**Percent Efficiency Problems**

**% Efficiency = E out x 100**

**E in**

**The energy in is usually electrical energy. E = Pt**

**The energy out is usually heat energy. Q = mc∆T**

**Every electrical appliance will "lose" energy as heat energy because of the friction between the electrons and the metal atoms of the wire. You want this to happen with a curling iron, kettle, radiator etc. This is the energy out or the useful energy.**

**But...the energy out can be mechanical energy, sound energy, light energy etc. It depends on what you want the appliance to do--mix your cookie dough, provide you with music or videos...**

**So in a problem, read the English and figure out whether you are dealing with electrical energy in or heat energy out (or some other type of energy you want) or are you dealing with the energy lost?**

**If the appliance is considered 100 % efficient then: E in = E out**

**Pt = mc∆T**

**Remember: a lot of these formulae will not be given!!!**

**No appliance is 100 % efficient but we live in General Science where such things happen!!**

**Please!! Make a list of all your variables with units. Write down all formulae. Re-arrange said formulae!!**

1

An experiment yields the following data:

|  |  |
| --- | --- |
| resistance of coil | 2.0 Ω |
| potential difference | 12.0 V |
| elapsed time | 30.0 min |
| mass of water | 2.50 × 102 g |
| specific heat of water |  |
| initial temperature | 85.0°C |
| final temperature | 100.0°C |
|  |  |

Calculate the percent efficiency of the energy conversion.

2

To find the efficiency of a 600.0 W microwave oven you carry out the following procedure:

You measure 150.0 g of water into a Styrofoam cup. You place the cup in the microwave oven and heat it for one minute. The water temperature rises from 23.0 °C to 70.0 °C.

Calculate the thermal energy absorbed by the water, the electrical energy consumed by the microwave oven, and hence the percentage efficiency of the oven.

3

You have at your disposal an electric calorimeter. You connect it to a 6.0 V battery and find that the current is 1.75 A. The temperature of 152.0 g of water in the calorimeter increases by 10.0°C after 10.0 minutes.

Does this transformation obey the law of conservation of energy i.e. is this device 100 % efficient?

4

A calorimeter (this time it is 100 % efficient) contains 120.0 g of water at a temperature of 22.0 °C. After the calorimeter was on for 10.0 minutes, the water reached a temperature of 27.0 °C.

How much heat energy was absorbed by the water?

5

You heated water in an electric calorimeter and made the following observations:

Mass of the water: 250.00 g

Initial temperature of the water: 18.0 °C

Final temperature of the water: 43.0 °C

Length of time current flowing: 10.0 min

Potential difference: 12.0 V

What current intensity (*I*) flowed through the calorimeter?

6

A calorimeter contained 250.0 g of water at 24.0 °C. An electric current was passed through a heater placed in the water. The heater transferred 14 700 J of energy to the water.

What is the final temperature of the water?

|  |  |  |  |
| --- | --- | --- | --- |
| A) | 14.0°C | C) | 58.8°C |
| B) | 38.0°C | D) | 82.8°C |

7

A water tank contains 200.0 kg of water. The water is heated by a 4500-W heating element

How much energy is required to raise the temperature of the water from 15.0 °C to 60.0°C?

|  |  |  |  |
| --- | --- | --- | --- |
| A) | 37 710 kJ | C) | 62 850 kJ |
| B) | 50 280 kJ | D) | 202 500 kJ |

8

The table below gives information about the antifreeze in a car’s cooling system.

|  |
| --- |
| Mass: 5 000. g  Initial temperature: 5.0 °C  Specific heat capacity: 2.2 J/(g•°C) |

When the car is running, this mass of antifreeze absorbs 935 000 J.

What will be the final temperature of the antifreeze?

|  |  |  |  |
| --- | --- | --- | --- |
| A) | 80.0 °C | C) | 90.0 °C |
| B) | 85.0 °C | D) | 411.0 °C |

9

A hot water tank is installed in a new house. The resistance of its heating cable is 5.0 Ω and it is immersed in a certain volume of water at a temperature of 20.0 °C as illustrated below :



When a 2.0 A current is allowed to run through the cable for a period of 5.0 minutes, the temperature of the water increased to 26.0 °C.

What is the quantity of water, in grams, in the hot water tank?

10

A current of 1.0 A flows through the heating element of a calorimeter. The calorimeter operates for 30.0 minutes. The potential difference is 20.0 V.

**If energy is conserved**, what is the increase in temperature of the 100 g of water in the calorimeter?

|  |  |  |  |
| --- | --- | --- | --- |
| A) | 1.4 oC | C) | 143.2 oC |
| B) | 85.9 oC | D) | 360 oC |

11

Juliana returned to her summer cottage after a long winter. For safety reasons, and to reduce energy costs, she had turned off the water heater in her absence. The temperature of the water in the heater is now 40.0 °C. The water heater has a total capacity of 180. L and operates with a current intensity of 20.0 A and potential difference of 220. V.

How much time will Juliana have to wait before taking a shower, if she wants the water temperature to be 60.0 °C?

|  |  |
| --- | --- |
| A) | 20.2 minutes |
| B) | 57.1 minutes |
| C) | 114.3 minutes |
| D) | 171.4 minutes |

12

Before leaving for work, your father asks you to warm up the car. The outside temperature is −10.00°C and the block heater, having a power of 1000. W, contains 1.50 litres of antifreeze (ethylene glycol).

Determine the amount of time required for the antifreeze to reach a temperature of 48.00 °C.

The density of ethylene glycol is 1.11 g/mL and *c*ethylene glycol = 2.21 J/g•°C.