Temperfect mug

Rebecca Nguyen
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I. INTRODUCTION

In this experiment we want to study the temperature of a liquid in two thermos mugs; Bodum and Temperfect. Bodum mug is a regular thermos cup. The Temperfect mug extracts excess heat from your beverage and stores it in its walls. This allows the newly-brewed beverage to be enjøyed right away. In the walls of this mug is a layer of insulation which changes from solid to liquid as it absorbs heat. Thereafter, the heat is used to keep the beverage at a perfect temperature and the material returns to a solid state. We will be looking at temperature development over time for both mug. Both in order to see if the mug works as advertised and discuss if Temperfect can be modelled as an Einstein solid.

II. THEORY

The multiplicity in an Einstein solid is given by

$$\Omega(N,q) = \frac{(q+N-1)!}{q!(N-1)!} \approx \frac{(q+N)!}{q!N!} \tag{1}$$

where q is number of energy units and N is number of oscillators. The expression has been further simplified using Stirling's approximation. We have considered the case q $\gg$ N (when there are more energy units than oscillators, the so-called 'high-temperature' limit) in order to simplify it. This gives us the expression for entropy

$$S \equiv k \ln \Omega \tag{2}$$

where k is Boltzmann's constant. Internal energy of an Einstein solid is given by

$$U = \frac{N}{2}\epsilon + q\epsilon \tag{3}$$

Which results in

$$\frac{dU}{dq} = \epsilon \rightarrow dU = \epsilon dq \tag{4}$$

with variations in.

One of the most important identities in thermal dynamics, derived from the first law of thermodynamics, is as follows

$$dU = Tds - Pdv \tag{5}$$

We assume constant pressure and volume which allows us to rewrite the equation as

$$dU = Tds \rightarrow T = \frac{dU}{dS} = \frac{\epsilon dq}{dS} \tag{6}$$

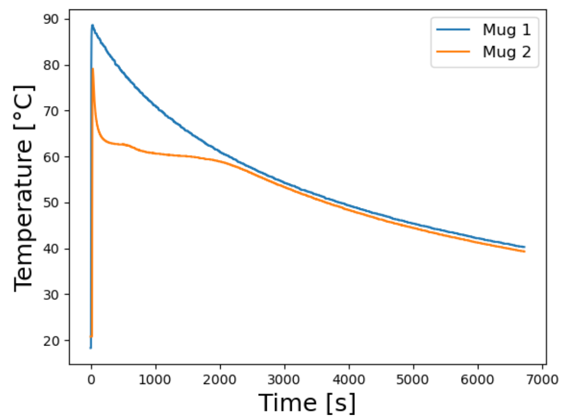

Figure 1. Temperature against time of both mugs

Lastly we have heat capacity

$$C_v = \frac{dU}{dT} = \frac{\epsilon dq}{dT} \tag{7}$$

III. METHOD

The Temperfect mug and Bodum thermos cup were both filled with 3dl of almost boiling water. The lids were not put on to allow temperature logging while the water in the mugs cooled. The temperature in the air outside of the mug was $T_a = 22°$.

IV. RESULTS

V. DISCUSSION

VI. CONCLUSION

ACKNOWLEDGMENTS

I would like thank myself for writing this beautiful document.

REFERENCES

- Reference 1
- Reference 2

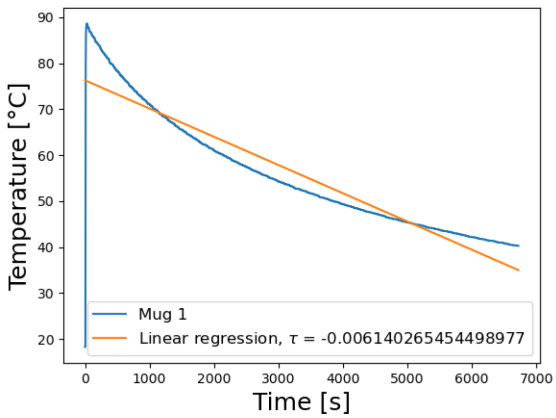

Figure 2.

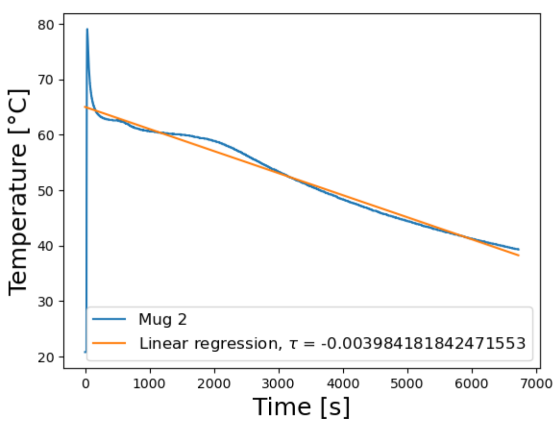

Figure 3. Temperature against time of both mugs

Appendix A: Name of appendix

This will be the body of the appendix.

Appendix B: This is another appendix

Tada.

Note that this document is written in the two-column format. If you want to display a large equation, a large figure, or whatever, in one-column format, you can do this like so:

This text and this equation are both in one-column format. [1]

$$\frac{-\hbar^2}{2m}\nabla^2\Psi + V\Psi = i\hbar\frac{\partial}{\partial t}\Psi \tag{B1}$$

Note that the equation numbering (this: B1) follows the appendix as this text is technically inside Appendix B. If you want a detailed listing of (almost) every available math command, check: https://en.wikibooks.org/wiki/LaTeX/Mathematics.

And now we're back to two-column format. It's really easy to switch between the two. It's recommended to keep the two-column format, because it is easier to read, it's not very cluttered, etc. Pro Tip: You should also get used to working with REVTeX because it is really helpful in FYS2150.

One last thing, this is a code listing:

```
This will be displayed with a cool programming font!
```

You can add extra arguments using optional parameters:

```
This will be displayed with a cool programming font!
```

You can also list code from a file using `lstinputlisting`. If you're interested, check https://en.wikibooks.org/wiki/LaTeX/Source_Code_Listings.

This is a basic table:

Table I. This is a nice table

Hey	Hey	Hey
Hello	Hello	Hello
Bye	Bye	Bye

You can a detailed description of tables here: https://en.wikibooks.org/wiki/LaTeX/Tables.

This is a more advanced table:

Table II. Tabelleksempel

Partikkelindeks (i)	**Posisjon** (m)	**Hastighet** (m/s)
0	139.22	12.4
1	14.88	18.7
2	233.9	10.10
3	816.12	13.4

I'm not going to delve into Tikz in any level detail, but here's a quick picture:

If you want to know more, check: https://en.wikibooks.org/wiki/LaTeX/PGF/TikZ.

[1] This equation is actually from quantum mechanics. "It's called Schrödinger's Time-Dependent Wave Equation", named after the awesome Austrian physicist Erwin Rudolf Josef Alexander Schrödinger. Yep, the "Schrödinger's cat" guy. Pretty cool dude actually, check his wiki page: https://en.wikipedia.org/wiki/Erwin_Schrodinger. He was physics' no. 1 Ladies' man if there ever was one. Anyway, you will learn more about this equation in FYS2140. You can also find it printed on a glass wall in the UiO Physics Building (it really is that important).

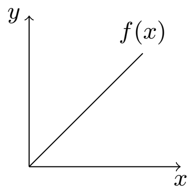

Figure 4. This is great caption