HEAT

REACH OUT

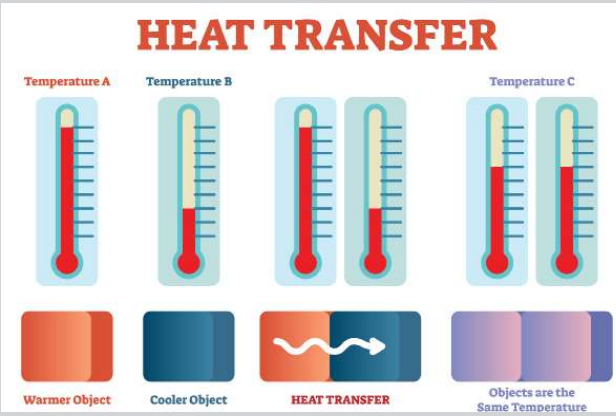
YEAR 6

name: class:

Knowledge Organiser • Particle and Chemical Reactions • Year 6

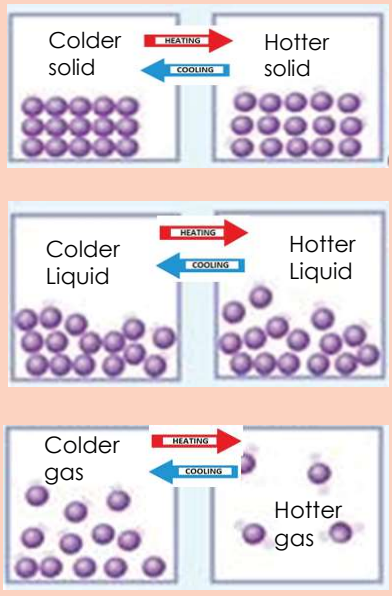
Properties of the particles in the three states of matter

Solid	Liquid	Gas
Particles are very close together In a regular pattern Particles cannot move but can vibrate	Particles are close together In a random arrangement Particles can slide past each other	Particles are far apart from each other In a random arrangement Moving constantly in all directions



Effect of heat on particles

- Heating particles makes them move more.
- In solids, they vibrate more in their fixed position.
- In liquids and gases, they move more quickly.
- As a result, substances expand when they are heated and contract when they are cooled.



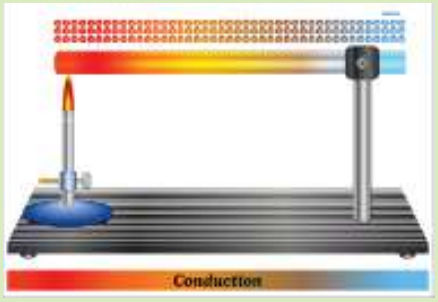
Heat transfer takes place when heat moves from a hotter object to a colder object.

Thermal equilibrium is reached when the heat is evenly spread between two or more objects.

Heat conduction - the process of heat energy being passed on between two objects in contact

Good conductors – materials that allow heat to pass through them easily (e.g. metals, graphite)

Good insulators - materials that DO NOT allow heat to pass through them easily (e.g cloth, plastic, wood)



Uses of Conductors

- Heating elements (e.g. the hot bits of toasters)
- Saucepans that contain food to be cooked
- From radiators
- Cooling fins on computers and car engines

Uses of Insulators

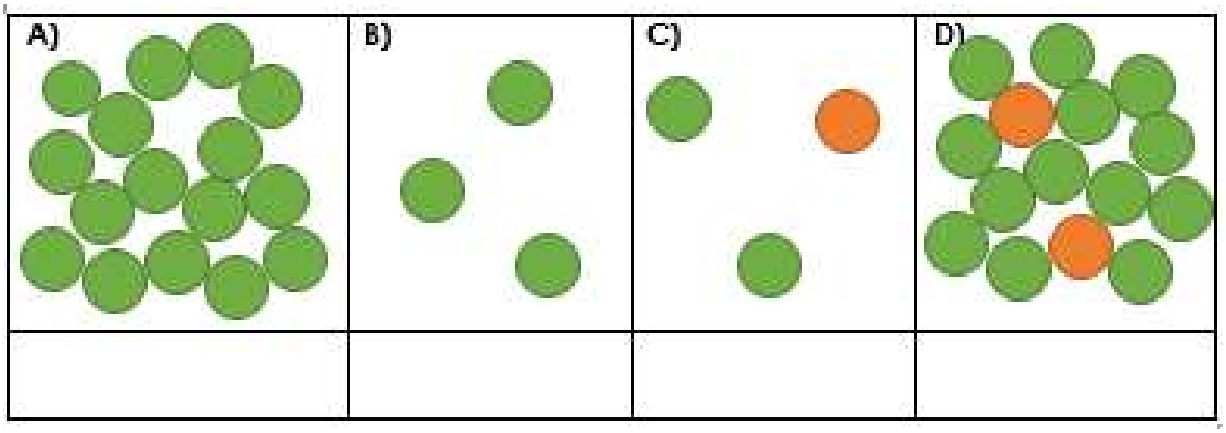
- Handles of saucepans
- Oven gloves
- The materials that coats are made from
- Through hot drinks containers
- Hair on your head or the fur coat of an animal

Lesson Question	You will learn	Learning Review
What happens when you heat particles?	• Describe how particles behave in solids, liquids and gases • Describe what happens to particles when they are heated • Explain what happens to particles when they change state	
Why does heat cause expansion in a substance?	• Describe what happens to a substance when it is heated • Predict whether an object will expand or contract • Suggest some engineering applications of this knowledge	
What is thermal equilibrium?	• Define what we mean by a thermal equilibrium • Describe how thermal equilibrium can be reached • Suggest ways that thermal equilibrium is reached more quickly	
How is heat transferred between particles?	• Describe how heat is transferred by particles through conduction • Describe a method to demonstrate the speed of conduction through metal • Explain why it is difficult to conduct heat directly through a liquid or a gas	
What are thermal conductors and insulators?	• Describe how heat is transferred by particles through conduction • Describe a method to demonstrate the speed of conduction through metal • Explain why it is difficult to conduct heat directly through a liquid or a gas	
How can we prevent heat from getting to an ice cube?	• Create a design to keep an ice cube frozen for as long as possible • Explain why your design will help the ice cube to stay frozen • Evaluate your design and suggest ways it could have	

Lesson
01 What happens when you heat particles?

Retrieval practice

1. Identify the particle diagrams below as a pure liquid, a pure gas, an impure liquid or an impure gas.



2. Why is a solution a mixture?

   A solution is a mixture because _____

3. Give 2 properties of liquids

   a. _____

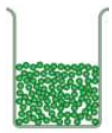
   b. _____

4. What do the following words mean?

   a. Soluble _____

   b. Insoluble _____

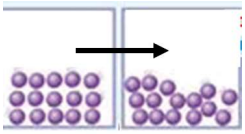
1. How could you show each of the following in a group of 4-5 students:

Solid 	• _____ • _____ • _____
Liquid 	• _____ • _____ • _____
Gas 	• _____ • _____ • _____

2. Read the following passage about phase changes

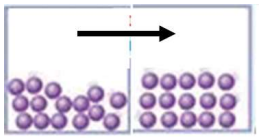
We know that particles can be arranged to make solids, liquids or gases but how do move from one phase to another?

When the particles in solids vibrate more and more as they are heated, some of their bonds start to break. This means the particles can begin to slide over each other which means they now form a liquid. This process is called melting.



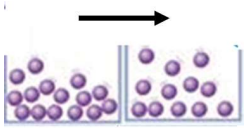
Melting

When these particles cool and move less, they become strongly bonded again and stuck in a fixed position – they have become a solid. We call this process freezing.



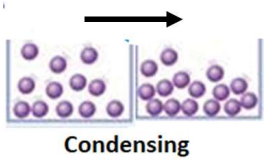
Freezing

When the particles in liquids move faster and faster as they are heated, the last bonds that were left start to break. This means the particles can begin to move freely and become far apart from each other. This means they now form a gas. This process is called boiling.



Boiling

When these particles cool and move less, they become bonded to each other again and are stuck together but can still move – they have become a liquid. We call this process condensation.



Condensing

3. Find answers to questions below in the passage on previous page

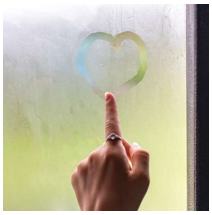
1. What happens to the particles in a solid when they are heated strongly?
   The bonds between some of the particles b_____ which means they can now s_____ o_____ each other. It has become a l_____ .

2. What happens to the particles in a liquid when they cool down a lot?
   The particles move more s_____ and become strongly b_____ together again. They are now in a f_____ p_____ and have become a s_____.

3. What happens to the particles in a liquid when they are heated strongly?
   Any bonds that are left over between particles now b_____ which means they can now move f_____ a_____ from each other. It has become a g_____.

4. What happens to the particles in a gas when they cool down a lot?
   As the particles move more s_____, the become b_____ together again. The are stuck together but can still s_____ p_____ each other and move so they have become a l_____.

4. Write down the phase change that is present in each example below and explain your choice

Example	Which phase change?	Why?
 When water forms on a mirror that you breath on		
 The steam produced from a kettle		

Example	Which phase change?	Why?
 Rain turns into snow		
 When a puddle turns to ice in cold weather		

5. You are going to practise acting out particles changing from a solid to a liquid and from a liquid to a gas and back again.

Can you act out:

1. Show particles in a solid become a liquid and then changing from liquid back to solid?
2. Show particles in a liquid become a gas and then changing from gas back to liquid?
3. Show particles in a solid change to liquid, then gas and back to liquid and back to a solid?
4. Show the phase change your teacher calls out.

6. Describe what happens to the particles in ice when it melts to become liquid

_____

_____

_____

7. Some substances will not exist as a liquid. How do you think the bonding between the particles in these particles will be different to other substances?

_____

_____

_____

Lesson
02

Why does heat cause expansion in a substance?

Retrieval practice

1. What happens to the particles in a solid when they are heated strongly?
   The bonds between some of the particles b_____ which means they can now s_____ o_____ each other. It has become a l_____ .

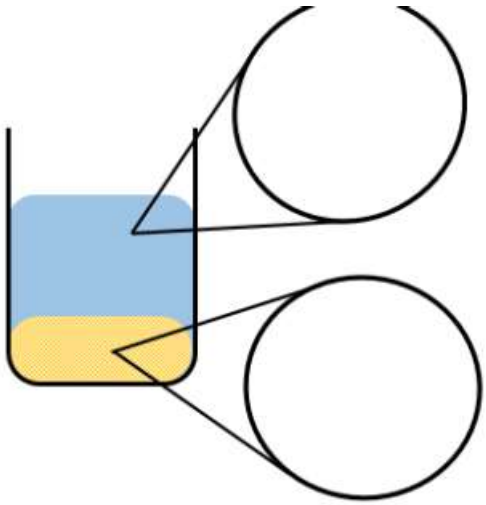
2. What happens to the particles in a liquid when they cool down a lot?
   The particles move more s_____ and become strongly b_____ together again. They are now in a f_____ p_____ and have become a s_____.

3. What happens to the particles in a liquid when they are heated strongly?
   Any bonds that are left over between particles now b_____ which means they can now move f_____ a_____ from each other. It has become a g_____.

4. What happens to the particles in a gas when they cool down a lot?
   As the particles move more s_____, the become b_____ together again. TheY are stuck together but can still s_____ p_____ each other and move so they have become a l_____.

From previous learning:

5. Complete the particle diagrams for this mixture of sand and water.

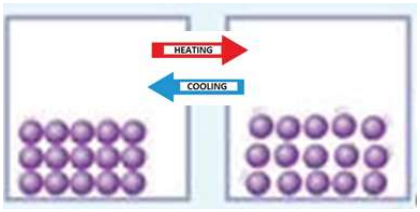


1. Read the following passage about heat and particles

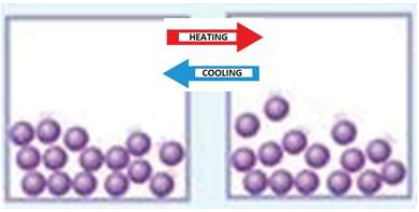
When heat is given to a substance, the particles in the substance begin to move more quickly. In a solid, this means that the particles will vibrate more. In a liquid and a gas, this means that particles will move with a faster speed.

When particles move more quickly, they push the particles around them more forcefully. This makes the particles spread out a bit more which means the substance they are in expands. This means the volume (the space taken up by the substance) increases.

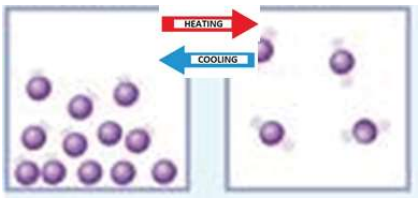
When a substance cools down, it loses some of its heat. This means the particles move less quickly. In a solid, this means that the particles will vibrate less and in a liquid and a gas this means that particles will move more slowly. As a result, the particles take up less room and the substance contracts (takes up less space).



Particles in a solid



Particles in a liquid



Particles in a gas

2. Find answers to questions below in the passage above

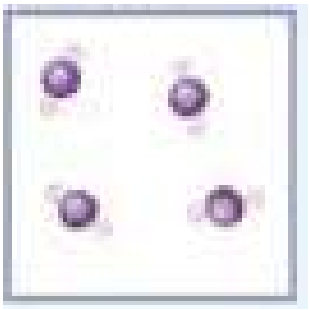
1. What to the particles in a substance if it is heated?
   If a substance is heated, the particles begin to _____.
2. What happens to the movement of particles in solids, liquids and gases when they are heated?
   In a solid, the particles will _____ more. In liquids and gases, the particles will move with a _____ .
3. What happens to a substance overall when it is heated and why?
   When a substance is heated it e_____ (this means the volume i_____). This happens because the particles push each other more _____ which makes the particles s_____ o_____.
4. What happens to a substance overall when cools down and why?
   When a substance cools, it c_____ (this means the volume d_____). This happens because the particles take up less s_____.

3. Act out 'cold' particles and 'hot' particles in solids, liquids and gases

4. Label of the diagrams below to show with one of the following:

- Cold solid
- hot solid
- cold liquid
- hot liquid
- cold gas
- hot gas

_____



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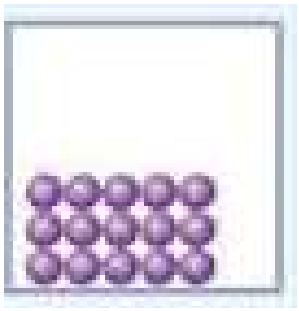


_____

_____

5. Discuss with a partner - how we might we be able to tell if a substance has expanded or contracted?

6. Watch the video of balloons being put into liquid nitrogen. What do you observe? Why does this happen? (https://www.youtube.com/watch?v=9vRMZSEF_a4)

7. How can heating and cooling be helpful in the following examples:

Putting a jar under the hot tap to help get the lid off	Heating the lid could be helpful because _____ _____ _____
Using liquid in a thermometer to tell temperature	Heating the liquid in a thermometer when you place it in something hot is helpful because ___ _____ _____
Cooling oxygen and hydrogen to put them into tanks	When storing gases like oxygen and hydrogen, cooling them is helpful because _____ _____ _____

8. Why might be dangerous to heat a gas when it is trapped in a metal can?

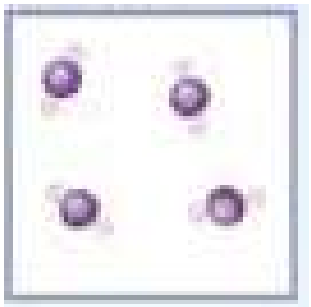
Lesson
03 What is thermal equilibrium?

Retrieval practice

1. Label of the diagrams below to show with one of the following:

- Cold solid
- hot solid
- cold liquid
- hot liquid
- cold gas
- hot gas

_____



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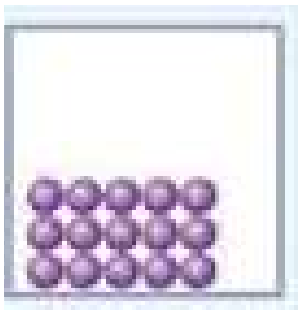
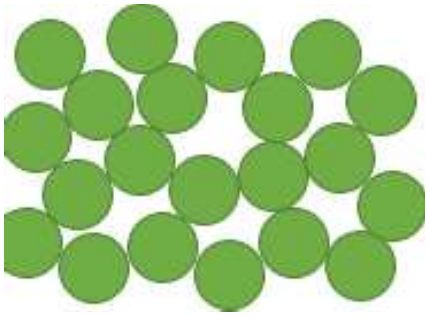


_____

_____

From previous learning:

2. Does this particle diagram represent a solid, a liquid or a gas?



How do you know? _____

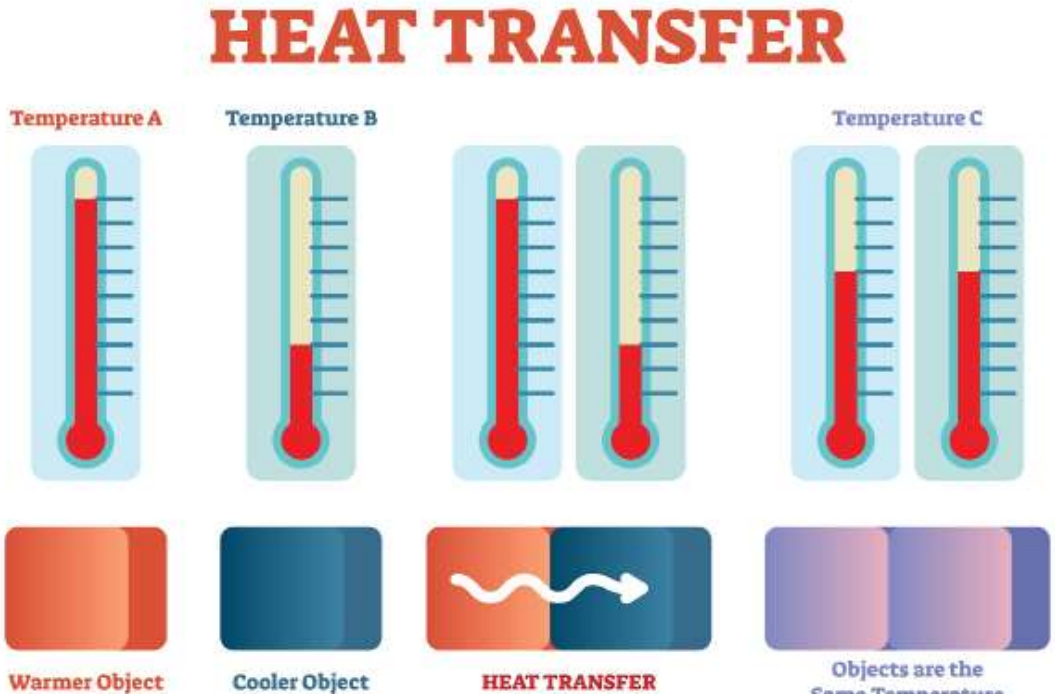
1. Place one hand in cold water and one hand in hot water for 1 minute. Then place both hands in room temperature water.
https://www.youtube.com/watch?v=gsgiYBGiYpU

Write down what you have observed: I observed that _____

_____

_____

2. Read the follow passage about thermal equilibrium



Whenever we say that something is 'hot' or that something is 'cold', what we are saying is that we find it hot or cold compared to us.

For example, hot water is hot to us because it is at a higher a temperature than us but it is much colder than, say, molten lava.

Equally, we would describe Ice Cream as cold but it is not nearly as cold as the South Pole.

3. What do we mean when we say something is 'hot'?

_____

_____

4. What do we mean when we say something is 'cold'?

This explains what happens when you put your hands in room temperature water when one hand has been in cold water and one hand has been in hot. The hand in the cold water finds the room temperature water warm by comparison it had been somewhere colder. The hand in the hot water finds the room temperature water cold by comparison it had been somewhere hotter.

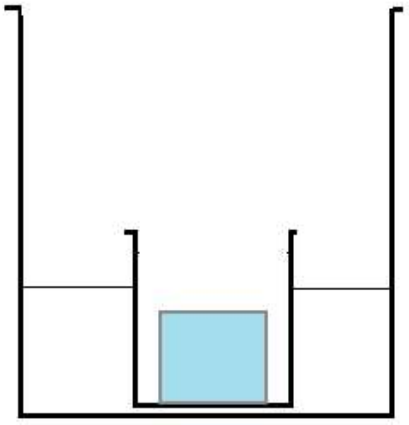
5. Why did the hand from cold water find the room temperature water 'warm'?

6. Why did the hand from hot water find the room temperature water 'cold'?

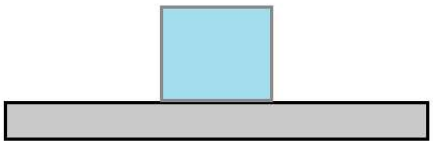
The amount of heat contained at a given place is known as temperature. The higher the temperature of an object, the more heat there is contained in that object. Heat will always travel from a warmer place to a colder place until the amount of heat has been spread about evenly. When the heat is evenly spread between two places, we say that the objects involved are in thermal equilibrium.

7. What has happened to the heat between two objects when they have reached 'thermal equilibrium'?

8. Observe the demonstration of objects reaching thermal equilibrium and add annotations to the diagrams below to show what happens:



Ice cube in a cup in a pan of boiled water



Ice placed in a metal pan

9. What happens to the heat in the following examples?

Example	How is heat transferred?
 Ice cream on an ice cream cone that begins to melt	In this example, heat moves from
 When someone stands outside without a coat on a cold day	In this example, heat moves from
 A bath that has just been filled up with hot water	In this example, heat moves from
 Shaking hands with someone whose hands are cold	In this example, heat moves from

10. Think of as many things that are hot or things that are cold as you can. Explain how heat moves to or from them to get to thermal equilibrium.

11. Discuss how we can stop from spreading to melt an ice cubes.

Lesson
04

How is heat transferred between particles?

Retrieval practice

1. What do we mean when we say something is 'hot' of if something is 'cold'?

   When we say something feels hot, we mean _____.

   When we say something feels cold, we mean _____.

2. Write down the phase change that is present in each example below and explain your choice

Example	Which phase change?	Why?
When water forms on a mirror that you breath on		
The steam produced from a kettle		
Rain turns into snow		
When a puddle turns to ice in cold weather		

From previous learning:

3. Match up the words with the correct definitions

Solute	When a solid cannot dissolve in a liquid
Solvent	A mixture of a solid that is dissolved in a liquid
Solution	A solid that has been dissolved into a liquid
Soluble	A liquid in which a solid has been dissolved
Insoluble	When a solid can dissolve in a liquid

1. Watch the demonstration of how heat can be transferred in a solid. Write down what you observe below (add a diagram to help you)

_____

_____

2. Read the following passage about heat conduction

As we have seen before, the more heat a particle has the more it vibrates (if it is a solid) or the more quickly it moves (it is in a liquid or gas). We have also seen that heat will transfer from an area of more heat to an area of less heat until thermal equilibrium is reached but how does this heat move from one area to another?

When two particles are in contact with one another, the vibrations of one particle will be passed on to another. If there are a long line of particles all in contact with one another, these vibrations are passed along the particles until they are all vibrating the same amount (they will have reached thermal equilibrium). This is how heat will spread through a solid. The process of heat energy being passed on between two objects in contact is known as heat conduction.

3. What happens to a particle in a solid as it gains more heat?

_____

_____

4. What happens to particles in contact when one particle is vibrating more than the others?

_____

_____

Conduction is used to heat objects or substances using a source of heat. One example of this saucepans on a stove during cooking. The hot hob passes heat on to the saucepan which spreads heat to the water or food that needs to be warmed up.

5. What is heat conduction?

_____

_____

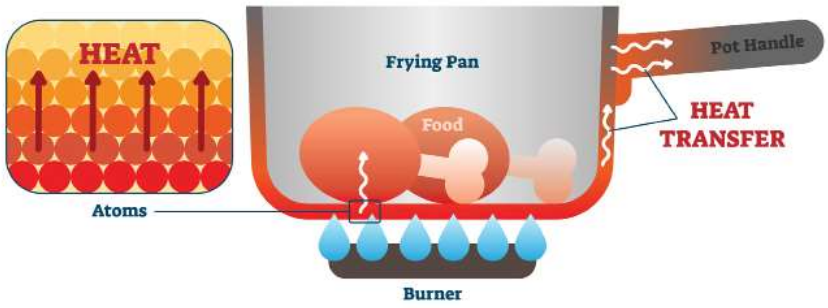
Another example is a Bunsen burner to heat a beaker in an investigation. A chemical reaction with the gas and the oxygen in the air heats the air which passes its heat on to the beaker which heats the mixture inside.

5. Give an example of an object heat is conducted through to warm up a substance:

_____

_____

6. Add annotations to the diagram below to show how heat is conducted through the handle of a saucepan.



7. Take part in the demonstration of heat conduction shown below

- Set up a metal knife (or another metal object) so that one side of the knife is directly above a candle
- Feel the other end of the knife and note how warm it feels
- Your teacher will light your candle – DO NOT PLACE YOUR HAND NEAR THE FLAME
- After every minute, gently touch the end of the handle of the knife and see how warm it feels
- Blow out the candle after 5 minutes and LEAVE THE KNIFE AND CANDLE TO COOL DOWN FOR 5 minutes

What did you observe over time?

_____

_____

Why do you think you observed this?

_____

_____

8. Why is it much more difficult for conduction to happen in a liquid or a gas?

Lesson
05

What are thermal conductors and insulators?

Retrieval practice

1. Describe why the following materials are used for each of the following situations:
   a. Plastic is used for handles of saucepans

   b. Iron (a metal) is used to make radiators

2. How do you calculate the density of a material?

From previous learning:

3. Are the following physical properties of a solid, liquid or gas?

Can flow and fill the bottom of a container	
Can be compressed	
Cannot change shape	

1. Read the passage below about thermal conductors and thermal insulators

Sometimes it is helpful for heat to be able to move quickly from one place to another but sometimes we do not want heat to move through something quickly.

Examples of each of these are given below:

Examples where would like heat to be transferred quickly	Examples where would NOT like heat to be transferred quickly
• Heating elements (e.g. the hot bits of toasters) • Saucepans that contain food to be cooked • From radiators • Cooling fins on computers and car engines	• Handles of saucepans • Oven gloves • The materials that coats are made from • Through hot drinks containers • Hair on your head or the fur coat of an animal

When we want a material to pass heat on quickly, we want to use a thermal conductor. Thermal conductors are materials that allow heat to pass through them easily.

2. What is a thermal conductor?

_____

_____

Almost every metal is an example of a good thermal conductors but some non-metals such as graphite and diamond.

3. Give an example of a good thermal conductor:

_____

_____

When we do not want heat to be passed on easily, we want to use a thermal insulator. A thermal insulator is a materials that does not easily allow heat to pass through it.

4. What is a thermal insulator?

_____

_____

Examples of good thermal conductors include cloth (such as wool or cotton), plastic and wood.

5. Give an example of a good thermal insulator

_____

_____

6. Give two examples of when a thermal conductor is needed:

1. _____
2. _____

7. Give two examples of when a thermal insulator is needed:

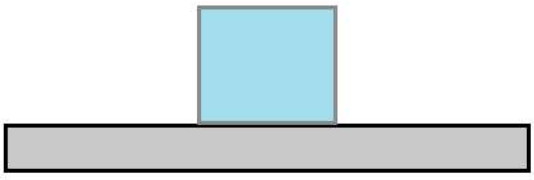
1. _____
2. _____

8. Do you think each of the following materials are thermal conductors or insulators? Use your teacher's help to put them into the right boxes

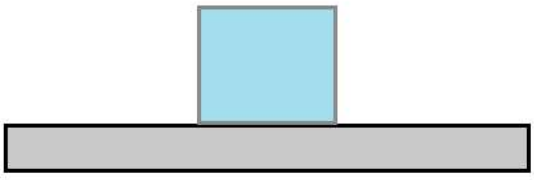
• Wood • Glass • Copper • Silver • Diamond • Rubber • Plastic • Aluminium • Cotton • wool

Thermal Conductors	Thermal Insulators

9. Watch the demonstration of the ice cube on an insulator and a conductor. Annotate the diagrams below to show what you observe



INSULATOR



CONDUCTOR

10. Why are each of the following materials used in the application stated?

1. Plastic is used for handles of saucepans

_____

_____

2. Iron (a metal) is used to make radiators

_____

_____

Write down and explain the use of any other thermal insulators or conductors:

_____

_____

_____

11. Write down whether each of the following materials are conductors or insulators (look back in your notes if you can't remember)

Cotton wool is a _____

Diamond is a _____

Rubber is a _____

Plastic is a _____

Wood is a _____

Silver is a _____

Glass is a _____

Copper is a _____

Aluminium is a _____

12. Why does it feel cold when you sit on a metal bench but it does not feel cold to sit on a wooden bench?

Lesson
06

How can we prevent heat from getting to an ice cube?

Retrieval practice

1. What is a thermal conductor?

2. What is a thermal insulator?

3. Give two examples of when a thermal conductor is needed:

4. Give two examples of when a thermal insulator is needed:

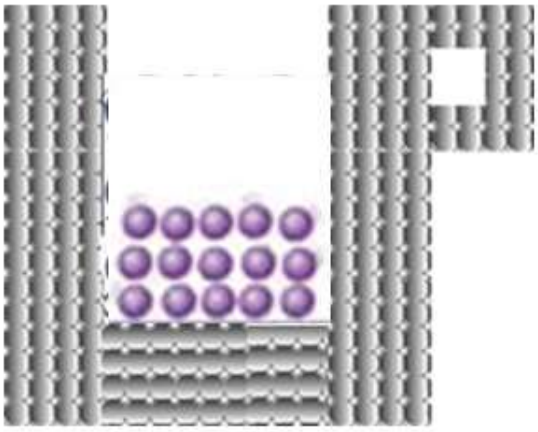
From previous learning:

5. Are the following physical properties of glass, ceramics or plastics?

Transparent, high melting point, does not conduct, brittle	
Poor conductors, lower melting point, malleable	
Opaque, high melting point, does not conduct, brittle	

1. Why is this model of an ice cube in a cup not completely accurate?

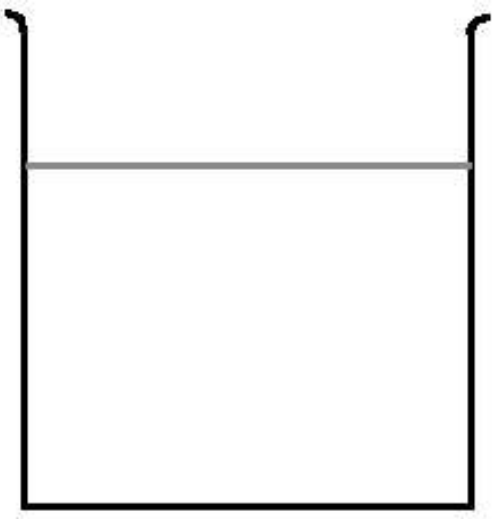
2. How is this model better? How could it be improved further?



3. You are going to investigate how to stop an ice cube melting for as long as possible.

4. Discuss what you could do to stop an ice cube from melting quickly. Write down your ideas in the box below

5. Draw out your design to show the materials you are going to use to try and keep your ice cube solid for as long as possible



6. Results:

Which ice cube?	Time taken to melt
Control ice cube	
Your group	
Another group	

We found that _____

_____

_____.

The group that kept their ice cube solid for the longest were _____.

They did this by _____.

Evaluation:

Things we did well with your design:

- _____
- _____

Things we would do if we could do it again:

- _____
- _____

7. Which kind of companies would find your research helpful for their products?

REACH OUT

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