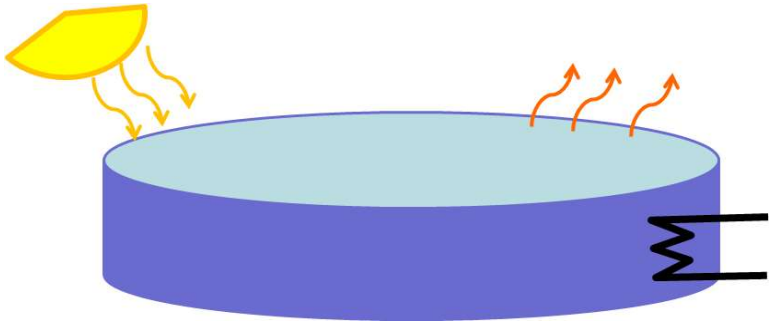
Given:

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

$V_s := 120\ \text{V} \quad I_s := 5\ \text{A}$

The heater efficiency is defined as

$\eta_h := 70\ \%$

The heat loss of the pool is defined as

$\dot{Q}_{loss} := 120\ \text{W}$

The heat provided by the sun is defined as

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

The time duration is defined as

$\Delta t := 6\ \text{hr}$

1st Law in rate form is

$$\frac{\mathrm{d}}{\mathrm{d}\ t} E_{sys} = \dot{\Sigma E}_{in} - \dot{\Sigma E}_{out}$$

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

$$\dot{\Sigma E}_{in} := \eta_h \cdot V_s \cdot I_s + \frac{Q_{sun}}{\Delta t} = 443.1\ \text{W}$$

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

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

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

$$\boxed{\dot{E}_{sys} := \dot{\Sigma E}_{in} - \dot{\Sigma E}_{out} = 323.1\ \text{W}}$$

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

$$\boxed{\Delta E_{sys} := \dot{E}_{sys} \cdot \Delta t = 6.980\ \text{MJ}}$$