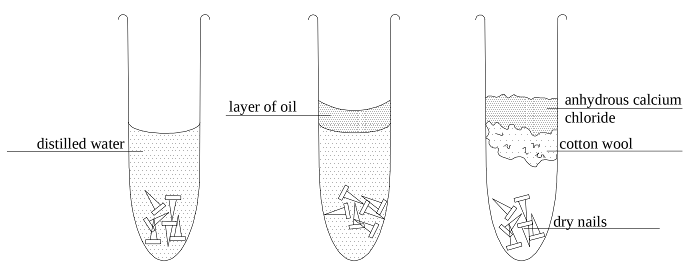
UNESCO-NIGERIA TECHNICAL & VOCATIONAL EDUCATION REVITALISATION PROJECT-PHASE II

NATIONAL DIPLOMA IN QUANTITY SURVEYING



BASIC ENGINEERING SCIENCE

COURSE CODE: QUS103

YEAR I- SE MESTER I

THEORY

Version 1: December 2008

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WEEK 1: SCALAR AND VECTR QUANTITIES. STABLE, UNSTABLE AND NEUTRAL EQUILIBRIUM

Introduction

What is Physics?

Physics is the study of matter in relation to energy.

Physics Includes

a. **Mechanics-** The study of mechanical energy.

(1) **Dynamics-** deals with objects in motion

(2) **Statics –** studies objects at rest

b. **Heat:** The study of heat energy

c. **Optics:** The study of light energy

d. **Sound:** The study of sound energy

e. **Magnetism:** The study of magnetic and electrical energy.

f. **Nuclear Physics:** The study of nuclear energy

Mass: is the quantity of matter that is contained in a body. The S.I Unit of mass is kilogram (kg). Mass is measured with a beam balance.

Weight: it is the force on a body due to gravity (g).

Weight = mass x acceleration due to gravity (g).

The S.I. Unit of weight is the Newton and it is measured by the use of a spring balance.

Force:- force is that which changes a body's state of rest or of uniform motion in a straight line. F = mass x acceleration

Scalar and Vector Quantity

Scalar Quantity; - A scalar quantity has magnitude or size but no direction. Examples of a scalar quantity are; mass, speed, work, energy, power, temperature, density, pressure etc.

Vector Quantity; - A vector quantity has magnitude and direction. Examples are; force, weight, velocity, acceleration, momentum, magnitude flux etc.

Stable, Unstable and Neutral Equilibrium

Stable Equilibrium;-

An object is said to be in stable equilibrium if when disturbed and slightly displaced will increase its original position. Note, that its center of gravity is raised on displacement and at its original position; its potential energy is lowered**.**

E.g. A cone standing on its base

w= gravitational force

G= center of gravity

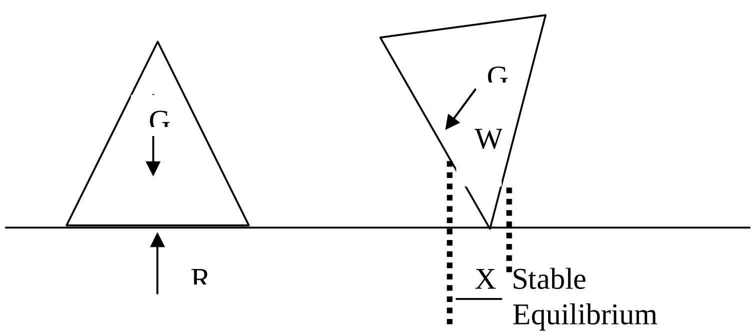


Fig a.

Unstable Equilibrium

An object is said to be in unstable equilibrium if it is slightly displaced, it is potential energy and center of gravity are then lowered and does not return to it's original position. E.g. cone on its apex

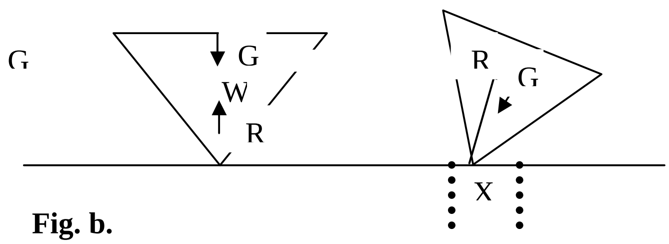


Fig. b.

Unstable equilibrium

Note;- G – Center of gravity

W – Gravitational force

R – Reaction force.

Neutral Equilibrium

An object is said to be in a neutral equilibrium if it is slightly displaced, the center of gravity will neither be raised nor fall (remains at the same height). E.g. A cone resting on it's curved surface

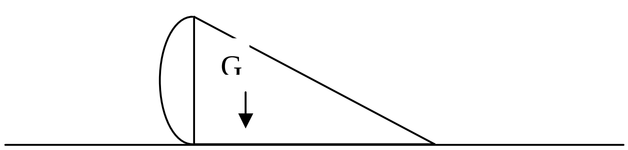


Fig. C Neutral equilibrium

WEEK 2: 2.0MOMENT OF A FORCE ABOUT A POINT

Moment of a Force

When we turn on a tap, tighten a nut with a spanner or screw a nail in or out of a wood with a screw driver we are exerting a turning force and producing a turning effect about a point or along an axis such a turning effect brought about in each case is called the moment of a force.

Two factors are involved

in each case;

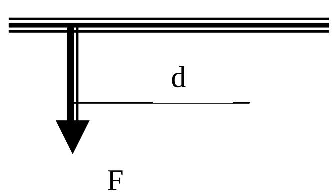
1. The magnitude of the force applied and
2. thee perpendicular distance of it's line of action from the axis or pivot about which the turning effect is felt or exerted

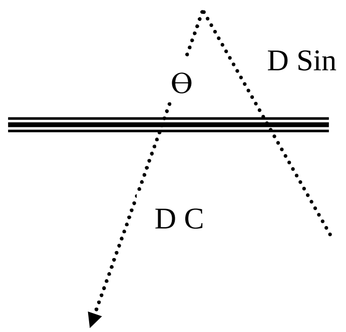
Definition of Moments;-

The moment of a force about a point (or axis) C is the turning effect of the force about that point. It is equal to the product of the force and the perpendicular distance of its line of action from the point C.

Moment = Force x Perpendicular distance of pivot to the line of action of the force.

Since force is in Newton's (N) and distance is in meters, the S.I unit of moment is expressed in Newton meters (Nm)





Principle of Moments

The principle of moments states that if a body is in equilibrium then the sum of the clockwise turning moments acting upon it about any point equal the sum of the anti clockwise turning moments about the same point.

Conditions of Equilibrium Under the Action of Parallel Coplanar Forces.

Coplanar forces are forces that lie in the same plane. Parallel forces are force whose lines of action are all parallel to each other.

A body acted upon by several forces is said to be in equilibrium if it does not move or rotate under this equilibrium condition, the sum of the forces acting in one direction (e.g. upwards) must be equal to the sum of the forces acting in opposition direction(e.g. downwards). Thus the total forces acting upwards must balance the total forces acting downwards.

Also the body can only remain in equilibrium if the moments of the forces about any point act in such away as to cancel each other. That is, the total clockwise moments of all the forces about any point of the object must be exactly counter balanced by the total anticlockwise moment about the same point.

Hence the two conditions for equilibrium of parallel coplanar forces can be stated as follows

1. **Force; -** The algebraic sum of the forces acting on the body in any given direction must be zero. That is, the sum of the upward force must be equal to the sum of downward forces or the sum of the forces acting in one direction must be equal to the sum of the forces acting in opposite direction.

2. **Moments;-** The algebraic sum of the moments of all forces about any point on the body must be zero, or the total clockwise moments of the forces about any point on the body must be equal to the total anticlockwise moments of the forces about the same point.

A light beam AB sits on two point C and D. A load of 10N hangs at 0, 2m from the support at C. Find the value of the reaction forces P and θ at C and D. Take the distances as shown in fig E.

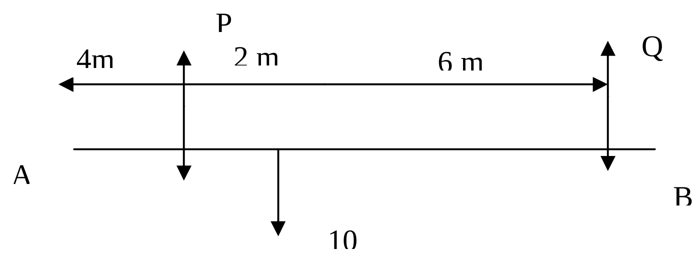


Fig.E

Solution;-

Because it is a light beam, we can ignore its weight from first condition of equilibrium, total upward forces = total downward forces i.e.

$P + \theta = 10N.$

From second condition of equilibrium, total clockwise moments = total anticlockwise moments.

Therefore, taking moment about C we have.

$10 \times 2 = \theta \times (2 \times 6) = 8\theta$

$\theta = \frac{20}{8} = 2.5$

Hence $P = 10 – \theta = 10 – 2.5 = 7.5N$

Alternatively we can take moment about D, Hence

$P \times 8 = 10 \times 6$

$P = \frac{10 \times 6}{8} = 7.5N$

$\theta = 10 - 7.5 = 2.5N.$

Thus we can take moment about C or D and get the same results.

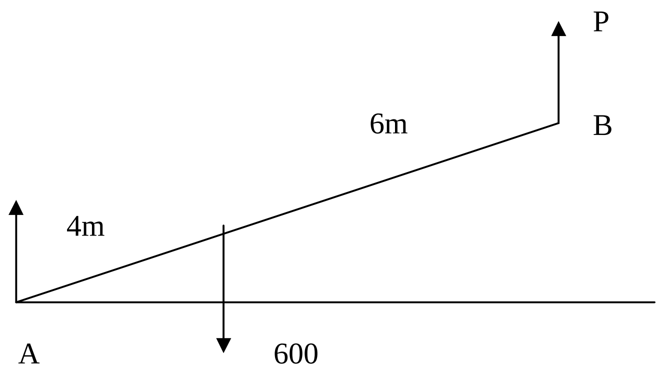
Example 2;-

A pole AB of length 10.0m and weight 600N has its centre of gravity 4.0m the end A, and lies on horizontal ground. Draw a diagram to show the forces acting on the pole when the end B is lifted by a vertical force.

Calculate the force required to lift this end. Prove that this force applied at the end A will not be sufficient to lift the end A from the ground.

Solution

The diagram is as shown in fig F. R is the reaction force at A. let the force required to just begin to lift the pole at B be P (N). Taking moments about A.



Clockwise moment = 600 x 4 = 2400Nm.

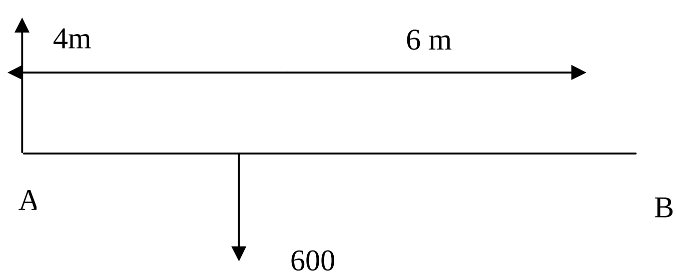
Anticlockwise moment = P x 10 =10P Nm.

For equilibrium; 2400Nm = 10P Nm

;. P = 240N

If this force of 240N is applied at A, we have the situation as shown in fig. G.

P = 240N.



Taking moment about B, we have,

Clockwise moment = 240 x 10 = 2400Nm.

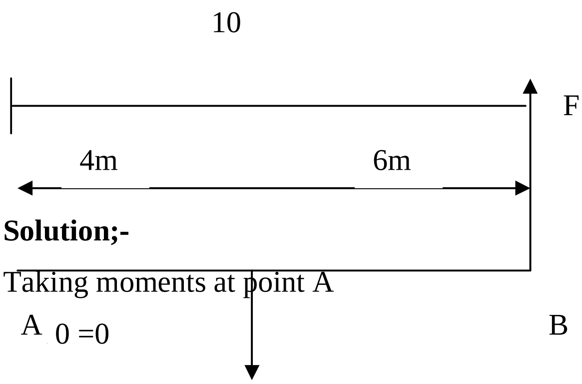
Anticlockwise moment = 600 x 6 = 3600Nm.

The anticlockwise moment is greater than the clockwise moment.

The 240N force at A will not be sufficient to lift the end A because the turning effect due to the 600N force far exceeds that due to the 240N force.

Example 3

A pole AB of length 10.0 and weight 800N has its centre of gravity 4.0m from the end A, and his on horizontal ground. The end B is to be lifted by a vertical force applied at B. Calculate the least force required to do this



Solution;-

Taking moments at point A

Clockwise moment = Anticlockwise moments.

800 x 4 = F x 10

3200 = 10F

$F = \frac{3200}{10}$

F = 320N.

Example; - 4

A uniform rod 8m long weighting 5Kg is supported horizontally by two vertical parallel strings at P and θ and at distances of 2m and 6m from one end weights of 1Kg, 5m and 2Kg are attached at distances of 1m, 5m and 7m respectively from the same end. Find the tension in each vertical string

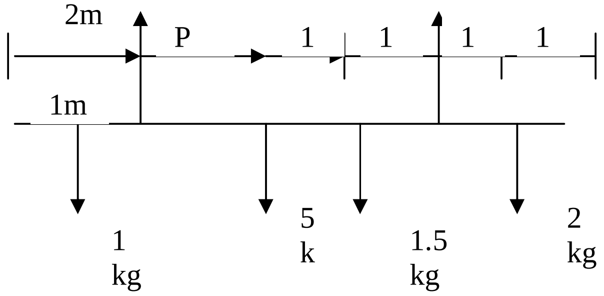


Fig H.

Solution:

Take moments at point P

P x 0 = 0

Clockwise moments = Anticlockwise moments.

(50 x2) + (15 x 3) + (20 x 5) = (10 x 1) + θ x 4

100 + 45 + 100 = 10 + 4θ.

10 + 4θ = 245

4θ =245 – 10

4θ = 235

$\theta = \frac{235}{4}$

θ = 58.75N.

Total upward forces = Total downward forces

P + θ = 10 +50 + 20 +15

P +θ = 95

P + 58.75N = 95

P = 95 – 58.75N

P = 36.25N.

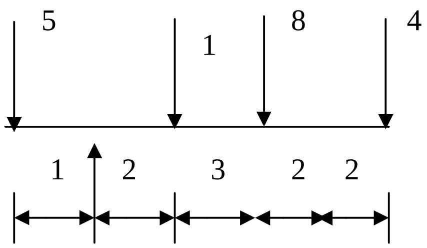
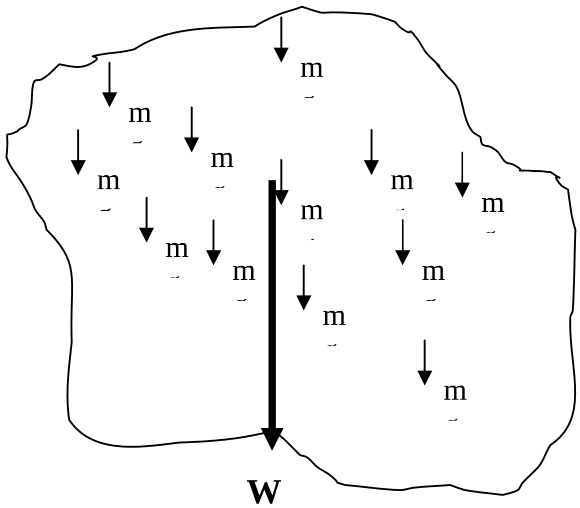


Fig. I

WEEK 3: 3.0 CENTER OF GRAVITY

Center of Gravity:-

The center of gravity of a body is defined as the point thjrough which the line of action of the weight of the body always passes irrespective of the position of the body. It is also the point at which the entire weight of the body appears to be concentrated.

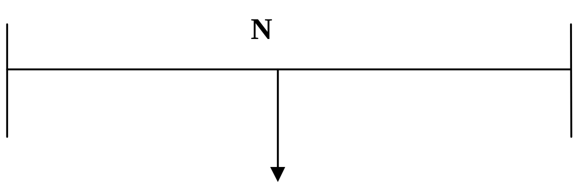


The resultant of all these parallel forces which is the total weight (w) of the body appears to act at some point G known as the center of gravity (C.G) of the body. If the body is supported at this point by an upward force equal in magnitude to the weight W, it will balance and thus be in equilibrium.

Centre of Mass;-

Similarly we can define the centre of mass of a body as the point at which the total mass of the body appears to be concentrated

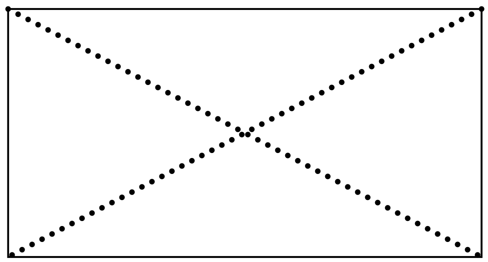
(a) Position of C. G for thin uniform Rod



a. Thin uniform rod

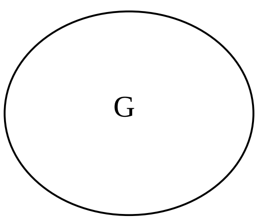
A uniform rod has its centre of gravity at the midpoint.

(b) Rectangular laminar.



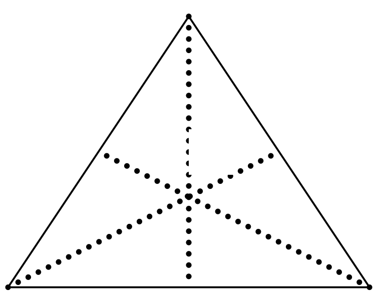
The centre of gravity of a uniform rectangular laminar is at the point of intersection of its diagonals.

(c) Circular laminar;-



The centre of gravity of a uniform circular laminar is at the centre.

(d) Uniform triangular plate.

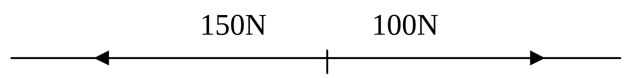


A

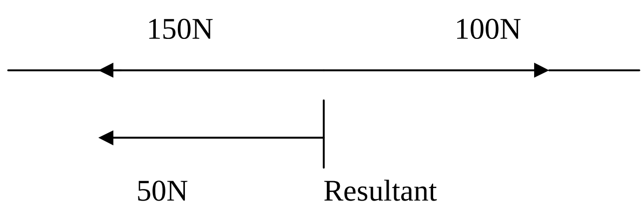
The centre of gravity of a uniform triangular plate is at the intersection of the medians

Resultant and Component of Forces.

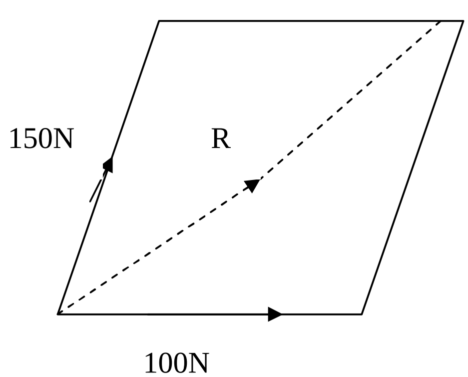
If two boys pull a sledge in the same direction by ropes with forces of 150 and 100N, the total or resultant force is (150 + 100) or 250N.



If the forces act in the opposite direction the resultant force is (150 – 100) or 50N in the direction of the 150N force.



Suppose the ropes are inclined at 60 to each one again is 150N and 100N. The sledge will now more forward more in the direction of the 150N then in the direction of the 100N force. The resultant force in the sledge is less than (150 + 100) = 250N.



Use cosine formula, to find the resultant force.

R^2 = 150 + 100 – 2 x 150 x 100 x cos 120

R^2 = 22500 + 1000 – 30000 x – 0.5

R^2= 32500 + 15000

R^2 = 47500

R = 217.9

Parallelogram of Forces

If two inclined forces are represented in magnitude and direction by the adjacent sides of a parallelogram, their resultant is represented in magnitude and direction by the diagonals of the parallelogram, passing through the point of intersection of the two sides.

Components of Forces

Sometimes only part of the force is used. A typical case is the use of a lawnmower. Suppose it is pushed with a force of 200N at a direction of 30 to the ground. The part of the force which pushes the mower horizontally is called it is resolved horizontal component. The other part, which presses the mower vertically into the ground, is called the resolved vertical component of the force.

Generally, then the component of a force F in direction inclined at an angle Q to it is always given by.

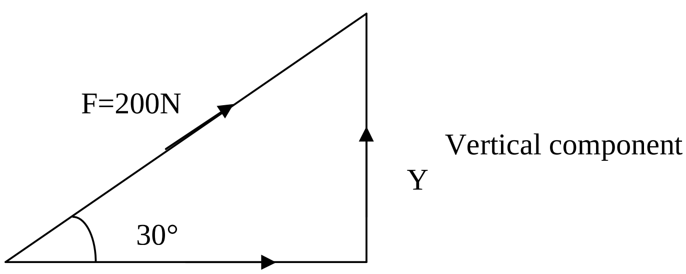
1.Horizontal component = Fcosθ

2.Vertical component = Fsinθ

Note. Horizontal component will be given by

$$\cos\theta = \frac{\text{Adjacent}}{\text{Hypotenuse}}$$

$$\frac{\cos 30}{1} = \frac{x}{200}$$



X

Horizontal component nent will be given by.

$COS\theta = \frac{Adjacent}{Hypotenus}$

$\frac{Cos\ 30}{1} = \frac{x}{200}$

X = 200 x cos30

X = 200 x 0.8660

X = 173.21N.

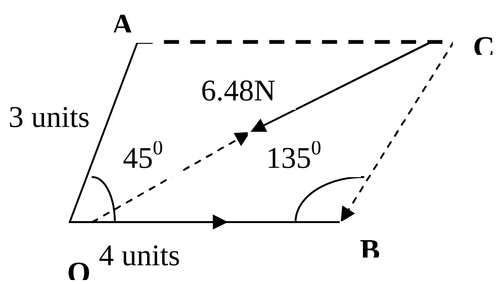
Example 1.

Find the resultant of two vectors of 3 units and 4 units acting at a point O at an angle of 45 with each other.

Solution by scale drawing.

Choose a suitable scale and draw the vectors OA and OB to represent 3units and 4units at an angle of 45 with each other.

Scale 1; 1 cm



Using Cosine formula.

OC^2 = OA + OB – 2 (OA) x (OB) x COS 135

OC^2 = 9 + 16 – 2(3) x (4) x – COS 45

OC^2 = 25 – 6 x 4 x (- 0.7071)

OC^2 = 25 + 16.97

OC^2 = 41.97

OC = √ 41.97

OC = 6.48

In general if two vectors P and Q are inclined at O to each other the resultant vector R is given by.

R = P + Q + 2PQCOSQ.

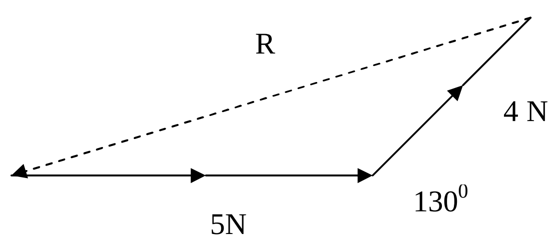
Example;-

Two forces 5N and 4N are inclined to each other at 30, find the resultant forces by the triangle method.

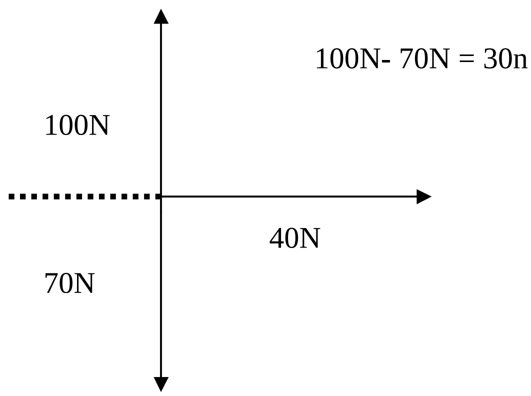
Using Scale drawing.

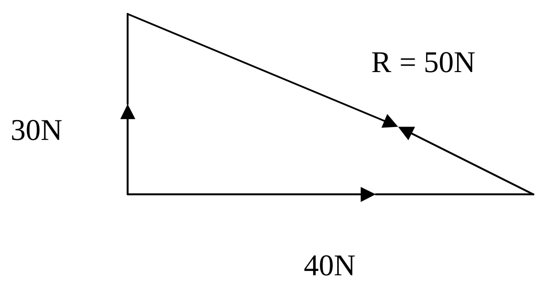
Solution.

Draw OA = 5cm to represent the 5N force. using a scale of 1cm = 1N from the top A, draw AB =4cm inclined to OA extended at 30 as shown join OB which represents the resultant vector in magnitude and direction.



After example 3 before the diagram





$R^2 = 30 + 40$

$R^2 = 900 + 1600$

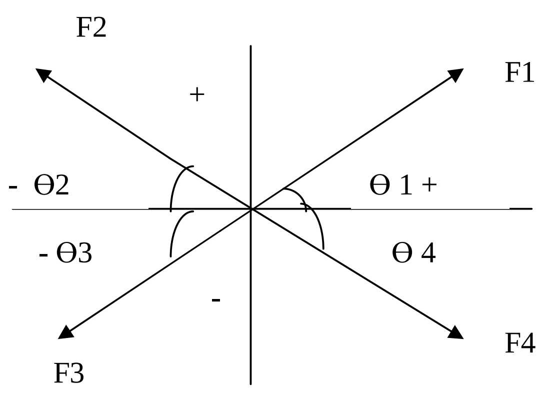
$R^2 = 2500$

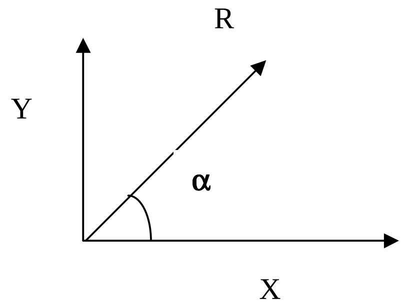
$R^2 = 50N$

The Resultant of More Than Two Vectors.

To find the resultant of more than two vectors, we resolve each vector in two perpendicular directions; add all the horizontal components X and all the vertical components Y.

For example consider four forces acting on a body as shown below





We add all the resolved horizontal components and obtain X = $F_1COSQ + (-F_2COSQ_2) + (-F_3COSQ_3) + (F_4COSQ_4)$

Note that we have taken the right hand or easterly direction as positive and the left hand or westerly direction as Negative. We now add all the resolved vertical components and obtain. Y = $F_1sinQ_1 + F_2sinQ_2 + (F_3sinQ_3) + (F_4sinQ_4)$

Note; - that we have taken the northerly or upward direction as positive and the southerly or downward direction as Negative. We then find the resultant of X and Y.

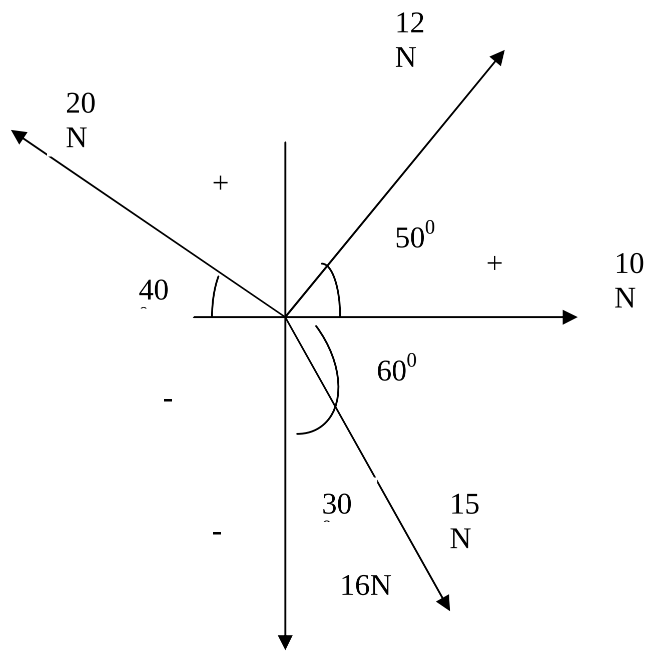
That is $R^2= X^2 + Y^2$

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

And the direction α is given by tanα= y/x

Example 5;

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



Solution;

The forces are resolved into the horizontal and vertical components as shown in the table below.

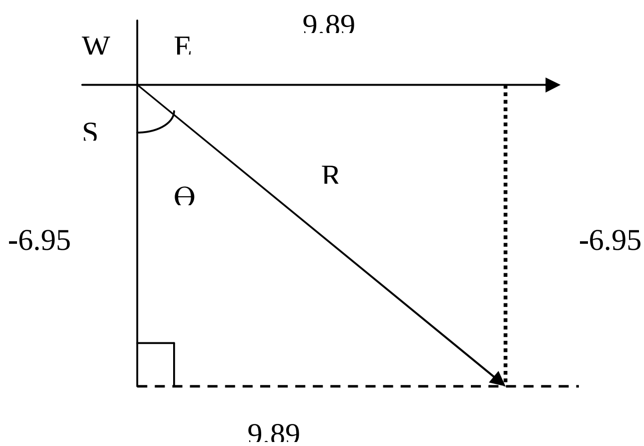
The forces are resolved into the horizontal and vertical components as shown in the table below.

Force	Inclination to Horizontal	Horizontal component	vert. comp
10N	0	10cosQ = +10.00	10sinQ = 0
12N	50	12cos50 = +7.71	12sin50 = 9.19
20N	40	-20cos40 = -15.32	+20sin40 = 12.85
16N	90	16cos90 = 0	-16sin90 = -16.00
15N	60	15cos60 = +7.50	-15sin60 = 12.99
		X = + 9.89	Y = -6.95

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

$$R = \sqrt{9.89^2+6.95^2}$$

R= 12.09N



$$\tan \alpha = \frac{9.89}{6.95} = 1.42$$

Thus there are four steps in using an analytic solution to find the resultant of several vectors.

1. Each vectors is resolved in X and Y direction
2. The X component are added
3. The Y components are added
4. The resultant of X and Y are combined to obtain their resultant

THEORY

WEEK 4: THE EFFECT OF FORCES ON MATERIALS

Structure and Forces

Loading;

Is the term for the forces acting on a building. These are classified as:

(1) Dead loads, made up of the self weight of the building fabric, which are

(2) Live loads made up of the weight of the occupants, furniture and equipment in a building and similar applied weight which are temporary loads in the sense that they may or may not be always present. They are also referred to as super impose or impose load.

(3) Wind loads – which is temporary but consider separately. In some areas snow loads and earthquake shock must be taken into account.

Loads are terms distributed loads if they are applied over the full area or length of a structural member and concentrated or point loads if they are concentrated at one point or over a very restricted area.

Concentrated and distributed loads is temporary but is consider separately. In some areas snow loads and earthquake shock must be taken into account.

Loads are termed distributed loads if they are applied over the full area or length of structural members and concentrated or point loads if they are concentrated at one point or over a very restricted areas.

Stress;

A force on a structural member may

(i) Stretch it, when it is termed a tensile force,

(ii) Compress it, when it is termed a compressive force,

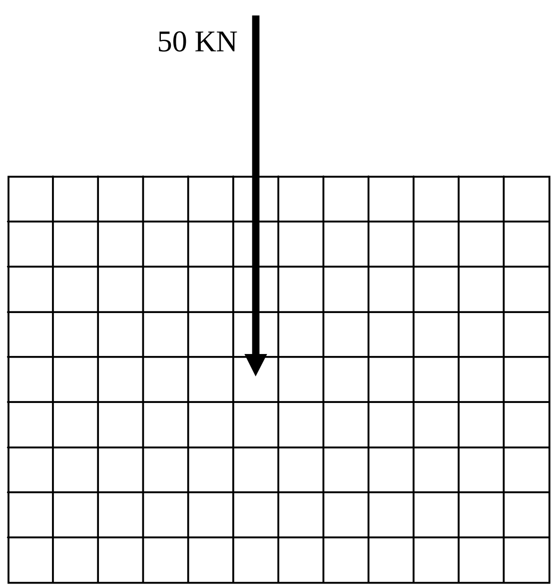
(iii) Caused one part of the member slid past another, when it is termed a shear force, and

(iv) Caused the member to twist, when it is termed a tensional force.

The effect of these various types of force is to put the material of a structural member into a state of stress and the material of the member is then said to be in a state either of tension, compression, shear or tension. To resist lengthening under a tensile force the material of a member must exert an inward pull or reaction and to resist shortening under a compressive force it must exert an outward push. This is demonstrated clearly by a spring.

In each case as soon as the external force is removed, the spring under the action of the internal forces immediately reverts to its original shorter or longer lengths as the case may be. In the case of shear, sliding is resisted by a force exerted by the material in a direction opposite to that of the shearing force.

The total load or force on an element gives no indication by itself of its actual effect upon the material of the element. For example, a load of 50KN might be applied to a column measuring 5000mm^2 in area or to another 50,000mm^2 in area. Both carrying 50KN but in the second ten times as much materials is carrying it as in the first, so that each unit of area in the second, in fact, carries only one tenth of the load carried by a similar unit in the first fig 4



Area 5000

A

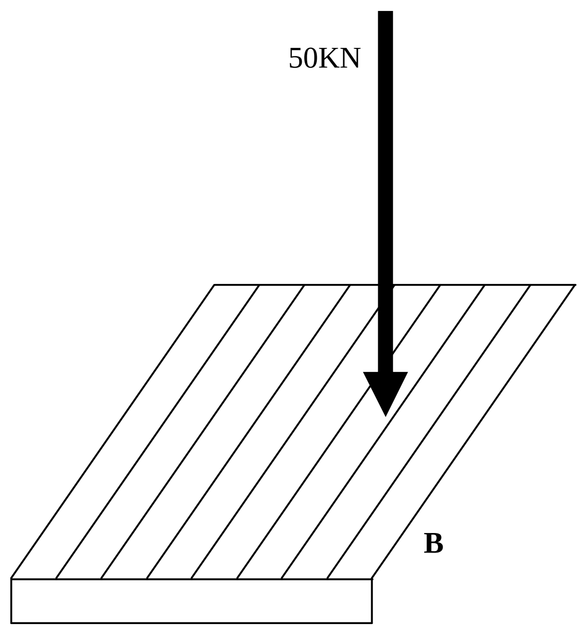


Fig 4

Stress (f) = w/A

Stress in A = 10Nmm^{-2}

Stress in B = 50,00/50,000 = 1Nmm^{-2}

In other words, the loading ids less intense. the measure of intensity of loading is expressed as a load or force per unit area, known as the intensity of stress (in practice, simpler "stress"), as is found by dividing the applied load (w) by the cross sectional area of the member (A) thus:-

stress (f) = w/A

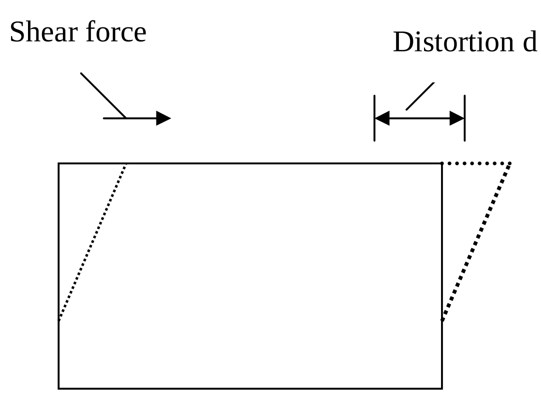
As with the loads causing them, the stresses may be tensile, compressive or shear stresses respectively. when the stresses are the intensity of loading expressed as so many units of load per unit of sectional area is termed the stress of the material of the 7 members are causes by axial load stretching or compressing member in the direction of the load they are termed as stresses fig 3. Compression and tension at right angles to the direction of the load is cause by bending in a beam or cantilever, and these termed bending stresses. Shear stresses also may be caused by bending. Shear stresses are also caused by torsion or the twisting of a structural member.

Strain:

The total change in the length of a member under a given tensile or compressive stress will vary with its length and, so with loading which must be related to a unit of area, it is necessary to relate this charge to a unit of length. The deformation or dimensional change in a member per unit length which occurs under load is found by dividing the change in length by the original length and is known as strain.

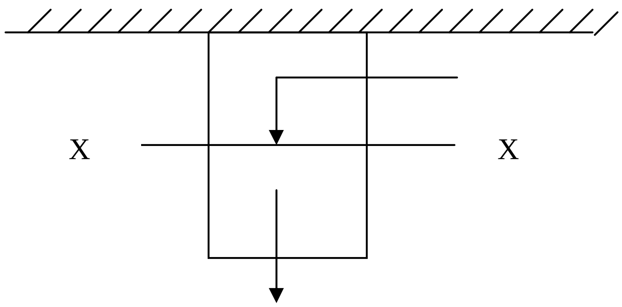
Within certain limits of loading it is assumed that stress is proportional to strain so that the ratio of stress/strain is constant for any given material and is known as its modulus of electricity (E). This is a property of the material and is a measured of its stiffness. The higher the E valve of a material the stiff it is and the larger the stress necessary to produce a given strain, the converse is the case with material of low E valve.

Tensile and compressive stresses cause tensile and compressive strain respectively and similarly, shear stress causes shear strain, but whereas the former produced changes in length the latter produce change of shape or distortion as the twisting or the parallelogram of a block in fig 5.



Tensile Stress;

This stress occurs in the fibers of a number which is subject to a pull.

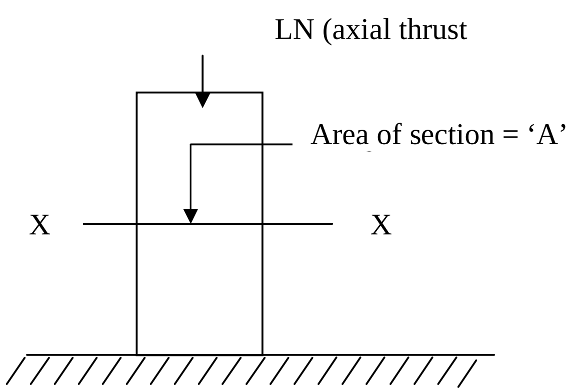


ln applied axial pull

Tensile stress ‘X X’ = $\frac{L}{A}$ N /mm^2

Compressive Stress

When a member transmits a thrust the material of the member is subject to this form of stress.



Compressive stress at section xx = $\frac{\text{LOAD}}{\text{AREA}} = \frac{L}{A}$ Neutral /mm

WEEK 5: MODULUS OF RIGIDITY / BULK MODULUS AND POISSON'S RATIO

Modulus of Rigidity / Bulk Modulus and Poisson's Ratio

Modulus of rigidity;-

It is defined as the ratio of shear stress to the shear strain and is denoted by G.

$$\text{Modulus of rigidity } G = \frac{\text{shear stress}}{\text{shear strain}}$$

$$G = \delta/Q$$

The unit modulus of rigidity is N/mm^2

Bulk Modulus

It is defined as the ratio of load to the volumetric strain and is denoted by K.

$$K = \frac{\text{load}}{\text{Volumetric strain}}$$

Poisson's Ratio

It is the ratio of transverse (lateral strain) to the corresponding axial (longitudinal strain resulting from uniformly distributed axial stress.

Shear Stress

This is the type of stress that occurs in the steel of a river which is loaded as indicated. When one portion of a member tends to slide over another portion at a certain plane in the material, the fibred and that plane are said to be in shear. E.g. using a scissors when cutting a piece of cloth.

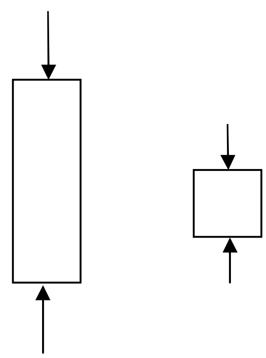
Working Stress

It is the maximum permissible stress allowable for a structural member, the maximum safe valve for the stress in the material of a practical structural member depends upon several factors.

(i) It will depend upon the nature of the material

(ii) It will also depend upon whether the stress is tensile, compressive or shear.

(iii) The actual manner in which the member is employed in the structure will also affect the maximum permissible stress. E.g. a ‘long’ compression member should not be so highly stressed as a ‘short’ one.



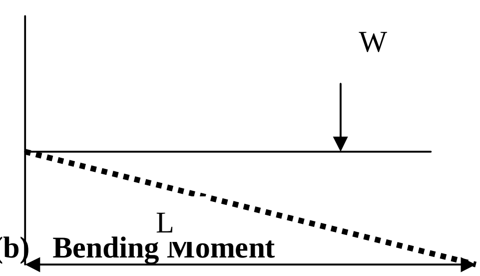
Tensile Strength

It is one of the fundamental properties of concrete. Although reinforce concrete structures are normally designed to resist direct tension, acknowledge of the tensile strength of their member helps in understanding the behavior of these structures and designed use this property to resist loads (flexural tension). Shear, shrinkage and temperature stresses

Identify Configuration of Loading

(a) Cantilever Beam

The configuration for a cantilever beam carrying a point loads at the end. The resultant effect on the beam is bending.



(b) Bending Moment

The bending moment at any section of a beam is the resultant moment about that section of all the forces acting to one side of the section.

(I) Shear Forces

The shear force at any section of a beam is the resultant vertical force of all the forces acting to one side of the section.

WEEK 6

THEORY

6.0 BEHAVIOUR OF VARIOUS FORMS OF STRUCTURES UNDER THE ACTION OF DIFFERENT LOADING AND RESTRAINTS

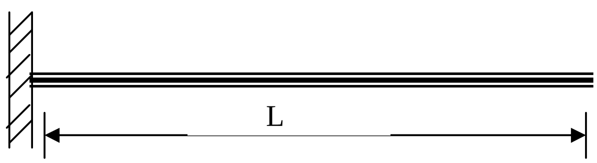
Beams;-

Beams are structural members carrying transverse loads i.e. loads acting across the length of the member.

Effects of such loads will cause shear force and bending moments at any section of the beam

(i) Cantilever Beam;-

It is a beam having its one end fixed and the other end free.

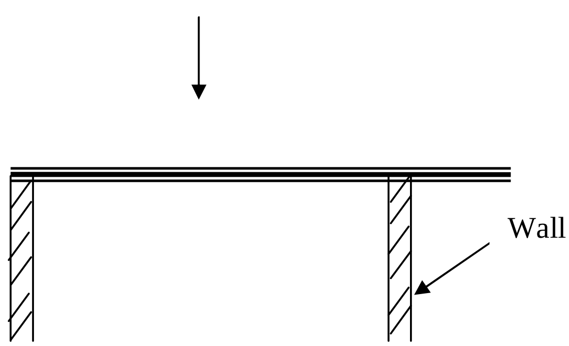


Deflection

L = length of beam

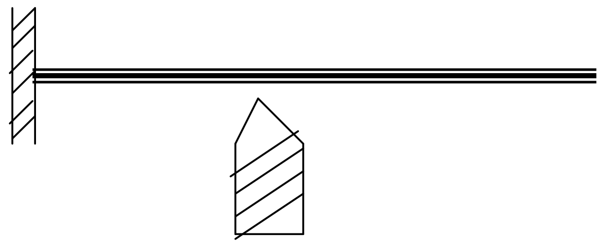
(ii) Simply Supported Beam;-

It is a beam having its both ends freely resting on walls or knife edges



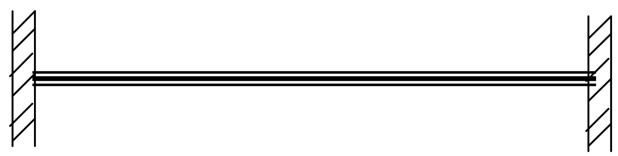
(iii) Over Hanging Beam;-

It is a beam having their supports one or both ends project beyond the supports.



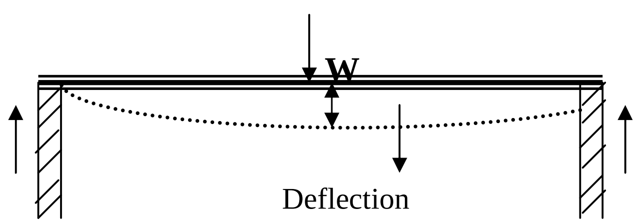
(iv) Fixed Beam;-

It is a beam having its both ends rigidity fixed or bulk in or encasted into its supporting walls or column



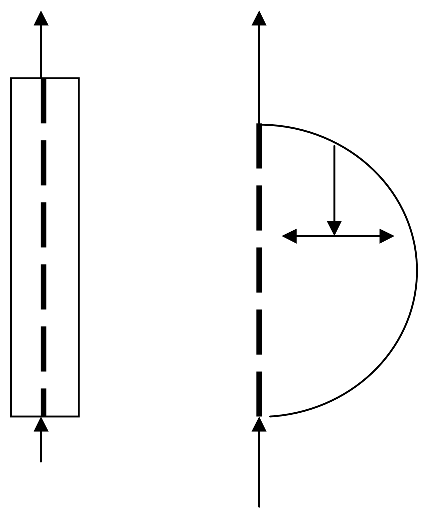
(B) Horizontal Supported Beam

The resulting effects of application of a point load at the centre of a beam is bending (deflection)



(C) Vertical Straight Column;-

The resulting effect of compressed load applied is deflecting or bulking.



WEEK 7: UNDERSTAND ATOMIC STRUCTURE AND CHEMICAL REACTIONS

Particulate Nature of Matter

Matter is made up of discrete particles, the main ones being atoms, molecules and ions.

Atoms

The ancient Greeks were the first to use the word atom, which means indivisible to describe the smallest particle of any substance. Its actual existence was not established until the nineteenth century when John Dalton, an English chemist, put forward a theory to discuss the nature of the atom .The atom is now consider to be the basic unit of simple substances or elements.

Definition; - An atom is the smallest particle of an element which can take part in a chemical reaction. Or

An atom is the smallest part of an element which can ever exist and still posses the chemical property of that element.

Element

A compound part substance that cannot be broken down into other substances.

An element is a substance which cannot be split into simpler units by ordinary chemical process e.g. oxygen 'O', 'H' for hydrogen element etc.

Molecules

Most atoms cannot exist alone. They generally bond with other atoms to form molecules. Molecules may be made-up atoms of the same element or of different elements.

The member of an atom in each molecule of an element is the atomicity of the element. This number is usually small, most gaseous elements like oxygen and chlorine are diatomic, and i.e. the molecule consists of two atoms. Other like phosphorus and sulphur exist as poly atomic molecules. The molecules of helium are monatomic i.e. they can exist independently as single atoms.

Atomicity of some molecular elements

ELEMENT	**FORMULA OF MOL**	**ATOMICITY**
Neon	Ne	1
Hydrogen	H_2	2
Nitrogen	N_2	2
Oxygen	O_2	2
Ozone	O_3	3
Phosphorus	P4	4
Sulphur	S_8	8

All compounds exist as molecule; the smallest particle possessing the chemical property of a given compound is its molecule. The number of atoms in the molecule of a compound may be small or large e.g. a hydrogen chloride molecule contains thousands of atoms.

Molecule

A molecule is the smallest particle of a substance that can normally exist alone and still retain the chemical property of that substance, be it an element or a compound.

Ions

Some substance are not built up of atoms or molecules, but are made up of charge particle called ions. There are two types of ions, the positively charge ions or cations and negatively charge ions or anions. An ions substance has the same number of positive and negative ions, so that it is electrically neutral

An ion is any atom or group of atoms which possesses an electric charge.

Formulae of some compounds are;

Compound	Molecular Formula
Hydrochloric acid	HCl
Water	H_2O
Ammonia	NH_3
Carbon (iv) oxide	CO_2
Lead (ii) chloride	$PbCl_2$
Calcium trioxonitrate (v)	$Ca(No_3)_2$
Zinc tetraoxosulphate (vi)	$ZnSo_4$

Compound;-

A compound is a substance which contains two or more elements chemically together. The component elements of a given compound are always present in a fixed ratio by mass.

E.g.; - Water is a compound formed as a result of a chemical reaction between the compound elements, hydrogen and oxygen in the ratio of 1: 8 respectively.

Examples of compounds;-

(i) Water (H_2O)

(ii) Limestone;- calcium, carbon, oxygen ($CaCo_3$)

(iii) Common salt;- Sodium, chlorine (Nacl)

(iv) Sugar (Sucrose);- Carbon, hydrogen, oxygen ($C_{12}H_{22}O_{11}$)

Mixtures;-

A mixture contains two or more constituents which can easily be separated by physical methods. Example of mixtures

i; Air; - constituents oxygen, carbon (iv) oxide, nitrogen, rare gases, dust, moisture.

ii; Soil; - sand, clay, humus, water, air, mineral salts.

iii; Urine; - urea, water, mineral salts.

iv; Crude oil; - petrol, heavy oil, gas oil, kerosene, napth, bitumen, gas. Etc

Comparison of mixtures and compounds

1	It may be homogeneous or heterogeneous	It is always homogeneous.
2	the constituents are not chemically bond together and can therefore be separated and recover by physical means.	the component elements are chemically bound together and cannot be separated by physical means.
3	The constituents can be added together in any ratio by mass. Hence, a mixture cannot be represented by a formula.	The components are present in a fixed ratio by mass. Hence, a compound can always be represented by a chemical formula.
4	The properties of a mixture are the sum of those of its individual constituents.	The properties of a compound differ entirely from those of its component elements.

WEEK 8: SOLUTION, SUSPENSION AND SOLUBILITY

Solution;-

A solution is formed when a solid, such as crystal of copper (ii) tetraoxosulphate (vi), dissolves in a liquid such as water to produce a homogeneous mixture. The solid is called the solute and the liquid the solvent

$CuSo_{4\ (s)} + 5H_2O_{(l)}$ …… $CuSo_4.5H_2O_{(s)}$

Solute solvent solution

Definition; - A solution is a uniform or homogeneous mixture of two or more substance. A solute is a dissolves substance which may be a solid, liquid, or a gas. A solvent is a substance (usually a liquid although it may be a solid or a gas) which dissolve a solute.

The most common solvent in nature is water. it is usually referred to as the universal solvent.

Examples of solution

Solution	solute (state)	solvent (state)
brine	sodium chloride(s)	water (1)
soda water	carbon (iv) oxide(g)	water (1)
air	mainly oxygen (g)	Nitrogen

Suspensions;-

In a suspension, the dispersed particle can be seen with the naked eye. If the suspension is left undistributed the dispersed particle eventually settle down, leaving the solvent or dispersion medium clear.

A suspension is a heterogeneous mixture of undissolved particle in a given medium. The particles are usually large enough to be seen without the acid of an instrument and they eventually settle down if left standing

Solubility

Although most substances are soluble in water, some are more soluble than the other i.e. means of comparing the extent to which different solute can dissolved in a particular solvent of a definite temperature.

factors that influence solubility are:

(i) temperature

(ii) surface area

(iii) concentration

(iv) cat ion

(v) pressure

Saturated and Unsaturated Solutions

Saturated Solution

A given volume of water can only dissolved a certain amount of salt in it at room temperature. If more salt is added to such a solution the will remain undissolved, such a salt solution is said to be saturated.

A saturated solution of a solute at a particular temperature is one which contains as much solute as it can dissolve at that temperature in the present of undissolved solute particular

The composition of a saturated solution is not affected by the present of excess solute particles. On the other hand an unsaturated solution can continue to dissolve more solute if added until the solutions become saturated. The concentration of a saturated solution varies with the solute, the solvent and with the temperature.

Crystal Structure;-

Many solid substances such as table salt, sugar, or ice grow from small beginnings into definite shape. A crystal is a piece or solid matter in which atoms or molecules are arranged in a regularly repeated pattern or lattice.

Most substance do not exist as single crystals form, then gradually grow they touch and become joined to each other.

Structure of Sample Crystals

We interpret the regular shapes of crystals as evidence that the atoms or molecule composing them are arranged in a regular three – dimensional lattice or frame work. Each atoms or molecule is confined to a definite small space between its neighbors

Fig A illustrates a simple cubic lattice, a simple type of structure in which the atoms or molecule are placed at the corners of imaginary cubes stacked side by side like building blocks. An example of this is the crystal of common salt (NaCl) in which atoms of sodium (Na) and chlorine (Cl) take alternating positions in the cube in each of the three directions. Each atom has six immediate neighbors. We can only imagine crystals as being made up of minutely small building blocks (atoms or molecules). We cannot actually see the atoms or molecules arranged in this way because they are very small. The pattern of the atoms can however be revealed by x-rays

There are other types of crystals apart from the simple cubic crystals. for example in the body centered cubic crystal, each atom has eight instead of size immediate neighbors iron and potassium form body – centre crystals.

In fact the atom in a crystal are not stationary but oscillate about their mean its own particular lattice site and very rarely wanders through the body of the lattice.

Amorphous Substances

Some other solid such as glass and plastic lack the definite orderly arrangement of atoms, so conspicuous in crystals. Such substances are called amorphous because they are without form

Alloys

Pure metals are not used widely because many of their property such as hardness, tensile strength, resistance to corrosion and luster can be improved by mixing them with other elements. These mixtures are known as alloys.

An alloy is a substance prepared by adding one or more elements to the base or parent metal to obtain desirable property. A true alloy can be considered as a uniform mixture it is usually made by melting the components together and solidifying the mixture and should not separate into distinct layers when the mixture solidify. They should not undergo any chemical changes during the process of alloying. The percentage can position of the component elements in an alloy may vary according to the desired quality.

Below are some alloys, their compositions and uses

Alloy	Composition	Advantages
(I) Brass	60 – 80$^o/_o$ cu 20 – 40 $^o/_o$Zn	Stronger and more malleable than copper; greater workability because of lower melting point, More alternative appearance, Does not corrode easily
(2) Bronze	90$^o/_o$ 0$^o/_o$	Greater resistance to chemical attack; more attractive appearance
(3) Duralumin	95$^o/_o$Al 3$^o/_o$cu 1$^o/_o$mg 1$^o/_o$mn	Very highs but stronger than Aluminium
(4) Steel	98.8$^o/_o$ 0.2$^o/_o$	More malleable and ductile than iron harder and stronger Can withstand great stress and strain
(5) Stainless Steel	60 – 80$^o/_o$fe 10 – 20$^o/_o$cr 8 – 20$^o/_o$$N_1$	Hard, resistant to corrosion very attractive in appearance

Uses

(1) For making moving parts of clocks and watches, nuts, rods, bolts, tubes, musical instruments and for several metal work

(2) For making coins and medals, sculptures and for general metal work.

(3) Construction air craft, ships, cars and machinery.

(4) Construction of bridges, ships, cars, and machinery

(5) For making tools, and surgical instruments.

WEEK 9

OXIDE

Oxides are formed when elements combined with oxygen. they can be classify into several groups, namely basic oxides, acidic oxides, amphoteric oxides, neutral oxides, peroxides and other higher oxides.

(i) **Basic Oxides;-** These are oxide of metals, they react with acids to form a salt and water only for example,

$Na_2O_{(s)} + 2Hcl_{(aq)} \Rightarrow 2Nacl_{(aq)} + H_2O_{(l)}$

$PbO_{(s)} + 2HNO_{3(aq)} \Rightarrow Pb(NO_3)_{2(aq)}\ H_2O_{(l)}$

(2) Acidic Oxides; - These are oxides of non-metals. They react with water to form acids. They react with alkalis to form a salt and water only

$Co_{2(g)} + 2NaoH_{(aq)} \Rightarrow Na_2Co_{3(aq)} + H_2O_{(l)}$

$So_{3(g)} + 2KOH_{(aq)} \Rightarrow K_2So_{4(aq)} + H_2O$

(4) **Armphoteric Oxides**;-These are metallic oxides which can behave both as basic oxides and acidic oxides, i.e. they can react with both acids and alkalis to form salts and water only. They include the oxide of aluminum, Zinc, lead and tin. the behavior of amphoteric oxides is determined by the conditions of the reaction

(5) **Neutral Oxides**; **-** Neutral oxides are neither acidic nor basic, hence they are neutral to litmus. they include water, carbon(ii) oxide and nitrogen(i)oxide

(6) **Peroxide**; **-** These are oxide containing a higher proportion of oxygen than the ordinary oxide. They contain the peroxide ions $(0 - 0)^{2-}$ and yield hydrogen peroxide, H_2O_2, when treated with dilute acids. Example of peroxide include Sodium peroxide (Na_2O_2), calcium peroxide, CaO_2 and barium peroxide, BaO_2

$BaO_{2(s)} + H_2So_4$ ....$BaSo_{4(s)} + H_2O_{(aq)}$

(7) **Other Higher Oxides**;-Other higher oxides resemble the peroxides in that they contain a higher proportion of oxygen than the ordinary oxides. however, they do not produced hydrogen peroxide with acids but show a tendency to release oxygen on heating and hence are oxidizing agent .e.g lead(iv)oxide PbO_2 and manganese(iv) oxide MnO_2, Iron(ii) di iron (iii) oxide Fe_3O_4

WEEK 10: RUSTING, ACIDITY/ALKANITY

Experiment

Rusting, Acidity/Alkanity

Determination of the percentage purity(or impurity) of acids and bases

Experiment 5.9

To determine the percentage purity (or impurity) of acids and bas.

You provided with 0.051 $moldm^{-3}$ of tetraoxosulphates(VI) acid, 6.00g of an impure sodium hydroxide per dm^3 and other materials, e.g. burette, pipette, conical flasks, methyl orange indicator, etc.

Method Pipette into the clean conical flask $25cm^3$ solution of the impure sodium hydroxide solution. Pour the acid into burette, after it has been rinsed. Take the initial reading of the burette.

1. Add two drops of methyl orange into the conical flask. Titrate as described in experiment 5.4 Record your results as shown below.
2. **Result** Volume of sodium hydroxide used = $25cm^3$

Indicator used: = methyl orange.

Burette reading				
final burette reading (cm^3)	Trial	1^{st} titre	2^{nd} titre	3^{rd} titre
Initial burette reading (cm^3)				
Volume of acid used (cm^3)				

Average volume of acid used = xc

Calculate

The equation of the reaction is

$$2NaoH_{(aq)} + H_2SO_{4(aq)} \longrightarrow Na2\ SO4_{(aq)} + 2H2O_{(l)}$$

Mole ratio of NaOH to H2so4 = 2:1

a. using the formula, $\frac{C_A V_A}{C_B V_B} = \frac{1}{2}$

$\frac{0.051moldm^{-3} \times X\ dm^{3}}{CB \times 0.025dm^{3}}$

$= Y\ moldm^{-3}$

Molar concentration of NaOH solution= Y

(correct to 2 significant figure).

Amount (n) of NaOH = CV→ YV

Molar mass (M) of NaOH= $\frac{m}{n} \rightarrow \frac{M}{Yv} = m$

.: mass concentration = Mx Yv →*p*

b . %purity = $\frac{\text{mass of pure} \times 100}{\text{mass of impure substance} \quad 1} = p \times \frac{100}{6.00}$

= *p%* (correct value to 2 significance figures)

c. mass of impurity per dm^{3} of the impure sodium hydroxide

= (6 – *p*) g

% impurity = $\frac{\text{mass of impurity}}{\text{Mass of impure substance}} \times \frac{100}{1}$

.: % impurity = $\frac{(6 - p)}{6.00} \times 100$

=A % (correct value to 2 significant figures)

WEEK 11: FACTORS INFLUENCING THE CAUSES OF DAMPNESS IN BUILDINGS.

Adhesion and Cohesion

Cohesion:-The force of attraction between molecules of the same substance is called cohesion.

Adhesion:- The force of attraction between molecules of different substance is called adhesion.

The adhesion of water to glass is stronger than the cohesion of water. Hence when water is spilled on a clean glass surface it wets the glass. on the other hand the cohesion of mercury is greater than its adhesion to glass. Thus, when mercury is spilled on glass it forms small spherical droplets or larger flattened drops and does not wet glass for the same reason, when these liquids are contained in glass vessels, the water surface is concave to the air while mercury concave to the liquid

The Origin of Surface Tension

The existence of surface tension can be explained by the molecular attraction between the liquid molecules

Right inside the liquid we say a molecule such as A is in equilibrium, since it is attracted by equal numbers of molecules all around it. The sphere around which molecules attraction is strong within the liquid. For a molecular attraction is in air and part is in water. The liquid has far more molecules than air. As a result of this more molecules are attracting B is hence toward the liquid than outwards. The resultant force on B is hence towards the liquid, the same occurs for all molecules near the surface consequently the surface of the liquid is pulled inward, straining the surface molecules so that they appear to be in a state of tension.

Surface tension:-the surface of a liquid behaves as if it were covered by an elastic skill. The surface thus appears to be under some force or tension, the tension or force acting parallel to the surface of the liquid is known as surface tension.

Inserts can walk on water due to surface tension. The phenomenon of surface tension is made possible due to cohesive force in liquids

Capillarity

If a very narrow glass tube is inserted in a beaker of water we observed that water rises up the tube and its surface is concave to the air in the tube. if an identical tube is placed in a beaker of mercury, the surface is convex to the air and is depressed below the outside level.

Capillarity is defined as the tendency of liquids to rise(or fall) in narrow capillary tubes

It is brought about by cohesive and adhesive forces. Water and some liquid which wet glass rise in a capillary, tube because the force of adhesion of the liquid molecules for glass is greater than their cohesion to each other. Hence water tends to rise up the glass and is concave upwards.

In the case of mercury the cohesion of mercury molecule is greater than their cohesion to glass. The mercury thus tends to curve inwards as becomes depressed in the tube.

Examples of capillary action;-
Water rising up the stem of a plant, we held on the rib of a pen, blood spreading through the five capillary channels in the body.etc

Practical Situation in Construction Where Capillary Occurs.

In water logged or damp sites, water can pass into the building through capillary action, blocks used in sub structural works contains pore through which water can penetrate through capillary action. Remedy – DPC.

WEEK 12 : EXCLUSION OF DAMPNESS EXPERIMENT NO.4 WATER REPELLENCE

Exclusion of Dampness

Many of the materials commonly used in the construction of the walls and roofs of the buildings are porous materials, that is they contain small air space, voids, distributed through their mass the important result of the presence of these voids is that the material will tend to absorb water by capillary action and to distribute that water uniformly through its mass. There is in consequence, a danger that dampness may penetrate to the insult of a building though this tendency can be largely averted

by making wall sufficiently thick, since the process of penetration takes times and is active only during periods when absorption can take place. For most parts of walls and roofs, such periods occurs mainly during actual rainfall, and therefore limited in extent.

Methods of Protecting Against Dampness

(1) Using damp-proof courses.

(2) Breaking the capillary path:- It has been explained that movement of water due to capillarity is caused by the ability of very narrow openings to attract moisture into them. A wide opening is an otherwise narrow passage has no such power of attraction and therefore provides a barrier to the further movement of moisture by capillary action. A simple example of this effect is provided by a capillary tube which has an enlarged bulb in its length. Fig V, if one end A is placed in water, water will be drawn up to point B. Beyond that point it cannot be drawn because the aperture widens out and loses its capillary property. this is a most valuable device for stopping the penetration of water through a porous material or a narrow opening

Cavity walls are example of the application of this device to building practice. Water may be absorbed by the outer leaf of the wall and in as far as the cavity, it cannot cross the cavity by capillary action, however, the inner leaf remains dry.

Using water proof skins;- A thin layer of waterproof material is a vulnerable feature of construction. When it is embedded in the construction, as in the case of the damp-proof courses already described, it is well protected and will gives satisfaction service. Water proof layers are usually embedded in the thickness of walls and floors in basement construction to resist the up thrust of the water pressure at a considerable depth. below ground level

(3) **Water – Repellent materials:-** Two methods are employed in using water – repellent materials for preventing penetration of dampness through wall. The materials may be incorporated as an integral part of the walling material or they may be applied as surface coatings.

The use of integral water proffers is principally confined to concrete walls and water proof coatings of cement mortar. These water proofers are frequently used in powder form, the particles of powder being strongly water repellent. A relatively small quantity of such a powder, mixed in with the concrete or mortar, will give the whole material when set a disinclination to absorb water. For ordinary exposure in wall, this is sufficient to prevent penetration of dampness through the material itself, but it should be remembered that it will not give protection against penetration through cracks, nor will it resist penetration under considerable pressure such as may exist for example below ground level.

Surface coatings may be applied in two ways: paraffin wax may be rubbed on to brick or stone surface which have been warmed with a blow – lamp. The warmth melts the wax and enables it to penetrate some distance below the surface. Alternatively, a wax may be dissolved in a liquid that will evaporate quickly at normal temperatures (e.g. Benzene). The solution may then be brushed on to the wall surface where it will be absorbed some distance into pores and fine cracks. The solvent will evaporate, leaving the wax as a water – repellent coating of some depth. Both these methods are effective and have the advantages that the water proofing treatment does not, to any considerable extent, change the appearance of the wall surface.

WEEK 13 : BERNOULLI'S THEOREM

Flow of Water:-

The movement of water, like the movement of solid, is brought about by the action of forces and energy is consumed in the process. Water may posses potential and kinetic energy due, respectively to its position and to its velocity in the manner to be described later. Energy may also be stored in water due to its being under pressure.

Potential energy may be determined by this formula,

$$P.E = MgH \Rightarrow Ep = Mg \times H$$

Where Mg is the weight of the fluid and Hm its height above a given datum. Alternatively in the terms commonly used in connection with fluids, for a head of fluid Hm, the potential energy is energy is H kgm per kg of fluid. For a head of fluid Hm the potential energy is Hkgm per kg of fluid.

The kinetic energy is given by expression $\frac{WV^2}{20}$ kgm/s^2

Where Wkg is the weight of the moving substance and Vkg/s^2 its velocity.

Fluid under pressure Pkg/m^2 (kg/mm^2) has a corresponding head of $\frac{P}{W}$ m (cm, mm)

Where W is the density of the liquid in kg/m^3. The energy due to this head is $\frac{P}{W}$ kgm/kg.

The total energy posses by one KG of water may therefore be express as

$$H + \frac{V^2}{20} + \frac{P}{1000} \text{ Kgm.}$$

The density of water being taken here as 100Kg/m^3.

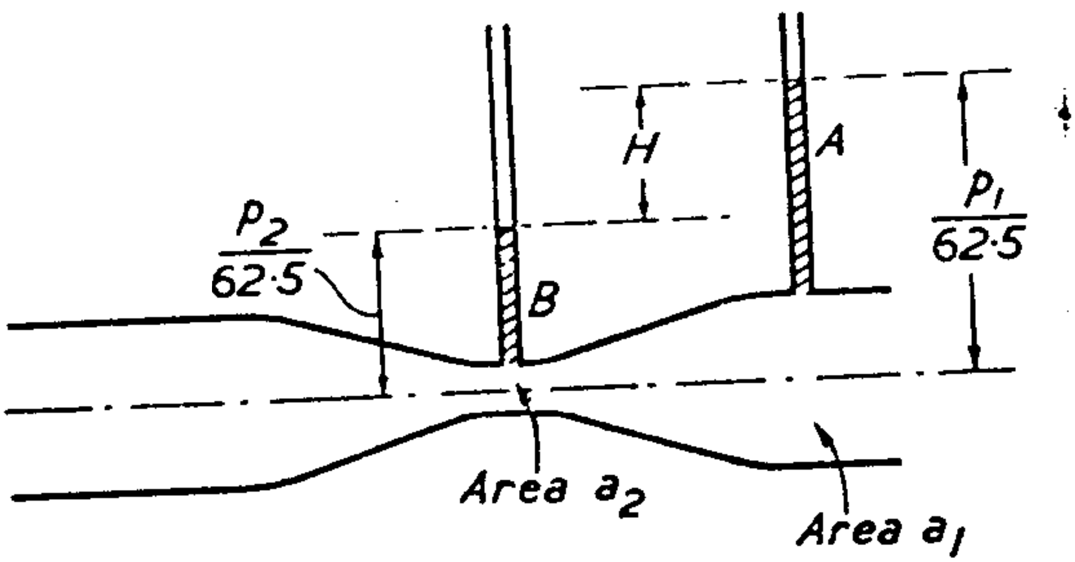
q meter cube (m^3) per sec.= quantity of water of water flowing=

$$a_1v_1 = a_2v_2$$
$$v^2 = 2as$$
$$v^2 = 2 \times 10 \times h$$
$$20h = v^2$$
$$h = \frac{v^2}{20.}$$

WEEK 14 : VENTURI METER

Venturi Meter

An important example of the application of the principle contained in Bernoulli's Theorem is provided by the venture meter, an instrument used for measuring water flow in pipes. The meter consists of a short length of pipe tapering to a narrow neck in the middle tubes enter the pipe at the throat and at a point outside the restricted portion, these enable the water pressure at those points to be measured.



[redacted].—Venturi Meter.

Venturi meter

If a_1 and a_2 m are the areas, respectively of the main pipe and the throat, and v_1 and v_2 m/s the velocity respectively at those points then q cubic meter per sec = quantity of water flowing = $a_1v_1 = a_2v_2$ = Area of pipe x velocity.

$$\frac{a_1v_1}{a_1} = \frac{a_2v_2}{a_1}$$

$$v_1 = \underline{a_2v_2}$$

a_1

Applying Bernoulli's equation (assuming meter horizontal)

$$\frac{p_1}{100} + \frac{v_1^2}{20} = \frac{p^2}{100} + \frac{v_2^2}{20}$$

$$\frac{P_1 - P_2}{100} = \frac{V_2^2 - V_2^2}{20}$$

$$\text{let } Hm = \frac{P_1 + P_2}{1000}$$

$$Hm = \frac{V_2^2 - V_1^2}{20} = \frac{V_2^2}{20}\left(\frac{1 - a_2^2}{a_1^2}\right)$$

$$H = \frac{V_2^2}{20}\left(\frac{1 - a_2^2}{a_1^2}\right)$$

$$\frac{20\,H}{V_2^2} = \left(\frac{1 - a_2^2}{a_1^2}\right)$$

$$V_2^2 = \frac{20H}{1} \times \frac{a_1^2}{a_1^2 - a_2}$$

$$V_2 = \sqrt{20H}^{\,2} \left(\frac{a_1}{\sqrt{a_1^2 - a_2^2}}\right)$$

Since a_1 and a_2 are constant for a given meter, $q = C \sqrt{H}$ where C is constant for a given meter. Since H may be determined from the readings at tubes A and B, the flow may be determined.

The above expression assumes that no loss of energy occurs due to friction or other causes. in practice it is found that there is always a small loss which may be determined for any given instrument, by experiment. Flow is determined from the expression

$$q = KC\sqrt{H}$$

where K is a co-efficient (less than 1) associated with the particular meter used.

WEEK 15 : SOLVE SIMPLE PROBLEMS INVOLVING FLOW OF WATER

Solve Simple Problems Involving Flow of Water

A venturimeter placed in a 5cm diameter pipe has a throat diameter of 2cm. determine the flow in cubic meter (m^3) per second when the meter records a difference in head between pipe and throat of 20cm of water the coefficient of the meter is 0.97

Solution

$q = KC\sqrt{H}$

a_1 = 22/7 x r^2= 5/100 = 0.05m/2 = $(0.025)^2$

a_2 = 22/7 x r^2 = r = 2/100 = 0.02m/2 = $(0.01)^2$

Therefore area of a_1^2 =22/7 $(0.025)^2$

Area of a_2 = 22/7 $(0.01)^2$

a_1^2 = 0.000003857m^2

a_2^2 = 0.000000098m^2

Area of a_2 = 22/7 $(0.01)^2$ = 0.0003142

Area of a_1 = 22/7 $(0.0025)^2$ = 0.001964

H = 20cm = 0.2m

C= $a_1\, a_2 \sqrt{20H}$

$$\sqrt{a_1^2 - a_2^2}$$

$q = KC\sqrt{H}$

$$C = \frac{0.000191964 \times 0.000314}{0.001939}$$

C = 0.000634

$q = KC\sqrt{H}$

$q = 0.97 \times 0.000634 \times \sqrt{0.2}$

$q = 0.97 \times 0.000634 \times 0.4472$

$= 0.000275 m^3/s = 2.75 \times 10^{-4} m^3/s$

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