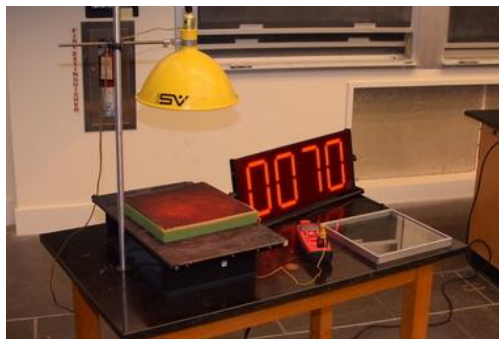




4B50.60/8A70.40 The Greenhouse Effect

4B50.60: To demonstrate the greenhouse effect.

8A70.40: To model the earth's atmosphere trapping thermal radiation from the sun.

DESCRIPTION: A heat lamp is aimed at a copper sheet, causing the temperature of the sheet and the air above it to increase until they reach equilibrium. Then, a glass tray is placed over the sheet, trapping a small pocket of air between the plate and the glass. With the glass tray to prevent the warm air near the sheet from mixing with the cooler air in the room, the system is able to reach a new, much higher equilibrium temperature.

SUGGESTED TECHNIQUE

Note: it takes a while for the air to reach a new equilibrium temperature after the glass tray is added, so it's best to start this demonstration at the beginning of class and return to it at the end.

1. The copper sheet will be brought to equilibrium in the absence of the glass tray before the demonstration. Note the equilibrium temperature on the large display.
2. Place the glass tray over the top of the copper sheet. Note that for the first four minutes, the temperature will drop because the glass tray is colder than the copper sheet.
3. Wait about 43 minutes for the air between the copper sheet and the glass tray to reach a new equilibrium temperature. Note that the new equilibrium temperature is higher than the original equilibrium temperature.

TECHNICAL DETAILS

LOCATION OF APPARATUS

EQUIPMENT	LOCATION
Glass Tray	Optics B
Copper Sheet and Foam	Thermo B
Thermocouple, Multimeter and Large Display	General Use F
Large Display Multimeter and Thermocouple	General Use D
Heat Lamp and 500 W Infrared Bulb	Optics A (or Blue Shelves Room 066)
Podium	Above General Use F

LOCATION OF COMMON ACCESSORIES

SETUP INSTRUCTIONS

Setup Time ~45 min

1. Screw an approximately 3 foot tall rod into one end of a table.
2. Use a right angle clamp to attach an approximately 2 foot long rod to the first rod.
3. Mount the heat lamp on the horizontal rod.
4. Position a podium under the heat lamp.
5. Set the foam square and the copper plate on the podium.
6. Adjust the height of the heat lamp such that it's 6-8 inches above the surface of the copper plate.
7. Plug the thermocouple into the multimeter. Note: either the small display multimeter and an external large display or the large display multimeter can be used as both have thermocouple options (see photos).
8. Set the multimeter to read temperature.
9. If you're using the small multimeter, plug it into the large display shown in the photo. Push RS232 to allow the large display to read the signal from the multimeter.
10. Sandwich the end of the thermocouple between the copper sheet and the foam.
11. Before class, turn on the heat lamp and bring the copper plate up to its equilibrium temperature.
12. Provide the glass tray.

[**LINK TO PICTURES**](#)

ADDITIONAL RESOURCES

REFERENCES

1. Climate change in a shoebox: Right result, wrong physics. AJP 78, p. 536 (2010):

The temperature rise observed in a popular classroom demonstration arises not from the radiative greenhouse effect responsible for global warming but primarily from the suppression of convective heat transport between CO₂ and air due to the density difference between the two. This density difference, much like the roof of a real greenhouse, suppresses gas mixing at the CO₂-air interface and therefore inhibits heat transfer. The magnitude of the radiative effect is more than an order of magnitude smaller and is difficult to demonstrate convincingly.