



This resource pack was created by Dr Rebecca Wilson  
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## Equipment per 1L Ice Cream

5L Stainless steel mixing bowl  
electric whisk  
1L cornello icecream mix  
metal sugar balls  
chocolate covered toffee balls  
chocolate sauce  
mini marshmallows  
stainless steel vaccum flask or a mini liquid nitrogen dewar  
Liquid nitrogen  
Metal serving spoon  
ice cream cones or mini tubs and spoons

## Script for Asteroid Ice-cream

Script in text, *instructions in italics.*

We are going to make – and eat – asteroid ice-cream!

80% of meteorites that we find are **chondrites**, they originate from the asteroid belt. In particular, some of the asteroids in the outer asteroid belt are rich in **organic carbon** – including the molecules essential for life. When asteroids collide with each other, chunks are broken off and sent towards Earth (**meteorites**).

*Show image of chondrite.*

This is the meteorite ice-cream we are going to make today. It is a **chondrite** that is made up of lots of different components all embedded in a fine rocky material called the **matrix** – represented by ice-cream mix.

*Add 1L ice-cream mix to the bowl.*

*Show image of chondrules.*

The next ingredient in a chondrite is **chondrules**...spheres of rocky material 1-5mm in size – represented by chocolate toffee balls.

FACT: chondrules form when mineral grains are flash heated and melted up to 2000K and quenched in a few seconds – hence they are akin to “igneous droplets”. There is no consensus on how chondrules formed [gravity waves, nebula lightening, X-wind, impacts]

*Add 3 tbsp toffee balls to bowl.*

*Show image of CAIs.*

Chondrites also contain **Calcium Aluminium -rich inclusions (CAIs)**. These minerals are fluffy and have formed at a very high temperature – most likely very close to the Sun.



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FACT: they are formed from high refractory minerals i.e. those that condensed first in the nebula close to the Sun.

*Add 2 tbsp mini marshmallows to the bowl.*

*Show image of metal.*

Chondrites also contain **Fe-Ni metal blebs**, these are sometimes visible with the naked eye.

*Add 1 tbsp metal sugar balls to bowl*

In the outer asteroid belt, the asteroids are **carbon rich** and include organic carbon.

FACT: We find a whole range of organic molecules in meteorites – some of which are essential for life including:

- amino acids (required for protein formation – all cells are made of proteins).
- Purines and pyrimidines (DNA/RNA nucleobase component)
- carboxylic acids, organic alcohols, polycyclic aromatic hydrocarbons etc etc

*Add 200ml chocolate sauce to bowl and stir it without turning the whisk on.*

Meteorites also contain **volatiles** e.g. H<sub>2</sub>, N<sub>2</sub>, CO, O<sub>2</sub>, CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub> and more!  
We are going to represent this with liquid nitrogen.

Optional: Liquid nitrogen is at ~ -190°C – that's 20°C colder than the average surface temperature on Titan. At room temperature it boils and turns into a gas.

*Ask audience to stand at least 1m away from table.*

*Tip dewar to fill 1L flask with liquid nitrogen using the funnel if necessary.*

*Pour ¼ liquid nitrogen from the flask into the bowl and stir with the metal serving spoon. Slowly add more liquid nitrogen, once it starts to get firm whisk on a low setting. After about 1L liquid nitrogen, the ice-cream will be “soft scoop” style. Just keep adding liquid nitrogen and whisking until ice-cream is formed. It may need up to 2L. Give everyone a plastic tablespoon to take some icecream away or scoop and serve into cornets/tubs.*



## Asteroid Ice-cream Cheat Sheet

<b>Meteorite Component</b>	<b>Description</b>	<b>Ingredient</b>
MATRIX	Fine grained “rocky” background material binds all components together	Ice-cream mix
CHONDRULE	Sphere of silicate melt - formed by rapid melting (to >2000K) and quenching	Toffee chocolate balls
CAIs	“Fluffy” blue-grey rocky pieces, formed of refractory minerals (Ca-Al), formed at very high temperatures close to the Sun	Marshmallows
METAL	Free Fe-Ni metal blebs formed in reducing environment	Metal balls
ORGANIC CARBON	Range of organic material found in meteorites including amino acids, purines/pyrimidines, organic alcohols etc. Carbon rich asteroids found in outer asteroid belt.	Chocolate syrup
VOLATILES	Asteroids rich in volatiles: N <sub>2</sub> , CO <sub>2</sub> , NH <sub>3</sub> , ices water etc	Liquid nitrogen