Combined Chemistry
Higher
Paper 1

Name: _____

Topic 1: Atomic Structure & Periodic Table

Topic 2: Structure & Bonding

Topic 3: Quantitative chemistry

Topic 4: Chemical Changes

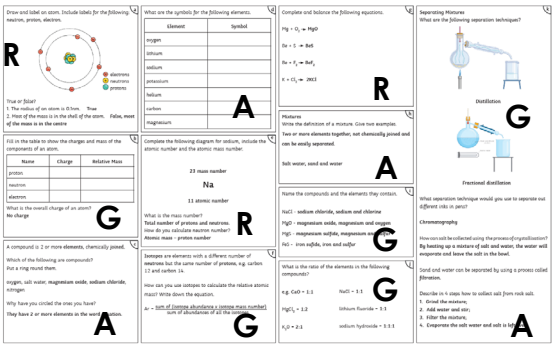
Topic 5: Energy Changes

Exam Date: Monday 19th May 2025

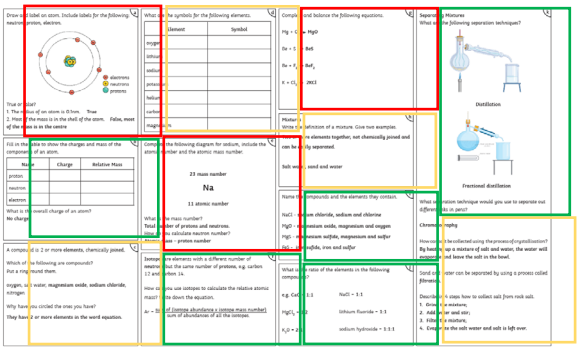
Instructions

This booklet has been separated according to the topic that will be covered in the exam.

1. Go through the revision mat for the topic and rate each box according to your understanding of that content. Use a typical RAG rating or 3 different colours of highlighter.
   For example:



OR



R = Red 😟 Low understanding

A = Amber 😐 Some Understanding

G = Green 😊 Good Understanding

2. Cut along the dotted lines of the question card template provided. Then produce a set of revision questions and answers for that topic – you should focus on those you have rated as red or amber on the revision mat. **For example:**

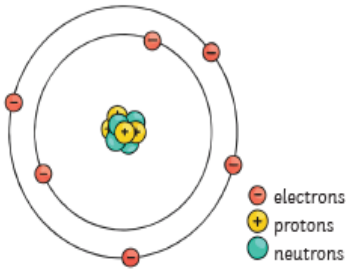
Front	**Back**
What is the mass number of an atom?	The total number of protons and neutrons found in the nucleus

3. Fold along the line indicated on the following page and glue where indicated to create a storage pocket for your question cards.
4. Regularly test yourself using your question cards or ask someone to test you and return them to your storage pocket for safekeeping after each use.

Topic 1: Atomic Structure & Periodic Table

a

Draw and label an atom. Include labels for the following: neutron, proton, electron.



True or false?

1. The radius of an atom is 0.1nm **True**
2. Most of the mass is in the shell of the atom. **False, most of the mass is in the centre**

b

Fill in the table to show the charges and mass of the components of an atom.

Name	Charge	Relative Mass
proton	+1	1
neutron	0	1
electron	-1	very small

What is the overall charge of an atom?

No charge

c

A compound is 2 or more **elements**, chemically **joined.**

Which of the following are compounds?
Put a ring round them.

oxygen, salt water, **magnesium oxide**, **sodium chloride**, nitrogen

Why have you circled the ones you have?

They have 2 or more elements in the word equation.

d

What are the symbols for the following elements?

Element	Symbol
oxygen	O
lithium	Li
sodium	Na
potassium	K
helium	He
carbon	C
magnesium	Mg

e

Complete the following diagram for sodium, include the atomic number and the atomic mass number.

23 mass number

Na

11 atomic number

What is the mass number?
Total number of protons and neutrons.
How do you calculate neutron number?
Atomic mass – proton number

f

Isotopes are elements with a different number of **neutrons** but the same number of **protons**, e.g. carbon 12 and carbon 14.

How can you use isotopes to calculate the relative atomic mass? Write down the equation.

$$Ar = \frac{\text{sum of (isotope abundance x isotope mass number)}}{\text{sum of abundances of all the isotopes.}}$$

g

Complete and balance the following equations. What is the name of the compound formed?

$2Mg + O_2 \rightarrow 2MgO$
magnesium oxide
$Be + S \rightarrow BeS$
beryllium sulphide
$Be + F_2 \rightarrow BeF_2$
beryllium fluoride
$2K + Cl_2 \rightarrow 2KCl$
potassium chloride

h

Mixtures

Write the definition of a mixture. Give two examples.

Two or more elements together, not chemically joined and can be easily separated.

Salt water, sand and water

i

Name the compounds and the elements they contain.

NaCl - **sodium chloride, sodium and chlorine**

MgO - **magnesium oxide, magnesium and oxygen**

MgS - **magnesium sulfide, magnesium and sulfur**

FeS - **iron sufide, iron and sulfur**

j

What is the ratio of the elements in the following compounds?

e.g. CaO = 1:1

$MgCl_2$ **- 1:2**

K_2O **- 2:1**

NaCl **- 1:1**

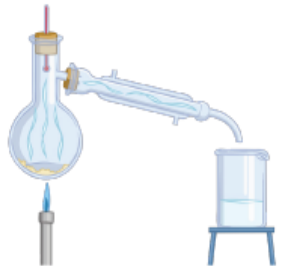
lithium fluoride **- 1:1**

sodium hydroxide **- 1:1:1**

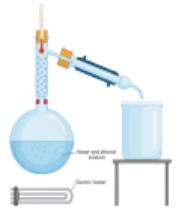
k

Separating Mixtures

What are the following separation techniques?



Distillation



Fractional distillation

What separation technique would you use to separate out different inks in pens?

Chromatography

How can salt be collected using the process of crystallisation?
By heating up a mixture of salt and water, the water will evaporate and leave the salt in the bowl.

Sand and water can be separated by using a process called **filtration.**

Describe, in 4 steps, how to collect salt from rock salt.

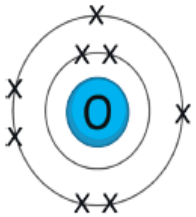
1. **Grind the mixture;**
2. **Add water and stir;**
3. **Filter the mixture;**
4. **Evaporate the salt water and salt is left over.**

Topic 1: Atomic Structure & Periodic Table

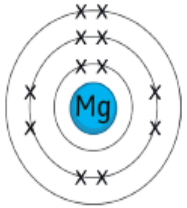
a

Complete the electronic structure diagrams for:

oxygen



magnesium



b

Describe why the noble gases are so unreactive.

Their outer shell is full of electrons.

The boiling points of the noble gases **increase** as you go down the group.

This is because there are more forces to bond the atoms together, therefore more energy is required to break the bonds.

c

Describe what happens to the reactivity of the alkali metals as you go down the group.

It increases

Why?

The number of electrons increases. They are further away from the nucleus. There is less pull on the outer electrons so the atom is more likely to loose an electron.

Complete the word and symbol equation for sodium reacting with water:

sodium + water → sodium hydroxide + **hydrogen**

$2Na + 2H_2O \rightarrow 2NaOH + H_2$

d

List 3 halogens

chlorine, fluorine, iodine, astatine

How many electrons do they have in their outer shell?

7 electrons

Describe how the reactivity changes as you go down the group.

They become less reactive, the atom becomes larger because there are more electron shells, further from the nucleus so the pull of the nucleus is less. So the electron is less likely to be gained as there is less of a positive pull.

Write balanced symbol equations for the following reactions:

bromine + potassium iodide

$Br_2 + 2KI \rightarrow 2KBr + I_2$

chlorine + sodium iodide

$Cl_2 + 2NaI \rightarrow 2NaCl + I_2$

fluorine + potassium chloride

$F_2 + KCl \rightarrow 2KF + Cl_2$

e

Underline the properties of metals and circle the properties of non-metals:

Strong, low density, malleable, dull, good conductors of heat and electricity, high melting and boiling point, brittle, not good conductors of electricity

f

James Chadwick discovered the...
(underline the correct answer)

proton

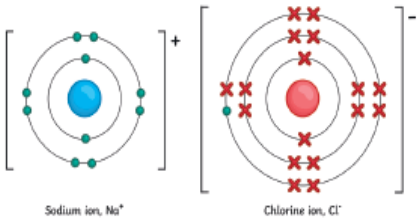
neutron

electron

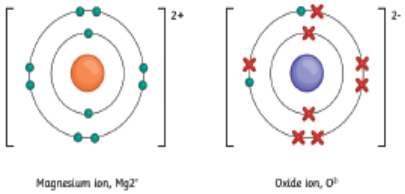
g

Complete the following dot and cross diagrams for:

NaCl



MgO



h

Complete word equations for the following reactions:

sodium + chlorine → **sodium chloride**

lithium + iodine → **lithium iodide**

potassium + bromine → **potassium bromide**

i

How are the groups arranged in the periodic table?

According to their properties.

How can you tell that the alkali metals are very reactive?

According to their properties.

How can you tell the noble gases are unreactive?

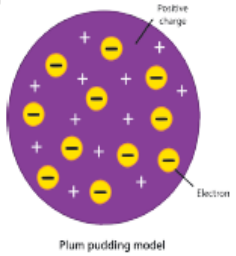
Full shell of outer electrons.

j

Describe the plum pudding model of the atom.

Draw a diagram.

A sphere of positive charge with electrons dotted about; looking like a plum pudding.



Why did scientists believe this model?

Lack of experimental evidence.

k

Describe what the alpha scattering experiment showed scientists.

Most alpha particles go straight through, some are scattered, some rebound off the gold foil.
This shows that the nucleus of an atom has a very small radius. Most of the mass is concentrated in the nucleus.

l

Niels Bohr discovered that

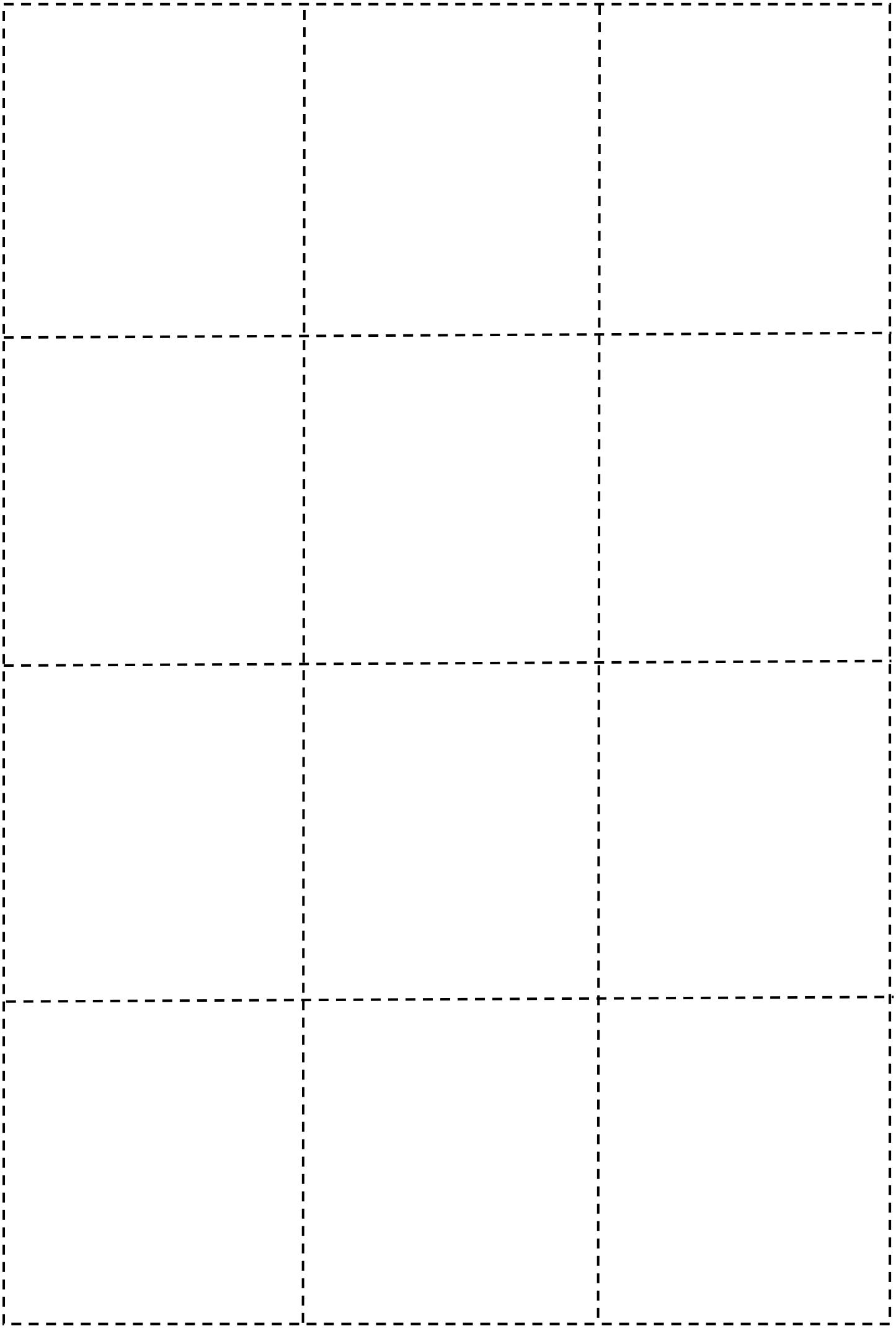
electrons orbit the nucleus in shells.

Why did Mendeleev leave gaps in the periodic table?

He knew that the elements existed but they hadn't been found, based on their mass.

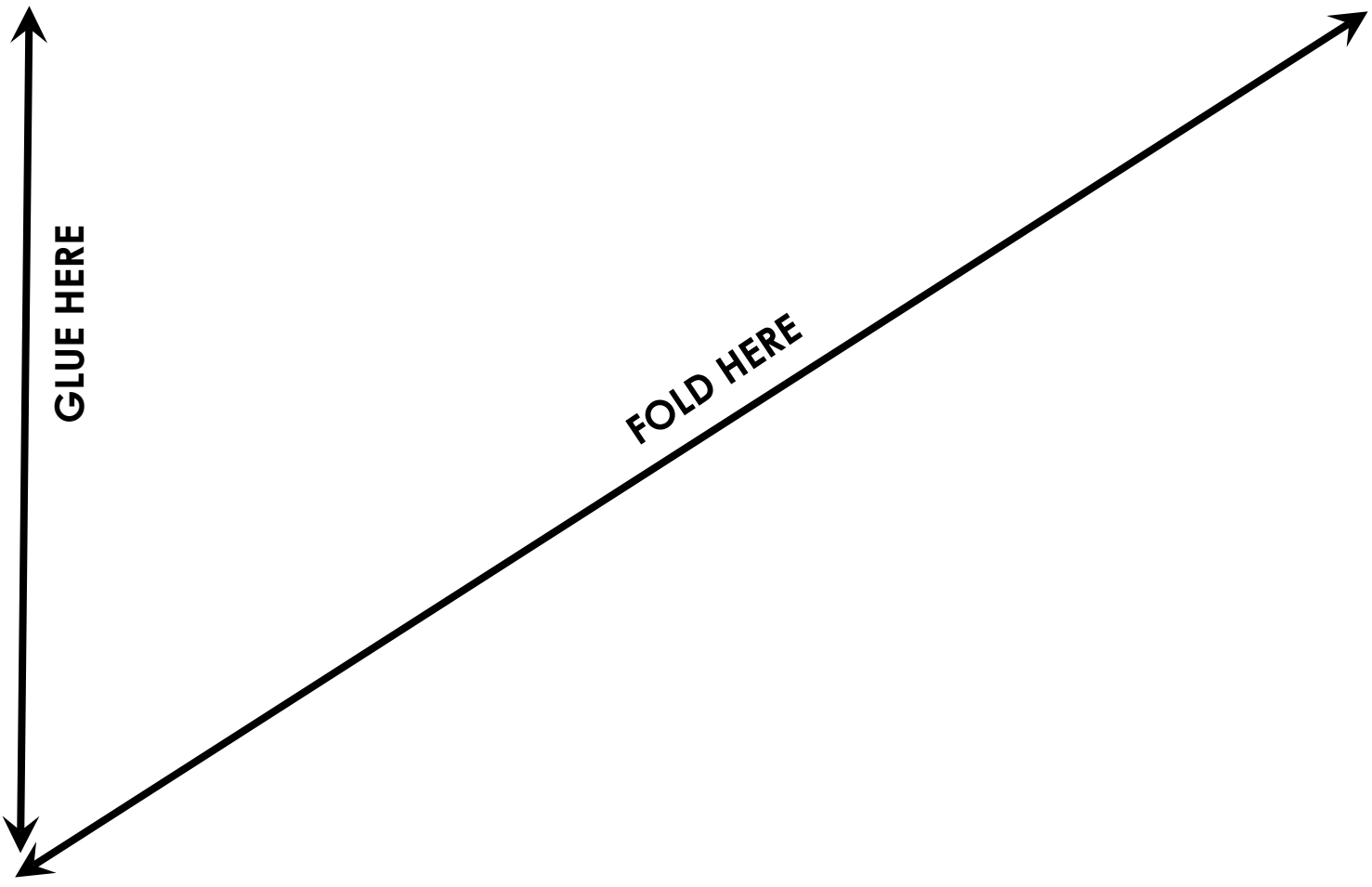
What happened to some of the gaps he left?

They have been filled. Scientists have found some of the elements.



Topic 1: Atomic Structure & Periodic Table

Question Card Storage



Topic 2: Structure & Bonding

a

The three types of chemical bonding are...

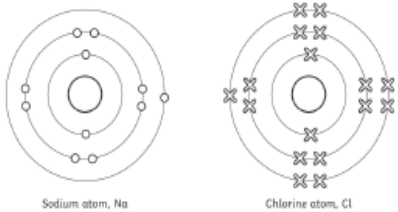
1. **ionic**
2. **covalent**
3. **metallic**

Describe the movement and arrangement of subatomic particles in each of the above.

1. **Electrons are lost and gained to fill the outer shell.**
2. **Electrons are shared to fill the outer shell.**
3. **Positive metal ions are surrounded by free electrons.**

b

Draw a dot and cross diagram for the following ionic bonding:
sodium chloride



Which four groups are more likely to make ions?

1, 2, 6 and 7

c

Describe the bonding in ionic compounds

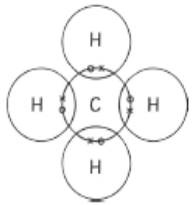
They are held together by the strong ionic forces of oppositely charged ions. Metal ions have a positive charge and non-metals ions have a negative charge so they are attracted. They have very strong bonds.

Why can ionic compounds conduct electricity when in solution?

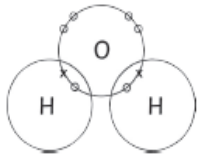
The ions are free to move about and can conduct electricity.

d

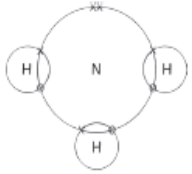
Using this example, draw dot and cross diagrams for H_2O, NH_3 and O_2



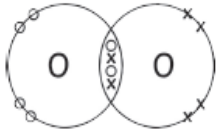
1. H_2O



2. NH_3

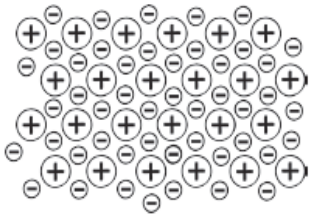


3. O_2



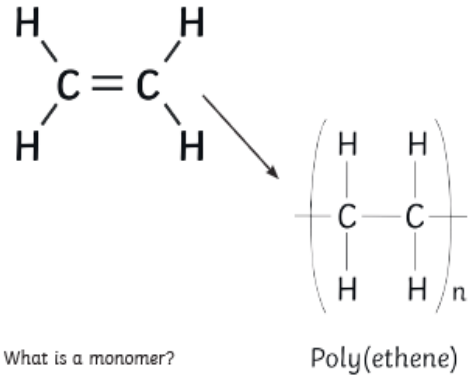
e

Describe how metals conduct heat and electricity. Use the diagram to help explain.
Metals have free Electrons that are able to move around and transfer energy.



f

Complete the polymer diagram for the following monomer.



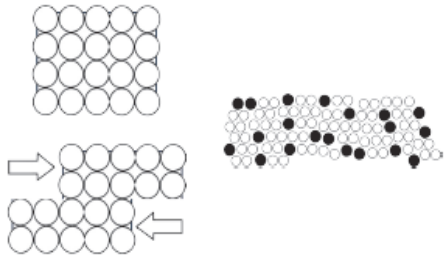
What is a monomer?
One molecule.

What is a polymer?
A long chain of monomers.

Poly(ethene)

g

Properties of metals and alloys.

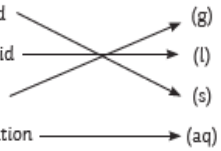


Describe how the 2 pictures are different to each other.
Alloys have different sized particles. In pure metals, all the atoms are the same.

Why are some alloys harder than pure metals?
They have different sized particles so the layers can not slide across each other as easily.

h

Match up the following with the state symbol.



What happens to the intermolecular forces when a liquid turns into a gas?
The forces of attraction become less as the particles gain energy and move about more.

i

Describe the changes of state during:

evaporation:
liquid changes to a gas.

condensation:
gas changes to a liquid.

melting:
solid changes to a liquid.

j

Small molecules form substances with **low** boiling points because they have **weak** intermolecular forces.

They **do not** conduct electricity because they do not have any free electrons.

k

My main areas for improvement are:

_____

_____

_____

_____

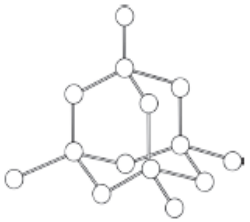
_____

_____

Topic 2: Structure & Bonding

a

Draw a diagram of the structure of diamond.



Why is this structure so strong? Choose the correct answer.

2. **Many strong covalent bonds.**

b

What is this a diagram of?

Graphite

Explain why it can conduct electricity and heat.
Graphite has free delocalised electrons that can pass between layers; the electrons can carry the charge.

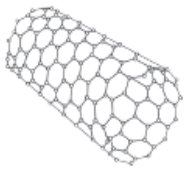
c

The topic I understand the most in this unit is

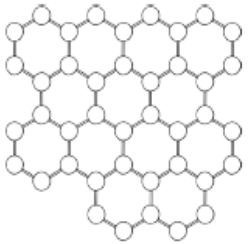
The topic I need to work on is

d

This is a carbon **nanotube**.
It has high **tensile** strength, high **heat** and **electrical** conductivity.



e



Graphene is a single layer of graphite.

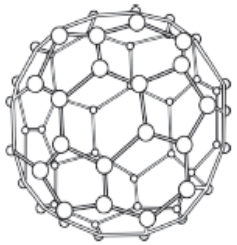
Why is this material so strong?

It has strong covalent bonds.

Where is this product used?

In electronics and composites.

f



What is this structure?

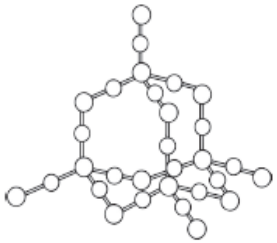
Buckminsterfullerene

How many carbon atoms are there?

e) 60

g

Explain the differences and similarities between silicon dioxide and diamond.
Silicon dioxide contains silicon and oxygen atoms instead of carbon but has a similar structure to diamond.



h

What are the formulas for the following?
Match up the answers.

Iron (II) oxide → $Fe(OH)_2$
Iron (II) hydroxide → FeO
Iron (lll) oxide → Fe_2O_3

i

How many:

mm in 1m? **1000mm**

m in 1mm? **0.001m**

What are the abbreviated units for the following:

metre; **m**

centimetre; **cm**

millimetre; **mm**

nanometre; **nm**

micrometre. **µm**

j

Compare diamond and graphite.
Describe the structure, hardness and conductivity.

Both – forms of carbon.

Single covalent bonds

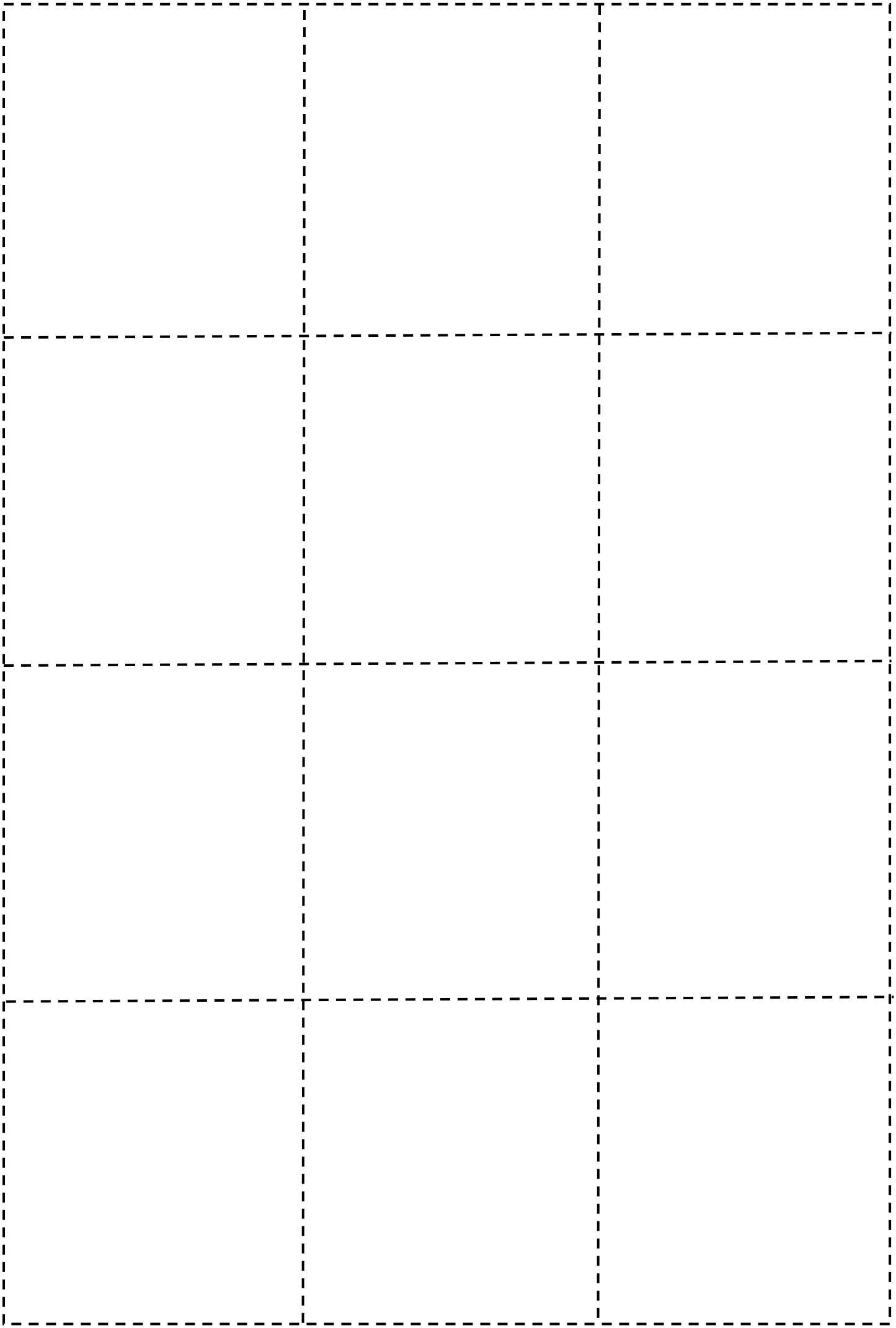
Have many atoms.

Graphite – flat sheets, conducts electricity, each carbon atom forms 3 covalent bonds.

Diamond – tetrahedral structure, each carbon atom forms 4 covalent bonds, does not conduct electricity.

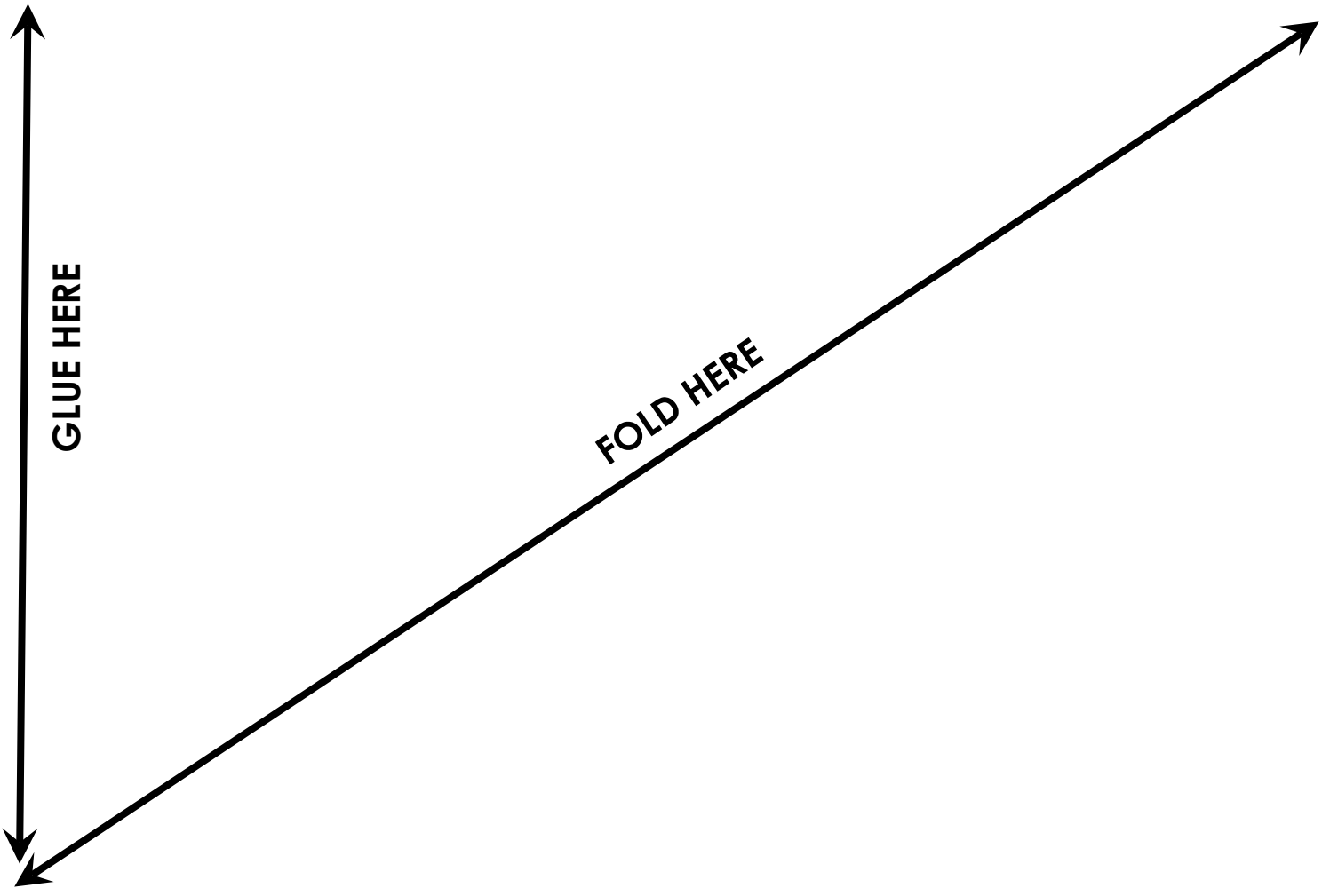
k

My main areas for improvement are:



Topic 2: Structure & Bonding

Question Card Storage



Topic 3: Quantitative Chemistry

a

Mass of the **product** must always equal the mass of the **reactants**.

Balance the following:

$2H_2 + O_2 \longrightarrow 2H_2O$
$2Na + Cl_2 \longrightarrow 2NaCl$
$Br_2 + 2KI \longrightarrow I_2 + 2KBr$
$N_2 + 3H_2 \longrightarrow 2NH_3$

b

Complete the following sentences

The relative formula mass is the (M_r) of a compound.

It is the sum of the **relative** atomic masses (A_r) of the atoms.

Calculate the relative formula mass for the following. Show your working out.

A_r of C = 12
A_r of H = 1
A_r of O = 16
A_r of N = 14

Example:
CO_2
12 + (16 × 2)
12 + 32
= 44

H_2O
(1 × 2) + 16
2 + 16
= 18

CH_4
12 + (1 × 4)
12 + 4
= 16

NH_4NO_3
14 + (1 × 4) + 14 + (16 × 3)
14 + 4 + 14 + 48
= 80

c

When a gas is produced during a reaction, why might the mass go down?

The gas may be released into the environment.

Write the equation for when magnesium reacts with oxygen.

$2Mg + O_2 \longrightarrow 2MgO$

What happens to the mass of the product from the question above?

The mass increases because oxygen is added from the environment.

d

$$\% \text{ mass} = \frac{A_r \times \text{number of atoms} \times 100}{M_r \text{ of the compound}}$$

Using the equation above, calculate the % mass of sodium (Na) in NaCl.

A_r of Na = 23

A_r of Cl = 35.5

$$\% \text{ mass} = \frac{23 \times 1 \times 100}{23 + 35.5}$$

$$= \frac{2300}{58.5}$$

= 39.3% (to 1d.p.)

e

Use the A_r values below to calculate the molar mass of these elements. Don't forget the units.

E.g. A_r of sodium = 23, one mole = 23g

A_r of K = 39

A_r of F = 19

A_r of O = 16

A_r of Mg = 24

potassium (39 × 1) 39g/mol

fluorine (19 × 2) 38g/mol

oxygen (16 × 2) 32g/mol

magnesium (24 × 1) 24g/mol

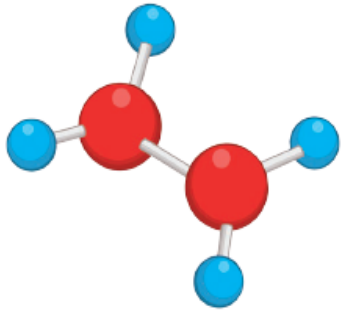
f

What is the equation to calculate the number of moles for a pure substance.

$$\text{moles} = \frac{\text{mass in g}}{M_r}$$

Rearrange the equation to calculate the mass.

mass = moles × M_r



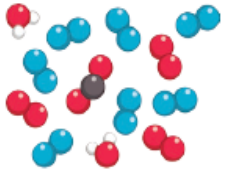
g

What unit are chemical amounts measured in?

1. cm
2. m/s
3. **moles**

Avogadro's constant is...

1. 6.03×10^{23} per mole
2. **6.02×10^{23} per mole**
3. 6.05×10^{23} per mole



h

What mass of nitrogen is in 92g of NO_2?

A_r of N = 14

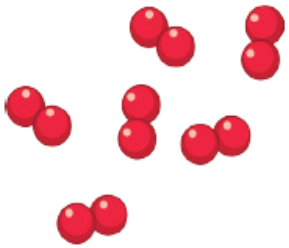
A_r of O = 16

M_r = 14 + (16 × 2) = 46

N = 14

$\frac{14}{46}$ = 0.304

0.304 × 92 = 28g



Topic 3: Quantitative Chemistry

i

Using the equation

$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$

What mass of NaCl would be produced from 2.5 grams of sodium carbonate?

A_r of Na = 23

A_r of H = 1

A_r of Cl = 35.5

A_r of O = 16

A_r of C = 12

M_r of NaCl = 58.5
M_r of Na_2CO_3 = 106

$\frac{2.5}{106}$ = 0.0236 moles (to 3 significant figures)

0.0236 × 2 = 0.0472 (1:2 ratio)

0.0472 × 58.5 = 2.76 grams of NaCl

j

What is the mass of solute when the concentration of a solution is 4mol/dm³ and the volume is 600cm³?

Convert 600cm³ to dm³ = 0.6dm³

mass = concentration × volume

4 × 0.6dm³ = 2.4g

k

concentration (gm/dm³) = $\frac{\text{mass of solute}}{\text{volume}}$

Using the equation above, calculate the following:

The mass of a solute is 60g and the volume is 0.5dm³, what is the concentration?

Concentration = $\frac{60}{0.5}$

= 120g/dm³

l

Rearrange the following equation to find volume.

concentration (mol/dm³) = $\frac{\text{mass of solute}}{\text{volume}}$

volume = $\frac{\text{mass of solute}}{\text{concentration}}$

m

Why, in some reactions, are the reactants in excess?

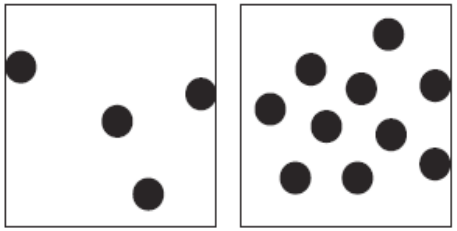
To make sure that the reaction has completely finished and the other reactant has been completely used up.

n

Define concentration.

The amount of a substance in a certain volume of a solution is called its concentration.

Draw a diagram to show a solution with a low concentration and a solution with a high concentration



o

Convert the following measurements in cm³ to dm³.

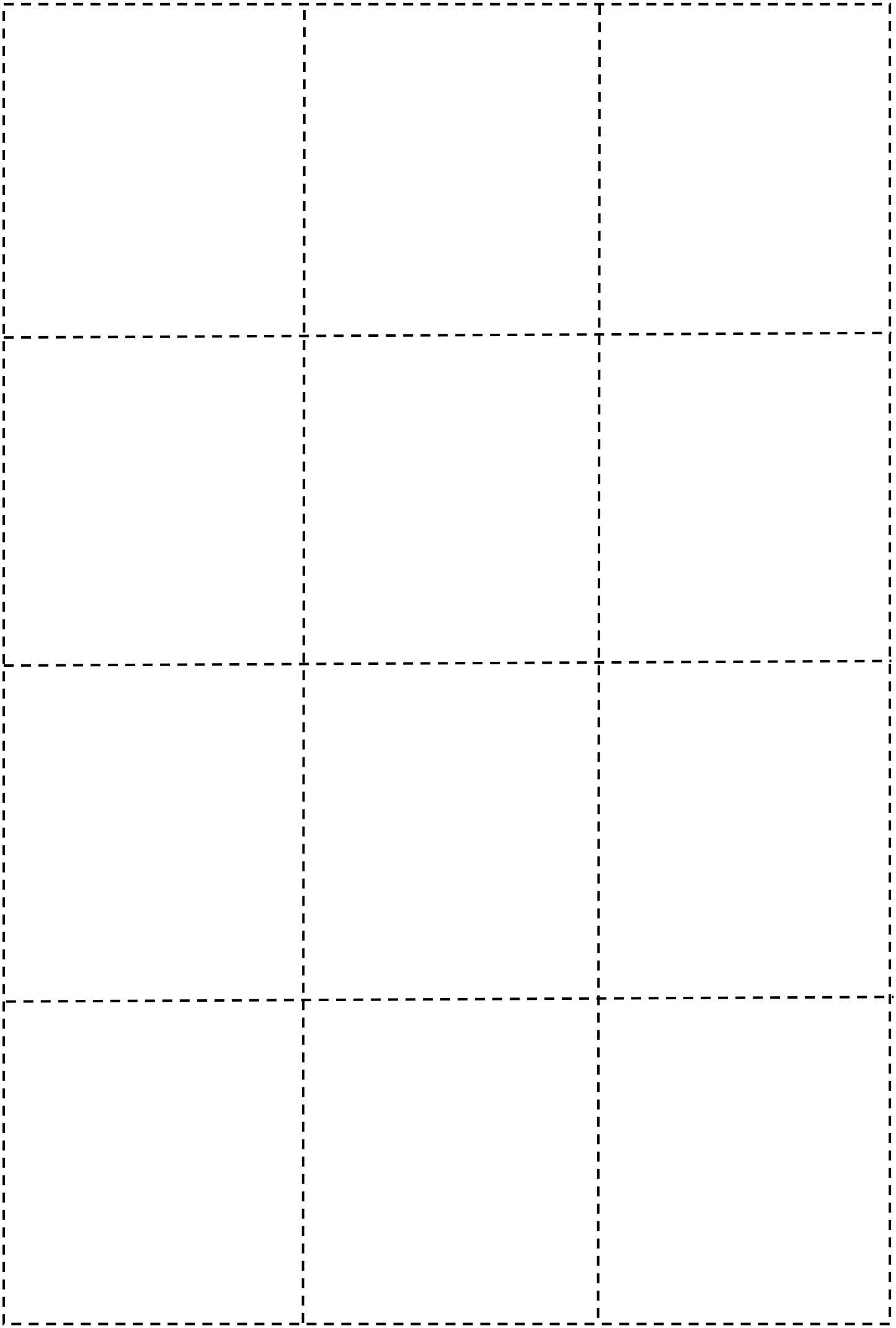
1. 15cm³
2. 60cm³
3. 90cm³
4. 0.5cm³

Divide by 1000

1. **0.015dm³**
2. **0.06dm³**
3. **0.09dm³**
4. **0.0005dm³**

I understand the following topic:

I need to work on the following topic:



Topic 3: Quantitative Chemistry

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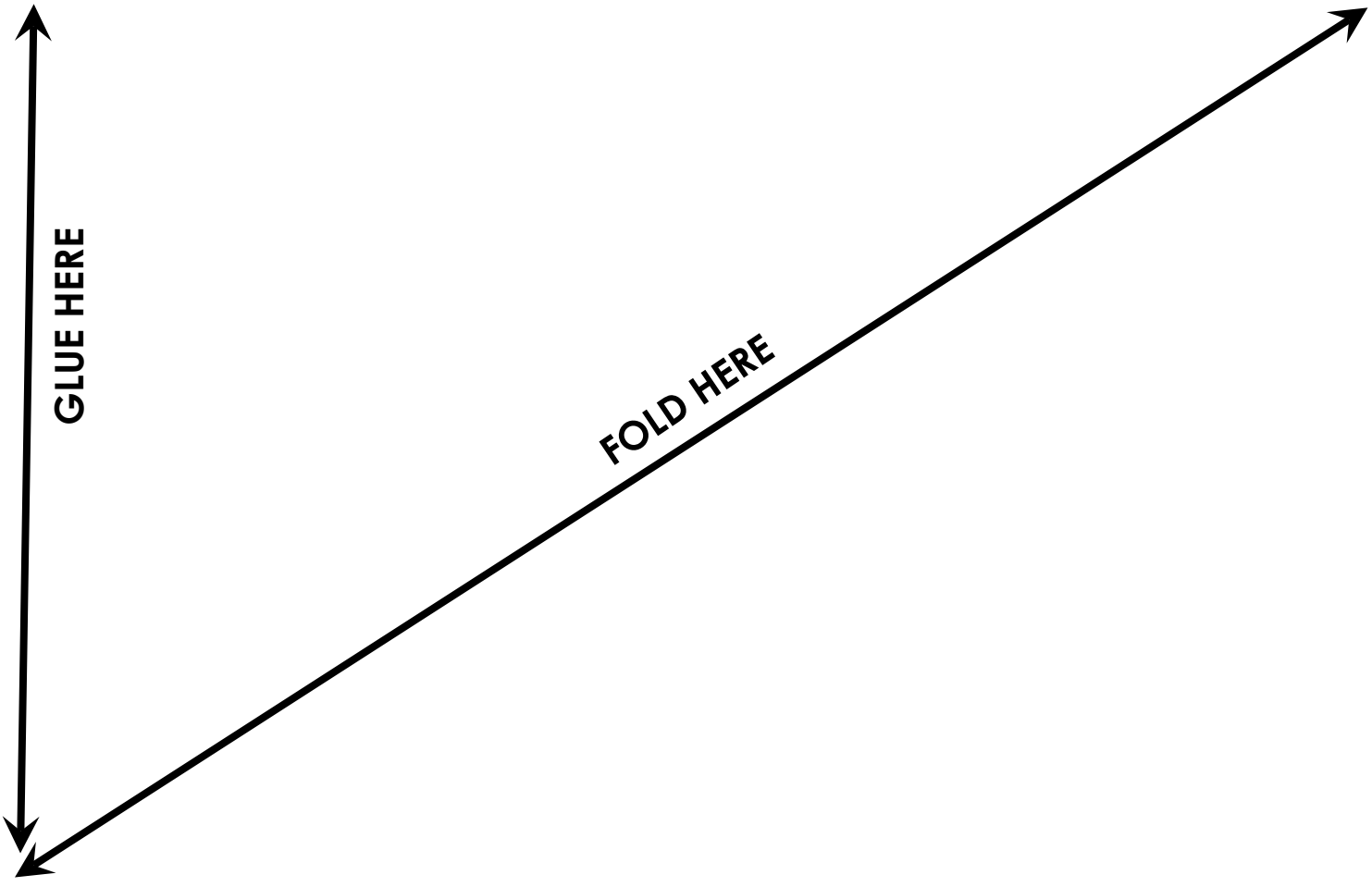


Topic 4: Chemical Changes

a

What is an oxidation reaction?

The gaining of oxygen in a reaction.

Write an equation to show an oxidation reaction.

e.g. copper + oxygen → copper oxide

What is a reduction reaction?

The loss of oxygen in a reaction.

Write an equation to show a reduction reaction.

e.g. magnesium oxide → magnesium + oxide

b

Place the following metals in order of reactivity – adding the names to the symbols.

Na, Zn, Fe, Cu, Li, K, Mg, Ca

potassium	sodium	lithium	calcium	magnesium	zinc	iron	copper

carbon hydrogen

Why are hydrogen and carbon sometimes included in the reactivity series?

They are used in the extraction of the metals.

Place arrows on the reactivity series where hydrogen and carbon could go.

Why is gold often found in its pure state?

Gold is a very unreactive metal.

c

Complete the word equations.

zinc carbonate + sulfuric acid → **zinc sulfate + water + carbon dioxide**

magnesium oxide + hydrochloric acid → **magnesium chloride + water**

magnesium carbonate + nitric acid → **magnesium nitrate + water + carbon dioxide**

calcium carbonate + hydrochloric acid → **calcium chloride + water + carbon dioxide**

d

Describe what a metal reacting with an acid can tell you about the reactivity of the metal.

acid + metal → salt + hydrogen

The speed of a reaction is shown by the rate that hydrogen gas is given off by the reaction.

The more reactive the metal, the faster the reaction will be.

Slow reactions: copper, zinc, iron

Quick reactions: potassium, sodium, lithium

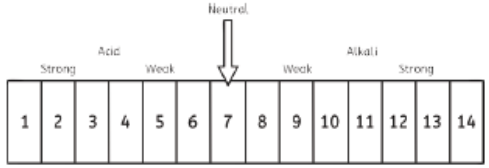
e

On the pH scale, label:

strong acid; **(0 - 3)**
strong alkali; **(12 - 14)**
neutral; **(7)**
weak acid; **(4 - 6)**
weak alkali. **(8 - 11)**

What does the pH show?

The measure of H^+ ions in the solution.



f

Some metals react with water to produce

metal hydroxide and hydrogen

Some metals react with acid to produce

salt and hydrogen

g

To measure pH you can use... **(select two)**

universal indicator
pH meter

h

Describe how to make a soluble salt from an insoluble base.

1. Choose an **acid.**
2. Choose an **insoluble** base.
3. Warm the **acid.**
4. Add the insoluble base to the acid until there is no further **reaction.**
5. **Filter** the mixture.
6. Heat the solution to **evaporate** the water.
7. **Crystals** of salt will start to form.

i

Complete the neutralisation reaction.

acid + base → **salt + water**

H^+ (aq) + OH^- (aq) → **H_2O (l)**

What is the pH of the products of a neutralisation reaction?

a) 1 **b) 7** c) 14

j

Complete the following:

Oxidation

Is

Loss

Reduction

Is

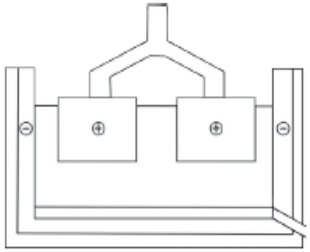
Gain

Oxidation is the loss of electrons and **reduction** is the gaining of electrons.

Topic 4: Chemical Changes

a

Describe how aluminium is extracted by electrolysis.



The positive Al^{3+} ions are attracted to the negative electrode (cathode) where they gain electrons (3) – making them neutral.
The negative O^{2-} ions are attracted to the positive electrode (anode) where they lose electrons (2) – making them neutral.

Why is aluminium oxide mixed with cryolite?

To lower the melting point.

What is the overall equation for the electrolysis of Al_2O_3 to make aluminium and oxygen?

aluminium oxide → aluminium + oxygen

$2Al_2O_3 \rightarrow 4Al + 3O_2$

Why can aluminium not be extracted by carbon?

Aluminium is more reactive than carbon so cannot be displaced.

Write the equation for the reaction at the negative electrode.

$Al^{3+} + 3e^- \rightarrow Al$

Write the equation for the reaction at the positive electrode.

$2O^{2-} \rightarrow O_2 + 4e^-$

b

Which of the following reactions will occur? (displacement)

copper oxide + magnesium

magnesium oxide + iron

potassium oxide + zinc

zinc oxide + lithium

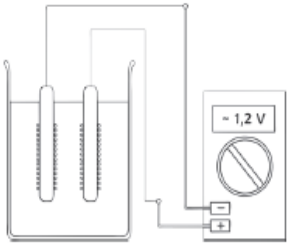
Why do some of them not work?

The metal has to be more reactive than the metal in the compound to take its place.

c

Describe what happens during the process of electrolysis.

When electricity is passed through the solution, the positive ions in the solution go towards the negative electrode where they gain electrons. The negative ions go towards the positive electrode where they lose electrons.



d

The pH of an acid or alkali is a measure of the concentration of H^+ ions.

A pH change from 4 to 2 increases H+ concentration by a factor of...

a) 10 **b) 100** c) 1000

(choose the correct answer)

The pH of a strong acid is **less** than the pH of a weaker acid if they have the same **concentration.**

Acids produce **H^+** in aqueous solutions.

Alkalis produce **OH^-** in aqueous solutions.

e

In copper sulfate solution what forms at the:

cathode	anode
copper	**oxygen and water**

Why?

Copper is less reactive than hydrogen so copper is formed.

In sodium chloride solution what forms at the:

cathode	anode
hydrogen	**chlorine**

Why?

Sodium more reactive than hydrogen so hydrogen is formed.

What are the tests for:

chlorine;
bleaches damp litmus paper

hydrogen;
squeaky pop test

oxygen?
relight a glowing splint

f

Strong acids are **completely**/partially ionised in an aqueous solution

A weak acid is completely/**partially** ionised in an aqueous solution.

The concentration of an acid is
a measure of the number of hydrogen ions in a solution.

g

I understand the following topic

_____

_____

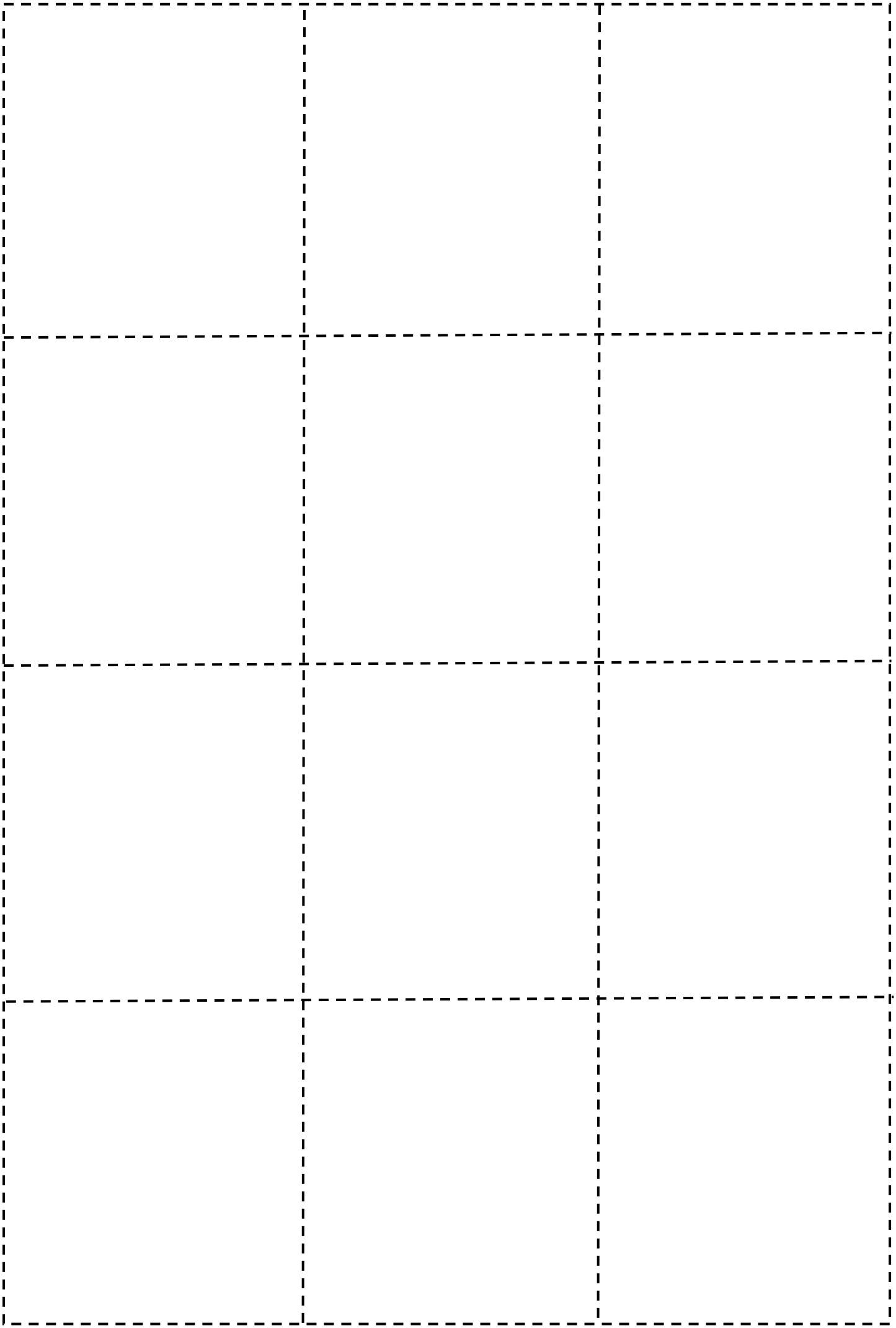
_____

I need to work on the following topic

_____

_____

_____



Topic 4: Chemical Changes

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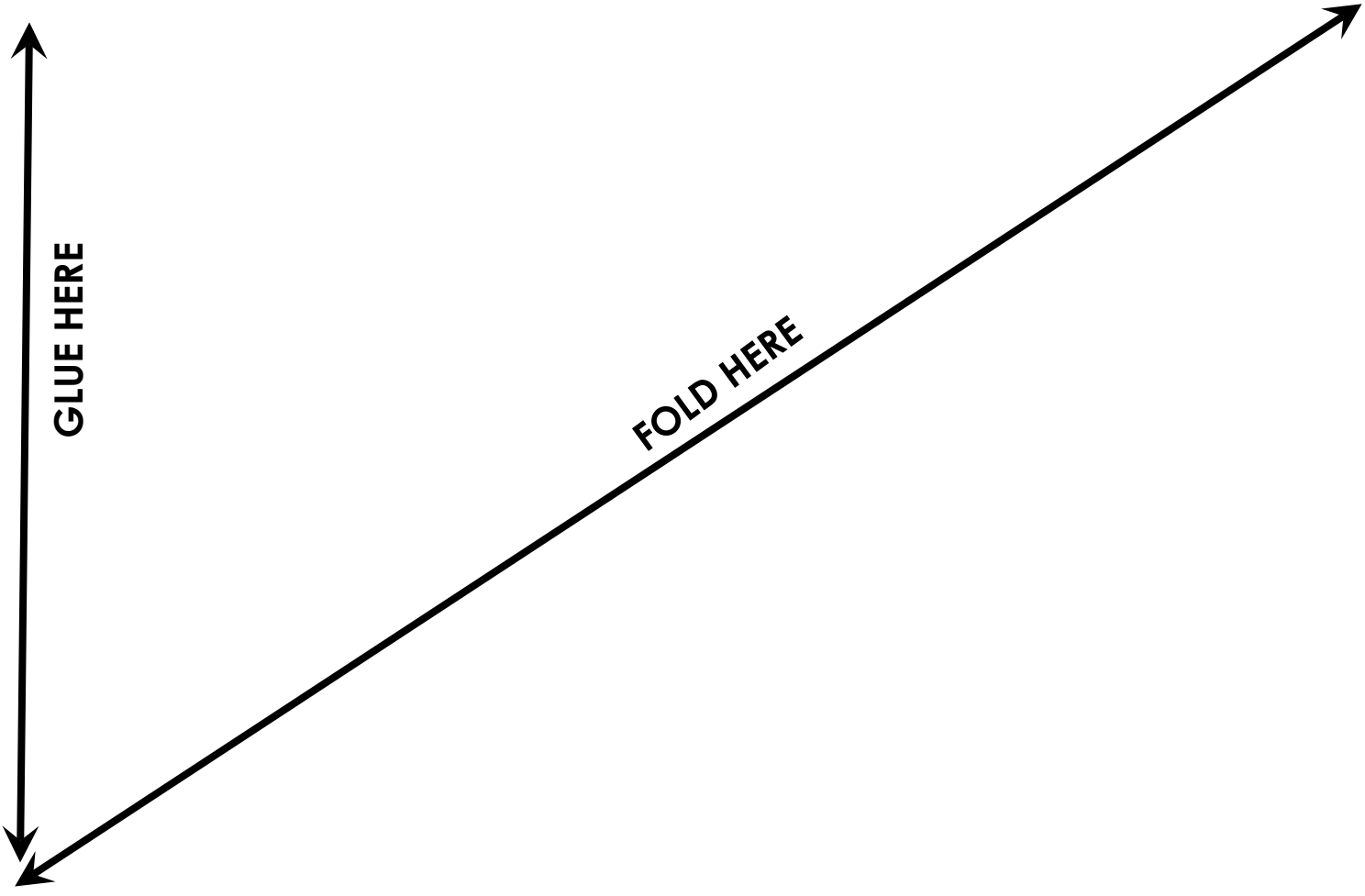


Topic 5: Energy Changes

a

In an exothermic reaction heat **exits** the reaction to the surrounding environment.

The surrounding temperature **increases** .

In an endothermic reaction heat **enters** the chemical reaction.

The surrounding temperature **deceases** .

b

Circle the exothermic reactions and underline the endothermic reactions:

combustion **exothermic**
photosynthesis **endothermic**
electrolysis **exothermic**
neutralisation **exothermic**
water reacting with calcium oxide **exothermic**
ammonium chloride reacting with water **endothermic**
Name some every day uses of exothermic reactions.
Hand warmers, self-heating cans, matches, etc.

Give an example of an every day use of an endothermic reaction.
sports injury packs, etc.

c

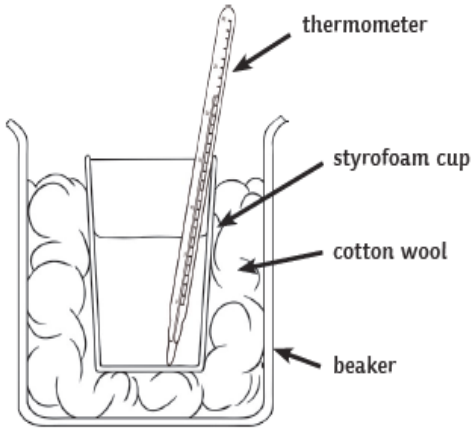
What is activation energy?
The minimum amount of energy needed by the reactants to start the reaction.

d

Describe how energy transfer can be measured in a practical.

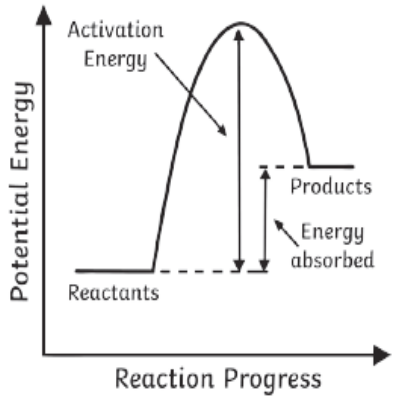
Draw a diagram to show the practical.

1. **Take the start temperature of the reactants.**
2. **Record the highest temperature.**
3. **Record the lowest temperature.**
4. **Take away the temperature from the temperature of the reactants.**



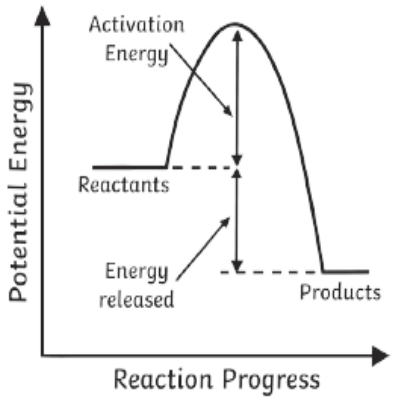
e

Sketch a reaction profile for an endothermic reaction.



f

Sketch a reaction profile for an exothermic reaction.



g

Describe the reaction profile of an endothermic reaction.
The products are at a higher energy level because energy has come into the chemical reaction.

Describe the reaction profile of an exothermic reaction.
The products are at a lower energy level because energy has gone out of the chemical reaction.

h

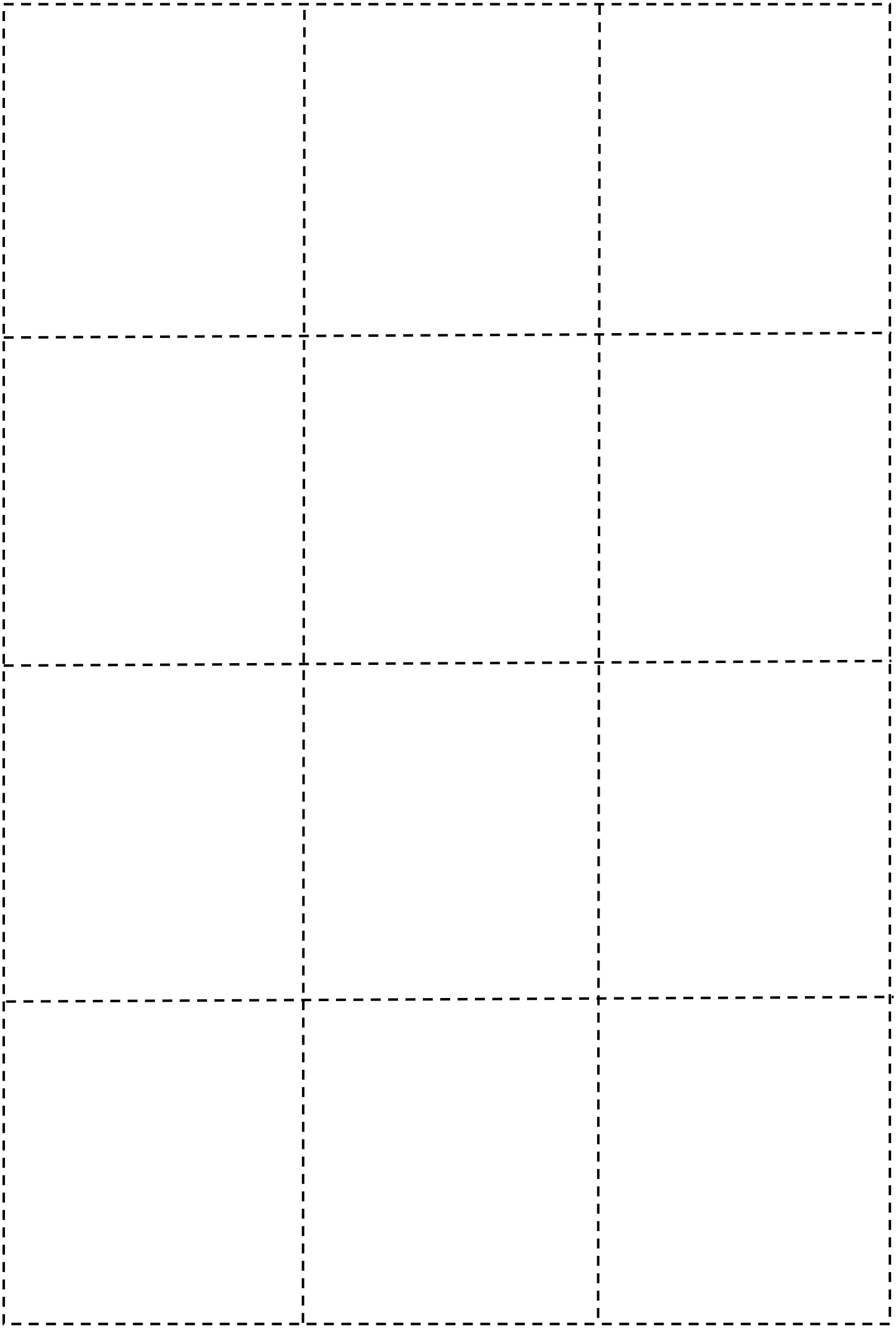
Use the approximate bond energies to calculate the energy change in the following reaction.
$H_2 + Cl_2 \rightarrow 2HCl$

State whether the reaction is endothermic or exothermic.
H–H = 436kJ/mol **Cl–Cl** = 243kJ/mol **H–Cl** = 432kJ/mol

436 + 243 → 432 + 432
679 → 864
- 185kJ/mol

The energy change is negative so the reaction is exothermic.

Additional Notes Page



Topic 5: Energy Changes

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