CLIL (Content and Language Integrated Learning)

A CLIL MODULE OF PHYSICS

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TITLE : *The equivalent mass of the calorimeter*

AIM: To determine the water equivalent of a given calorimeter

KEY WORDS: heat, temperature, thermal capacity, specific heat, calorimeter, equivalent mass.

See the video …

http://www.youtube.com/watch?v=dON9i_iSBsQ

THEORY: The *heat* is a kind of energy linked to the movement of atoms or molecules inside the matter. The unit of measure that defines it is the joule, but it can be also measured by the caloria (the necessary heat that 1g of water needs to increase of a degree its temperature from 14,5°C to 15,5°C) that is the equivalent of 4,186 J.

When an object increases its *temperature* of ΔT absorbing an heat amount ΔQ, between these two values there is a constant of proportionality called thermal capacity:

$$\Delta Q = C \cdot \Delta T$$

If we consider the *thermal capacity* in the unit of mass like, for example, the mole, we are talking about the molar *specific heat*, that is the property of a substance indicating the relationship between the variation of heat and the variation of temperature in a transformation.

If we consider an homogenous substance, the specific heat is:

$$c = \Delta Q / (\Delta T \cdot m)$$

It can be used the *calorimeter* (fig. 1 and fig. 2) to measure the specific heat of a substance.

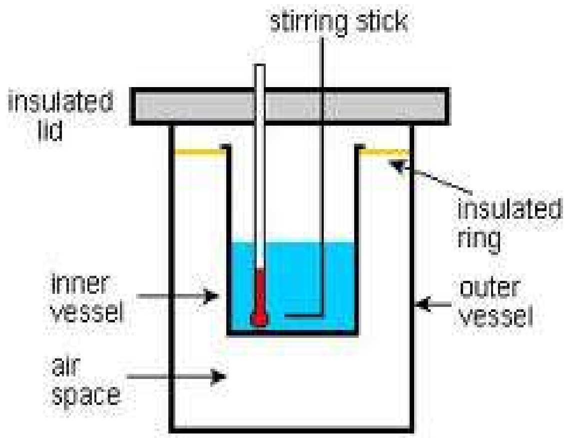

Figure 1: schematic drawing of the calorimeter

Figure 2: photo of the calorimeter

The instrument that we use during the experiments is made by a Dewar vase (a thermos flask), by a plastic support, a synthetic cover (lid) and a mixer (agitator, stirrer). A Dewar vase has the capacity of about 300 cm^3 and a reflecting silver-plated wall in order to reduce the heat leak (the dispersion of heat)because the energy isn't transmitted only by conduction, but also by radiation, i.e. by elettromagnetics waves).

The cover has two holes, one for the agitator and one for the thermometer, necessary for the survey of the temperatures.

Before proceeding with an experiment, it is neccessary to consider that the instrument can be not perfectly insulating and it would influence the exchanges of energy by absorbing heat.

So we have to estimate the so called "*equivalent mass of the calorimeter*": it is an imaginary mass of water which absorbs as much as the set of parts of the calorimeter. This mass has to be considered in the heat balance.

FOCUS

THE EQUIVALENT MASS IS : an imaginary mass of water which absorbs as much as the set of parts of the calorimeter.

If we mix two masses of water one of which (M1) is at room temperature (T1) and the other one (M2) hotter (T2), they get the equilibrium (Tf).

The heat that one mass releases (Qr) is absorbed by the other one (Qa), but also the calorimeter absorbs and therefore we must add the *equivalent mass (*Meq). It remains the only unknown factor in the equation.

Being the c of H_2O equal to 1, using cal/g·C:

$$Qr = Qa$$

$$Qr= M2 \cdot (T2-Tf)$$

$$Qa=(M1 + Meq)\cdot (Tf-T1)$$

$$M2\bullet (T2-Tf)= (M1+Meq) \bullet (Tf-T1)$$

$$Meq= [M2 \bullet (T2-Tf)/ (Tf-T1)] – M1$$

See the Calorimetry - Water equivalent of the calorimeter.mp4video ...

http://www.youtube.com/watch?v=P_29z_29m-Y

PROCEDURE:

- Insert a mass M1 of water at room temperature.

- Heat a second mass M2 of water up to about 70 Celsius degrees.

-Blend them.

- Measure the final temperature of equilibrium.

-Calculate the equivalent mass of the calorimeter.

TABLE :

M1(g)	M2[g]	T1[C]	T2[C]	Tf[C]	Meq[g]
					#DIV/0!

CONCLUSION: There are certainly accidental errors in the experiment, because of the heat exchange with the room.

Sources

http://www.physicsclassroom.com/class/thermalP/u18l2c.cfm

http://www.robertobigoni.eu/Fisica/Studenti/Tosi/documenti/relazione_ing.htm