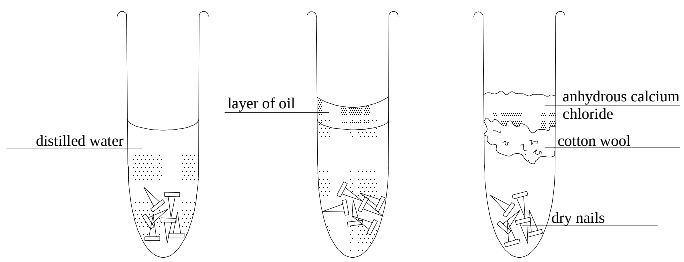
UNESCO-NIGERIA TECHNICAL &
VOCATIONAL EDUCATION
REVITALISATION PROJECT-PHASE II

NATIONAL DIPLOMA IN QUANTITY SURVEYING



BASIC ENGINEERING SCIENCE

COURSE CODE: QUS103

YEAR I- SE MESTER I

PRACTICAL

Version 1: December 2008

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PRINCIPLE OF MOMENTS 2

WEEK 1:

EXPERIMENT

SCALAR AND VECTOR QUANTITIES
STABLE, UNSTABLE AND NEUTRAL EQUILIBRIUM

PRACTICALS:

Apparatus: - A cone and a flat stable equilibrium board.

Step I: Place a cone on a flat board, on its bottom

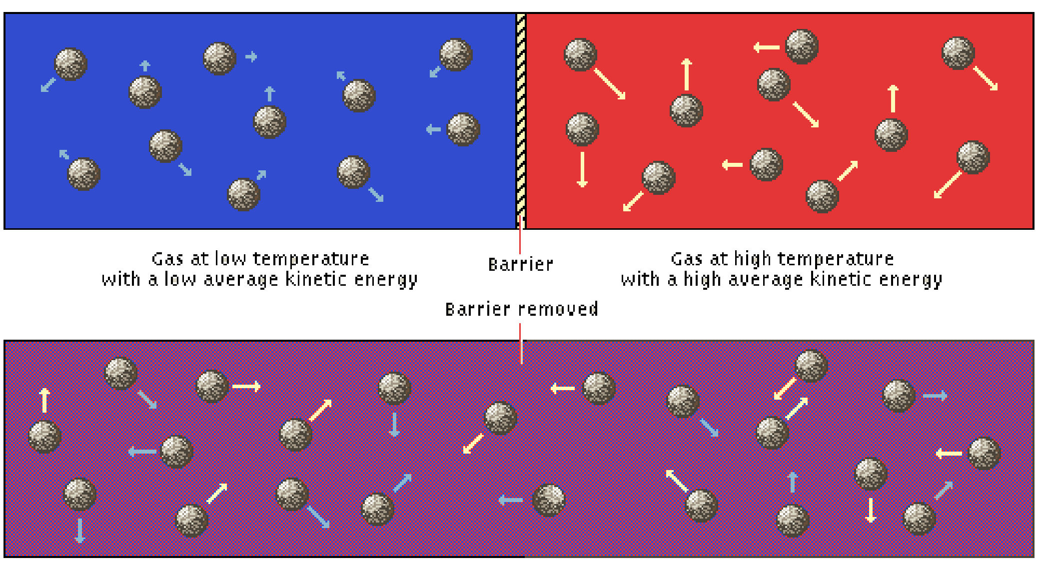
Step II: Touch the cone. If it fall's back to it' original position it has a stable equilibrium. If it doesn't it has an unstable equilibrium.

Step I: **Unstable equilibrium**

Place a cone on its apex. You will observe that it will fall. It has an unstable equilibrium.

Step I: **Neutral equilibrium**

Place a cone on its sides you will observe that it will be over. It has a neutral equilibrium

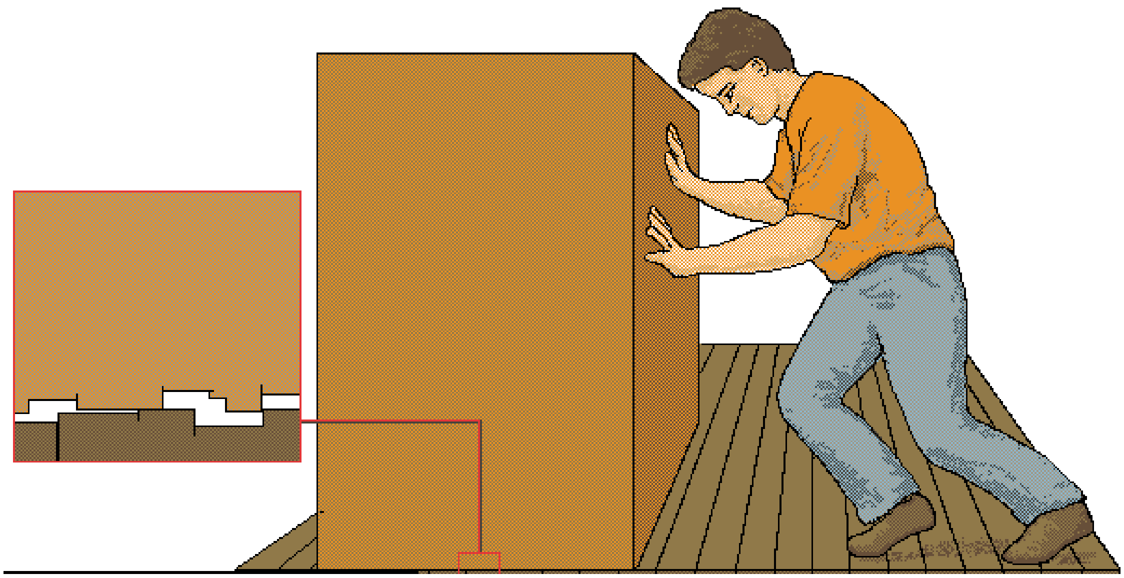


Gases mix, now both have the same average kinetic energy

WEEK 2:

EXPERIMENT

TITLE : THE PRINCIPLE OF MOMENTS



Friction

Microscopic bumps on surfaces cause friction. When two surfaces contact each other, tiny bumps on each of the surfaces tend to run into each other, preventing the surfaces from moving past each other smoothly. An effective lubricant forms a layer between two surfaces that prevents the bumps on the surfaces from contacting each other; as a result the surfaces move past each other easily.

Aim: **To verify the Principle of Moments**

Apparatus: Meter rule, knife edge, object A (unknown mass= 100g), Masses

W=20g, 30g, 40g, 50g and 60g and string.

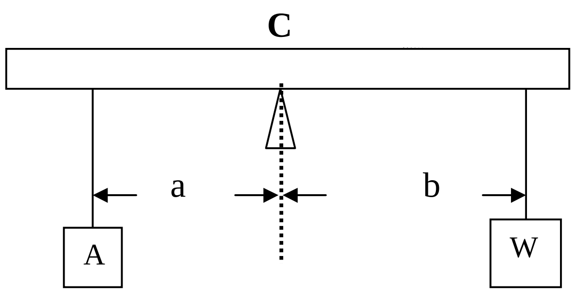


FIG.13 Principle of Moments

Method

(i) Place the metre rule horizontally on the knife- edge. (Fig.13)

(ii) Adjust the metre rule until it settles horizontally. Read and record the

point of balance C of the metre rule.

(maintain the knife – edge at point C throughout the experiment)

(iii) Suspend the object A at the 20cm mark and adjust its position until the metre rule settles horizontally.

Read off the position F of the mass M of the metre rule.

Record the distance b between C and F. also, record

(iv) Repeat the procedure keeping the knife – edge at C and the object A at the 20cm mark but using the masses W=30, 40, 50 and 60g on the other side of C.

Record the distance b and the corresponding value of w.

(v) Determine the values of 1/b.

(vi) Plot a graph of w against1/b.

Determine the slope, s, of the graph.

(vii) State two precautions taken to ensure accurate results.

Position of balance C=

W/g	A/cm	b/cm	$\frac{1}{b}$/cm^{-1}
20.0 30.0 40.0 50.0			

Table 14

(i) state the (i) Conditions of equilibrium for a body acted upon by a number of co-planar parallel force

(ii) A uniform metre rule P Q is balanced on a knife - edge which is 55cm from Q. If a mass of 20g is hung at R, which is 15cm from p, compute the mass of the metre rule.

WEEK 3

EXPERIMENT:

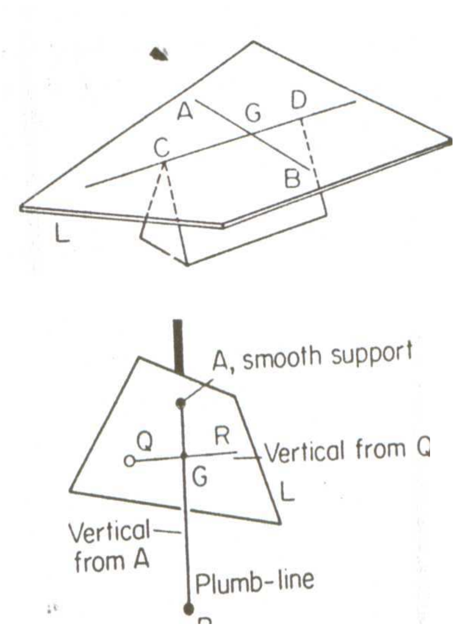
EXPERIMENTS TO LOCATE C.G. OF LAMINA


Encarta Encyclopedia, PictureQuest/James A. Sugar/Black Star Publishing

Approximate method First, try to balance a lamina such as a thin wooden board on a point. Since the whole weight acts at the centre of gravity G, the position is roughly determined in this way. As this is not precise, a more practical way is to balance the lamina L on a sharp, such as the edge of a triangular glass prism, and to draw the line AB of the edge (Fig 4. 18). The C.G. lies somewhere on AB. The lamia is then removed, turned round and balanced again. The new line CD of the edge is drawn on it. Then the centre of gravity G is the point of intersection of AB and CD.

(2) Accurate method

To find the centre of gravity more accurately, suspend the lamina from a smooth horizontal support at A, near one edge, making sure it can swing freely (Fig. 4. 19). Now suspend a plumb line from A, consisting of a small weight attached to a thread. The line of the thread is then vertical, and it can be drawn on the lamina



The experiment is repeated by suspending the lamina from another point Q. Since the lamina always comes to rest with its centre of gravity G vertically below the support, G is the point of intersection of the lines QR and AB. The C.G. of an object such as a stool can be found in a similar way by suspending it in turn by its legs, and locating the vertical lines by using thread if necessary tied to the legs.

WEEK 4

THE EFFECT OF FORCES ON MATERIALS

Experiment No 1

Title: Overturning of Walls

Model wall sections, cut from wood, stand on a bench as shown in Fig. 73(a). Side thrust is applied by means of a cord attached to the wall and running over a pulley at the edge of the bench. Sliding of the wall prevented by means of a stop fixed to the bench. Weights are placed in a scale pan attached to the cord and the load required to overturn the wall is determined. (the weight of the scale pan must be added to the weights in determining this load.) the wall itself is then weighed.

The point at which the resultant of the weight of the wall and the side – thrust cuts the base of the wall when overturning takes place is determined by either of the methods given in Example 15 above. This point should be very near the top of the wall.

The experiment should be repeated with an additional weight on the toe of the

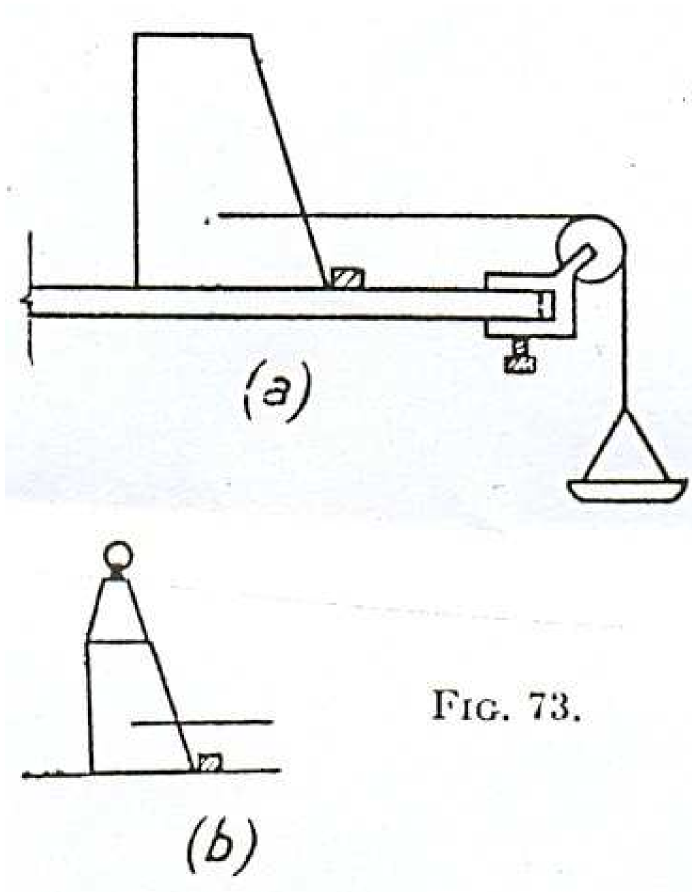


FIG. 73.

wall (Fig. 73 (b)

WEEK 5
FINDING OUT THE CONDITION FOR IRON RUST

Encarta Encyclopedia, Photo Researchers, Inc./Junebug Clark

i. Place a few clean, unused nails in a test tube containing distilled water. Leave the test tube exposed to the air for 3 or 4 days. (Fig. 25.1). Observe any changes.

ii. Place some distilled water in a second test tube and boil it for few minutes to drive off any dissolved gases. Quickly place a few clean unused nails in the test tube and seal off the surface of water by adding a layer of kerosene or palm oil. Set the tube aside for or 4 days.

iii. Place a few clean, new nails in a third, dry test tube and plug with cotton wool. Place a good layer of anhydrous calcium chloride on top of the cotton wool to keep the air dry. Leave the test tube with the other two for 3 or 4 days.

Observation

i. The nails in test tube 1 become covered with a reddish brown layer after exposure to air for a few days. This reddish brown layer is hydrated iron(III) oxide, $2Fe_2 O_3$, $3H_2O$, or iron rust this layer can be removed as a power, exposing fresh parts of the nails to further attack. The nails have rushed due to atmospheric oxidation.

ii. The nails in the other two test tubes from no reddish-brown layer of rust as they have not been exposed to both air and water. The oxygen in the water in test tube 2 was removed by boiling and moisture was exclude from test tube 3 by means of cotton wool and drying agent, calcium chloride.

iii. Both moisture and air, therefore, appear to be the important conditions for the rusting of iron.

WEEK 6

EXPERIMENT

BEHAVIOR OF VARIOUS FOROMS OF STRUCTURE UNDER THE ACTION OF DIFFERENT LOADINGS AND RESTRAINTS

Experiment M9

Title: young's modulus of the material of a cantilever beam

Aim: To determine the young's modulus of a cantilever beam

Apparatus: 2 metre rule, retort stand, pointer(pin), G- clamp, sellotape or plasticize, slotted mass labeled P= 150g and thread.

DIAGRAM

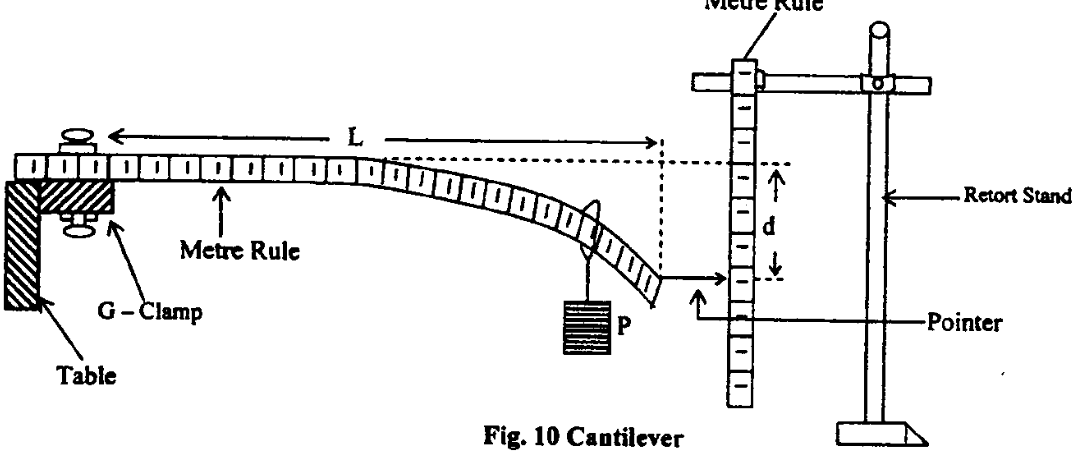


Fig. 10 Cantilever

METHOD

(i) Clamp the metre rule horizontally onto the edge of the bench with its graduated face

upwards such that L= 90cm projects over the edge of the table as shown above. (Fig. 10)

(ii) Attach a pointer at the free end of the metre rule to move over a vertical scale. Note and record the equilibrium position of the free end of the rule.

(iii) Hang the mass labelled P to the free end. Measure the depression d of the rule from its equilibrium position. Evaluate L3.

(iv) Repeat the procedure for L = 80, 70, 60, and 50cm respectively. Measure and record the depression d of the rule and evaluate L^3 in each case.

(v) Plot a graph of d on the vertical axis against L3 on the horizontal axis, starting from the origin **(0, 0).**

(vi) Determine the slope **'S' of** the graph.

Measure and record the width W and thickness **t** of the metre rule. Hence

compute $E = \frac{KM}{Wr^3 S}$

Where K 39.2ms^{-2}, M is the mass of P

(vii) State two precautions taken to ensure accurate results.

Equilibrium position of free end =

Table 10

Length **L** ***/cm***	**Depression** **d/cm**	L^3 **/ cm^3**
90.0		
80.0		
70.0		
60.0		
50.0		

WEEK 7

EXPERIMENT

MIGRATION OF IONS

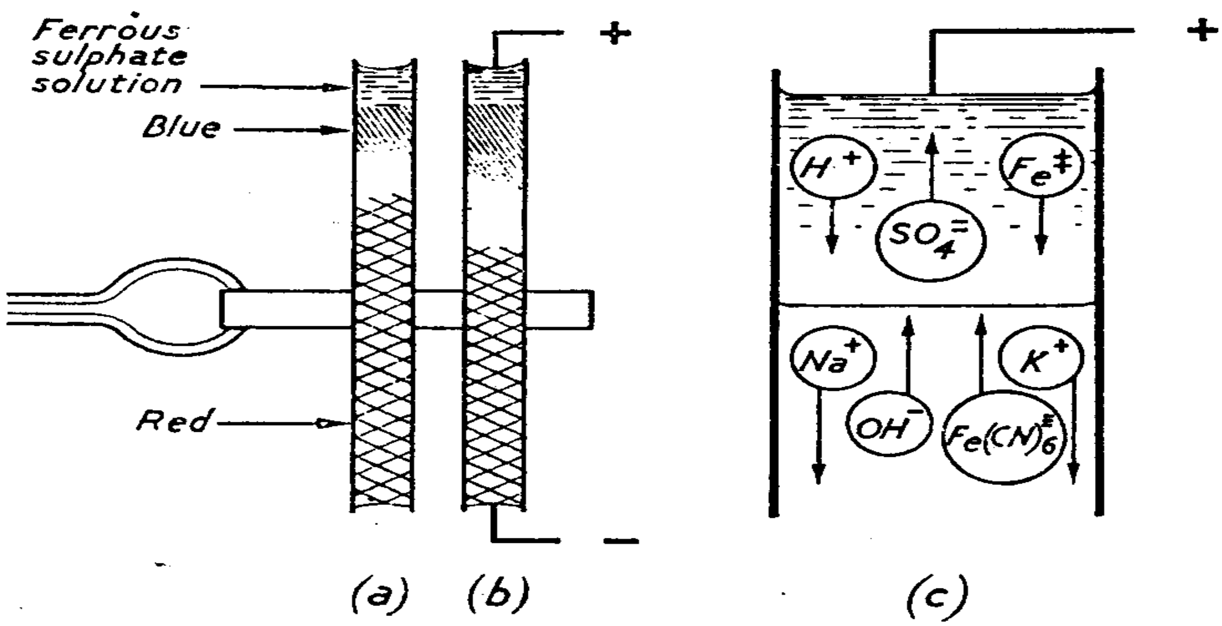


FIG. 23.

EXPERIMENT No. 7.—Migration of Ions

(This experiment is given by Sherwood Taylor in *Elementary Practical Physical Chemistry* (O.U.P.).)

Prepare the two tubes shown in Fig. 23 as follows:

Dissolve 3 grm. of gelatin in 50 ml. water, warming to about 50° C. and stirring well. Add a few drops of phenolphthalein solution and about 0·05 grm. of potassium ferricyanide. Add dilute caustic soda solution drop by drop until the solution turns pink. Dip a glass tube about 20 cm. long into the solution, and suck up enough to fill all but about 4 cm. of its length. Close one end with the finger and withdraw it from the solution. Lay it horizontally on the bench, adjusting the liquid so that there is an air space at each end of the tube. When the jelly has set, which should be in about half an hour, cut the tube at the centre, making two tubes as shown.

Support the two tubes vertically in a cork, and into the spaces above the gelatin pour a solution of ferrous sulphate containing about 5 per cent. of sulphuric acid.

The chemical reactions which take place are:

(*a*) $$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O.$$

This reaction, by neutralising the caustic soda, renders the jelly colourless.

(*b*) $$\underset{\text{Potassium ferricyanide}}{2K_3Fe(CN)_6} + \underset{\text{Ferrous sulphate}}{3FeSO_4} \rightarrow \underset{\text{Ferric ferricyanide (Prussian blue)}}{Fe_3[Fe(CN)_6]_2} + \underset{\text{Potassium sulphate}}{3K_2SO_4}.$$

The progress of this reaction is indicated by the blue colour produced.

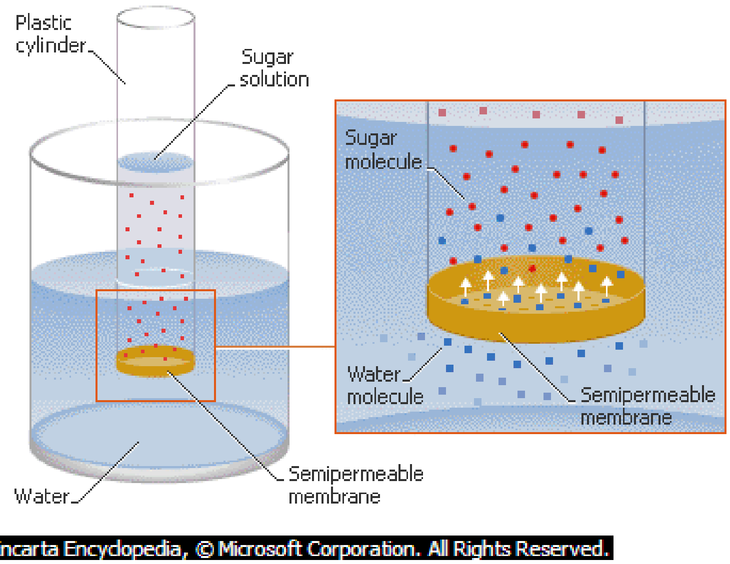
upon the diffusion of the ions, and after about 3 hours the tube will present an appearance as indicated at (a) in Fig. 23. Hydrogen ions move more rapidly than Fe ions, and the colourless zone therefore precedes the blue colour.

If electrodes are inserted in the ends of the tube and connected to the poles of a battery, it will be found that the progress of the reaction is accelerated. The progress indicated at *(b)* in Fig. 23 may be obtained in about 30 minutes with 60 volts or in about 3 hours with 12 volts.

The ionization which takes place is shown at *(c)* in Fig. 23 and the migration of ions to he expected from the passing of the current is indicated. This migration should result in the acceleration of the progress of the reaction, a forecast which is confirmed by the result of the experiment.

It is this migration of ions which causes the passage of the electric current through a solution. Pure water will not conduct electricity to any appreciable extent, but solutions of ionic compounds will do so.

WEEK 8



EXPERIMENT

TITLE: SOLUTIONS, SUSPENSION AND SOLUBILITY

Aim: Finding Suitable Solvents for Fats, Oils and Paints.

Apparatus: palm oil sample, kerosene sample, leads paint sample, ethanol, petrol, iodine, water, white cloth, cotton, turpentine, test tubes and vanilla

Method

(i) Try and dissolve some palm oil in a test tube of water and then in a test tube of kerosene.

(ii) Try removing a stain of palm oil from a piece of white cloth by means of a piece of cotton soaked in kerosene.

(iii) Try to dissolve a small quantity of lead paint in a test tube of oil of turpentine.

(iv) Try to clean three areas of varnish from an old piece of varnish-polished furniture with water, ethanol and petrol, respectively.

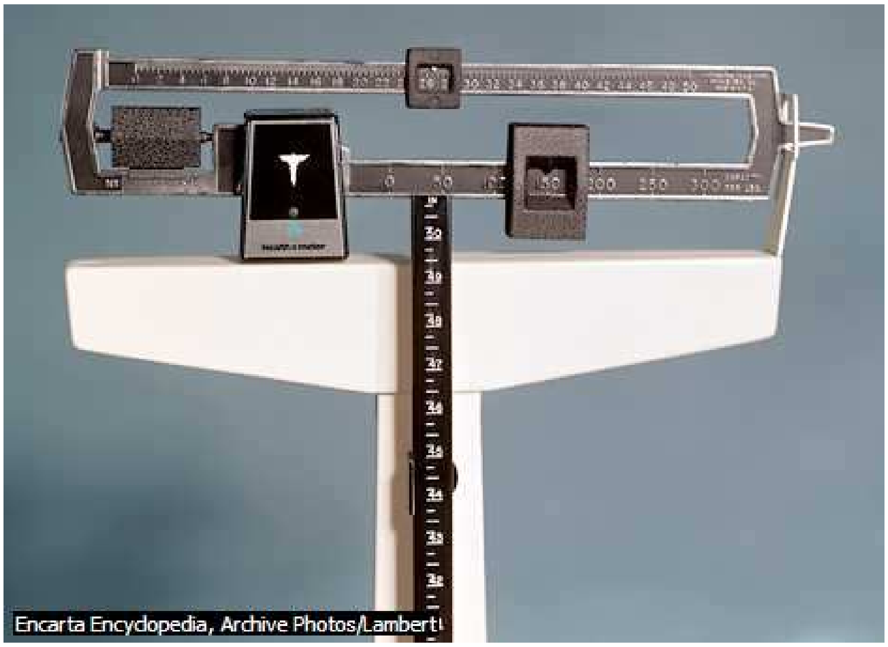
(v) Dissolve some vanilla in a test tube of ethanol, and some iodine in ethanol

Record all your observations.

Observations

In all experiments above water is found not to be suitable solvent. Kerosene is found to dissolve substances such as oil and grease, and oil of turpentine to dissolve paints and varnishes. Petrol will also dissolve paints and varnishes while ethanol dissolves substances such as drugs (e.g. iodine), flavours (e.g. vanilla), perfumes and varnishes.

WEEK 9



EXPERIMENT

Title: Young's Modulus of the material of a cantilever Beam

Aim: To determine the young's modulus of a cantilever Beam.

Apparatus

2 meter rule, retort stand, pointer (pin), G-clamp, sellotape or plasticine, slotted mass labeled P = 150g and thread.

METHOD

i. Clamp the meter rule horizontally onto the edge of the bench with its graduated face upwards such that L = 90m project over the edge of the table as shown above. (Fig. 10)

ii. Attach a pointer at the free end of the meter rule to move over a vertical scale note and record the equilibrium position of the free end of the rule.

iii. Hang the mass labelled P to the free end. Measure the depression d of the rule from its equilibrium position. Evaluate L3.

iv. Repeat the procedure for L = 80,70,60, and 50cm respectively.

Measure and record the depression of d of the rule and evaluate L3 in each case.

v. Plot a graph of d on the vertical axis against L3 on horizontal axis, starting from the origin (0,0).

vi. Determine the slope ‘S’ of the graph.

Measure and record the width W and thickness t of the meter rule. Hence

$$Compute\ E = \frac{KM}{Wt3S}$$

Where K = 39.2ms-2, M is the mass of P

vii. State two precautions taken to ensure accurate results.

Equilibrium position of free end =

Length L/cm	Depression d/cm	L3/cm3
90.0		
80.0		
70.0		
60.0		
50.0		

Table 10

i. What do you understand by moment of a couple?

ii. Use your graph to determine the value of L for which the depression d is 3.0cm.

WEEK 10-

TITLE: RUSTING /ACIDITY/ALKALANITY

Aim: Finding out the Conditions for Iron Rust.

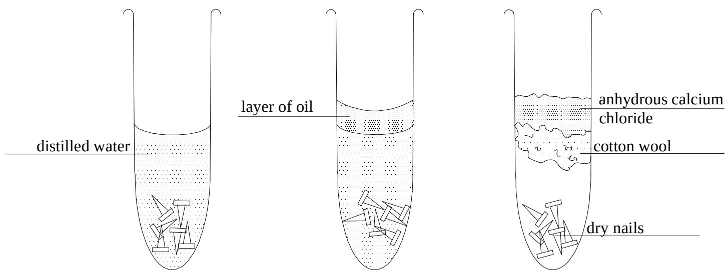


Fig 1

Method:

i. Place a few clean, unused nails in a test tube containing distilled water. Leave the test tube exposed to air for 3 or 4 days. Observe any changes.

ii. Place some distilled water in a second test tube and boil it for a few minutes to drive off any dissolved gases. Quickly place a few clean unused nails in the test tube and seal off the surface of the water by adding a layer of kerosene or palm oil.et the test tube aside for 3 or 4 days.

iii. Place a few clean, new nails in a third, dry test tube and plug with cotton wool. Place a good layer of anhydrous calcium chloride on top of the cotton wool to keep the air dry. Leave the test tube with the outer two for 3 or 4 days.

Observations:

i. The nails in test tube 1 become reddish brown layer after exposure to air for a few days. This reddish brown layer is hydrated iron (III) oxide, $2Fe_2O_3, 3H_2O$, or iron rust. This layer can be removed as a powder, exposing fresh parts of the nails to further attack. The nails have rusted due to atmospheric oxidation.

ii. The nails in the other 2 test tubes form no reddish brown layer of rust as they have not been exposed to both air and water. The oxygen in the water in the test tube 2 was removed by boiling and moisture was excluded from test tube 3 by means of cotton wool and the drying agent, calcium chloride.

Both moisture and air, therefore, appear to be important conditions for the rusting of iron.

WEEK 11:

FACTORS INFLUENCING THE FLOW OF DAMPNESS IN BUILDINGS

(ADHESION, COHESION, SURFACE TENSION AND CAPILLARITY)

Aim: (Capillary Actions with H_2O & Mercury)

Apparatus: A Beaker of water, A Beaker of Mercury 2 Capillary tubes (very narrow tubes).

Methods:

i. Insert a capillary tube into a beaker of water.

ii. Insert the other capillary tube into a beaker of mercury.

Observation:

i. Water rises up the first capillary tube and its surface is concave to the air inside the tube.

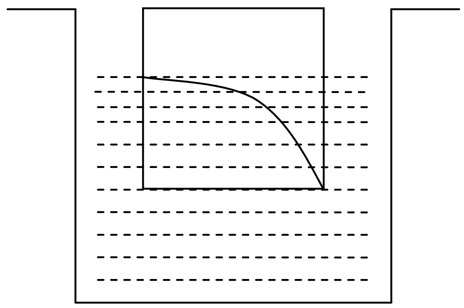
ii. The surface of the mercury raised up in an identical tube placed in a beaker containing mercury is convex to the air and is depressed below the outside level.

This is brought about by cohesive & adhesive forces. Water & some liquids which wet glass side in a capillary tube because the force of adhesion of the liquid molecules for glass is greater than their cohesion to each other. Hence H2O tends to rise up the glass and is concave upwards.

In the case of mercury, the cohesion of mercury molecules is greater than their adhesion to glass. The mercury thus tends to curve inwards and becomes depressed ion the tube.

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

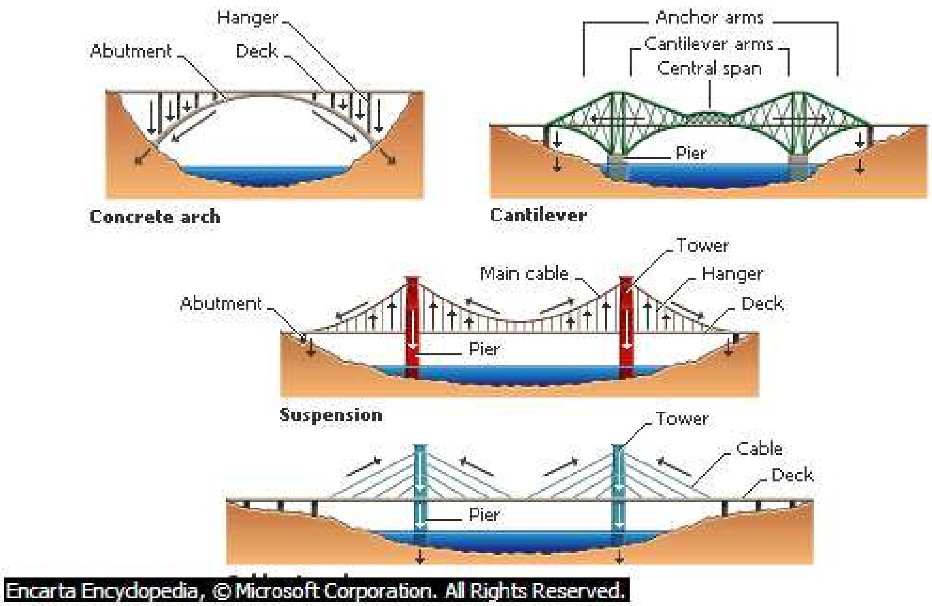
STEP 1: Set up the apparatus for the apparatus for the experiment with the inside surfaces of the glass plates made slightly greasy. Place the whole apparatus in a tray of water and observe the effect, which should be figure a.



Remove the glass plates and clean their surfaces with methylated spirit: - finish by polishing with a clean cloth. Set up the apparatus again and observe the effect of filling the tray with water.

Step II:- take a small quantity of water repellant powder (calcium stearate is suitable). Place it in a beaker of water and try to mix it with the water. It should be found that the powder rests on the surface of the water and resists all attempts at mixing.

WEEK 13



TITLE: MASS OF AN OBJECT BY PRINCIPLE OF MOMENTS.

Aim: To Determine the Mass of an Object using the Principle of Moments.

Apparatus

Meter rule, knife edge, thread, unknown mass labeled T = 50g and a 100g mass labeled M

DIAGRAM

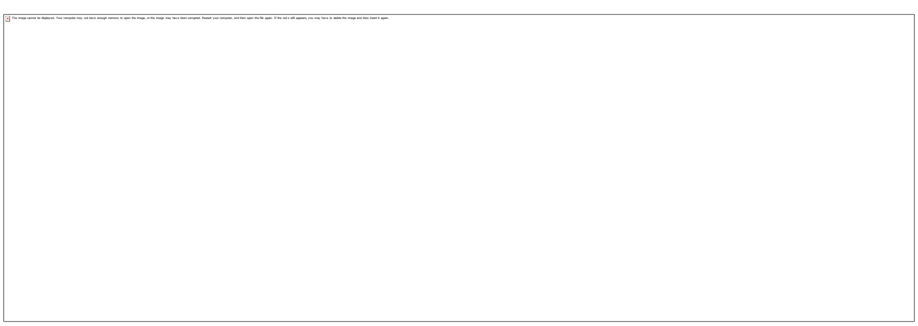


Fig. Mass of an object by principle of moments

METHOD

(i) Place the metre rule on a knife edge and adjust until it balances in a horizontal position.

(ii) Attach a string to T and hang it on the 10cm mark and adjust the position on the other side until the rule balances horizontally.

Note the distance a and b.

(iii) Repeat the experiment by hanging T on the 15, 20, 25 and respectively and obtain the corresponding positions of M.

(iv) Plot a graph with b on the vertical axis and a on the horizontal axis.

Deduce the value of T from the slope.

(v) State precautions taken to ensure good results.

Position of knife edge C =

a/cm	**b/cm**
10.0	
15.0	
20.0	
25.0	
30.0	

Table 15

(B) (i) Define moment of a force about a point.

(ii) A body of mass 60g is suspended at the 20cm mark of a uniform metre q The metre rule is adjusted on a pivot until it settles horizontally at the 40cm mark. Determine the mass of the metre rule.

WEEK 14

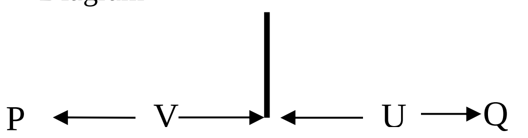
TITLE: MASS OF A METRE RULE BY PRINCIPLE OF MOMENTS.

Aim: To Determine the Mass of a Metre rule by Principle of Moments.

Apparatus

Metre rule, Knife-edge, 100g mass and fin long thread.

Diagram



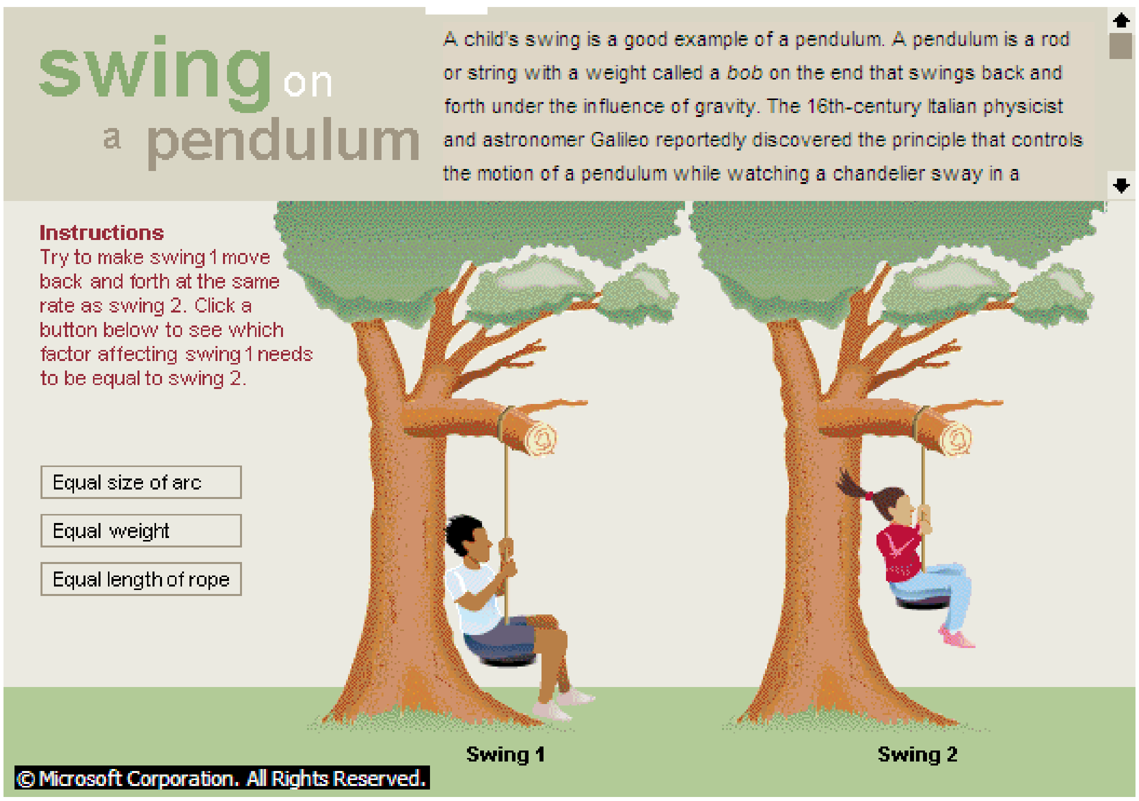


Fig.15 Mass of a metre rule by principle of moments

Method

(i) Attach the thread to the 100g mass and suspend it such that V = 5cm.

(ii) Determine the position of the pivot at which the metre rule with the hanging mass will be in equilibrium.

Find U.

(iii) Repeat the experiment with V = 10, 15, 20, 25 and 30cm.

cm marks

Determine and record the corresponding values of U in each case.

Plot a graph of, V. on the vertical axis and U on the horizontal axis starting both axis from the origin.

(iv) Determine the slope of the graph.

(v) State precautions taken to ensure accurate results.

V/cm	U/cm
05.0	
10.0	
15.0	
20.0	
25.0	
30.0	

Table 16

(B) (1) The relation between V and U in the experiment above is given by

$$V = -\left(\frac{m + 100}{m}\right) U + 50$$

Where m is the mass of the metre rule. Use the value of your slope to determine the mass m, of the metre rule. If m is the mass of the metre rule and R is the reaction at the knife-edge, write an equation of moments about the zero point of the rule when the system is in equilibrium.

WEEK 15

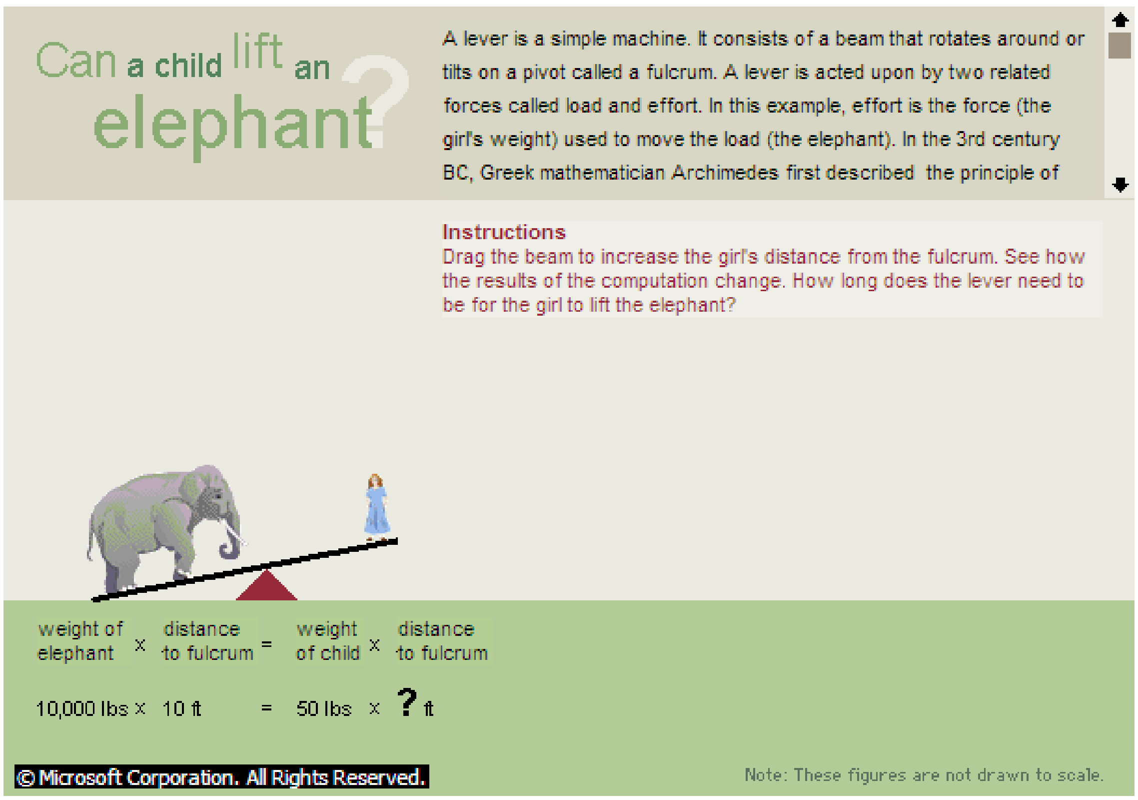
TITLE: PRINCIPLE OF MOMENTS

Aim:

Apparatus :

G-clamp, Metre rule, Masses, Stop watch/clock and Sellotape.

Diagram



METHOD

(i) Clamp the metre rule to the edge of the table such that 90cm of the rule projects from the edge and the rule capable of performing vertical oscillations as shown above. (Fig. 17)

(ii) With W = *50g* fixed to the free end of the rule.

(iii) Deflect the rule so that it performs vertical oscillations and determine the time, t, for 20 oscillations.

Calculate the period T of oscillation, Evaluate T2.

(iv) Repeat the experiment for values of W 100, 150, 200 and *250g.* Determine the corresponding values oft, T and T2 in each case.

(v) Plot a graph ofT2 against M starting both axes from the origin (o, o).

(vi) Determine the slope, S, and the intercept I of the graph.

(vii) State two precautions you took to obtain accurate results.

Table 18

W/g	Time for 20 oscillations		Mean t/s	Period t/s	T^2/S^2
	t1	t2			
50.0					
100.0					
150.0					
200.0					
250.0					

(i) Explain what is meant by stating that a body is in stable equilibrium.

(ii) If R is the reaction from the bench, m the mass of the metre rule and M the mass of the attached load, draw a force — diagram of the arrangement when the rule is in equilibrium and write down an equation relating R, m and M together.