

# UNIT 5:

## HEAT TRANSFER

### 5.1. **Demonstration:** *Thermodynamics*

**Task 1:** *Read the demonstration and give some examples deal with the first law of thermodynamics:*

Thermodynamics is that branch of science dealing with the mechanical action of heat. There are certain fundamental principles of nature, often called laws of thermodynamics, which govern our existence here on Earth, several of which are basic in the study of refrigeration. The first and most important of these laws is the fact that energy can neither be created nor destroyed, but can be converted from one type to another. A study of thermodynamic theory is beyond the scope of this manual, but the examples that follow will illustrate the practical application of the energy law.

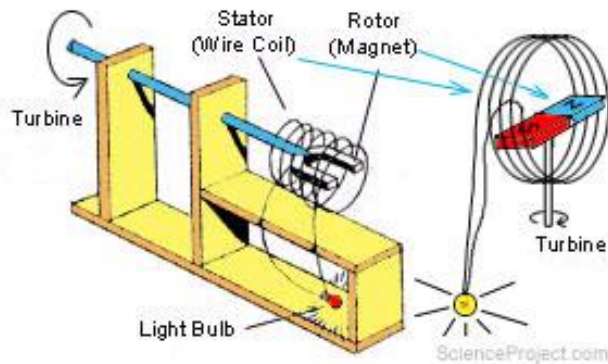


Fig.5.1

### 5.2. **The second law of thermodynamics:**

*There are three mechanisms by which thermal energy is transported. What are they?*

*Now read the text:*

The second important law of thermodynamics is that heat always travels from a warm object to a colder one. The rate of heat travel is in direct proportion to the temperature difference between the two bodies.

Assume that two steel balls are side by side in a perfectly insulated box. One ball weighs one pound and has a temperature of  $400^{\circ}\text{F}$ ., while the second ball weighs 1,000 pounds and has a temperature of  $390^{\circ}\text{F}$ . The heat content of the larger ball is tremendously greater than the small one, but because of the temperature difference, heat will travel from the small ball to the large one until the temperatures equalize.

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Heat can travel in any of three ways: radiation, conduction, or convection.

Radiation is the transfer of heat by waves similar to light waves or radio waves. For example, the sun's energy is transferred to the Earth by radiation. One need only step from the shade into direct sunlight to feel the impact of the heat waves, even though the temperature of the surrounding air is identical in both places. There is little radiation at low temperatures, and at small temperature differences, so radiation is of little importance in the actual refrigeration process. However, radiation to the refrigerated space or product from the outside environment, particularly the sun, may be a major factor in the refrigeration load.



Fig.5.2

Conduction is the flow of heat through a substance. Actual physical contact is required for heat transfer to take place between two bodies by this means. Conduction is a highly efficient means of heat transfer as any service-man who has touched a piece of hot metal can testify.

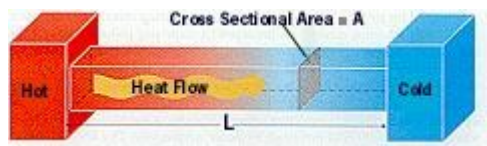


Fig.5.3



Convection is the flow of heat by means of a fluid medium, either gas or liquid, normally air or water. Air may be heated by a furnace, and then discharged into a room to heat objects in the room by convection.

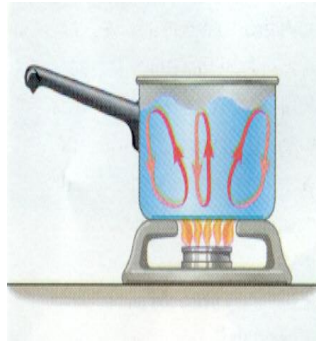


Fig. 5.4

In a typical refrigeration application, heat normally will travel by a combination of processes, and the ability of a piece of equipment to transfer heat is referred to as the overall rate of heat transfer. While heat transfer cannot take place without a temperature difference, different materials vary in their ability to conduct heat. Metal is a very good heat conductor, while asbestos has so much resistance to heat flow it can be used as insulation.

### 5.3. Answer the questions

#### **Task 2:** 1. Answer the questions:

- 1/ What is thermodynamics?
- 2/ What is the first law of energy?
- 3/ In the second law of thermodynamics, how does heat travel ?
- 4/ Name three ways in which heat can travel.

#### 2. True or false:

- 1/ Thermodynamics concerns the mechanical action of heat.
- 2/ Study of refrigeration is not in thermodynamics.
- 3/ Laws of thermodynamics do not govern our existence here on Earth.
- 4/ Energy can neither be created or destroyed.
- 5/ Heat will travel from the hotter small ball to the colder large one until the temperatures equalize.
- 6/ The sun's energy is transferred to the Earth by wave radio.
- 7/ Conduction is the flow of heat through a substance
- 8/ Convection is the flow of heat by means of air or water.
- 9/ Metal does not transfer heat better than asbestos.

### 5.4. Language study

#### *Active or Passive*

#### **Task 3:** Review some grammatical points about active and passive voice:

We use passive forms for reasons of style and of clarity, as well as of meaning. Mostly the rules of passive formation are straightforward. Subject of an active verb can be the agent of a

passive verb. We often don't mention the agent in the passive, but if we do it is introduced with *by*:

- Ex: 1, They established an industrial area in the zone last year.  
 => An industrial area was established in the zone last year **by them**.
- 2, A furnace may heat air.  
 => Air may be heated **by a furnace**.

We then use the passive form of verbs in all tenses by using *be* in the appropriate tense plus the past participle of the main verb:

- Ex: 3, The sun's energy is transferred to the earth by radiation.  
 4, Hot piston cylinders in automobile engine are cooled by water forced around them.

### Form of Passive:

Subject + finite form of *to be* + Past Participle (3rd column of irregular verbs)

|                            | Active                                          | Passive                                                    |
|----------------------------|-------------------------------------------------|------------------------------------------------------------|
| <b>Simple Present</b>      | Mr Smith <i>writes</i> the delivery notes.      | The delivery notes <i>are written</i> (by Mr Smith).       |
| <b>Present Progressive</b> | Mr Smith <i>is writing</i> the delivery notes.  | The delivery notes <i>are being written</i> (by Mr Smith). |
| <b>Simple Past</b>         | Mr Smith <i>wrote</i> the delivery notes.       | The delivery notes <i>were written</i> (by Mr Smith).      |
| <b>Present Perfect</b>     | Mr Smith <i>has written</i> the delivery notes. | The delivery notes <i>have been written</i> (by Mr Smith). |
| <b>Past Perfect</b>        | Mr Smith <i>had written</i> the delivery notes. | The delivery notes <i>had been written</i> (by Mr Smith).  |
| <b>Future</b>              | Mr Smith <i>will write</i> the delivery notes.  | The delivery notes <i>will be written</i> (by Mr Smith).   |
| <b>Auxiliary Verbs</b>     | Mr Smith <i>must write</i> the delivery notes.  | The delivery notes <i>must be written</i> (by Mr Smith).   |

When rewriting active sentences in passive voice, note the following:

- the object of the active sentence becomes the subject of the passive sentence
- the finite form of the verb is changed (*to be* + past participle)

- the subject of the active sentence becomes the object of the passive sentence (or is dropped)

## 5.5. Practice

### Sentences

#### Task 4: Match

Match the each picture with its sentence or name about the heat transfer. And say how they can transfer heat.

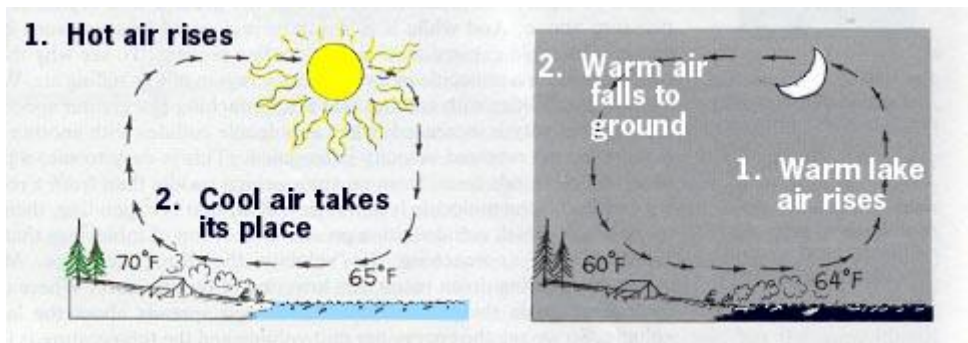


Fig. 5.5

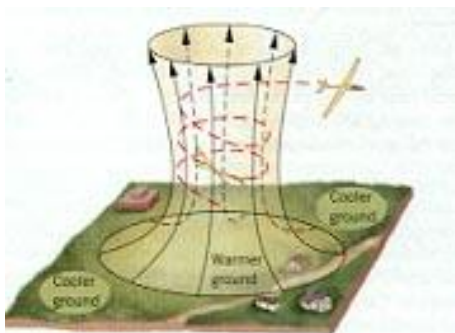


Fig. 5.6



Fig5.7

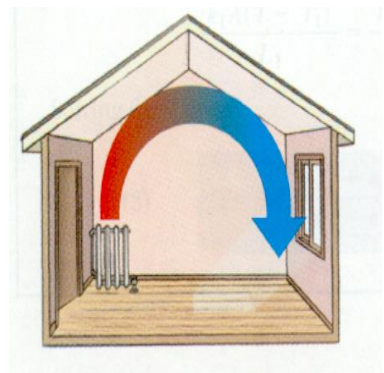


Fig.58

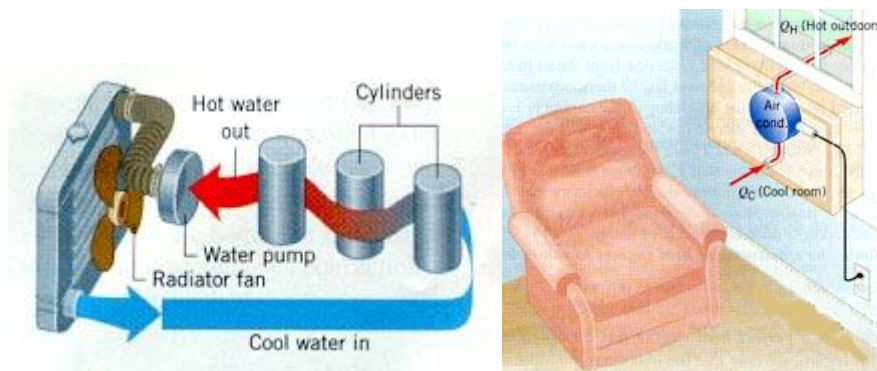


Fig.5.9



Fig. 5.11

Fig.5.10

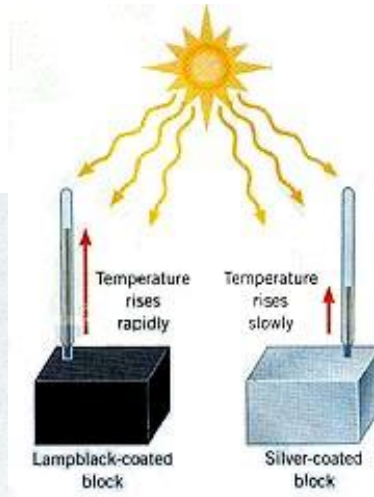


Fig.5.12

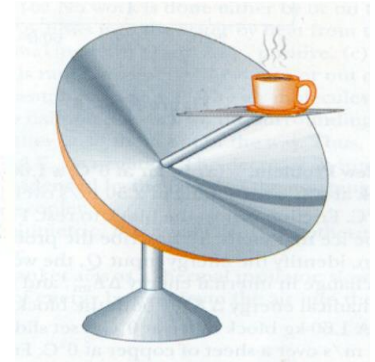


Fig. 5.13

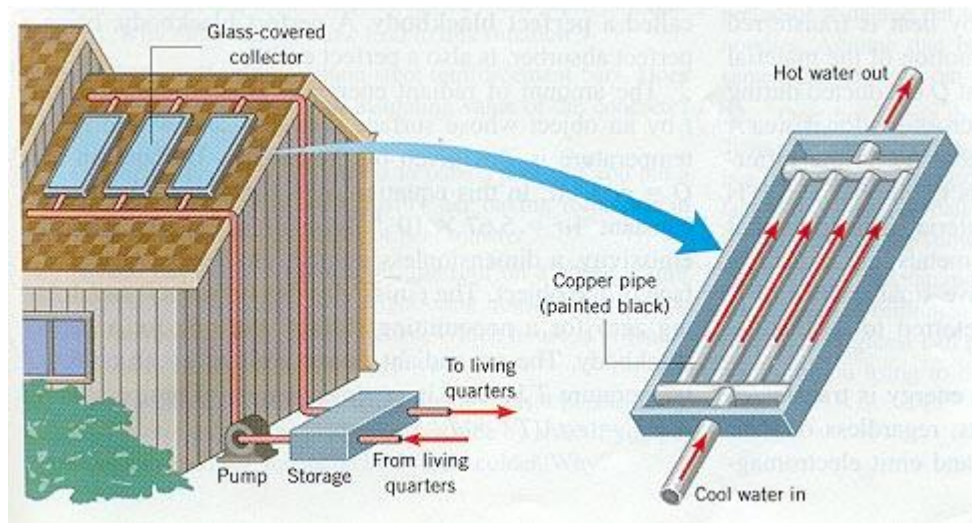


Fig. 5.14

A/ Air above warmer ground rises.

B/ Heated air rises, cools, then falls. Air near heater is replaced by cooler air, and the cycle repeats

C/ Warm land is cooled during the day, while cooler land is warmed at night

D/ Hot water rises, cools, and falls.

E/ Hot room air is forced outside, while cooler air replaces it.

F/ Water at the bottom of the drops is evaporated and provides insulation against further evaporation. Pan must be very hot.

G/ Solar cooker.

H/ Pipes in Solar Panels are painted black

I/ Summer clothing: white reflects radiant energy better than black.

J/ Hot piston cylinders in automobile engine are cooled by water forced around them.

## 5.6. More reading

### Temperature

Temperature is the scale used to measure the intensity of heat, the indicator that determines which way the heat energy will move. In the United States, temperature is normally measured in degrees Fahrenheit, but the Centigrade scale (sometimes termed Celsius) is widely used in other parts of the world. Both scales have two basic points in common, the freezing point of water, and the boiling point of water at sea level. Water freezes at  $32^{\circ}\text{F}$ . and  $0^{\circ}\text{C}$ ., and water boils at sea level at  $212^{\circ}\text{F}$ . and  $100^{\circ}\text{C}$ . On the Fahrenheit scale, the temperature difference between these two points is divided into 180 equal increments or degrees F., while on the Centigrade scale the temperature difference is divided into 100 equal increments or degrees C. The relation between Fahrenheit and Centigrade scales can always be established by the following formulas:

$$\text{Fahrenheit } 9/5 (\text{Centigrade} + 32^{\circ})$$
$$\text{Centigrade } 5/9 (\text{Fahrenheit} - 32^{\circ})$$

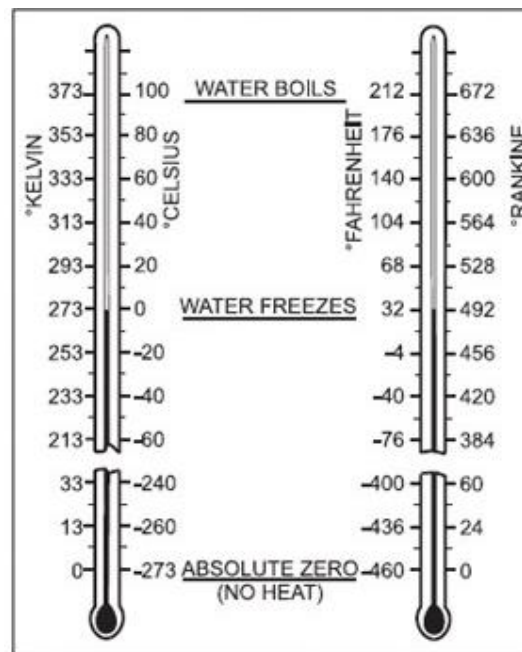


Fig. 5.15

## 5.7. Exercise

I/ Rewrite the passive sentences into active sentences

1/ In the United States, temperature is normally measured in degrees Fahrenheit.

⇒ \_\_\_\_\_

2/ Air may be heated by a furnace.

⇒ \_\_\_\_\_

3/ The sun's energy is transferred to the Earth by radiation.

⇒ \_\_\_\_\_

4/ The relation between Fahrenheit and Centigrade scales can always be established by the following formulas.

⇒ \_\_\_\_\_

5/ Ice was harvested in the winter to be used in the summer.

⇒ \_\_\_\_\_

**II/ Rewrite the sentences in passive voice.**

1. I confirm the reservation.
2. We will deliver the goods immediately.
3. We arranged a meeting.
4. You can cancel the contract within five business days.
5. They execute all orders carefully.
6. You have made a mistake.
7. We are processing your order.
8. Jane had booked a flight.
9. He has not answered our letter.
10. She did not sign the contract.

**III/ Decide whether to use simple present, simple past, present perfect, conjunctive or passive voice. Use the long forms.**

The Fellowship of the Ring (be)\_\_\_\_\_ the first book of J.R.R. Tolkien's The Lord of the Rings trilogy, which (set)\_\_\_\_\_ in a fictive world, Middle Earth. It (tell)\_\_\_\_\_ the story of Frodo, a hobbit, and a magic ring.

As the story (begin)\_\_\_\_\_, Frodo (give)\_\_\_\_\_ a magic ring. The wizard Gandalf then (tell)\_\_\_\_\_ him of the Rings of Power and of Sauron, the Dark Lord, who (make)\_\_\_\_\_ the Master Ring to rule all other Rings. Gandalf (advise)\_\_\_\_\_ Frodo to leave home and keep the ring out of Sauron's hands who

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already (send)\_\_\_\_\_his Black Riders in search for it. Frodo's ring  
(give)\_\_\_\_\_Sauron the power to enslave Middle Earth.