Efficiency of Boiling Water

Purpose: To estimate the efficiency of our household appliances in order to make a cup of tea

Procedure:

1) Measure an amount of water that you are going to boil. (If you are using cup measurements at home you can use THIS converter to convert "cups" to mL). You can measure any amount of water, but my recommendation is between 250mL and 600mL.
2) Measure the temperature of the water. If you do not have a thermometer, assume the temperature of the water is the same temperature as your house (check your thermostat in your house)
3) Begin to boil the water. You have two options:
    a) If you are boiling the water with a stovetop & pot (it would look LIKE THIS), or a kettle (it will look LIKE THIS) assume the power rating of your stovetop is 950W
    b) If you are boiling the water with a plug-in kettle (it would look LIKE THIS), the power rating (in Watts) will be written on the bottom of the kettle.
4) Measure (in seconds) how long it takes for the water to reach boiling point (100 ^{O}C).
    - If you are using an electric kettle, it will automatically shut off
    - If you are using a kettle on a stovetop, it will start whistling
    - If you are using a pot of water, it will turn into a rolling boil (it will look LIKE THIS)
5) Make yourself a cup of tea to enjoy while you solve the calculations below:

Data Table: (10 marks)

Amount of water used (in L)	0.75L
Power rating of Kettle/Stovetop (in W)	1500W
Initial temperature (in ^{O}C)	21^{O}C
Final temperature (in ^{O}C)	100^{O}C
Time for boiling (in sec)	241s

Calculations:

1) What formula represents the W_{in}? (1 mark)
   $P = W_{in} / t$
   $W_{in} = Pt$

2) What is the energy input into the system (in J)? (2 marks)
   $E_{in} = Pt$
   $E_{in} = (1500W) \times (241s)$
   $E_{in} = 361{,}500\ J$

3) What is the formula for the W_{out}? (1 mark)
   $W_{out} = M_{CP} \Delta T$

4) What is the energy (W_{out}) absorbed by the water (in J)? (2 marks)
   $Q_{out} = MC_P \Delta T$
   $Q_{out} = (0.75\ kg)\ (4{,}200\ J/kg/C)\ (100^{O}C - 21^{O}C)$
   $Q_{out} = (0.75\ kg)\ (4{,}200\ J/kg/C)\ (79^{O}C)$
   $Q_{out} = 248{,}850\ J$

5) What is the efficiency of the process? (2 marks).
   $Efficiency = (W_{in} / W_{out})\ 100$
   $Efficiency = (248{,}850\ J / 361{,}500\ J)\ 100$
   $Efficiency = (0.69)\ 100$
   $Efficiency = 69\%$

6) Give one reason why might this process be less than 100% efficient? (2 marks)
   This could be because energy is lost through the kettle making noise and through vapour escaping.
   Note: The actual water temperature was significantly lower than the room temperature because tap water was used.