Practical 2 – Topic 7

Measuring the solar constant

Criteria assessed

- CE

This can also be a design experiment.

Materials needed

- Watch
- About five plastic containers of the same surface area (about 30×15 cm^2)
- Thermometers
- Ruler

What to do

- Place different quantities of water in the containers so that the depth h of the water in each is different. The minimum depth should be about 3 cm.
- Place the containers outside, in a place where they are exposed directly to the sun, preferably at noon when the sun is directly overhead (and the sky is clear!). Ideally the containers must be protected from any wind.
- Measure the temperature, θ, of the water in each container immediately before you take them outside. Ideally the initial temperature of the water should be a few degrees below the ambient air temperature outside.
- Measure the water temperature again after a fixed time, e.g. 30 minutes later, and so obtain the change in the water temperature $\Delta\theta$ for each container. Ideally the final temperature of the water should be a few degrees above the ambient air temperature outside – why is this desirable?

For each container, assuming that 30% of the incoming intensity is reflected and there are no other energy losses.

$$0.70 \times SAt = mc\Delta\theta$$
$$= \rho Ahc\Delta\theta$$

where S is the solar constant and c is the specific heat capacity of water.

$$\Delta\theta = \frac{0.70St}{\rho c}\frac{1}{h}$$

- Plot $\Delta\theta$ versus the 1/(water depth), $\frac{1}{h}$, and use your graph to obtain the solar constant S.

In your report you must concentrate on the main sources of errors and ways to reduce or eliminate them.