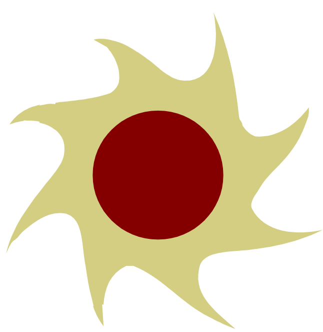
PASSIVE SOLAR HEATING



PASSIVE SOLAR HEATING
By Susan Grinstead

Level: Junior – Intermediate Gr. 7 - 12
Subject: Geography, Environment Sciences or Renewable Energies
Objective: to understand the concept of using solar radiation for passive solar heat
Concepts:

1. Gather Solar Radiation
2. Storage of Heat
3. Circulation and Distribution

Keywords:

azimuth	orientation
altitude	passive solar energy
circulation	solar noon
distribution	solar radiation
greenhouse effect	smog
heat sink or storage	thermo-mass

Lesson:
1. Gather Solar Radiation

The sun's azimuth (height) is introduced. The azimuth is 0* at dawn and dusk, and 90* at noon. The best time for gathering heat is at solar noon when the sun's rays strike the earth at 90* and there is less atmosphere to penetrate. Solar noon will vary according to the time zone. Thunder Bay's solar noon is 1 pm. Eastern Standard Time or 2 pm. Eastern Daylight Saving Time because it is located at the farthest western edge of the local time zone. The most efficient direction (orientation) for gathering solar heat is to face due south.

The sun's seasonal altitude can be looked at. Many children will have noticed that the sun casts long shadows in the winter and short shadows in the summer. This is due to the sun's varying altitude on the southern horizon at noon throughout the seasons. In Thunder Bay, the sun is approximately 20* altitude on the winter solstice, December 21st, but it is about 60* altitude on the summer solstice, June 21st. The most efficient season for gathering solar heat is the summer because the solar rays enter our atmosphere at a better angle and less solar radiation is reflected.

2. Storage of Heat

Long-wave solar radiation passes readily through glass but does not easily reflect back through it. The same condition explains the nature of the “greenhouse effect” on the earth caused by the burning of fossil fuels. The extra carbon in the air acts like a layer of glass or like a blanket.

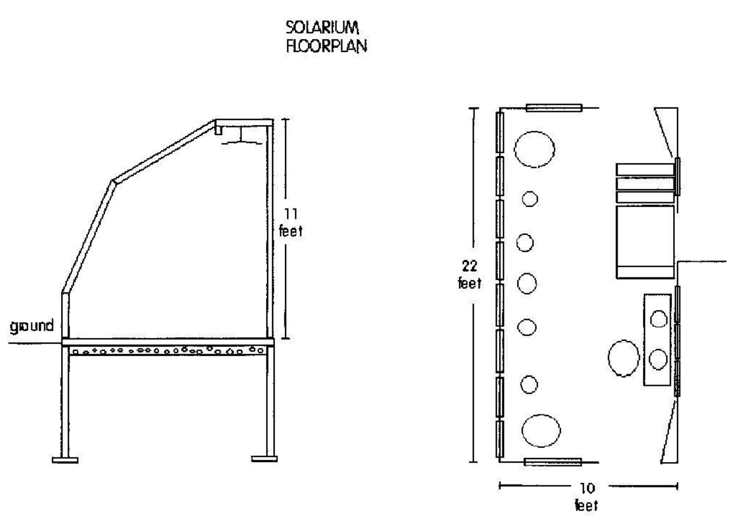
Different items heat up at different rates when exposed to sunlight. The longer a substance takes to heat up is directly related to how long that substance takes to cool down. The following is a list of thermo-mass or heat sink substances. They are in order from most to least efficient:

best - rock
brick
concrete
earth
wood
glass
worst - aluminum

Use the large drawing of the “SOLARIUM FLOORPLAN” addition to note the thermo-mass of the concrete floor and brick wall.

3. Circulation and Distribution

Warmed air is moved along by fans, air exchangers, vents, summer furnace switches and open windows. Use the “SOLARIUM FLOORPLAN” to show how the air is directed to the basement and main floor of the house through windows and vents into the forced-air heating system. “PASSIVE SOLAR AIR WALL” is included. Use examples of other solarium or solar wall pictures from the internet, magazines, etc.



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Activities:
1. Gather Solar Radiation
Touch Experiment 1*
Time: 10-15 minutes

Take the group outside and stand in the shaded north side of the building. Touch the bricks, glass window and aluminum window strips. Note the temperature felt when touching these items. Remain at least 5 minutes for your body to notice the temperature. This is also an ideal time to take the outdoor temperature in the shade.

Take the group to the south side of the building. Touch the bricks, glass window and aluminum window strips again. Note the temperature felt when touching these on the sunny side. Remain at least 5 minutes and take the air temperature again. There will be a noticeable difference if this is done in the early afternoon on a bright sunny day. This is an introductory example of the strength of solar radiation.

Other Experiments:
Time: 1 period each (45-55 minutes)

Perform “Measuring the Altitude of the Sun Experiment” to demonstrate the capacity to gather heat when the sun rays are more direct and not reflected due to the seasonal change.

Perform “Roof Overhang Experiment” to demonstrate the importance that shading has on the ability to reduce solar heat gain.

2. Storage of Heat
Touch Experiment 2*
Time: 10-15 minutes

Place a sample of the following items on the ground in full sunlight for several hours.

rock, brick, concrete, earth, wood, glass, aluminum
laser thermometer (optional)

If possible, have the group feel these items at solar noon and again later in the day to feel the comparison. If it is only possible to do this once, then do it later in the day to feel the storage of heat. The above items are listed in order of greatest capacity on the left and least capacity on the right. They can be placed in a mixed order and the group can discover and place them in order. The surface temperature of the objects can recorded with a laser thermometer to confirm their findings.

Other Activities:
Time: 2 or 3 periods (45-55 minutes each)

Perform research in the library, internet, neighbourhood excursions, etc. looking for examples of architecture that use the concept of storage of heat. Make posters, collages, presentations, etc.

3. Circulation and Distribution
Touch Experiment 3*
Time: 1 or 2 periods (45 mins.- 1.5 hrs.)

Visit a solarium or conservatory in your area.

View a power point presentation called "SOLARIUM: A Case Study".
View a power point presentation on Solar Air Heating by Renewable Energy Technologies (RET). http://www.retscreen.net/ang/g_solara.php

Draw and Label Diagram
Time: 15-20 minutes

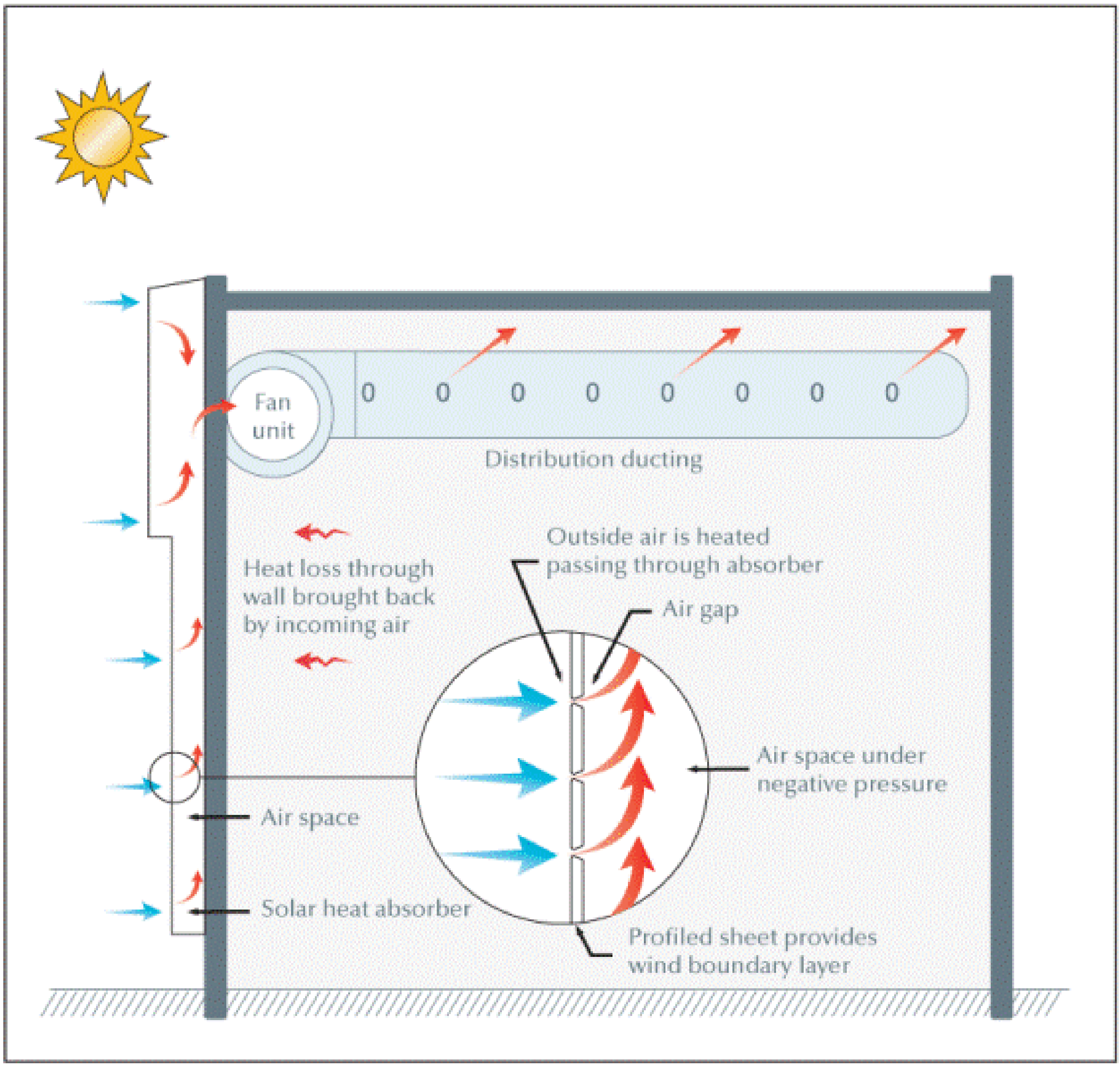
Use the "SOLARIUM FLOORPLAN" (included) to demonstrate the concepts of heat storage and circulation of air. Use it as a template for classroom copies, power point presentations, etc. You can make this activity simple or complex. The group can identify and label the 3 concepts:
G – gather solar radiation
S – storage of heat
C – circulation and distribution

Read through the speaker's notes and draw the solarium described. http://www.retscreen.net/ang/speakers_notes_passive_solar_heating_project_analysis.php

Resources
Foster, H. and Sewell, W.R.D. "Solar Home Heating in Canada: Problems and Prospects", Office of the Science Advisor, Report # 16, Department of Fisheries and Environment, Ottawa, 1977.
Grinstead, Susan "SOLARIUM: A Case Study", 2005.
Thunder Bay Conservatory, 1601 Dease Street, Thunder Bay, Ontario
www.cansia.ca
www.retscreen.net

PASSIVE SOLAR AIR WALL

RETScreen



www.retscreen.net

SOLARIUM FLOORPLAN