_D_i_a_g_r_a_m_ _s_h_o_w_i_n_g_ _J_o_u_l_e_s_ _a_p_p_Unit :- I

Energy: - Whenever a body is capable of doing work, the body is said to possess energy. Thus energy is defined as the ability of a body to do work and the amount of energy possessed by a body is equal to the amount of work it can do when its energy is released.

Units of energy: -

On S.I. system, energy is measured in the units of joules or in calories, and on C.G.S. system in ergs. However, the commercial unit of energy is kilowatt-hour. The energy is said to be one kilowatt-hour, when a body consumes one kilowatt of energy in one hour. Thus,

	1 kilowatt-hour	=	1000 watts x 1 hour.
But	1 watt	=	1 joule .
			1 sec.
Therefore	1 Kwh	=	1000 x 1 joule x 60 x 60 sec.
			1 sec.
		=	36 x 10 5 joules
		=	3.6 x 10 6 joules.

The unit of kilowatt-hour is actually used to measure electric energy and one unit of electric energy means one kilowatt-hour. Thus,

1 unit = 1 kilowatt-hour.
= 3.6 x 10 6 joules.

Forms of energy: - Energy exists in various forms, some of its important forms include:

(i) **Mechanical energy**:- The mechanical energy of a body is defined as the sum of its potential energy (i-e energy possessed due to position) and kinetic energy (i-e energy possessed due to its motion).

(ii) **Heat energy: -** The energy present in a hot body due to its higher temperature is termed as the heat energy of that body .

(iii) **Chemical energy:-** The energy produced when two or more chemicals interact with each other in a chemical reaction is referred to as chemical energy.

(iv) **Electric energy:-** The energy present or produced by the electric current is termed as electric energy .

(v) **Nuclear energy:-** The energy produced by the fission or fusion of a radioactive nucleus of an atom is termed as the nuclear energy .

(vi) **Solar energy:-** The energy radiated by the sun or energy obtained from the rays of the sun is termed as the solar energy. It is also termed as cosmic or radiant energy.

CONSERVATION OF ENERGY OR PRINCIPLE OF CONSERVATION OF ENERGY:-

Whenever one form of energy disappears in a process soon another form of energy appears, thus one form of energy is transferred to another. However, the total energy of the system remains same i-e no energy is being created or destroyed in the process of its transformation. This is called as principle of conservation of energy. It states that, "Energy can neither be created nor destroyed, during any physical or chemical change, though its one form can be transferred into another from one body to another". This can understood clearly by the under given example:

Consider a body is dropped from a certain height. When the body falls down, its potential energy is converted gradually into an equal amount of kinetic energy and when the body hits the ground its potential energy becomes zero and its kinetic energy becomes maximum .At this stage, all the potential energy of the body has been converted into an equal amount of kinetic energy without any creation or destruction of energy .Thus the total energy of the body remains constant.

An Engine: - An engine is a device, which converts mechanical energy into chemical energy. It is of two main types, viz.

(i) Internal combustion engine.
(ii) External combustion engine.
(iii) Internal combustion engine: -

An internal combustion engine is a type of engine in which combustion of the fuel takes place inside its carburettor, which cannot be seen from outside. It is of two main types viz.

(a). Petrol engine: -

An internal combustion engine, which uses petrol oil as its fuel is called as a petrol engine. It was first of all
constructed by Nikolus Otto in the year 1876.

(b). Diesel engine: -

An internal combustion engine, which uses diesel oil as its fuel is called as a diesel engine. It was invented by
Rudolf Diesel in the year 1890.

(ii). External combustion engine: -

An external combustion engine is a type of engine, in which combustion of the fuel takes place in a fire box outside the cylinder, which can be seen from outside.

Principle of an Internal Combustion (Petrol) Engine: -

An internal combustion engine (petrol engine) has a carburettor where the petrol (fuel) is vaporised and mixed with the correct amount of air .The mixture is then passed into a cylinder fitted with a movable piston. Here it is compressed and ignited by an electric spark from spark plug, thereby producing a large volume of hot gases. Which expand due to high temperature and push the piston upwards. The piston pushes a rod called piston rod that turns the crankshaft and the crankshaft turns the wheels. In this way the up and down movement of the piston is converted into
the rotatory motion of the wheels.

(a) Construction of a Petrol Engine: -

An internal combustion engine (petrol engine) consists of a metal cylinder (C) having an airtight movable piston (P) fitted in it. It is provided with a rod (R) connected to the crankshaft. The crankshaft inturn is connected with wheel (W) of the vehicle. The cylinder head has two holes, which are controlled by two valves (V1) and (V2). Which are closed and opened by an engine driven shaft .The valve (V1) is called as intake valve. The mixture of fuel and air enters through this valve. The valve (V2) is called as exhaust valve .The burnt or spent gasses of the cylinder leave through this valve .The cylinder head is also provided with a spark plug (S). It produces a high voltage spark of electric current into the cylinder to burn the gaseous mixture entering through valve (V1). The electric current required

for sparking is provided by the battery.

Working of a Petrol Engine: -

The working of an internal combustion (Petrol) engine can be studied into four stages called as four strokes Viz.

(i). The Intake Stroke: -

In this stroke, when the engine is started the piston (P) moves downwards which creates a low pressure inside the cylinder. The fuel mixture is sucked into the cylinder through the valve (V1) from the carburettor. This stroke is also called as charging stoke.

(ii). The Compression Stroke: -

In this stroke, the fuel mixture is highly compressed to a small volume because when sufficient amount of fuel mixture enters into the cylinder, the piston is forced to move upwards, but the valve (V1) is closed. As a result, the fuel gets compressed to about one eighth of its original volume. The compression also heats the fuel mixture and it becomes easily combustable.

(iii). The Power Stroke: -

In this stroke, the electric plug produces an electric spark, which sets fire to the fuel mixture. The fuel mixture burns to produce large volume of smoke (gases) and liberates enormous amount of heat. The heat produced expands the gases creating a pressure which pushes the piston downwards with a great force .The piston inturn pushes the piston rod and the piston rod pushes the crankshaft which is joined to the wheels of the vehicle. When the crankshaft turns, it rotates the wheels of the vehicle. In this way a series of such successive pushes of the piston occurring in the cylinder moves the car as long as these pushes continue in the piston.

(iv). The Exhaust Stroke: -

In this stroke, the burnt or spent gases are forced out of the cylinder through the exhaust valve (V2). Infact when the piston is at the bottom of the cylinder, the exhaust valve (V2) opens and when the piston moves upwards, it expel the burnt gases out into the atmosphere through the valve (V2). When all the gas is expelled out of the cylinder, the valve (V2) gets closed and the valve (V1) is opened again for the reputation of the intake stroke.

_____In this way, the power produced during the little explosion of every power stroke keeps on pushing the piston, turning the crankshaft and wheels of the vehicle.

(b) Construction of a Diesel Engine: -

A diesel engine consists of a metal cylinder (C) having an air tight movable piston (P) fitted in it .The piston is Provided with a rod (R) called the piston rod connected with a crankshaft (K) of the wheel (W) of a vehicle. The cylinder head has two holes in it, which are controlled by two valves (V1) and (V2). These valves are opened and closed systematically by an engine driven shaft. The valve (V1) is called as intake valve. The air enters into the cylinder of a diesel engine through it .The valve (V2) is called as exhaust valve. It removes the spent gases of the cylinder. The head of the cylinder is also provided with a nozzle (N) through which the diesel oil is put in the cylinder

in the form of a fine spray.

Working of a Diesel Engine: -
Like a petrol engine the complete cycle of a diesel engine is divided into four phases or strokes Viz.
(i). The Intake Stroke: -
In this stroke, only air enters into the cylinder. Infact when an engine is started, the piston starts moving downwards which creates a region of low pressure in the upper part of the cylinder and the air enters into it through
the intake valve (V1)..
(ii). The Compression Stroke: -
In this stroke, the air present in the cylinder is greatly compressed because when a sufficient amount enters into the cylinder, the piston is forced to move upwards but the intake valve (V1) is closed. Due to this the air in the cylinder gets compressed to about one sixteenth of its original volume. As a result of this compression the in the
cylinder gets heated to about 10000C.
(iii). The Expansion or The Power Stroke: -
In this stroke, when the piston reaches the upper part of the cylinder a fine spray of diesel oil is injected through the nozzle into the cylinder containing a very hot air. Due to the high temperature of the air, the diesel oil is burnt and a large volume of gases like Co2, Co and water vapour are produced. The process is also accompanied with the production of heat energy, which causes expansion of the gasses and pushes the piston down wards with a great pressure. The piston inturn pushes the piston rod, which moves the crankshaft. The crankshaft turns the wheels of the
vehicle.
(iv). The Exhaust Stroke: -
In this stroke, the smoky and burnt gases of the cylinder are forced out through the exhaust valve (V2). Infact, when the piston is at the bottom of the cylinder, the exhaust valve (V2) is opened and when the piston moves upwards it expels out the burnt gases into the atmosphere. When all the spent gases are expelled out of the cylinder, the exhaust
valve (V2) is closed and the intake valve (V1) is opened again for the reputation of the intake stroke of the next cycle.
_____In this way the four strokes keeps on pushing the piston and turning the piston rod, which turns the crankshaft connected to the wheels and hence the wheels of a vehicle remain moving.
_

Distinguish between: -

Transformation of Energy: -
In 1942 Robert Mayor a German physicist found that energy exist in many forms and all forms of energy can be converted or transformed into each other. He referred this interchanging of one form of energy into another as transformation of energy. For example, water stored in a high rise dam has potential energy. When this water is allowed

to fall from its great height, the potential energy of the water gets converted into kinetic energy, which is used to drive huge turbines. These are connected to electric generators, which convert kinetic energy into electric energy. Thus potential energy of water gets transformed first into kinetic energy and then into electric current or electric energy.

Transformation of Mechanical energy into Heat energy: -

When we rub our hands, our hands get heated. This is due to the conversion of mechanical energy (kinetic energy) into heat energy by friction. An English scientist James joule first of all investigated the relationship between the mechanical energy and heat energy. In this experiment he concluded that there is an exact equivalence between the mechanical energy spent and the heat energy produced in a system.

Experiment: - In 1845 James joule performed an experiment to measure very carefully the amount heat energy produced by a certain amount of work (mechanical energy). He showed that there is an exact relation between the mechanical energy spent and heat energy produced .The apparatus used by James Joule is shown under:

The apparatus consists of a cylindrical metal vessel (C) called calorie meter provided with a number of fixed vanes (V1), (V2) and (V3) etc. The calorimeter is also provided with a paddle (P) carrying a number of vanes, which can turn between the fixed vanes of the calorimeter. The calorimeter is filled with a known mass of water and the paddle is used to steer the water to produce friction. The paddle (P) is connected to a wooden drum (D) having two pieces of chords wound around it in such a way that its both the ends leave at the same upper level but in opposite direction. The chords pass over two pulleys (X) and (Y) and carry equal weights (W1) and (W2) at their ends. The apparatus is also provided with two vertical scales (S1) and (S2) on the two sides. The temperature of the water in the calorimeter is measured with a thermometer (T) placed in it.

Working: - To start with, the initial temperature of the known mass of water in the calorimeter is recorded with the thermometer. Then both the weights W1 and W2 are allowed to fall simultaneously from the same height and their fall is measured on the vertical scales S1and S2. When the weights W1and W2 fall, they rotate the drum (D) and the paddle (P) against the force of water. As a result of this, water gets heated due to heat produced by the movement of paddle and when the weights touch the ground, the temperature of the water in the calorimeter is again recorded. The amount of work done by the falling weights is calculated by using the relationship:

Work done by weights or Mechanical energy spent = 2 m 1 x g x h

Where m1 = Mass of each weight.

g = Acceleration due to gravity.

And h = Distance through which each weight falls.

The heat produced in the process is calculated by relation; Q = m2 x s x t + c x t .

Where m2 = mass of water

s = Specific heat of water

t = Rise in temperature of H2o

c =5 Thermal capacity of calorimeter and paddle.

Results of the experiment:- James Joule after careful analysis found that, when 4186 joules of mechanical energy (work) was spent by the falling weights , the temperature of 1kilogram of water rises by 1oC. But from the calorimeter, it was already known that if 4186 joules of heat energy is supplied to 1kilogram of water ,its temperature increases by 10C. Thus, it was clear that

4186 joules of heat energy = 4186 joules of mechanical energy.

Or 1joule of heat energy = 1 joule of mechanical energy.

Importance of joules work: - The importance of the joules work can be understood easily by the following points:

Joule showed that mechanical energy can be converted into heat energy and thus proved an evidence that heat energy is a form of energy.

Joule showed that during transformation one form of energy into another, the total energy of the system remains conserved and thus proved an evidence for law of conservation of energy.

Joule showed that there is a definite relation between work done and heat energy produced, i-e exactly the same quantity of heat was always produced by certain amount of work.

Solar Energy:- The energy produced by the sun in the form of heat and light energy is called as solar energy. Principles of utilisation of Solar Energy: - Solar energy is utilised by the involvement of two main principles:

(i). In the appliances requiring a moderate temperature, the incident sun rays or reflected by a plain mirror on a black container which absorbs the solar energy and gets heated .

(ii). In the appliances requiring a high temperature, the incident sun rays are reflected and concentrated by using a large concave reflector which focuses all the sun rays at a single point called focus and any object kept at the focus gets strongly heated.

Harnessing or utilisation of Solar energy:- The sun is the ultimate source of energy having a remarkable capacity to produce energy in the form of heat and light. The energy produced by the sun in one day is about 50,000 times more than the energy consumed in the whole world in one year. But solar energy has certain limitations, which does not facilitate its large-scale utilisation. However, solar energy can be put to use in two differ ways Viz.

Direct utilization :- Directly the solar energy can be used either by collecting it as heat energy or by converting it into electricity.

2) Indirect utilization:- Indirectly the solar energy can be utilized by converting it into chemical energy like biomass or by utilising the energy obtained from wind, sea waves, tides etc.

Solar Heating Devices: - A device that gets heated by absorbing solar energy radiated by the sun in the form of heat and light energy is called a solar heating device. For eg. Solar cooker, solar water heater, solar furnace and solar cells are solar heating devices.

(i). **Solar cooker: -** A solar cooker is a device which utilises solar energy for cooking food material. It consists of an insulated wooden box (B) painted with black from inner

side. The lid of the box is provided with a plane mirror reflector (R) and a glass sheet (G). The food to be cooked is placed in a metal container (C) painted with black from outer side and kept in the box .The container is covered with the glass sheet. The box is then kept in direct sunlight and its reflector is adjusted in such away that a strong beam of sun light falls over it.

Working:- When the solar cooker is kept in direct sunlight , the reflector (R) reflects both visible and infrared rays of the sunlight on to the top of the box in the form of a strong beam of light. The black surface of the box and the vessel absorbs it. When the inner black surface becomes quite hot, it also starts radiating heat energy in the form of infrared rays, but the upper glass sheet (G) does not allow these rays to pass through it and go outside the box. As a result, these infrared rays get absorbed in the box, which increases its internal temperature up to about 1000C. This
high temperature cooks the food material kept in the metallic container inside the box.

(ii) **Solar water heater:-** A solar water heater is a device used to heat water by utilising solar energy radiation radiated by the sun . A solar water heater consists of an insulated box (B) painted black from inner side. Inside the box are fitted copper tubes (T) in the form of a coil. These copper tubes are also painted black from outer side, so that they may absorb heat rays of the sun more efficiently. To prevent the loss of heat energy from the box, the box is provided with a glass lid on its upper side. The two ends of the copper tubes are joined to a water storage tank (K). The solar heater and the water tank are fitted on the roof of a building so that they may receive directly the rays of the sun.

Working:- The cold water from the main water pipe enters into the storage tank (K) through an inlet pipe (P). This cold water then enters into the copper tubes (T) of the solar heater through the pipe (M). When the solar radiation is incident on the heater, the copper tubes (T) gets heated due to absorption of the solar energy, and as the cold water passes through these pipes it also gets heated. The hot water then leaves the coppertubes and enters into the upper portion of the storage tank through the pipe (N). Being lighter, the hot water of the storage tank remains in the upper part of the storage tank and can be taken out through the pipe (R). The continuous circulation of the water between the solar heater and the storage tank heats up all the water of the tank and the degree of a hotness of water in the tank
depends upon the time period of the sunshine incident on it .

(iii) Solar furnace: - A solar furnace is a device which utilises solar energy in producing heat energy . It consists of thousands of small plain mirrors arranged in a curve in such a way that they form a very big concave reflector capable of focusing the entire incident solar radiation on its focus. When a furnace is kept at the focus of such a spherical reflector it gets tremendously heated, and its temperature rises upto about 30000C which is enough to melt
various metals like iron, steel etc.

(iv) Solar cell: - A solar cell is a device which converts solar energy (light energy) directly into electricity. It is

made of semi-conducting material like silicon, germanium, selenium or gallium.
A modern solar cell is made from wraffers of semi conducting materials containing impurities in such away that a potential difference gets generated when light falls on them. A 4 cm2 solar cell produces a potential difference of about 0.4--0.5volts and generate about 60milli-amperes of current. To generate a large amount of current a number of solar cells are arranged together in a definite pattern in a solar panel. The energy (electric current) generated in a solar panel is stored in a battery connected to it and can be used for various purposes.

Uses of a solar cell: - The solar cells are used effectively in various fields, but some of its important uses are:
1. Solar cells are used for production of electricity for lighting, houses, streets etc.
Solar cells are used for production of electricity to run electronic appliances like televisions, radios, watches,
calculators, toys, toy games etc.
Solar cells are used to develop electricity for offshore oil drilling platforms etc.
Solar cells are used to generate electricity in artificial satellites, rockets, and space vehicles etc.

Solar power plants: - A solar plant is a multipurpose project where solar energy is utilised to generate electricity. It consists of a large concave reflector, which reflects the incident solar energy on to the black pipelines containing water. As the water gets heated, it gets converted into steam, which is used to run large turbines. These turbine inturn drive generators and generate electricity which is supplied through electric wires and used for various purposes.
Uses of solar energy:- The important uses of solar energy are listed as under;
1. Solar energy is used for production of electricity in solar power stations.
2. Solar energy is used to generate electricity needed in satellites, rockets and other space vehicles.
Solar energy is used to generate electricity for lightening houses, streets and for heating purposes..
Solar energy is used for running various electrical and electronic appliances like televisions, radios, watches,
cameras, calculators, toys, and even computers etc.
5. Solar energy is used for cooking food material with the help of solar cookers.
6. Solar energy is used for heating water is big building like hotels, hospitals with the help of solar heaters.
Solar energy is traditionally used for drying clothes, obtaining salt from salt water and preservation of fruits, vegetables and fish etc .

Wind: - When large masses of air move from one place to another it is referred to as wind. During this process
kinetic energy gets associated with it which is referred to wind energy.

Principle of utilisation of wind energy: -
Wind energy is efficiently converted into electrical energy with the aid of a windmill.

A windmill is a large fan having big blades, which rotate by the force exerted by moving wind on them. These blades remain continuously rotating as long as wind is blowing and can be used to drive a large number of machines like water pumps, flour mills etc. But these days a windmill is used to generate electric current which is used for various purposes and therefore wind power stations are established all over the world which convert wind energy directly into electrical energy. However generating electricity with the help of wind power stations has an advantage that it does not produce any environmental pollution.

Uses of wind energy: - The important uses of wind energy are;

1. It is used to drive windmills, water lifting pumps and flour mills etc.
2. It is used to propel sale boats.
3. It is used to fly engine less aeroplanes or gliders in the air.
4. It is used to generate electricity used for various purposes like lightening, heating etc.

Advantages of generating wind energy: - The chief advantages of using wind energy are;

1. It is readily and abundantly available at every place of the earth free of cost.
2. It is ecofriendly and does not produce any kind of environmental pollution.
3. It is a renewable source as air itself is a renewable and inexhaustible resource.
4. It is a cheap source of energy, as it does not involve any costly investment.

Hydro electricity: - When the water flowing in a river is stored in a high rise dam and allowed to fall from the top of the dam. The water rushes down with a great force, which can be utilised to drive large water turbine. These turbines are connected with electric generators, which generate electric current. The electricity generated in this process is termed as hydro electricity or hydel power. Infact the process involves transference of potential energy of
the water into kinetic energy and then into electric energy.

Advantages of generating hydro electricity:- The main advantages of using water energy for the generation of
hydro electricity are listed as under;

1. It is readily and abundantly available everywhere free of cost.
2. It is ecofriendly and does not produce any kind of environmental pollution.
3. It is a renewable source as water itself is a renewable and inexhaustible resource.
4. It is a cheap source of energy, as it does not involve any costly investment.

Energy from Oceans: - The oceans acquire almost 71% of the surface of the earth and the enormous amount of water present in them not only act as a big collector of solar heat energy, but also store large amount of it due to its high specific heat. Thus ocean water can be used as a renewable resource of energy. The main forms of ocean energy
are described as under;

i) Ocean Thermal energy: - The energy available due to the temperature difference between the deeper levels and
surface of an ocean is called as ocean thermal energy.

ii) Ocean Tidal energy: - The rise of ocean water due to attraction of the moon is referred

to as high tide and its fall as low tide. The enormous movement of water due to high and low tide provide a large amount of energy
known as ocean tidal energy. This tidal energy can be utilised by constructing a tidal barrage or dam.

iii) Sea wave energy: - The energy obtained from the high speed sea waves is referred to as sea wave energy. Infact these high speed sea waves have a lot of kinetic energy associated with them, which can used to drive dynamos
which convert kinetic energy into electrical energy.

iv) Energy from Nuclear deuterium of oceans : - The ocean water contains unlimited amount of heavy hydrogen isotope called deuterium which is an isotope hydrogen having one proton and one neutron in its nucleus. Scientists are working hard to produce energy by carrying by out controlled nuclear fission of deuterium isotope. The
process is still in its experimental stage.

v) Energy from Salinity gradient in seas :- The difference in the concentration of salts in the water of the two or more seas is called as salinity gradient. This salinity gradient is now a days used to obtain energy with the involvement
of suitable techniques.

vi) Energy from sea vegetation or biomass :- Sea vegetation or biomass is another direct source of energy because the enormous amount of sea weeds present in the sea water provides an endless supply of methane fuel.

ENERGY

.

Petrol Engine	Diesel Engine
1. It uses petrol oil as fuel.	1. It uses diesel oil as fuel.
2. During the intake stroke, the mixture of fuel oil and air enters into the cylinder.	2. In case of diesel engine, only air enters into the cylinder through the intake valve.
3. During the compression stroke, the compression of	3. During compression stroke, the compression of

the compression of the fuel mixture takes place.	air takes place.
4. During the compression stroke, the fuel mixture is compressed to one eighth of its original volume.	4. During the compression stroke, the air is compressed to about one sixteenth of its original volume.
5. The combustion of the fuel mixture takes place by the voltage spark produced by the spark plug.	5. The combustion of the fuel mixture takes place by the heat generated in the compression stroke.
6. It is used in light motor vehicles like cars, scooters,	6. It is used in heavy motor vehicles like buses, truck

Steam Engine	Petrol Engine
It is an external combustion engine using wood or coal as fuel.	1. It is an internal combustion engine using petrol oil as its fuel.
2. Here the fuel oil is burnt in a firebox of the boiler outside the cylinder.	2. Here the fuel is burnt inside the cylinder of the engine.
3. The high pressure steam provides the energy for the force of the propelling of the engine.	3. Here the energy for propelling is the expanding gases inside the cylinder.
4. It is big, heavy and occupies a lot of space	4. It is small, light and occupies less space.
5. It takes a lot of time to get started.	5. It takes gets started within no time.
6. It is less efficient.	6. It is very efficient.

Internal Combustion Engine	External Combustion Engine
1. It is smaller and lighter.	1. It is big and heavy in weight.
2. It is started at once at a moment's notice.	2. It takes a lot of time to get started.
3. It is quite safer to use.	3. It is not too safe to use.
4. It has a higher efficiency.	4. It is less efficient than an I. combustion engine.
5. It is complex and requires much maintenance.	5. It is less complex and requires less maintenance.

Mixture of fuel and air

Compressed fuel mixture