ICY DELIGHT

Which type of chocolate melts the fastest?

What happens to liquid milk when it is cooled?

All about changing states of matter…

Equipment required:

1 x small and 1 x large sealable bag

300 mL milk

Measuring jug

1 tbsp caster sugar

¼ tsp vanilla extract (optional)

Ice

6 tbsp salt

Scales

2 x Balloon

Milk, white and dark chocolate

Pan

Hob

Fridge

Towel

Can you explain the findings?

Kitchen Chemistry: Icy Delight

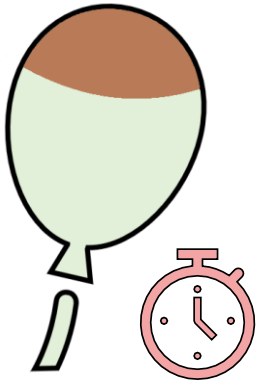
DEPARTMENT OF CHEMISTRY

UNIVERSITY OF OXFORD

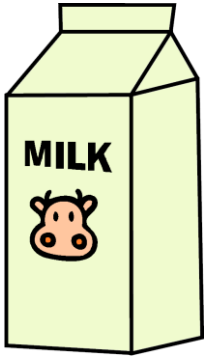
1 Measure out equal portions of white, milk and dark chocolate.

2 Ask an adult to melt chocolate over hob. Time how long each takes to melt.

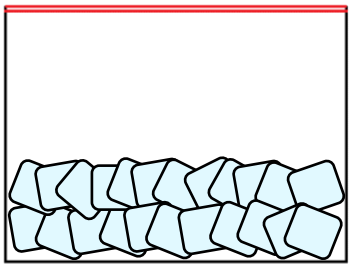
3 Dip balloon in chosen chocolate. Chill in fridge for 30 mins.



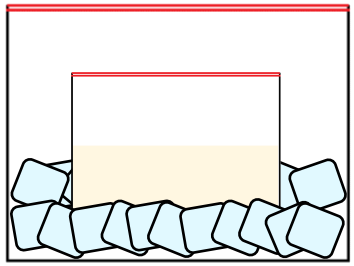
4 Add milk, sugar and vanilla essence to small sealable bag.



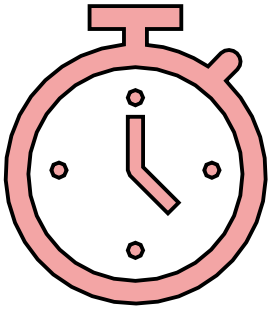
5 To the larger sealable bag, add ice and generous amount of salt.



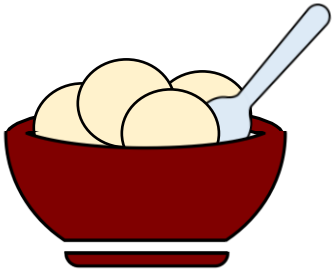
6 Put the smaller bag containing the milk into the larger ice bag.



7 Wearing winter gloves, shake the bags for 5 minutes to make ice-cream.

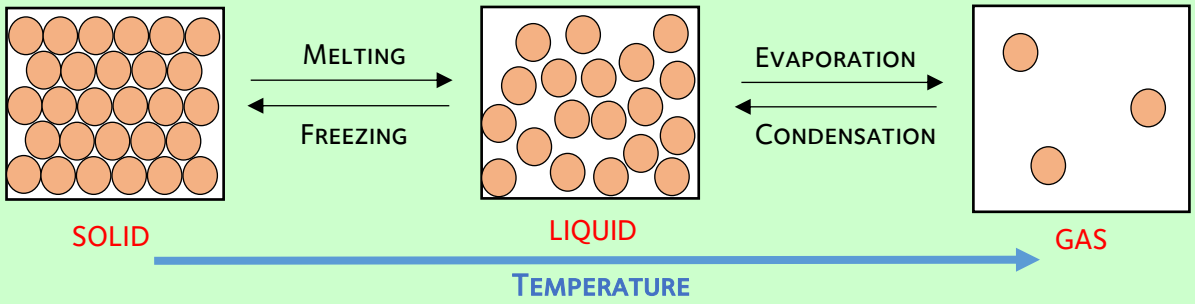


8 Pop balloon to leave chocolate bowl. Scoop out ice-cream and enjoy!



The science behind the scenes...

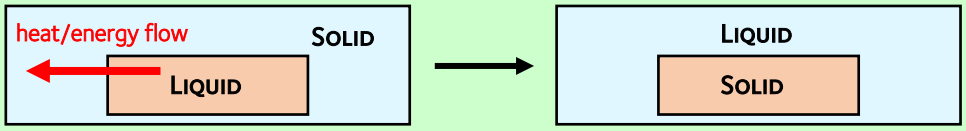
The three fundamental states of matter are solid, liquid and gas. They can be converted between each other through changing the temperature (heating or cooling):



Their properties reflect their **molecular structure**. In solids, the molecules are tightly packed which gives them a rigid structure. In liquids, the molecules still have some **order**, but the layers can slide over one another, which allows liquids to flow and fill the container it is in. Gases, on the other hand, have very little order, the molecules are far apart and so they take up a lot of space.

Different compounds have different melting and boiling points, and the range of temperature at which they melt over depends on their purity. The **less pure** a substance is, the **wider the range** of temperatures it will melt over. This is because there will be a higher proportion of **contaminants** which will have different melting points, and so will widen the substance's overall melting point range.

Changing the state of matter by melting and boiling requires **energy** for molecular **rearrangement**. The surrounding temperature has to be increased to facilitate the changes, providing the energy to do so. It is this principle that is used to form our ice-cream in a bag! Adding salt to the ice lowers the melting point (adding an **impurity**), which means the ice added at 0°C is now above its melting/freezing point, and will start to melt. Melting requires energy to make the molecules less ordered and move around more, so the ice gains this heat energy from the milk liquid. This lowers the energy of the milk molecules, which causes the milk mixture to **solidify** (as the molecules have less energy to move around and be disordered) to form the ice-cream mixture.



White, milk and dark chocolate melt at different temperatures and over a different range of temperatures due their **different compositions**. Dark chocolate has the highest percentage of cocoa and hence is the purest, so will melt the quickest and over the smallest range of temperatures. Adding milk and sugar to the chocolate to form milk chocolate lowers the melting temperature but also increases the range of temperatures over which the chocolate melts over as it becomes less pure. The larger the range of temperatures the chocolate melts over, the longer the solid sample of chocolate will take to melt.

Practical investigation:

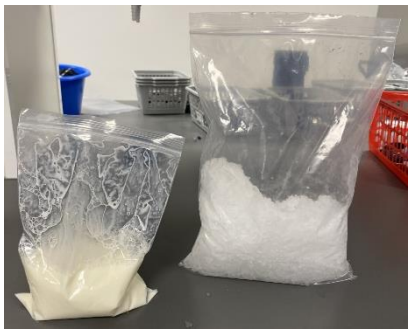
Equipment:

- ☐ 1 x small and 1 x large sealable bag
- ☐ 300 mL milk
- ☐ Measuring jug
- ☐ 1 tbsp caster sugar
- ☐ ¼ tsp vanilla extract (optional)
- ☐ Ice
- ☐ 6 tbsp salt
- ☐ Scales
- ☐ 2 x Balloon
- ☐ Milk, white and dark chocolate
- ☐ Pan
- ☐ Hob
- ☐ Fridge
- ☐ Tea towel

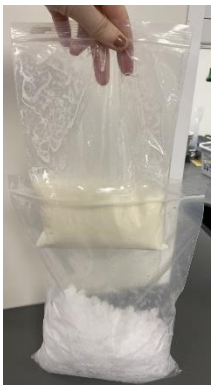
Note: measurements above for 2 servings

Method:

1. Weigh out roughly equal pieces of white, milk and dark chocolate. The pieces of chocolate should be as close to the same size as possible.
2. Ask an adult to help melt each chocolate in turn on hob at the same heat. Use a preheated pan. Time how long it takes to melt each portion of chocolate.
3. Dip balloon in chosen chocolate and leave to chill in fridge for 30 minutes.
4. Add 300 mL milk, 1 tbsp caster sugar and ¼ tsp vanilla extract (optional) to smaller sealable bag. Seal.
5. Add ice and salt to the second, larger sealable bag.



6. Place the smaller bag containing milk mixture into the larger ice bag:



7. Ensuring the milk mixture stays in contact with the ice, shake the bags and roll the milk mixture over the ice (use tea towel to protect hands as may be too cold).

8. Check the milk mixture consistency after 5 minutes of shaking and rolling.
9. Once chocolate has set, pop the balloon, serve your ice-cream in bowl and enjoy!!

Questions:

(a) How do we make sure we are carrying out a fair test when comparing the chocolate types?
[Equal weight of chocolate used when melting; heat on same heat setting on hob; ensure pan preheated before adding each chocolate for same starting temperature.]

(b) How do the properties and appearance of the chocolate change as it is heated?
[Becomes runnier- melting, becoming a liquid; spreads out as it melts, liquids move to fill the shape of the container then are in whereas solids have a rigid structure]

(c) Which chocolate melted the fastest? Why might this be?
[Dark chocolate melts the fastest. This is because it has a higher cocoa percentage and is therefore purer. The less impurities there are in a mixture, the smaller the range of temperatures the substance will melt over, as each different component has its own signature melting point, i.e. milk, sugar, cocoa butter etc all have different melting points.]

(d) How does the consistency of the milk mixture change as it is cooled by the ice bag?
[Solidifies: takes a more rigid structure, crystalizing.]

(e) What processes are we undertaking to make the chocolate bowl?
[Melting, followed by freezing.]

Science isn't just useful in the lab...

Adding impurities to substances to lower the melting point is a really useful tool, and is used in the winter to keep us safe! **Salt** is added to the roads in winter to prevent ice forming on the roads which would make driving dangerous. The salt **lowers** the melting/freezing point of water and ice collected on the roads, and so any ice on the roads **melts** as the temperature will be above the new lower melting point of the ice-water mixture. This also prevents water from freezing to ice, as we would need much lower temperatures to be reached to freeze the water, making it more difficult to do so. The more salt that is added, the more the freezing point is lowered.

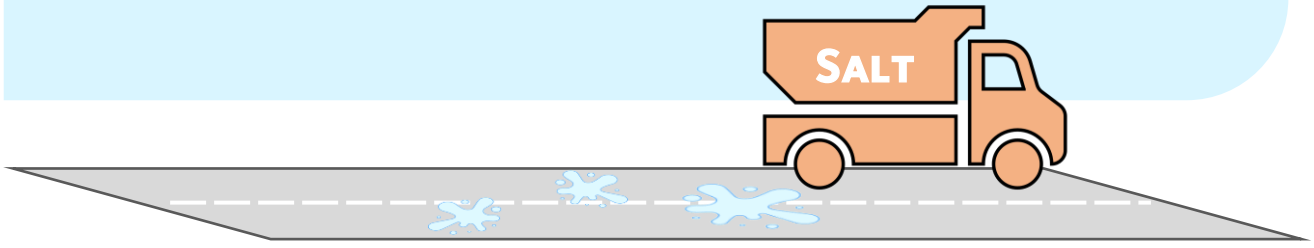


Photo citations:
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