SCHEME OF WORK FIRST TERM

PHYSICS (S.S.S. I)

WEEK	TOPIC	CONTENT
1	(a) Introduction to physics. (b) Quantities and units	(i) Definition of physics (ii) Branches of physics (iii) Application of physics(in automobile, space, aeronautics, electronics, communication, warfare, medicine, etc.) (iv) career prospects in physics (v) -Fundamental quantities and units, -Derived quantities and units -Dimension
2 3	Measurements Time measurements Scalar and vector quantity	- Length and mass - Concept of time - Ways of measuring time
4	Position, distance and displacement	Measurement of distance - Concept of direction - Distinction between distance and displacement
5	Speed and velocity	(a) Concept of speed (b) Concept of velocity (c) Distance – time graph (d) Displacement – time graph (e) Instantaneous speed/velocity.
6	Rectilinear	(a) Concept of acceleration (b) Uniform and non-uniform acceleration (c) Velocity-time graph. Analysis of rectilinear motion.
7	Scalars and Vectors	-Concept of scalars -Concept of vectors -Distinction between scalars and vectors -Vector representation -Addition of vectors -Resolution of vectors
8	Motion	Type of motion – (a) Random motion (b) Translation motion (c) rotational motion (d) Oscillatory motion. 2. Relative motion
9	Motion	(1) Cause of motion (2) Types of forces (3) Reducing friction (4) Simple ideas of circular motion
10	Work, energy and power	(a) Concept of work, energy and power (a) Measurement of work, energy and power (c) Types of mechanical energy – Potential and Kinetic energy (d) Conservation of mechanical energy.

WEEK ONE

INTRODUCTION TO PHYSICS

INTRODUCTION

For man to harness and enhance the universe in which they live, the knowledge of science of which physics is one major branch is required.

Physics is the branch of science that deals with the physical properties of matter and energy and how they interact in respect to the universe.

Branches of physics are mechanics, electricity, optics, sound, heat, atomic physics and magnetism.

(1) **Mechanics:** This is the branch of physics that studies force and its cause, types of force, properties of matter etc. It is divided into kinematics (dynamics) and statics. Kinematics studies body in motion while statics studies body at rest.

(2) **Electricity:** This is the branch of physics that studies generation of voltage and currents, charges and their effects. Electricity can be direct current (d.c) or alternating current (a.c).

(3) **Optics**: This is the branch of physics that studies luminous energy i.e. energy which causes the sensation of vision, it modes of propagation and measurable properties like reflection, diffraction and refraction.

(4) **Sound**: This is the branch of physics that studies sound energy, it propagation though gaseous, liquid and solid particles.

(5) **Heat:** This is the branch of physics that studies energy in relation to how it can be used to do useful work and it transfer through conduction, radiation and convection.

(6) **Atomic physics:** This is the branch of physics that deals with the bombardment of the nucleons of different substance like uranium to obtain atomic energy.

(7) **Magnetism:** This is the branch of physics that studies magnet and its properties. It also studies the production of magnet by passage of electric current in a solenoid.

Application of physics

(1) Physics is applied in the study of engineering and technology
(2) It is applied in the study of geophysics
(3) It is applied in the study of industrial physics
(4) It is applied in the study of biophysics

Careers in physics

Accelerator operator; Application engineer; Data analyst; Design engineer; High school physics teacher; IT consultant; Laser engineer; Laboratory engineer.

Experiment and Theory:

Science means the ability to know, being inquisitive of something. Those that studies sciences are called scientist. In science, experiment is carried out to verify observation and hypothesis. Hypothesis is making intelligent guess based on observation. The outcome of the experiment leads to result and analysis. When the result is accepted by other scientist, it becomes a theory. If the result is proved beyond doubt and put into practice and it works, then, it becomes a law.

Scientific method involves:

(i) Observation
(ii) Identification
(iii) Hypothesis
(iv) Experiment
(v) Result and analysis
(vi) Theory (vii) Law

QUANTITIES AND UNITS

INTRODUCTION

Physics quantities are those measurable quantities that are used in physics. Examples of physical quantities are velocity, mass, area, acceleration, momentum etc.

Fundamental quantities and units: Fundamental quantities are those physical quantities upon which other quantities depend for their definition and units. The three basic quantities are length, mass and time. Other includes electric current, thermodynamic temperature and amount of substance.

The S.I (System Internationale) unit of fundamental quantities is called fundamental units.

Examples of fundamental quantities and units are shown below

Fundamental quantities	unit	Abbreviation
Length	Metre	M
Mass	Kilogram	Kg
Time	Second	S
Thermodynamic temperature	Kelvin	K
Electric current	Ampere	A
Amount of substance	Mole	Mol.

Derived quantities and units:
Derived quantities are those quantities that are derived from fundamental quantities i.e. they are those quantities obtained by the combination of two or more fundamental quantities. Example are velocity, area, density, pressure, force etc.

Derived quantities	Derivation	Derived units	Abbreviation
Area (A)	Length x breath	Metre square	m^2
Volume (V)	Length x breath x height	Meter cube	m^3
Velocity (V)	Displacement / time	Metre per-second	m/s or ms^{-1}
Acceleration (a)	Velocity / time	Metre per second square	m/s^2 or ms^{-2}
Momentum	Mass x velocity	Newton second	Ns or Kgm/s
Density (S)	Mass / volume	Kilogram per metre cube	Kg/m^3 or kgm^{-3}
Force (F)	Mass x acceleration	Newton	N
Pressure (P)	Force / Area	Newton per metre square	N/m^2 or Nm^{-2}
Work or energy (W/E)	Force x distance	Joule or Newton metre	J or Nm
Power (P)	Work / time	Joule per second (watt)	J/s or Js^{-1}

DIMENSION:

The dimension of a physical quantity is the algebraic symbol assigned to the quantity independent of its units. It shows how quantities are made in terms of fundamental quantities symbol.

Fundamental quantities	Dimension
Length	L
Mass	M
Time	T
Electric current	I

The dimensions of derived quantities are functions of or depend on the dimension of fundamental quantities. Example: Velocity = displacement /Time i.e. Length / Time
:. The dimension of velocity is LT^{-1} or L/T

Derived Quantities	Dimension
Volume = length x breadth x height	L^3
Density = mass / volume	M/L^3 or ML^{-3}
Force = mass x acceleration	MLT^{-2} or ML/T^2
Velocity = length x breadth	LT^{-1} or LT
Power = work/Time	ML^2T^{-3}
Area = Length x breadth	L^2
Pressure = force / Area	$ML^{-1}T^{-2}$ or M/LT^2
Work = Force x distance	ML^2T^3 or ML^2/T^3
Momentum = Mass x velocity	MLT^{-1}
Acceleration = Velocity / time	LT^{-2} or L/T^2

Multiples and Submultiples

Multiples and submultiples of basic units can be obtained as follows:

Multiple	Example	Prefixes
10^1	decametre	deca- (da)
10^2	Hectometre	hecto – (h)
10^3	Kilogram	Kilo – (K)
10^6	Mega Newton	Mega – (M)
10^9	Giga Joule	Giga (G)
10^{12}	Tera Joule	Tera (T)

Submultiples	Example	Prefixes
10^{-1}	Decimeter	deci- (d)
10^{-2}	Centimetre	Centi – (c)
10^{-3}	Millimetre	Milli (m)
10^{-6}	Micrometre	Micro – (μ)
10^{-9}	Nanometre	Nano - (n)
10^{-12}	Pic farad	Pico (p)

WEEK TWO & THREE
MEASUREMENT OF MASS, LENGTH AND TIME

INTRODUCTION
System Internationale (S.I) units is a system of units that is use in physics to obtain similar results when different instruments are use to measurement the same quantity by different scientists.

Measurement of mass and weight: Mass is the quantity of matter in a body. The S.I unit of mass is kilogram (Kg). Instruments use in measuring mass are lever balance, chemical or beam balance, top pan balance and spring balance.

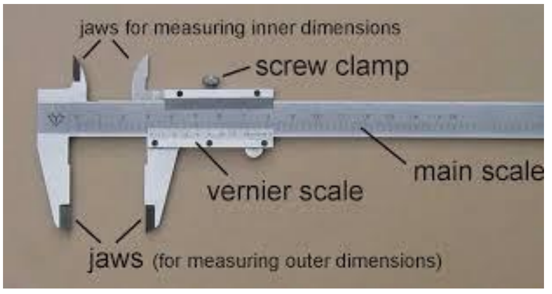
It should be noted that the chemical or beam balance is use for comparing masses. It is expedient to note that mass of an object is different from the weight of the same object but they are related by the equation w = mg.
Where
W is weight in Newton (N)
M is the mass in kilogram (kg)
g is acceleration due to gravity in metre/second square (m/s^2)
and it has a constant value of $9.8m/s^2$ = $10m/s^2$

Differences between mass and weight

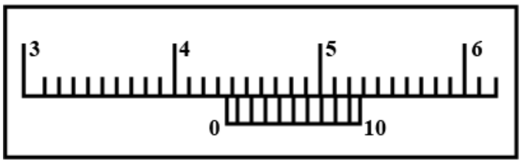
Mass	**Weight**
It is a measure of the quantity of matter	It is the pulling force of the earth on an object.
Its S.I unit is kilogram (kg)	Its S.I unit is Newton (N)
It's the same on the surface of the earth	Its varies from place to place on the earth's surface
Mass = weight/acceleration due to gravity	Weight = Mass x acceleration due to gravity
Measured using chemical balance	Measured using spring balance

Measurement of length: The distance between two points is called length. The S.I unit of length is metre(m). The instruments use for measuring length differs depending on the length to be measured.
Large length like the school compound is measured using measuring tape. Short length is measured using metre rule. The diameter of a cylinder is measured using vernier calipers. The external and internal diameter of a tube is measured by the two sets of jaws on a vernier calipers.

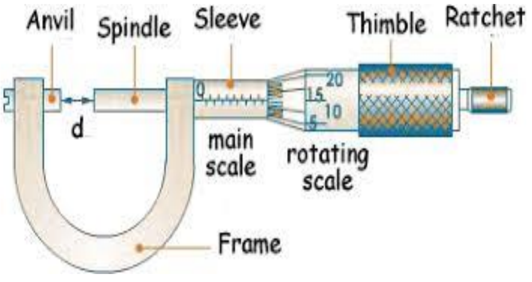
Vernier caliper: Vernier caliper is an instrument that is used to measure small length like the thickness of a plate. It is also used to measure the internal and external diameter of a tube, diameter of thin rod and the depth of a cavity like depth of a cup. It has an accuracy of 0.01cm.
The vernier caliper has two scales, the main scale and the vernier scales. The true reading = main scales reading + vernier scale reading.
The vernier scale reading is gotten by dividing nine of 0.1cm into ten equal intervals so that each vernier scale division has a length of 0.09cm



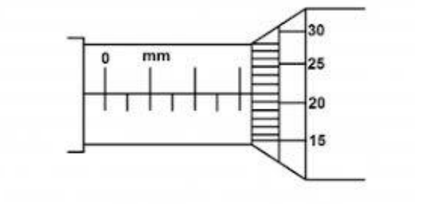
Vernier caliper



Main scale reading = 4.3
Vernier scale reading = + 0.07
True reading 4.37cm



Micrometer screwguage



main scale reading = 3.0mm
vernier scale reading = +0.21mm
true reading 3.21mm

Micrometer Screwguage:

Micrometer screwguage is an instrument for measuring smaller or thing length like the diameter of a wire and the thickness of a paper. Like the vernier caliper, it has the main scale and vernier scale. The vernier scale is obtained by dividing 0.05cm (0.5mm) by 50. Hence, it has an accuracy of 0.001cm (0.01mm). true reading = main scale + vernier scale.

Time measurement:

Time is that in which events are distinguishable with reference to before and after.
In time past, the natural time unit is the sun, crooking of clock etc. The time for the earth to complete or revolution on its axis is found to be 24 hours. One hour is found to be 60 minutes and one minute is equal to 60s. Therefore, one day is equal to 24 x 60 x 60 = 8640 seconds. The S.I unit of time is second. The instruments for measuring time in the laboratory are stop watch and clock.

MEASURING OF VOLUME

Regular objects: Regular objects are those objects whose shapes are defined or known by science or mathematics principles. Examples are sphere, rectangular block and cylinder.

(i) **Sphere:** The diameter of the sphere is measured using micrometer screwguage

$$Volume\ of sphere = 4\pi r^3/3$$

But, $r = \frac{d}{2}$

$$Volume = \pi d^3/6$$

$$Therefore, Volume = 4\pi r^3/3 = \pi d^3/6$$

(ii) **Rectangular block:** The volume of a rectangular block is obtained by multiplying the length, breadth and height i.e volume = l x b x h

(iii**)** **Cylinder:** This can be obtained by first measuring the height of the cylinder and its diameter.

$$Volume\ of\ cylinder = \pi r^2 h = \frac{\pi d^2 h}{2}$$

(iv**) Liquid:** The volume of liquid is measured using the measuring cylinder, a pipette or burette.

Volume of irregular objects: An irregular object are those shapes that cannot be determined by science or mathematics principle eg of object with irregular shape is stone. Therefore, the volume of an irregular solid is obtained by immersing the solids into an eureka cylinder or can. Some liquid will be displaced into a measuring cylinder. The volume of the irregular solid is equal to the volume of liquid inside the measuring cylinder.

WEEK FOUR
POSITION, DISTANCE AND DISPLACEMENT

INTRODUCTION

In physics, physical quantities are classified as scalar or vector.

Scalar quantity: A scalar quantity is a physical quantity with magnitude but no direction. Examples of scalar quantities are length, mass, temperature, speed, distance etc.

By magnitude, we mean that it has numerical value only e.g 12cm of length, 20^oc etc

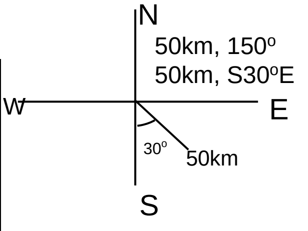
Vector quantity: A vector quantity is a physical quantity with magnitudes and direction. Examples of vector quantities are forces, velocity, displacement etc. 20cm from your left, 50cm, N30^oE

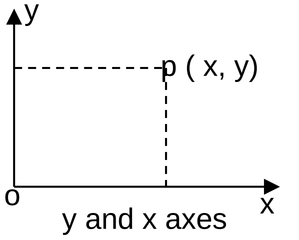
Distinction between vector and scalar quantities: Vector quantities has magnitude (numeric value) and direction but scalar quantity has only magnitude but no direction.

Position: The position of an object in space is described with reference to point whose location is well defined. In physics, it is normal to use reference axes to locate objects. For the purpose of this topic, we are going to use only the x and y axes.

Y – axis is the vertical reference axis and x – axis is the horizontal reference axis. The point of intersection of the value zero (o). The point that describes the position of an object with references to the x and y axes is called the coordinates and it is represented by (x, y).

Another method of describing the position of an object is by taking cardinal points which are North, South, East and West. The reference cardinal point is the North and is assigned the value zero (o) and angular measurement goes clockwise. South cardinal point is also taken as reference point.





Distance (d): Distance is the length between two points or length traveled in an unspecified direction. The S.I unit of distance is metre(m) but bigger unit is kilometer while smaller units is centimeter (cm). Distance is a scalar quantity e.g 20m, 50m etc.

Displacement: Displacement is distance traveled in a specified direction. It has same unit as distance but it's a vector quantity. E.g. 20m due North, 30m due South, 10m, N30^oE.

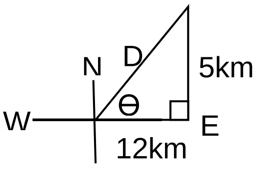
<u>Calculation</u>

(i) A man rides a motor cycle 12km due east and 5km due north. Calculate

(a) Total distance traveled,

(b) Displacement of the man

Solution:



(i) Total distance 12+5 = 17km

(ii) Using Pythagoras theory,

$D^2 = 122 + 52$

$D^2 = 144 + 25 = 169$

$D = \sqrt{169} = 13km$

$\tan \Theta = 5/12$

$\Theta = \tan^{-1} (5/12) = 22.6^o$

Direction = $90 – 226^o = 67.4^o$

.: (i) 17km (ii) 13km, N67.4^oE

WEEK FIVE

SPEED AND VELOCITY

INTRODUCTION

Physical quantities are grouped into scalar and vector quantities. Scalar quantity has magnitude only but vector has both magnitude and direction.

Speed (v): It is the rate of distance traveled. The S.I. unit of speed is metre per second (m/s). It is scalar quantity mathematically, speed = distance/time i.e. v =d/t

Where v is speed in metre per second (m/s)
d is the distance
t is time in second(s)

Velocity (V): This is the rate of change of displacement. It is a vector quantity. Velocity is also defined as speed traveled in a specified direction.

Types of Velocity

(i) **Uniform or constant velocity:** Is a velocity where equal displacements are covered in equal time.

(ii) **Non-uniform or variable velocity:** Is the velocity of a body that does not cover equal displacement in equal time.

(iii) **Instantaneous velocity:** is the velocity of a body at a particular point or instant.

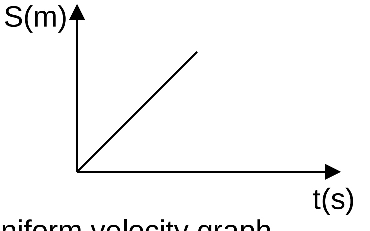
(iv) **Average velocity:** Is define as the ratio of total displacement to total time taken to cover the displacement.

V= D/t

Where V is velocity in metre per second (m/s)
D is the displacement in metre (m),
t is time in second (s).

<u>Displacement/Distance - time graph:</u>

Displacement/distance-time graph is a graph that shows the velocity or speed of a body in motion.



Uniform velocity graph

From the displacement/distance-time graph, the velocity or speed of a body under consideration can be gotten.
As shown in the graph, the slope of the graph is a measure of the velocity or speed of a body.
Example: Calculate the speed of a car that covered a distance of 30m in 10s

Solution:

Speed = distance/time

Distance = 30m

Time =10s

v = 30/10 = 3m/s

WEEK SIX

RECTILINEAR ACCELERATION

INTRODUCTION

When a body in motion changes its velocity either by decreasing or increasing it, the change in velocity in respect to the time taken to make the change is called deceleration and acceleration.

Acceleration (a): Acceleration is the rate of change of velocity with time. It is a vector quantity. The S.I unit of acceleration is metre per second square (m/s^2).
Formula for acceleration is given by i.e.

$$\mathbf{a} = \frac{v-u}{t}$$

Where **a** is acceleration in (m/s^2)
v and u are final and initial velocities in m/s
t is time in (s).

Types of acceleration

(i) **Uniform acceleration** is the acceleration of a body that is constant throughout the space of consideration.

(ii) **Non-uniform** or variable acceleration is the acceleration of a body that is not uniform or constant

(iii) **Instantaneous acceleration** is the acceleration of a body at an instant.

Deceleration (Retardation):
Deceleration is the rate of decrease of velocity with time or it is the reversal of acceleration. The only difference is that it has a negative value.

Example:

(1) A train travels at 10m/s and accelerates uniformly to 40m/s in 10s. calculate the acceleration of the car

(2) A car slows down uniformly from velocity of 60m/s to 20m/s in 8s. calculate its acceleration

Solution:

(1) a =(v-u)/t

v=40m/s

u=20m/s

t=10s

a =?

a= (40-20)/10

.: $a=2\ m/s^2$

(2) a =(v-u)/t

v=20m/s

u=60m/s

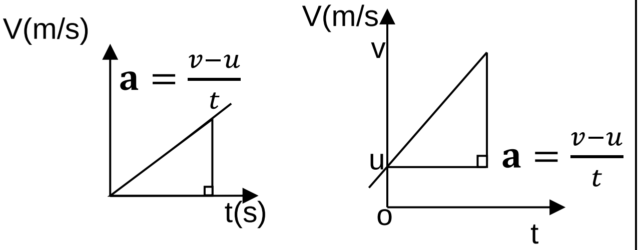
t=8s

a=?

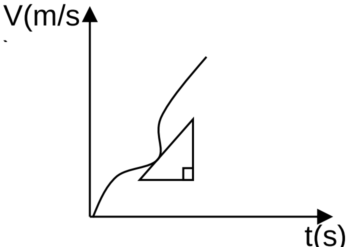
a= (20-60)/8

.: $a=-5m/s^2$

Velocity – Time graph



Uniform acceleration



Non=uniform acceleration

Example: A car starts from rest and accelerate uniformly until it reaches a velocity of $30ms^{-1}$ after 5 seconds. It travels with uniform velocity for 15 seconds and is then brought to rest in 10 seconds with a uniform retardation.

Determine:

(a) The acceleration of the car,

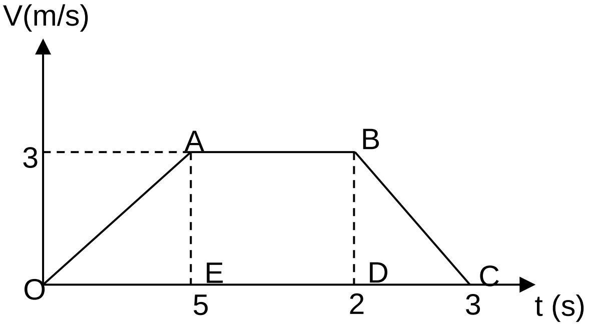
(b) The retardation

(c) The distance covered after 5 seconds

(d) The total distance covered

Solution:

Using the graphical method, the velocity – time graph for the journey is shown below:



(a) The acceleration = slope of OA

= AE/EO

.: OA = 30/5

a = $6ms^{-2}$

(b) Distance traveled during acceleration.

= Area of AEO

= ½ x 5 x 30

= 75m

(c) Total distance covered = area of the trapezium OABC

= ½ (OC + AB) × AE

= ½ (30 + 15) × 30

= ½ × 45 × 15

= 675m

Equations of linear motion:

Linear motion is the motion of a body that is moving on a straight path (horizontal, vertical or both).

If a body accelerates uniformly with acceleration ‘a’ from initial velocity of ‘u’ to final velocity ‘v’ in a time (t). The distance covered by the body is equal to average velocity x time i.e $S = \frac{(u + v)\,t}{2}$ - - - - - (i)

(ii) $V = u + at$

(iii) $S = ut + ½ at^2$

(iv) $V^2 = u^2 + 2as$

Example (1): A car moves from rest with an acceleration of 0.4 ms^{-2}. find its velocity when it has moved a distance of 60m.

Solution:

From the question, it is noticed that the equation does not involve t, so we use,

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

u=0 m/s

$a=0.4m/s^2$

s=60 m/s

v = ?

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

$v = \sqrt{u^2 + 2as} = \sqrt{0^2 + 2 (0.4) \times 60}$

$V = \sqrt{9.6} = 3.098 = 3.1ms^{-1}$

Example (2): When the brakes are applied to a moving car traveling at 60km/hr, it decelerates at a uniform rate of $5ms^{-2}$. Calculate the time taken to reach a velocity of 36kh/hr.

Solution:

$U = 60km/hr = \frac{60 \times 1000}{60 \times 60} = \frac{50}{3} ms^{-1}$

$V = 36km/hr = \frac{36 \times 1000}{60 \times 60} = 10ms^{-1}$

$a = - 5ms^{-1}$ (because retardation is negative acceleration).

$V = u + at$

$10 = \frac{50}{3} + (- 5t) = \frac{50}{3} - 5t$

t = 1.33sec

Example (3): A body starting from rest travels for 30 secs. Determine the final velocity attained after covering a distance of 40m.

Solution:

U = 0m/s,

t = 30s,

s=40m

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

$40= \frac{(v+0)}{2} \times 30$

v= (2×40)/30= 2.7m/s

.: v=2.7m/s

WEEK SEVEN

SCALARS AND VECTORS

INTRODUCTION
In physics, physical quantities are classified as scalar or vector.

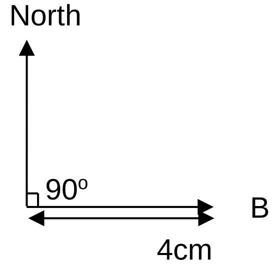
Scalar quantity: A scalar quantity is a physical quantity with magnitude but no direction. Examples of scalar quantities are length, mass, temperature, speed, distance etc.
By magnitude, we mean that it has numerical value only e.g. 12cm of length, 20^{o}c etc.

Vector quantity: A vector quantity is a physical quantity with magnitudes and direction. Examples of vector quantities are forces, velocity, displacement etc. 20cm from your left, 50cm, N30^{o}E

Distinction between vector and scalar quantities: Vector quantities has magnitude (numeric value) and direction but scalar quantity has only magnitude but no direction.

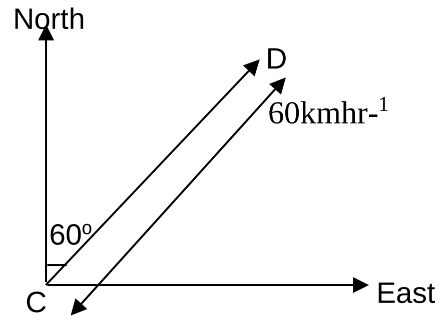
VECTOR REPRESENTATION

Since a vector quantity has both magnitude and direction, it is represented by a straight line which has an arrow head indicating the direction of the given vector. The length of the line is drawn proportional to the magnitude of the vector.
Since displacement and velocity are vector quantities a displacement of 400km to the east can be presented by a straight-line AB, 4cm long which points towards the east from the chosen origin.
This can be represented below and the scale used is 1cm representing 100km.



a. Scale: 1cm : 100km

Also, a velocity of 60kmhr-^{1} in a direction N 60^o E (or 60^o east of north) using a scale of 1cm to 10kmhr-^{1} can be represented below:

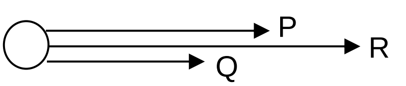


b.

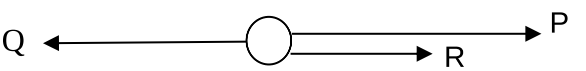
Scale: 1cm : 10kmhr-^{1}

ADDITION OF VECTORS (VECTOR RESULTANT)

Vectors are quantities with magnitude and direction, they must be added in a special way. If two vectors P and Q are in the same direction their sum or resultant is given by R = P + Q.
The direction of R is the common direction of P and Q. if P and Q are in opposite direction and if P is greater than Q, their resultant R = P – Q. these are shown below.



R = P + Q .



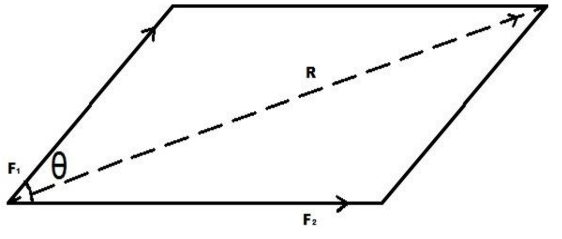
R = P – Q in the direction of P since P>Q

When two vectors are inclined at a certain angle, the resultant of the two vectors can be determined. The resultant, R, of two vectors inclined at a certain angle is that single vector which would have the same

effect in magnitude and direction as the original vectors acting together.
Generally, there are two methods of adding or compounding vectors to find the resultant. These are (i) The parallelogram method and (ii) The Triangular method

DETERMINATION OF RESULTANT OF TWO VECTORS INCLINED AT AN ANGLE.
The Parallelogram Method

Parallelogram of vectors

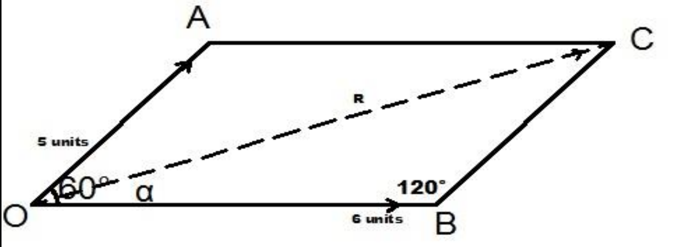


Parallelogram law of vector addition states that when two vectors F_1 and F_2 are represented in magnitude and direction by the adjacent sides of a parallelogram, the resultant vector, R, is represented in magnitude and direction by the diagonal of the parallelogram originating from the point of intersection of the two vectors.

EXAMPLE:
Find the resultant of two vectors of 5 units and 6 units acting at a point, O, inclined at an angle of 60^o with each other.

SOLUTION:
This can be done in two ways
First, by scale drawing and
Second, by analytical method

BY SCALE DRAWING:
Choose a suitable scale, say 1cm to 1 unit and draw the vectors OA and OB to represent 5 units and 6 units at an angle of 60^o with each other.



The parallelogram is completed by drawing AC parallel to OB and BC parallel to OA. OC is joined and measured. OC represents the resultant vector in magnitude and direction. Angle α is also measured using the protractor.

BY ANALYTICAL METHOD

Through this method, the resultant vector is obtained by cosine rule.

$R^2 = F_1^2 + F_2^2 + 2\, F_1 \text{x } F_2 \text{Cos } \theta$

$= 6^2 + 5^2 + 2\text{x}5\text{x}6 \text{ Cos } 60$

$= 36 + 25 + 60 \text{ Cos } 60$

$R = \sqrt{91}$

$R = 9.54$ units

To determine α, we use the sine rule.
Since BC is equal to OA,

$$\frac{Sin\ \alpha}{BC} = \frac{Sin\ 120}{OC}$$

$$Sin\ \alpha = \frac{BC \times Sin 120}{OC}$$

$$Sin\ \alpha = \frac{5 \times 0.8660}{9.54}$$

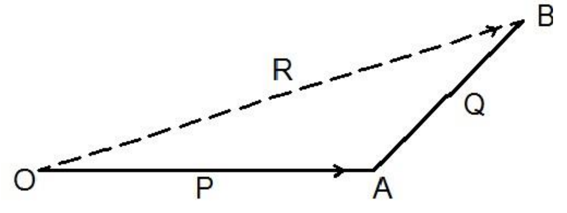
$\alpha = 26.99^o = 27^o$

FINDING THE RESULTANT OF TWO VECTORS BY TRIANGLE METHOD.

The steps for finding this resultant using the triangle method are as follows:

1.Starting from a point O, draw OA (according to scale) to represent P.

2. Next, draw the second vector Q to scale, placing its tail at the tip of the first vector P, ensuring that its magnitude and direction are correct.



3.Finally, draw OB to complete the triangle as shown above. OB represents R, the resultant vector in magnitude and direction

VECTOR RESOLUTIONS

Consider first a vector V which lined in an X-Y plane. This vector can be expressed as the sum of two other vectors called the components of the original vector V.

The component of a vector in a given direction is the effective value in that direction. For example, the horizontal component of a vector is its effective value in a horizontal direction. The process of finding the components of a vector is known as the resolution of the vector into its components. It is customary and most useful to resolve a vector into components along mutually perpendicular direction usually the horizontal or X-direction and the vertical or Y-direction

Suppose a vector V is inclined at an angle ϴ to the horizontal direction

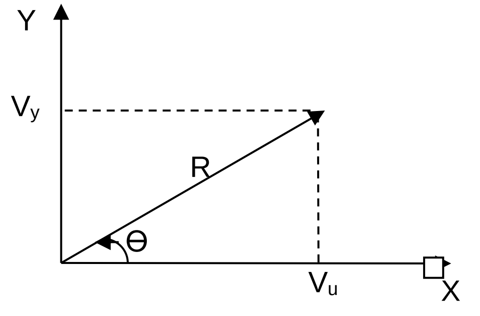


Fig. Resolution of Vectors V

The horizontal component of the vector V is given by

V_x =V Cosθ

The vertical component of V is given by

V_y = V Sinθ

V_y and V_x are at right angles to each other

Example (3): Resolve a force of 100N inclined at 50° to the horizontal into the horizontal and vertical components.

Solution:

Horizontal component F_x = 100 Cos 50°

= 62.28N

Vertical component F_y = 100 Sin 50°

= 76.60N

Resolution of more than two vectors.

To find the resultant of more than two vectors, we first resolve each vector in two perpendicular directions and add all the horizontal component, X and all the vertical component, Y. For example, consider four forces acting on a body as shown below.

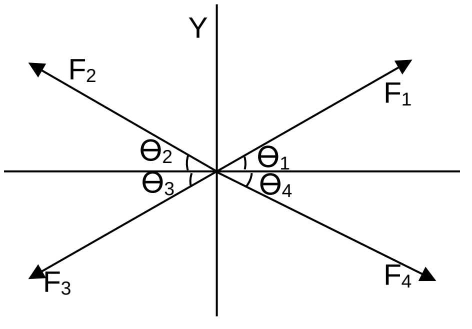


Fig (a)

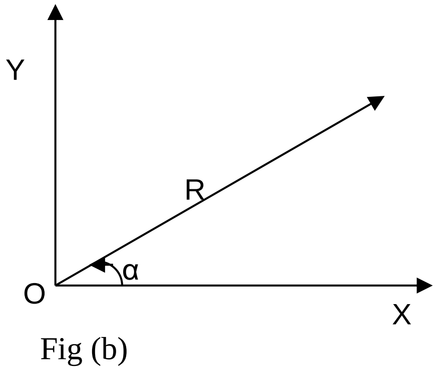


Fig (b)

We add all the resolved horizontal components and obtain

$X = F_1 \text{ Cos } \Theta_1 + (-F_2 \text{ Cos } \Theta_2) + (-F_3 \text{ Cos } \Theta_3) + F_4 \text{ Cos } \Theta_4$

Note that the right hand or easterly direction is taken as positive and the left hand or westerly direction is taken as negative.

We add also the resolve vertical components and obtain

$Y = F_1 \text{ Sin } \Theta_1 + F_2 \text{ Sin } \Theta_2 + (-F_3 \text{ Sin } \Theta_3) + (-F_4 \text{ Sin } \Theta_4)$

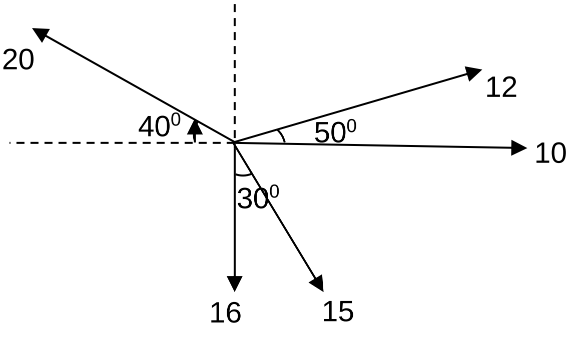
The resultant of X and Y is obtained by

$R^2 = X^2 + Y^2$

$R = \sqrt{X^2 + Y^2}$

and the direction α is given by tanα= Y/X

Example: Calculate the resultant of five coplanar forces of values 10N, 12N, 16N, 20N, 15N acting on an object at O as shown in the diagram below:



The forces are resolved into the horizontal and vertical components are show below

Forces (N)	Inclination to horizontal
10	0^o
12	50^o
20	40^o
16	90^o
15	60^o

Horizontal component	vertical component
10 Cos 0^o = + 10.00	10 Sin 0^o = 0
12 Cos 50^o = + 7.71	12 Sin 50^o = 9.19
-20 Cos 40^o = - 15.32	+ 20 Sin 40^o = 12.85
-16 Cos 90^o = 0.00	-16 Sin 90^o = 16.00
15 Cos 60^o = +7.50	- 15 Sin 60^o = 12.99
X = + 9.89	Y = - 6.95

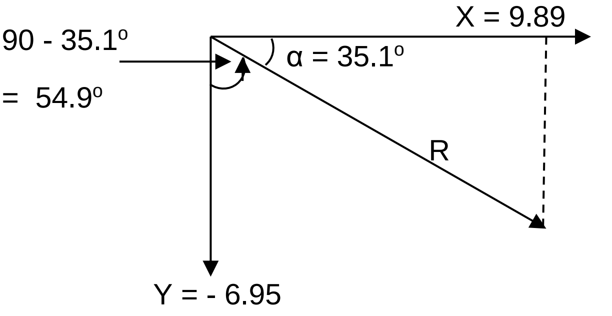
$R = \quad X^2 + Y^2 = (9.89)^2 + (-6.95)^2$

$R \quad = \quad 12.09.N$

$\tan\alpha = \quad 6.95/9.89$

$\alpha = \tan^{-1}(6.95/9.89)$

$.: \alpha \;=\; 35.1^o$



The direction of the resultant is S54.9°E

WEEK EIGHT

MOTION

INTRODUCTION

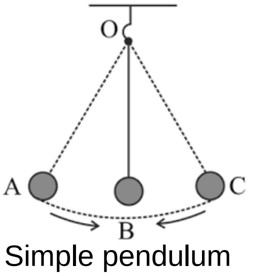
The study of motion is very imperative in physics. The physical quantities - velocity(v), acceleration, displacement and time are crucial in the analysis of rectilinear motion. As highlighted in the previous topic, their combination give rise to equation of linear motion.

Motion: Motion is the change of position of an object with respect to time. Kinematic is the study of the motion of a body without the agent causing the body to be in motion. Dynamics is the study of the motion of a body in respect to the causative agent that is making the body to be in motion.

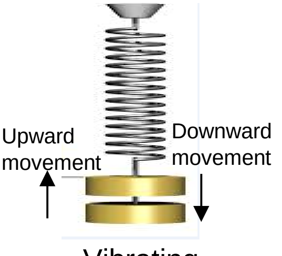
Types of motion

The various types of motion are oscillatory/vibrational motion, rotational motion, translational/rectilinear motion and random motion.

(i) **Oscillatory/ vibrational motion:** This is the motion of a body that moves to and fro i.e it repeat itself and follows the same path. Such motion is said to be periodic. Examples are the motion of a simple pendulum, the motion of a disturbed loaded mass on a spring, the strings of a plucked guitar etc.

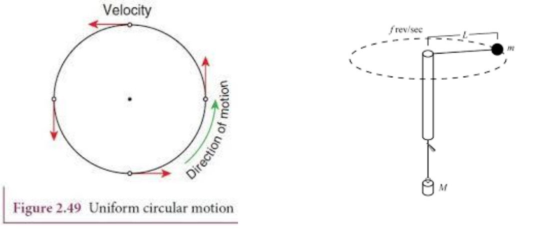


Simple pendulum



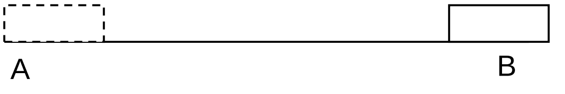
Vibrating mass

(ii) **Rotational motion**: This is the motion of a body in a circular path and all the points of the body must be concentricity. Examples are the motion of the earth about its axis, the rotation of the blades of a fan and the motion of the wheel of a car

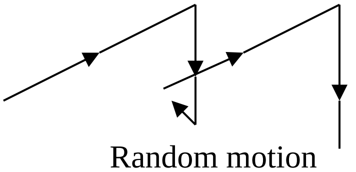


Rotational motion

Translational/rectilinear motion: This is the motion of a body moving on a straight path. The body does not rotate. Example is the motion of a car from one point to another



(iii) **Random motion:** This is the motion of a body in no specific direction or pattern. It is an irregular or haphazardly or disorderly motion of a body. Examples are the motion of nylon blown by air and the motion of a butterfly.


Random motion

Relative: This is the motion of a body with respect to a reference point. The reference point may be a body at rest or moving in the same direction or opposition.

If a body is moving at a speed of 50km/h, it speed relative to a still body is 0 + 50 = 50km/

WEEK NINE

CAUSES OF MOTION

INTRODUCTION
An agent that tends to change or changes the state of a body at rest or in motion is called force.

What is force? Force is that which tends to change or changes the position of an object or body.

TYPES OF FORCE
There are basically two types of force. These are
(i) Contact force
(ii) Field force

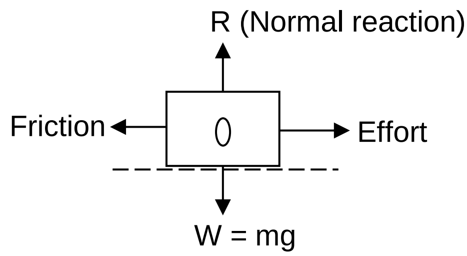
Field force: Field force is a force that does not require contact with the body to which they act. Examples are magnetic force, electric force and gravitational force.

Contact force: Contact force is a force that must touch the object upon which it acts. Examples are forces of push, pull, reaction, tension and frictional force.

Friction: Friction is the forces that acts on the surface of separation of two or more bodies in contact and opposes their relative motion ever one another. There are two types of friction. These are:

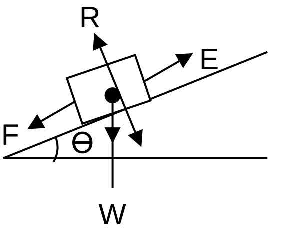
(i) **Static or limiting friction:** It is the maximum frictional force that must be overcome before a body starts to move.

(ii) **Kinematics or dynamic friction:** It is the force that must be overcome for a body that is in motion to continue to be in motion.



LAWS OF FRICTION
(i) Friction opposes motion between relative bodies in contact
(ii) Friction depends on nature of surface o contact
(iii) It is independent of area of surfaces in contact
(iv) The force of friction increases to the same extent as to the force which tends to start the motion
(v) Frictional force is directly proportional to normal reaction (R)

Coefficient of Friction: Experiment shows that friction is directly proportional to normal reaction (R).
Symbolically, $F \alpha R$
i.e. $F = \mu R$
$U = F/R$
U is known as coefficient of friction
R is normal reaction in Newton
F is frictional force in Newton
If a body is inclined at an angle Ө,
$\mu = \tan Ө$



$\mu = \tan Ө$

$F = R \tan Ө$

Recall $F= \mu R$

but $\mu = \tan Ө$

.: $F = R \tan Ө$

Examples: A body of 6N was placed on a table. It was pulled by a force of 3N. (i) What is the coefficient of friction?
(ii) What

Solution:

$F = \mu R$

$\mu = F/R$

$F = 3N$

$R = 6N$

$\mu = 3/6 = 1/2$

$\therefore \mu = 0.5$

ADVANTAGES OF FRICTION

(i) Friction enables us to walk, hold an object etc
(ii) Friction enables car tyre to grip firmly with the road
(iii) Friction is utilized in fan belt of car engine
(iv) Friction allows nail to be position after nailing
(v) Friction enables brakes to stop a car.

DISADVANTAGES OF FRICTION

(i) It causes wear and tear
(ii) It causes loss of energy
(iii) It causes the heating of engine

METHOD OF REDUCING FRICTION

(i) The use of ball and roller bearing
Streamlining the shape of a moving body.
(ii) the use of lubricants such as grease and oil

WEEK TEN
WORK, ENERGY AND POWER

INTRODUCTION
Work means different thing in different spheres of life.

work.

In physics, work is defined as distance covered in the direction of applied force or it is the product of force and distance covered in the direction of the applied force.

Work = force x distance. The S.I. unit of work is Newton metre (NM) or Joule.

Example: A force of 10N covers a distance of 5m in the direction of the force. What is the work done?

Solution:

W = F x S
F = 10N
S = 5m
W = 10 x 5 = 50NM or 50J

WORK DONE IN A FIELD

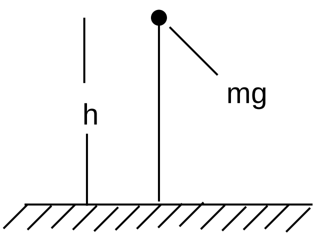
When a body is lifted upward or when a body climbs upward, the work done is given by i.e W = Mgh

Where M is the mass of the body in kilogram (kg)

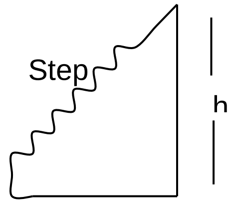
g is acceleration due to gravity ($g = 9.8m/s^2 = 10m/s^2$)

h is the height in metre (m)

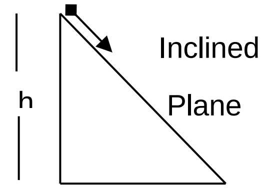
NB. If a body falls from a height, work done is = mgh



Work = mgh



work = mgh



work = mgh

Energy: It is defined as the capacity to do work. A moving car has energy. Energy and work had the same S.I unit ‘Joule’. There are different forms of energy. These are mechanical energy, chemical energy, heat energy, solar energy, light energy, electrical energy, sound energy and atomic energy.

Mechanical energy: Mechanical energy is the energy possess by a body either in motion or suspended by a height. There are two types of mechanical energy. These are: (i) Potential energy (ii) Kinetic energy.

Potential energy: This is the energy possess by a body by its virtue of its position or state. A body on top of a table has potential energy, fruit on a tree has potential energy, a coiled spring when stretched or compressed has potential energy. To measure or calculate the potential energy of a body, we use the equation i.e. P. E = mgh or Ep = mgh.

Kinetic energy: This is the energy possess by a body due to its motion kinetic energy depends on mass and velocity of the body in motion.

Example:

(i) What is the potential energy of a body of mass 2000g falling from height of 10m ($g = 10m/s^2$)?

(ii) An object of mass 5kg is moving with a velocity of $20m/s^2$. calculate its kinetic energy

Solution

i. P.E $= mgh$

m $= 2000g = 2kg$

g $= 10m/s^2$

h $= 10m$

P.E $= 2 \times 10 \times 10$
$= 200J$

ii. K.E $= \frac{1}{2} mv^2$

m $= 5kg$

v $= 20m/s$

K.E $= \frac{1}{2} \times 5 \times 20^2$

$= \frac{1}{2} \times 5 \times 400$

$= 1000J$

Conservation of mechanical energy: A body at rest can be made to move and stop. Hence, there is transformation of energy from potential energy to kinetic energy and back to potential energy.

The law of conservation of energy states that energy can be transformed from one form to another but the total energy remains the same in an isolated system.

Total energy = P.E + K.E = mgh.

Power: Power is defined as the rate of doing work. It two boys of the same weight climb steps of the same height, the body who gets to the top first is said to have a greater power.

$$\text{Power} = \frac{\text{work done or energy expended}}{\text{time}}$$

$$\text{Power} = \frac{\text{Force x distance}}{\text{time}}$$

The S.I. unit of power is Joule per second (J/S) or watts (w).

E.g. A car is moving with a speed of 10m/s. the propelling force is 500N. calculate the engine power of the car.

Solution:

Power = Force x distance/time
F =500N
V =10m/s = distance/time
.: P = F x V =500 X 10 = 5000W