**EFFICIENCY**

Setting out is really important and marks are allocated as to how you set out your answers.

.

The steps you should use to complete all calculations are as follows:

Step 1: Write down what you need to find.

Step 2: Write down the information given.

Step 3: Select the appropriate equation from the Formula And Data Sheet and write this down

Step 4: Substitute the given quantities into the equation

Step 5: Simplify the equation

Step 6: Express the answer in the appropriate units and significant figures

Efficiency (%) = Output Energy x 100

Input Energy

Efficiency applies in the area of heating and cooling when energy is transferred from one substance to another or energy is converted from one form into another.

**Example 1**:

Find the efficiency of an electric kettle if 500 J of electrical energy is converted into 350 J of heat energy.

Solution:

Efficiency = ? Input Energy = 500 J Output Energy = 350 J

Efficiency (%) = Output Energy x 100

Input Energy

= 350 x 100

500

= 70 %

**Example 2**

2.00 L of water is placed in a plastic kettle and the element is switched on. If the element operates at 1000 W and at 90 % efficiency for 10 s and assuming no heat transfer to the kettle, find the rise in the water temperature.

Solution

P = 1000 W t = 10 s Efficiency = 90 % m = 2 L = 2 kg C = 4180 J kg-1 K-1  ΔT = ?

Q = E = P x t = 1000 x 10 = 10000 J

If 90 % efficiency then only 90 % of Q is transferred

Qeffective = 90 x Q = 90 x 10000 = 9000 J

100 100

Q = m x C x ΔT

9000 = 2 x 4180 x ΔT

ΔT = 9000 = 9000 = 1.08 K

2 x 4180 8360

**Example 3**

The element of an urn operates at 2.00 kW in heating water. If 1.00 L of water is placed in a copper urn with a copper element (total mass = 1.00 kg). The water was originally at 0 o C. and reached 100 oC in 3600 s. What is the efficiency of the element? (Cwater  = 4200 J kg-1 K-1  Ccopper = 400 J kg-1 K-1 )

Solution

Find the input energy

P = 2 kW = 2000 W t = 3600 s Qinput  = ?

Qinput = P x t = 2000 x 3600 = 7200000 J

Find the output energy

Mwater  = 1 l = 2.00 kg Mcopper  = 1.00 kg

Cwater = 4200 = 4200 J kg-1 K-1  Csopper = 400 J kg-1 K-1

ΔT = 100 - 0 = 100 K ΔT = 100 - 0 = 100 K

Qoutput = Mcopper x C copper x ΔT + Mwater x C water x ΔT

Qoutput = 1 x 400 x 100 + 2 x 4200 x 100

Qoutput = 40000 + 840000

Qoutput = 880000 J

Find the efficiency

Efficiency (%) = Output Energy x 100

Input Energy

= 880000 x 100

7200000

= 12.2 %