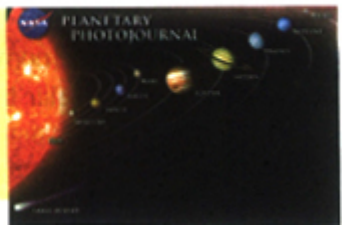
14 SOLAR ENERGY



WHAT IS SOLAR ENERGY?

Solar energy is the light and radiant heat from the Sun that reaches the earth. This energy from the sun is responsible for the Earthâ€™s climate, weather and life on Earth. The Earth receives 174 petawatts (PW) of incoming solar radiation at the upper atmosphere. In tropical regions like in Northern Nigeria, about 1000W/m^2 of energy reaches the ground. This amount of solar energy reaching the earthâ€™s surface is so vast and can be a source of future energy requirement if properly harnessed.

Applications of solar energy technology

1. Solar energy is used in drying clothes, drying seeds or crops like maize, tomatoes, etc.
2. Solar energy is used in agriculture for growing crops, pumping water, brooding chicks and drying chicken manure.
3. Solar thermal technologies can be used for water heating, space heating, space cooling and process heat generation. Solar hot water systems use sunlight to heat water.
4. Solar water treatment-solar energy may be used in a water stabilization pond to treat waste water without chemicals or electricity.
5. Solar cookers use sunlight for cooking, drying and pasteurization. Thermal energy from the sun can concentrated in a small area called focus where cooking pots or kettles for boiling water are placed.
6. Sunlight can be converted into electricity using photovoltaics (PV) and concentrating solar power (CSP). PV has mainly been used to power small and medium-sized electronic devices like calculators and wrist watches. Many solar cells (PV) can be connected together to power a house, car or space communication satellites. For large-scale generation of electricity CSP plants as have been used recently in multi-megawatt PV plants. In 2007, a 14 MW power station is built in Nevada and a 20 MW power station in Beneixama.
7. Aircrafts, space shuttles and communication satellites are powered by solar panels. Space telescopes lunched by NASA in the 1980s use

5KW of electrical power from a solar panel.

Solar tea heating panel used to boil water in a kettle

11 MW Serpa solar power plant in Portugal

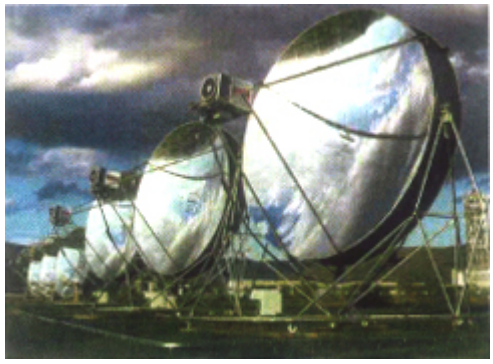
Solar heating panel

As stated above, about 1000W/m^2 reach the ground particularly in northern Nigeria. Solar hot water systems called solar heating panel use this energy from the sunlight to heat water. The solar panel collects solar radiation from the sun and converts them into heat. The most common types of solar water heaters are evacuated tube collectors.

Types of solar heating panel

There are many different types of solar panels. The basic principles of all solar heating panels are:

1. **Concentrating heat radiation from the sun into a small area**. Mirrors or other reflecting surfaces are used to concentrate light and heat from the sun into a small cooking area. The concentrated energy in small area raises the temperature of the spot to boil water or cook food.



The parabolic dish engine system, which concentrates solar power

2. **Improving the effectiveness of turning the energy of sunlight into heat**. Dull black surfaces are good absorbers of heat. Painting the surface of the panel and pipes carrying water black will improve the effectiveness of turning light into heat.
3. **Using the greenhouse effects in trapping heat**. Isolating the air inside the cooker from the air outside the cooker makes an important difference. Using a clear solid, like a plastic bag or a glass cover, will allow light to enter, but once the light is absorbed and converted to heat, a plastic bag or glass cover will trap the heat inside using the Greenhouse Effect. This makes it possible to reach similar temperatures on cold and windy days as on hot days.

Constructing a solar panel

To construct a solar panel, the following materials are needed:

1. blackened pipes to capture more heat radiation from the sun. The pipe is coiled so that the water flowing in it is delayed until absorbs enough heat to boil the water.
2. blackened metal base resting on an insulating base.
3. a box with glass cover to trap heat and raise the temperature of the panel to the required temperature.

The solar panel is constructed so as to trap sunlight energy in order to increase the temperature enough to boil water. The black metal base and pipes ensure that maximum energy are absorbed, the insulating base ensures that heat trapped in the panel is not lost and the glass cover uses Greenhouse effect to trap sunlight energy. The glass cover permits heat radiation to pass through it but stops longer wavelength heat radiation from escaping from the panel. The water flowing in the pipes are heated and retained in the pipe as heat lost by evaporation is reduced. Solar panels can be a source of heating water or cooking food in tropical regions of Nigeria.

Questions

1. What is solar energy?
2. State three applications solar energy.
3. Describe two ways of improving the efficiency of a solar collector.
4. (a) Describe briefly structure of a solar panel.
   (b) Give reason for the use of
      (i) blackened pipes and blackened metal base.
      (ii) glass cover.

THE INDUSTRIAL UNITS

Horse power – The industrial unit of power

The horsepower is a non-metric unit the power of engines. The term â€œhorsepowerâ€ was first used by James Watt while working to improve the performance of his steam engines. Watt discovered that a horse could do some amount of work per second. He rated his steam engine by the number of horses it can replace. This means that a machine rated five-horsepower is able do the work of five horses. **Horsepower (hp)** is a non-metric unit (not SI unit) of power. We can convert horsepower to watt or not SI unit. A horsepower (1 hp) is equal to 746 watts.

Different definitions of horsepower

The following definitions have been widely used:

- Mechanical horsepower is defined as 746 watts or 0.746 kW.
- Electrical horsepower is defined as 0.746 kW (746W). The **electrical horsepower** is used by the electrical industry for electrical machines and is defined to be exactly 746 W at 100% efficiency. Electric motors can never run at 100% efficiency.
- Metric horsepower is defined as 0.73549875 kW, or roughly 98.6% of mechanical horsepower.

Most electrical appliances are rated in watts or kilowatts. For example, an electric iron is rated lkw. If an electric iron is used for 1 hour, the energy used is lkilowatt hour (1kwh). This is equivalent to 3600000 J of energy.

Questions

1. What is a horsepower?
2. What is a horsepower in metric or SI unit of power?
3. An air conditioner is rated three (3) horsepower. Calculate the power of the air conditioner in watts.

Barrel – The industrial unit of volume

The barrel is the name of unit of volumes of liquids, particularly crude oil or petroleum products. Generally it ranges between 100-200 litres or 30-50 US gallons for various liquids. The standard **crude oil or petroleum products barrel** is about 42 U.S gallons or 159 litres. Some countries measure oil in cubic metres (m^3) or in tonnes (t). A barrel of crude oil is 159000 m^3. Using fractional distillation about 25 gallons of gasoline is obtained by refining a barrel of crude oil, the rest of the crude oil are converted to other products like jet fuel and heating oil, using fractional distillation.

Acre- The industrial unit of area

The **acre** is a unit of area. The most commonly used acres today are the international acre and the survey acre. One international acre is equal

4047 m^2. The acre is often used to express areas of land. In the metric system, the hectare is commonly used for the same purpose. An acre is approximately 40% of a hectare. 1 international acre is equal to the following metric units: 4047 m^2 or 0.4047 hectare.

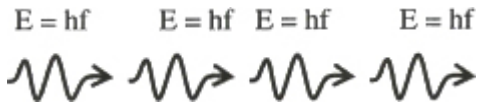
Questions

1. (a) What is a barrel?
   (b) Convert to acre a piece of land measuring 12800 m^2.
2. A plot of land is measured 100m by 85m. Calculate the area of the plot of land in acre.

PHOTON

Photon and its nature

Light is radiated from a source as a small burst or unit of energy called **wave packet.** A **wave packet** behaves as a particle because it has particleâ€™s properties like mass and momentum. At the same time, it behaves like wave with wave properties like frequency, wavelength and amplitude as it moves in space. A **wave packet** is called a **photon.** A ***photon*** is a discrete bundle of light energy traveling in a given direction in space. Photons are always in motion and, in a vacuum, travel with the speed of light (3.0 Ã— 10^8 m/s). The concept of photon was developed by Albert Einstein to explain experimental observations that did not agree with the idea of light as a wave. The energy of a photon is proportional to frequency of the source.



How light photons travel

We perceive light photon as continuous due to persistence of vision

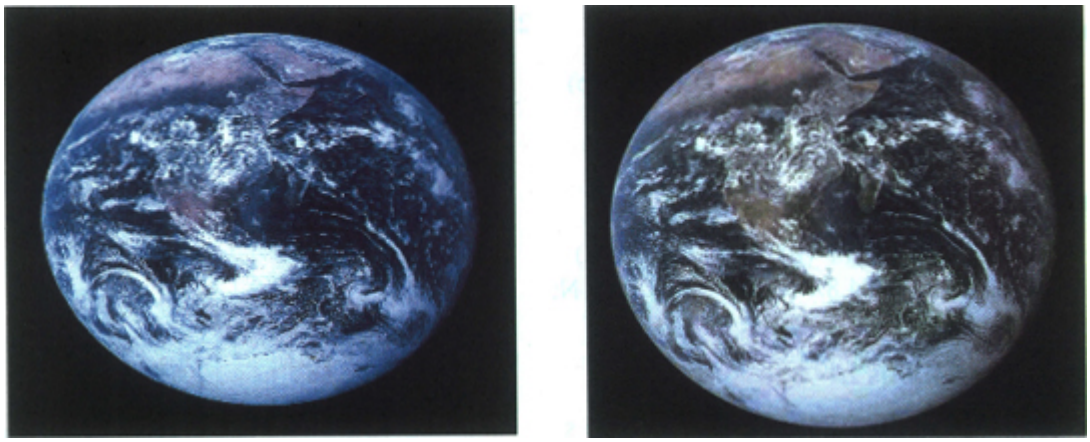
Questions

1. What is a photon?
2. State two particle and two wave properties of photons.

Shape and Size of the Earth

Aristotle and Pythagoras both argued that the earth was a sphere from the curved shadow it cast during lunar eclipses. Sir Isaac Newton extended the ideas of Aristotle and Pythagoras by saying that the earth was not a perfect sphere. Newton showed through mathematics that the Earthâ€™s shape is an oblate spheroid. An oblate spheroid is a rounded shape with a bulge around the equator although the precise shape is geoid. The diameter of earth is 12735 km. Gravity

measurements give evidence that the Earth is not perfectly spherical. The pull of gravity on an object changes as the distance of the object from the centre of the earth changes. The further an object gets from the centre of the Earth, the less it weighs. Photographs from space, as shown in figure below confirms that earth is round.



Questions

1. What is actual shape of the earth? Give two reasons to support your answer.
2. Using the pull of gravity on objects on the earthâ€™s surface, explain why the shape of the earth is not spherical.

Electrical continuity testing

Electrical continuity tester consists of (1) light bulb (2) a cell which supplies current and (3) conducting wires. When these parts are connected as shown in the diagram below, electric current flows showing that the path or wire is continous.