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| **Make marshmallow** | | |
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| **Stay safe** |  |  |
| Whether you are a scientist researching a new medicine or an engineer solving climate change, safety always comes first. An adult must always be around and supervising when doing this activity. You are responsible for:     * ensuring that any equipment used for this activity is in good working condition * behaving sensibly and following any safety instructions so as not to hurt or injure yourself or others     Please note that in the absence of any negligence or other breach of duty by us, this activity is carried out at your own risk. It is important to take extra care at the stages marked with this symbol: ⚠ | | |
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| **Age range:** 11-14-year-olds or younger with adult supervision  **Approx time:** 45 minutes – 1 hour [+2 hours cooling] |  | **Key words / Topics:**   * Materials * DT * Science * Maths * Changing state * Dissolving * Cooling and heating * Measuring temperature * Weight * Ratios |
| **Introduction** |  |  |
| This resource will tell you how to make your own marshmallows. But not only that, we will be learning about the science of baking, and how a small change to the mixture can make a big difference.  You will be surprised by the maths and science that goes into making these lovely little treats. Working out what works well, what doesn’t, how many ingredients to use and ratios, are all packed into one fun resource. | | |
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| **Equipment** ⚠ |  | **Ingredients** |
| * Weighing scales * Tablespoon * Electric whisk * Deep bowl or jug to dissolve the gelatine in * Large mixing bowl * Measuring jug * 2 saucepans * Large, deep rectangular dish or roasting tin * Sugar thermometer |  | * 3 large egg whites * 13 leaves of gelatine (traditional or vegetarian will work) * 700g white caster sugar * 1½ tablespoons liquid glucose (find it in the baking aisle) * 1 vanilla pod (cut in half with the seeds separated) * Sunflower oil to grease the tin   For dusting   * 100g icing sugar * 4 tablespoons cornflour |
|  |  | This quantity makes around 50 chunky marshmallows |
| **Instructions** ⚠ |  |  |
| **Step 1**  Split the eggs – how do we do this?  Crack the egg carefully, then, over a bowl, pour the yolk from one half of the shell to the other. As you do this, the egg white will separate and pour into the bowl, while the egg yolk will be left in the shell. Then you can pour the egg yolk into a separate bowl.  *When you are whisking egg whites, it is important that you don’t get any yolk in the white as it will take much longer to whip up into the consistency you want, and if you get too much yolk in there, it won’t whip up at all. But…why? Find out in the ‘Science’ section below…*  Whisk the egg whites in a large heatproof bowl using electric beaters. Whisk until soft peaks form then set the bowl aside.    **Step 2**  Put the gelatine in a different deep bowl or jug and cover with 200ml cold water to soften.    **Step 3**  Put the caster sugar, liquid glucose and 300ml of water in a large, high-sided saucepan, and cook over a medium-high heat until the mixture reaches 130 degrees Celsius (°C) on a sugar thermometer.  *Remember, water boils at 100°C – this is even hotter than boiling water.*    **⚠ Be very careful when you work with hot sugar and make sure your adult is concentrating!**  Take the pan off the heat then add the gelatine water mixture into the hot sugar.  **⚠ Take care and wear oven gloves as the hot sugar can bubble up.**    Stir until the gelatine has dissolved then carefully pour the mixture into a heatproof jug.  **Step 4**  Return the beaters to the egg whites and whip up further until stiff peaks form. Keep whisking while you slowly pour in the warm syrup in a steady stream. The saucepan might be a little heavy so you might want to get help from an adult for this bit.  Keep beating the mixture until it is smooth and shiny, then add the vanilla seeds.  Check the clock as you will need to continue to use the electric beaters for around 8-10 mins or until the mixture is noticeably thicker.  **Step 5**  Line a 25cm x 35cm roasting tin (or any large deep rectangular dish) with cling film and brush with sunflower oil.  Mix the icing sugar and cornflour together then sieve a third of the mixture into the tray to coat the inside (now is the time to use your fractions. Don’t forget, the parts need to be equal).  Pour in the marshmallow mixture, level with a spatula and leave to set for 2 hours.  **Step 6**  Spread a large sheet of baking parchment over your work surface and sieve another third of the cornflour sugar mix over it.  Upturn the set marshmallow onto the dusted sheet and peel away the cling film. Dust with a little more of the cornflour sugar and dust a large sharp knife with it too.  **Step 7**  Cut the marshmallows into small squares approx. 3cm x 3cm sieving a little more cornflour sugar over all cut sides and knife as you go. You may not need all of it, but they need to be coated in the cornflour sugar on all sides otherwise they will stick. **⚠ Take care when using the sharp knife and make sure your adult is concentrating.**    How will you ensure that all the marshmallows will be the same size? You might need to use some of your multiplication and division skills. | | |
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| **Science and maths** |  |  |
| Egg whites are made almost entirely of protein. When we whip them, the motion of the whisk forces the proteins to unfold and recombine in rigid structures. Whisking transforms egg whites into a mass of foamy bubbles and the proteins form the bubble walls.  If a drop of yolk goes into the white, it breaks up the proteins, and therefore the proteins can’t do their work. The proteins in egg whites are twisted and curled into a spherical shape. Once they are beaten with a whisk, the proteins are broken down and air bubbles are added into them and therefore the egg white rises. So, the proteins in a non-whisked egg white go from being tightly folded together to being forced into a long strand by the whisking action, and as a result, the egg white rises. We’ve done the science…. now here comes the maths!  **What will you need to do if you want to make more, or less marshmallows? Supposing you want to make 100, well, that’s an easy one! 75? 150?**  Think about how many people you will be entertaining and visiting over the festive period, you could take them a little edible gift of marshmallow snowballs, so make sure you make enough!  Increasing or decreasing a recipe is all about ratio and proportion. If you want to make 75 marshmallows, you will need to multiply each of the ingredients by one and a half, x1.5.  Use your knowledge of ratio and proportion to make the amount you want. | | |
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| **Calculations** |  |  |
| |  |  |  | | --- | --- | --- | | **Original Ingredient** | **Calculation** | **Answer** | | 3 large egg whites | 3 x 1.5 | = 4.5 egg whites | | 13 leaves of gelatine | 13 x 1.5 | = | | 700g white caster sugar |  | = | | 1½ tablespoons liquid glucose |  | = | | 1 vanilla pod |  | = | | 100g icing sugar |  | = | | 4 tablespoons cornflour |  | = | | | |
| **Extension** |  |  |
| What is better than marshmallow? Marshmallow covered in chocolate! Decorate your marshmallows with the coating below. | | |
| **Ingredients** |  |  |
| * 55g desiccated coconut * 55g drinking chocolate or cocoa powder * 55g butter or coconut oil * ½ tin condensed milk (200g) * 14 digestive biscuits * Fine coconut for coating |  |  |
| **Instructions** |  |  |
| **Step 1**  Melt the butter on a low heat in a microwave or in a small saucepan on a low heat on the hob and mix with the crushed digestives, drinking chocolate, coconut and condensed milk.  **Step 2**  Use this mixture to cover a marshmallow, rolling each into a neat round ball. If your hands are damp while you do this, it makes things a lot easier.  Also try not to have too much biscuit mixture around the outside – you really want a much greater ratio of marshmallow to biscuit mix!  **Step 3**  Toss the chocolate covered marshmallows in fine coconut to dust and place in the fridge to set.  As soon as the chocolate has set, they can be served straightaway or you keep in an airtight container for up to 2 days, separated with layers of baking parchment. | | |
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| **The Engineering Context** film |
| Baking is engineering. It is using science, maths and technology skills to engineer and create solutions and new tasty products. Engineers need all these skills – precision in weighing out ingredients, the safety required in the kitchen and product design and quality engineering to test, taste and improve with each bake! |

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| **Curriculum links** | | | |
| **England: National Curriculum**   * **Science; lower KS2** * observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C). * **Science; upper KS2** * know that some materials will dissolve in liquid to form a solution. * demonstrate that dissolving, mixing and changes of state are reversible changes - explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible. | **Northern Ireland Curriculum**   * **Primary; The world around us** * KS1 The effect of heating and cooling some everyday substances. * KS2 changes that occur to everyday substances, for example, when dissolved in water or heated and cooled. | | |
| **Scotland: Curriculum for Excellence**   * **Science; Materials – Properties and uses of substances; Second** * By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed. | **Wales: National Curriculum**   * **Science KS2** use standard measures and S.I. units, e.g. kg, s, N, m. * **Science KS3** use a range of apparatus and equipment safely and with skill, taking action to control the risks to themselves and others | | |
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