Kuwait University	Course 125 Phys. Lab.I
Physics Department	Experiment 1: Green House Effect

Objectives

- Studing the trapping of the solar energy and the related factors (materials, time, other environment)
- Observing the green house effect and thermal equilibrium

Equipment to be used

- Static test box
- Different glass layers of the same dimensions
- Steel black metallic plate
- Magnetic surface alcohol thermometer
- Three mircury thermometers
- Stop watch
- Sun or solar simulator

Theory:

Everyday and especially in a sunny cold day one will experience the Greenhouse Effect while sitting in a car with the windows rolled up, and same is mostly true in houses with glass windows.

In a typical Greenhouse Effect the glass enclosure permits the transmission of the short and long waves energy from the sun. This energy will be absorbed by opaque objects inside and hence be converted into heat energy. The heat energy is long wave radiations (e.g **Infrared**) which cannot pass out through glass and thus the temperatures within the Greenhouse will rise higher than outdoor air temperatures. In this particular experiment three mechanisms are involved in transferring the heat energy. A brief explanation is given as follows:

Conduction: in which the heat energy is transferred through the material between parts of different temperatures. The time rate of heat transfer H, across an area A of a slab of thickness L with differering temperatures T_1 and T_2 obey the law of heat conduction:

$$Heat\ current\ =\ H\ =\ KA\ \frac{\Delta T}{L} \tag{1}$$

where (K) is the thermal conductivity of the material, $(\frac{K}{L})$ is called the thermal resistance, (H) is a form of energy per sec (power) and the equivalence between thermal units (k cal/s) and the mechanical units (J/S = watt) has been established to be (1 k cal/s = 4187 watt). The term $(\frac{H}{A})$ is the power per unit area (or intensity U) and it is measured in (Watt/m^2). Therefor equation (1) can be writen as:

$$U\ =\ \frac{H}{A}\ =\ K\ \frac{\Delta T}{L} \tag{2}$$

Convection: This occurs when temperature differences cause fluid motion (due to convection currents) from side near the hot object to the cooler one and vice versa. The rate of heat energy flow per unit area is given by:

$$U\ =\ h\ \Delta T \tag{3}$$

where (h) is the convection coefficient of the fluid .

Radiation: In which the heat energy transfer is due to the emission of electromagnetic energy by all objects. The warm objects radiates towards the cooler. objects with a rate obeying stefan's formula:

$$U\ =\ e\ \sigma\ T^4 \tag{4}$$

where (e) is the emissivity, (σ) is the Stefan- Boltzman constant, (T) is the temperature of the radiant body, and (U) is called the rate of emission of radiant energy per unit area (watt/m^2) . The rate of loss (or gain) of radiant energy per unit area is given by:

$$U = e\,\sigma\,(T_1^4 - T_2^4) \tag{5}$$

where (T) is temperature in Kelvin; T_1 and T_2 refers to temperatures of two bodies. The thermal radiation processes involves absorption, reflection and transmission and those depend on the type of the surfaces (dull colour, rough objects, smooth, polished surfaces ....). From equations (2),(3) and (5) the heat energy transfer depends mainly on the temperature differences.

PRECAUTIONS DURING THE EXPERIMENTAL RUN

- Do not look directly to the sun or the Sun Simulator lights or even its reflected light from a glass or mirror surfaces.
- Do not shade the area around the test box during the measurements of the solar radiation meter.
- Permit for air circulation around the setup.

Procedure

Part A: Glass Enclosure

1. Prepare the test box as shown in Figure(1) where you insert each glass Layer Properly into a static frame of the test box.

2. Keep the distances (within the test box) between the glass layers to be equal, and **attach** the thermometers T_1 and T_2 as shown in figure (2). The thermometer T_o is used to record the room temperature.

3. Clamp the Sun Simulator on a vertical holder and at a suitable distance d from the first glass surface (recomended $d = 30\ cm$).

4. Orient the glass enclosure such that the incident rays are perpendicular to the glass surface.

5. Record T_o, T_1 and T_2 before you put the Sun Simulator on (time is zero).

6. Switch ON the Sun Simulator and record each temperatures T_1 and T_2 at one minute intervals for 10 minutes, then at suitable longer intervals until 1 hour period or more.

7. Plot the graphs of ΔT_1 and ΔT_2 versus time t (in minute) on the same graph paper.

8. Comment on the heat transfer in each part in the glass enclosure.

Part B: Glass Enclosure with Black Metal Surface

1. Open the test box used in part A to be cooled.

2. Keep the set up of experiment in part A exactly the same excepting the insertion of the black metal sheet instead of the second glass surface.

3. Fix the magnetic surface thermometer T_m on the metal surface so that it is facing the Sun Simulator.

4. Record T_o , T_1 , T_2 , and T_m before switching the Sun Simulator on.

5. Switch the Sun Simulator ON and be sure that the rays are incident perpendicularly on the first glass layer.

6. Record each temperature T_1 , T_2 , and T_m at one minute interval at the beginning and then for any other suitable interval for one hour or more.

7. Plot the graphs of ΔT_1 , ΔT_2 , and ΔT_m versus time t on the same graph paper.

8. Comment on the graphs and compare ΔT_1 and ΔT_2 with the results obtained in part A.

Kuwait University	Course 125 Phys. Lab. 1	Student's Name:
Physics Department	Experiment 1: Lab results	Student's Number:
Date:		Group:

Laboratory Assignment

1. What is the solar radiation?

2. Which test box has got more trapping heat in part A or in part B? and why?

3. What is the use of the glass cover over the black metal layer in part B?

4. Define thermal radiation - Conduction - Convection.

5. In the winter season which one is colder a cloudy day or a blue sky.day? And why?

Worksheet for Experiment 1(Part A: Glass Enclosure)

Table 1: Room Tempreture $T_o =$ .... $d =$ ....

Time t(m)	T_1	T_2	$\Delta T_1 = T_1 - T_o$	$\Delta T_2 = T_2 - T_o$
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
12				
14				
16				
18				
20				
22				
24				
26				
28				
30				
32				
34				
36				
38				
40				
45				
50				
55				
60				

Worksheet for Experiment 1(Part B: Glass and Metal)

Table 2: Room Tempreture T_o = ... d = ...

Time t(m)	T_1	T_2	T_m	$\Delta T_1 = T_1 - T_o$	$\Delta T_2 = T_2 - T_o$	$\Delta T_m = T_m - T_o$
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
12						
14						
16						
18						
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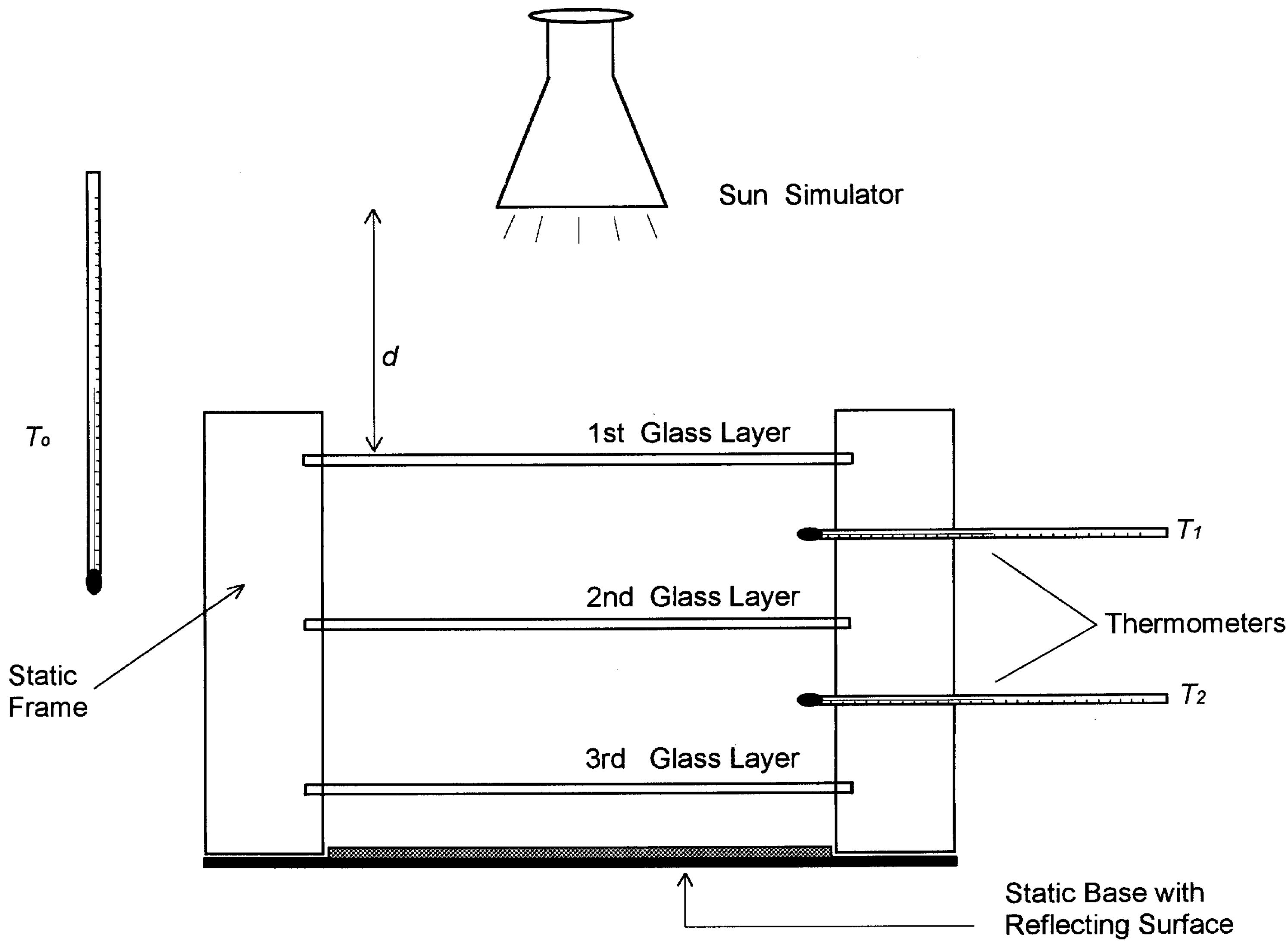

Figure (1.1): Green house Effect with Glass Enclosures

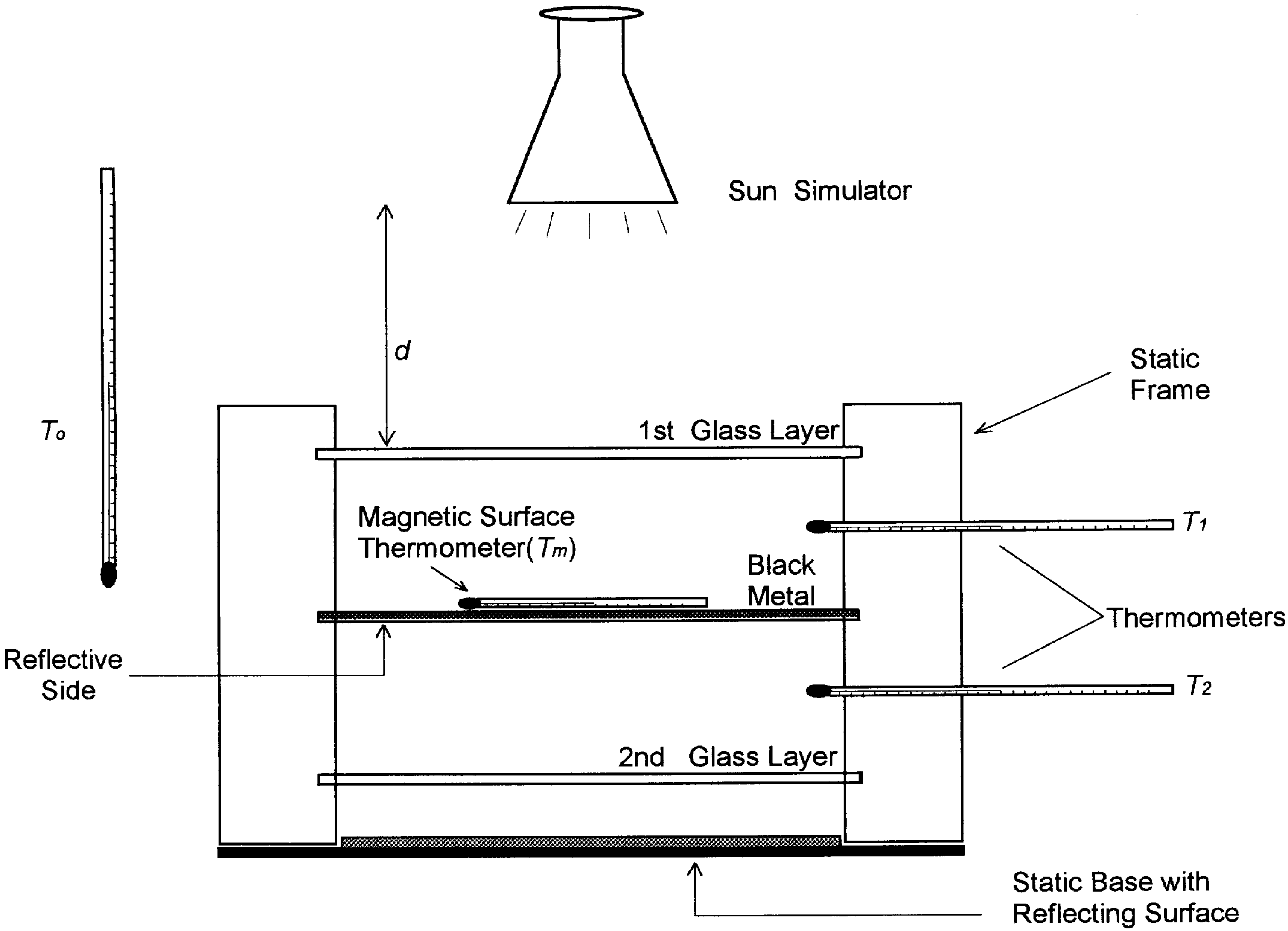

Figure (1.2): Green house Effect with Glass and Black Metal Enclosure.