

## Thermochemistry Reading



### Not Too Hot to Handle

1) Have you ever had the urge to walk on red-hot coals? Maybe not. But you've probably been in a hurry to thaw a piece of meat that you forgot to take out of the freezer. Let me try to shed some light on these two activities – which, believe it or not, are scientifically connected.

2) You probably remember the infomercial for "Miracle Thaw" that goes something like this: "You'll never worry again about forgetting to thaw meat! Just take the meat from the freezer, put it on the miraculous thawing plate, and in minutes it's ready to be cooked. Your days of uneven microwave defrosting are over." To emphasize that the product was a true technological marvel, the infomercial showed an ice cube melting almost instantaneously on the Miracle Thaw. Should we bow our heads in reverence, or is there a more mundane explanation for this purported miracle? In order to understand what is going on here, let us digress for a moment and look at the mysterious practice of fire walking.

3) Who hasn't been amazed by the feat of feet treading on glowing coals? Some motivational gurus claim that one needs special powers in order to do this. And, of course, they alone are capable of teaching the mind-control techniques that protect the feet from the red-hot embers. Popular motivational speaker Tony Robbins is perhaps the most famous proponent of this idea, and he even suggests that successful fire walking is proof that his seminars have taught people to overcome extreme adversity. With the right mental focus, he asserts, we can rearrange the molecules of our feet so that they can withstand the heat. Indeed, many of his followers claim that the practice has made them feel powerful, rejuvenated, and less reliant on doctors. Robbins even says that he's seen some cancers go into remission after his fire-walking sessions. If the mind can conquer the coals, he implies, then it can also conquer disease. But you don't need metaphysical mumbo-jumbo to conquer high temperatures – plain old down-to-earth physics will do.

4) Ah...those high temperatures. Therein lies the secret. It is not only the temperature of a material that determines its potential for causing burns, but also its heat content. Temperature and heat content are very different things. Temperature is a measure of how rapidly molecules are moving about in a material. The faster they move, the higher the temperature. When rapidly moving molecules bump into slower-moving molecules, they can transfer their energy to them: the fast molecules slow down, and the target molecules speed up. What does all this mean? When we touch a hot object, the molecules in our hand speed up, and we feel heat.

5) But the heat we feel is dependent not only on how fast the molecules in the hot material are moving, but also on how many molecules are available to transfer their energy. In other words, it depends on the heat content of the material. A sparkler of the type used on birthday cakes serves as an illustration. The sparks that it produces are very hot, but they do not burn because they have a small mass and therefore do not contain enough molecules to cause burning by energy transfer. However, if you were to touch the

sparkler itself, you'd get a nasty burn. Its temperature is the same as the sparks it sends out, but it has far more molecules ready to transfer their energy. Similarly, when you reach into an oven, your hand doesn't burn, because the mass of the air molecules in the oven is small and does not contain enough heat. If you touch the aluminum cake pan, however, you'll yowl because it has a much greater mass. Furthermore, aluminum is a very good heat conductor, so as soon as some heat transfers from the surface to your hand, it is replenished from the interior of the metal.

6) A knowledge of heat transfer is certainly handy – especially if you're buying jade. Experience jade buyers can tell if a sample is real or fake just by its feel. Real jade has a high thermal conductivity, and it carries heat away from the hand very easily; fake jade doesn't. Basically, real jade is real cool.

7) Fire walking, on the other hand, is really hot, but it does have a cool explanation. When coals burn, their surface forms a spongy, soft layer of soot. Although this layer is quite hot, it is not massive. Relatively little energy is transferred to the foot. Also, since the coals conduct heat poorly, the heat transferred to the foot is not quickly replenished from below. Consequently, the footprints that a firewalker leaves behind are black, demonstrating that the surface of the coal has cooled down. So, it certainly isn't the rearrangement of the molecules in the feet through mind power that enables a person to walk on hot coals – it's the low heat content of spongy coal.

8) Now, back to our miraculous thawing device. It's really just another example of heat transfer. Think of the frozen meat as your foot, and the metal thawing plate as the bed of coals. Of course, this time we want the opposite of fire walking; we want the efficient transfer of heat to the meat. So we choose a material capable of replenishing with ease the heat transferred to the meat – in other words, a good conductor. Aluminum is a good conductor, and it's cheap. As it transfers heat to the meat, it picks up energy from the air. The thawing plate serves as a conduit of heat energy from the air to the meat. But if all this is true, then the special plate isn't really necessary. Any good conductor will do the job.

9) However, just to make sure that I hadn't missed some technological breakthrough, I decided to put Miracle Thaw to the test. First, I made a batch of standard-size ice cubes. Then I gathered together a variety of pots and pans. I also assembled some helpers – one wife and three daughters – for the epic experiment. Our audience was a curious cat. One by one, we placed the ice cubes on the various unheated test surfaces and, using a stopwatch, measure the time it took for each cube to melt completely. The results were conclusive. The copper pan was wonderful. The waffle iron was great. So was an aluminum frying pan. Miracle Thaw trailed the field. Even a stainless steel sink outperformed it. The overall winner? No contest. Our cat had taken an interest in the proceedings, and he decided to find out what this nonsense was all about. He began to lick one of the ice cubes, and it melted in a jiffy. Pretty good heat transfer there, but somehow I don't think we could market the cat as a meat-thawing device.

10) So, the secret behind Miracle Thaw and walking on hot coals lies in an understanding of temperature and heat content. If you are still in doubt, just ask a firewalker to place an aluminum sheet (or several Miracle Thaws – which have by now been relegated to the discount bin) over a bed of hot coals. The metal will reach the same temperature as the coals. Now ask the prospective walker to focus his mind, rearrange his molecules, and take the fire walk. He'll probably hotfoot it out of there real quick.

Schwarcz, Joe. *That's the Way the Cookie Crumbles*. Toronto: ECW Press, 2002