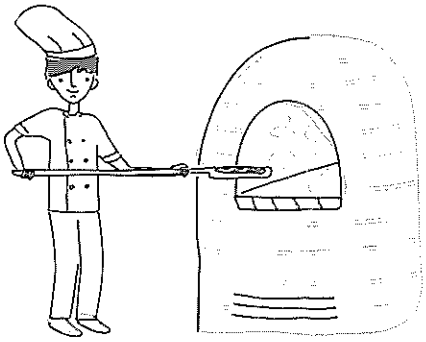
6.1 Which change is that?

Science understanding

Visual/Spatial

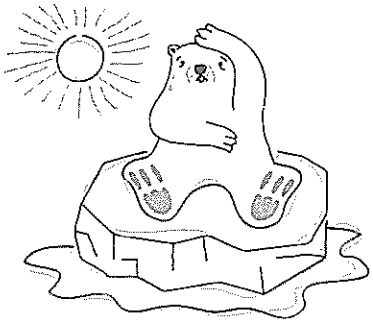
The world around you is constantly changing. Some of these changes are known as physical changes, in which no new substances are produced. Other changes are known as chemical changes, in which new substances are produced. **Classify** each of the following situations as a physical or chemical change.

(a) Cooking a pizza



Physical ☐ Chemical ☐

(b) Ice melting

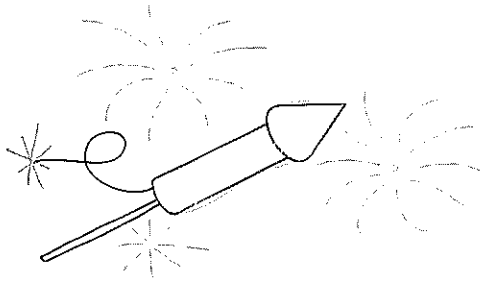


Physical ☐ Chemical ☐

(c) Chopping wood

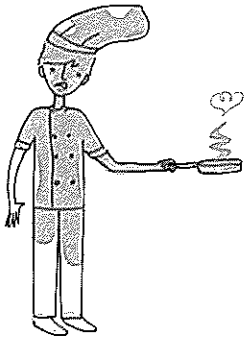
Physical ☐ Chemical ☐

(d) Fireworks



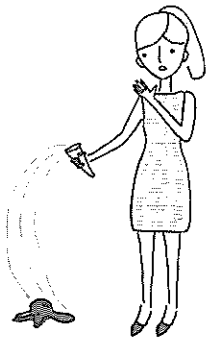
Physical ☐ Chemical ☐

(e) Burning breakfast



Physical ☐ Chemical ☐

(f) Ice-cream hitting the ground

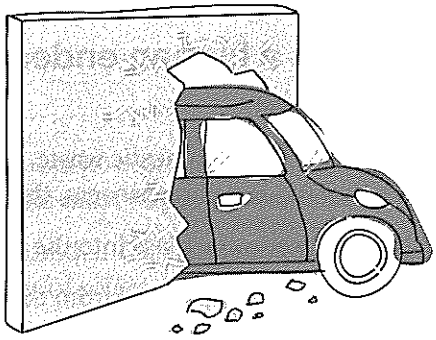


Physical ☐ Chemical ☐

(g) Stirring a cake mixture

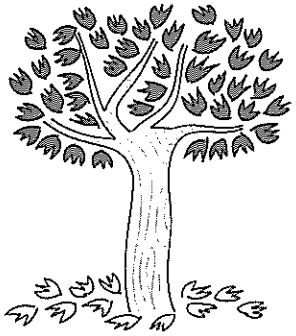
Physical ☐ Chemical ☐

(h) Crashing a car



Physical ☐ Chemical ☐

(i) Autumn leaves changing colour



Physical ☐ Chemical ☐

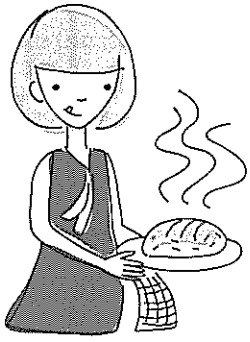
(j) An explosion

Physical ☐ Chemical ☐

(k) Synthesising a new chemical

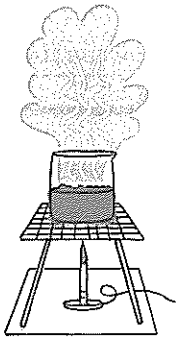
Physical ☐ Chemical ☐

(l) Baking bread



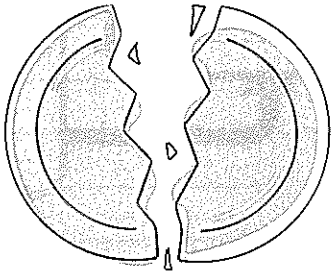
Physical ☐ Chemical ☐

(m) Boiling water



Physical ☐ Chemical ☐

(n) Breaking a plate



Physical ☐ Chemical ☐

6.2 Recycling glass

Science as a human endeavour

Visual/Spatial

Glass makes up 7% of domestic waste. Fortunately glass can be recycled over and over again. During the recycling process, the glass goes through several physical changes.

1 When you throw the glass into the bin, it gets mixed in with the rest of the rubbish.

2 The glass is then separated from the general waste.

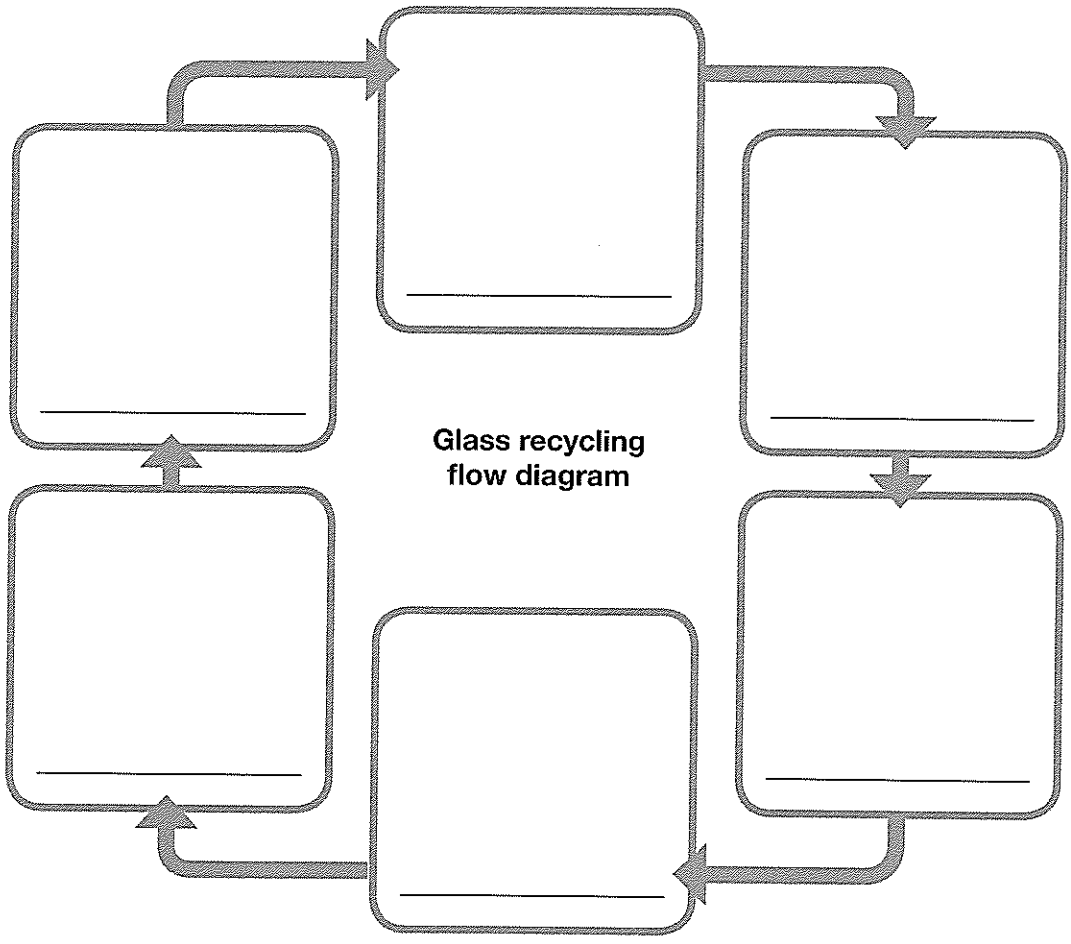
3 The glass is then separated by colour.

4 Each type of glass is then crushed into small pieces.

5 The small pieces of glass are then melted in a furnace to make liquid glass, which is then poured into moulds.

6 The glass is then allowed to solidify into its new form, such as bottles, plates or windows.

Use this information to fill in the flow diagram below. **Label** each physical change and **construct** a diagram to represent each stage in the process.



6.3 The particle model

Science understanding

Verbal/Linguistic Visual/Spatial

Scientists use models to help understand and predict how things work. The models are simplified versions of the real thing that explain the most important features.

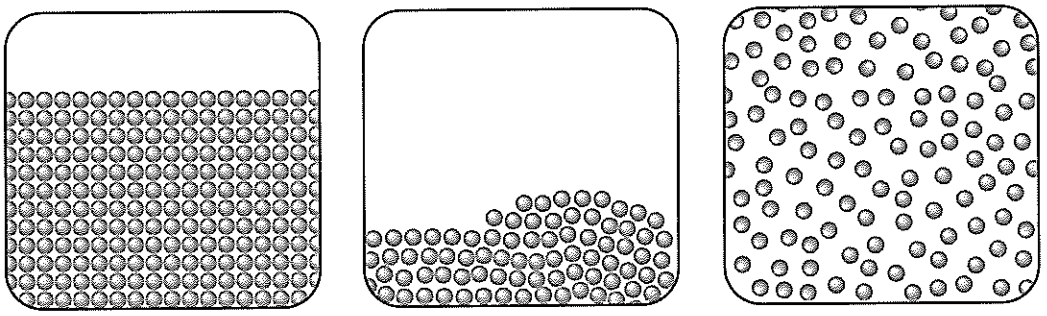
A very important model in science is the particle model. The particle model is used by scientists to understand the physical properties of solids, liquids and gases. The particle model makes three assumptions:

1 Solids, liquids and gases are all made up of hard, ball-like particles that cannot be split (are indivisible) and are invisible to the naked eye.

2 These particles are constantly moving and/or vibrating.

3 There are forces of attraction between the particles.

Below are diagrams of solids, liquids and gases as described by the particle model.



1 Refer to the particle model diagrams above to **compare** the movement of particles in solids liquids and gases.

_____

_____

_____

_____

2 **(a)** The forces of attraction hold the particles of substance together. **Deduce** in which state of matter (solid, liquid or gas) these forces are:

(i) strongest _____

(ii) weakest _____

(b) **Justify** your answers.

_____

_____

_____

_____

3 From your answers to questions 1 and 2, **propose** why solids hold their shape, liquids take on the shape of their container, and gases fill their container.

4 **Use** the particle model diagrams to **describe** the distance between particles in solids, liquids and gases.

5 **Explain** why solids and liquids are incompressible (cannot be squashed) while gases are compressible.

6 **Use** the particle models to **construct** particle model diagrams of the following cases.

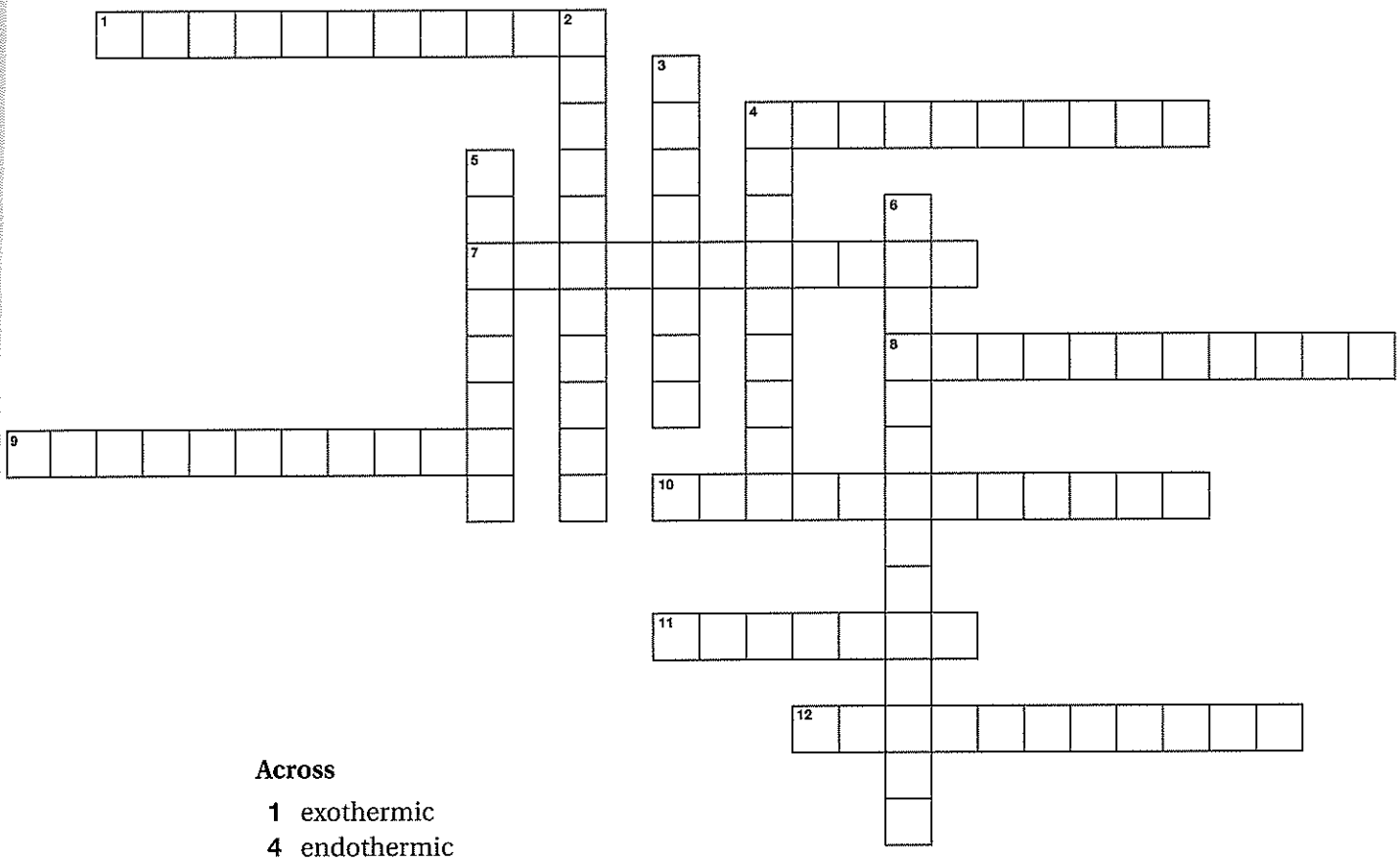
(a) An ice cube floating in water	**(b)** A bubble of air trapped in a block of ice
(c) Boiling water	**(d)** A water droplet suspended in air

6.4 Opposite processes

Science understanding

Verbal/Linguistic

To solve the puzzle, **identify** and record the name of the process that is *opposite* to the clue provided.



Across

1 exothermic
4 endothermic
7 condensation
8 deposition
9 expansion
10 evaporation
11 freezing
12 non-spontaneous

Down

2 dissolve
3 crystallise
4 contraction
5 melting
6 spontaneous

6.5 Breaking bonds

Science inquiry

Verbal/Linguistic Visual/Spatial

The particles in solids are held together by strong bonds that fix the particles in position. When the solid is heated, the particles begin to vibrate more and more. At the melting point, the particles vibrate so rapidly that the particles break their bonds and move around freely. This is when the solid melts and becomes a liquid.

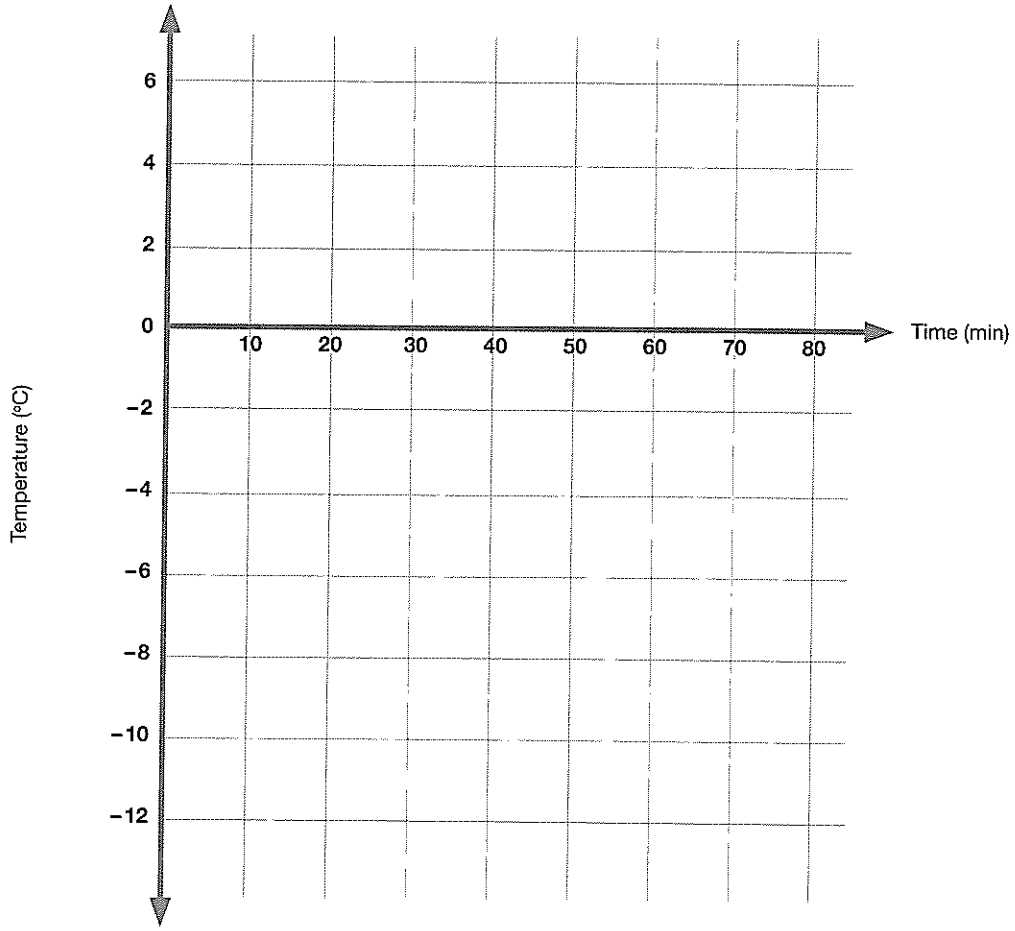
Jessica decided to measure the temperature of ice as it was heated through the melting point. She took a beaker of ice and heated it gently with a constant heat. She then measured the temperature of the ice–water mixture every 5 minutes. Her results are shown in the table below.

Time (min)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
Temperature (°C)	–11	–9	–7	–5	–3	–1	–0.5	0	0	0	0.5	1	2	3	4	5

1 **Construct** a graph of Jessica's results on the axes below.

2 **State** the melting point of ice. _____ °C

3 Using the graph, **identify** whether ice or liquid water heats up fastest. _____



4 **Describe** what happens to the temperature of the ice–water as it passes through the melting point.

5 The particle model makes three assumptions about the particles in solids, liquids and gases.

1 The particles are made up of hard, incompressible and indivisible balls.

2 The particles are constantly moving.

3 The particles are attracted to each other.

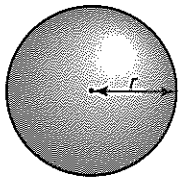
Propose which of these properties explains how the temperature changes near the melting point. **Use** the particle model to **justify** your answer.

6.6 Density calculations

Science understanding, Science inquiry

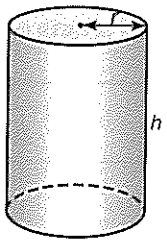
Logical/Mathematical

1 The volume of the following regular objects can be calculated by using a mathematical formula. **Identify** the correct name and formula for each of the following regular objects by linking them with lines.

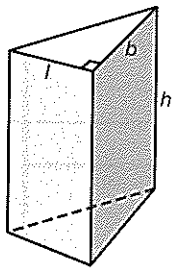


Cube $V = l^3$

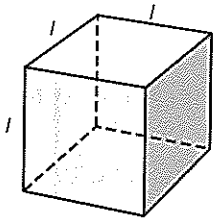
Rectangular prism
$V = lwh$



Triangular prism
$V = \frac{1}{2}lbh$

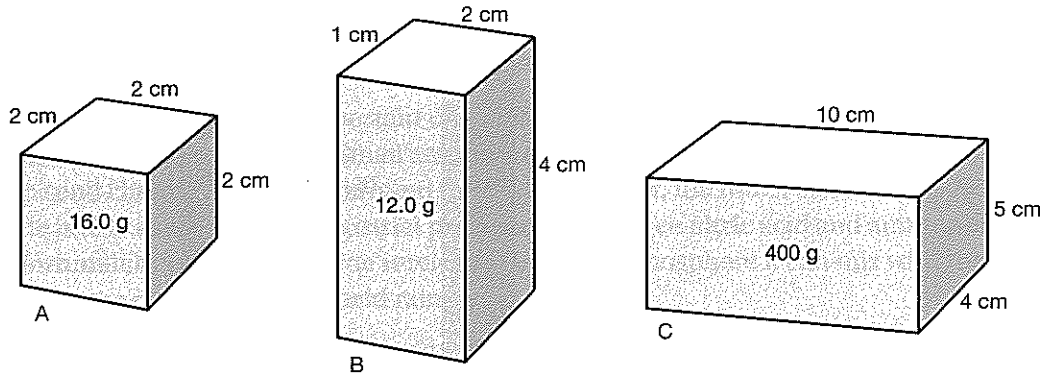


Cylinder $V = \pi r^2 h$



Sphere $V = \frac{4}{3}\pi r^3$

2 (a) **Use** the formula $V = lwh$ to **calculate** the volume of the rectangular prisms shown.



Prism A: $V =$ _____ cm^3

Prism B: $V =$ _____ cm^3

Prism C: $V =$ _____ cm^3

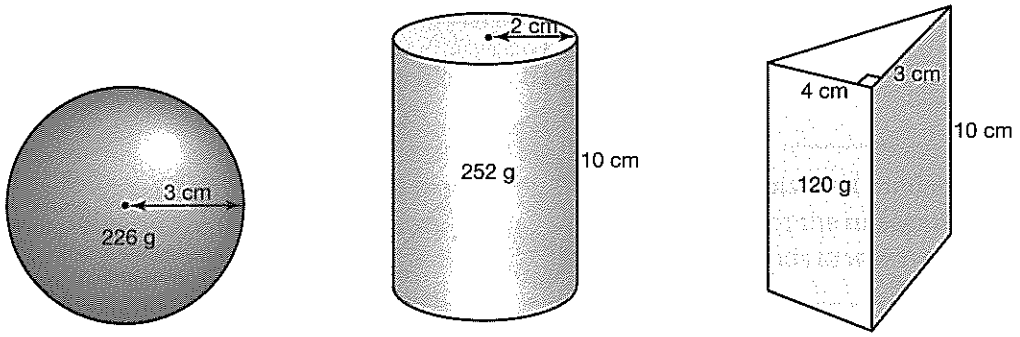
(b) **Use** the masses given for each of the prisms to **calculate** their densities.

Prism A: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

Prism B: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

Prism C: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

3 (a) **Use** the mathematical formulas given on the previous page to **calculate** the volume of the regular objects below.



Sphere A:

$V =$ _____

_____ cm^3

Cylinder B:

$V =$ _____

_____ cm^3

Triangular prism C:

$V =$ _____

_____ cm^3

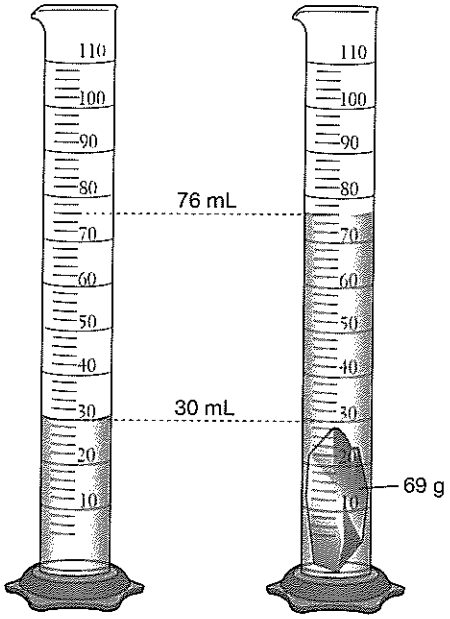
(b) **Use** the masses given for each of the objects to **calculate** their densities.

Sphere A: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

Cylinder B: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

Triangular prism C: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

4 (a) Calculate the volume of the irregular object shown.

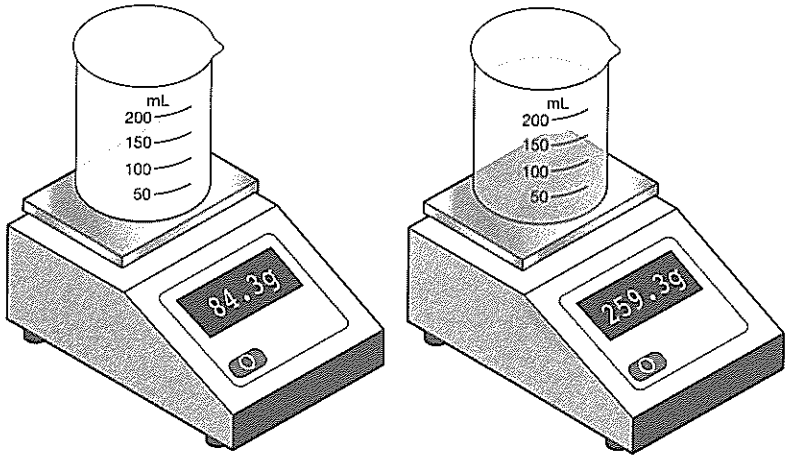


V = _____ mL = _____ cm^3

(b) Use the mass given for the irregular shape to **calculate** its density.

Irregular shape: $d = \frac{m}{V}$ = _____ / _____ = _____ g/cm^3

5 The mass of an unknown liquid was determined by the method shown.



(a) Use this information in the diagram to **calculate** the density of the liquid.

_____

_____

(b) From its density, **propose** what the unknown liquid is most likely to be.

_____

6.7 Math-o-mat reactions

Science understanding

Visual/Spatial

Nitric oxide (NO) is a very important chemical that has both advantages and disadvantages to our society. Small amounts of nitric oxide are needed in our blood to help send chemical messages around the body. However, too much can be toxic. Nitric oxide is also used in many industrial processes to produce nitric acid and ammonia. Unfortunately, when nitric oxide is released into the atmosphere it can mix with the water in the clouds and form acid rain.

Nitric oxide also contributes to the depletion of the ozone layer. The nitric oxide reacts with the ozone (O_3) in the atmosphere to produce nitrogen dioxide (NO_2) and oxygen gas (O_2).

1 **Construct** a word equation for the depletion of ozone by nitric oxide by filling in the blanks.

_____ + _____ → _____ + _____

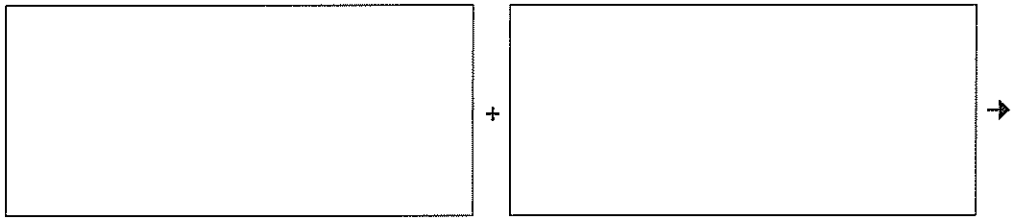
2 **Identify** the reactants and products of this equation by their chemical formulas.

	Chemical name	Chemical formula
Reactants		
Products		

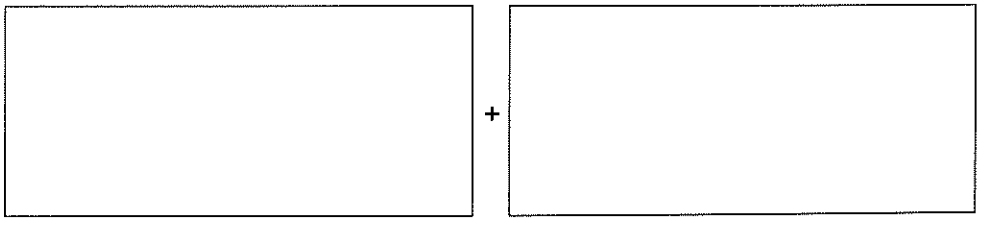
3 **Construct** a formula equation by filling in the blanks.

_____ + _____ → _____ + _____

4 **Use** the chemical formulas and a math-o-mat or compass to **construct** models of the reactants in the equation above. Choose a different colour for the nitrogen and oxygen atoms in the reaction and indicate which colour corresponds to which element.



5 **Use** the chemical formulas and a math-o-mat or compass to **construct** models of the products.



6.8 Making equations

Science understanding

Verbal/Linguistic

Use the combined word and formula equations to fill in the blanks in the following equations.

Equation 1

carbon + _____ → carbon dioxide

C + O_2 → _____

Equation 2

sodium hydroxide + _____ → sodium chloride + _____

NaOH + HCl → _____ + H_2O

Equation 3

sulfuric acid + calcium carbonate → calcium sulfate + carbon dioxide + water

H_2SO_4 + $CaCO_3$ → _____ + _____ + _____

Equation 4

_____ + sulfur → hydrogen sulfide

H_2 + S → _____

Equation 5

_____ → calcium oxide + _____

$CaCO_3$ → CaO + CO_2

Equation 6

potassium hydroxide + nitric acid → potassium nitrate + _____

KOH + HNO_3 → _____ + H_2O

Equation 7

hydrochloric acid + silver nitrate → silver chloride + _____

_____ + $AgNO_3$ → _____ + HNO_3

Equation 8

copper sulfate + _____ → copper chloride + _____

_____ + $BaCl_2$ → _____ + $BaSO_4$

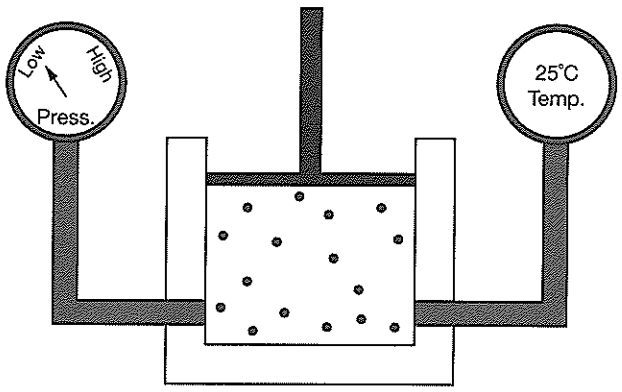
6.9 Boyle's law

Science as a human endeavour

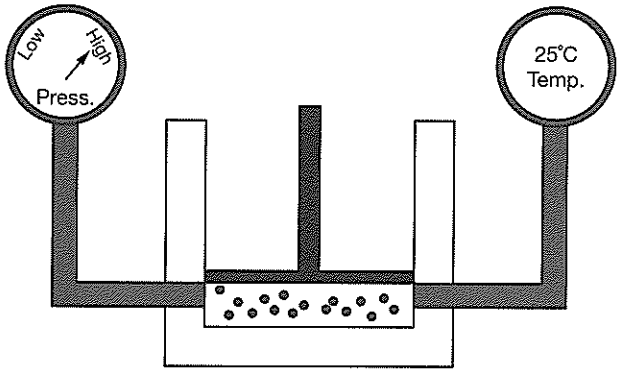
Visual/Spatial **Verbal/Linguistic**

Robert Boyle (shown right) was born in Ireland in 1627 and was considered to be an alchemist. Like all alchemists, he believed that base metals such as lead could be turned into gold. However, unlike other alchemists, he approached his work with strict scientific method and criticised other alchemists for their careless approach. For this reason, he can also be considered one of the world's first chemists.

Boyle was particularly interested in studying the pressure of gases. The pressure of a gas is how much force the gas puts on its container. Boyle discovered that the pressure of a gas changed when the size of its container (volume) changed. In one of his most famous experiments, Boyle measured the pressure of a gas as the volume of the container was decreased. He also made sure the temperature stayed the same.



When the volume is large, the pressure is low.

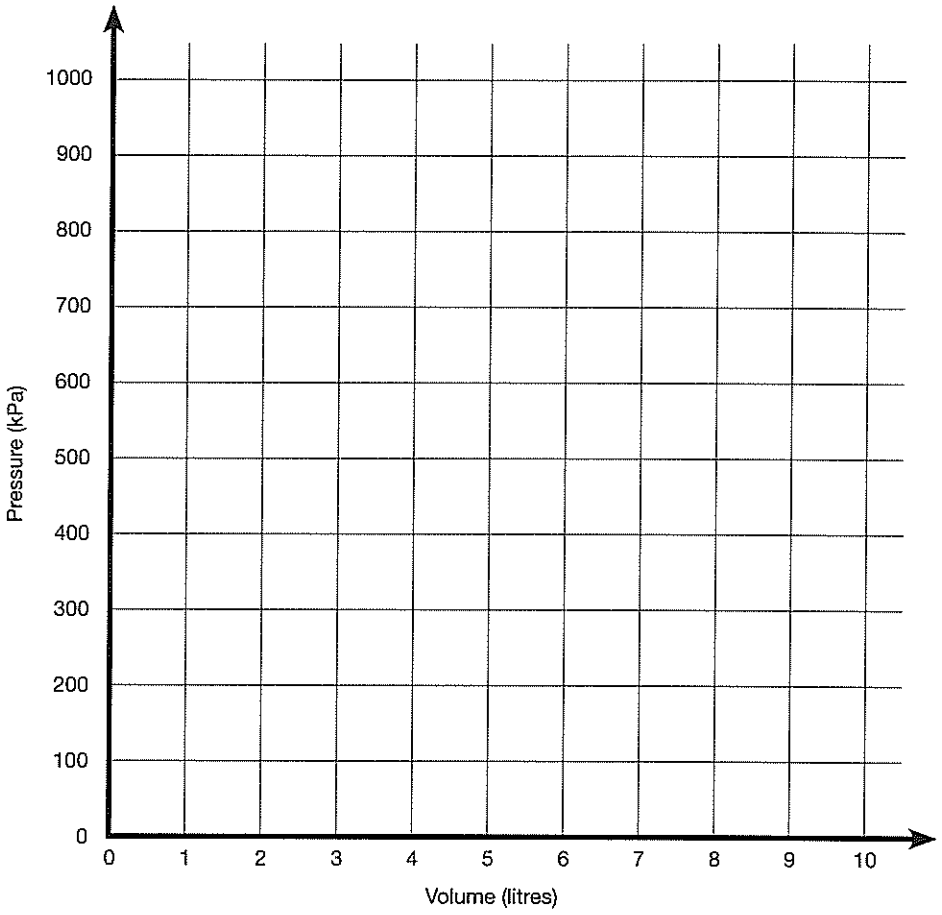


When the volume is small, the pressure is high.

Some results that he may have observed are shown in the table.

Volume (L)	10	9	8	7	6	5	4	3	2	1
Pressure (kPa)	100	111	125	143	167	200	250	333	500	1000

1 Using the data from the table, **construct** a line graph on the axes below to show how the pressure of the gas changed as its volume decreased.



2 **State** Boyle's law by completing the following sentences.

(a) As the volume increases, the pressure _____.

(b) As the pressure increases, the volume _____.

(c) When the volume doubles, the pressure _____.

(d) When the pressure doubles, the volume _____.

6.10 Literacy review

Science understanding

Verbal/Linguistic

Recall your knowledge of physical and chemical change by choosing words from the list to complete the statements below. Cross out the words as you write them.

substances	mass	physical	products	precipitate
heat	particle	reactants	equations	volume
formulas	moving	colour	gas	chemical
attracted	products	high	low	chemical
chemical				

1 The world around you is constantly changing. These changes can be classified as either _____ or _____ changes.

2 During a physical change, no new _____ are produced. During a chemical change, new substances are produced. A chemical change can be identified by a permanent change in _____, a _____ being given off, a _____ forming from two clear solutions or energy being produced or absorbed in the form of _____ and light.

3 Physical and chemical changes can be understood by the _____ model. This model assumes that all substances are made up of hard, indivisible particles. The model also assumes that these particles are _____ to each other and are constantly _____.

4 Density is a measure of how much _____ is contained in a certain _____. A large, lightweight object is said to have _____ density. A small, heavy object is said to have _____ density.

5 When a chemical change occurs, scientists say that a _____ reaction has taken place. A chemical reaction is the process of converting substances into different substances. The initial substances are known as the _____. The substances that are produced by the chemical reaction are known as the _____.

6 Scientists use chemical _____ to describe what is happening during a chemical reaction clearly and efficiently. A _____ equation uses the chemical names of the reactants and products to describe the chemical reactions. A formula equation uses the chemical _____ of the reactants and products to describe the chemical reaction.