University of California at Santa Cruz
Jack Baskin School of Engineering
EE-80J: Renewable Energy Sources

Greenhouse Effect Pre Questionnaire

Student's name______________________ Student ID________________________ Grade _____ / _____

TO BE COMPLETED AND TURNED IN TO TA BEFORE STARTING THE EXPERIMENT

1. Consider two identical black objects. Both objects have the same shape, form and mass. One of the objects is contained in a clear, plastic box, and the other is not. When both objects are placed under the sun at the same time, which object would heat up the fastest?
   a. The object inside a clear box
   b. The object not in the box
   c. They would heat up at the same rate.
2. Consider the same scenario as above. If both objects were left out under the sun for a long period of time. What would their final temperatures be?
   a. The temperatures would be the same
   b. The object inside a clear box would have higher temperature
   c. The object without a clear box would have higher temperature
3. Consider the two objects at room temperature. One has a black color and the other has a silver color. If each object were to be placed in a separate clear box and out in the sun at the same time. Which object would heat up the fastest?
   a. Silver object b. Black object c. Equally
4. If the silver and black objects are originally at the same temperature and now are cooling down. Which of the following is true?
   a. The black object would cool down faster than the silver one
   b. The silver object would cool down the faster than black one
   c. Both objects would cool down at the same rate
5. Consider the same scenario as in question 4, except each object was in its own plastic container. Which of the following is true?
   a. The black object in its own clear, plastic container would cool down faster
   b. The silver object in its own clear, plastic container would cool down faster
   c. Both objects would cool down at the same rate

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Greenhouse Effect Laboratory Experiment

Oxana Pantchenko and Prof. Ali Shakouri

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ABSTRACT

In this lab, students will learn about the Greenhouse Effect and will demonstrate the concept of solar heating. Students will compare the rate of increasing temperature of an open container versus a closed container. They will also collect data comparing aluminum to the dark side of aluminum plates. Students will also compare the cooling off effect between the two plates.

INTRODUCTION

First constructed in the 1880s by Charles Fritts, solar cells allow the sun's energy to be converted into direct current electricity. Solar energy surrounds us in different forms and can be used in a variety of ways including: photovoltaics, solar heat, wind energy, hydroelectric energy and biogas. Today's most widespread applications for using regenerative energies are solar panels, wind power plants and hydro electric power plants.

LIST OF MATERIALS

- Solar box
- Plastic cover
- Aluminum Plate
- Cable assembly
- Multi-meter
- Rod stand

Figure 1 This is what your greenhouse box should look like. If you are missing part, please inform your TA.

PROCEDURE

1. Remove the thumbscrew on the aluminum plate. Place the thermistor lug underneath the center hole on the aluminum side of the plate. Insert the thumbscrew through the hole. On the black side, put the shadow indicator over the screw and tighten.
2. Place the aluminum plate inside the Solar Box, with the black side face up.
3. Snap the bottom and top tabs of the clear, plastic cover into the Solar Box

4. Connect an ohmmeter to the side jacks
5. Use the rod clamp to mount the base of the Solar Box to a rod stand.
6. Adjust the angle of the box such that the sun’s rays enter the box perpendicularly. Use the white knob indicator as a guide.
   Note: If there is no shadow on the plate, the sun’s rays are perpendicular to the plate.
7. Turn on the meter and take a resistance measurement. To find the temperature, use the resistance-to-temperature conversion chart in Appendix A.
   WARNING: overheating the box may permanently damage the thermistor and the plastic lid. The thermistor’s maximum temperature capacity is 135°C.
8. Mount the box with the plate to a rod stand, such that Sun’s angle is the perpendicular to the aluminum plate and the white plastic knob has no shadow. Keep the black side of the aluminum plate facing up.
9. Have a piece of cardboard available to shade the box while setting up.
10. With the plastic cover on, collect data every minute. Let the box heat until the temperature levels off. (The approximate duration is 10 to 30 minutes, depending on the outside temperature and the intensity of the sunlight.) Note: Watch the angle of the sun. The angle of the sun must be 90 degrees to the box while you are collecting data/ you might have it adjust the angle the box during the run.
11. Make a temperature vs. time plot.

12. Repeat step 10 with plastic cover off.
13. Make a temperature vs. time plot.

14. Record your observations. What do you conclude?

15. Look carefully at both curves at the start of the run. The slope (rate of heating) for the uncovered box should be larger than for the covered box. Why?

16. Which has the highest final temperature, the covered box or the uncovered box?

17. Which curve has a more consistent heating rate? Why?

18. Repeat steps 8 to 10. Compare the aluminum side up to the black side up with the cover on. Plot both curves on the same axis. Which surface is a better absorber of energy? Look at not only how fast the plate heats up, but collect data long enough to look at the final temperature. The black side should heat up much faster than the aluminum side, but does the black side reach a higher final temperature? Be sure to answer all the questions above.

EXTRA CREDIT

19. For both sides (aluminum and black), start with the plate hot (let it sit in the sun), and then move the plate to the shade to watch it cool.
    a. Which surface cools faster?
    b. Which is a better emitter of energy?
    c. Try cooling with and without the cover on the Solar Box.

Plot a graph temperature vs. time below.

Appendix A

Resist. (Ohms)	Temp (Cels)	Resist. (Ohms)	Temp (Cels)	Resist. (Ohms)	Temp (Cels)
32660	0	6808	34	1876	68
31040	1	6532	35	1813	69
29500	2	6268	36	1751	70
28060	3	6016	37	1693	71
26680	4	5776	38	1637	72
25400	5	5546	39	1582	73
24180	6	5326	40	1530	74
23020	7	5118	41	1480	75
21920	8	4918	42	1432	76
20880	9	4726	43	1385	77
19900	10	4544	44	1341	78
18970	11	4368	45	1298	79
18090	12	4202	46	1256	80
17260	13	4042	47	1216	81
16460	14	3888	48	1178	82
15710	15	3742	49	1141	83
15000	16	3602	50	1105	84
14320	17	3468	51	1071	85
13680	18	3340	52	1038	86
13070	19	3216	53	1006	87
12490	20	3098	54	975	88
11940	21	2986	55	945	89
11420	22	2878	56	916	90
10920	23	2774	57	889	91
10450	24	2674	58	862	92
10000	25	2580	59	836	93
9574	26	2488	60	811	94
9166	27	2400	61	787	95
8778	28	2316	62	764	96
8408	29	2234	63	742	97
8058	30	2158	64	720	98
7722	31	2082	65	699	99
7404	32	2012	66	679	100
7098	33	1942	67		

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