Calculation with LaTeX by means of CalcTeX

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Contents

1 Calculation with LaTeX

This folder consider couples of examples – all files `*-calc.tex` in LaTeX input format with defined operations that are included in a single pdf document with calculated operations by means of CalcTeX package.
For received a final calculation of all `*-calc.tex` files please use a LINUX prompt command: `sh go`.
For more info please visit a web page on: http://sg.bzip.pl/CalcTeX or contact me by e-mail: CalcTeX (at) onet (dot) eu
I am open for any kind of questions or commands.
The file "`1st-example-ke-eng-calc.tex`" is the simplest and I recommend this file for study of CalcTeX used at first.
The file " http://sg.bzip.pl/CalcTeX/example/all-in-one.tgz " consider all necessary files for calculation of this example if you have installed a LaTeX compiler and python language as well it's checked for LINUX system.
All files which suits to mask `*-iso-calc.tex` are autamaticlly calulated and included into single pdf format document in order to `ls *-calc.tex` comment and for calulation are included all `python` files available on `bin/py` folder. This following example based on calculation available on
http://blowers.chee.arizona.edu/cooking/heat/ex11.html

1.1 Water/Bucket system

There is $V_w := 6 \cdot \mathrm{l}$ (liters) of water ($\rho_w := 998 \cdot \mathrm{kg/m^3}$) in a $m_b := 750 \cdot \mathrm{gm}$ bucket. The initial temperatures of the water and bucket are $T_w := 60 \cdot {}^\circ\mathrm{C}$ and $T_b := 22 \cdot {}^\circ\mathrm{C}$ respectively. The heat capacity of water is $c_w := 4.2 \cdot \mathrm{kJ/(kg \cdot {}^\circ C)}$ and the heat capacity of the bucket is $c_b := 910 \cdot \mathrm{J/(kg \cdot {}^\circ C)}$. Determine the final temperature of the water/bucket system.

1.1.1 Calculation Water/Bucket system

First we must determine what is going on in this problem. There is heat that is being transferred. The heat moves from the water to the bucket since the water is at a higher temperature and heat flows from hot to cold. The temperature of the water will decrease as more heat is transferred while the temperature of the bucket will increase as more heat is transferred. Eventually, the water and the bucket will reach the same final temperature. Even though heat is still being transferred, it is transferred equally now, from the water to the bucket and vice versa. In order to determine this final temperature, the following equation must be used:

$$\Delta Q_s = m_s \cdot c_s \cdot \Delta T \tag{1}$$

Recall that ΔQ_s is the amount of heat lost or gained. We want to know the final temperature of the system, and we have determined that occurs when the amount of heat transferred from the water to the bucket equals the amount of heat that is transferred from the bucket to the water. We will set ΔQ_s for the water to the bucket equal to ΔQ_s for the bucket to the water.

$$-\Delta Q_w = \Delta Q_b \tag{2}$$

where:
ΔQ_w heat transferred from the water to the bucket,
ΔQ_b heat transferred from the bucket to the water.
Since heat is lost from the water and gained by the bucket, the sign for ΔQ_w is negative and the sign for ΔQ_b is positive. Plugging in the definition of ΔQ_s gives the following equation

$$-m_w \cdot c_w \cdot (T_f - T_w) = m_b \cdot c_b \cdot (T_f - T_b) \tag{3}$$

$$-m_w \cdot c_w \cdot T_f + m_w \cdot c_w \cdot T_w = m_b \cdot c_b \cdot T_f - m_b \cdot c_b \cdot T_b \tag{4}$$

$$+m_w \cdot c_w \cdot T_w + m_b \cdot c_b \cdot T_b = m_b \cdot c_b \cdot T_f + m_w \cdot c_w \cdot T_f \tag{5}$$

$$+m_w \cdot c_w \cdot T_w + m_b \cdot c_b \cdot T_b = T_f \cdot (m_b \cdot c_b + m_w \cdot c_w) \tag{6}$$

Mass of the water

$$m_w := \rho_w \cdot V_w; \quad m_w \cdot \mathrm{kg}^{-1} = 5.988$$

where:

$m_w \cdot \mathrm{kg}^{-1} = 5.988$	–	mass of the water,
$c_w \cdot (\mathrm{kJ}/(\mathrm{kg} \cdot {}^{\circ}\mathrm{C}))^{-1} = 4.2$	–	heat capacity of the water,
$m_b \cdot \mathrm{kg}^{-1} = 0.75$	–	mass of the bucket,
$c_b \cdot (\mathrm{kJ}/(\mathrm{kg} \cdot {}^{\circ}\mathrm{C}))^{-1} = 0.91$	–	heat capacity of the bucket,
$T_w \cdot {}^{\circ}\mathrm{C}^{-1} = 60.0$	–	initial temperature of the water,
$T_b \cdot {}^{\circ}\mathrm{C}^{-1} = 22.0$	–	initial temperature of the bucket,
T_f	–	the final temperature of the system.

All of the variables in this equation are known from the problem statement, except the final temperature (T_f). This is the variable that we want to solve for. Solving the above equation for T_f gives

$$T_f := \frac{m_w \cdot c_w \cdot T_w + m_b \cdot c_b \cdot T_b}{m_w \cdot c_w + m_b \cdot c_b}; \quad T_f \cdot {}^{\circ}\mathrm{C}^{-1} = 58.996016584$$

Please note that in our problem we are using a temperature in °C and heat capacity in J/(kg · °C) gennerally is more safe to use a temperature in K. Additionally, the heat capacity have the same value in J/(kg · °C) and in J/(kg · K), for example:

$$\left(c_w \cdot \left(\frac{\mathrm{kJ}}{\mathrm{kg}\cdot{}^{\circ}\mathrm{C}}\right)^{-1} = 4.2\right) = \left(c_w \cdot \left(\frac{\mathrm{kJ}}{\mathrm{kg}\cdot\mathrm{K}}\right)^{-1} = 4.2\right)$$

Answer: The final temperature of the water/bucket system is roughly $T_f \cdot {}^{\circ}\mathrm{C}^{-1} = 59.0$.

1.1.2 Source – 2nd-bucket-eng-iso-calc.tex

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This following example based on calculation available on \\
\linkurl{http://blowers.chee.arizona.edu/cooking/heat/ex11.html}{http://blowers.chee.arizona.edu/cooking/heat/ex11.html}

\Task{Water/Bucket system}

There is  $V_w:=6\cdot \liter$ (liters)
of water  $"("\rho_w:=998 \cdot \kg/\m^3
")"$ in a $m_b:=750 \cdot \gm$ bucket.
The initial temperatures of the water and bucket are
$T_w := 60 \cdot \oC$ and $T_b := 22 \cdot \oC$
respectively.
The heat capacity of water is
$c_w:= 4.2 \cdot \kJ/(\kg\cdot \oC)$
and the heat capacity of the bucket is
$c_b:= 910 \cdot \J/(\kg\cdot \oC)"."$
Determine the final temperature of the water/bucket system.

\Calculation{Water/Bucket system}

First we must determine what is going on in this problem.
There is heat that is being transferred. The heat moves from the water to the
bucket since the water is at a higher temperature and heat flows from hot to cold.
The temperature of the water will decrease as more heat is transferred while the
temperature of the bucket will increase as more heat is transferred. Eventually,
the water and the bucket will reach the same final temperature.
Even though heat is still being transferred, it is transferred equally now,
from the water to the bucket and vice versa. In order to determine this final
temperature, the following equation must be used:

\begin{equation}"
\Delta Q_s = m_s \cdot  c_s\cdot  \Delta T"
\end{equation}

Recall that $"\Delta Q_s"$ is the amount of heat lost or gained.
We want to know the final temperature of the system,
and we have determined that occurs when the amount of heat transferred
from the water to the bucket equals the amount of heat that is transferred
from the bucket to the water. We will set $"\Delta Q_s"$ for the water to the bucket
 equal to $"\Delta Q_s"$ for the bucket to the water.

\begin{equation}"
-\Delta Q_w = \Delta Q_b
"\end{equation}

where:
\\
$"\Delta Q_w"$  heat transferred from the water to the bucket,\\
$"\Delta Q_b"$  heat transferred from the bucket to the water.\\

Since heat is lost from the water and gained by the bucket,
the sign for $"\Delta Q_w"$ is negative and the sign for
$"\Delta Q_b"$ is positive.

Plugging in the definition of $"\Delta Q_s"$ gives the following equation
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\begin{equation}"
-m_w \cdot c_w \cdot(T_f-T_w) = m_b\cdot c_b \cdot(T_f-T_b)
"\end{equation}
\begin{equation}"
-m_w \cdot c_w \cdot T_f + m_w \cdot c_w \cdot T_w =
 m_b \cdot c_b \cdot T_f - m_b \cdot c_b \cdot T_b
"\end{equation}

\begin{equation}"
+ m_w \cdot c_w \cdot T_w + m_b \cdot c_b \cdot T_b=
 m_b \cdot c_b \cdot T_f +m_w \cdot c_w \cdot T_f
"\end{equation}

\begin{equation}"
+ m_w \cdot c_w \cdot T_w + m_b \cdot c_b \cdot T_b=
T_f\cdot ( m_b \cdot c_b  + m_w \cdot c_w)
"\end{equation}

Mass of the water
\[
m_w:=\rho_w\cdot V_w
";\;\;\;\;"
m_w\cdot \okg
\]

where:\\
\begin{tabular}{lcl}
$m_w\cdot \okg$ &--& mass of the water,\\
$c_w\cdot \left(\kJ/(\kg\cdot \oC) \right)^{-1}$
                &--& heat capacity of the water,\\
$m_b\cdot \okg$ &--&mass of the bucket,\\
$c_b\cdot \left( \kJ/(\kg\cdot \oC) \right)^{-1}$
                &--& heat capacity of the bucket,\\
$T_w\cdot \ooC$ &--& initial temperature of the water,\\
$T_b\cdot \ooC$ &--& initial temperature of the bucket,\\
$"T_f"$         &--& the final temperature of the system.
\end{tabular}
\\
All of the variables in this equation are known from the problem statement,
except the final temperature $"(T_f)."$ This is the variable that we want to solve for.
Solving the above equation for $"T_f"$ gives

\[ T_f := \frac{m_w \cdot c_w\cdot T_w + m_b\cdot c_b\cdot T_b}{m_w\cdot c_w + m_b \cdot c_b}
";\;\;\;"
T_f\cdot \ooC \]

Please note that in our problem we are using a temperature in
$"\oC"$ and heat capacity in $"\J/(\kg\cdot \oC)"$ gennerally is more
safe to use a temperature in K.
Additionally, the heat capacity have the same value in
$"\J/(\kg\cdot \oC)"$ and in $"\J/(\kg\cdot \K),"$
for example:

\["\left("
c_w\cdot \left(\frac{\kJ}{\kg\cdot \oC} \right)^{-1}
"\right)=\left("
c_w\cdot \left(\frac{\kJ}{\kg\cdot \K} \right)^{-1}
"\right)"\]
{\bf Answer:}
\texblanche{$T_f:=round(T_f,1)$}
The final temperature of the water/bucket system is roughly $T_f\cdot \ooC"."$
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