**MATERIAL WORLD – MATTER**

**Electronic Science LabBook**

***Designed by HMG and FHR***

When you are required to put an answer in this booklet, the point at which you start typing is marked with a **red X.** Your typed answer should also appear in **red**. Delete the **X** leaving just your answer.

If you are required to paste or draw something, this is stated in **BLUE.** You can then photograph your work and paste it into this LabBook. In many experiments and investigations, you will be asked to photograph or video the experiment. You should insert these in the appropriate place in this LabBook.

When you are asked to look at a website for information to write an answer don’t just cut and paste the information in. Read the information and write an answer in **YOUR OWN WORDS**. You may wish to discuss your answer with your classmates and teacher first to make sure you understand it correctly.

For additional work (e.g. homework, revision) you will use the following books. You will be told which pages to use.

1. SciPad – pages 48-67
2. Science World 9 textbook (written as SW9) – chapter 3, pages 36 – 58.

# Learning outcomes for this topic

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# The three states of matter

## Describe the three states of matter

Reference: SW9 Pg 37

### Task 1

Everything around us is made of matter. Take pictures of 3 objects around the school- you have only 5 min. Insert these pictures in the table below

|  |  |  |
| --- | --- | --- |
|  |  |  |

### Task 2

Measure the mass using the electronic balance and calculate the volume. Fill in the table below X

|  |  |  |  |
| --- | --- | --- | --- |
| Object name | Estimated mass | Measured mass | Calculated volume (l x b x h) |
| Small Book |  |  |  |
| Tissue box |  |  |  |
| White board duster |  |  |  |

All matter has X and occupies X

All matter can be organised into 3 states of matter - X, X and X

### Task 3

Watch the video <http://www.youtube.com/watch?v=bMbmQzV-Ezs>

And go through this website

<http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/particle_model/revision/1/>

### Task 4

Experiment on properties of the 3 states of matter, see text book. SW9 Pg38.

Perform experiment

Fill in the table X

|  |  |
| --- | --- |
| Statesofmatter | Properties |
| Can be weighed | Occupy space | Fixed shape | Fixed volume | Can be compressed |
| Solids | √ |  |  |  |  |
| Liquids | √ |  |  |  |  |
| Gases | √ |  |  |  |  |

## https://encrypted-tbn3.gstatic.com/images?q=tbn:ANd9GcT_kSX1AN9CcdhoKTxcARVdOeXJOZJU0YbH2sBnpsBbNT39ShdxDescribe and explain changes in state, linking to heating and cooling

Reference: SW9 Pg 45

### Task 5

Find a diagram showing how we can change between the three states of matter and paste it here

### Task 6

The table below lists five changes of state. For each change decide whether heating or cooling is needed. Place a tick ( √ )in the correct column and fill in final column. X

|  |  |  |  |
| --- | --- | --- | --- |
| Change of state | Heating | Cooling | Energy taken in or energy released |
| Solid to liquid |  |  |  |
| Liquid to gas |  |  |  |
| Liquid to solid |  |  |  |
| Gas to liquid |  |  |  |
| Solid to gas |  |  |  |

The boiling point of water is X °C, whereas the melting point of water is X °C.

What is the physical state of water at these temperatures?

45 °C X

125 °C X

-23 °C X

75 °C X

### Task 7

Here are the melting and boiling points of some elements. What state are they at 25 °C?

|  |  |  |  |
| --- | --- | --- | --- |
| Element | m.p.(0C) | b.p. (0C) | State at 250C |
| Chlorine | -101 | -34 | X |
| Iodine | 114 | 184 | X |
| Fluorine | -220 | -188 | X |
| Bromine | -7 | 59 | X |

# http://www.teachengineering.org/collection/cub_/lessons/cub_images/cub_intro_lesson05_activity1_clipart1.jpgThe particle theory of matter

## Describe the kinetic theory of matter

Reference: SW9 Pg 46-49



### Task 8

Go to <http://library.thinkquest.org/C0110228/molecules/kinetic.htm> and <http://everythingscience.co.za/grade-10/03-states-of-matter/03-states-of-matter-02.cnxmlplus>

 and summarise the main points about the kinetic theory of matter

X

Go to <http://www.youtube.com/watch?v=Y8j6peP5nNg> which is a youtube video (5 mins) to help explain the kinetic theory of matter

Go to <http://phet.colorado.edu/en/simulation/states-of-matter-basics> which is an excellent for simulations (as shown in the youtube video above)

### Task 9

Practice writing long answers: put your ideas together about solid/ liquid/gas in to 3 paragraphs.. The solid part is done for your – you need to write descriptions for the liquid and gas

|  |  |  |  |
| --- | --- | --- | --- |
| States | Solid | Liquid | Gas  |
| Description  | Particles are arranged in a regular way and are very close together. There are strong attractive forces holding the particles together in a fixed position. The particles have a small amount of energy and can only vibrate. They are unable to move freely. |  |  |

Temperature of the substance is related to the average X (two words) of particles.

For particles to theoretically stop moving, they have to be cooled to -273.15°C. This temperature is called X (two words)

For experts –

go to <http://www.youtube.com/watch?v=28F_oPDZHSk>

and <http://www.youtube.com/watch?v=TNUDBdv3jWI>

(this will NOT be tested)

## http://cambodianwriter.files.wordpress.com/2013/03/clipart_of_water-drop-cartoon.jpgLink the kinetic theory of matter to the three states of matter

Change of state

* When substances are heated or cooled, a change of state may occur.
* This is a physical change as a new substance has not been formed, a physical property of the substance has changed.
* We can use particle theory to explain changes of state.

### Task 10

Fill in the process names:

 X

  

X

X

X

X

 X

<http://www.docbrown.info/page03/3_52states/3_52statesQ.htm>

Explaining melting (solid-liquid) in terms of the kinetic theory of matter

When a solid is heated the particles gain more kinetic energy and vibrate faster.

At the melting point the particles have gained so much energy and vibrate so much that they are moving fast enough to overcome the forces of attraction between the particles and move far enough apart so that they can slide past each other. When this happens the solid becomes a liquid.

### Task 11

Explain what happens when water boils. (the quality of answer required is modelled above)

In your answer include the concepts of *moving particles*, *energy*, *forces of attraction*, *distance between particles*.

X

### Task 12

Experiment on heating ice until it boils, see textbook SW9 page 49+50

Perform the experiment

Complete the table: X

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Time (min)  | 0 | 0.5 | 1.0 |  |  |  |  |  |  |  |  |  |  |  |
| Temp(0C) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Graph your results: X

Answer the ‘Questions and Conclusions’ and the ‘Challenge’ on page 50 X

States of Matter Task: use 3 colours to group statements about the three states of matter.

### Task 13

One statement in each column highlighted in magenta is done for you - there are other characteristics that also belong to the solid state, highlight them in magenta as well.

Highlight all the statements about liquids in green

Highlight all the statements about gases in yellow

 Solid Liquid Gas

|  |  |  |
| --- | --- | --- |
| Arranged in rows | Not able to change places | Spread to fill container |
| Takes on the shape of the container | Not arranged in any particular way | Fixed shape |
| Examples of Solids =* Ice,
* Table,
* Pencil,
 | Examples of Gases=* Oxygen,
* Carbon Dioxide,
* Sulfur Dioxide,
 | Move about and change places |
| Relatively close together | Not held together as tightly as solids | Fixed volume |
| Can be easily compressed | Particles are far apart | Very weakly held together |
| Particles are held close together tightly | Particles Flow | Move very fast in all directions |
| Particles vibrate | Solid  | Examples of Liquids=* Water,
* Juice,
* Coffee,
 |
| Gas |

# https://encrypted-tbn1.gstatic.com/images?q=tbn:ANd9GcT_SKGV6AB4QT_rXMazgEkSxBmCfIZ2dLFU7sdIavAAplz8Z06Rr-IcSwExplain the properties of matter

## Describe some physical properties of matter

### Task 14

Watch the video /presentation, then complete this table

|  |  |
| --- | --- |
| Properties | Meaning |
| State |  |
| Colour  |  |
| Density |  |
| Solubility |  |
| Malleability |  |
| Shape  |  |
| Mass  |  |
| Volume  |  |
| Melting point |  |
| Boiling point |  |
| Conductivity |  |

This is a song about physical properties:

<http://www.youtube.com/watch?v=uJOGy0dgmUU&list=PL1B5C9748DDFF1499>

### Task 15

Explaining the properties of matter in the three states of matter

Why do solids, liquids and gases have their own distinct properties? Let’s look at them at microscopic level.

Homework, please preview these websites before you come to class.

<http://www.chem.purdue.edu/gchelp/liquids/character.html>

<http://www.youtube.com/watch?v=s-KvoVzukHo>

<http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/particle_model/revision/2/>

Explaining properties:

### Task 16

Put down your ideas about how

particles in each state are arranged,

the strength of attraction forces

and how they move around.

|  |  |  |  |
| --- | --- | --- | --- |
| State | Solid | Liquid | Gas |
| **The arrangement of the particles** *(regular or irregular)* |  |  |  |
| **distance between particles***(small or large)* |  |  |  |
| **Strength of attractive forces between particles***(strong or weak)* |  |  |  |
| **Speed of particles** *(fast or slow)* |  |  |  |
| **Example in pictures** |  |  |  |

Answer the following in small paragraphs:

1) Explain why air is able to be compressed? X

2) Explain why we can pour liquid and gas but not solid? X

## https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQlXzPHBoMSvJYvWH77KBB-Wipx53Wo2pY8KB9S3CTJ2hO0DC8jUnderstand that density is mass per unit volume and use the formula density=mass/volume

## Link density to floating and sinking.

Density is how much mass is packed in to a measured volume. Density tells us something about how tightly packed the particles are in a substance. The following is a table showing the density of some substances.

|  |  |
| --- | --- |
| substance | http://wonderingfair.files.wordpress.com/2012/09/dead-sea-man-floating.jpgDensity (g/cm3) |
| air | 0.0013 |
| cork | 0.2 |
| ice | 0.9 |
| water | 1.0 |
| aluminium | 2.7 |
| iron | 7.8 |
| lead | 11.3 |
| mercury | 13.5 |
| gold | 19.3 |

A substance will float in water if its density is less than the density of water; while a substance will sink in water if its density is greater than the density of water

Name two substances that will float in water. X

Name two substances that will sink in water. X

Name a substance that will sink in water but float in mercury.X

Look up the average density of the human body X

Explain why the man in the photograph above is able to float in the Dead Sea (in the Middle East)? X

### Task 17

Explain why we use aluminium rather than iron to make air plane parts? X

Go to the simulation at <http://phet.colorado.edu/en/simulation/density> and investigate what is happening.

Calculating density

If we know the mass and the volume of a substance, we can calculate its density by using the formula

density = mass/volume

mass = density x volume

volume = mass / density

### Task 18

Experiment on measuring density

Reference: SW9 page 41

Note that 1mL = 1 cm3

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Object | Mass (g) | Initial volume (mL) | Final volume (mL) | Volume of object (mL) | Density (g/cm3) |
| pebble | 10.5 g | 10.0 mL | 12.6mL | 12.6mL-10.0mL= 2.6 mL(or 2.6 cm3) | d = m/V = 10.5/2.6 = 4.04 g/cm3 |
| X |  |  |  |  |  |
| X |  |  |  |  |  |
| X |  |  |  |  |  |

When you do calculations you MUST:

1. Show the formula you are using
2. Show the numbers you are using
3. Calculate the answer
4. Give units for the answer

### Task 19

1. If you know that a small piece of gold has a mass of 20g and a density of 19.3 g/cm3, calculate its volume.

X

1. If you know that a small piece of aluminium has a volume of 50cm3 and a density of 19.3 g/cm3, calculate its mass.

X

## Explain expansion and contraction as a change in density

## Link expansion and contraction of a substance to heating and cooling, the kinetic theory of matter and the three states of matter

**Expansion & Contraction**

Reference: SW9 Pg 55

Substances **expand** or get bigger when they are heated up. Substances **contract** or get smaller when they are cooled down. This property can be useful e.g. the liquid in thermometers expands and occupies more space, so the liquid rises up the thermometer.



Materials expanding and contracting can also cause problems e.g. railway lines expand in the summer heat and need special joints to stop them bending out of shape.

**What do the particles do**

When substances expand or contract, their particles stay the same size. It is the space between the particles that changes:

The particles in a **solid** vibrate more when it is heated, and take up more room

The particles in a **liquid** move around each other more when it is heated, and take up more room.

The particles in a **gas** move more quickly in all directions when it is heated, and take up more room.

**Solids, liquids & gases all expand (get larger) when heated. When they are cooled they contract (get smaller).**

As a solid is heated the particles gain e and vibrate more violently and start to bump in to each other. This causes them to move further a so that they have more s, therefore the solid as a whole ex.

When a solid expands, the mass stays the same, but the v increases, therefore what will happen to the density? X

When the solid is cooled the particles lose e and vibrate more slowly. This causes them to slow down, move c together and occupy less s, therefore the solid as a whole c .

When a solid contracts, the mass stays the same but the v decreases, therefore what will happen to the density? X

Water is an exception !! - find out about the expansion of water. X

## Explain some uses and problems associated with expansion and contraction

Look at the following pictures pictures – the harbour bridge (a metal bridge), a join in the structure of the harbour bridge and power lines in summer.





### Task 20

1. Explain why the harbour bridge requires finger-like joins in the bridge structure. Explain what would happen in summer when it is hot and in winter when it is cold.

X

1. Explain why the power cables, which are made of metal, droop so much in summer when it is hot. Describe and explain what would happen in winter when it is cold.

X

## http://free.clipartof.com/176-Free-Cartoon-Owl-Clipart.jpgKnow that different substances expand/contract at different rates

### Task 21

Experiment on Bimetallic strip (solid metals of different types):

Take a picture and insert here and then describe and explain your observation:

|  |  |
| --- | --- |
| Picture | Explanation X |

Experiment on ball and ring (solids):

Take a picture and insert here and then describe and explain your observation:

|  |  |
| --- | --- |
| Picture | Explanation X |

Demonstration of coloured water in a tube(liquid):

Take a picture and insert here and then describe and explain your observation:

|  |  |
| --- | --- |
| Picture | Explanation X |

Demonstration of balloon on top of flask (gas)

Take a picture and insert here and then describe and explain your observation:

|  |  |
| --- | --- |
| Picture | Explanation X |

Some interesting facts

1. When liquids and gases get hot they expand, just as solids do. When heated by the same amount, liquid expands about 10 times more than solids, and gases expand about 1000 times more than liquids.
2. Different substances expand and contract by different amount.
3. Water is an exception, when it is heated, it expands, but when it is frozen, it also expands.
4. All gases expand at the same rate

### Task 22

Watch the collapsing can experiment - video <http://www.youtube.com/watch?v=FjYB8hgkvOU>

 Explain how it works - Use particle theory, including particles/ kinetic energy/forces/density. X

Watch videos about hot air balloons- video <http://www.youtube.com/watch?v=Ev9xlnWseyw>

and <http://www.youtube.com/watch?v=wBAes6MMa40>

Explain how a hot air balloon can rise? Use particle theory, including particles/ kinetic energy/ forces/density. X



## Link diffusion of a substance to the kinetic theory of matter

Reference: SW Pg 53,54

### Task 23

Definition: Diffusion is X



Watch <http://www.youtube.com/watch?v=VY0mZUDvbH4>

and <http://www.youtube.com/watch?v=KRLNDTmBFZY>

Demonstration of diffusion of gases (teacher only demo , hazardous substances used)



Watch <http://www.youtube.com/watch?v=S9yuoLkfI3E>

 and <http://www.youtube.com/watch?v=L41KhBPBymA>

Explain the formation of the ‘white smoke’ X

Which gas moved faster? X Explain your answer X

Demonstration of diffusion in liquids (teacher only demo , leave for a few weeks)

Place some water in a large measuring cylinder. Add about 50mL of dilute acid and some universal indicator. Leave to settle. Then drop in large crystals of sodium carbonate (washing soda) and drop in a little more acid carefully. Leave it to settle and observe every day

Take a photograph and place it here

Explain what is happening X

### Task 24

Experiment to show diffusion in liquids

Place some water in a large petri dish and let it become very still. Place a few crystals of potassium iodide at one side and a few crystals of lead nitrate on the opposite side. Watch until something happens. Take a photograph and place it here

Explain what has happened. X

In biology, we get diffusion of substances through membranes – the membranes have tiny holes in them through which the substance can move.



The movement of water through a semi-permeable membrane is given a special name - it is called X.

Watch <http://www.youtube.com/watch?v=OXCKjhE1xco> diffusion and osmosis in cells

Watch <http://www.youtube.com/watch?v=wyJyDvQ6zaI> to illustrate osmosis in raisins

Go to the simulation at <http://phet.colorado.edu/en/simulation/membrane-channels> and investigate what is happening.

### Task 25

Experiments with Dry Ice (solid carbon dioxide)

Experiment 1: Put dry ice in a balloon.

Observation and explanation: X

Experiment 2: Put a piece of dry ice into a film canister.

Observation and explanation: X

Experiment 3: Put a piece of dry ice into a beaker with a little water in it.

Observation and explanation: X

Experiment 4: Pour the gas from experiment 3 into another beaker and put a lit splint into it.

Observation and explanation: X

Experiment 5: Put some water into a beaker with a little bit of universal indicator in it along with a piece of dry ice.

Observation and explanation: X

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### Task 26

Practising comparison explanations:

Step 1: write a general statement (a topic sentence) about solids, liquids and gases.

X

Step 2: write a sentence or two comparing and contrasting the distance between particles.

X

Step 3: write a sentence or two comparing and contrasting the forces between particles.

X

Step 4: write a sentence or two comparing and contrasting the speed of the particles.

X

### Task 27

Compare and contrast the difference between evaporating and boiling in a paragraph.

Use a contrasting linking word from here: (whereas, even though, but, while, less than, although, unlike, yet, however, different from, whilst…)

X