Hand Warmers

Teachers' Guide

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Information guide for teachers

The information provided in this pack is designed to be used only as a guide. The material may be adapted, changed or expanded as required.

Some of the outcomes and experiences that may be covered during this activity are listed at the end of this guide. It is not intended to be an exhaustive list. It is also possible to expand the activity to cover more outcomes and experiences.

Context

This activity would fit nicely with a project on winter and also on body matters (extremities and keeping warm).

Suggested lesson plans

For some of the lesson plans a number of different active learning approaches have been suggested. The approach chosen will depend on the preferred style of individual teachers, time constraints, the composition of pupils in the class etc.

Brief outlines of possible lessons

Activity	Title	Brief outline	Skills / Concepts	SCN
1	Introduction (15-30 minutes)	Commercial hand warmers are investigated and information gathered about how to use	Researching, exploring, investigating	LIT 2-05a LIT 2-15a
2	Reuseable hand warmers (15-20 minutes)	Take apart a reuseable hand warmer Show the same reaction in a flask Compare with snow formation. Show BBC video	Observations, evaluating	SCN 2-15a – Properties (changes in substances) SCN 2-05a – Processes And to some extent SCN 3-05aSCN2-20b – Topical Science LIT 2-05a LIT 2-15a
3	Exploring factors that affect solubility (45 minutes +)	Using sodium chloride, investigate the factors that influence solubility	Making saturated solutions, filtering, investigative skills, reliable and fair testing	SCN 2-16a - Properties (separating mixtures) SCN 2-16b - (factors affecting solubility) LIT 2-02a LIT 2-04a LIT 2-09a LIT 2-21a
4	Making super saturated sodium acetate solutions (30 minutes+)	Design and carry out own experiment to make super saturated sodium acetate solution	Making saturated solutions, filtering, investigative skills, reliable and fair testing Group working skills	SCN 2-16a - Properties (separating mixtures) SCN 2-16b - (factors affecting solubility) SCN 2-19a – Properties (chemical and physical changes) LIT 2-02a LIT 2-04a LIT 2-09a
5	Make hand warmers. (10 minutes or longer if the solution has been left from day before)	Using super saturated super cooled solutions, make individual hand warmers (This lesson may be omitted if the 'home made' hand warmers are prepared during lesson 4)		SCN 2-16a - Properties (separating mixtures) SCN 2-16b (factors affecting solubility) SCN 2-19a – Properties (chemical and physical changes)
6	Bringing it all together (45 minutes)	Write up, design posters, presentations and so on to highlight the important aspects of the activity	Evaluating, elaborating, literacy	LIT 2-06a LIT 2-10a / LIT 3-10a LIT 2-22a LIT 2-24a LIT 2-26a

For a description of these SCN outcomes – see appendix

Activity 1 – Introduction

Teacher led discussion based on pupils prior knowledge, experience and questions they may have

The topic of hand warmers is mentioned by the teacher – perhaps by linking in to a topic on winter, cold, or the human body.

Individually pupils are asked to think of and then record in their lab book three 'things' about hand warmers. My suggestion would be that one of the 'things' should be a question the pupil would like answered. All three 'things' could be questions if appropriate.

In small groups or pairs the three 'things' are discussed and from this the group chooses the best three 'things' to present to the class. In a whole class discussion the teacher collates and writes down on the board (or perhaps better still on a concept map) what the pupils already know and what they would like to find out..

Exploring reusable and disposable hand warmers

One of each of the hand warmers being investigated is given to each group along with the original packaging with instructions (you may wish to laminate the packaging onto card so it can easily be re-used). I would encourage the groups to activate the hand warmers to observe and explore how they work. The next part of the activity can be organised in a number of ways.

a) **Similarities / differences**

This involves giving the group a table (see 'Exploring Hand Warmers' in the pupil sheets) for them to record the similarities and differences between the hand warmers. The groups gather the information from the evidence and record their conclusions in the table. A class discussion will then take contributions from each group.

b) **Answer worksheet questions and story writing**

A question sheet could be given out (see pupil sheets for examples) and groups could work out their answers to the questions. To put this into a real life context each individual pupil could then be given the task of writing a story describing a hand warmer being used (see 'Storytime' in the Pupil Sheets).

Important words and new vocabulary should be displayed on a word wall.

Activity 2 – reusable hand warmers

The super saturated super cooled sodium acetate solution for this will need to be prepared in advance (probably best done the day before). There are instructions for this in the technical section of this guide.

A re-useable hand warmer could be initiated to show again what happens. Good questioning here could draw out some explanations from the pupils. It may be possible to take apart a hand warmer and slowly pour the solution into a beaker (or even onto a white tile or similar). This allows the 'hot ice' sculptures to form. There are some video demonstrations of this available on the BBC website and also on 'YouTube'.

www.bbc.co.uk/bang/videos/yan_street/bang_yan_sodiumacetate/

www.youtube.com/watch?v=uy6eKm8IRdI

With prepared sodium acetate solution in a beaker the reaction of the hand warmer can again be demonstrated. By passing round the beaker the pupils will realise that heat is being given out as it was when the hand warmer was initiated. The changes happening must be highlighted and pupils should be encouraged to record their observations in a lab book.

You may wish to show the class what powdered sodium acetate is like so they can compare the crystals formed in the beaker with the original solid. The BBC video gives a good simple explanation for what is happening. If you wish to turn a solid into a liquid by melting then you put in heat. This means that if you want to turn a liquid into a solid then heat must be given out. The same process happens when snow forms. There are some snow related activities and worksheets in 'Contemporary Chemistry for Schools and Colleges' published by the Royal Society of Chemistry.

www.rsc.org/Education/Teachers/Resources/Contemporary.asp

It is possible to super cool water – that is, to cool it below its freezing point. When it is removed from the freezer, snow formation can be initiated by tapping the side of the container.

Activity 3 – factors affecting solubility

This lesson should be as much about gaining investigative skills as about the actual outcomes being learnt. It is possible to discuss fair testing and reliability with the class but equally most will 'discover' this by themselves as they progress through the investigation. There are some thinking activities on fair testing and reliability included in the pupil sheets.

Whichever teaching method is adopted, it is recommended that some time is devoted to 'introducing' co-operative learning techniques if this is a new style of working for the class. Every member of each group should have a clearly defined role within the group and the 'job' of each role could be displayed on the wall.

a) **Entirely by discovery**

The question sheet - 'investigating solubility' is issued to groups and they work through the instructions and ideas. Teacher input is necessary to help 'guide' groups in the correct direction.

b) **Teacher input**

Begin by having a class discussion about things that dissolve and how they can be made to dissolve quicker. List all the pupil suggestions on the board and then split the class into groups; each group exploring a different 'factor' from the list. Groups can be given the opportunity to design their own experiments for this.

Depending on time each group could explore all of the factors, or each group could investigate one factor and the results could be collated in a class discussion at the end of the investigation. It is important that the main findings from this activity are recorded by everyone as they will need the information to help them make their own hand warmers.

Activity 4 – making super saturated sodium acetete solutions

Using the information from lesson 3, groups of pupils set about making their own super saturated sodium acetate solutions.

It is recommended that trays are set up in advance with the 'kit' the groups will use for this. Tubs containing about 20 g of sodium acetate also can be prepared in the kits.

If time permits, it is simpler, to make the 'home made' hand warmers at this stage with the warm solution that has been prepared during this lesson. A method for making 'reusable' hand warmers is included in the pupil pack.

Activity 5 – make hand warmers

The solutions made in the previous lesson could be activated, if any have crystallised. Warming them will regenerate the solution (although these will then need to be allowed to cool before activating again). A simple way to activate the 'hand warmer' solution is to add a little sodium acetate powder. Pupils should be encouraged to make observations and record these in their lab book.

The sodium acetate can be reheated and poured into bags, whilst warm, to make a 'reusable' hand warmer
(see 'making a reusable hand warmer').

Activity 6 – bringing it all together

It is important that the ideas that have been explored can be put together and some assessment made of pupils' learning.
There are many ways this can be achieved; the simplest would be to ask for a write up of the experiment. A suggested write up format is included in this pack.

Ideas for further related activities

Snow

Other hand warmers – bean filled microwave ones

Explore the reaction taking place in disposable hand warmers (involves an oxidation reaction)

http://matse1.mse.uiuc.edu/metals/k.html

How to make a super saturated super cooled sodium acetate solution

Theory

Sodium Acetate re-useable hand warmers work by starting a crystallisation reaction. The clicker provides a shock to initiate the reaction. The solution is super saturated (no more solid will dissolve) and super cooled (allowed to cool down beyond the temperature at which it would normally be solid – room temperature in this case).

The process gives out heat (exothermic) and reaches temperatures of 55^{0}C. This can be explained if you consider heat is needed to melt a substance and so for it to become solid it must release heat.

A similar reaction takes place when snow forms. The water in the atmosphere is super cooled (the water remains a liquid even below 0^{0}C) and super saturated with water vapour and when it is initiated (often by small bits of dust) it starts the freezing process. The temperature then rises (more information can be found in 'Contemporary Chemistry for Schools and Colleges' published by the Royal Society of Chemistry).

The sodium acetate solution for the demonstration needs to be prepared in advance and allowed time to cool to room temperature (overnight).

Equipment and chemicals

- 100 cm^3 beaker or similar
- Electric hotplate (food warmer or a tea light candle and a small stand)
- Spatula
- Filter funnel
- Filter paper
- Conical flask or similar, for example, another beaker
- Sodium acetate trihydrate (about 20 g for 20 cm^3 water)
- Extra strong zip lock bags (400 gauge, 100µ) and hair snappers if making into a 'homemade' hand warmer (see 'where to buy' section)

Procedures

- Heat 20 cm^3 of water on a hot plate.
- When the water is hot (it doesn't need to be boiling) a large spatula of sodium acetate is added to the water and the mixture swirled if necessary.
- When the solid has all dissolved add more sodium acetate.
- Repeat until some solid remains in the beaker.
- Filter the mixture while it is warm directly into a conical flask. Sometimes a solution may form crystals as it is being filtered but you should still have plenty of solution in the conical flask. Should crystals form in the conical flask, gently heat these until they are dissolved again.
- Cover the flask (to prevent dust entering the mixture) and leave to cool.

The hand warmer action can be started by adding a small amount of sodium acetate solid to the solution. It is also possible to start the freezing process by knocking or tapping the flask. The solution could also be poured gently and slowly onto a plate to form ice sculptures.

Where to buy

Sodium acetate trihydrate (sodium acetate – 3 water)		
Supplier	Cost / 500g (£)	Link
S+C	4.00	www.scichem.com
Philip Harris	4.95	www.philipharris.co.uk
Fisher	6.56	https://extranet.fisher.co.uk

It can also be purchased online for approximately £5 per kg (including postage). The quality may not be the same and it may be that larger quantities are needed to fully saturate the solution.

- Zip lock bags – these can be reused. As the hair snappers can pierce the bags it is important to use heavy duty bags. I used: polythene 'Clear reclosable bags – Extra Heavy duty 400 gauge (100 µ) 3"x 4" (76 x 102 mm)'.
- Hair snappers (hair clips) – these need to be quite stiff, and can be purchased from your local supermarket. Painted or plastic coated ones will last longer as they will not rust as quickly.

Safety information

Sodium acetate – 3 water is used as an additive in food and so as such has low hazards associated with it. You will not be using food grade sodium acetate and so the usual precautions about washing hands and cleaning up spills should be applied.

Although heavy duty zip lock bags have been suggested for use in the home made hand warmers they are still likely to pierce when using a hair snapper to activate. Care should be taken to ensure that the home made hand warmer is used only under adult supervision and in a location where a little spillage will not cause any damage.

When re-activating homemade hand warmers it is NOT possible to heat in the microwave or in a pan of boiling water as would be the case for commercial hand warmers. The plastic used in the bag has too low a melting point. The home made hand warmer can be placed in a beaker (or mug) of boiled water from the kettle. It may be necessary to replace the boiling water after a few minutes.

Appendix

SCN	Outcome description
LIT 2-02a	When I engage with others, I can respond in ways appropriate to my role, show that I value others' contributions and use these to build on thinking.
LIT 2-04a	As I listen or watch, I can identify and discuss the purpose, main ideas and supporting detail contained within the text, and use this information for different purposes.
LIT 2-05a	As I listen or watch, I can make notes, organise these under suitable headings and use these to understand ideas and information and create new texts, using my own words as appropriate.
LIT 2-06a	I can select ideas and relevant information, organise these in an appropriate way for my purpose and use suitable vocabulary for my audience.
LIT 2-09a	When listening and talking with others for different purposes, I can: ▶ share information, experiences and opinions ▶ explain processes and ideas ▶ identify issues raised and summarise main points or findings ▶ clarify points by asking questions or by asking others to say more.
LIT 2-10a / LIT 3-10a	I am developing confidence when engaging with others within and beyond my place of learning. I can communicate in a clear, expressive way and I am learning to select and organise resources independently.
LIT 2-15a	I can make notes, organise them under suitable headings and use them to understand information, develop my thinking, explore problems and create new texts, using my own words as appropriate.
LIT 2-21a	I can spell most of the words I need to communicate, using spelling rules, specialist vocabulary, self-correction techniques and a range of resources.
LIT 2-22a	In both short and extended texts, I can use appropriate punctuation, vary my sentence structures and divide my work into paragraphs in a way that makes sense to my reader
LIT 2-24a	I consider the impact that layout and presentation will have and can combine lettering, graphics and other features to engage my reader.
LIT 2-26a	By considering the type of text I am creating, I can select ideas and relevant information, organise these in an appropriate way for my purpose and use suitable vocabulary for my audience.
SCN 2-05a – Processes	I can apply my knowledge of how water changes state to help me understand the processes involved in the water cycle in nature over time.
SCN 3-05a	By contributing to experiments and investigations, I can develop my understanding of models of matter and can apply this to changes of state and the energy involved as they occur in nature.
SCN 2-15a – Properties (changes in substances)	By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed.
SCN 2-16a - Properties	I have participated in practical activities to separate simple mixtures of substances and can relate my findings to my everyday experience.
SCN 2-16b	By investigating common conditions that increase the amount of substance that will dissolve or the speed of dissolving, I can relate my findings to the world around me.
SCN 2-19a – Properties (chemical and physical changes)	I have collaborated in activities which safely demonstrate simple chemical reactions using everyday chemicals. I can show an appreciation of a chemical reaction as being a change in which different materials are made.
SCN2-20b – Topical Science	I can report and comment on current scientific news items to develop my knowledge and understanding of topical science.

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