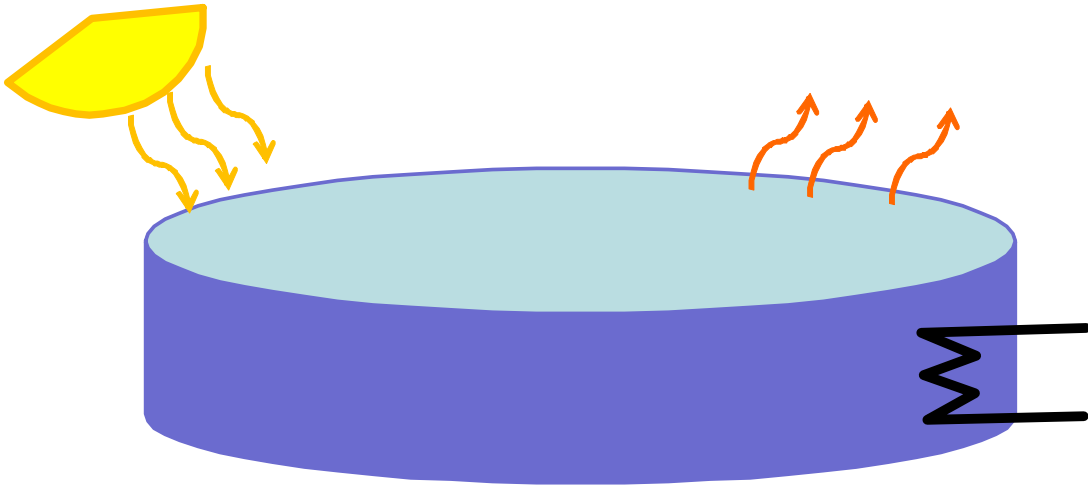
Given: $kJ := 1000J$ $MJ := 1000kJ$

A heater running off 120 V and 5 A with an efficiency of 70% is used to heat a pool. The pool loses heat at a constant rate of 120 W. Over the course of the day, the sun provides 500 kJ of heat over a 6 hour period.



Required:

Determine the rate of heating (or cooling) in the pool. What is the net energy gain (or lost) by the pool after the 6 hour sunny period?

Solution:

The supplied voltage, and current are defined as

$$V_s := 120V \qquad I_s := 5A$$

The heater efficiency is defined as

$$\eta_h := 70\%$$

The heat loss of the pool is defined as

$$Q'_{loss} := 120W$$

The heat provided by the sun is defined as

$$Q_{sun} := 500kJ$$

The time duration is defined as

$$\Delta t := 6hr$$

1st Law in rate form is

$$\frac{d}{dt}E_{sys} = \Sigma E'_{in} - \Sigma E'_{out}$$

The energy rate coming into the system is by way of the heater and the sun so

$$\Sigma E'_{in} := \eta_h \cdot V_s \cdot I_s + \frac{Q_{sun}}{\Delta t} = 443.148\ W$$

Solution (contd.):

The energy rate leaving the system is by way of the constant heat rate stated in the problem statement so

$$\Sigma E'_{out} := Q'_{loss} = 120\ W$$

The rate of heating of the pool may then be found by

$$E'_{sys} := \Sigma E'_{in} - \Sigma E'_{out} = 323.1\ W$$

The net energy gained by the pool in the time period is then

$$\Delta E_{sys} := E'_{sys} \cdot \Delta t = 6.98 \cdot MJ$$