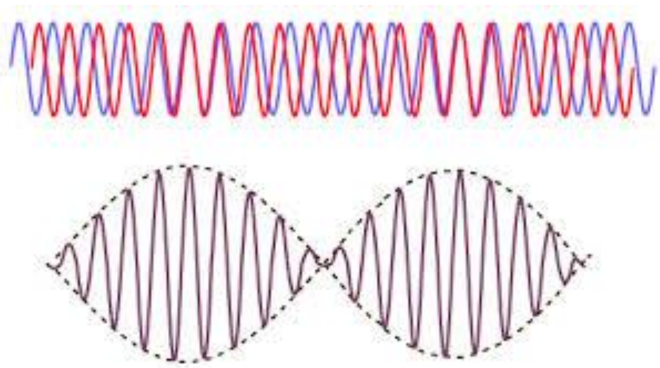
- Whenever path difference is an integral multiple of wavelength, the two waves are added up. This effect is called *constructive waves*.

$$\Delta S = n\lambda$$
$$n = 0, \pm 1, \pm 2, \pm 3, \ldots$$

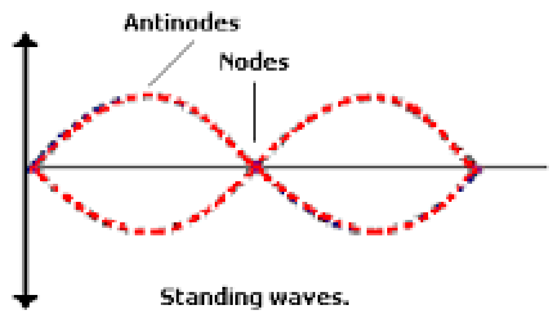
- The path difference is an odd integral multiple of half the wavelength, the two waves will cancel each other's effect; this effect is called *destructive waves.*

$$\Delta S = (2n+1)\frac{\lambda}{2}$$
$$n = 0, \pm 1, \pm 2, \pm 3, \ldots.$$

- Two waves of slightly different frequencies and travelling in same direction (***Beats***)



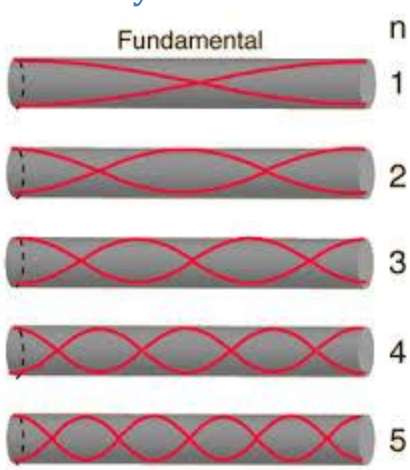
- Number of beats per second is equal to difference between the frequencies of the tuning forks
- Two waves of equal frequency travelling in opposite direction (***stationary waves***)



Reflection of waves:

- If a transverse wave travelling in a rare medium is incident on a denser medium, it is reflected such as it undergoes a phase change of 180 degree
- If a transverse wave travelling in a denser medium is incident on a rare medium, it is reflected without any change in phase

Stationary waves in an air column:

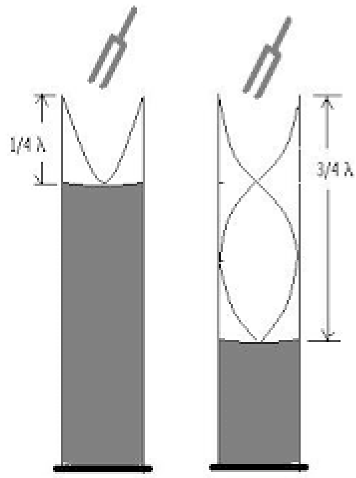


This is in open pipe at both ends. The number of waves is multiple of 2.

$$\lambda_n = \frac{2l}{n}$$

$$f_n = \frac{v}{\lambda_n} = \frac{nv}{2l}$$

n=1, 2, 3, 4,..



If the pipe is closed at one end and open at the other, the closed end is a node. Only the odd harmonics are generated.

$$\lambda_1 = 4l$$
$$f_1 = \frac{v}{\lambda_1} = \frac{v}{4l}$$
$$f_n = \frac{nv}{4l}$$
$$n = 1,3,5.,..$$

Doppler Effect:

"This effect shows that if there is some relative motion between the source of waves and the observer, an apparent change in frequency of the waves is observed."

When observer moves towards the source:

The observer A is moving with velocity u_o, the relative velocity of the waves and observer is increased to $(v+u_o)$. The number of waves received in one second or modified frequency f_A is:

$$f_A = \frac{v + u_0}{\lambda}$$

When observer moves away from source:

$$f_B = \frac{v - u_0}{\lambda}$$

When the source is moving towards observer:

Source is moving towards observer with velocity u_s

$$f_C = \frac{v}{v - u_s}$$

When the source is moving away towards observer:

$$f_D = \frac{v}{v + u_s}$$

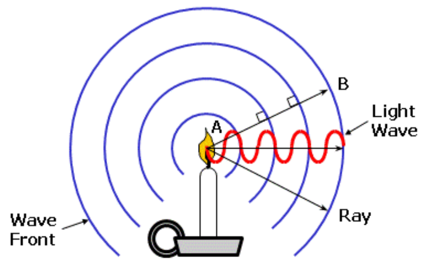
Applications of Doppler Effect:

- In sonar, Doppler detection relies upon the relative speed of target and detector to provide an indication of the target speed
- Astronomers use the Doppler effect to calculate the speed of distinct starts and galaxies
- In radar speed trap , by measuring the Doppler shift, the speed at which the car moves is calculated by computer program.

Chapter:9 " Physical Optics "

WaveFronts

Such a surface in which all the points have same phase of vibration is known as wavefront



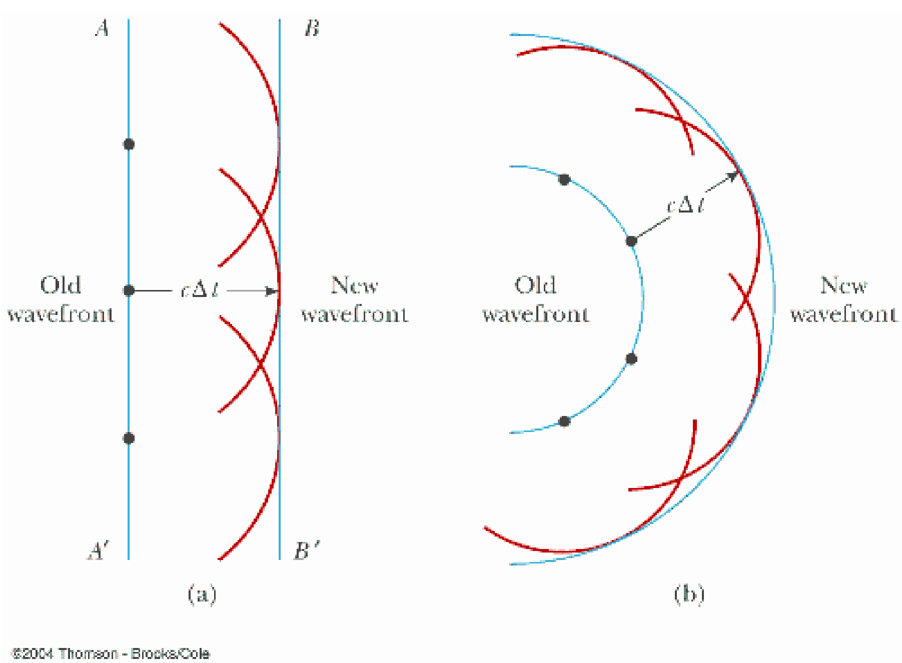
Wave Fronts Propagating From a Point Source

Huygen's Principle

Every point on a wave-front may be considered a source of secondary spherical wavelets which spread out in the forward direction at the speed of light. The new wave-front is the tangential surface to all of these secondary wavelets.

This principle enables us to determine

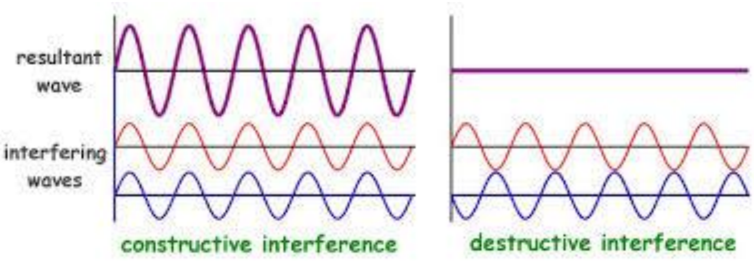
- Shape
- Location of the new wavefront



Interference of Light Waves

Wave interference is the phenomenon that occurs when two waves meet while traveling along the same medium.

The waves interfere either CONSTRUCTIVELY or DESTRUCTIVELY

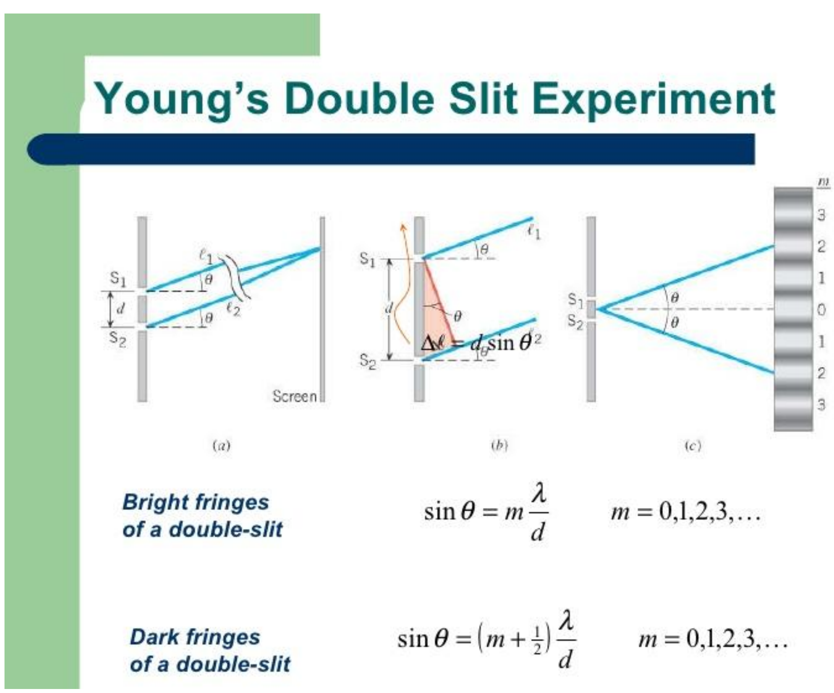


It has been shown that

- Amplitude increases in case of constructive interference
- Amplitude decreases in case of destructive interference
- If the crests fall on crests and troughs fall on troughe the result will be the constructive interference
- If the crests fall on troughs and the troughs fall on crests the result will be the destructive interference

Conditions for the interference of light waves

- The interfering beams must be monochromatic i.e, of single wavelength
- The interfering beams must be coherent (same phase)



Using Young's double slits to find the wavelength of light: $\lambda = \frac{ax}{D}$

λ = wavelength
x = fringe spacing
s = distance between slits
D = distance from slits to screen

Spacing between fringes

Sin $\theta \approx$ y/L

So that the formulas specifying the y - coordinates of the bright and dark spots, respectively are:

$y^B{}_m = \frac{m\lambda L}{d}$ bright spots

$y^D{}_m = \frac{(m+\frac{1}{2})\lambda L}{d}$ dark spots

The spacing between the dark spots is

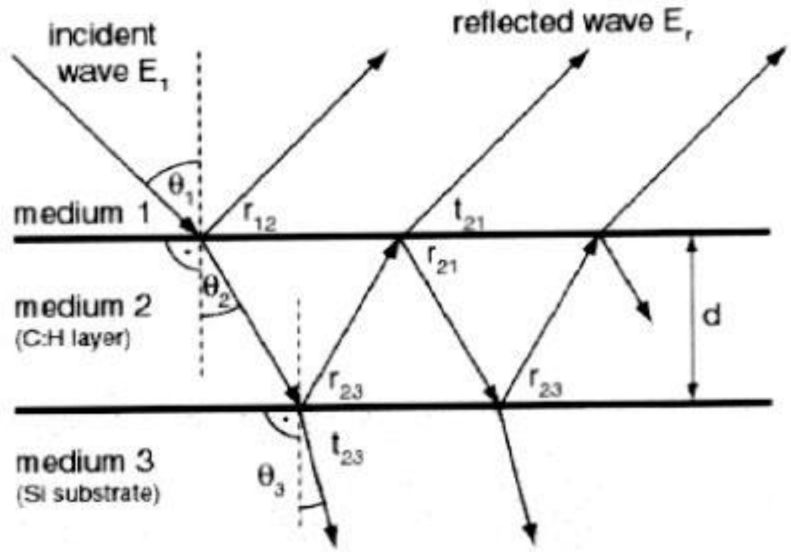
$\Delta y = \frac{\lambda L}{d}$

Similar is the case with spacing between bright spots

So, Spacing can be increased by

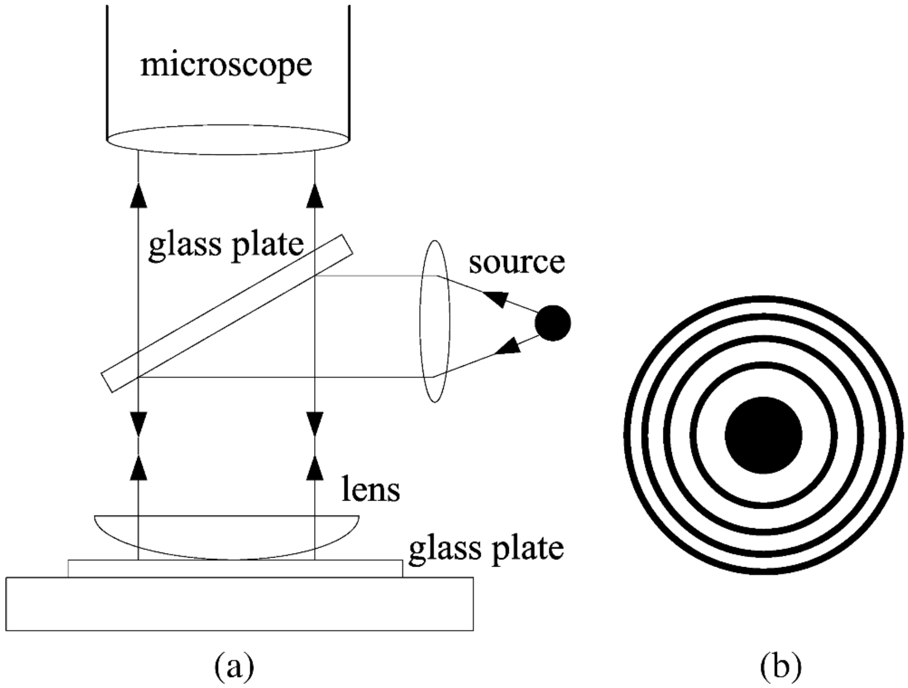
- Increasing wavelength
- Increasing distance between slits and screen
- Decreasing separation of slits

Interference in Thin Films



Newton's Ring

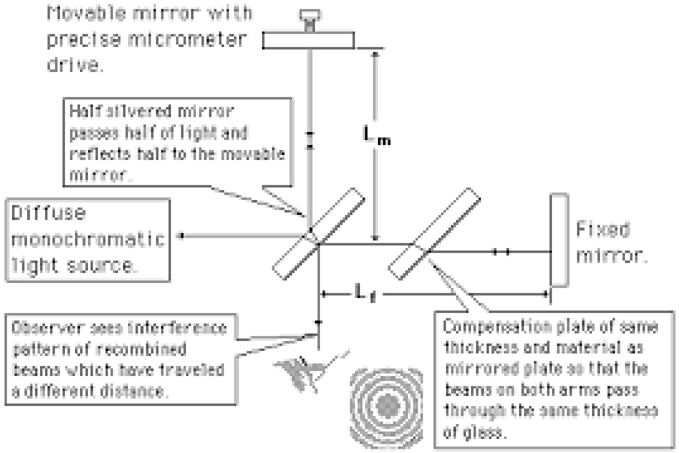
Newton's rings is a phenomenon in which an interference pattern is created by the reflection of light between two surfaces—a spherical surface and an adjacent flat surface.



Due to reflection at lower surface of air film from denser medium, an additional path difference of **λ/2 is introduced. Consequenty the centre of Newton's Ring is dark due to destructive interference**

Michelson's Interferometer

The Michelson interferometer produces interference fringes by splitting a beam of monochromatic light so that one beam strikes a fixed mirror and the other a movable mirror. When the reflected beams are brought back together, an interference pattern results.

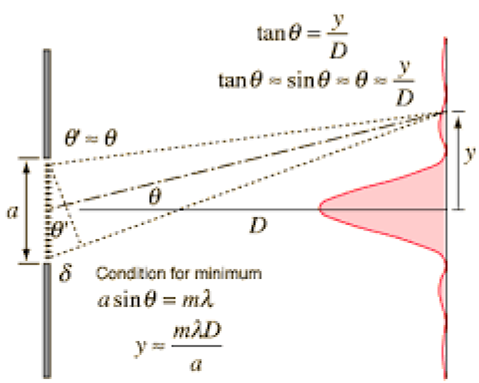


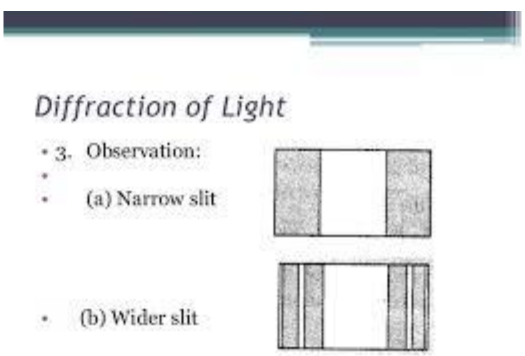
Diffraction of Light

The property of bending of light around the obstacles and spreading of light waves into geometrical shadow of an obstacle is called diffraction

- Diffraction is found to be prominent when the wavelength of light is large as compared with size of obstacle or aperture of the slit

Diffraction due to narrow slit

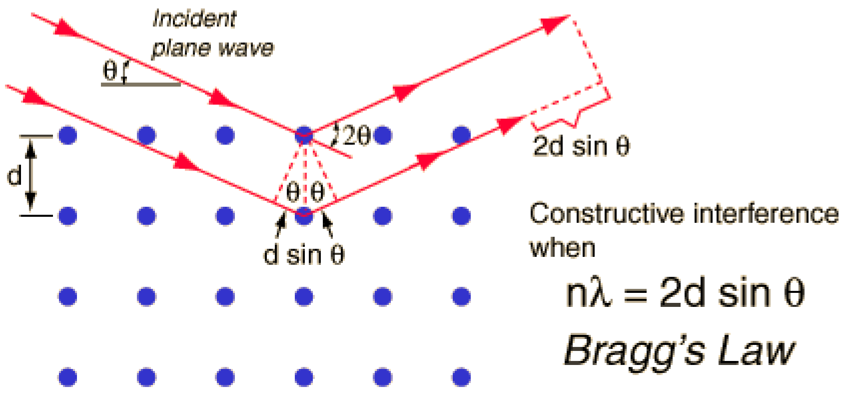




Diffraction Grating

- A **diffraction grating** is the tool of choice for separating the colors in incident light.
- The condition for maximum intensity is the same as that for a double slit.
- Angular separation of the maxima is generally much greater because the slit spacing is so small for a diffraction grating

Diffraction of X-rays by crystal (Bragg's Law)



When x-rays are scattered from a crystal lattice, peaks of scattered intensity are observed which correspond to the following conditions:

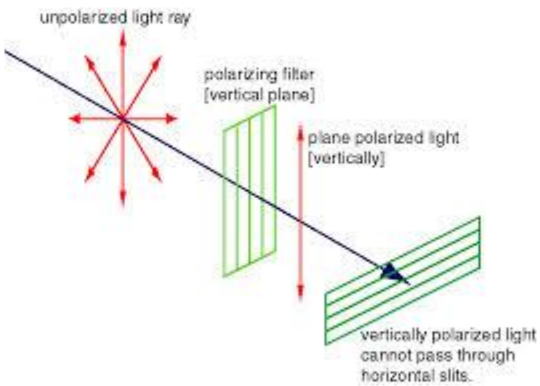
1. The angle of incidence = angle of scattering.
2. The pathlength difference is equal to an integer number of wavelengths.

Polarization

Polarization is a property of waves that can oscillate with more than one orientation.

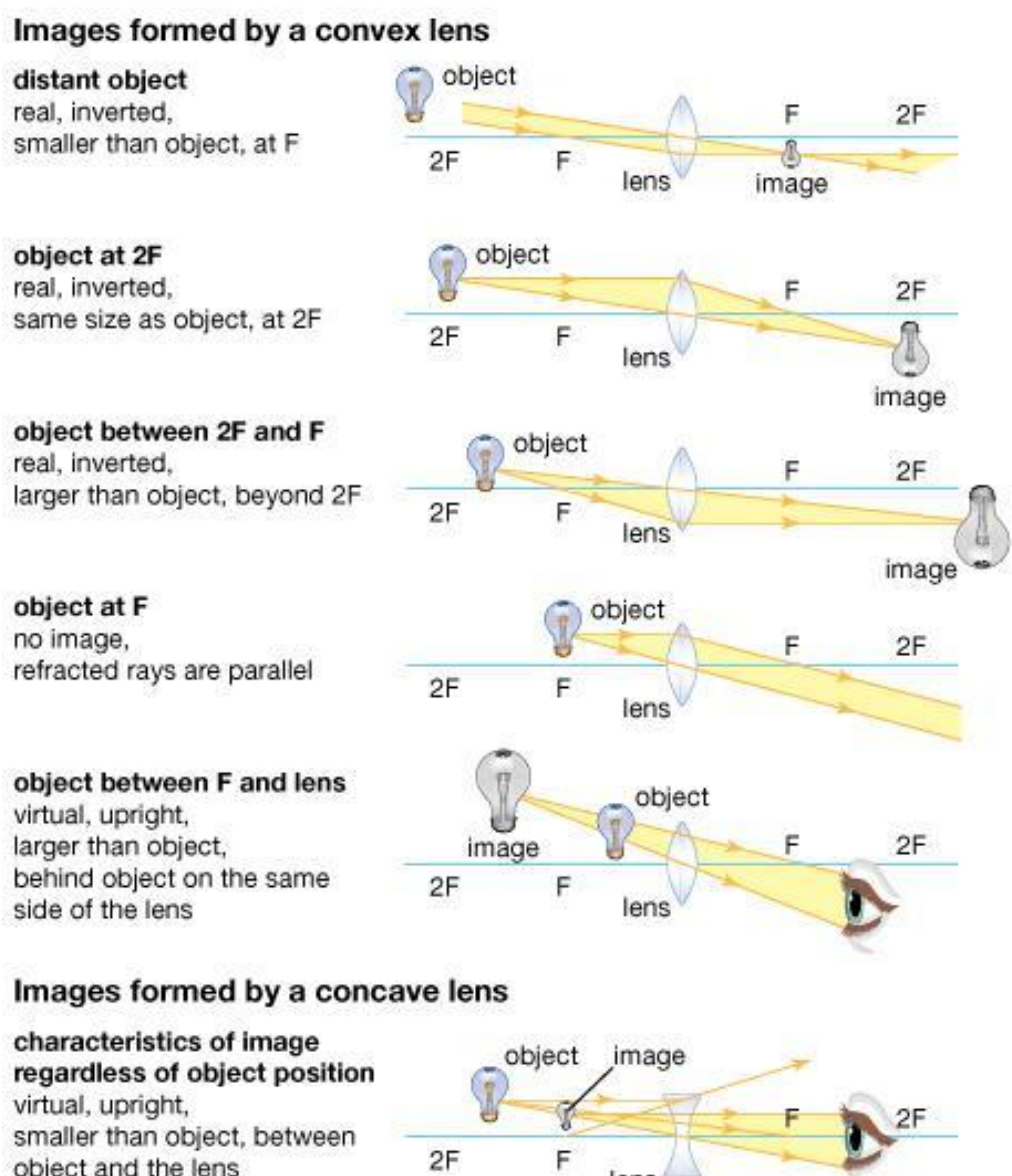
Electromagnetic waves such as light exhibit **polarization**, as do some other types of wave, such as gravitational waves.

- Polarization shows light waves to be the transversed waves

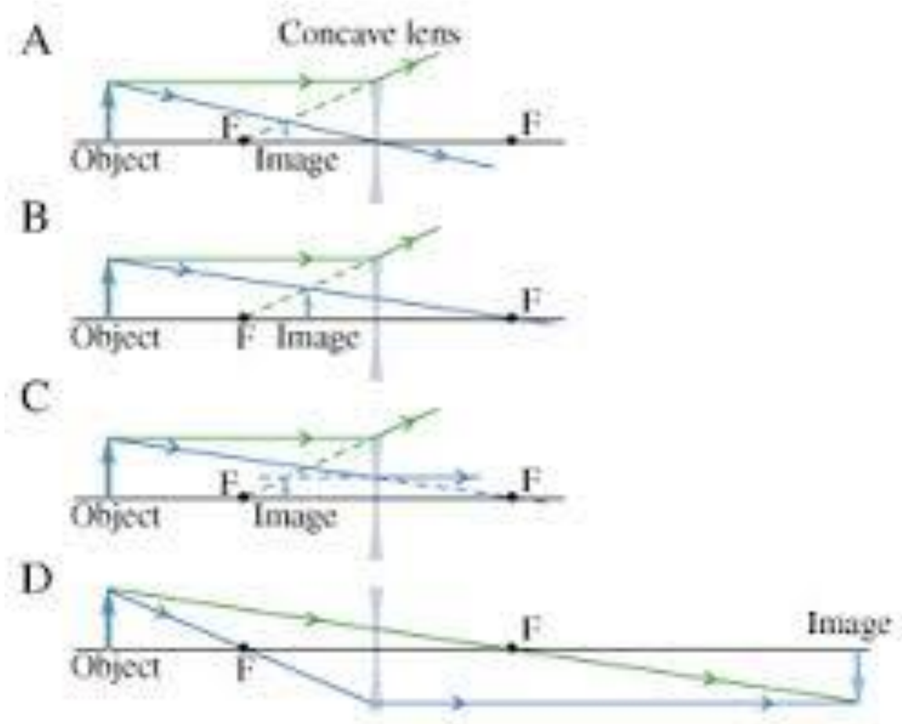


Chapter : 10 “ Optical Instruments

Images formed by convex lens



Images formed by concave lens



Resolving Power of an instrument

Resolving power is the ability of an imaging device to separate (i.e. to see as distinct) points of an object that are located at a small angular distance or it is the **power** of an optical instrument to separate far away objects that are close together into individual images.

$$R = 1/\alpha(min)$$

$$= D/1.22\lambda$$

Also

$$\mathbf{R = N * m}$$

Where N= number of rulings on grating

Simple Microscope

- The object is placed inside the focal length of lens.
- The magnified and virtual image is formed at least distance of distinct vision or much farther from the lens

$$M=\beta/\alpha$$

Where

β=angle formed by the image

α=angle formed by the object

Also

$$M=q/p$$

Where

q=distance of image

p=distance of object

Also

$$M=d/p=1+d/f$$

Lens formula

$$1/p=1/f+1/q$$

Compound Microscope

Compound microscope has two convex lenses:

- Object lens of short focal length
- Eye piece of large focal length

Sequence of image formation

- The object is placed just beyond the principle focus of the objective
- A real and magnified image is formed within the focal length of eye piece
- The eye piece is positioned and final image is formed at the near point of eye at distance d

$$M=q/p\ (1+d/fe)$$

More details can be viewed by using wider objective and light of short focal length

Astronomical Telescope

It consists of two convex lens

- An objective of long focal length
- An eye piece of short focal length

Image formation

- The object forms a real,inverted and diminished image
- The final image formed is virtual,enlarged and inverted

M=fo/fe

Speed of light

C=16fd

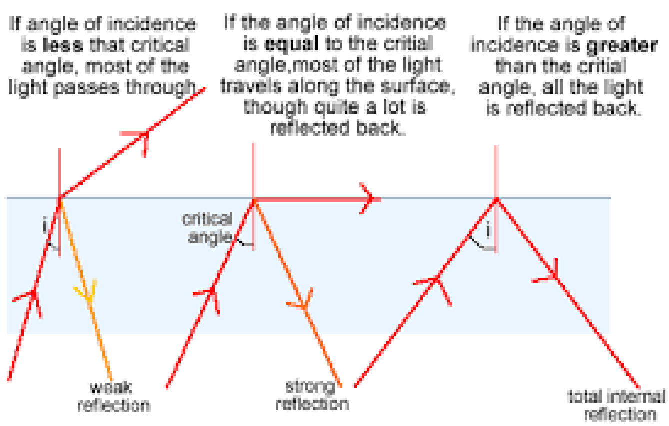
The speed of light depends on the nature of medium

- The speed of light in vaccum
  C=2.99792458 * 10^8 m/s
- The speed of light in other medium is always less than that in vaccum

Fibre Optic Principles

1. Total Internal Reflection

Total internal reflection is a strange phenomenon that happens when a propagating wave strikes a medium boundary at an angle larger than a particular critical angle with respect to the normal to the surface.



Refractive index = n=c/v

Where

c=speed of light in vaccum
v=speed of light in medium used

Critical Angle = sin θc = n2/n1

Where

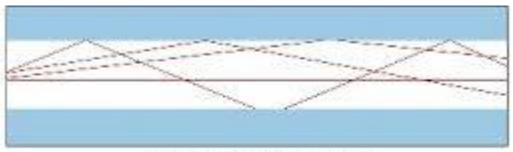
N2=refractive index of rare medium
N1= refractive index of denser medium

2. Continuous Refraction

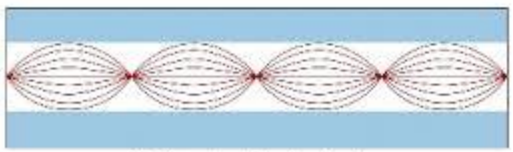
The light within optical fibre is continuosly refracted

Two types of fibres are used in which continuous refraction takes place

- Multi-mode step index fibre
- Multi-mode graded index fibre



Multimode, Step-Index



Multimode, Graded Index

HEAT & THERMODYNAMICS

Thermodynamics:

Energy exists in many forms, such as heat, light, chemical energy, and electrical energy. Energy is the ability to bring about change or to do work. Thermodynamics is the study of energy.

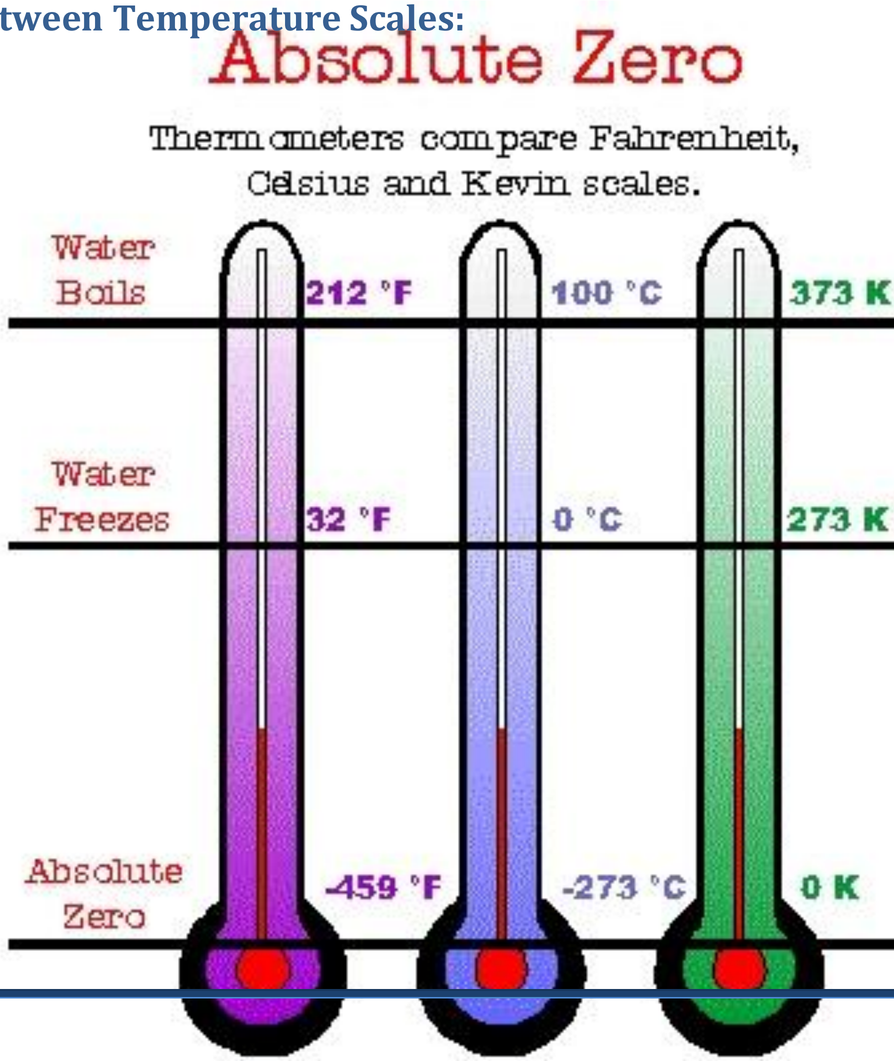
Difference between Heat & Temperature:

Heat is a form of energy whereas the quantity which describes the level of thermal energy is Temperature.

Temperature Scales:

1. Centigrade (°C)
2. Fahrenheit (°F)
3. Kelvin Scale (K)

Relation between Temperature Scales:



CONVERSIONS:

Fahrenheit / Celsius Formulas

$$°F = 9/5\ °C + 32$$

$$(°F - 32) * 5/9 = °C$$

A person with hypothermia has a body temperature of 29.1°C. What is the body temperature in °F?

$$°F = 9/5\,(29.1°C) + 32$$
$$= 52.4 + 32$$
$$= 84.4°F$$

K = °C + 273

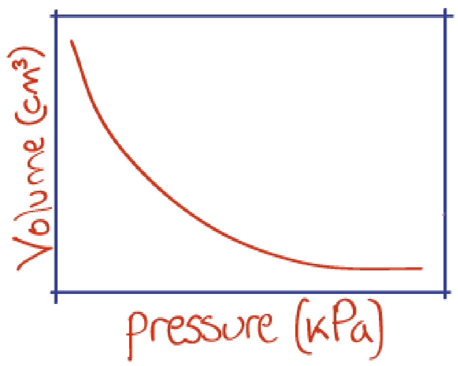
PRESSURE OF GAS:

Read theory from book. Keep in mind important relations like:

- Pressure is directly proportional to Kinetic Energy.
- Temperature is directly proportional to Kinetic Energy.

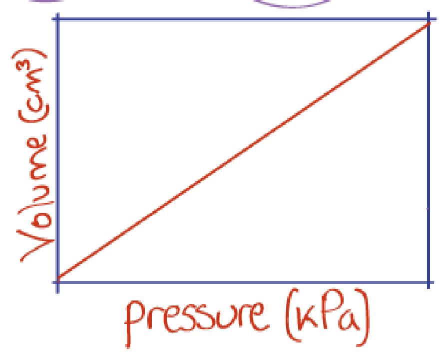
GAS LAWS:

Boyle's Law



Volume and pressure are inversely proportional: If the pressure doubles, the volume halves.

Charles' Law



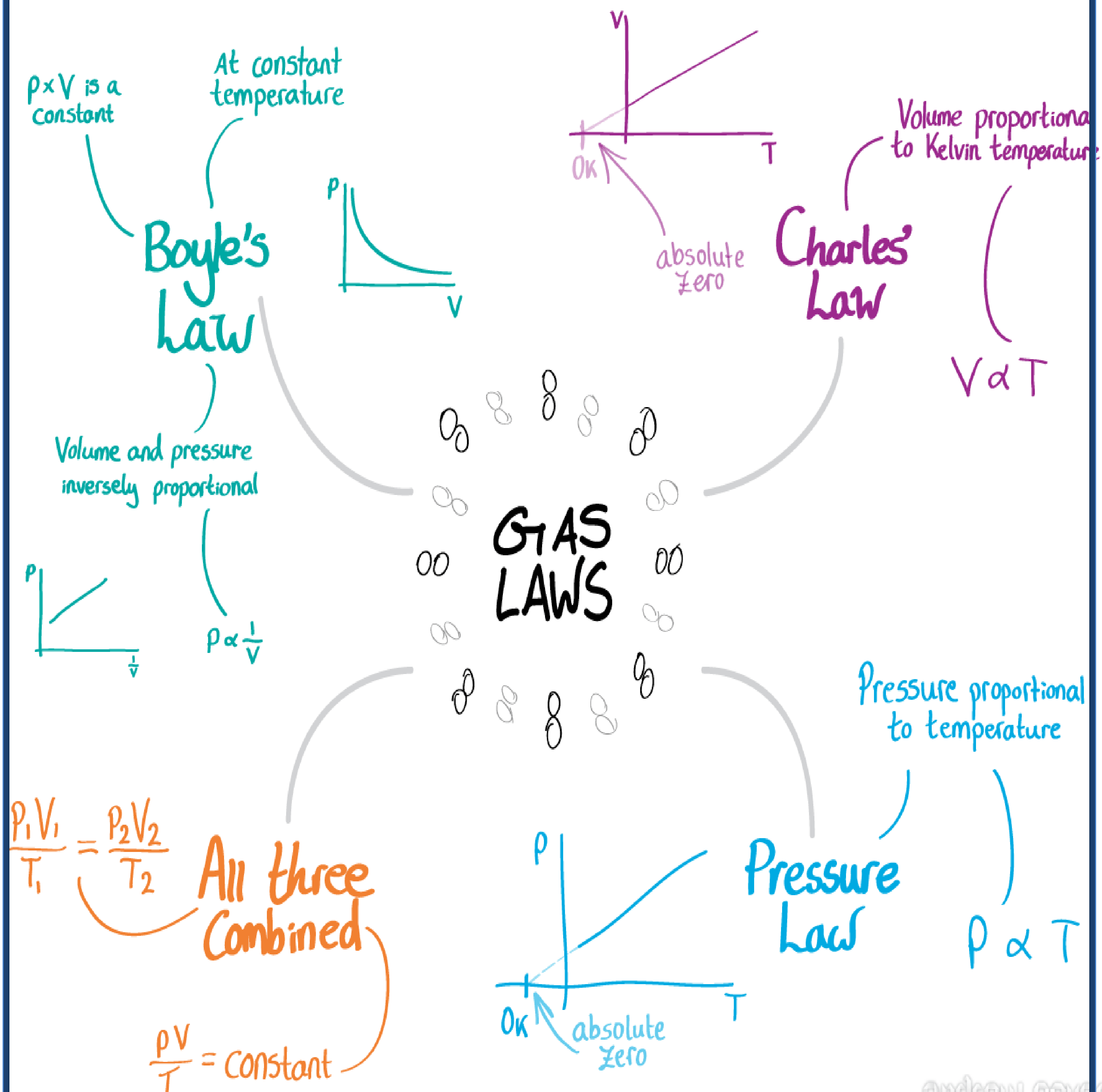
The volume is proportional to the Kelvin temperature. If the Kelvin temperature doubles, the volume doubles.

$\frac{P \times V}{T}$ is a constant number.

The vol. of a gas in a sealed container is

① Proportional to K temperature - if T doubles, V doubles.

② inversely proportional to the pressure - If P doubles, V halves.


GAS LAWS
Boyle's Law
p×V is a constant
At constant temperature
Volume and pressure inversely proportional
p ∝ 1/V
P
V
P
1/V
Charles' Law
Volume proportional to Kelvin temperature
V ∝ T
V
T
0K
absolute zero
Pressure Law
Pressure proportional to temperature
p ∝ T
P
T
0K
absolute zero
All three Combined
P₁V₁/T₁ = P₂V₂/T₂
pV/T = constant
andrew power

Thermal Expansion:

It is the expansion on heating. It has different types. i.e.

1. The change in length of object due to rise in temperature is known as linear thermal expansion.
2. The change in volume of object due to rise in temperature is known as volume expansion.
3. The change in area of a surface due to rise in temperature is known as Area expansion or Superficial expansion.

Internal Energy:

The sum of all forms of molecular energies(kinetic and potential) of a substance is termed as its internal energy. The internal energy of an ideal gas system is generally the translational K.E of its molecules. For an ideal gas system, the internal energy is directly proportional to its temperature. It is important to note that heat energy can be added to a system even though no heat transfer takes place. In thermodynamics, Internal energy is a function of state. So, it does not depend on path of process but depends on initial and final states of the system.

First Law of Thermodynamics:

Energy can be changed from one form to another, but it cannot be created or destroyed. The total amount of energy and matter in the Universe remains constant, merely changing from one form to another.

Or

The change in a system's internal energy is equal to the difference between heat added to the system from its surroundings and work done by the system on its surroundings.

Though this may sound complex, it's really a very simple idea. If you add heat to a system, there are only two things that can be done -- change the internal energy of the system or cause the system to do work (or, of course, some combination of the two). All of the heat energy must go into doing these things.

$$Q = \Delta U + W.$$

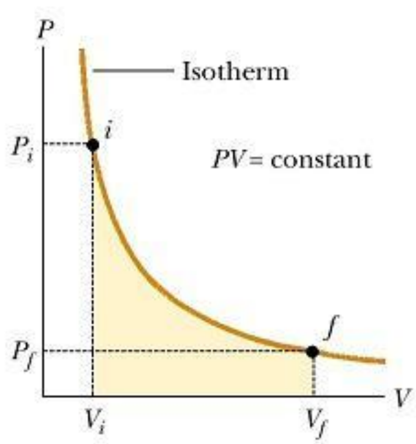
Adiabatic Process:

- It is a thermodynamic process in which no heat is transferred to or from the system.
- Any process that occurs within a container which is a good thermal insulator is adiabatic.
- Strictly speaking adiabatic processes do not exist, since one cannot provide absolute thermal isolation.
- In this sense adiabatic process is an idealization. However, there are situations when it is a good approximation to treat a process as adiabatic. These situations are:
  1) The system is fairly well thermally isolated.
  2) The process is so fast that heat has no time to escape or to enter the system.
  3) Neither the system is isolated, nor the process is very fast, but the system is very large.

Isothermal Process:

- An isothermal process is a change of a system, in which the temperature remains constant:

$$\Delta T = 0$$



The *PV* diagram for an isothermal expansion of an ideal gas from an initial state to a final state. The curve is a hyperbola.

MOLAR SPECIFIC HEATS OF A GAS:

Molar Specific Heat:

It is the amount of heat required to raise the temperature of one mole of a substance through 1 Kelvin.

To study the effect of heating the gases, either pressure or volume is kept constant.

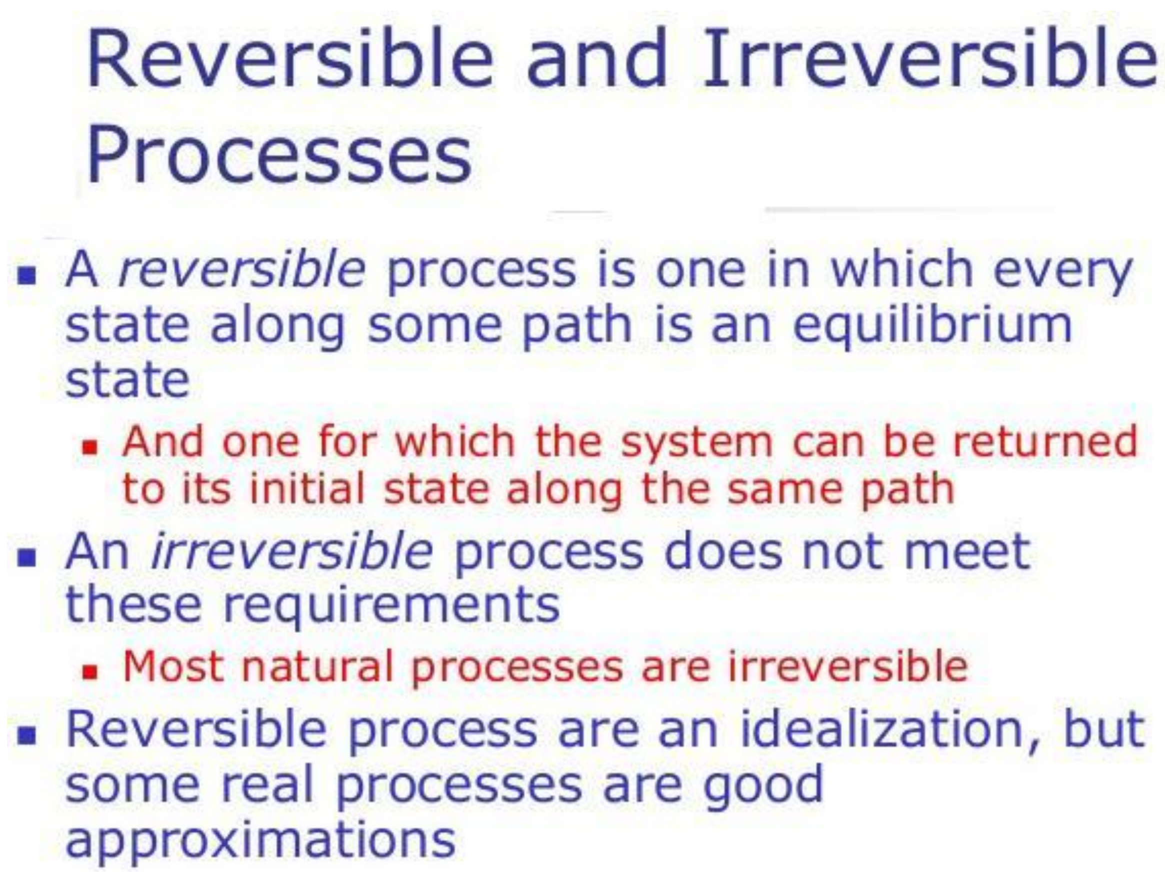
Molar Specific Heat at Constant Volume:

It is the amount of heat required to raise the temperature of one mole of a substance through 1 Kelvin at constant volume. It is denoted by C_v. Units are $Jmol^{-1}K^{-1}$.

Molar Specific Heat at Constant Pressure:

It is the amount of heat required to raise the temperature of one mole of a substance through 1 Kelvin at constant pressure. It is denoted by C_p. Units are $Jmol^{-1}K^{-1}$.

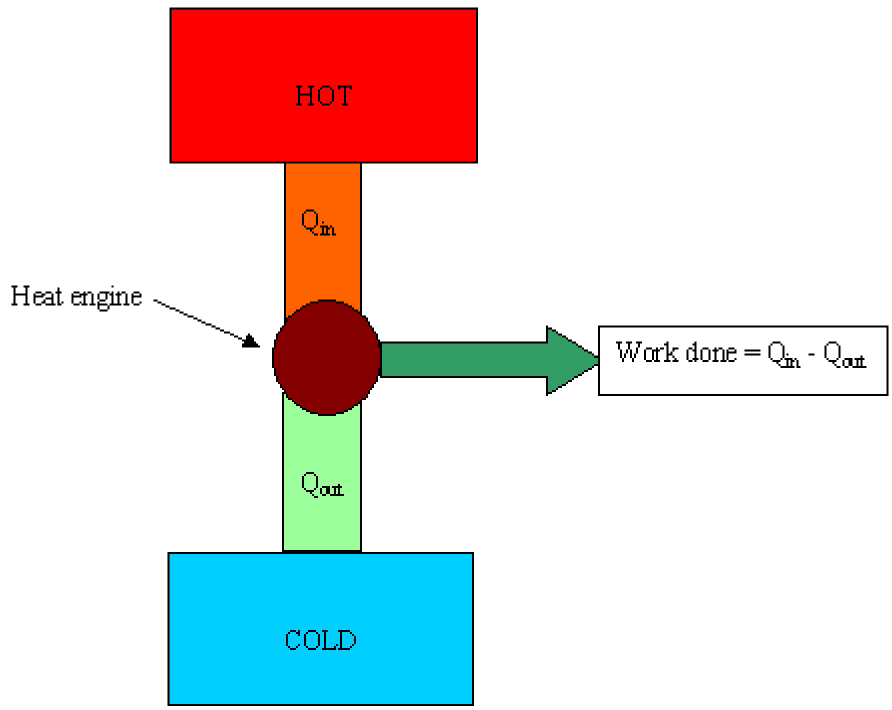
Learn all the relations like $C_p - C_v = R$..



Heat Engine:

In thermodynamics, a heat engine is a system that converts heat or thermal energy to mechanical energy, which can then be used to do mechanical work.

A heat engine consists of hot reservoir which can supply heat at high temperature and cold reservoir or sink into which heat is rejected at a lower temperature.



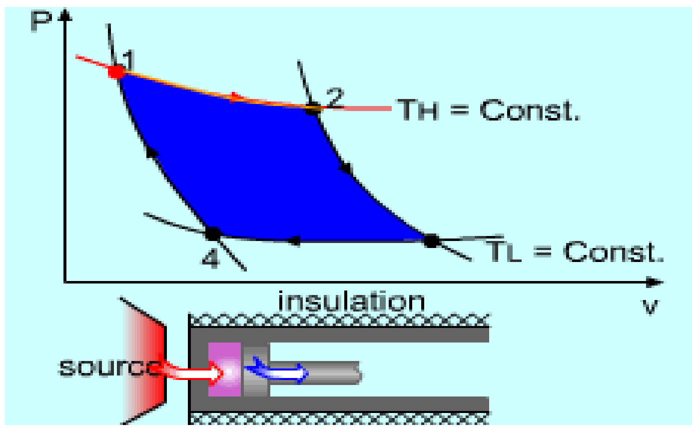
SECOND LAW OF THERMODYNAMICS:

The second law says that heat cannot be transferred from a colder body to a hotter body without work being done by an outside agent. Stated another way, no device can be built that will repeatedly extract heat from a source and deliver mechanical energy without ejecting some heat to a lower-temperature reservoir. The perfect example is the heat engine,

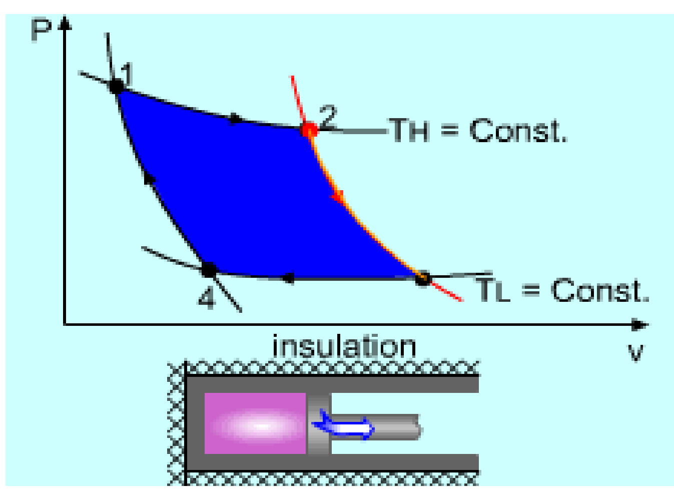
CARNOT CYCLE:

It consists of four steps.

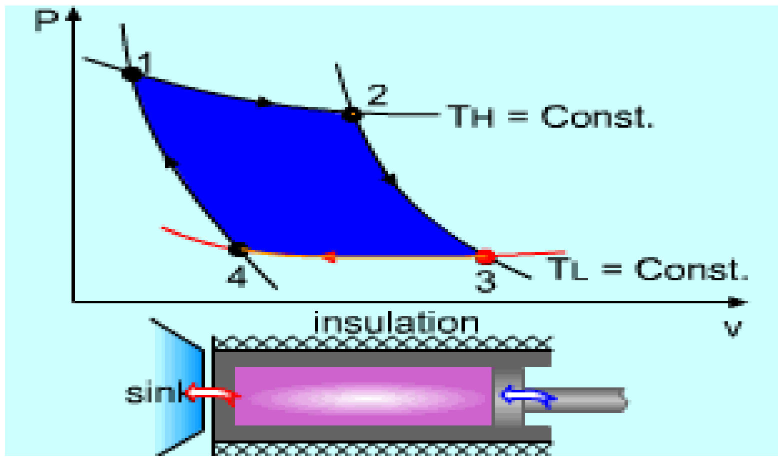
- **Reversible Isothermal Expansion (process 1-2):**
  Heat transfer between the heat source and the cylinder occurs with an infinitesimal temperature difference. Hence, it is a reversible heat transfer process. Gas in the cylinder expands slowly, does work to its surroundings, and remains at a constant temperature T_H. The total amount of heat transferred to the gas during this process is Q_H.



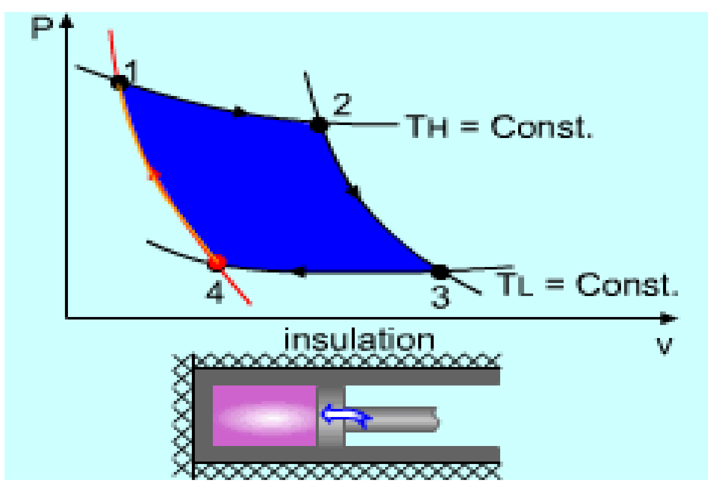
- **Reversible adiabatic expansion (process 2-3):**
  The heat source is removed, and the gas expands in an adiabatic manner. Gas in the cylinder continues to expand slowly, do work to its surroundings till the temperature of the gas drops from T_H to T_L. Assuming the piston moves frictionless and the process to be quasi-equilibrium, the process is reversible as well as adiabatic.

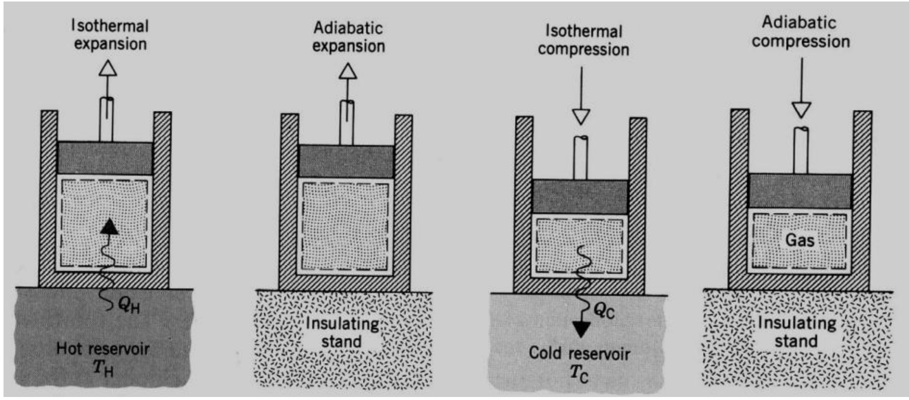


- **Reversible isothermal compression (process 3-4):**
  The cylinder is brought into contact with a heat sink at temperature T_L. The piston is pushed by an external force and which does work on the gas. During the compression, the gas temperature maintains at T_L and the process is a reversible heat transfer process. The total amount of heat rejected to the heat sink from the gas during this process is Q_L.



- **Reversible adiabatic compression (process 4-1):**
  The heat sink is removed and the gas is compressed in an adiabatic manner. Gas in the cylinder continues to be compressed slowly, accepting work from its surroundings till the temperature of the gas rises from T_L to T_H. The gas returns to its initial state, which completes the cycle.





See the formulae of efficiencies from book.

Thermodynamic Scale of Temperature:

Thermodynamic temperature is defined by the third law of thermodynamics in which the theoretically lowest temperature is the null or zero point. At this point, called absolute zero, the particle constituents of matter have minimal motion and can become no colder.

- The **THERMODYNAMIC** temperature scale is **theoretical** and is **independent of the properties of any particular thermometric substance.**

- The scale is also known as the **Absolute Temperature Scale**.

The ***two fixed points*** in the Thermodynamic Temperature Scale are:

(a) **absolute zero** which is the temperature at which the pressure of an *ideal* gas becomes zero. It is arbitrarily given the value 0 K.

(b) **the triple point of water** which is the temperature at which *ice, water and water vapour coexist in dynamic equilibrium.*

- The **triple point** of water is chosen because it
  - is unique, invariant and occurs only at **one definite temperature** and **pressure**.
    (T = 273.16 K and Pressure = 611.73 Pa)
  - can be **easily and accurately reproduced** using a triple point cell.

The unit of temperature in the *thermodynamic scale* is the **kelvin**, symbol **K**.

Kelvin is also the S.I. unit of temperature

One kelvin is defined to be $\frac{1}{273.16}$ of the thermodynamic temperature of the triple point of water

$$\text{If, } \frac{1}{273.16} \times T_{tr} = 1\,\text{K}$$

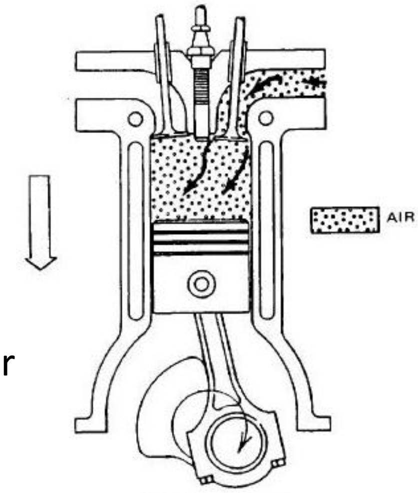
$$T_{tr} = 273.16\,\text{K}$$

PETROL ENGINE 4 STROKE:

Brief Review of 4-Stroke Engine Cycle

1) Intake Stroke

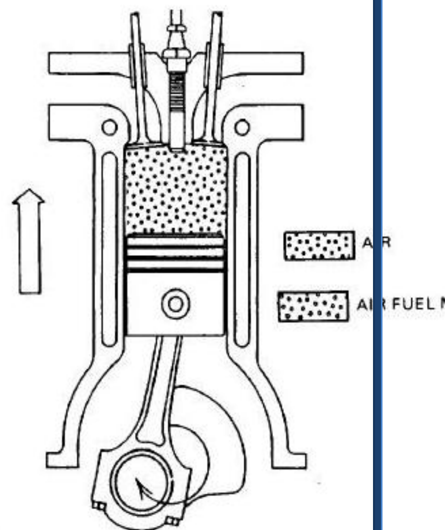
The inlet valve is opened and the fuel/air mixture is drawn in as the piston travels down.



A. INTAKE STROKE

2) Compression Stroke

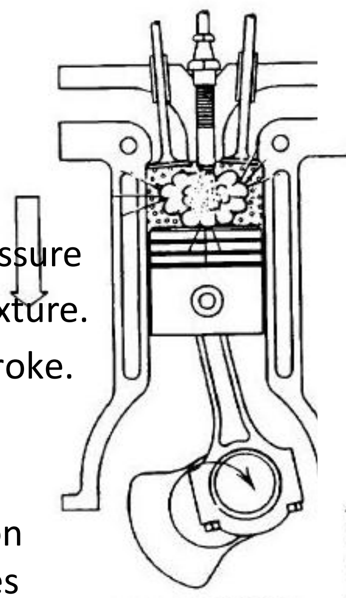
The inlet valve is closed and the piston travels back up the cylinder compressing the fuel/air mixture. Just before piston reaches the top of its compression stroke a spark plug emits a spark to combust the fuel/air mixture.



B. COMPRESSION STROKE

3) Combustion Stroke

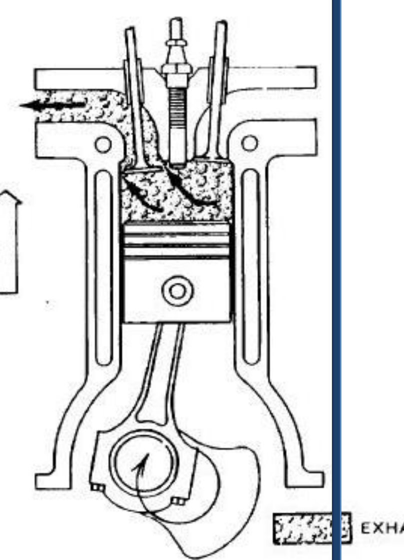
The piston is now forced down by the pressure wave of the combustion of the fuel air mixture. The engines power is derived from this stroke.



C. POWER STROKE

4) Exhaust Stroke

The exhaust valve is opened and the piston travels back up expelling the exhaust gases through the exhaust valve.
At the top of this stroke the exhaust valve is closed. This process is then repeated.



D. EXHAUST STROKE

Efficiency is 25 to 30% in petrol Engine.

Diesel Engine:

No spark plug is used in diesel engine. It's efficiency is 35 to 40%.

Entropy

- Thermodynamic function that describes the number of arrangements that are available to a system existing in a given state.
- A thermodynamic (*energy*) function that describes the degree of ***randomness*** or ***probability*** of existence.
- As a *state function* – entropy change depends only on the initial and final states, but not on how the change occurs.
- The driving force for a spontaneous process is an increase in the entropy of the universe.

What is the significance of *entropy*?

- Nature spontaneously proceeds toward the state that has the highest probability of (energy) existence – highest entropy
- Entropy is used to predict whether a given process/reaction is thermodynamically possible