Students Workbook
for
Solar Thermal Systems Module
(Solar cookers and Solar water heaters)

Ministry of New and Renewable Energy
Government of India
Contents

Unit 1: Introduction to Solar Energy  
Unit 2: Solar Thermal Energy  
Unit 3: Solar Cookers  
Unit 4: Solar Water Heaters (SWH)
Q1. Fill in the blanks

1. ___________ is the major source of energy on Earth.
2. Solar energy is used in the form of ____________ and ____________.
3. Solar power systems collect the sun's energy and convert it into ____________.
4. Solar energy systems are equally effective in both summer and winter. (True/False)
5. Where will you prefer to place your solar energy system – Balcony / Roof top

Answer the following questions briefly

Q2. List down three ways in which sun's energy has been used traditionally.
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Q3. Why should we use solar energy?
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Q4. Name five factors that we need to consider for utilising solar energy power.
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Q5. When you place your solar energy system on the roof top, what is the main factor to consider?
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Q6. List three solar energy appliances that you see in public places
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Q7. Do solar energy systems work only on sunny days?
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Q8. Why we should go for solar energy?
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Q9. What are the applications of solar energy?
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Q10. How to measure solar radiation?
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Unit 2: Solar Thermal Energy

Q1. Objective questions

1. Appliances used to capture sun’s energy are commonly known as _________.
2. A solar collector works on the principle of converting solar energy into heat by taking advantage of a process known as
   a. Heat house effect   b. greenhouse effect   c. Sunshine effect
3. Mention the three ways in which heat moves.
4. _______________ glass plates are used as solar collectors.
5. Mention the names of the solar thermal appliances that can be used for the following purposes:
   a. Heating water
   b. Cooking food
   c. Drying fruits/crops
   d. Purifying water

Q2. Explain heat transfer

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Q3. Explain the function of a basic solar still and how it works.

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Q4. Explain in brief the working principle of a solar collector

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Q5. What are thermal applications of solar energy?
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Q6. What is the principle of working of a solar water heating system?
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Q7. What are the types of solar water heating collectors?
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Q8. Explain in brief, working principle of a solar collector.
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Q9. What are the types of heat transfer?
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Q1. **Objective questions**

i). Box Solar cooker cooks food very fast (True/False)

ii). A solar cooker works on a cloudy day (True/False)

iii). What type of a solar cooker will you suggest for the following places:
   a. City residence
   b. Ashram
   c. Hostel
   d. Small hotel
   e. Village school

iv). Black pots are used in solar cookers because
   a. They absorb maximum heat
   b. They don’t get dirty
   c. They don’t burn

v). The metallic sheet used for fabrication of dish solar cooker is
   a. Stainless steel
   b. Aluminium
   c. Copper

vi). Solar energy in the form of heat is known as _____________.

vii). The dish solar cooker is also known as _________________.

viii). The best direction to point the solar cooker is
   a. East
   b. West
   c. South

ix) The heat in the box solar cooker does not rise beyond
   a. 150°C
   b. 200°C
   c. 100°C

x). The double glass lid helps in the following manner:
   a. If the upper glass breaks by accident the inside glass will still protect the food.
   b. If the inside glass breaks because of heat the outside glass will protect the food.
   c. The space between both the glass acts as insulation and maintains the heat.
xi). Name the two types of performance tests conducted to evaluate the performance of the solar cooker.
   a. 
   b. 

   xii). Minimum number of sunny days required to complete the degradation test
   a. 10
   b. 20
   c. 30

Q2. Explain in brief, working principle of a typical solar cooker.
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Q3. Write down the advantages and limitations of a typical solar cooker.
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Q4. List down the types of solar cookers.
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Q5. What are the different parts used in a solar box cooker?
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Q6. List down the precautions to be taken during box cooker's installation.
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Q7. List down the typical problems faced in a box cooker and actions to be taken.
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Q8. In the diagram given below, label the following parts shown by arrows:
Q9. Mention three maintenance points required in the box solar cooker.

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Q10. Mention three limitations of a box solar cooker.

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Q11. Mention the advantages and limitations of a dish solar cooker.

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Q12. Describe the Solar dish cooker.

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Q13. Explain community cooker in brief.

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Q14. List down the materials required for solar community cooker.

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Q15. Explain in brief, the principle of working of a solar community cooker.

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Q16. Explain the installation of a solar community cooker.

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Project Assignment

Activity I: Record the temperatures reached in a box solar cooker

Objective: To understand the temperatures reached in a box solar cooker when exposed to sunlight throughout a day

Requirements: Box solar cooker, thermometer

Procedure:
1. Place the solar cooker in sunlight at about 8 in the morning.
2. Record the temperature throughout the day from 8 in the morning till about 6 in the evening at about intervals of two hours. Make the recordings in the table below. Answer the questions following the recording.

Data for Recording

a) Name of the instrument:
b) Name of the Manufacturer:

<table>
<thead>
<tr>
<th>Recording Time</th>
<th>Temperature</th>
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Questions for evaluation

1. What was the maximum temperature recorded inside the solar cooker.
2. How long did it take to reach that temperature?
3. How long did the solar cooker stay above 1500°C temperature

Activity II: Cooking with a Box Solar Cooker

Aim: To prepare a dish using solar cooker

Requirements: Solar cooker, cooking pots

Ingredients: Rice, water, salt

Procedure:

1. Place the cooker in the sun. The place selected should receive direct sunshine. Ensure that it will not come under the shadow of trees or buildings.
2. Leave the reflector mirror in the open position at an angle which permits the sun’s rays on the collector or glass covers.
3. Wipe away dust, foreign particles and moisture from both mirror and glass surfaces.
4. Allow a minimum pre – heating time of about 30 minutes. If the food to be cooked is to be placed in the cooker at 10-00a.m., place the cooker in the sun at 9-30a.m or earlier.
5. While the cooker gets pre – heated, lift the glass cover of the cooking tray and remove the cooking pots.
6. Load the material to be cooked along with the required quantity of water and close the cooking pots.
7. Keep the cooking pots on the tray and close the double glass cover of the tray.
8. Now the food is left to be cooked. The food will be ready in one or two hours, depending
upon the intensity of sun.

Data for recording

Name of the instrument: __________________________________________

Name of the manufacturer/supplier: __________________________________________

Type of food
Duration in hrs.
Conducting Time
Initial Temperature
Final Temperature
Remarks

Questions for Evaluation:

After performing the practical task the students are required to answer the following questions.

Q1. What are the main apparatus required for preparing food?
Answer:

Q2. How long did it take the rice to get ready?
Answer:

Q3. Did you have to change the position of the solar cooker to make maximum use of sunlight? If yes, how many times
Answer:

*This activity has been sourced from Non Conventional Energy Sources Lab from the web.*

Activity III: Boiling water in a dish solar cooker

Aim: To note the amount of time it takes to boil water in a dish solar cooker

Requirements: Dish Solar cooker, 12 litre cooking pot, 10 litre of water for boiling

Procedure:

1. Place the dish cooker in the sun. The place selected should receive direct sunshine. Ensure that it will not come under the shadow of trees or buildings.
2. Align the dish so that the light converges on the cooking area.
3. Place the pot with water on the cooking frame.
4. Observe the amount of time it takes for the water to boil. Note the temperature of water.

5. Repeat the experiment at different times of the day. Record the time water takes to boil at different times of the day.

**Data for recording**

a) Name of the instrument: ________________________________

b) Name of the manufacturer/supplier: ________________________________

**Recordings**

<table>
<thead>
<tr>
<th>Start time</th>
<th>Time at which water boiled</th>
<th>Time taken in (mins/hrs)</th>
<th>Temperature of water (°C)</th>
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</table>
Remarks

After performing the practical task the students are required to answer the following questions.

Q1. During which part of the day did water take the least amount of time to boil?

Q2. During which part of the day did water take the maximum time to boil?

Q3. Based on your observation write your conclusions regarding the use of the dish cooker for boiling water.
Q1. Objective questions

1. Most domestic solar water heaters are provided with ___________ back-up.
2. If the glass panel is covered with dust it does not affect the working of a SWH in any way. (True/False)
3. Water should never boil in the solar collector. (True/False)
4. A passive solar water heating system is also called ________________.
5. A thermosyphon system requires an electric pump to run. (True/False)
6. A collector is fixed facing ______________ direction.

Answer the following questions briefly:

Q2. What is a solar water heater (SWH)?

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________________________________________________________________________
________________________________________________________________________

Q3. What are the problems caused due to the deposition of scales in the solar water heater?

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Q4. In the diagram given below, label the parts of the solar water heating system.

Q5. On what basic principle, does the thermosyphon solar water heating system work?

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Q6. What is the regular maintenance required with SWH?

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Q7. What is the maximum possible temperature it could attain?

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Q8. Write the possible reasons for a SWH giving luke warm water.

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Q9. Does the SWH generate hot water on all days and in all seasons of the year?

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Q10. Can we use any type of water such as municipality treated water, bore well water or tank water?

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Q11. What is the disadvantage of using untreated metal sheet in the system?
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Q12. Give advantages and limitations of a solar water heating system.
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Q13. Explain in brief, working principle of:

   i) Natural Thermo-Siphon system
   ii) Fixed temperature Forced flow system and
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Q14. Give the advantages and limitations of the same.
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Q15. What factors would you consider while selecting a site installing a solar water heating system?
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Q16. Explain operation and maintenance of a SWH.

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Q17. What precautions should one take during manufacturing of a SWH system?

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Q18. What activities are involved in manufacturing of a hot water tank?

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________________________________________________________________________

Q19. Design a system for 500LPD. What kind of system you will prefer? How many collectors will you use? What tank specification will you use? How and where to install? Practically perform an experiment and see the output of the system.

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Project

Activity I: Installing a Solar Water Heater

Aim: To be able to install a solar water heater

Requirements: (1) flat plate solar collector, (2) insulated storage tank (3) insulated hot water carrying pipes and (4) cold water carrying pipes (5) nuts, bolts and plumbing devices

Procedure:
1. Follow the guidelines given by the manufacturer of the SWH to assemble the system.

Data for recording

Name of the instrument: __________________________________________

Name of the manufacturer: __________________________________________

Observations:__________________________________________

PRACTICALS

1. Differentiate between solar thermal collectors and solar electrical collectors.
2. Conduct a practical, 'heating of water in a container to demonstrate different modes of heat transfer'.
3. Demonstration: Solar cooker: 1. Orientation. 2. Tracking. 3. Effective use. (Record the time taken to cook)
4. Design a system for 500LPD. What kind of system you will prefer? How many collectors will you use? What tank specification will you use? How and where to install? Practically perform an experiment and see the output of the system- hourly output @60 Deg C and plot a graph.

Ans: The preferred system would be natural thermo siphon so both ETC and Flat plate collectors will do. Generally 4 flat plate collectors will do. The collectors should be facing true south and the angle of tilt should be or generally preferred is latitude + 15 degrees. It should be installed in a shadow free area. The location should be selected accordingly. Four collectors should be connected in series with alternate up and down connections. As the tank would be of 500lpd, 1.2mm thick SS and PUF or Rockwool insulation will do. The thickness of insulation will vary accordingly.

5. Experiment on a system connected to a bathroom having cold & hot mixers by placing the mixer lever on either side or in the centre.

Ans: Ask the students to open the hot water outlet piping at the tank outlet on the terrace demonstrating the cold water coming back to the system when the mixer lever is in the centre.