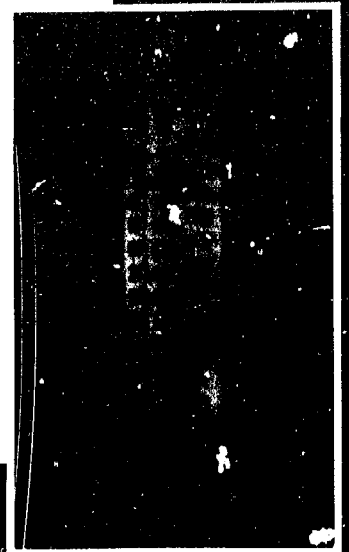
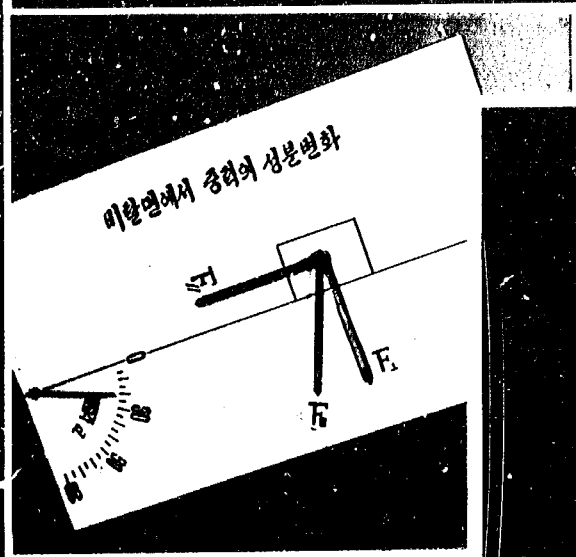
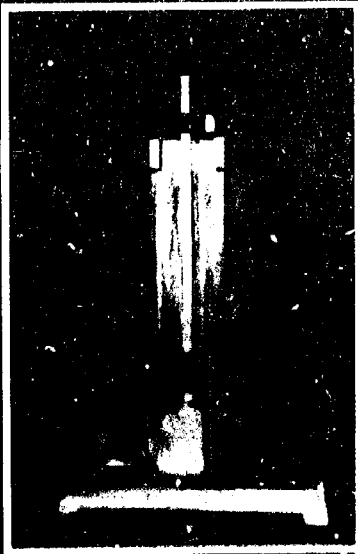


LOW-COST SCIENCE AND TECHNOLOGY MATERIALS AT THE SENIOR MIDDLE SCHOOL LOWER GRADES LEVEL

(Examples of National Institutions
of Democratic People's Republic of Korea,
People's Republic of China and Brasilia)



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INTRODUCTION

1. In many countries, in all regions of the world, educational authorities and specialists are giving increasing attention to the place of science in general education at the pre-primary, primary and secondary levels.

2. There seems to be some general agreement among them regarding the important role that science should play, and can play, within the context of education; and on the need to give children opportunities to develop their natural curiosity, the use of their senses and their ability to think and act within their natural and social environment.

3. But the picture is not so clear when it comes to the specific aims and objectives to be attained, and even less so regarding the ways of translating those objectives into a set of activities that may help the children, appropriately and efficiently, to acquire the scientific concepts, the technical skills and the attitudes which they will need: How should classroom work be organized for those objectives actually to be achieved? What sort of pupil participation could be envisaged? What is the role of the teachers in all this? What materials will they have at their disposal, for their own work and for their pupils?

4. During the last two decades efforts have been made to introduce science and technology education in pre-primary, primary and secondary curricula. But these efforts have not always been successful because they have not drawn from everyday life examples and meaningful experiences with obvious scientific and technological applications. Furthermore, various experiments have been conducted during this period on the production and use of low-cost equipment making use of resources available locally. Unfortunately, these experiments have not always yielded the expected results, because those responsible for implementing them have not always had the time or the motivation nor have the means made available been sufficient.

5. This is why Unesco organized in May 1987 at Pyongyang in the Democratic People's Republic of Korea, an interregional workshop to focus on the efforts already made and the recommendations put forward to promote the dissemination of innovative materials and equipment and develop national, regional and interregional co-operation.

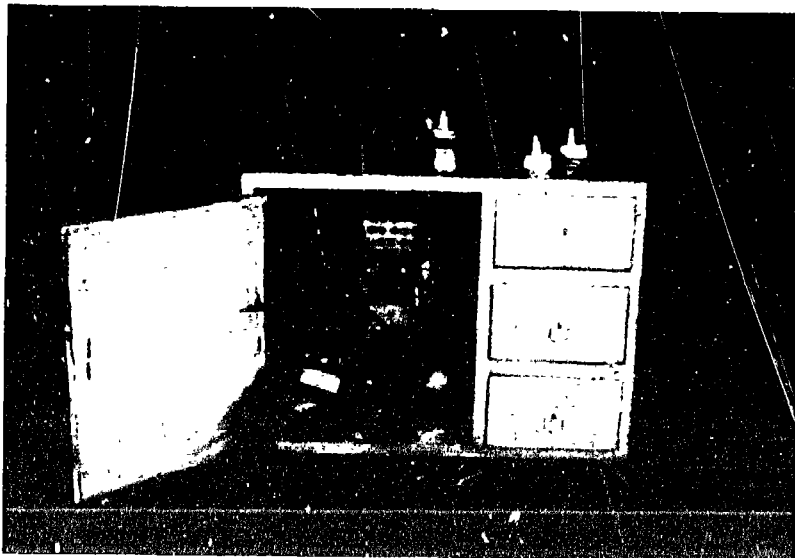
6. To follow on this workshop, it has been foreseen that a guide book with examples would be produced and disseminated. The photo-album which is presented here is intended to show to readers the materials and equipment made in the Democratic People's Republic of Korea, People's Republic of China and in Brazil and which were selected for exhibition at the workshop. Furthermore, it aims at stimulating new initiatives and opportunities for national, regional and interregional co-operation.

The proceedings and papers of the Pyongyang interregional workshop may be obtained from the following address:

Division of Primary Education
Literacy, Adult Education and
Education in Rural Areas
Unesco
7, place de Fontenoy
75700 Paris
France

C O N T E N T S

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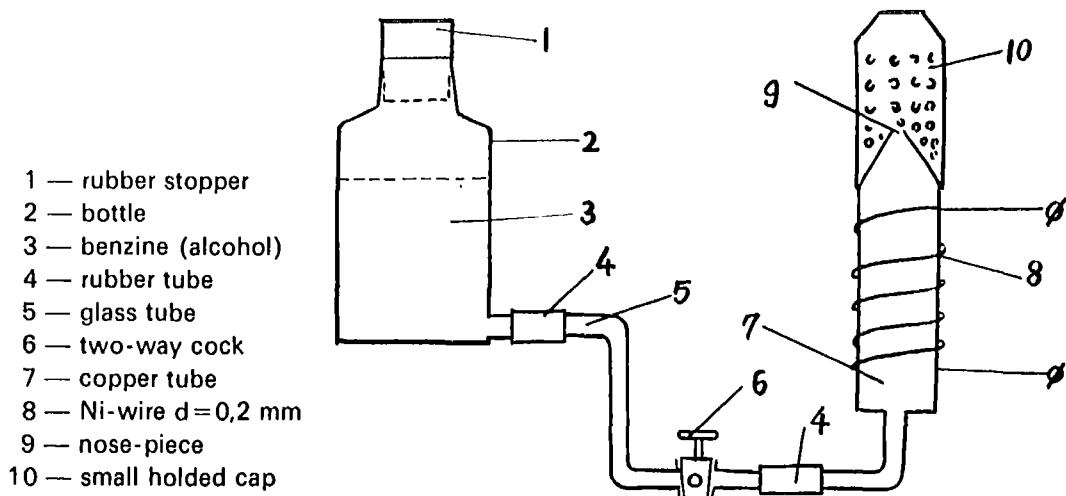
Kerosene Burner for Glass Work

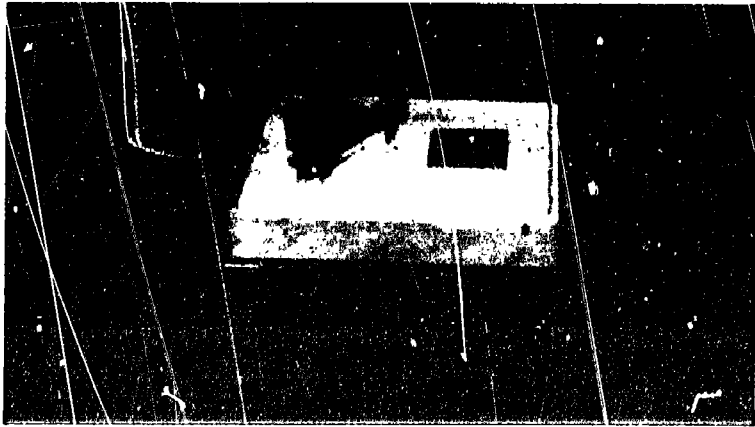
Purpose:

A burner to work with glass instruments in schools.

Structure:

The apparatus consists of the box of kerosene, an electric heating device to heat up the combustible, and nozzles. The nozzle has 3 shapes according to the glass piece being worked. The apparatus has no compressor. It is safe and easy to make.

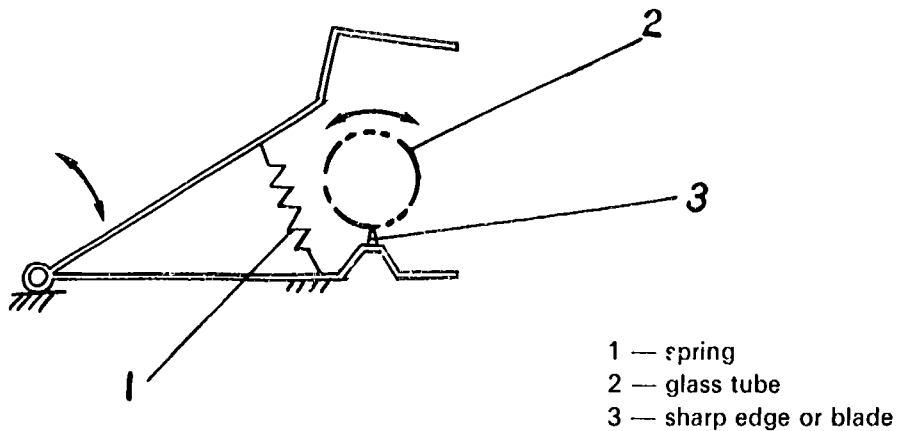


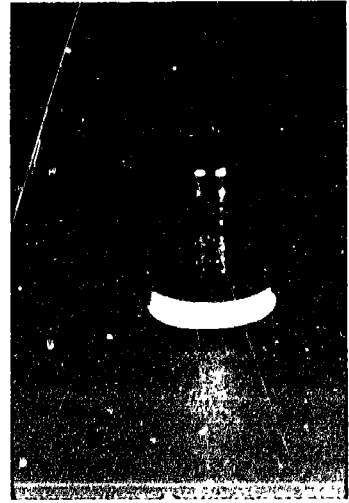
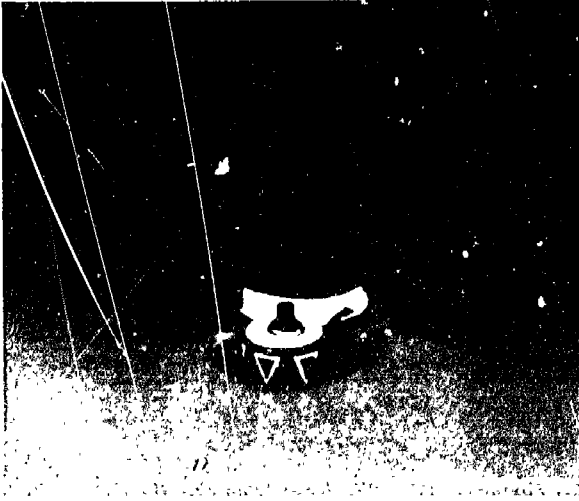


Glass Tube Cutter

Purpose:

The instrument is used to cut glass tube of desired length. It consists of blades and a grip. The glass tube is placed between the blades and the holder and the cutter are turned so as to mark the glass. The tube is then broken at the mark.





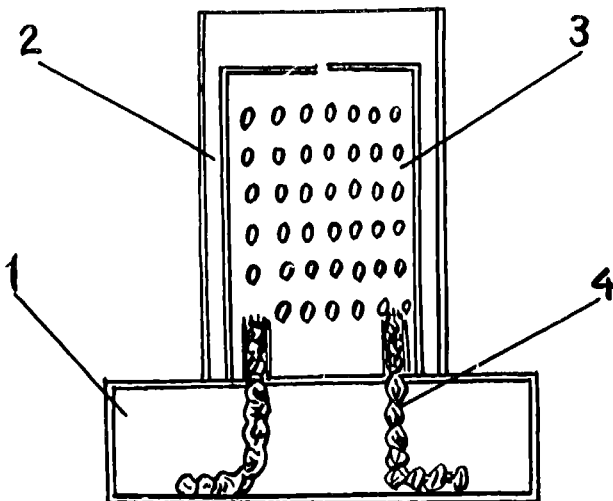
Kerosene Burner

Purpose:

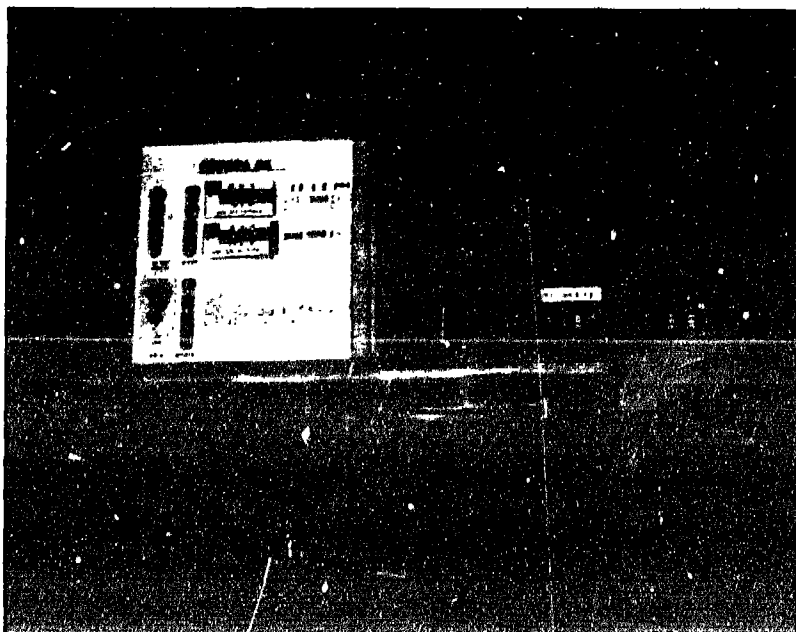
The apparatus uses kerosene instead of alcohol, providing a burner which may replace the alcohol burner.

Structure:

The apparatus consists of an oil tank, a wick and a heating pipe which carries air quickly. The burner is designed to make use of kerosene and alcohol substitute.



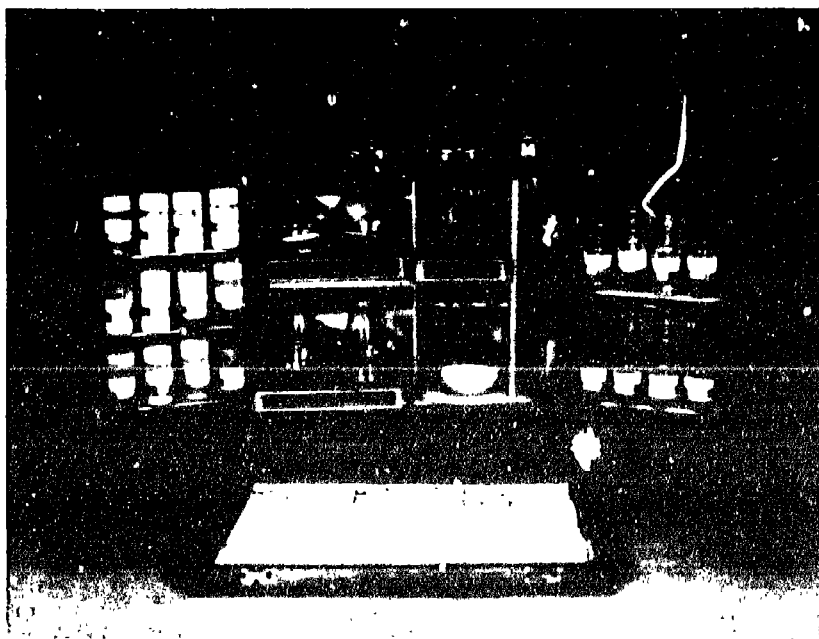
- 1 — box
- 2 — metal cap
- 3 — small held cap
- 4 — wick



An Indicator

Purpose:

This indicator is a natural pigment which can be used as a substitute for litmus and phenolphthalein widely used in chemical experiments. It may be used in liquid form or on paper. It has the advantage of being easily made by using plant flowers such as azaleas, violets, bell flowers, magnolia and bush clover flowers.



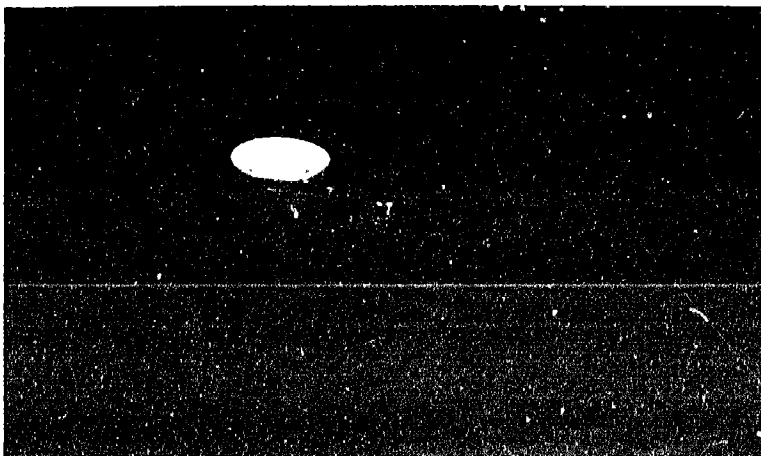
A Box for Chemical Experiments

Purpose:

The box is designed for keeping and transporting the glassware and reagents needed for experiments in chemistry lessons in classrooms.

Structure:

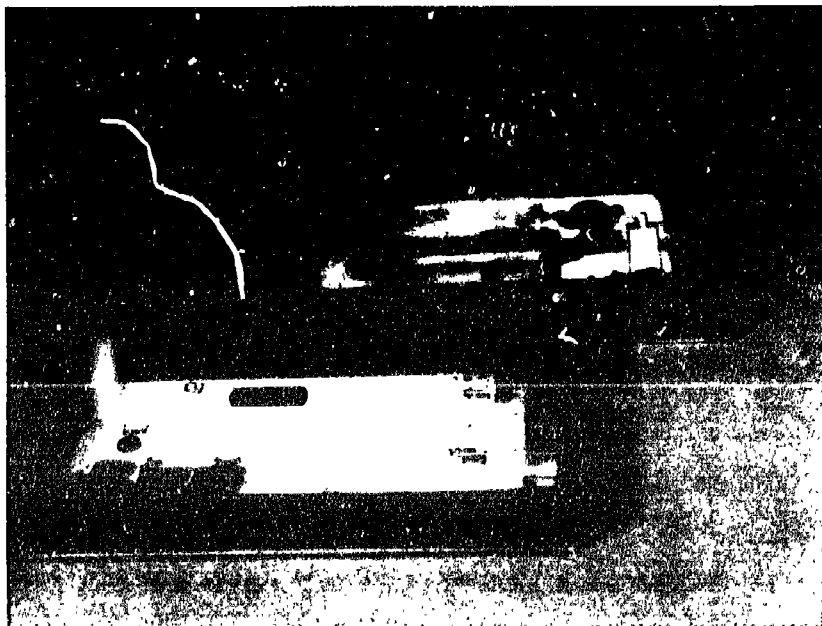
The box has six compartments in which glassware, reagents and accessory equipment (tripods, brushes, spoons) can be kept. It also serves to assemble diverse systems of chemical experiments by using a metal sheet perforated at regular intervals. More than 40 different experiments can be shown by means of this kit.



A Chemical Balance

Purpose:

This instrument is designed to weigh chemical reagents to a maximum of 100 grams with an accuracy of ± 1 mg. Based on the lever principle, it will give a direct measure of the weight without a balance weight.



Chemical Experimental Box for Projector

Purpose:

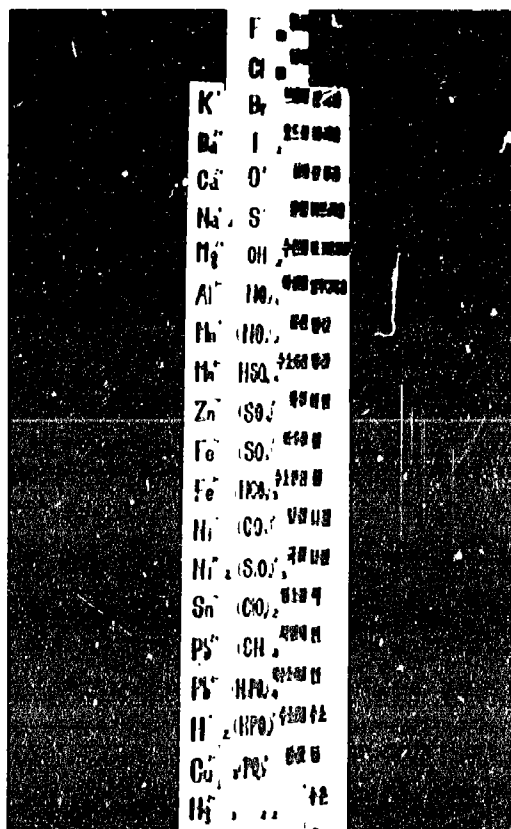
An instrument to show various chemical reactions, using a projector.

Structure:

The box contains a projector and a set of test-tubes. It is fitted with one, two or three partitions made of transparent plastics (acrylene, styrene).

Methods of use:

Place the test-tubes in the projector and conduct various chemical experiments. It is then possible to observe on the screen changes in colour or precipitation or fluid drops. More than 50 chemical visual experiments can be shown with the equipment.



Chemical Formula Ruler

Purpose:

This is an apparatus for teaching chemical symbols and how to make chemical formulas.

Structure:

The ruler consists of a moving part and a fixed part, both marked with various chemical symbols. More than 400 chemical formulas can be built up by fitting the two plates correspondingly.



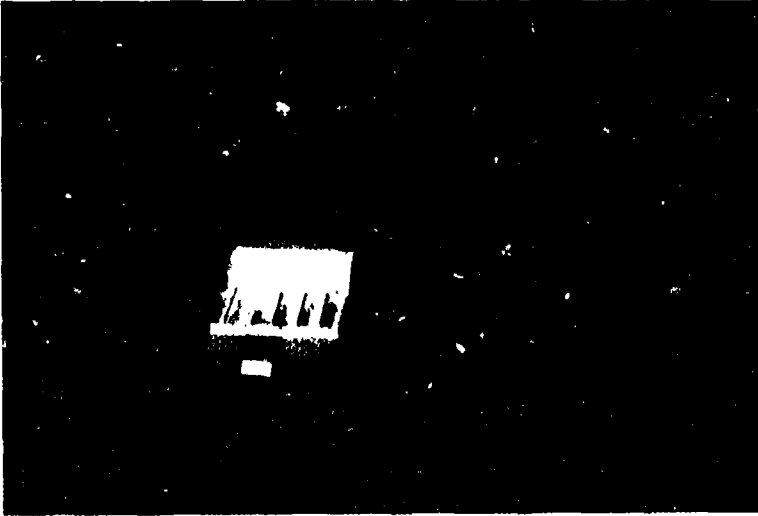
Comprehensive Apparatus Showing the Properties of Gases

Purpos::

To show the properties of gases in chemistry lessons. To demonstrate the effect of temperature on volume when pressure is kept constant and the effect of pressure on volume when temperature is kept constant.

Structure:

The apparatus consists of a syringe pump, a manometer, a flask, a thermometer and an alcohol lamp.



Sample Cutter for Microscope

Purpose:

This is an apparatus for preparing a microscope sample by slicing leaves, trunks or roots of any plant.

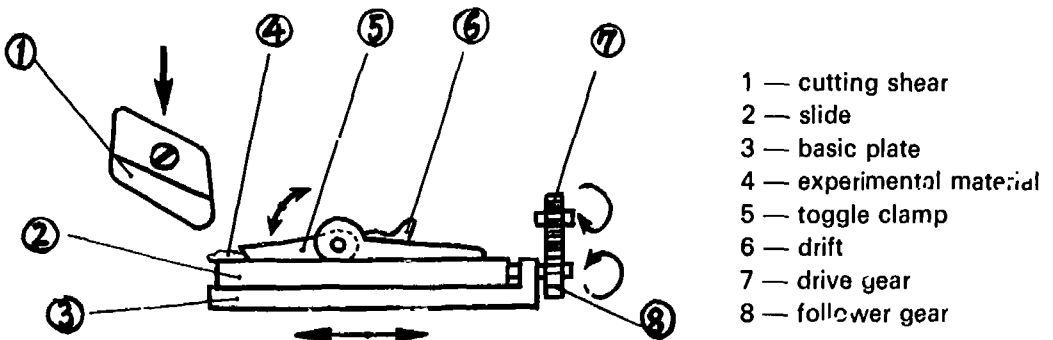
Structure:

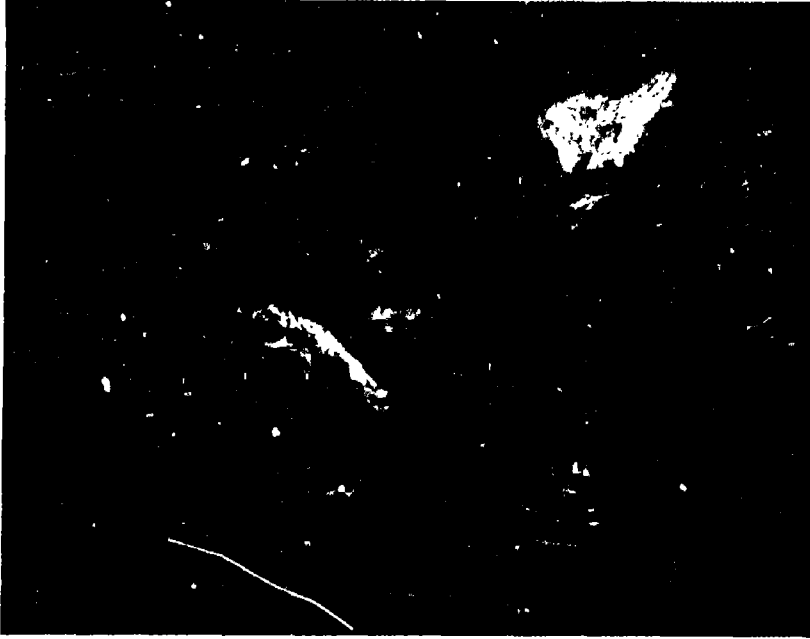
It is composed of a blade (safety razor), cover of blade, leading frame, spring frame for laying the sample, control screw for sample thickness, etc.

Minimum thickness of sample: 8-10 mm.

Size of sample: 5x5 - 10x10.

The apparatus is small but convenient to use.





Dried Specimens of Animals

Purpose:

For biology lessons. Animal specimens dried by a special process to last for a long time.

Making:

The specimen is treated by freezing and drying after extracting the oil component from the animal body. The special feature of the method is that it preserves the original figure of the specimen for years.



Natural Coloured Specimens of Vegetation

Purpose:

The natural colours of the plants are preserved in these specimens.

Making:

Specimens of leaves and flowers may be preserved in the dry condition after treatment with copper sulphate solution, alcohol and formalin.



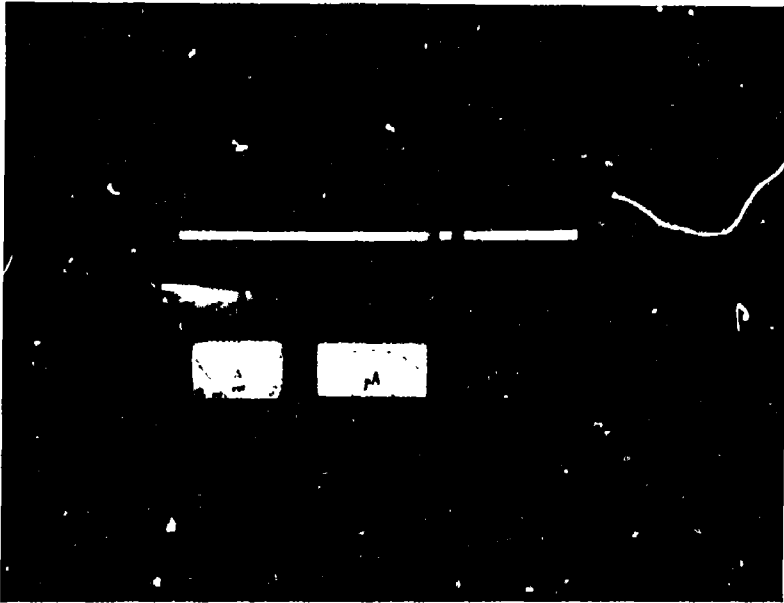
Reagent for Dyeing Cells

Purpose:

Process of dyeing cells of animals and plants for observing under the microscope.

Making:

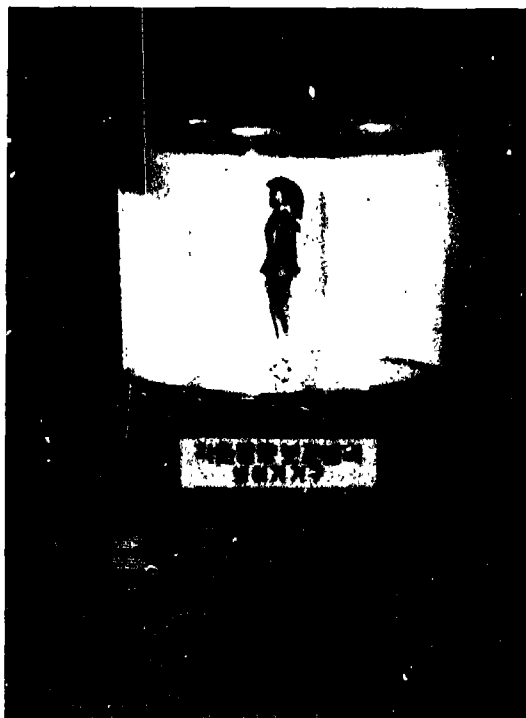
This reagent is made from roots of common plants such as *Rumex acetosa*, *Sanguisorba officinalis*, and the sweet berry. Acetic acid is used to extract the dyes by macerating in the acid plants containing emetin, anthocyanin and alizarin.



Apparatus for Electrochemical Reaction

Purpose:

A complex device to demonstrate electrochemical reactions. The instrument shows the principle of the battery and the processes of corrosion of metal, electrolysis and electroplating. The property of electrolyte and the movement of ions are shown. The equipment consists of several electrolytic tanks, an electrode, connecting lines and a battery.



Apparatus for Showing Angular Momentum Conservation

Purpose:

This apparatus is used to illustrate the law of angular momentum conservation in terms of the relation between the moment of inertia and the angular velocity in the absence of a moment of force about the axis of rotation.

Structure:

The device consists of two parts. One is used for an ice-skater to keep her rotating and the other to change the moment of inertia by moving the arms up or down.

Method of use:

After making the ice-skater revolve by pushing the starter control to the left, change the position of the arm by changing the position of the control for arm movement. We can see that the higher the ice-skater holds her arms, the slower she revolves and the lower she keeps her arms the quicker she revolves.



Radiometer

Purpose:

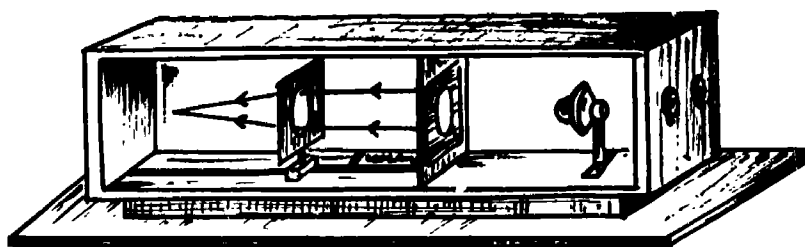
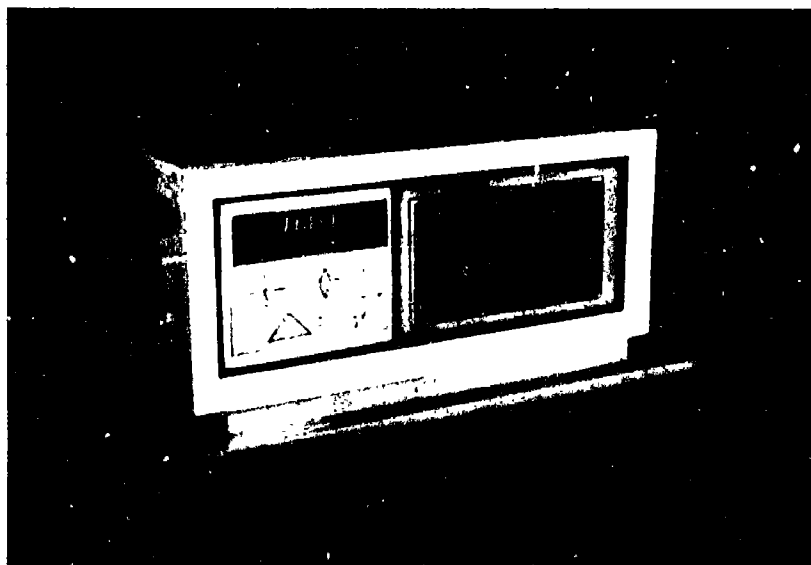
An apparatus that shows that light can produce movement.

Structure:

The device consists of a cross with 4 light aluminium vanes at the ends of the arms pivoted on a fixed sharp point inside an evacuated bulb. Each vane has one side white and the other painted black, so that as the cross rotates the black-painted sides always face the same way.

Method of use:

As light falls on the bulb, the vanes rotate. The speed of rotation depends on the light intensity.



Apparatus for Optical Experiments

Purpose:

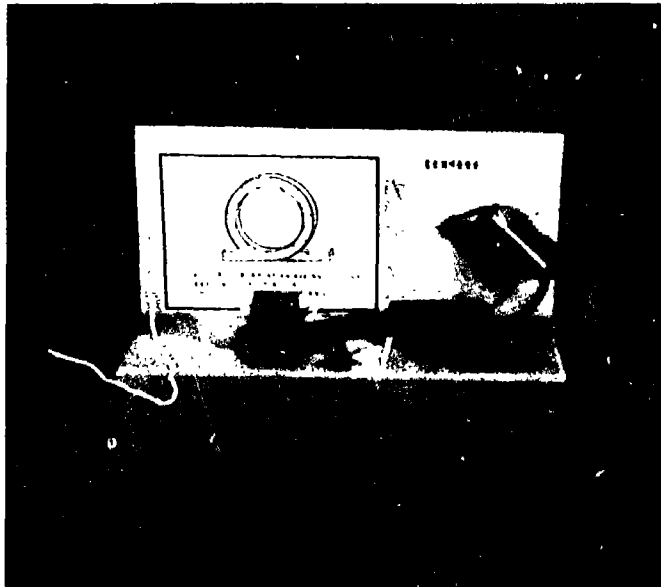
The apparatus illustrates the reflection and refraction of light rays at the boundary surface of a medium. 10 different experiments can be carried out with the equipment.

Structure:

Light source, smoke-making apparatus, a box and various kinds of mirrors and lenses to show the path of light rays.

Method of use:

Fill the box appropriately with smoke and with the help of a plane mirror and a slit to produce a ray of light, observe reflection and illustrate the laws of reflection. Use a screen with 3 parallel slits and observe the path of light rays at the surface of concave and convex mirrors and through convex and concave lenses.



Apparatus to Observe Total Internal Reflection

Purpose:

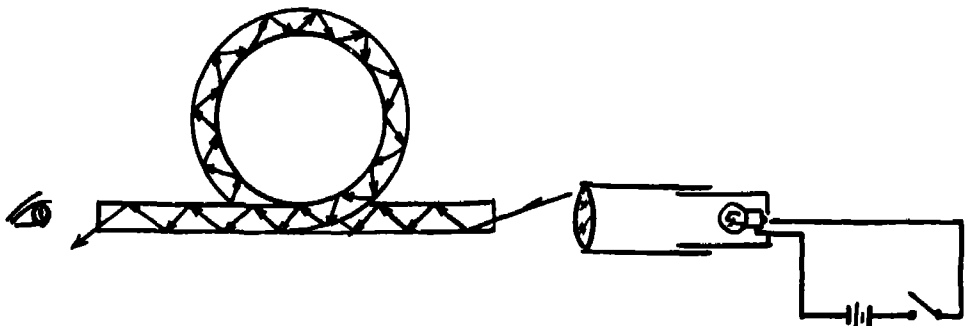
To show total internal reflection in transparent media and illustrate the principle of light fibre.

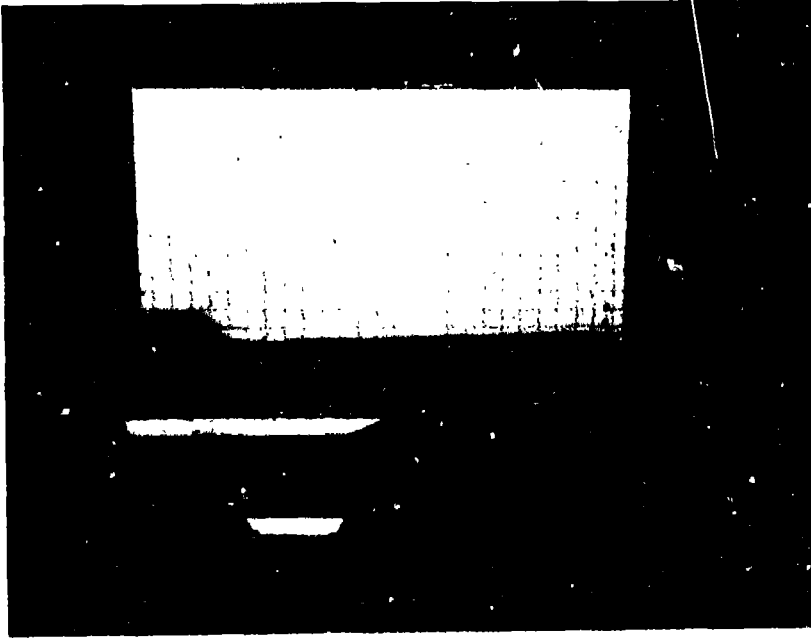
Structure:

Prism, transparent plastic tube made into a loop. Light source (3 volts).

Method of use:

Shine the light from the 3-volt bulb light source on to a right-angled prism and notice the internal reflection taking place at the hypotenuse surface of the prism. Next shine the light on one end of the plastic tube and note that the light shines through at the other end.





Apparatus for Experiments on Motion

Purpose:

The equipment may be used for the following experiments on motion:

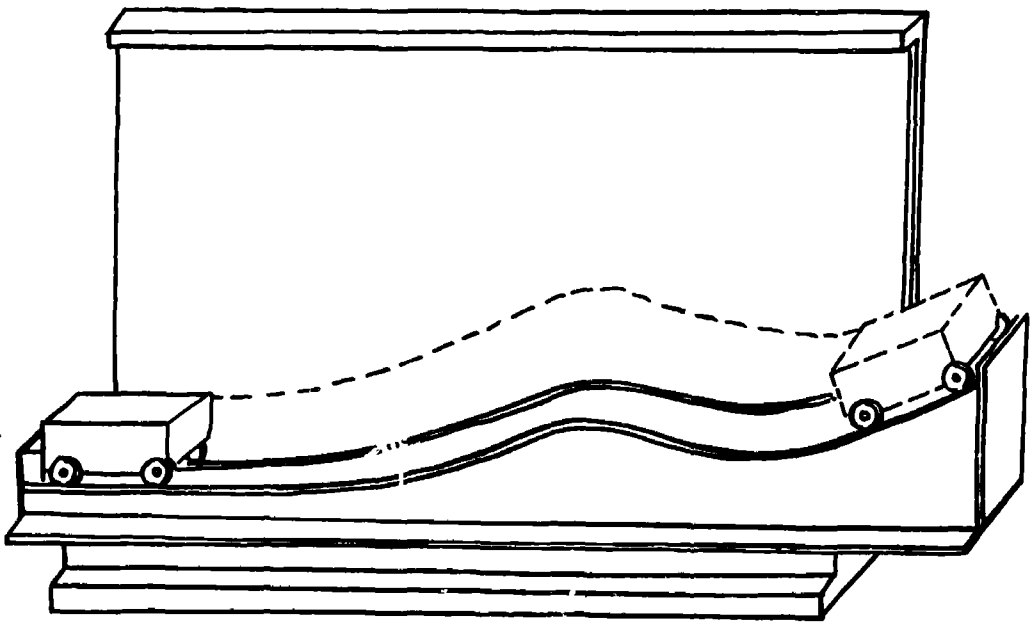
- 1) Trajectory showing rectilinear and curvilinear motion.
- 2) Showing uniform and non-uniform motion.
- 3) Showing instantaneous speed.
- 4) Showing uniform accelerated motion.
- 5) Showing relative motion.
- 6) Showing motion of a projectile.

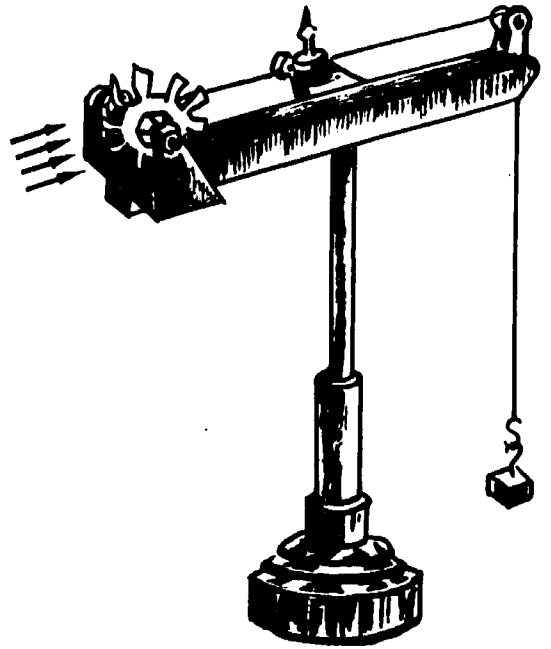
Structure:

Apparatus consists of a glass display board, a wooden guiding stand, motion pushcart on wheels, time recording equipment and bullet shooting equipment.

Method of use:

Assemble appropriate parts according to the experiment to be carried out.





Apparatus Showing Energy Conversion

Purpose:

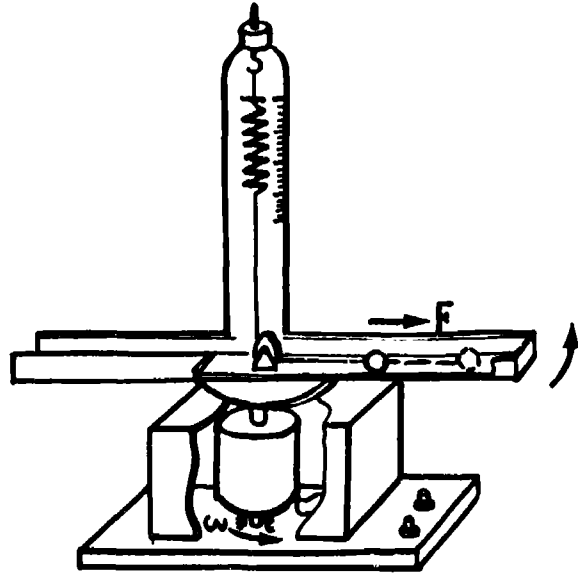
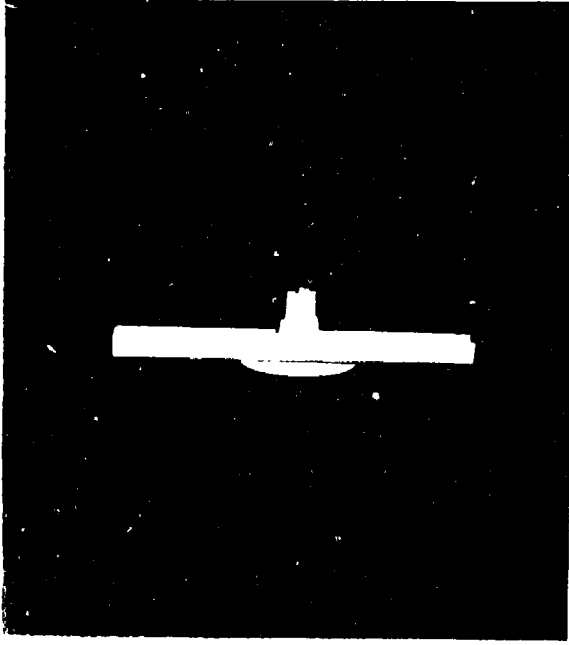
To show the interconversion of kinetic and potential energy.

Structure:

The apparatus consists of a windmill connected with a thread to a light weight hanging over a pulley. The whole system is supported on a stand.

Method of use:

When a current of air blows on the windmill, the weight is pulled up. The kinetic energy of the wheel is thus converted into work. When the wind stops the weight falls and pulls the string causing the windmill to spin. The potential energy of the weight is thus converted into kinetic energy of rotation of the wheel.



Apparatus Showing Centrifugal Force

Purpose:

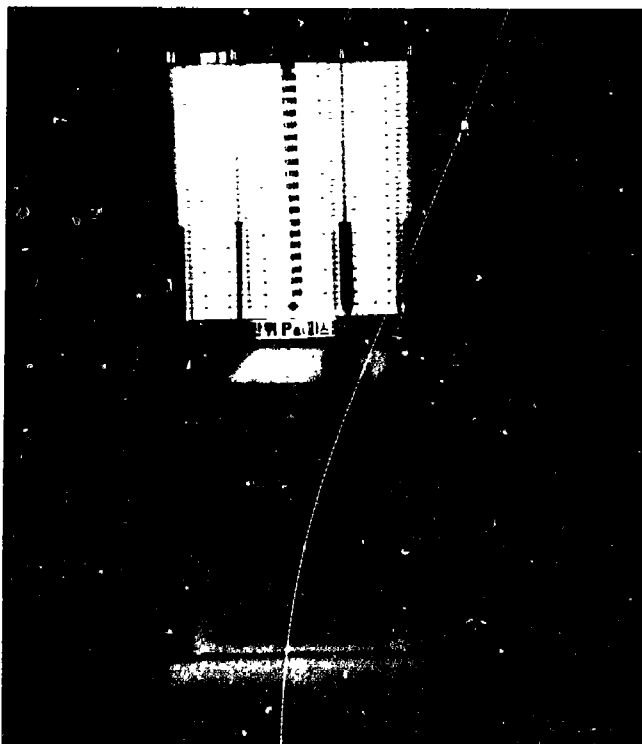
The apparatus shows the centrifugal force acting on the iron ball when moving with a uniform circular motion.

Structure:

The apparatus consists of an equipment with an iron ball connected to a gauge. The iron ball can move radially along a groove in a wooden guide. The guide may be made to spin round at a uniform speed using an electric motor.

Method of use:

Connect up the source of electric power and adjust the speed of rotation of the iron ball with the speed control break. The force gauge registers the force operating on the ball in an outward radial direction.



Liquid Pressure Apparatus

Purpose:

The apparatus may be used for the following experiments on liquid pressure:

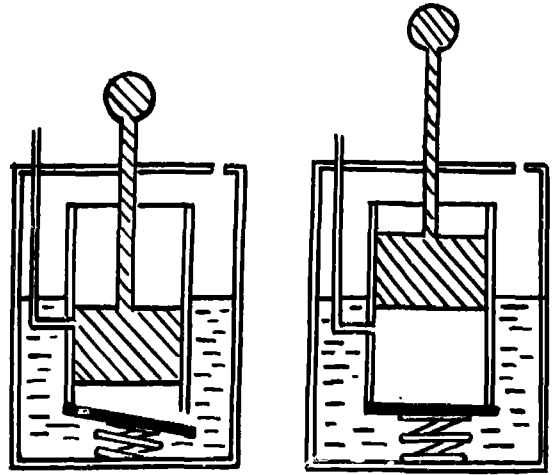
- 1) Showing Pascal's law.
- 2) Showing liquid pressure.
- 3) Illustrating the principle of connected tubes.
- 4) Showing Archimedes' principle.
- 5) Determining the volume of a body.

Structure:

Glass tubes of various wide thicknesses are fixed on a board fitted with a scale. At their lower ends the tubes are fitted with a rubber tube which dips into a tube containing water. Inside the water tube there is an air bag to change the pressure in the liquid. The volume of the air bag is changed by means of an external air box. To fill the tube, a funnel is used.

Method of use:

By adjusting the external air box, change the liquid pressure as required to verify the phenomenon being studied.



Apparatus to Illustrate the Action of the Forcing Pump

Purpose:

This apparatus shows the construction and action of the forcing pump.

Structure:

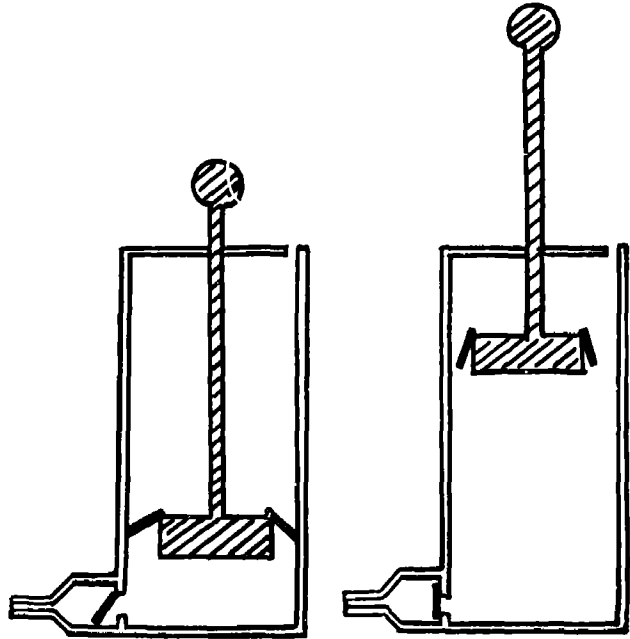
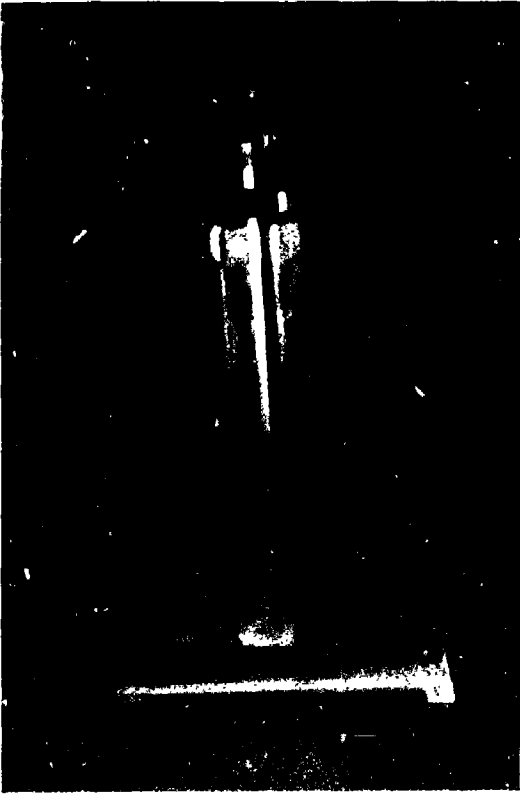
It consists of the pump body, the cylinder in which a piston can move up and down, and a valve.

All parts are made of wood except the piston rod (metallic).

Method of use:

As the piston is drawn upwards the valve is closed and air is sucked in through the side tube. When the piston is pushed down the side tube is closed, the air is trapped in the cylinder. The rise in the pressure causes the valve to open and the air is pushed out.

The net effect is to extract air from any apparatus connected at the side tube.



Principle of the Air-compressor Pump

Purpose:

Apparatus to show the structure and action of an air-compressor pump.

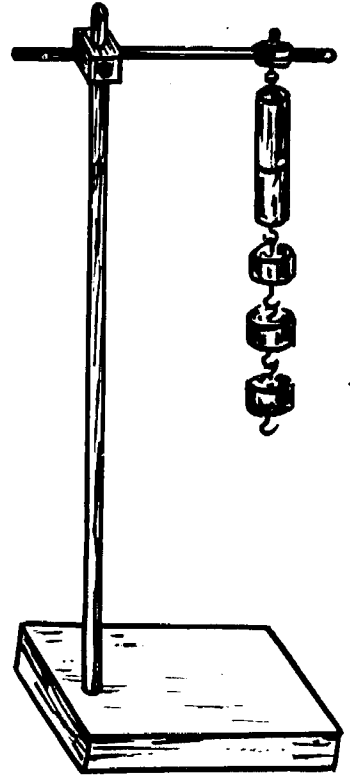
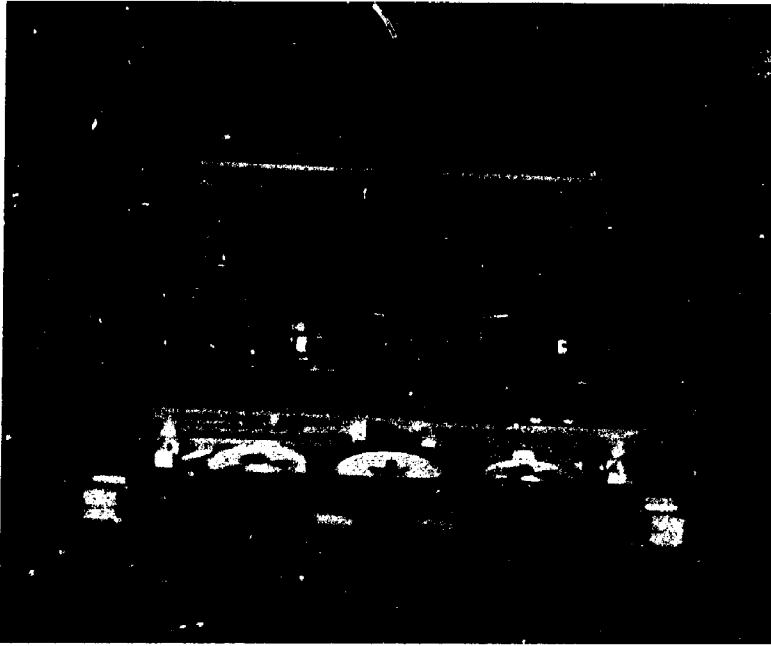
Structure:

It consists of a piston fitted with a valve and travelling up and down inside the cylinder forming the body of the pump. All the parts are made of wood except the piston handle which consists of an iron rod.

Method of use:

When the piston is pushed down, the valve at the end of the piston closes and traps the air below the piston. The pressure rises causing the exit valve of the pump to open. The air thus is pushed out of the pump.

When the piston is drawn up, the outside pressure closes the exit valve, the piston valve opens to let air flow into the lower end of the pump ready to be pushed out at the next down stroke of the piston.



Comprehensive Kit for Experiments in Dynamics

Purpose:

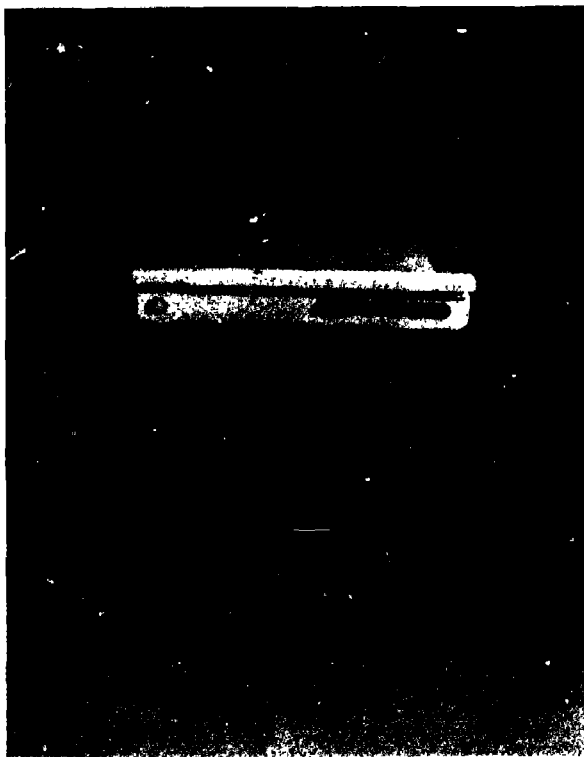
About 26 different experiments in the fields of motion, force, pressure, work and energy.

Structure:

Support stand, force gauge, box of weights, pulleys, Maxwell's pendulum, lever apparatus, liquid pressure apparatus, pushcart for motion experiments, large cart. All parts are fitted in a wooden box.

Method of use:

Assemble the parts as needed for the experiment to be performed.



Adjustable Multi-purpose Support

Purpose:

This equipment may be used in many experiments to adjust the height of the apparatus as necessary.

Structure:

An articulated structure which can be adjusted to different heights by means of an adjustment screw placed under the board.

Method of use:

The apparatus is placed on the table and the height adjusted as required.



Hydraulic Press Model

Purpose:

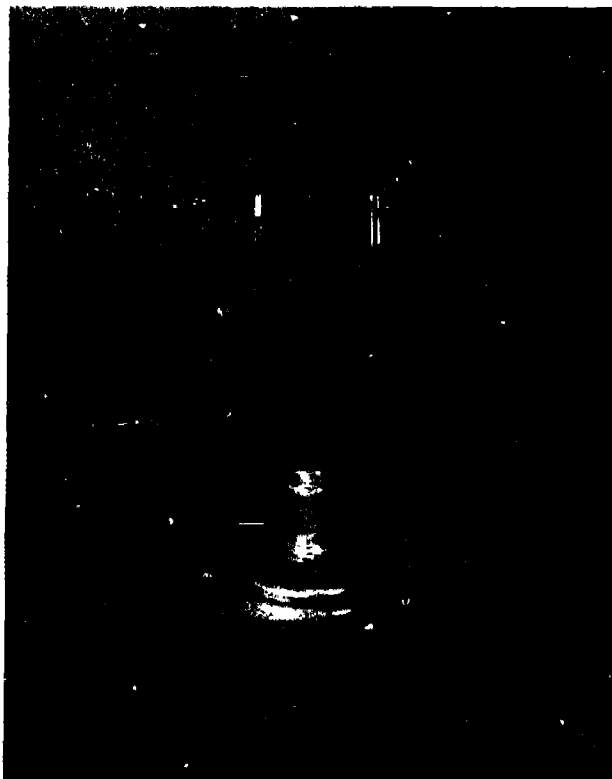
An apparatus to illustrate the action of the water-pressure press.

Structure:

It consists mainly of two pistons of widely different diameters and valves to control the water flow.

Method of use:

As the small piston goes down, the bottom valve closes and the side valve opens communicating the water pressure to the large piston which goes up. On the upstroke of the small piston, the side valve closes maintaining the large piston in its place. The bottom valve opens allowing in water from a reservoir and filling the small cylinder ready for the next downstroke.



Connected Tubes (liquid pressure)

Purpose:

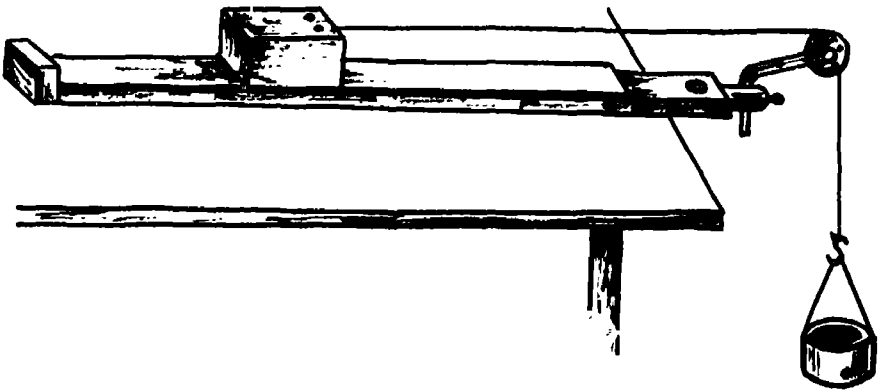
To show that the height to which a liquid rises in a vessel does not depend on the shape of the vessel.

Structure:

Five glass tubes of different shapes and thicknesses are joined together at their lower end.

Method of use:

The coloured water is filled in through a tube. It is then noted that the height of the water column in each tube is the same.



Friction Apparatus

Purpose:

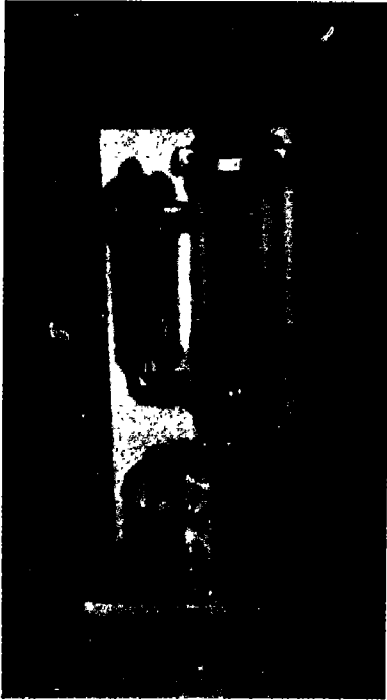
To compare sliding and rolling frictions, and measure the efficiency on the slope.

Structure:

It consists of a wooden base board on which the body is moved; an adjustable stand for the slope, and the weights to pull up the block. There is also an iron plate, a sheet of rubber and a glass board to study the frictional forces on various surfaces.

Method of use:

Place the body to be experimented with on the base board, and place weights in the holder until the block starts to move and calculate the coefficient of friction for the surface under study. Repeat with other surfaces.



Apparatus to Show Action of a Water-suction Pump

Purpose:

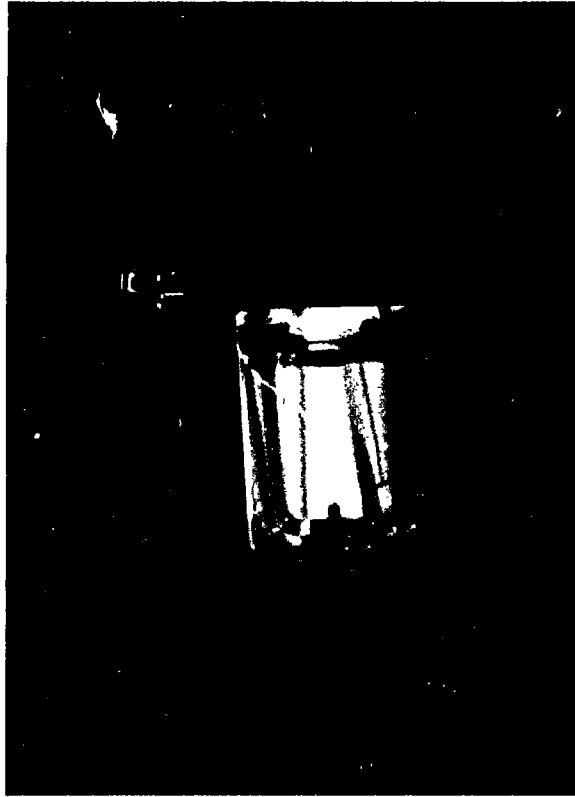
The apparatus is used to show the structure and the action of a water pump.

Structure:

A glass cylindrical tube fitted with a glass piston is fixed to a wooden stand. The lower end of the tube is tapered and fitted with a valve in the form of a glass ball. Just above the lower valve is a side outlet leading on to a small tube fixed upright on the same stand. A glass valve also occupies the lower end of the side tube.

Method of operation:

Dip the lower end of the pump into water contained in a beaker and operate the pump by moving the piston up and down successively. Observe the movements of the ball valves.



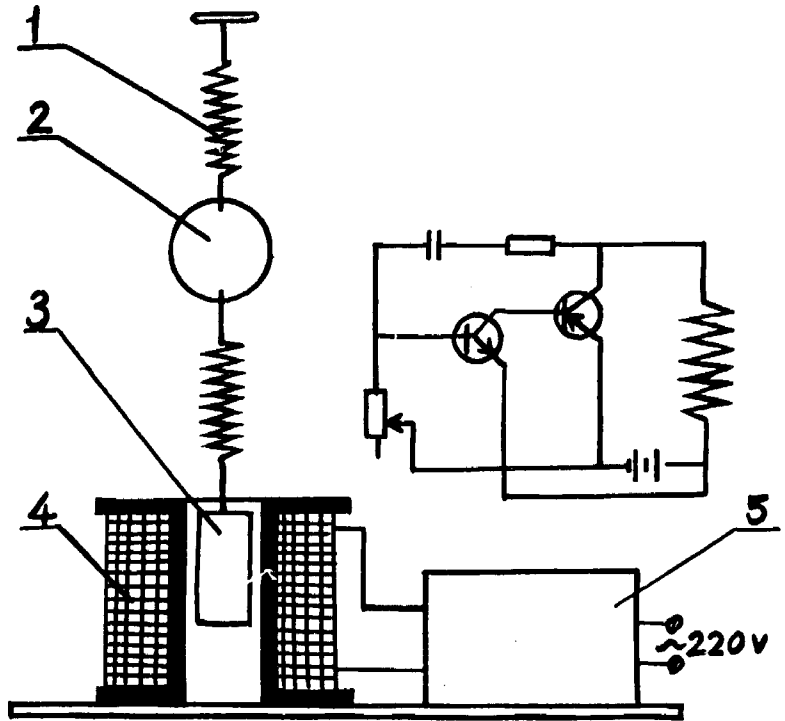
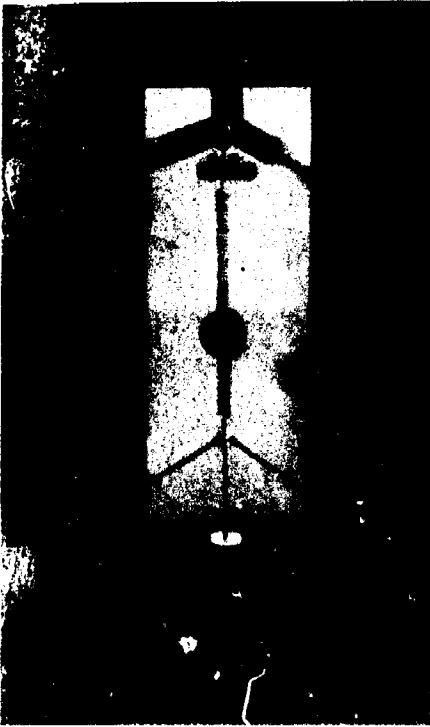
Apparatus to Show Water Convection

Purpose:

This apparatus may be used to show the phenomenon of thermal convection in water.

Structure:

A wide U-shaped glass tube open at the upper ends is fixed to a vertical metal plate by 3 metal rings. Just below the open ends, the limbs of the tube have an outlet across which a horizontal tube is fitted by means of short rubber tubings. In one limb, a long wire holding a small spoon-shaped fitting can be raised and lowered.



Dynamic Vibration Apparatus

Purpose:

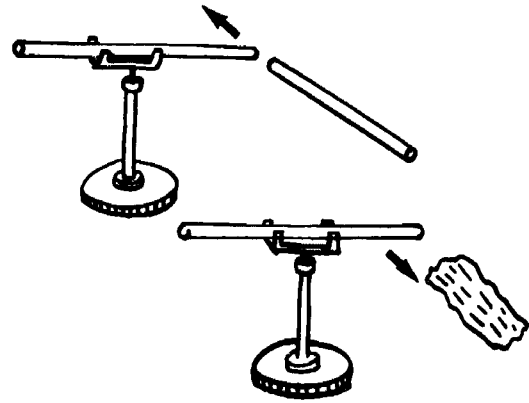
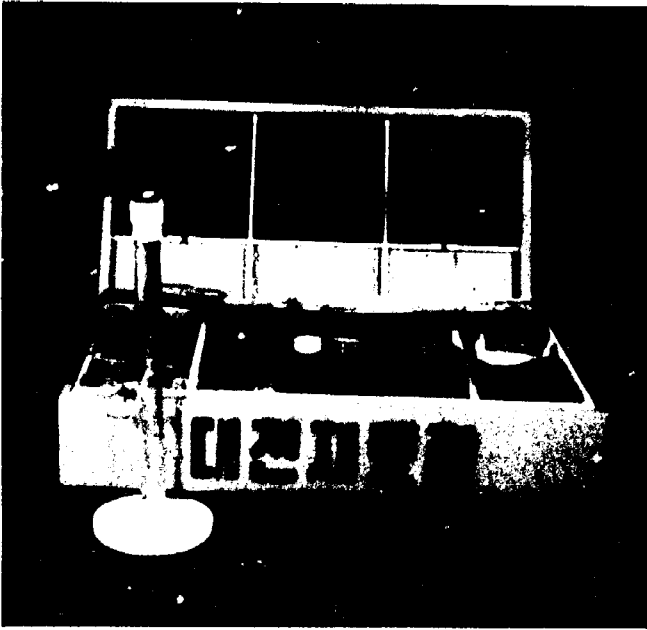
This apparatus may be used to show the conditions for forced vibrations and resonance.

Structure:

This apparatus is composed of an electric oscillator and a spring pendulum with an iron cylinder at the end. The cylinder moves up and down inside a coil. Alternating current is fed into the coil from the oscillator circuit.

Method of use:

By operating the oscillator, the spring pendulum is caused to vibrate. As the frequency of the oscillator is changed, the pendulum changes its frequency of vibration. The amplitude of the forced vibrations is small. When the frequency of the oscillator equals the natural frequency of the pendulum system, the amplitude of the oscillation becomes very large.



Experimental Kit for Static Electricity

Purpose:

The following experiments may be performed:

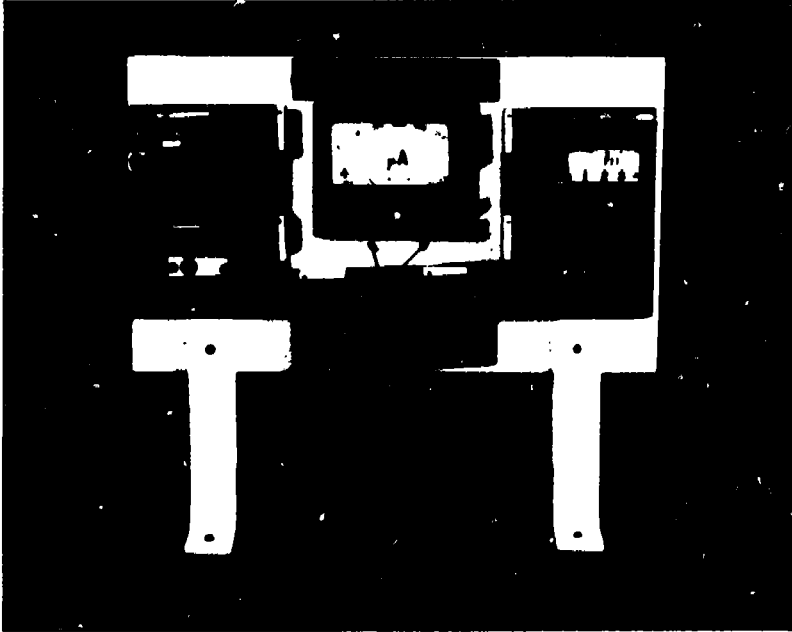
- 1) Charging by rubbing.
- 2) Two kinds of electric charges.
- 3) Electric field and lines of force.
- 4) Induction of static electricity.
- 5) Testing an electric field.

Structure:

The kit box contains compartments for charged bodies, a dryer and the electricity system. The compartment of charged bodies contains various kinds of bodies such as vinyl chloride sheet and stick, glass stick wool, silk and vinyl cotton. There are also parts to show static electric induction. The electricity system consists of gauge measuring the charge and showing the polarity of the charge.

Method of use:

Make sure that all equipment is dry by submitting to dryer before performing any experiment. Assemble parts are necessary to carry out any possible specific experiment.



Experimental Kit for Semi-conductors

Purpose:

This apparatus can be used to show the properties of semi-conductors, mainly the following:

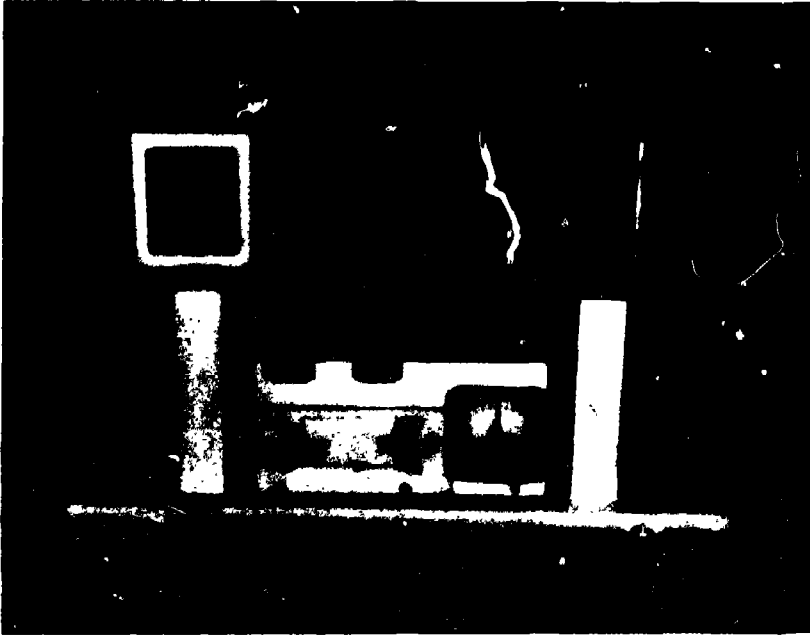
- 1) Properties of semi-conductors diodes.
- 2) Property of transistor.
- 3) Property of thermal resistance of semi-conductor.
- 4) Photo-electric properties of semi-conductors.
- 5) Property of thermocell of semi-conductor.
- 6) Property of photocell of semi-conductor.

Structure:

Several convenient contact points are placed on the front plate of the panel containing the various elements of circuitry, diode, transistor, thermal resistance, light resistance, thermocell and photocell of semi-conductor.

Method of use:

A micro-ammeter shows the property of current control by the semi-conductor.



Model of a Telephone

Purpose:

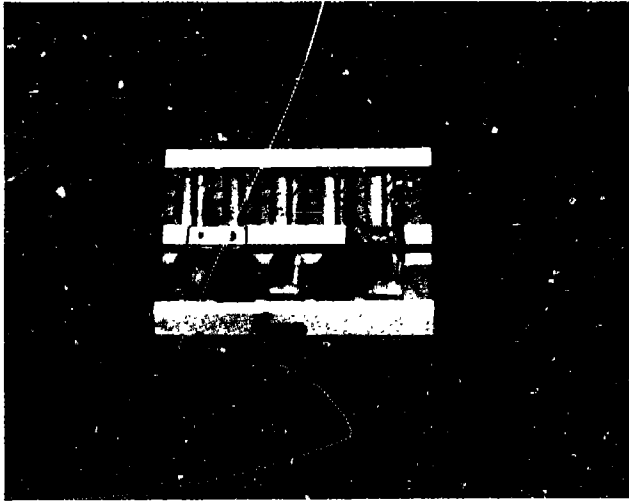
Apparatus used to teach the principle of the telephone and to show the structures of the receiver and the transmitter.

Structure:

The apparatus consists of a transmitter and receiver and a micro-ammeter. It is connected to the electric source (12V D.C.). The transmitter is a model of a carbon microphone. It contains carbon particles between two plates: one fixed, the other one movable. The demonstration receiver consists of an oscillator in the form of a movable plate attached to two coils wound around the poles of a permanent magnet (U-shaped).

Method of use:

Tap the vibration plate of the transmitter. The carbon particles will move and the plate of the receiver will vibrate. At the same time, the pointer of the micro-ammeter will move.



Metal Samples for Density Determination

Purpose:

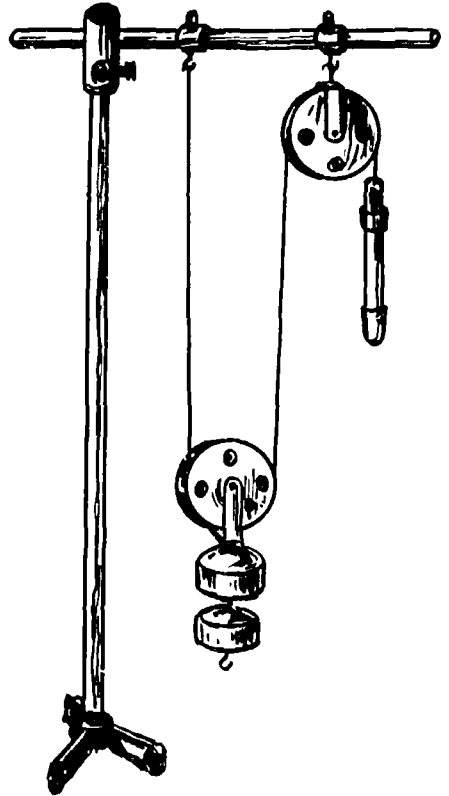
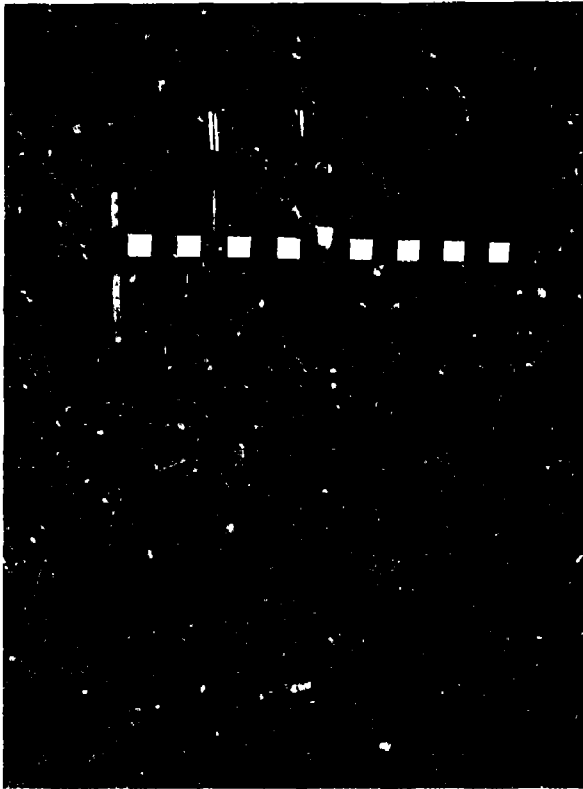
The samples are used for measuring densities and comparing specific weights.

Structure:

A box contains samples of 5 different materials of equal volume and same shape. The materials are iron, copper, aluminium, lead and synthetic plastic wood. The materials are all in the shape of a cylinder of height 32 mm and diameter 20 mm.

Method of use:

The relative specific weights of the materials are obtained directly by weighing the cylinders. The density can be calculated from the formula: $\text{density} = \text{mass}/\text{volume}$.



Kit for Experiments in Dynamics

Purpose:

The following experiments can be performed:

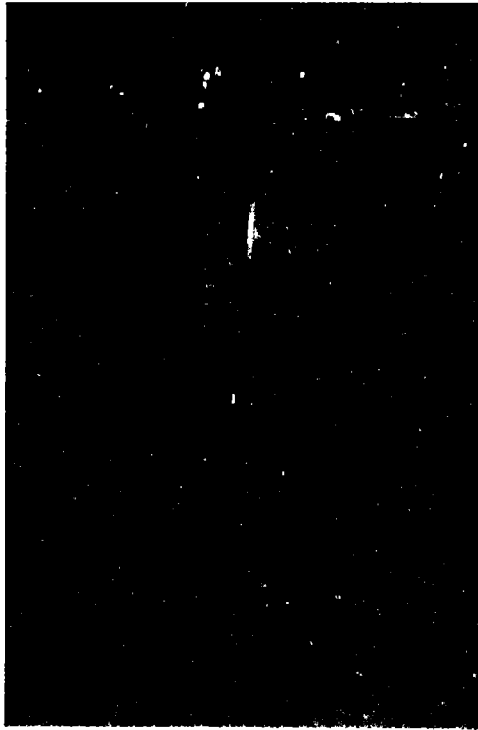
- 1) Marking the scale using the principle of moments.
- 2) Illustrating Archimedes' principle.
- 3) Density gauge for solids.
- 4) Work using a roller.
- 5) Work on a slope.

Structure:

The kit includes: stand on three legs with scale hanging by the middle; slope; lever; bucket and cylinder for Archimedes' law; specimen for density gauge; and roller.

Method of use:

Assemble the parts according to the experiment to be carried out.



Maxwell Pendulum

Purpose:

For observing the processes of converting kinetic energy into potential energy and vice-versa.

Structure:

The apparatus consists of a frame fixed on a stand and the Maxwell's wheel. Both ends of the wheel spindle are of conical shape.

Method of use:

Place the pendulum spindle up to the maximum height it can go and allow the wheel to rotate down vertically. The pendulum will be found to move down and up as the potential energy initially stored is transformed into kinetic energy and the kinetic energy transformed, in its turn, into potential energy, associated with height.



Apparatus to Show the Resultant of Two Forces and the Resolution of One Force into Two Components

Purpose:

To show the resultant of two forces and how a force may be resolved into two components.

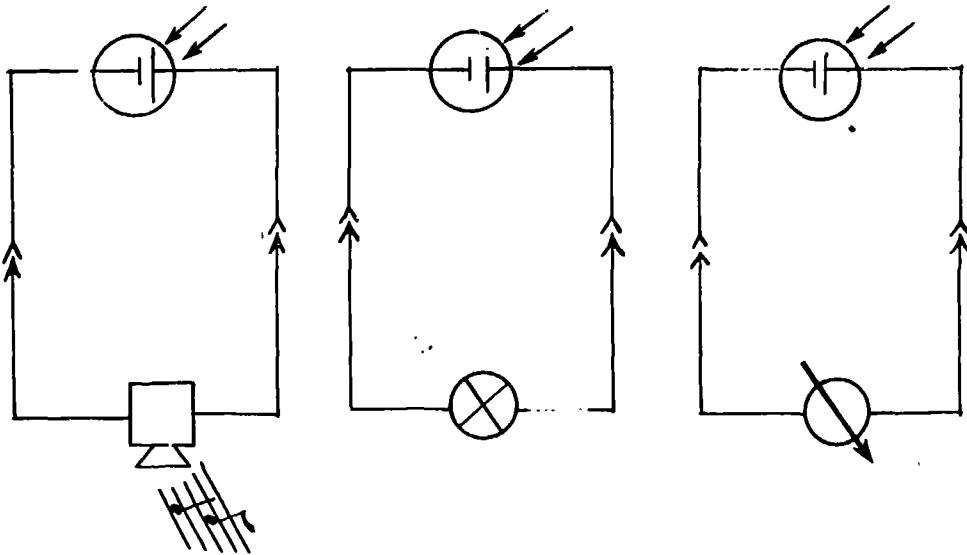
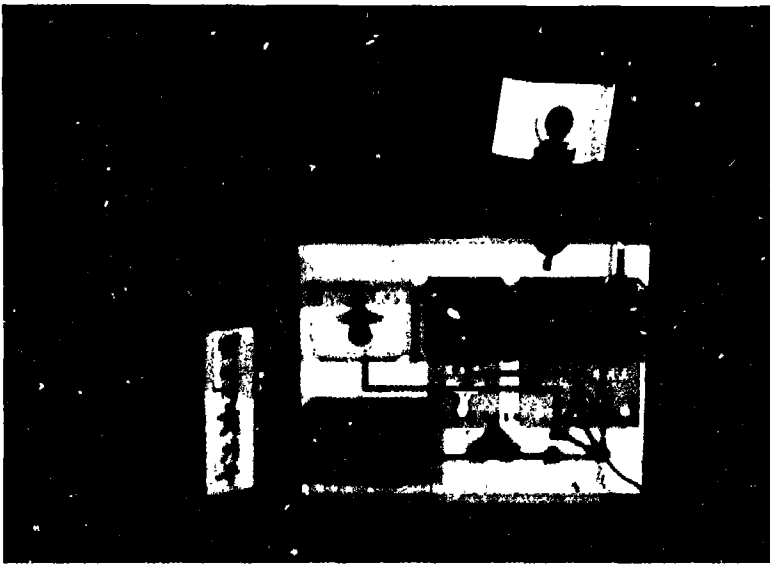
Structure:

Coloured disc marked in degrees and mounted so as to rotate in a vertical plane. A dynamometer (spring gauge) is placed as shown and its position adjusted so that it is made to support two weights placed at different points of the circumference around small pulleys attached to the rim of the disc. The supporting frame and the disc with angular scale are made of wood.

Method of use:

Adjust the weights and the directions of the strings by means of the disc so that the point of attachment of the 3 forces coincides with the axle of the disc. Note the positions of the pulleys, the weights hanging from the pulleys and the reading of the force gauge.

Hence the law of composition of forces can be verified.



Apparatus Using Light as a Source of Energy

Purpose:

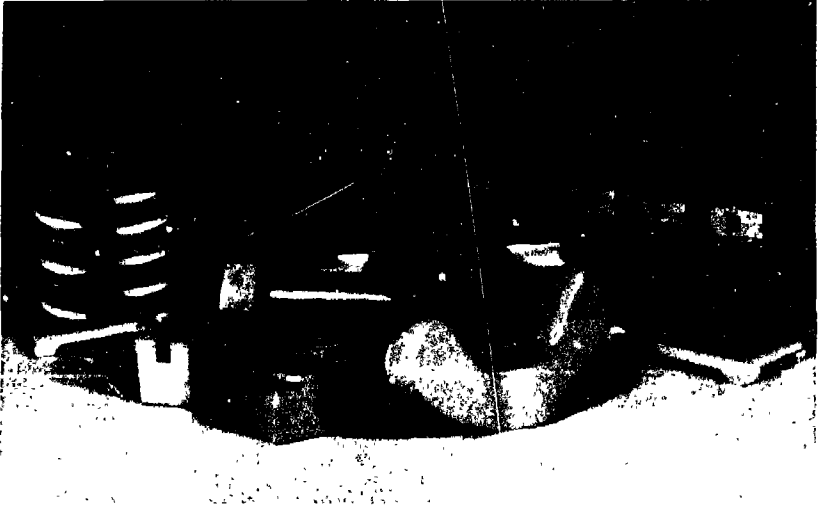
To perform experiments that show that light has energy.

Structure:

The accessories of articles such as motor, radio and lamp are attached to the plate and the photo-voltaic cell is connected to the various instruments as indicated in the circuit diagrams.

Method of use:

When light shines on the photo-voltaic cell, a current is generated which will activate the circuit which has been switched on.



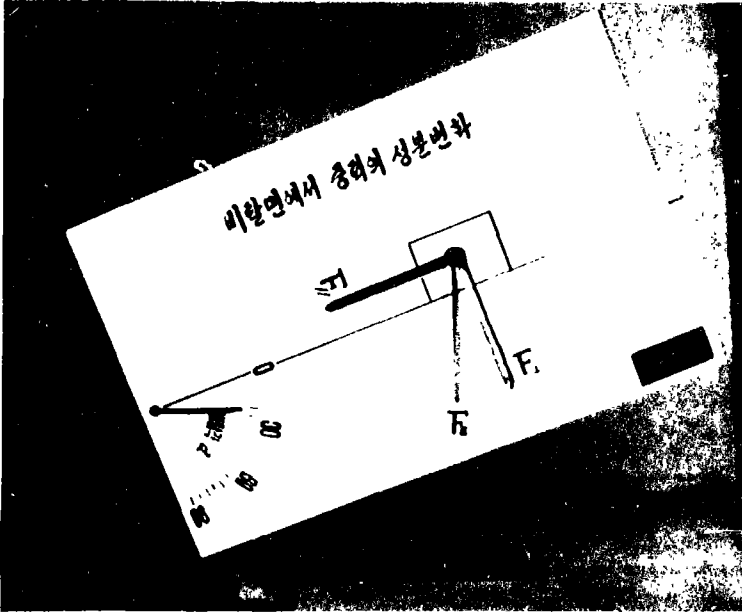
Various Kinds of Screw Models

Purpose:

To show the structure of various screws, bolts and nuts and connected features.

Structure:

All the screws, bolts and nuts are made of wood.



Apparatus to Show the Effect of Change of Slope on Gravity

Purpose:

This is an experiment to show how, in the case of a body placed on a slope, the component of the force of gravity along the slope changes with the angle of the slope.

Structure:

A white board fixed to the slope indicates the \angle of the slope in degrees and the components of the weight of the body along and perpendicular to the slope.

The inclined plane is made of wood. As the slope changes, the \angle of the slope, as measured on the circular scale, changes and the new inclination indicated. The vertical vector indicating the weight of the body has to be adjusted to point vertically down as the \angle of the slope is altered.

Method of use:

As the \angle is changed, the components of the weight along and perpendicular to the slope change in directions.

