SOLAR THERMAL ENERGY

Materials
- aluminum plate (10,0 cm tall, 20,0 cm large, 0,05 cm thick)
- expanded polystyrene slab
- scotch tape
- nail
- wooden frame
- glass
- aluminiumm foil
- notebook
- graph paper
- pen

Instruments
- digital thermometer
- stopwatch
- balance
- rule or steel tape

Procedure 1
1. Take a small piece of alluminium foil and wrap it on the sensitive part of the digital thermometer. This will improve the thermal coupling between the thermometer and the alluminium plate.
2. Cut a piece of adhesive tape and use it to keep the thermometer as close as possible to the alluminium plate surface.
3. Take the aluminium plate and stick it on the polystyrene slab using the tape all along the borders making a sort of picture frame. The alumimium and the polystyrene will form a "sandwich" with the thermometer in between.
4. Take the nail and fix it by hand near the border of the polystyrene slab. The nail should be perpendicular to the polystyrene surface and will be used to orient your panel perpendicular to the solar rays.
5. Now you are ready to start the Experiment 1.

Experiment 1
You have to measure the temperature T vs time t, write down the values on a table and after having collected the data plot T (°C) vs t (min) on the graph paper.
1. Orient the panel so as the nail shadow disappears, that means the panel is perpendicular to the solar rays, this is the optimal position to collect as much energy as possible.
2. Write down the initial value of the temperature and push the start button on the stopwatch.
3. Every 30 sec write on your table time and temperature values.
4. Wait until the temperature stabilize (doesn't change anymore as time passes by).
5. Cover the panel, for example ask somebody to stand in front of it so as the sun rays do not reach the panel anymore, in the same time continue to collect the temperature and time data.
6. Now you will see the temperature decreasing due the heat dispersion. Wait until temperature goes down to the room temperature, continuing the data collection.

Data Analisys 1
1. Geometrically try to evaluate the two slopes of the temperature vs time graph at a given temperature, for example at 50 °C, one when the temperature increases (in the first part of the

experiment) and the other when the temperature decreases (in the second part of the experiment, after the plate has been obscured).

2. The two slopes correspond to the ratio ΔT over Δt that gives us an information about the power absorbed by the aluminium plate and the power disperded by the aluminium plate respectively.

3. The power absorbed $P_A = c\ m\ (\Delta T/\Delta t)$, where c is the specific heat, m the mass

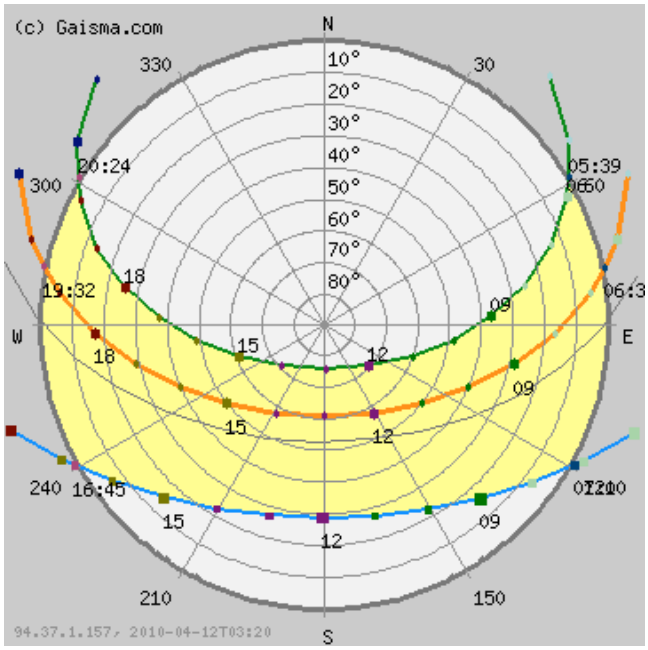
4. The power disperded $P_D = c\ m\ (\Delta T/\Delta t)$

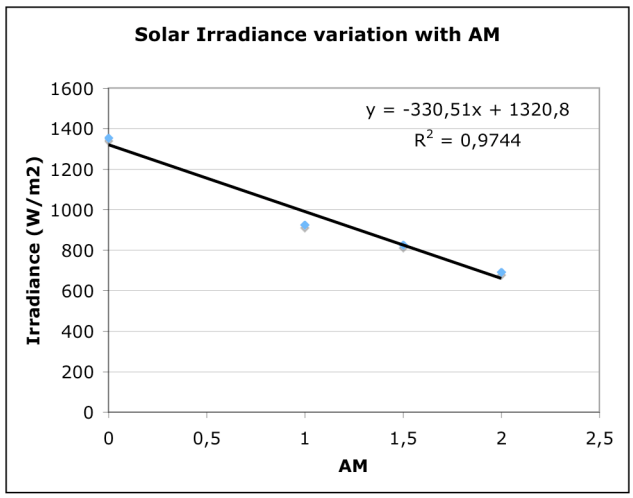
5. The solar power incident is given by: $P_I = P_A - P_D$

6. Considering the abosbtion coefficient *a* (0.9) we can correct $P = P_I/a$

7. Dividing by the surface S we can obtain the energy flux (or specific power), i.e. the energy per second and per square meter incident over the plate: $\Phi = P / S$

8. Compare such value with the estimate one which is about 1000 W/m^2 corrected considering the solar inclination.





Time variation of solar elevation and air mass factor in Catania the 12th of April

time	elevation	AM	solar irradiance
hh:mm	°		W/m^2
09:00	28,77	2,1	634
10:00	40,11	1,6	808
11:00	50,32	1,3	891
12:00	58,10	1,2	931
13:00	61,25	1,1	944
14:00	58,33	1,2	932
15:00	50,69	1,3	894
16:00	40,55	1,5	812
17:00	29,25	2,0	644