**Deriving the function for thermal energy change over time**

**Radiation into empty space:**

From the Stefan-Boltzmann law we know that the rate of energy change due to thermal radiation is given by:

Where e is energy, t is time, A is surface area, ε is emissivity, σ is the Stefan-boltzmann constant and T is temperature.

We also know that the thermal energy responsible for T is:

Where m is mass and C is the specific heat capacity of the material. It turns out that C actually depends upon T, but for simplicity we will assume it is constant.

Combining the above we get:

For simplicity let us assume that

so this simplifies to:

this rearranges to

If we integrate both sides by t:

so

To find the value of c, we need to give the value of e for a particular value of t. For instance, we can know that at time t = 0, the energy of the object was its starting energy, e0.

Combining the above we get:

This can be rearranged to give e as a function of t:

Finally, we reinsert the values for z:

**Conduction from one body into another**

Let us assume that:

Where e is the thermal energy of an object, t is time, k is the thermal conductivity of that object, A is the size of the contact area with another object, T0 is the temperature of the object and T1 is the temperature of the object it is touching.

We can replace the T’s with e’s to give:

where m is mass and c is the thermal heat capacity. If we assume there is no energy loss to outside sources then:

so:

which can be re-arranged to:

therefore:

This integrates to:

which simplifies to:

because we know the starting thermal energy, we can say that when t = 0, e0 = E0, so:

therefore

putting this back into the formula we get: