Vocabulary:

1. Model: A model is a visual representation of something that we cannot see.
2. Solid: A substance is a solid when it has a fixed shape that cannot be changed.
3. Liquid: A substance is a liquid when it can be poured and takes on the shape of a container.
4. Gas: A gas is a substance that fills any space and cannot be seen (there are exceptions).
5. Diffusion: Diffusion is a process in which particles in liquids and gases move from a highly concentrated to a lower concentration area of those particles.
6. Heating: Heating occurs when energy is added to a substance and there is a rise in temperature.
7. Cooling: Cooling occurs when energy is removed from a substance and there is a fall in temperature.
8. Density: Density is the amount of mass for a given volume of the material.
9. Pressure: Pressure is the force that gas particles exert on the walls of a container and other particles by colliding with the walls and the particles.
10. Macroscopic: What we can see with the naked eye and experience with our senses
11. Microscopic: What we cannot see with the unaided eye

Notes

1. A model is used to explain the behaviour of particles because particles are too small to see.
2. Atoms and molecules are referred to as particles in the particle model of matter.

We represent these particles as circles.

1. THE PARTICLE MODEL OF MATTER STATES:

1. All matter is made up of particles.
2. The particles are continuously moving.
3. The particles have spaces between them.
4. The particles exert forces on each other.
2. **Explanation**
   a. The particle model of matter is a scientific model that we use to explain the properties and behaviour of matter.
   
b. We refer to an atom or a molecule as a particle in the particle model of matter.
   
c. The particles are represented as circles.

**Questions**
1. What is the particle model of matter?
2. What are the particles that are mentioned in the particle model of matter?

**Explanation**
   a. All substances, such as air, water, wood, metal and plastic, are made up of tiny particles, which are atoms and molecules.
   
b. These particles are so small that we cannot see them, even when we use a microscope. We say that they are **microscopic**.
   
c. The particle model of matter is a representation of the particles that we cannot see.
   
   *Atoms and molecules are not really circles but circles are easier to draw.*
   
d. The particles are constantly moving.
   
e. The energy that the particles have is known as kinetic energy or movement energy.
   
   *How fast or slow the particles move depends on the amount of energy they have.*
   
f. The spaces between the particles are empty. There is nothing in the spaces, not even air, because air is actually made up of oxygen and nitrogen particles.
   
g. There are forces of attraction between the particles.

**TASK**
Draw a square in your book. Draw ten circles inside the square. These circles represent the particles of a substance. Indicate the four principles of the particle model of matter in your drawing.

**Questions**
3. What is between the particles in a substance?
4. What is the energy called that the particles have due to their movement?

*What are the principles of the particle model of matter? (Answer: All matter consists of particles that are constantly moving and exerting forces on one another. There are spaces between the particles.)
Lesson Title: States of matter: Solids

Notes

**Macroscopic Properties of a Solid**

1. Matter can exist in a solid state.
2. A solid has a definite shape. It can be hard, soft or powdery.
3. A solid occupies a definite space.
4. Solids cannot be compressed.

**Microscopic Properties of a Solid**

1. The particles of a solid are closely packed and arranged in an orderly way.
2. There are strong forces between the particles in a solid.
3. The particles of a solid vibrate about fixed points in one place.
4. There are small spaces between the particles.

**Questions**

5. What can you say about the shape of a solid?
6. How do the particles of a solid move?

**Explanation**

a. Salt is a compound and consists of sodium atoms and chlorine atoms.

b. Let us explain the macroscopic properties of a solid by looking at the microscopic properties of the particles. We will use a salt crystal as an example.

c. The salt crystal is hard because the particles are very closely packed together.

d. The crystal is rigid and has a fixed shape because the particles are packed in an orderly arrangement and there are strong forces of attraction between the particles.

e. The shape of the salt crystal will remain the same even when we apply force with our hands.

f. The salt crystal cannot be compressed because there are small spaces between the particles.

g. Even though we cannot see or feel it, the particles of the crystal are vibrating but they have low kinetic energy.

**TASK**

Complete the following task in your workbook.

1. Choose any solid object.
2. Draw the solid and list the properties that you can see.
3. Use the particle model of matter to draw the particles of the solid.
4. List the microscopic properties of the object.
Questions
7. Why does a solid object have a definite shape?
8. Why is a solid not compressible?

*How are the particles of a solid arranged? (Answer: The particles of a solid are arranged in an orderly way with small spaces between them).

Lesson Title: States of matter: Liquids
Notes
Macroscopic Properties of a Liquid
1. Matter can exist in a liquid state.
2. Liquids are runny. Some liquids are more runny than others.
3. A liquid has a definite volume.
4. A liquid takes the shape of its container.
5. Liquids are not easily compressible.

Microscopic Properties of a Liquid
In a liquid the particles:
6. are loosely arranged but are still in contact.
7. are constantly moving and sliding past each other in all directions.
8. have weaker forces between them.
9. have small spaces between them.

Explanation
a. Liquids can flow and can be poured from one container to another.
b. Liquids do not have a definite shape but do have a definite volume. They take on the shape of the container they are in.
c. Weak forces exist between liquid particles but the forces are still strong enough to keep the particles in contact with each other.
d. Liquid particles do not have fixed positions but move freely around.
e. The liquid particles slip and slide past each other.

Questions
9. What is a property of a liquid?
10. How do the particles of a liquid move?
**TASK**
Write the following paragraph in your workbook and fill in the missing words.
The particles in _____ are still close together but are arranged more loosely. Particles of solids are arranged in a more ______pattern. Particles can move _______ in a liquid and ______ over each other in _____ directions. The forces of attraction are _______ in solids than liquids. The spaces between liquid particles are still small, although the spaces are _______ than in a solid. Liquid particles have _____ kinetic energy than that of solids.

**Questions**
11. Why are liquids runny?
12. Does a liquid have a fixed volume or a fixed shape?

*How do the particles of a liquid move? Answer: The particles slide over one another in all directions and do not have a fixed position.

**Lesson Title: States of matter: Gases**

**Notes**

MACROSCOPIC PROPERTIES OF A GAS
1. Matter can exist in a gaseous state.
2. Most gases are colourless and not visible.
3. A gas has no definite shape or volume and will fill all the available space.
4. A gas can be compressed into a smaller space.

MICROSCOPIC PROPERTIES OF A GAS
In a gas the particles
1. have no particular arrangement.
2. move very fast in straight lines until they collide with another particle of the walls of the container.
3. have extremely weak forces between them.
4. have very big spaces between them.

**Explanation**

a. Most gases are not visible but there are a few that are coloured and that we can see. For example, chlorine gas is green.
b. A gas has no definite shape but it spreads out to fill the available space.
c. A gas is compressible.
d. The particles of a gas are constantly moving freely in all directions.

e. Gas particles move in straight lines until they collide with other gas particles. Then they change direction and move in a straight line again.

f. The particles of a gas are far apart from one another.

g. Very weak forces of attraction exist between the particles.

**Questions**

13. How are the particles in the gas state arranged?

14. Why are gases compressible?

**TASK**

*Observe social distancing*

1. Each learner represents a particle.

2. To represent a solid, learners should:
   - stand in straight rows and columns to form an orderly grid.
   - touch one another lightly at the side, in front and at the back.
   - move slightly to all sides (vibrating) but remain in one position.

3. To represent a liquid, learners should:
   - move freely in a gliding way but still touch the other learners.

4. To represent a gas, learners should
   - walk very fast in any direction.
   - keep spaces between them without touching other learners.
   - change direction as soon as they touch another learner and then move in a straight line in a new direction.

**Questions**

15. Why do gases not have a fixed shape?

16. Why are there such big spaces between gas particles?

*In what way do the particles of liquids and the particles of gases behave in a similar way? Answer: Liquid particles and gas particles are able to move freely.*

**Lesson Title: Diffusion**

*Note*

1. **Diffusion** is a process in which the particles move from a highly concentrated area to an area with a lower concentration of those particles.

2. Diffusion only takes place in liquids and gases.
3. **Concentration** refers to the number of particles in a certain area. A high concentration contains many particles and a low concentration contains fewer particles.

4. Diffusion is faster in gases than in liquids.

5. Gas particles move more quickly and at greater speeds and, therefore, they will move more quickly from a high concentration area to a low concentration area.

6. The speed at which particles diffuse depends on the size of the particles, the state of the particles and the temperature of the particles.

**Explanation**

a. Diffusion is a process in which the particles in liquids and gases move from a place where there are many particles, to a place where there are fewer particles.

b. Diffusion occurs only in gases and in liquids.

c. The particle model of matter explains diffusion.

d. Diffusion occurs because particles of matter are in continuous motion.

e. Diffusion takes place faster in gases than in liquids because the particles in a gas move more quickly than the particles in a liquid.

f. The rate at which particles diffuse depends on the size of the particles, the state of the particles and the temperature of the particles.

**Questions**

17. What is diffusion?

18. Do liquid particles or gas particles diffuse faster?

**Questions**

19. Why do gases diffuse more quickly than liquids?

20. When will the process of diffusion stop?

What property must particles have to be able to diffuse? (Answer: The particles have to be able to move freely and randomly.)

**Lesson Title: Change of state: Heating**

Notes

1. When a substance is **heated**, it gains energy and the temperature of the substance increases.

2. When a solid is heated, it changes to a liquid state.

3. When a solid changes to a liquid, we call it melting.

4. When the particles of the solid gain energy, they overcome the strong forces of attraction and move more freely.
5. When a liquid is heated, it changes to the gas state.

6. When a liquid changes to a gas, we call the process evaporation or boiling.

7. The liquid particles gain more energy they overcome the forces of attraction, and are able to move faster and further apart from one another.

8. The amount of matter stays the same during a change of state.

**Explanation**

a. Heating a substance can cause the substance to change state.

b. When a solid is heated, it can change to a liquid state. We say the solid melts.

c. According to the particle model of matter, the particles of a solid start to vibrate more vigorously when they receive energy. These vibrations overcome the forces of attraction and the particles break away and start to move past each other. This causes the solid to melt.

d. If we keep on heating the liquid, it will start to evaporate and change to the gas state.

e. The liquid particles will gain more energy, move even faster and overcome most of the forces of attraction. The particles will move even further apart and escape to the gas state.

f. The amount of a substance remains the same during a change of state.

**Questions**

21. What happens when a substance is heated?

22. What do we call the change of state from a solid to a liquid?

**TASK**

Use the following words to draw a flow diagram of the changes of states from a solid to a gas

| Liquid | Energy added | Gas | Energy added | Evaporation/ Boiling | Solid | Melting |

**Questions**

23. How are evaporation and boiling similar?

24. What is the difference between evaporation and boiling?

*What is needed for a substance to melt? (Answer: The substance must be heated and energy has to be added).
Notes
CHANGE OF STATE: Cooling

1. When a substance is cooled, heat is taken away and the temperature of the substance decreases.

2. When a gas is cooled, it changes to the liquid state. We call it condensation.

3. The particles of the gas lose energy. They move less energetically and closer to each other.

4. When a liquid is cooled, it changes to a solid state. We call this change of state freezing or solidification.

5. The liquid particles lose energy and move even closer together, until they only vibrate in one place.

6. The amount of matter stays the same during a change in state and the particles do not change.

7. Gas $\xrightarrow{\text{Energy is removed}}$ Liquid $\xrightarrow{\text{Energy is removed}}$ Solid

Condensation Freezing / Solidification

Explanation
a. Taking heat away from a substance can cause the substance to change state.

When heat is taken away from a gas, it condenses to form a liquid.

The gas particles have less energy and move closer to the other particles until they touch and form a liquid.

If we cool a liquid, it will change to a solid state. We call this process freezing or solidification.

The liquid particles lose more energy and move even closer to each other. This happens to the point where the particles are so close together that they cannot move freely anymore.

They remain in one place and are only able to vibrate.

The amount of a substance remains the same during a state change and the particles do not change.

Questions
25. What happens when a gas is cooled?

26. What do we call the change in state when a liquid changes to a solid?

TASK
Copy the paragraph into your workbook and fill in the missing words.
When a solid is heated, its _____ increases and it _____. The solid changes to a _____.
When a liquid is _____, its energy decreases and it _____. The liquid
changes to a _____. A _____ changes to a liquid when it is cooled. This is called _____. The energy of the particles _____. During evaporation a _____ changes to a _____, as the temperature is _____. The energy of the particles _____.

Questions
27. What do we call the process where water droplets form on the outside of a cold can of Coke?

28. What change of state will happen when a liquid is put in a freezer?

*How can materials be made to change their state? (Answer: Materials need to obtain energy or lose energy to change state).

Lesson Title: Density: Mass and volume
Notes

DENSITY
1. The density of a material describes the amount of mass in a given volume of that material.
2. Density is a property of matter.
3. Mass is a measure of the amount of matter that an object is made of. It is measured in grams (g) or kilograms (kg).
4. There are a thousand grams in one kilogram (1000 g = 1 kg).
5. Volume is the amount of space an object occupies. It is measured in millilitres (ml) or litres (l).
6. There are a thousand millimetres in 1 litre (1000 ml in 1 l) and 1 millimetre is equal to 1 cubic centimetre (1 ml = 1 cm³).
7. Mass and volume are physical quantities of a material. This means that we can observe and measure them.
8. The formula for density is the mass per unit of volume:

   \[ \rho = \frac{m}{V} \]

   where,

   \( \rho \) is the symbol for density and the unit is g/ml or g.cm³
   \( m \) is the symbol for mass and the unit is g
   \( V \) is the symbol for volume and the unit is ml or cm³.

Explanation
a. Density is a measure of how much mass of a material fits into a given volume.
b. Density is a property of all matter and every material has a specific density.
c. The mass of an object is how much matter the object has and it is measured in grams or kilograms.

d. The volume of an object is the space that the object occupies and is measured in millilitres or litres.

e. The formula for density is \( \rho = \frac{m}{V} \)

f. The unit for density is g/ml or g/cm³.

Questions
29. What is the relationship between density, mass and volume?
30. What is the unit of mass?

Explanation
a. We can think of density as the lightness or heaviness of objects of the same size.

b. Density depends on the mass and volume of a substance.

c. Mass, volume and density are physical properties of objects and we can use these to describe objects.

d. The greater mass an object has the more matter it has. When we measure the mass of a small object, we measure the mass in grams. When we measure the mass of a big object, we measure the mass in kilograms.

e. When we have two copper rods, each with mass of 350 g, then the two rods will have exactly the same amount of copper atoms.

f. We can determine the volume of a regular shape by using the formula for volume:

Volume = length x breadth x height

Explanation
a. If you have different objects with the same volume, the object with the highest mass will have the greatest density.

b. Fill four cups with the same amount or pour 250 ml of the following liquids into the cups: cooking oil, water, vinegar, golden syrup, milk or whatever is available. Let a learner pick up each of the cups and compare their masses. Alternatively, the mass of each cup can be measured with the kitchen scale. Let the learners arrange them in order of increasing density.

[Answer: Oil, water, vinegar, milk, golden syrup]
c. When we have different objects with the same mass, they will have different sizes (volumes) because their densities are different.

d. Find four objects with the same mass. Order them from the smallest to the largest. The smallest object will have the highest density and the biggest object will have the smallest density. For instance, iron, wood and sponge, with the same mass, will have different sizes. The sponge will be the biggest, and then the wood and the iron will be the smallest.

**TASK**

1. Look at the diagram and answer the questions that follow.

1.1 Which block do you think will have the highest density? Why do you say so?

1.2 Calculate the density of each block.

1.3 Put the blocks in order of increasing density.

2.1 Which block do you think will have the lowest density? Why do you say so?

2.2 Calculate the density of each block.
3. Look at the diagram and answer the questions that follow.

Water Density = 1
Sea Water Density = 1.1
Rock Density = 3
Iron Density = 8
Mercury Density = 13.6

3.1 Which block do you think will be the heaviest? Why do you say so?
3.2 If the volume of each block is 15 ml, determine the mass of each block to see whether your answer in question 3.1 was correct.

4. Look at sample A, B and C of a material.

4.1 Which sample do you think will have the lowest density?
4.2 Calculate the density of each sample.
4.3 What conclusion can you draw from the densities in 4.2?

Sample A
mass = 200g

Sample B
mass = 100g

Sample C
mass = 50g
Questions
31. How does mass affect density when the volumes of objects remain the same?
32. How does volume affect density when the masses of objects remain the same?

*What are the two physical properties of a material that we need to determine its density? Answer: We need its mass and volume.

Lesson Title: Density: States of matter
Notes
Density, mass and volume

1. The density of a material depends on the state that it is in.
2. Solids, liquids and gases have different densities because of the distances between their particles.
3. The closer together the particles are, the greater the mass of that substance in a given volume, and the higher the density.
4. A solid has a high density because its particles are tightly packed with little spaces between them.
5. A solid cannot be compressed because of its high density.
6. There is little difference between the density of a solid and the liquid state of a material. The particles of a liquid still stay closely packed together although they can move more freely.
7. In general, gases are less dense than liquids and solids. The particles of gases are far apart and the spaces between them are big.
8. The order of density from least dense to most dense is usually gas, liquid and solid.

Questions
33. Which state of matter has the lowest density?
34. Which state of matter has the biggest mass for a given volume?

Explanation
a. In general, gases are less dense than liquids and liquids are less dense than solids.

b. The reason that different states of matter have different densities is easily explained using the particle model of matter.

c. The particles of solids are tightly and orderly packed in a certain space. No particles can be added to the arrangement. Each particle has a certain mass, so solids have the maximum mass per volume of the substance.

d. Particles in a solid are tightly packed and cannot be squeezed closer together into a smaller volume. This explains why solid material cannot be compressed.
e. Liquids are also very dense. The density of a liquid is almost the same as the density of the solid state of the same substance. This is because their particles are close together, even though they are not in fixed positions. Liquid particles slide over each other.

f. Most liquids cannot be compressed into smaller volumes. The spaces between them are too small.

g. Gases are not very dense at all because of the large spaces between the gas particles. Particles of a gas are spaced far apart with no particular arrangement.

h. In the same way as solids or liquids, gases have much less matter and therefore less mass.

i. Gases can easily be compressed because of the small number of particles in a large volume.

Questions
35. Which state of water has the biggest spaces between the water molecules?
36. What is the order of the states of water from least dense to most dense?

Lesson Title: Density: Different materials
Notes
1. Different materials have different densities.
2. The density of a material depends on the kind of particles it is made of and the way in which they are packed in the solid or liquid state.
3. When a material is made up of big particles, they will have a high mass.
4. A material with small particles will have a smaller mass.
5. It is easy to fit many particles of some materials into a small space. The particles of other materials might be too big and fewer will be able to fit into a certain space.
6. A material that has a lower density floats on a liquid with a higher density.
7. Less dense liquids float on top of denser liquids.

Explanation
a. Some materials have a low density and some have a high density.

b. The individual particles making up one material may have different masses, compared to the individual particles making up another material.

c. The way in which particles are packed in a solid or liquid determines the size of the spaces between the particles, and the density of the solid or liquid.

d. A material with a lower density will float on a liquid with a higher density. However, a material with a higher density than the liquid it is in, will sink.
Questions
37. What are the two factors that influence the density of a material?
38. When will a solid float on a liquid?

Lesson Title: Expansion of materials
1. Only when sufficient heat energy is added to a material will the material change state.
2. In general, solids, liquids and gases tend to expand when heated.
3. Expansion is an increase in the size of an object when the temperature is increased.
4. When a material is heated, the particles move faster and push further apart. The spaces between the particles get bigger and the material expands.
5. When a material expands, the size and number of particles do not change.

Questions
39. What happens to a material when it is heated?
40. How do the particles change when a material expands?

Questions
41. Where do we find the concept of expansion in our everyday lives?
42. Do all materials expand the same?

Lesson Title: Contraction of materials
Notes
1. Materials contract when they are cooled.
2. Contraction is a decrease in the size of an object when the temperature is decreased.
3. When a material is cooled, the particles move less and, as they move closer to each other, the space between them gets smaller.
4. When a material contracts, the size and number of particles does not change.
5. When materials contract, no state change takes place.

Questions
43. What happens to a material when it is cooled?
44. How does the particles change when a material contracts?

Questions
45. What happens to the volume of a liquid when it is cooled down?
46. Why does the liquid in a thermometer contract when put in cold water?
Lesson Title: Pressure of gases
Notes
1. Pressure is an important property of a gas.

2. Pressure is the force that gas particles in a closed container exert on the sides of the container and other particles.

3. Gases exert pressure in all directions.

4. Gases do not possess a definite shape or volume because the gas particles are free to move in any direction, until they collide with each other or an object.

5. Gas particles inside a closed container move around very quickly and collide more frequently with each other and the sides of the container.

6. The factors that influence the pressure of a gas are:
   a. the number of gas particles
   b. the temperature of the gas
   c. the volume of the container.

Questions
47. What is pressure?

48. What factors influence the pressure of a gas?

TASK
Look at the aerosol cans that the teacher is showing you and answer the following questions in your workbook.

1. What is an aerosol can?

2. Give three examples of aerosol cans.

3. What does the label state regarding the pressure of the gas inside the container?

4. Why do the labels of many aerosol cans state, "Protect from sunlight and do not expose to temperatures exceeding 50 °C"?

Questions
49. What happens when many gas particles collide with the surface of an object?

50. Will a gas on a cold day exert a high or a low pressure on a surface?

Lesson Title: Increasing pressure on gases
INCREASE IN PRESSURE

1. Pressure is the force that gas particles exert on the container it is in.

2. The force that gas particles exert while colliding against the sides of a container causes a pressure inside the container.
3. There are three ways to increase the pressure of a gas in a container:
   a. A decrease in the volume of a gas
   b. An increase in the number of gas particles
   c. An increase in the temperature of the gas.
4. In each case more collisions of the gas particles occur, which leads to an increase in pressure.

**Questions**
51. What can we do to increase the pressure of a gas?
52. What can we do to increase the pressure of a gas?

**Questions**
53. How can you increase the pressure in an aerosol can?
54. How can you increase the pressure in a car tyre?

**Lesson Title: Decreasing pressure on gases**

**DECREASE IN PRESSURE**
1. Pressure is the force that gas particles exert on the container it is in.
2. The force that gas particles exert while colliding against the sides of a container causes a pressure inside the container.
3. There are three ways to decrease the pressure of a gas in a container:
   a. An increase in the volume of a gas
   b. A decrease in the number of gas particles
   c. A decrease in the temperature of the gas.
4. In each case more collisions of the gas particles occur, which leads to an increase in pressure.

**Questions**
55. What must we do to decrease the pressure of a gas?
56. What must we do to increase the pressure of a gas?

**Questions**
57. How can you decrease the pressure in a plastic bottle?
58. How can you decrease the pressure in a bicycle tyre?