Medium Term Plan
Energy - Heat

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P levels
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Primary Science Teaching Trust recommends that a full risk assessment is carried out before undertaking in the classroom any of the practical investigations contained in the plans.

Safety Note
PSTT advises teachers to refer to either CLEAPSS website or SSERC website for up to date health and safety information when planning practical activities for children.

Teacher's Notes: Energy - heat

Big Questions

- Is heat the same as temperature?
- What is the best colour for an ice cream van?
- Why does ice float?
- Can things keep getting colder?

Learning Objectives

Pupils will have opportunities:

- To explore heat energy and transfer

Answers

- Heat is the total energy of molecular motion in a substance. Temperature is a measure of the average energy of the molecules in a substance.
- If you paint your ice-cream van black, it will emit light energy and stay cooler. If you paint it white, some of the light energy will be absorbed and the van will become warmer.
- Ice floats because its water molecules are arranged in a lattice and are further apart than in liquid water. Ice is 9% less dense than water.
- Nothing can be colder than absolute zero on the Kelvin scale (-273.15^{o}C) because atoms would stop moving.

Quick review activities

- Listen to Why does the sun shine? by They Might Be Giants http://www.youtube.com/watch?v=uLpu2UP3rGI
- Play with contact/strip thermometers and watch the colour changes
- Try out mood rings – they are supposed to change colour according to your 'mood' (available on line)
- Experiment with heat sensitive paper/ mugs etc
- Experience hot and cold packs.
- Put a tub of water outside in the sun light and feel how warm it gets over the course of the day

Vocabulary relevant to this topic

- Temperature – how hot or cold something is
- Thermometer – used to measure temperature
- Heat- one way of moving/ transferring energy
- Expand – get bigger
- Contract – get smaller
- Insulator –material that stops heat transferring easily
- Conductor- material that lets heat transfer easily

- Hot, cold, gets bigger, gets smaller, burns

Background information about this topic

- Sometimes energy is transferred from place to place by heating. Heat was once thought of as an entity in its own right that heat flowed from hot bodies to colder ones. Today it is understood as a form of electromagnetic radiation (infrared) or the movement of particles in a substance.
- Particles that form substances are in constant motion and the hotter the substance the greater the movement of the particles. If a hot object is placed next to a cold one then energy if transferred to the colder object until they are at the same temperature. It is not possible for particles to stop moving altogether although scientists have got very close – this temperature is called absolute zero and been found by extrapolating a graph back to -273.15^{o}C. Helium becomes a liquid at -269^{o}C.

- Temperature is a measure of how hot or cold a substance is – it is not the same as the amount of thermal energy in the material. For example, two objects of different masses in the classroom will be the same temperature but the larger object has more thermal energy because of its size. A thermometer measures the temperature of something quantitatively – Celsius invented the 100 point scale used by many countries. Some places use the Fahrenheit scale which was devised from finding the coldest thing (in 1724 this was the freezing point of salty water) and calling that 0ºC. As a result the freezing point of water was then 32ºF and body temperature 98.4ºF.
- A thermal conductor allows energy to transfer by heating. Metals and diamond are good conductors because their particles are arranged in such a way that vibrations can pass through quickly. Graphite is a poor thermal conductor because of the way it is layered – it is good to allow the transfer of electrical energy though. Poor thermal conductors tend to have particles arranged more randomly and/or particles that are further apart.
- When objects are heated they expand because the volume increases: contraction is the opposite process. There are no changes in the number or size of particles in either case. The change in volume is because the vibrating particles take up more or less space.
- The sea temperature remains fairly constant because water has a large specific heat capacity (a lot of energy is transferred to heat 1 kg by 1ºC compared to most other substances). During the day the land warms up more quickly than the sea and this creates a convection current that moves air from the sea to the land: when the land is cooler than the sea the opposite happens. Water consists of 2 hydrogen and 1 oxygen atoms and below 4ºC the water molecules are attracted to each other forming 'loose' groups which take up more space than liquid water above 4ºC and so ice is less dense than water.
- At any temperature particles will have a range of energy levels - so that the fastest moving particles in a liquid will escape and is why evaporation happens at temperatures below boiling point. As the temperature increases more particles have the energy to escape until the majority do and this is boiling. The bubbles in boiling water do not contain air – they contain water vapour.

Energy - heat P1-3

Objective: To explore heat energy and transfer

Descriptions of intended outcomes at different levels of attainment

- Encounters experiences with heat energy (P1i)
- Shows intermittent responses to the different heat energy experiences (P1ii)
- Accepts and engages in coactive or shared exploration of hot and cold (P2i)
- Communicates consistent preferences /dislikes for particular events or temperatures (P2ii)
- Remembers some learned response for longer e.g. intentionally revisits an experience like touching the hot packs (P3i)
- Initiates interactions and activities e.g. switches on the fan heater or pick up a Chinese lantern (P3ii)

Energy - heat P1-3

Objective: To explore heat energy and transfer

Possible Activities:	Resources:
Experience putting hands and feet into water at different temperatures Experience coloured convection currents – place a stoppered jar of hot coloured liquid into a big jar of cold water. Then remove the stopper and watch. http://www.youtube.com/watch?v=nD5NHjdxRlY	Bowls, hot water, cold water, ice cubes. Big jar of cold water, tiny jar of coloured liquid e.g. red ink that is hot.

Optional activities you might like to try include:	Resources:
Experience hot and cold things Suspend a spiral cut form card above a heat source	Hot and cold packs, hair dryer or fan heater (hot and cold air), fan, hot water bottle, wheat bag, eye packs that are put in the freezer. Spiral, string, heat source e.g. lamp
Experience Chinese floating paper lanterns and/or home made hot air balloons (see website in general list). Experience Angel chimes or similar	

Points to Note:

Some floating Chinese lanterns contain wire and can harm livestock. You can buy biodegradable, wire-less ones.

If you make a hot air balloon attach some thin cotton so you can control how far it goes to avoid falling to earth in the wrong place

Energy - heat P4-6

Objective: To explore heat energy and transfer

Descriptions of intended outcomes at different levels of attainment

- Explores in the intended way and observes outcomes (P4i)
- Communicates awareness of changes in temperature or volume of liquid after freezing (P4ii)
- Anticipates activities and takes turns (P5i)
- Tries out the activities and responds to simple questions (P5ii)
- Makes sensory based comparisons with support (P6i)
- Completes a procedure following simple instructions (P6ii)

Possible Activities:	Resources:
Freeze liquids in sealed containers and observe what happens. Make colourful convection currents (see website in general list) and then let pupils put a jelly cube in the corner of a clear plastic tank and add hot water to a depth of about 25/30 cm and watch. Might be useful to video and play back	Small sealable containers, water, milk, pop, cooking oil, syrup, treacle. 4 identical bottles, hot and cold water. yellow and green food colouring, dark coloured jelly cubes, hot water, clear tanks

Energy - heat P4-6

Objective: To explore heat energy and transfer

Optional activities you might like to try include:	Resources:
Find objects round school that give our heat and hang different sorts of spirals above them. Find out what happens when different amounts of hot water are added to cold water – feel the before and after effects.	Access to back of fridge, radiator, heaters, computer, toaster, cooker, microwave, string, spirals
Using a yogurt pot and anything that will fit inside it find out who can keep an ice cube the longest Make hot chocolate in different sorts of mugs/ cups and let pupils feel the difference. Repeat wearing different sorts of gloves and talk about what they found.	

Points to Note:

Care with hot liquids.

Energy - heat P7-8

Objective: To explore heat energy and transfer

Descriptions of intended outcomes at different levels of attainment

- Responds to questions requiring an informed decision e.g. how much water shall we use? Which spoons do we need? (P7i)
- Makes a connection between the start and the end of the test (P7ii)
- Locates some of the right equipment to use for a simple test e.g. different spoons (P8i)
- Records result simply e.g. putting a red sticker on the hottest spoon or beginning to put the insulators in order (P8ii)

Possible Activities:	Resources:
Find out if heat transfers through spoons at the same speed. Feel them all after the same amount of time. Compare different sized metal spoons to see if there is a difference. Find out if different travel mugs or vacuum flasks keep things hot for the same time	Plastic , wooden, metal, silicon spoons, hot water, beaker or similar, timer, different sized metal spoons. Range of different makes of travel mug or flasks, thermometer, hot water or soup

Energy - heat P7-8

Objective: To explore heat energy and transfer

Optional activities you might like to try include:	Resources:
Freeze the same volume of water in different shaped containers and find out which shape freezes the fastest or slowest. What sort of shape would give you the fastest ice lollies? Talk about why there could be a difference Attach some wax crayons of different colours to a sheet of card using wire. Stand the card upright and then heat with a hairdryer and watch the crayons melt and run down the card	Different shaped containers, water, measuring jug or similar – mark level with tape so easy to measure. Different coloured wax crayons, hair dryer, white card, wire.
Find the best insulator to stop an ice pop melting. Talk about how to do this. E.g. ask where we need to put ice pops? Do they need to use the same colour ones? How much insulation will they use? Could develop by seeing if the colour of the ice pop makes a difference to how fast it melts or if the number of layers of insulation makes a difference. Show pupils what happens when a blown up balloon is gradually lowered onto a candle (it bursts!). Get them to fill balloons with water and do the same thing (it doesn't burst!)	

Energy - heat L1-3

Objective: To explore heat energy and transfer

Descriptions of intended outcomes at different levels of attainment

- Recognises and begins to describe changes in the experiments using everyday vocabulary e.g. hot, cold (L1i)
- Responds to prompts to say what happened and if it was expected (L1ii)
- Identifies what has changed when observing (L1iii)
- Draws on their observations and ideas to offer answers to questions (L2i)
- Identifies things to observe or measure that help to answer the question being investigated (L2ii)
- Responds to prompts to suggest different ways they could have done things (L2iii)
- Makes quantitative measurements (L3i)
- Identifies simple patterns in results (L3ii)
- Explains what they have found out in their experiments linking cause and effect (L3iii)

Energy - heat L1-3

Objective: To explore heat energy and transfer

Possible Activities:	Resources:
For some pupils it might be appropriate to demonstrate 'standard' conduction experiments e.g. drawing pins attached with wax on different metal rods	

Optional activities you might like to try include:	Resources:
For some pupils it might be appropriate to demonstrate 'standard' convection experiments e.g. coloured crystal in beaker of water heated at one corner	
For some pupils it might be appropriate to demonstrate 'standard' radiation experiments e.g. vacuum flask: comparing white/black or shiny/matt surfaces	

Energy - heat L1-3

Objective: To explore heat energy and transfer

Possible Activities:	Resources:
Make ice-cream in plastic bags: https://www.stevespanglerscience.com/lab/experiments/homemade-ice-cream-sick-science/	Various milks, ice, caster sugar, salt, large and small zip seal bags, flavouring (optional)

Optional activities you might like to try include:	Resources:
Feel different objects in the classroom. Which feel the coldest? Use thermometers to take the temperatures of different objects in the classroom	Various thermometers or data loggers

Points to Note:

All objects in the same room are at the same temperature – some feel colder because they transfer heat more rapidly away from our hands i.e. conductors.

Sometimes pupils think that cold is a substance that enters the body

If pupils want to taste ice cream prepare in hygienic conditions. Some pupils might be allergic to milk

Energy - heat L1-3

Objective: To explore heat energy and transfer

Possible Activities:	Resources:
Find out which volume of water gets hot the quickest by finding out how long it takes to heat 100 cm^3 and then 200cm^3 to 60^oC	Bunsens or other means of heating, water, measuring cylinders, beakers, tripod, gauze, thermometer.

Optional activities you might like to try include:	Resources:
Find out if the colour of a container makes a difference to how fast chocolate melts. Link to the colour of delivery vans delivering chocolate in the summer. After each turn of the egg timer (or 2 minutes) check to see if chocolate is soft. Can use unifix cubes to record if not melted after each visit – forms a 3D bar chart for some pupils.	Chocolate, timers (egg timers for some),lamp, coloured containers – paint plastic containers, unifix cubes
Make a fridge using terracotta pots. Put a smaller pot in a larger one and then fill the space between them with wet sand and cover top with a wet cloth. Try it to see how long a tub of ice cream or ice pop keep frozen. Try varying the space between the two pots. Does dry sand work? Or wet soil?	

Points to Note:

Some pupils think heat energy and temperature are the same.

Also some think that temperature is always hot not cold as well

This experiment should help to show the difference between heat energy and temperature. Both lots of water were the same temperature but the larger volume needed more heat transferring to get it to that point.