APES Energy lab-solar thermal panel

Here's our solar thermal panel setup:

Lab process:

- Cool water enters the bottom right, control the flow with the valve
- Hot water (CAUTION!) comes out the upper left
- Temperature is measured (in °F, so you will have to calculate °C) by the meter under the upper left corner, unless you use the

neato infrared thermometer (small yellow unit)

- Flow will be calculated by recording the time needed to fill a 1 liter container
- Turn on the hose under the stairs to begin, and do this when the sun is shining (boring otherwise, but not hopeless)
- Things to measure:
  - temp in (convert to °C if needed)
  - temp out (convert to °C if needed)
  - time to fill container (seconds)
  - capacity of container (liters)
  - Area of the panel in m2 (length x width, using a meter stick NOT A YARDSTICK)
  - solar radiation in Watts/m2 during your test (look on the weather station or 10.14.58.3)
- Make sure you are not covering the panel with your shadow, be like a ninja (invisible)
- Make two runs: one with the water slow, one with the water faster, recording everything both times

Metrima temperature meter:

- hold the grey button for 5 seconds
- push until you see “20” in the window
- push again to get 22 (hot temp in °F)
- push again to get 23 (cool temp in °F)
- You may also use an infrared camera or sensor to verify these

Your Calculations:
We want power in Watts from this panel, and panel efficiency
If we know the area of the panel, and the solar insolation (note spelling):
area x solar insolation = ideal power in Watts
length in meters: _____m
width in meters: _____ m
area in m^2: _____m^2
solar insolation: _____W/m2
ideal power: _____Watts
Efficiency: _____%

Cloudy day option:
length in meters: _____1.2_____m
width in meters: _____2.2_____ m
area in m^2: _____m^2
solar insolation: _____800_____W/m2
ideal power: _____Watts

Calculating Power:
Power collected from the panel is more complex:
$Q = mc\Delta t$
Q is in calories
m is in grams
c is 1.00 (water)
Δt is change in temp in °C
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mass of water ____1000_____ grams
cool temp (°F) _____68_____
cool temp (°C) _____
hot temp (°F) _____98_____
hot temp (°C) _____
change in temp _____ °C
Calories x 4.18 = Joules _____ Joules
Time to collect this water _____37____seconds
joules/seconds = Watts: _____Watts
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Divide actual power by ideal power x100 to get panel efficiency:

actual power: _____W
real power: _____W
efficiency: _____%

Questions:

1. What was the highest efficiency of the solar thermal panel and at what flow rate?
2. How could you optimize this automatically?
3. What do you think orientation has to do with this?
4. If this panel cost you $1000 and lasted for 30 years producing this amount of energy each day, how much money would it make you total? (use $0.42/kWh)
5. How long would it take to pay it off?