

## Self Heating Food Containers—Chemical Thermodynamics

### The Assignment:

Your group has been given the assignment to develop a food container that utilizes a chemical reaction in order to heat up its contents anytime and anywhere. A presentation of your product will be given at the end of the assignment to promote the features of your product and to convince the general public that your product is safe and scientifically sound.

### You will:

- Choose which reaction your product will utilize as its heat source
- Determine amounts of reactants that will be placed in the container
- Design the container and describe how it will work.
- Create a 4-5 minute presentation (video, PowerPoint, skit, etc.)

### Your presentation should include:

- An explanation of your design.
- Features and uses. What can your product be used for?
- Who is the intended user of your product?
- Cost of your product.
- A full explanation of the balanced thermochemical equation including how much heat is produced in your product and how much the temperature of the contents will rise.
- Any consumer warnings that should be issued for your product.
- List of references.

The table below includes several reactions that you may find useful for heating your apparatus. This is not a complete list. You can use the table from the Handbook of Chemistry and Physics (linked to the course website) to find the necessary heats of formation to calculate the heat of reaction for each option.

(Beware: the CRC gives heats of reaction in units of kcal/mol. You will need to convert these values into kJ/mol.)

Chemical Equations	
$\text{CaCO}_3 (s) + 2 \text{HCl} (aq) \rightarrow \text{CaCl}_2 (aq) + \text{H}_2\text{O} (aq) + \text{CO}_2 (g)$	
$\text{CaCl}_2 (s) + \text{H}_2\text{O} (l) \rightarrow \text{CaCl}_2 (aq) + \text{H}_2\text{O} (l)$	
$\text{HCl} (aq) + \text{NaOH} (aq) \rightarrow \text{H}_2\text{O} (l) + \text{NaCl} (aq)$	
$\text{ZnCl}_2 (s) + \text{H}_2\text{O} (l) \rightarrow \text{ZnCl}_2 (aq) + \text{H}_2\text{O} (l)$	

### Some things to consider:

1. Most food that we consume (and especially most that we drink) is comprised mainly of water. Therefore, many things have specific heats that are very close to water. For instance, beef stew has high water content, but the additional ingredients would make the specific heat slightly different. When you are designing, your apparatus, you will need to approximate the specific heat of your fare. You will need to consider if it would have a specific heat that is slightly higher or lower than that of water and then take that into consideration when you are running thermodynamic calculations. Make sure you include your justification for your specific heat in your presentation. You might look at specific heats for other substances to help you justify your choice.

2. In order to get an A on this assignment, you must use the Table of Thermodynamic Data from the CRC (linked from the course website) to come up with **your own balanced chemical equation** to use in your apparatus.
3. The Materials Safety Data Sheet or MSDS (<http://hazard.com/msds/index.php>) might be helpful for determining what potential consumer warnings might be required for your product. You should also consider other more practical warnings that might come due to reactants and products in your apparatus.
4. Use ideas from the videos shown in class. The commercials were very informative and your presentation should be even more so because you will also be including information about the thermodynamics of the chemical reaction in the can.

### Grading Guide:

- An explanation of your design.
- Features and uses. What can your product be used for?
- Cost
- Who is the intended user of your product?
- A full explanation of the balanced thermochemical equation including how much heat is produced in your product and how much the temperature of the contents will rise.
  - Balanced Thermochemical Equation—with complete thermodynamic calculations for  $\Delta H^\circ_{\text{rxn}}$ .
  - Specific Heat of food item(s)—with justification.
  - Complete calculation for  $\Delta T$  for food item.
- Any consumer warnings that should be issued for your product.
- List of references.

### Resources:

These are links to the videos shown in class as well as some additional information.

Hot Can Website: [www.hotcan.com](http://www.hotcan.com)

Hot Can Commercial: [http://www.youtube.com/watch?v=Y3\\_Rh\\_tJWH8&feature=fvw](http://www.youtube.com/watch?v=Y3_Rh_tJWH8&feature=fvw)  
<http://www.youtube.com/watch?v=HfBn49VykhQ&feature=related>

Heater Meals: <http://www.youtube.com/watch?v=i9Cf39kuNXY&feature=related>

Other interesting sites:

News Release: <http://www.engadget.com/2004/12/20/the-tale-of-the-single-serving-self-heating-coffee-can/>

Review of self heating beverage: [http://www.lanceandeskimo.com/chefelf/bev\\_hillsidecoffee.shtml](http://www.lanceandeskimo.com/chefelf/bev_hillsidecoffee.shtml)