

# LEARNING GUIDE

**Programs**      Plumbing and Heating,  
Heating Ventilating Air Conditioning

**Module**        RENEWABLE ENERGY

**Learning Unit** Design and Install a Solar  
Domestic Hot Water System

## **Introduction**

The installation of a solar thermal, ethyl glycol, solar domestic hot water system requires that the necessary components be installed in their proper order. This learning guide will teach you the order of components necessary for the operation of a solar thermal, ethyl glycol, domestic hot water system. As importantly, it will review the scientific principles that necessitate the use of these components.

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**UPPER CAPE COD REGIONAL  
TECHNICAL HIGH SCHOOL**

**Components of a Solar, Glycol,  
Domestic Hot Water System**

**Performance Objective:** The student will design and install a working solar domestic hot water system and give the purpose of each component.

**Given:** An instruction sheet, schematic, instructor lecture, components and appropriate tools

**The Student Will:** Design and install a solar thermal domestic hot water system

**How Well:** You must successfully pass a knowledge test and a performance test.

NAME: \_\_\_\_\_

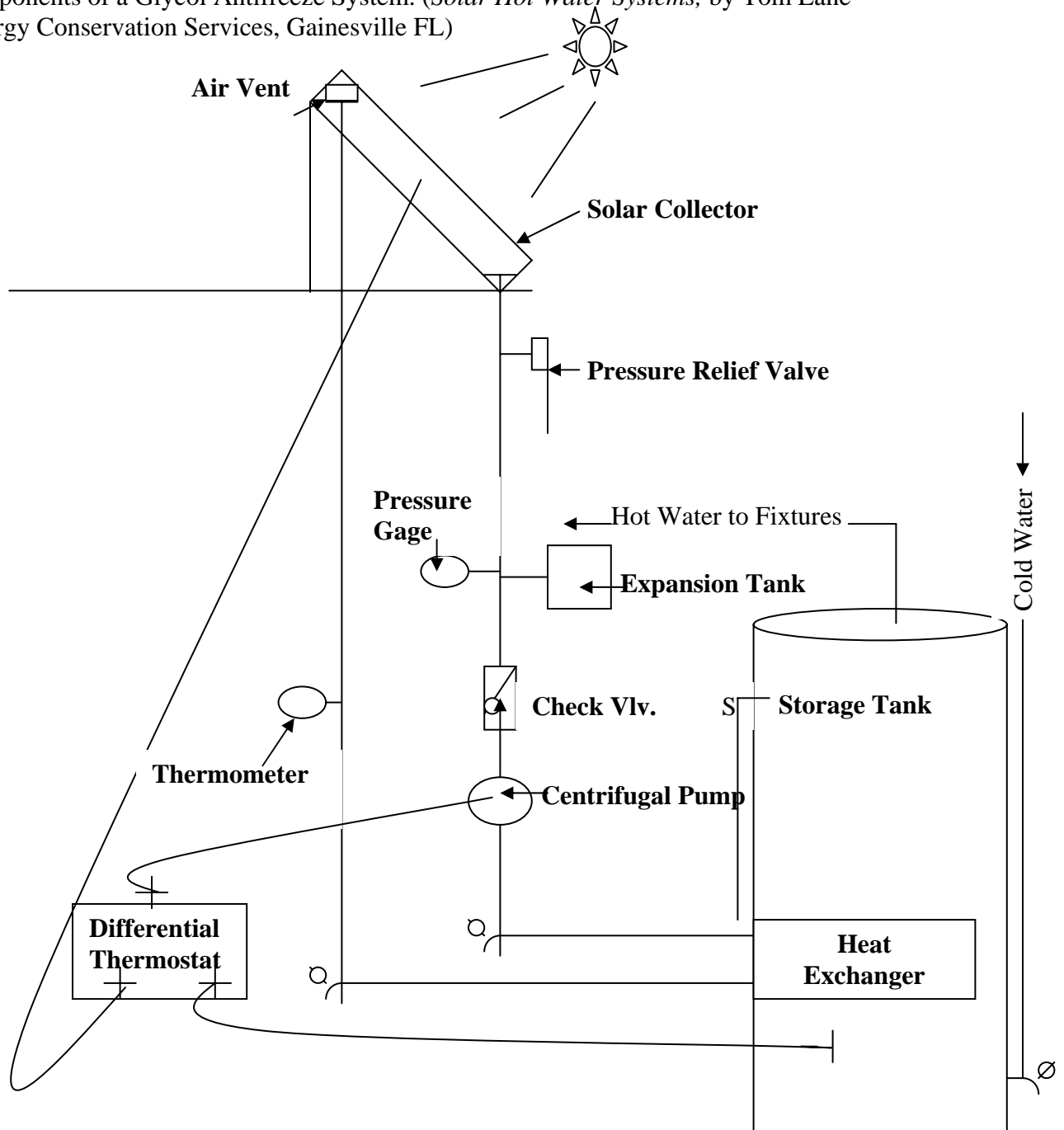
DATE: \_\_\_\_\_

GRADE: \_\_\_\_\_

## INSTRUCTION SHEET

**Pressurized Glycol Systems** circulate heated ethyl glycol (antifreeze) from solar collectors through a coil of tubing (a heat exchanger) that's submerged in an insulated storage tank. Many components are required for the proper operation of a Solar Domestic Hot Water System.

**Reading Assignment:** Read *Solar Hot Water Systems* pages 35-42 to understand the major components of a Glycol Antifreeze System. (*Solar Hot Water Systems*, by Tom Lane Energy Conservation Services, Gainesville FL)



## COMPONENTS

**Air Vent:** The air vent uses a float to allow air to exit while keeping the ethyl glycol within the closed system. An air slug within the system could stop the circulation of antifreeze.

*MA Science Frameworks 4.3 Differentiate between open and closed systems*

**Check Valve:** The check valve prevents any backward flow of antifreeze by gravity.

**Differential Thermostat:** The differential thermostat senses the temperature at the collector and at the storage tank. When the temperature is higher at the collector than at the storage tank, the control creates a circuit so that the circulating pump moves the antifreeze through the system. *MA Science Frameworks 4.5 Identify tools, and controls in a thermal system*

**Expansion Tank:** The expansion tank is partially filled with liquid (incompressible) and partially filled with air (compressible). A diaphragm separates the two. When a liquid is heated, it expands. The air compressing inside the expansion tank relieves the thermal expansion of the antifreeze. In this manner, excessive pressure cannot build up within the system. *MA Science Frameworks incompressibility of liquids*

**Heat Exchanger:** The heat exchanger is a series of loops of copper tubing. The tubing usually has fins. The fins give the tubing a larger surface area. Heated antifreeze is pumped through the inside of the tubing. The tubing is heated and the heat is transferred through **conduction**. The domestic hot water outside of the coil of tubing is heated through this exchange. *MA Science Frameworks 4.1 conduction, and convection*

**Solar Collector:** The solar collector consists of a network of tubes through which liquid is heated from the **radiation** of the sun. Behind the tubes is insulation. Above the tubing is glass, usually low iron, and tempered, designed to hold in the sun's energy within the collector and to transfer this heat energy through the tubes and absorber plates by **conduction**. *Science Frameworks 4.1 conduction, convection, radiation, re-radiation*

**Pressure Relief Valve:** The pressure relief valve is held closed by a spring. When dangerously excessive pressures are created, the valve is opened to relieve that excessive pressure.

**Storage Tank:** The storage tank holds the heated water. It should be sized large enough so that heat energy is maintained through days of low sunlight. With a heat differential of 7 degrees Fahrenheit inside the tank, **convection** will take place. Some alternate heat source should also be included in the design of the system. *MA Science Frameworks 4.1 convection*

**Water Pump** (circulation pump): The circulating pump is a centrifugal pump. When a circuit is created through the differential thermostat, the circulating pump circulates liquid from the solar collector to the heat exchanger. *MA Science Frameworks centrifugal force*

## KNOWLEDGE TEST

## Directions

Evaluate your knowledge by achieving “Proficient” on the following question.

Explain how the sun's heat energy (radiation) heats the water that ultimately comes from your tap. Include its passage through all the components of the system.

### Grading Rubric

#### **Mastery**

Completely accurate account including radiation, conduction, and convection examples

#### **Proficient**

Basically accurate account, student lacks a complete understanding of component operation

#### **Needs Improvement**

Incomplete data, does not understand the operation of the system

## PERFORMANCE TEST

### Directions

Given access to a work station, the proper tools, and the schematic drawing in this learning guide, you will design and install all of the components required for a solar domestic hot water heating system. You will be evaluated for attainment of this task based on the items listed below.

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## Performance Standards

All items must be marked YES for attainment

### PROCESS

1. Were all safety rules observed?
2. Are all components installed as per drawing?
3. Are all components installed in proper sequence?
4. Are all pipes level or plumb?
5. Are all pipes properly sized?
6. Are all fittings and joints free of leaks?
7. Was the water heater installed in accordance with the Commonwealth of Massachusetts Fuel Gas and Plumbing Codes?
8. Did the student return all excess materials and tools to the designated area?

Yes

No

## **List of RESOURCES**

Lane, Tom. Solar Hot Water Systems. Energy Conservation Services, 6120 SW 13<sup>th</sup> Street, Gainesville FL 32608. [www.ecs-solar.com](http://www.ecs-solar.com)