Approach

The approach below gives a guideline in how to solve the problems presented during this course. Correctly applying this approach will lead to a good understanding of the concepts presented in this course.

Analysis

1. Explain the problem: which physical phenomena are important in this problem?

2. Make a sketch of the problem

3. Give the known variables (with the appropriate units!)

Approach

1. Explain the assumptions you make to solve the problem

2. Show the solution method for solving the problem

Elaboration

1. Show the calculation steps and explain the equations you use

2. Give references if values are found online or in tables

Evaluation

1. Check the units of your solution

2. Is the answer realistic/expected?

3. Did you answer all the questions asked?

4. Iterate if this is required

Assignment 1

Consider an electric kettle like the one shown below. In this kettle, electrical energy is converted to heat by use of a heating coil. The kettle has a power of 2200 W.

In this assignment we will make some calculations on the heating of water. Please state the assumptions you make, the values you have used and the correct dimensions.

Suppose we want to make a large pot of tea (1000 mL). We turn on the kettle for 20 seconds. The starting temperature of the water is 20 °C.

a) What is the temperature increase of the water inside the kettle?

b) If we want to bring this water to a boil, how long will this take? Clearly state the assumptions you make.

c) If the applied voltage to the wires is 230 V, what would be the current through the heating coil? Also determine the electrical resistance.

Another way to heat the water is to put a pan on a gas fired stove. The chemical energy of natural gas is 32 MJ/m^3. A cubic metre of natural gas costs 0.79 euro, a kWh of electricity costs 0.22 euro.

d) How many liters of gas do you need to boil the water? Clearly state the assumptions you make.

e) Determine which of the methods is cheapest.

The production and usage of electricity and gas is bad for the environment. Therefore, new methods for boiling water are researched. One option is presented by a local gym, which has a machine called 'the step climber'. For this machine, a person walks a stairs by way of exercise, moving his full body weight a step higher every time. By attaching a dynamo on the machine, the mechanical energy is turned into electrical energy, which powers the kettle.

f) A group of 8 men is walking on the step climber. Determine the vertical distance they need to cover per person to provide the kettle with enough energy.

   The total amount of energy they need to

Now suppose the bikes inside the gym are attached to dynamos as well. A man riding the bike wants to boil his water within 5 minutes.

g) Determine the minimal amount of power needed to boil the water.

h) Is this a reasonable power that can be generated on a bike? If so/if not, please state why and give references to used information.