Zig Zag Education

Chemistry **GCSE (9-1) | AQA | 8461**

Homework Pack

for GCSE AQA Chemistry Topics 1-5

zigzageducation.co.uk **POD 8049**

Contents

Teacher's Introduction

These homework tasks are designed to be used with topics 1-5 of the AQA GCSE Chemistry course.

Every major topic in the course is covered, allowing regular homework to be set approximately every two weeks of teaching. They are designed so that they can be handed out to students, and they contain all the instructions the students will need to complete the tasks. It is expected that students will be applying knowledge of content learned in lesson time, and so no new content is covered in the homeworks.

Twenty topics are covered, with each homework directly linked to the AQA specification. Each homework is created to check and reinforce learning, through interesting and challenging tasks which are original and focussed.

Exam skills are explicitly tested at the end of every homework in brief exam-style questions. These are original exam-style questions, based on the exam questions from the sample assessment materials.

Differentiation
For each homework, two versions are provided.
In the version with an  symbol, some tasks will have more scaffolding, more examples or more support as appropriate. The hardest aspects of the exam style questions may also be more broken down
The version with an  symbol is designed for students who will need less support and are more confident with a topic. It is expected that individual students might get different versions for different topics.

Tiering
Some areas of the course contain higher tier only content. In these instances we have still provided two versions of the homework as some higher tier students may still benefit from additional support. Conversely some foundation tier students might need more support than others.

In the quantitative chemistry section of the course:

- For students covering HT content, the following homeworks should be used:
  - *Moles and Concentrations (HT);*
  - *Percentage Yield and Atom Economy (HT);*
  - *Moles in Volumes of Solutions and Gases (HT)*.
- For students doing the FT paper, the *Quantitative Chemistry (FT)* homework covers the mathematical section of the course without moles. Students covering HT content **should not** use this homework as it covers the same material as the three HT homeworks.

Two additional changes:

- Only the  version of *Electrolysis* contains half equations (HT content).
- Only the  version of *Energy Changes* contains bond enthalpy calculations (HT content).

Answers
An answer sheet is provided for marking by either teachers or students. Marks are not given on the worksheets, but are included on the answer sheet, to allow for the possibility of tracking progress across the year.

We hope that these homeworks are useful to your teaching, and that they provide a valuable way to easily differentiate so that each child can make the best possible progress inside and outside of the classroom.

December 2017

Atoms, elements, compounds an

Specification reference: 4.1.1.1 - 4.1.1.2

Activity 1: Word unscramble

Unscramble the missing words, and then match each word to the correct definitio

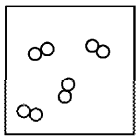
smoat	atoms	a m fro
elmc		a s typ
copmodun		a m dif
mituxre		ele the
ftilraotin		a m fro co
crysatlislaotin	crystallisation	tw wh
sipmle dsitilltiano	simple distillation	a s ato
frctaionla dsitlliatoin	fractional distillation	a m so
chmroatoagryph	chromatography	a m sta

Activity 2: Categorise the matter

Categorise the following as either an element (E), a compound (C) or a mixture (M) each circle.

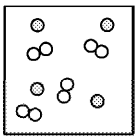
E C M

There are **four** mixtures, **five** elements and **three** compounds.

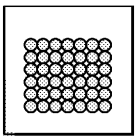


E

air



a mixture



carbon dioxide

oxygen

tap water

Activity 3: Compound interest

Compounds get their name from the ions they are made from. For example:

NaCl is sodium chloride because sodium's symbol is Na, and chlorine's symbol is Cl
MgO is magnesium oxide because magnesium's symbol is Mg and oxygen's symbol

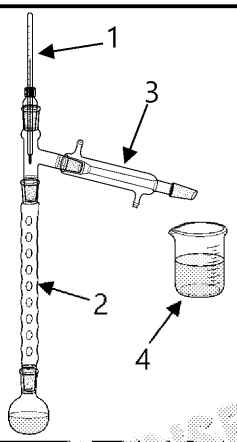
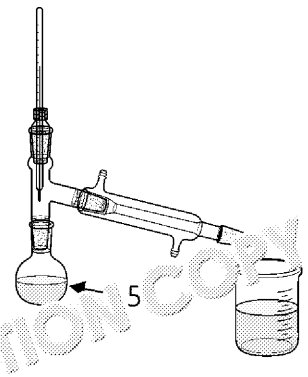
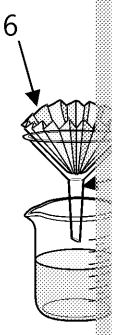
⚠	**Key Information:** The charge on compounds has to add up to 0. **Example:** Na^+ has a 1+ charge. O^{2-} has a 2- charge. There need to be **two** Na^+ ions for each O^{2-}. This makes the total charge add up to 0. Formula = Na_2O

Complete the table using the ions in the boxes.

Name	Ions involved	Formula
sodium oxide	Na^+ and O^{2-}	Na_2O
		$MgBr_2$
		KI
		$CaBr_2$
lithium iodide		
zinc oxide		
aluminium chloride		
copper iodide		

Activity 4: Separation apparatus

a) Identify each of the following experiments (A–D) and write its name in the relevant box.
Options: Evaporation, simple distillation, fractional distillation, filtration

A =	B =	C =
		

b) Name each piece of apparatus (1–8), and explain what it is used for.

	Name	Wha
1	thermometer	
2	fractionating column	
3		or..lensing the vapou
4		collecting the liquid (d
5		holding the liquid reac
	funnel	
8	crystallisation dish	

Activity 5: Exam-style questions

Exam-style questions

1. Which of the following is an accurate description of a coin made only from c

   A element

   B compound

   C mixture of elements

   D mixture of compounds

2. Write the word equation for the following reaction:

   Ca + $CaCl_2$ .....

3. Plan a method for obtaining pure water from seawater, including names for

   Name of method: .....

   Key equipment:

   - .....
   - .....
   - .....

   Method: .....

   .....

   .....

   .....

   .....

Atoms, elements, compounds an

Specification reference: 4.1.1.1 - 4.1.1.2

Activity 1: Word unscramble

Unscramble the words, and then match each word to the correct definition.

smoat	.....	a m a sc
lem	.....	a su type
dumpnooc	.....	a m diff
tuxrime	.....	elem thes
liftnotria	.....	a m a sc cond
slaclstnraitioy	.....	two whic
liemps tildoniitlas	.....	a su ator
lanacrtifo adslltnitioi	.....	a m solu
aohrrcmopyacth	.....	a m stat

Activity 2: Categorise the matter

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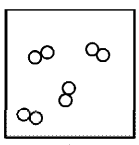
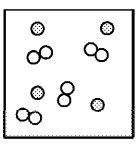
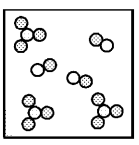


E





air

carbon dioxide

oxygen

tap water

Activity 3: Compound interest

Compounds get their name from the ions they are made from. For example:
NaCl is sodium chloride because sodium's symbol is Na, and chlorine's symbol is Cl
because magnesium's symbol is Mg and oxygen's symbol is O.

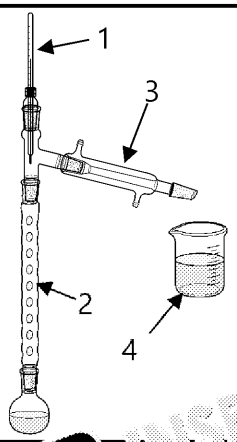
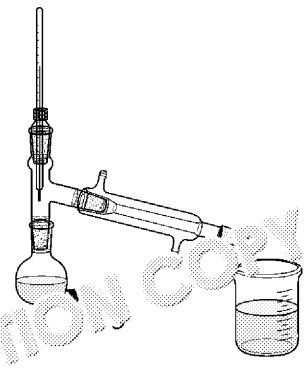
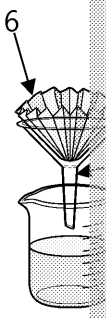
⚠	**Key information:** The charge on compounds has to add up to 0. **Example:** Na^+ has a 1+ charge. O^{2-} has a 2- charge. Therefore need to be **two** Na^+ ions for every O^{2-}. This makes the total charge add up to 0. Formula = Na_2O

Complete the table using the ions in the boxes.

Name	Ions involved	Formula
sodium oxide	Na^+ and O^{2-}	Na_2O
		$MgBr_2$
	K^+ and I^-	
	Ca^{2+} and Br^-	
lithium iodide		
zinc oxide		
aluminium chloride		
copper iodide		
	Zn^{2+} and O^{2-}	
magnesium nitrate		

Activity 4: Label the apparatus

a) Identify each of the following experiments (A–D) and write its name in the rel

A =	B =	C =
		

b) Name each piece of apparatus (1–8), and explain what it is used for.

	Equipment	
	Name	What
1		
2		
3		
4		
5		
6		
7		
8		

Activity 5: Exam-style questions

Exam-style questions

1. Which of the following is an accurate description of a coin made only from c

   A element

   B compound

   C mixture of elements

   D mixture of compounds

2. Write the balanced ... ation for the following reaction:

   calcium + chlorine → calcium chloride

   .....

   .....

3. Plan a method for obtaining pure water from seawater, including names for

   .....

   .....

   .....

   .....

   .....

   .....

   .....

   .....

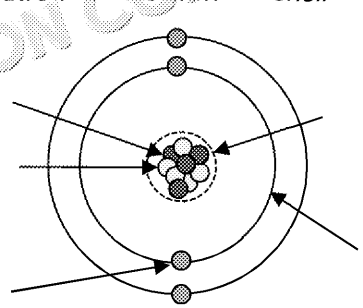
Atomic structure

Specification reference: 4.1.1.3 - 4.1.1.7 You shouldn't trust a

Activity 1: Label the diagram

Label the diagram with the following words:

proton *neutron* *electron* *shell* *n*



Activity 2: Particle personals

The subatomic particles are each signing up for a dating site, and they nee themselves. Make sure you include their charge, their mass and where the

For example:

'I'm your chilled-out, neutral particle who is never charged and is ro I like to be around positive particles hanging out in the nucleus.'

Proton .....

.....

Neutron .....

.....

Electron .....

.....

Activity 3: Atomic numbers

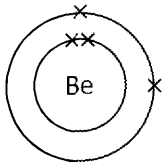
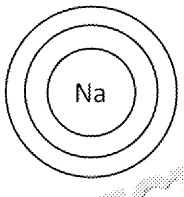
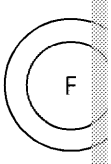
For the following atoms and ions, complete the data in the table. One has forget that:

- mass number = protons + neutrons
- atomic number = protons
- charge = protons – electrons

atom	$^{9}_{4}Be$	$^{23}_{11}Na$	$^{7}_{3}Li$	
atomic number	4	11		
mass number	9		7	
number protons	4	11		
number of neutrons	5			
number of electrons	4		3	

Activity 4: Drawing electronic structures

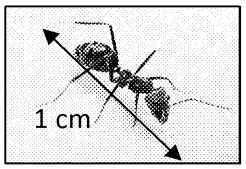
Complete the electronic structures of the atoms and ions below. The first one has

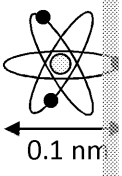
$^{9}_{4}Be$	$^{23}_{11}Na$	$^{7}_{3}Li$	$^{19}_{9}F$
			

Activity 5: [illegible] atom

An ant and [illegible] are shown below. Use the table of prefixes to answer the fo
e.g. 1 µm = 0.000 001 m (six orders of magnitude)

Prefix	Order of magnitude
Centi (c)	1/100
Milli (m)	1/1000
Micro (µ)	1/1 000 000
Nano (n)	1/1 000 000 000





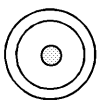
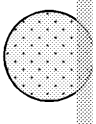
1. What is 1 cm in m^2? .....

2. What is 0.1 nm in m^1? .....

3. How many orders of magnitude bigger is the [illegible] the atom? .....

Activity 6: Atomic model timeline

Match each date to a [illegible] conclusion and an atomic diagram.

Date	1803	1897	1909
Name	Thomson	Dalton	Rutherfo (Geiger and M
Conclusion	Atoms are hard spheres. Different elements have different ty of at	Electrons are in she [illegible] shell has a different energy.	Atoms are s of positive c Negative ele are spre through
Diagram			

Exam-style questions

1. How many neutrons does an atom of $^{11}_{5}B$ have?

   A 5

   B 6

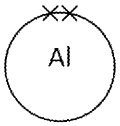
   C 11

   D 16

2. State the relative mass of a proton.

   .....

3. Complete the electronic structure of aluminium (Al). The first shell has been



4. Explain how the understanding of the atom has changed over time.

   Make sure you include a description of each atomic model, including the ide
   Ruthe nd Bohr.

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   .....

   .....

Atomic structure

Specification reference: 4.1.1.3 - 4.1.1.7 You shouldn't trust a

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Label the diagram with the following words:

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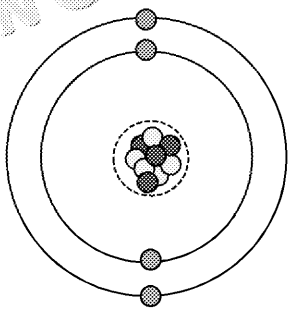

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themselves. Make sure you include their charge, their mass and where they like to

For example:

'I'm your chilled-out, neutral particle who is never charged and is ro
I like to be around positive particles hanging out in the nucleus.'

Proton .....

.....

Neutron .....

.....

Electron .....

.....

Activity 3: Atomic numbers

For the following atoms and ions, complete the data in the table. One has been d

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atomic number	4			
mass number	9			
number of proton				
number of neutrons	5			
number of electrons	4			

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Draw the electronic structures of the atoms and ions below. The first one has bee

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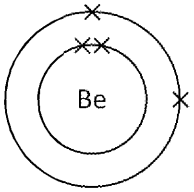			

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An ant and a ... atom are shown below. Use the table of prefixes to answer the foll

Prefix	Order of magnitude
Centi (c)	1/100
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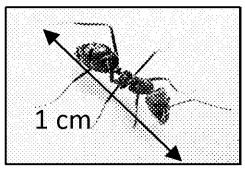
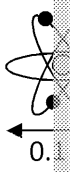
Micro (μ)	1/1 000 000
Nano (n)	1/1 000 000 000





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Name	Thomson	Dalton	Rutherfo... (Geiger and M...)
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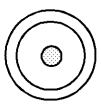
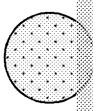
Diagram			

Exam-style questions

1. How many neutrons does an atom of $^{11}_{5}B$ have?

   A 5

   B 6

   C 11

   D 16

2. State the relative mass of the subatomic particle with a charge of +1.

   .....

3. Draw the electronic structure of an aluminium (Al) atom.

4. Explain how the understanding of the atom has changed over time. Ensure you mention particular scientists in your answer.

   .....

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The periodic table

Specification reference: 4.1.2.1 – 4.1.2.3 Or, as I ca

Activity 1: Periodic table quote hunt

Identify the elements from the clues and fill in the boxes below. When you have fi
symbols will spell out a quote from Mendeleev.

1 An atom of nitrogen
2 An atom of oxygen
3 Atom with atomic n
4 A grou le ... two shells
5 Atom ...er 7
6 An ato... this element has eight electrons
7 Atomic number 88
8 Five electrons in its second shell
9 Yttrium
10 Thorium
11 Group 7, but a higher bo
electron shells than chlo
12 Same number of outer e
fewer electrons
13 Element in the same gro
electrons (just the first le
14 The first metal to the rig
beginning with P
15 Relative atomic mass of

"

1	2	3	4	5	6	7

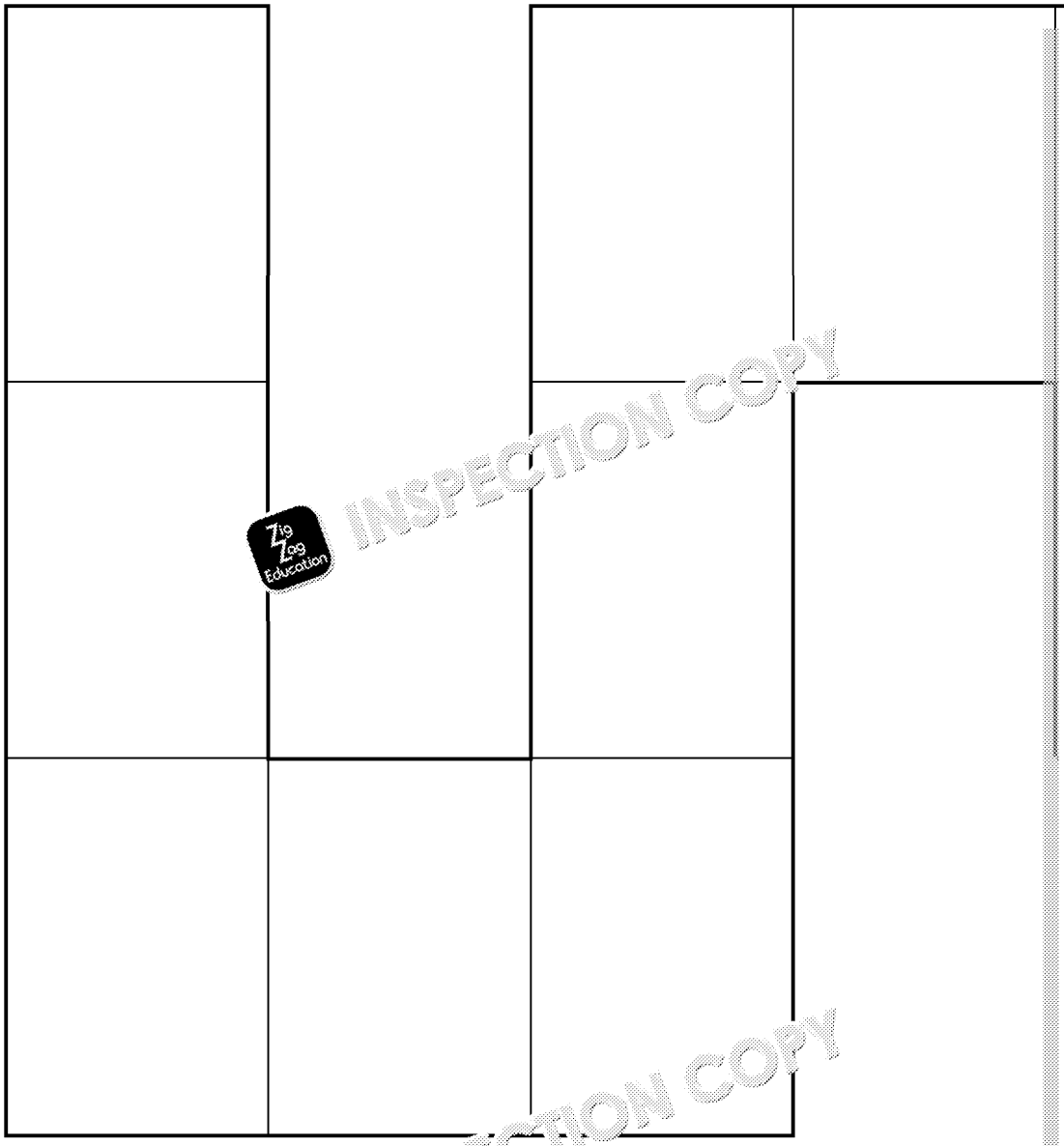
						...
10	11	12	13		15	

– Dm

Activity 2: Dom...

a) Write t... inoes in the correct order to make a timeline of events in the hi
b) Colour in the dominoes to show whether they refer to the early periodic table
table (green) or the modern periodic table (red).

Start	The first periodic table placed elements in order of atomic weights...
... such as putting al metals that reacted vi with water togeth	
... for elements that hadn't yet been discovered.	Isotopes were also discovered which explained ...
... the order of elem didn't match the at weights.	
... which m...at some of the elements were in the wrong order.	Mendeleev changed things by taking account of how they reacted...



Activity 3: Quick-fire questions

What is the name of the columns in the periodic table? .....

What is the name of the rows in the periodic table? .....

Who is the person credited with developing the first modern periodic table? .....

Which subatomic particle affects which element an atom belongs to? .....

Which subatomic particles affect the mass of an atom? .....

Which subatomic particles affect the charge of an atom? .....

Do metals form positive ions or negative ions? .....

Do non-metals form positive ions or negative ions? .....

Activity 4: Exam-style questions

Exam-style questions

1. Which of the following is likely to be shared by el[illegible]ts in the same gro[illegible]

   A Melting point

   B Electrical conductivity

   C Number of [illegible]

   D [illegible]ation

2. Elements in the periodic table are ordered by the number of protons in th[illegible]

   They do not always appear in order of atomic mass; for example, cobalt i[illegible] than nickel.

   a) Other than protons, which subatomic particle affects the relative ato[illegible]

   .....

   .....

   b) What term is used to describe two atoms with the same number of p[illegible] atomic masses?

   .....

   .....

3. How did Mend[illegible]e[illegible]d[illegible]the results from experiments in his work? Give o[illegible] an[illegible]

   .....

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   .....

The periodic table

Specification reference: 4.1.2.1 - 4.1.2.3 Or, as I ca

Activity 1: Periodic table quote hunt

Identify the elements from the clues and fill in the boxes be... When you have f... symbols will spell out a quote from Mendeleev.

1 An atom of nitrogen
2 An atom of oxygen
3 Atom with ato... 1...
4 A gro... ...en ...t with two shells
5 Atomi... ...er 7
6 An atom of this element has eight electrons
7 Atomic number 88
8 Five electrons in its second shell
9 Yttrium
10 Thorium
11 Group 7, but a higher bo... electron shells than chlo...
12 Same number of outer e... fewer electrons
13 Element in the same gro... electrons (just the first le...
14 The first metal to the rig... beginning with P
15 Relative atomic mass of ...

"

						/
1	2	3	4	5	6	7

						...
10	11	12	13	...	15	

– Dm...

Activity 2: Domi...

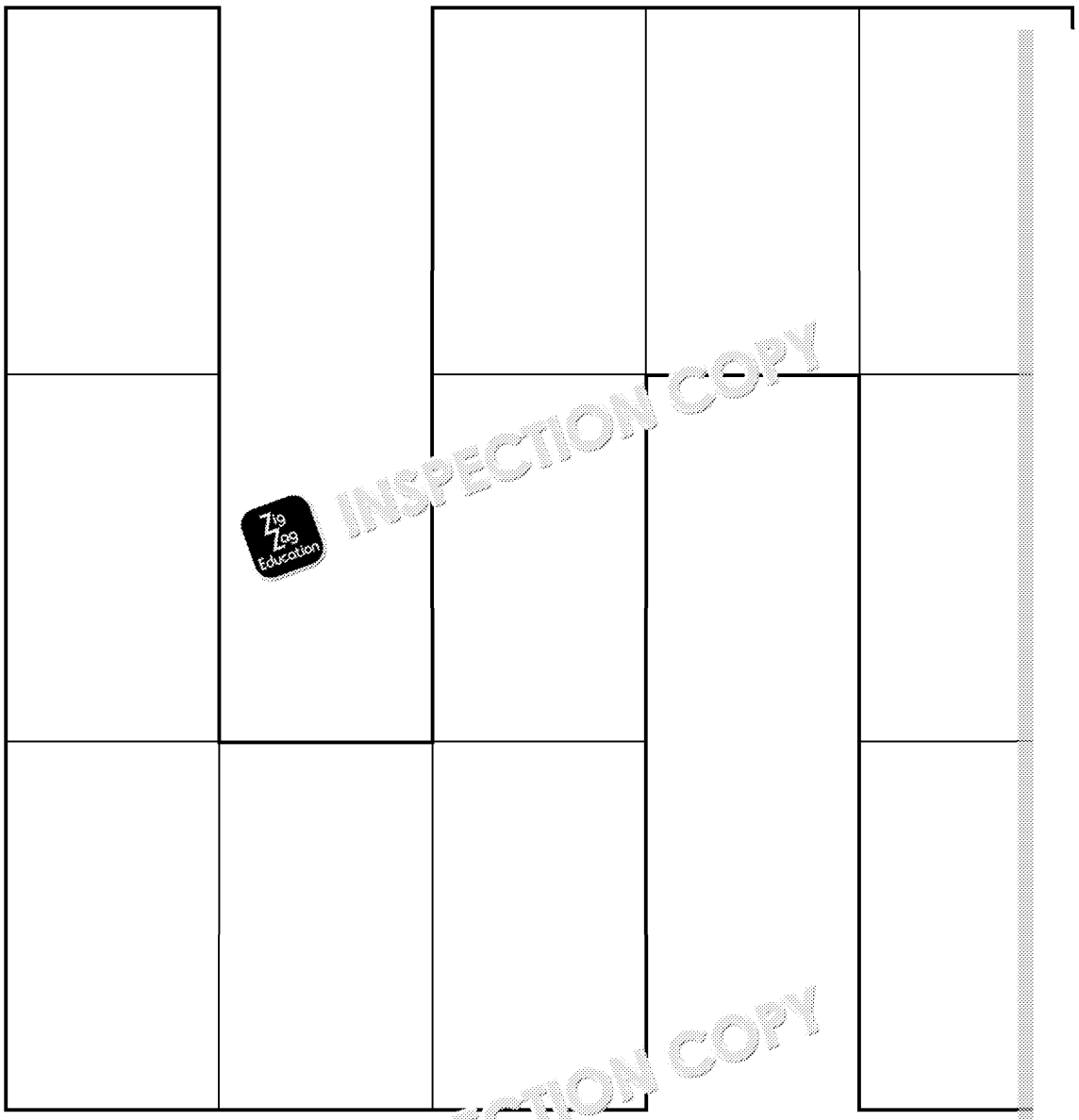
a) Write t... ...ir ...es in the correct order to make a timeline of events in the h...
b) Colour ... dominoes to show whether they refer to the early periodic table ... table (green) or the modern periodic table (red).

Start	The first periodic table placed elements in order of atomic weights...
... such as putting all the metals that reacted violently with water together.	He also left gaps in the periodic table...
... the ord... ...le... ... didn't ma... ...atomic weights.	**End**

... such as gallium ... germanium.

... which meant t... some of the elem... were in the wrong ...

... for elements th... hadn't yet bee... discovered.



Activity 3: Quick-fire questions

Who is the person credited with developing the first modern periodic table? .....

Which subatomic particle affects which element an atom belongs to? .....

Which subatomic particles affect the mass of an atom? .....

Which subatomic particles affect the charge of an atom? .....

Do metals form positive ions or negative ions? .....

Do non-metals form positive ions or negative ions? .....

Why are some elements not arranged in order of atomic weight in the periodic table? .....

What is the same about every atom in a group of the periodic table? .....

Activity 4: Exam-style questions

Exam-style questions

1. Which of the following is likely to be shared by elements in the same group

   A Melting point

   B Electrical conductivity

   C Number of electrons

   D Forces of attraction

2. Elements in the periodic table are ordered by the number of protons in their

   They do not always appear in order of atomic mass; for example, cobalt has a higher atomic mass than nickel.

   a) Other than protons, which subatomic particle affects the relative atomic mass?

   .....

   .....

   b) What term is used to describe two atoms with the same number of protons but different atomic masses?

   .....

   .....

3. How did Mendeleev use the results from experiments in his work? Give one answer.

   .....

   .....

   .....

   .....

   .....

   .....

   .....

   .....

   .....

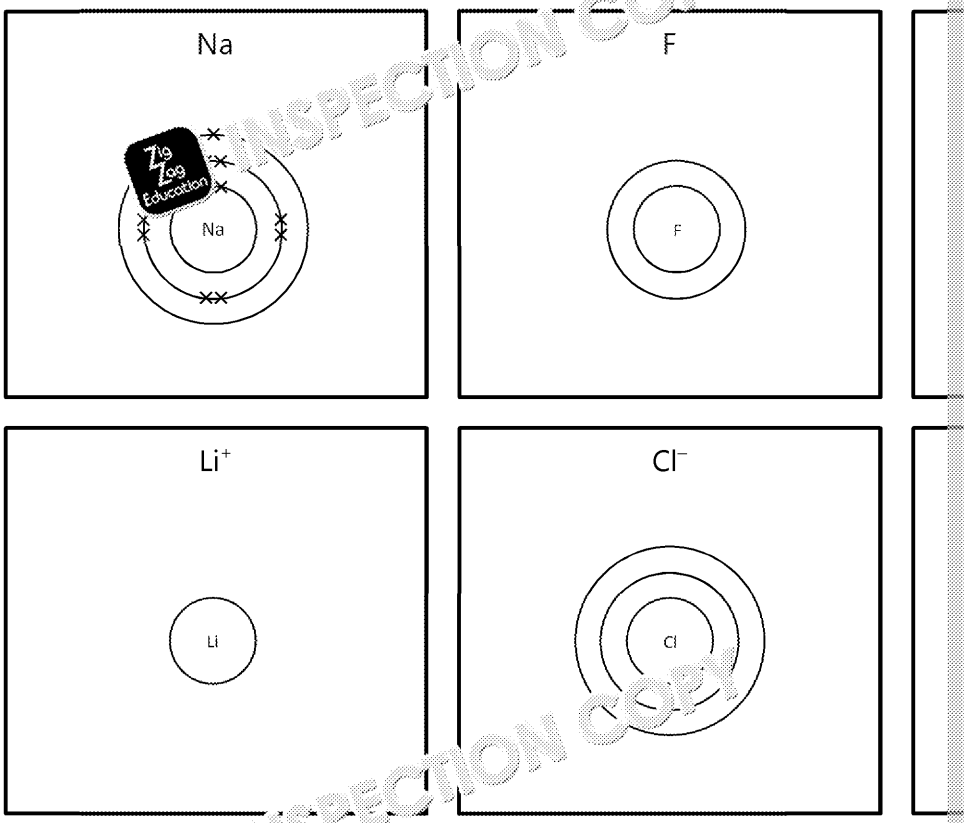
   .....

Groups and their reactiv

Specification reference: 4.1.2.4 - 4.1.2.6 An alkali metal ion says to a ha

Activity 1: Electronic structure drawing

Complete the electronic structure for each of the following:



Activity 2: Spot the odd one out

Circle the odd one out, and then write a description of why you chose that one. You may wish to refer to groups, periods, elements, compounds, protons or electrons.

1.	Li	Na	(Cl)	Li and Na are in group 1
2.	F	Cl	Ar	.....
3.	He	Ne	Cl	.....
4.	Li	F	Ar	.....
5.	He	Ne	Ar	.....
6.	Li^+	He	F	.....
7.	LiF	Na_2	Cl_2	.....
8.		F	Xe	.....
9.	K	F	Ar	.....

Activity 3: Who am I?

Four elements from the following list have written short poems about themselves. element in the box next to each poem.

Elements

Li	K	Cl	Br	I	He	Ne

☐ I'm an unreactive eleme[illegible]ts up signs at night
I don't easily for[illegible]mpounds but electrons make me glow bright

☐ [illegible]me into water and I'll begin to fizz
[illegible]t not as much as others which catch fire and go whizz

☐ I'm a non-metallic element; I go around in twos
I'll take electrons off iodide or bromide, if they've got some to lose

☐ I'm an unreactive element; my atoms are always on their own
I'm lighter than air and safe to use, so into balloons I'm blown

Write a poem about another element. Try to include a reference to its reactivity o
Make sure your poem can only apply to one element in the list!

Element **[illegible]em**

.....

☐ .....

.....

Activity 4: Increase or decrease?

For each of the following, identify whether it **increases** or **decreases** by using t

↑ ↓

↑ Number of electrons, going down a group.

↑ Number of electrons, going **left** acros[illegible]eriod.

↑ Ability t[illegible] p[illegible]tive ions, going[illegible] group 1.

↑ Number of protons, going down group 0.

Activity 5: Exam-style questions

Exam-style questions

1. Why does helium have a lower boiling point than argon?

   A Argon has stronger covalent bonds

   B Argon is covalent but helium is ionic

   C Helium is less reactive

   D forces between argon's atoms are stronger

2. Potassium is usually stored in oil as it reacts with oxygen in the air to form

   a) In which group of the periodic table is potassium located?

   .....

   b) Predict how the reaction of sodium with air would be different from th with air.

   .....

   .....

   c) Potassium can be removed from the oil to react with water.

   Write the word equation for this reaction

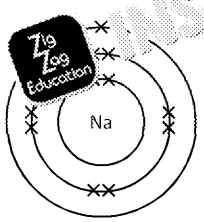
   .....

Groups and their reactiv

Specification reference: 4.1.2.4 - 4.1.2.6 An alkali metal ion says to a ha

Activity 1: Electronic structure drawing

Draw the electronic structure for each of the following:

Na 	F	
Li^+	Cl^-	

Activity 2: Spot the odd one out

Circle the odd one out, and then write a description of why you chose that one.
Your reasons must be to do with groups, periods, elements, compounds, protons o

1.	Li	Na	(Cl)	Li and Na are in group
2.	At	Cs	Rb	.....
3.	He	Ne	Cl	.....
4.	Li	F	Ar	.....
5.	He	Ne	Ar	.....
6.	N^{3-}	F^-	C^{2-}	.....
7.	LiF	N[illegible]	Cl_2	.....
8.		F	Xe	.....
9.	K	F	Ar	.....

Activity 3: Who am I?

Four elements from the following list have written short poems about themselves. element in the box next to each poem.

Elements

Li K F Cl Br I He Ne Ar

☐ I'm an unreactive element tha[illegible] up signs at night
I don't easily form co[illegible] but electrons make me glow bright

☐ [illegible]e into water and I'll begin to fizz
B[illegible] as much as some others which burn purple and go whizz

☐ I'm a non-metallic element; I go around in twos
I'll take electrons off iodide or bromide, if they've got some to lose

☐ I'm an unreactive element; my atoms are always on their own
I'm lighter than air and safe to use, so into balloons I'm blown

Write a poem about another element. Try to include a reference to its reactivity o
Make sure *your poem can only apply* to one element in the list!

Element **[illegible]em**

☐ .....

.....

.....

Activity 4: Increase or decrease?

For the following, identify whether it **increases** or **decreases** by using the approp

↑ ↓

Ability to form positive ions, going down group 1.

Number of protons, going down gr[illegible] 0.

Melting p[illegible] element[illegible]ng down the [illegible]roup.

Boiling point of group 0 elements, going down the group.

Activity 5: Exam-style questions

Exam-style questions

1. Why does helium have a lower boiling point than argon?

   A Argon has stronger covalent bonds

   B Argon is covalent but helium is ionic

   C Helium is less reactive

   D There forces between argon's atoms are stronger

2. Potassium is usually stored in oil as it reacts with oxygen in the air to form

   a) In which group of the periodic table is potassium located?

   .....

   b) Predict how the reaction of sodium with air would be different from that of potassium with air. Explain why.

   .....

   .....

   .....

   .....

   c) Potassium can be removed from the oil to react with water.

   i) Write the word equation for this reaction.

   .....

   ii) Write the formulae for the two products of this reaction.

   .....

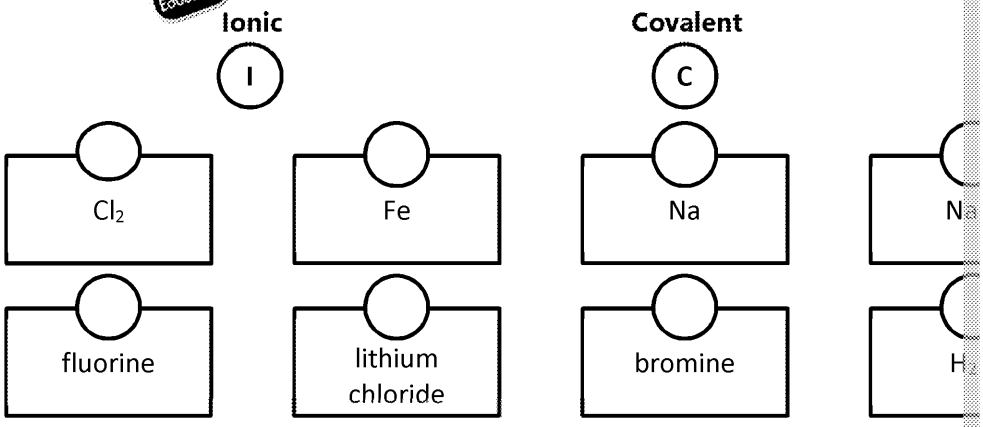
Ionic, covalent and metallic

Specification reference: 4.2.1.1 - 4.2.1.5

Activity 1: Predict the bonding

Add symbols to the circles to predict the type of bonding in the following molecu

Hint: The type of bonding in the compound depends on the type of elem
- Non-metal with a non-m[illegible] covalent
- Metal with a non-[illegible] ionic
- Pure m[illegible]



Activity 2: Codebreaker

Read the following passage, and complete the key by matching the words in the w

Codebreaker

Molecule A is made of only one type of ◎, so it is a[illegible]ic is a non-❖, and so its bonding is ⌘.

Compound B is made from one ◎ of molecule A, and two ◎s of oxygen. Its bonding is also ⌘, and the ♦s are shared by the atoms.

Substance C has a giant ❍ic lattice, formed from ❍s of sodium and chlorine. An ♦ is transferred from sodium to chlorine to form the ❍ic bonds.

Substance D has ❖lic bonding, and contains a sea of ✸ ♦s between positive ❖ ❍s.

❑ .....

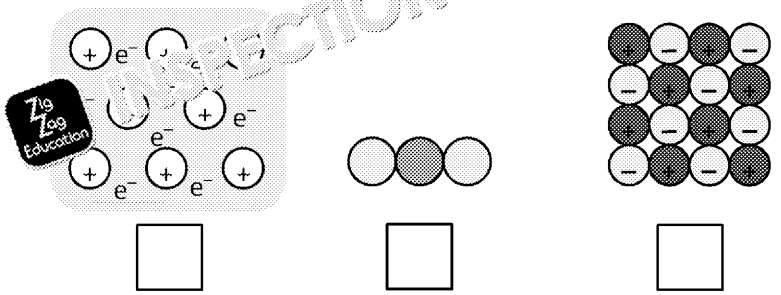
❖ .....

⌘ .....

❍ .....

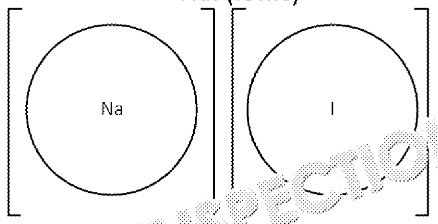
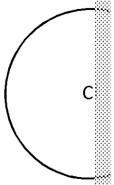
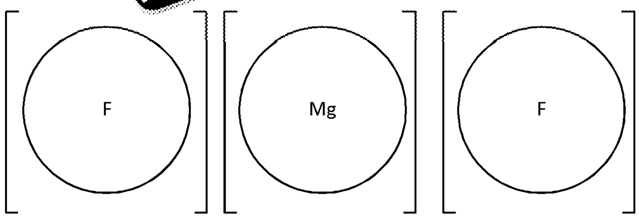
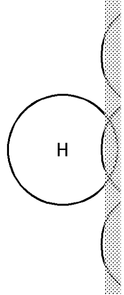
Wordlist
electron
element
delocalised

In the box under each diagram below, write the letter (A, B, C or D) of the molecul describes it in the codebreaker:



Activity 3: Dot-and-cross diagrams

Draw dot-and-cross diagrams to show the bonding in the following substances. Y
shell of electrons.

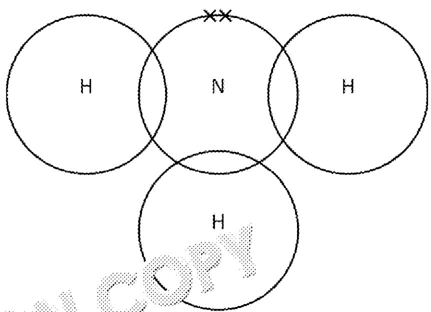
NaI (ionic) 	Cl_2 
MgF_2 (ionic) 	CH 

Activity 4: Exam-style questions

Exam-style questions

1. What kind of bonding is there in sodium chloride?
   - **A** intermolecular
   - **B** covalent
   - **C** metallic
   - **D** ionic

2. Complete the dot-and-cross diagram for NH_3, which is covalent.



3. Describe the metallic bonding in pure aluminium.

....

....

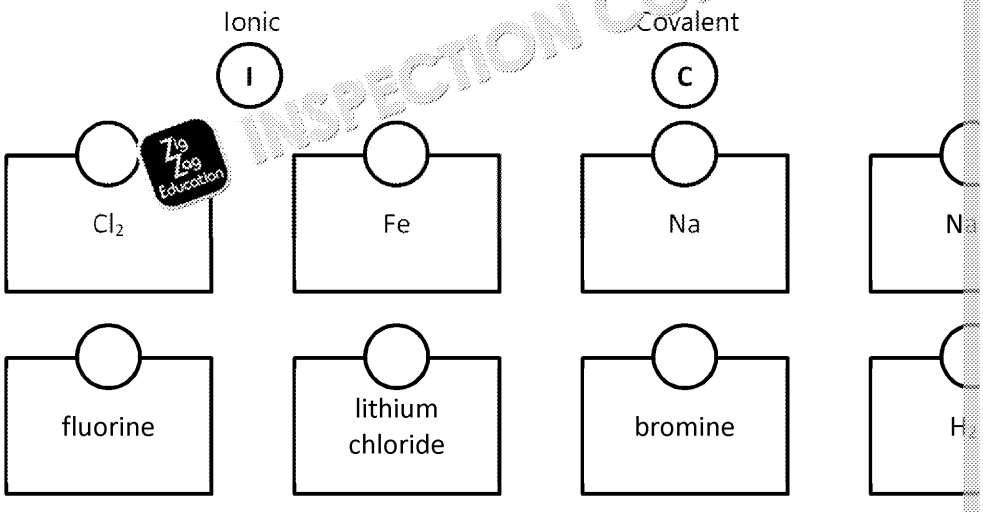
....

Ionic, covalent and metallic

Specification reference: 4.2.1.1 - 4.2.1.5

Activity 1: Predict the bonding

Add symbols to the circles to predict the type of bonding in the following molecul



Activity 2: Codebreaker

Read the following passage, and complete the key by identifying the words replac

Codebreaker

Molecule A is made of only ◎, so it is an ❑. It is a non-[illegible] so its ♦ing is ⌘.

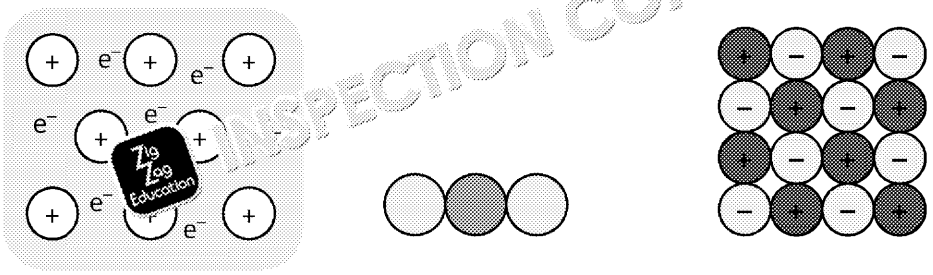
Compound [illegible] from one ◎ of molecule A, and two ◎s [illegible] oxygen. Its ♦ing is also ⌘, and the ♦s are [illegible] by the atoms.

Substance C has a giant ❍ic lattice, formed from ❍s of sodium and chlorine. An ♦ is transferred from sodium to chlorine to form the ❍ic ♦s.

Substance D has ❖lic ♦ing, and contains a sea of ✸ ♦s between positive ❖ ❍s.

❑ .....
❖ .....
⌘ .....
❍ .....
◎ .....
✸ .....
♦ .....
♦ .....

In the box under each diagram below, write the letter (A, B, C or D) of the molecul describes it in the codebreaker:



Activity 3: Dot-and-cross diagrams

Draw dot-and-cross diagrams to show the bonding in the following substances. Y
shell of electrons.

NaI

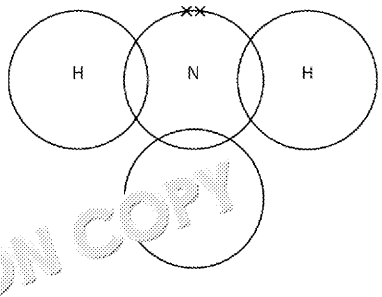
MgF_2

Activity 4: Exam-style questions

Exam-style questions

1. What kind of bonding is there in iron chloride?
   - **A** molecular
   - **B** covalent
   - **C** metallic
   - **D** ionic

2. Complete the dot-and-cross diagram for NH_3, which is covalent.



3. Describe the metallic bonding in pure aluminium.

.....

.....

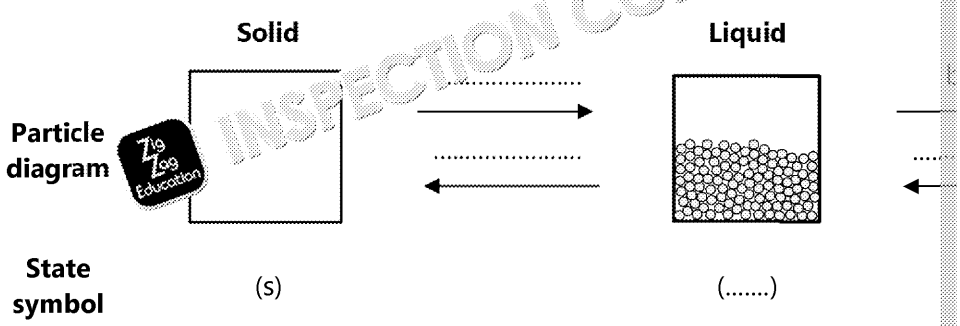
.....

Properties of matter

Specification reference: 4.2.2.1 - 4.2.2.8 RIP con

Activity 1: Add labels to the diagram

In the following diagram: a) draw the missing particle diagrams in the boxes, b) ad changes (e.g. boiling), and c) fill in the missing state sy



Activity 2: Short questions

Using the words in the Keywords box, give brief answers to the following question you drew above. You may use words more than once.

	Solid	Liquid	Gas
How are the particles laid out?			
How far apart are the particles?			
How do the particles move?			

Activity 3: What ... nce?

You are go... market with various types of substance in your bag. Recomme substance ba... on their requirements.

Recommendation: a)	I need something which will dissolve in water and conduct electricity.
Recommendation: b)	Can you recommend something which contains ions that isn't giant ionic?
Recommendation: c)	What have you ... delocalised e... ons?
Recommendation: d)	Give me the substance with the lowest boiling point you have.
Recommendation: e)	I need a covalent substance made of very long chains

Exam-style questions

1. What is the correct name for the state change from liquid to solid?

   A Boiling

   B Condensing

   C Freezing

   D Evaporating

2. Describe how particles are laid out and how they move in a solid.

   .....

   .....

3. Sodium iodide is an ionic compound.

   Explain why sodium iodide can conduct electricity when it is aqueous but n

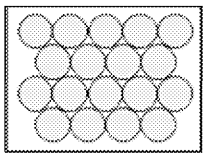
   .....

   .....

   .....

   .....

4. The diagram shows the arrangement of ions in a pure metal.



   a) Explain why metals can be bent without breaking.

   .....

   .....

   b) Explain what an alloy is and why alloys are useful.

   .....

   .....

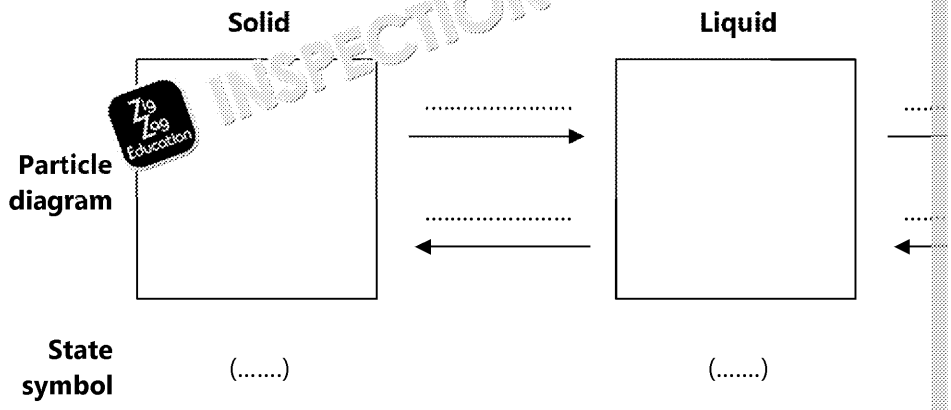
   .....

   .....

Specification reference: 4.2.2.1 - 4.2.2.8 RIP con

Activity 1: Add labels to the diagram

In the following diagram: a) draw the missing particle diagrams in the boxes b) add changes (e.g. boiling), and c) fill in the missing state symbols.



Activity 2: Short questions

Give brief answers to the following questions for each of the state diagrams you d

	Solid	Liquid
How are the particles laid out?		
How far apart are the particles?		
How do the particles move?		

Activity 3: Gridlock

Shade out boxes where the property **doesn't** apply to the type of substance. For e
don't have covalent bonding, so the square in the grid is shaded out. When you h
the **unshaded** boxes will spell out a question.

	Giant ionic	Small lecule	Polym
Covalent bonding		W	H
Ionic bonding	T	K	Q
Metallic bonding	D	W	L
Electrons a ed between atoms	Y	I	N
Sea of delocalised electrons	U	J	T
Contains ions	F	L	R
Long chains	F	F	U
Only conducts electricity when (l) or (aq)	B	S	Z
Usually solid at room temperature	S	T	T
Normally conducts electricity when (s)	O	F	S
Contains intermolecular forces	E	E	I
Contains only non-metal atoms	F	S	D
Bonds can be represented using lines which represent a pair of electrons	R	A	M
Attractions between particles act in all directions	N	S	J
Bonds break when ... solved	?	A	D

Question:

.....

Answer:

.....

Activity 4: Exam-style questions

Exam-style questions

1. What is the correct name for the state change from liquid to solid?

   A Boiling

   B Condensing

   C Freezing

   D Precipitation

2. Describe how particles are laid out and how they move in a solid.

   .....

   .....

3. Sodium iodide is an ionic compound.

   Explain why sodium iodide can conduct electricity when it is aqueous but n

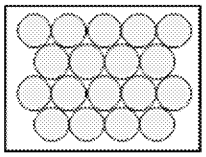
   .....

   .....

   .....

   .....

4. The diagram shows the arrangement of ions in a pure metal.



   a) Explain why metals can be bent without breaking.

   .....

   .....

   b) Explain with the use of a diagram why metals are mixed with other m

   .....

   .....

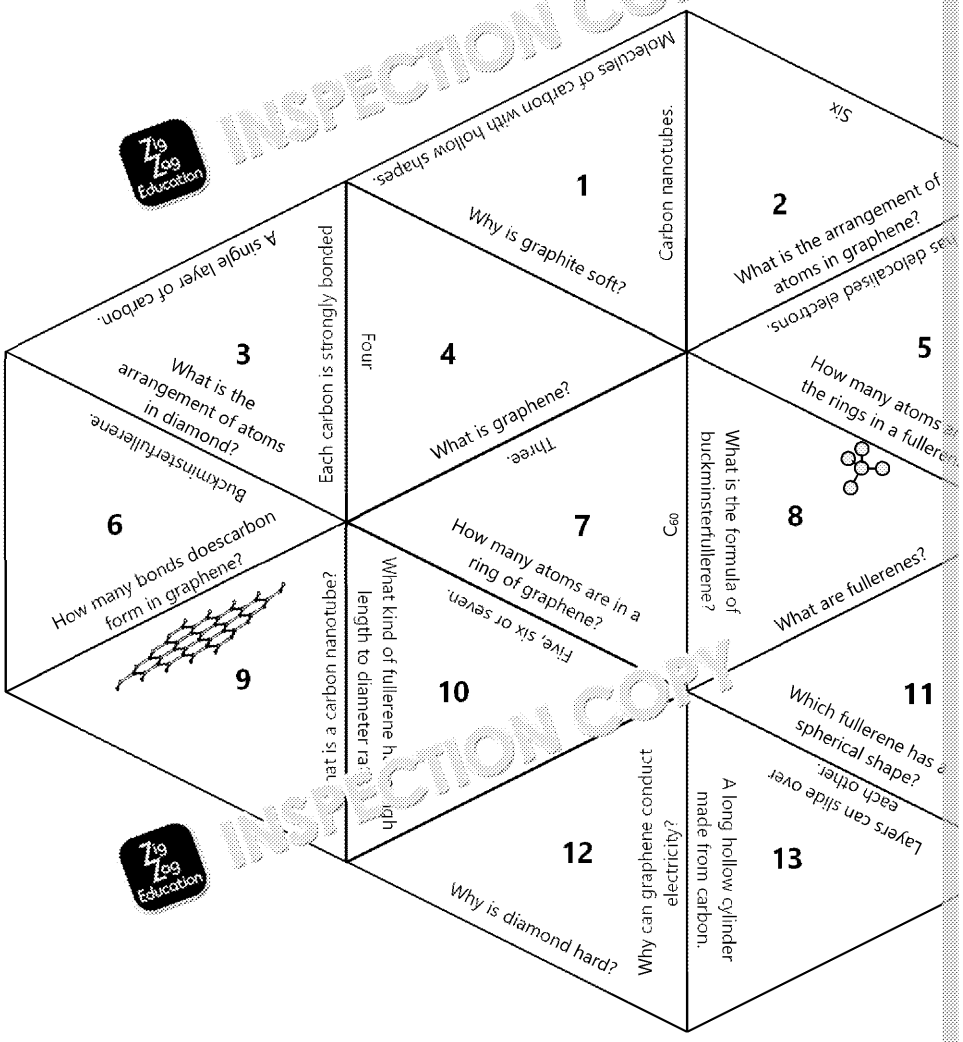
   .....

Forms of carbon

Specification reference: 4.2.3.1 - 4.2.2.3 What do you call two iden

Activity 1: Question tessellate

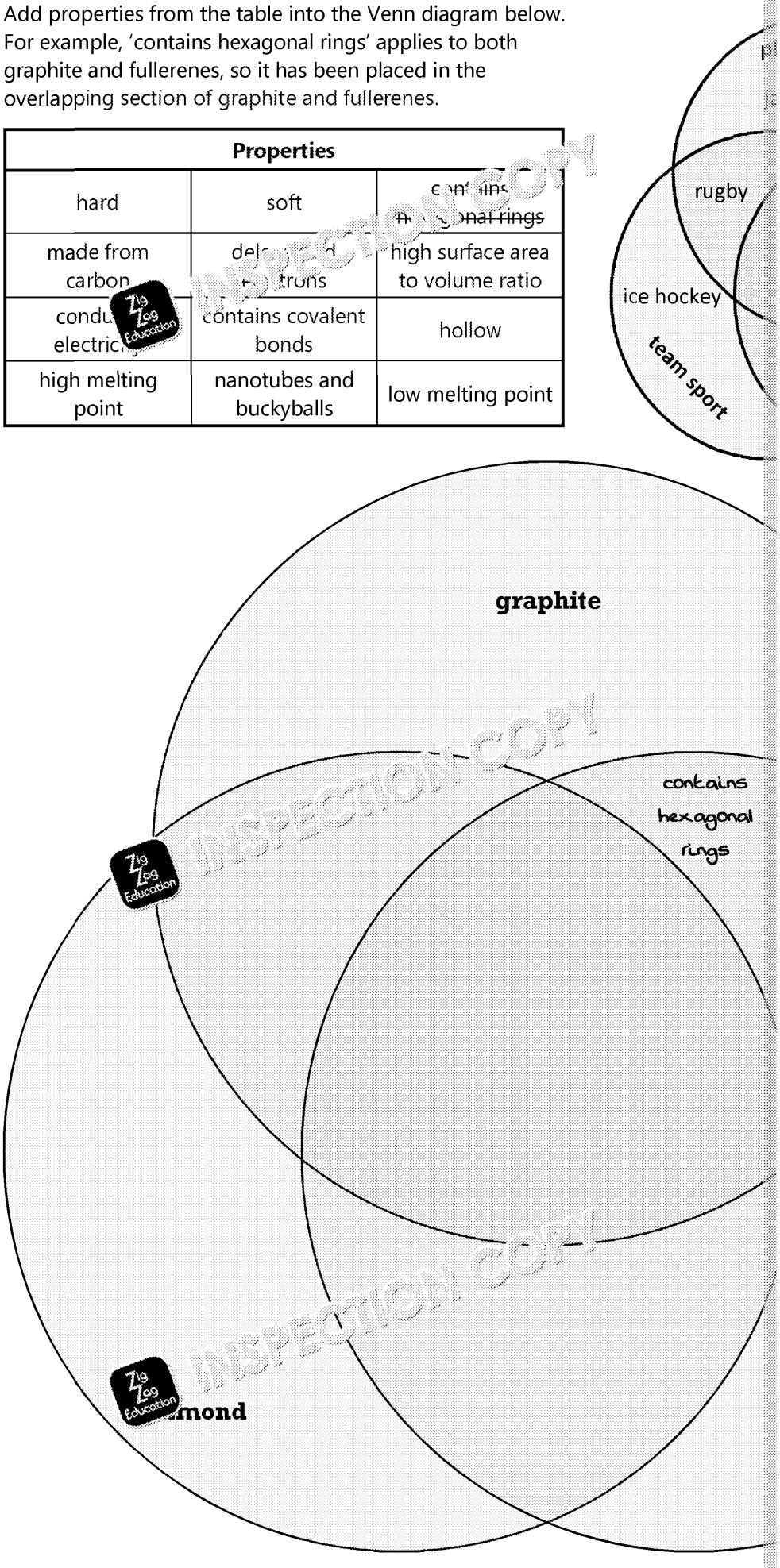
Cut out the following triangles, arrange them, and then stick them down so that th



Activity 2: Venn diagram

Add properties from the table into the Venn diagram below. For example, 'contains hexagonal rings' applies to both graphite and fullerenes, so it has been placed in the overlapping section of graphite and fullerenes.

Properties		
hard	soft	contains hexagonal rings
made from carbon	delocalised electrons	high surface area to volume ratio
conducts electricity	contains covalent bonds	hollow
high melting point	nanotubes and buckyballs	low melting point



Activity 3: Explaining the properties

Graphite and diamond are both made out of carbon, but have very different prop
- different hardness
- different electrical conductivity

Use the statements from the Key Statements box to explain these properties in te
graphite and diamond.

	Graphite	Diamond
Hardness	So	Hard
Reason		
Electrical conductivity	**Conductive**	**Not conductive**
Reason		

Key St
- Dif bo
- Ele mo car
- No thr
- Re
- Eac
- Eac thr
- Eac not
- Ato
- Eve fou
- Lay
- Eac in

Activity 4: Exam-style questi

Exam-style questions

1. Which of the following is **not** made from carbon?
   - **A** graphite
   - **B** buckminsterfullerene
   - **C** graphene
   - **D** silica

2. This diagram shows the layout of carbon atoms in diamond. Explain why di

   .....

   .....

3. Graphite can conduct electricity.

   a) Describe the structure of graph

   .....

   .....

   b) Explain why graphite can conduct electricity.

   .....

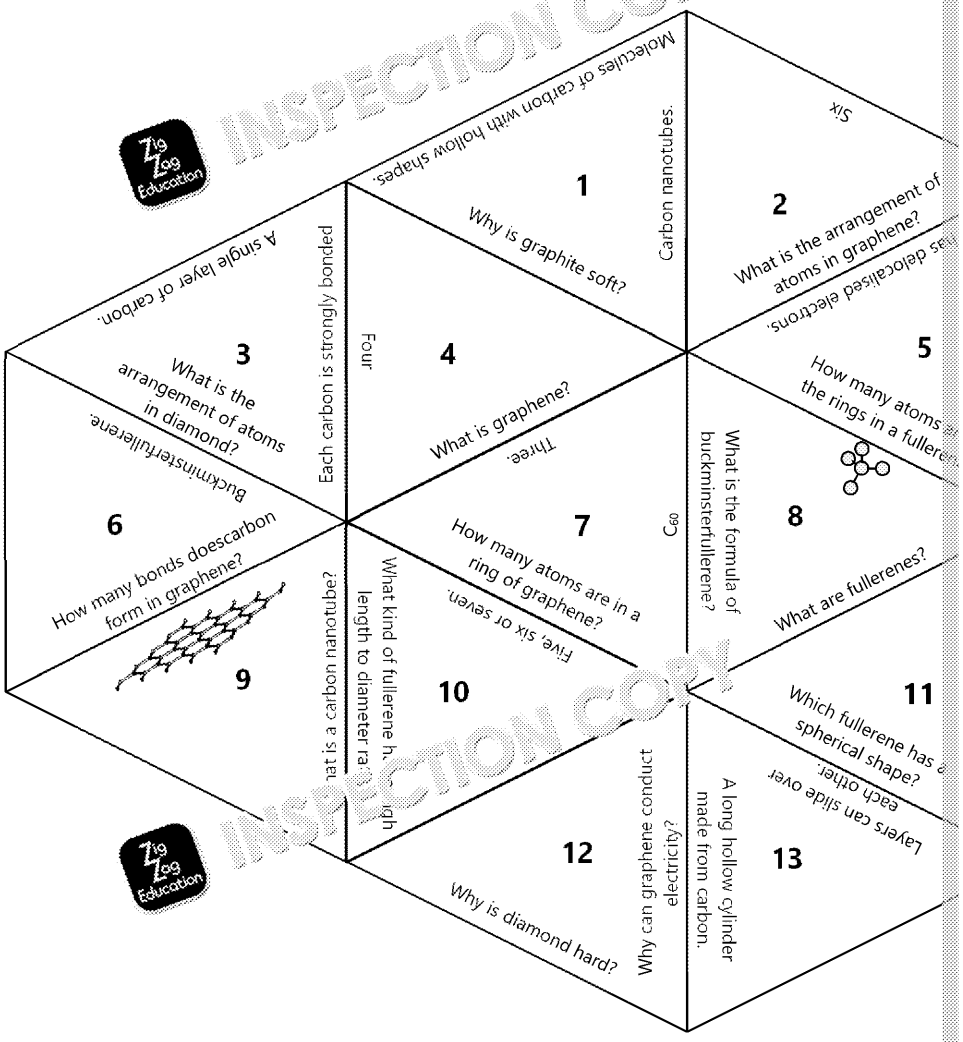
   .....

Forms of carbon

Specification reference: 4.2.3.1 - 4.2.2.3 What do you call two iden

Activity 1: Question tessellate

Cut out the following triangles, arrange them, and then stick them down so that th



Activity 2: Venn diagram

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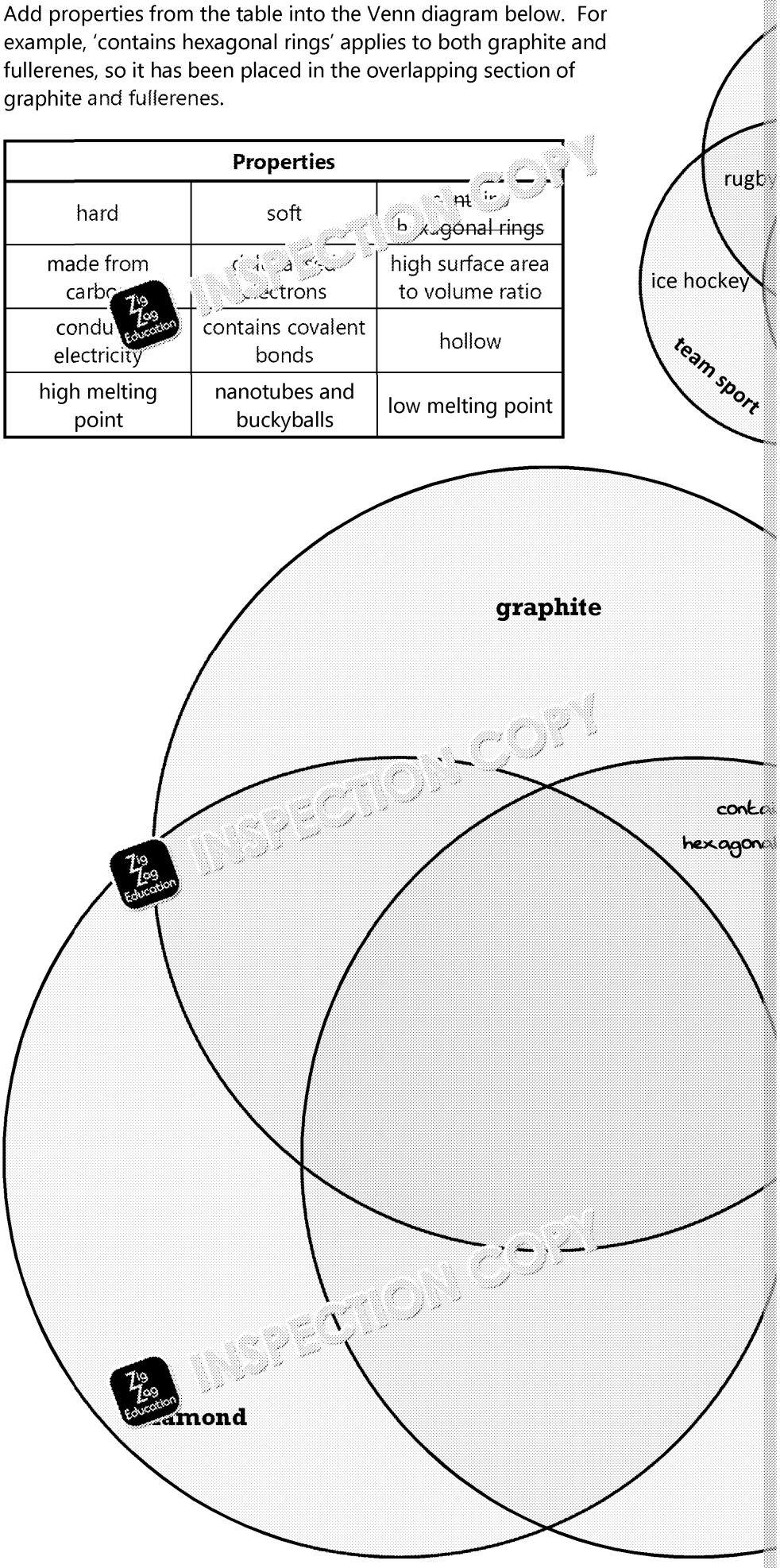
Properties		
hard	soft	[illegible] hexagonal rings
made from carbo[illegible]	[illegible]ectrons	high surface area to volume ratio
condu[illegible] electricity	contains covalent bonds	hollow
high melting point	nanotubes and buckyballs	low melting point



Activity 3: Explaining the properties

Graphite and diamond are both made out of carbon, but have very different prop
- different hardness
- different electrical conductivity

Explain these properties in terms of structure and bonding in graphite and diamo

	Gra	
Hardness (Soft/Hard)		
R		
Electrical conductivity (Conductive / Not conductive)		
Reason		

Activity 4: Exam-style questions

Exam-style questions

1. Which of the following is **not** made from carbon?
   - **A** graphite
   - **B** buckminsterfullerene
   - **C** graphene
   - **D** silica
2. This diagram shows the layout of carbon atoms in diamond. Explain why d

   .....

   .....
3. Graphite can conduct electricity.

   Describe the structure of graphite, and exp[illegible] h[illegible] graphite can conduct e

   .....

   .....

   .....

   .....

Nanoparticles

Specification reference: 4.2.4.1 - 4.2.4.2

Activity 1: Standard form calculations

Standard form is a way of representing numbers. It is especially useful when you [illegible] very big or very small.

Examples:

The number **1,200,000,000** [illegible]g. After the first digit (1) there are nine other [illegible] represented [illegible] × [illegible].

This also works for very small numbers. 0.0000000000245 is very small. Before th[illegible] This can be written as **2.45×10^{-11}**.

Write the following numbers in standard form:

Big numbers			Sm[illegible]	
1.	1450	..... × 10.....	1.	0.0045
2.	34 000	..... × 10.....	2.	0.000000345
3.	3 000 000	..... × 10.....	3.	0.0000000000000[illegible]
4.	50 800 000	..... × 10.....	4.	0.0040003
5.	700 040 000 000	..... × 10.....	[illegible].	0.00000501003

Activity 2: If this is th[illegible]r, what was the question?

Look at these [illegible]der[illegible]s about the use of nanoparticles in **deodorants**. Wri[illegible] answers.

Question: .....

.....

.....

The reason is because they have a large surface area to volume ratio and so might be better at stopping od[illegible] than regular deodorants.

Question: .....

.....

.....

Nanoparticles [illegible] area to volume [illegible] at many f[illegible] materials. Ho[illegible] very small the[illegible] and could caus[illegible]

Activity 3: Newspaper article

Read the newspaper article and then answer the questions below.

Science News

Nanoparticles can enter the foo

By Sam Wainwright
2nd November 2017

A study has shown that exhaust gases and fertilisers contain nanoparticles that can affect the growth of some plants.

Nanoparticles are very small particles of a material which are between 1 and 100 nanometres – that's one billion times smaller than a metre!

Nanoparticles are added to many different products, such as cosmetics, paints, fuels and deodorants.

Nanomaterials have a very high surface area to volume ratio, so only a small amount of a nanomaterial is required.

This makes nanoparticles very useful for many applications, such as catalysing a reaction, or giving materials bright colours.

However, some people think that nanoparticles are dangerous. Their high surface area to volume ratio means that if they have adverse effects then only a small amount could be very harmful. Additionally, because of their size, nanoparticles can easily enter the body through the skin.

In the study, nanoparticles made from zinc oxide and cerium oxide were added to the soil of soybean plants. The effect on their growth was measured. The researchers also measured the build-up of the nanoparticles in different parts of the soybean plants.

- Zinc oxide is a comm... antibacterials. Zinc o... from sewage which i...
- Cerium oxide is used ... combustion and redu...

The researchers chose to ... important crop. It is used ... fifth-most produced crop ...

The researchers found th... enter the roots of the soy... of nanoparticles had diff...

- Zinc oxide nanoparti... better. Zinc was foun... soybean plant. Howe... were not detected in ...
- Cerium oxide nanopa... the plants to grow les... oxide was found as n... suggesting that nano...

The presence of zinc oxi... in the plants may have a... may be toxic to humans ...

1. This article is about nanoparticles. What are nanoparticles?

.....

.....

2. Which two metal oxide compounds are the nanoparticles made from?

.....

.....

3. What effect did the nanoparticles have on the plants grown in soil?

.....

.....

4. Which useful substances are nanoparticles added to?

.....

.....

.....

.....

5. How did the nanoparticles enter into the plants?

.....

.....

6. Which kind of nanoparticle was found in the soybean plants?

.....

Activity 4: Exam-style questions

Exam-style questions

1. Which of the following sizes could be the diameter of a nanoparticle?
   - **A** 4×10^{-6} m
   - **B** 0.02 cm
   - **C** [illegible]
   - **D** [illegible]

2. Nanoparticles have different properties to bulk materials. For example, nanoparticles are better catalysts than regular materials made from the same substance.

   Explain why nanomaterials are better catalysts than regular materials.

   .....

   .....

3. Silver nanoparticles are used in some plasters to kill bacteria.

   a) Give one advantage of using silver nanoparticles in plasters.

   .....

   b) Give one possible disadvantage of using silver nanoparticles in plasters.

   .....

   c) Silver nanoparticles used in plasters are 5 nm in diameter. Write this in

   .....

Nanoparticles

Specification reference: 4.2.4.1 - 4.2.4.2

Activity 1: Standard form calculations

Standard form is a way of representing numbers. It is especially useful when you [illegible] very big or very small.

Write the following numbers in st[illegible]n:

Big numbers		Small numbers	
1. 1450	1.45×10^3	1. 0.0045	
2. 34000	.....	2. 0.000000345	
3. 3000000	.....	3. 0.00000000000005	
4. 50800000	.....	4. 0.0040003	
5. 700040000000	.....	5. 0.00000501003	

Activity 2: Nanoparticles in deodorant

Look at the label on this deodorant.

Explain why nanoparticles rather than regular materials are used in this deodorant

.....

.....

.....

.....

Explain one possible risk associated with using nanoparticles in deodorants.

.....

.....

.....

.....

Activity 3: Newspaper article

Read the newspaper article and then answer the questions below.

Science News

Nanoparticles can s…er the fo…

By Sam Wainwright
2nd November 2017

A study has shown th… …gases and fertilisers contain nanoparticl… ca… …ect the growth of some plants.

Nanoparticle… …e very small particles of a material which are between 1 and 100 nanometres – that's one billion times smaller than a metre!

Nanoparticles are added to many different products, such as cosmetics, paints, fuels and deodorants.

Nanomaterials have a very high surface area to volume ratio, so only a small amount of a nanomaterial is required.

This makes nanoparticles very useful for many applications, such as catalysing a reaction, or giving materials bright colours.

However, some people think that nanoparticles are dangerous. Their high surface area to volume ratio means that if they have adverse effects then only a small amount could be very harmful. Additionally, because of their size, nanoparticles can easily enter the body through the sk…n.

In the study, nanoparticles made from … …d cerium oxide were added to the soil … …he effect on their growth was mea… …ers also measured the build-up of the na… …le… different parts of the soybean plants.

- Zinc oxide is a comm… antibacterials. Zinc o… from sewage which i…
- Cerium oxide is used … combustion and redu…

The researchers chose to … important crop. It is used … fifth-most produced crop…

The researchers found th… enter the roots of the soy… of nanoparticles had diff…

- Zinc oxide nanoparti… better. Zinc was foun… soybean plant. Howe… were not detected in …
- Cerium oxide nanopa… the plants to grow les… oxide was found as n… suggesting that nano…

The presence of zinc oxi… in the plants may have a… may be toxic to humans …

1. This article is about nanoparticles. What compounds are the nanoparticles m…

   .....

   .....

2. What effect did the nanoparticles have on the plants grown in soil?

   .....

   .....

3. Which useful substances are nanoparticles ad…ed to…

   .....

   .....

   .....

   .....

4. Which of the two types of nanoparticle is likely to be more of a risk to human plants? Explain your answer.

.....

.....

5. Evaluate whether zinc oxide nanoparticles should be used as a fertiliser for soy make tofu.

.....

.....

.....

.....

.....

.....

Activity 4: Exam-style questions

Exam-style questions

1. Which of the following sizes could be the diameter of a nanoparticle?

   A 4×10^{-6} m

   B 0.6 m

   C

   D 75 nm

2. Nanoparticles have different properties to bulk materials.

   For example, nanoparticle materials are better catalysts than regular materials substance.

   Explain why nanomaterials are better catalysts than regular materials.

   .....

   .....

3. Silver nanoparticles are used in some plasters to kill bacteria.

   a) Give one advantage of using silver nanoparticles in plasters.

   .....

   b) Give one possible disadvantage of using silver nanoparticles in plasters

   .....

   c) Silver nanoparticles used in plasters are 5 nm in diameter.

   How many orders of magnitude bigger are tennis balls, which are 5 cm

   .....

Mass changes in reactio

Specification reference: 4.3.1.1 - 4.3.1.4 Think chemistry is a load of hot

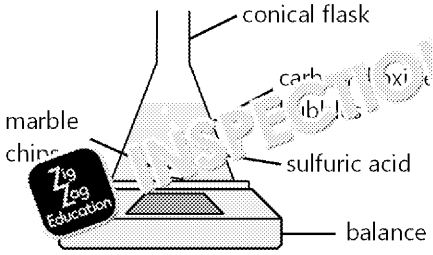
Activity 1: Balance chemical equations

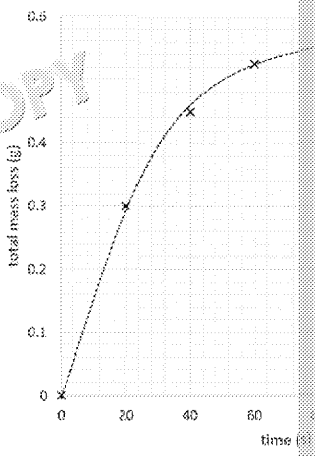
Balance these chemical equations so that there is the same number of each atom o

1. $H_2 + Br_2 \rightarrow$.....HBr .....
2. $Na_2O + H_2O \rightarrow$.....NaOH .....
3. $Mg(OH)_2$ +.....HCl → M... H_2O .....
4. $CaCO_3$ +.....aC... → $CaCl_2 + Na_2CO_3$ .....
5. $CaCO_3$ +.....HCl → $CaCl_2 + CO_2 + H_2O$ .....
6. .....Cl_2 +.....Na →.....NaCl .....
7. $MgBr_2$ +.....K →.....KBr + Mg .....
8. N_2 +.....H_2 →.....NH_3 .....
9. Br_2 +.....KI →.....KBr + I_2 .....

Activity 2: Graph interpretation

In an experiment, marble chips are added to sulfuric acid on a balance. The total m
20 seconds and plotted on the graph below.





Answer the following questions:

1. Suggest a piece of apparatus that could accurately measure the volume of su
.....
2. What is the mass loss at 40 seconds?
.....
3. How long did it take for the mass to have decreased by 0.25 g?
.....
4. What is the total mass los
.....
5. Sugges... the mass of the reaction flask decreases.
.....
.....

6. Suggest how the graph would look if the top of the conical flask was sealed.

.....

7. Identify where the reaction is the fastest, and explain how you know this from

.....

.....

Activity 3: Design the experiment

Design an experiment to investigate the following question for the four pieces of

'How does the shape of a piece of copper affect how the mass changes w

What equipment will you use to burn the copper?	Name **three** safety p burning the copper 1. 2. 3.
Explain how you will measure the change in mass (what equipment you will use, and when you will use it).	

Variables

What is the independent variable (the one you choose)?

What is the dependent variable (the outcome of the experiment)?

Name **two** control variables (things you will keep the same between experimen

1. 2.

Prediction

A student has a hypothesis that shapes with higher surface areas lead to a large

Each of these shapes has the same mass of copper (0.2 g).

wire coil A | thin sheet B | solid lump C | fine mesh D

Put the letters of the different shapes in the boxes below in order of increasing

According to the student's hypothesis, which of the shapes will have the largest

lowest surface area ⟶ hi

Activity 4: Exam-style questions

Exam-style questions

1. In an investigation, magnesium, Mg, is heated in a crucible, forming magnesium oxide, MgO.

   The following chemical reaction occurred:

   $$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

   The mass of the substance in the crucible is recorded before and after the experiment.

   Why does the mass increase?

   A Magnesium decomposed

   B A gas reacts with magnesium and adds to the mass

   C A salt was produced

   D A solid was lost from the crucible

2. A reaction is performed on a balance.

   The reaction has the equation:

   $$HCl(aq) + MgCO_3(s) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$$

   a) What is meant by the symbol (g)?

   .....

   b) Explain why the mass decreases during the experiment.

   .....

   .....

   .....

   c) Balance the equation for this reaction.

   .....$HCl + MgCO_3 \rightarrow MgCl_2 + H_2O + CO_2$

Mass changes in reactio

Specification reference: 4.3.1.1 - 4.3.1.4 Think chemistry is a load of hot

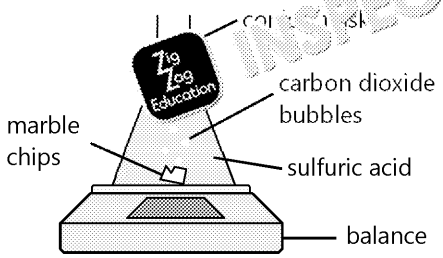
Activity 1: Balance chemical equations

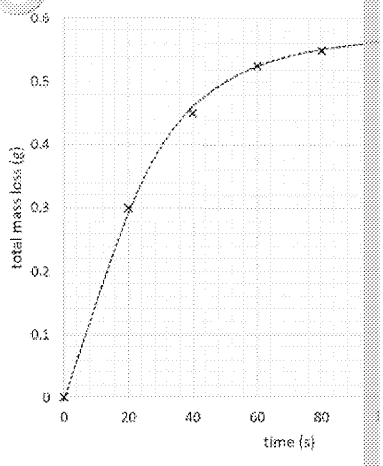
Rewrite these chemical equations and balance them so that there is the same nun
the arrow.

1. $H_2 + Br_2 \longrightarrow HBr$ .....
2. $Na_2O + H_2O \longrightarrow NaOH$ .....
3. $Mg(OH)_2 + HCl \longrightarrow MgCl_2 + H_2O$ .....
4. $CaCO_3 + NaCl \rightarrow CaCl_2 + Na_2CO_3$ .....
5. $CaCO_3 + HCl \rightarrow CaCl_2 + CO_2 + H_2O$ .....
6. $Cl_2 + Na \rightarrow NaCl$ .....
7. $MgBr_2 + K \rightarrow KBr + Mg$ .....
8. $N_2 + H_2 \rightarrow NH_3$ .....
9. $Br_2 + KI \rightarrow KBr + I_2$ .....

Activity 2: Graph interpretation

In an experiment, marble chips are added to sulfuric acid on a balance. The total m
20 seconds and plotted on the graph below.





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2. What is the mass loss at 40 seconds?
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3. How long did it take for the mass to have decreased by 0.25 g?
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4. What is the total mass loss?
.....

5. Suggest why the mass of the reaction flask decreases.

.....

6. Suggest how the graph would look if the top of the conical flask was sealed.

.....

7. Identify where the reaction is the fastest and explain how you know this from

.....

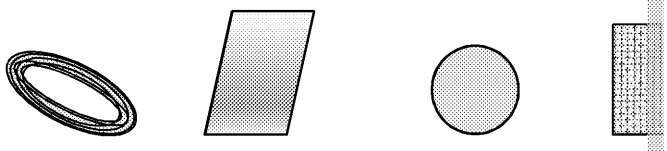
Activity 3: Designing the experiment

Design an experiment to investigate the following question:

'How does the shape of a piece of copper affect how the mass changes w

A student has a hypothesis that shapes with higher surface areas lead to a larger c

Each of these shapes has the same mass of copper (0.2 g).



wire coil A | thin sheet B | solid lump C | fine

Include in your plan:

- Equipment used to burn the copper and take measurements
- Safety precautions
- Independent, dependent and control variables
- A ranking of the four shapes from 'lowest surface area' to 'highest surface are shape will have the highest change in mass

Activity 4: Exam-style questions

Exam-style questions

1. In an investigation, magnesium, Mg, is heated in a crucible, forming magnesium oxide, MgO.

   The following chemical reaction occurred:

   $$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

   The mass of the substance in the crucible is recorded before and after the experiment.

   Why does the mass increase?

   A Magnesium decomposed

   B A gas reacts with magnesium and adds to the mass

   C A salt was produced

   D A solid was lost from the crucible

2. A reaction is performed on a balance.

   The reaction has the equation:

   $$HCl(aq) + MgCO_3(s) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$$

   a) Predict how the reading on the balance changes while the reaction is occurring.

   .....

   b) Explain why there is a change in mass during the experiment.

   .....

   .....

   .....

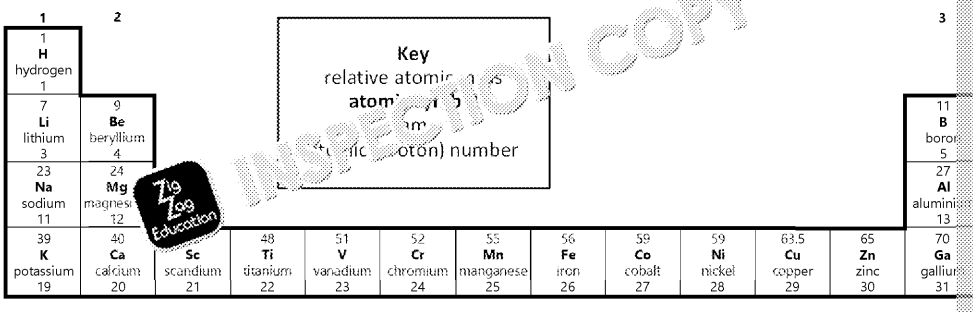
   c) Balance the equation for this reaction.

   .....$HCl(aq)$ + ...$MgCO_3(s) \rightarrow$ .....$MgCl_2(aq)$ + ...H_2O

Quantitative chemistry (FT mat

Specification reference: 4.3.1.1 - 4.3.1.4 & 4.3.3.1 - 4.3.3.2 High

Activity 1: Relative formula mass calculations



1. Calculate the relative formula mass of:

   a) Nitrogen dioxide, NO_2

   .....

   b) Iron(III) oxide, Fe_2O_3

   .....

   c) Copper nitrate, $Cu(NO_3)_2$

   .....

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up the r

Thi
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ato

2. A solution has a concentration of 0.4 g / dm^3. A student doubles the volume
   Predict the concentration in g / dm^3 of the new solution.

   .....

   .....

3. A solution with a concentration of 6.4 g / dm^3 is left out until half of the wate
   concentration of the remaining solution in g / dm^3.

   .....

   .....

4. 5 g of a compound is added to 0.2 dm^3 of water. Calculate the concentration

   .....

   .....

5. 2.4 g c h ed in a crucible so that it all reacts with oxygen. It is then
   substar 0 g. Calculate the mass of oxygen which reacted with the mag

   .....

   .....

Activity 2: Percentage yield calculations

Use the equation below to calculate the following:

$$\text{percentage yield} = \frac{\text{actual mass}}{\text{theoretical mass}} \times 100$$

You might
version of

actual mas

theoretica

1. Calculate the percentage yield for a reaction which produces 4.5 g of product and has a theoretical yield of 5.0 g.

.....

.....

2. Calculate the percentage yield for a reaction which produces 4.2 g of product a

.....

.....

3. Calculate the actual mass produced in a reaction with a percentage yield of 75 %

.....

4. Calculate the theoretical mass of a reaction which produces 68.0 g and has a

.....

Activity 3: Atom economy calculations

For the reactions below, calculate the atom economies for the desired products in

$$\text{atom economy} = \frac{\text{relative formula mass of desired product}}{\text{relative formula mass of all products}} \times 1$$

1. KNO_3 in $KCl + KOH \rightarrow \mathbf{KNO_3} + H_2O$

..... / ..... × 100 = ...

.....

2. C_2H_5Cl in $C_2H_4 + HCl \rightarrow \mathbf{C_2H_5Cl}$

..... / ..... × 100 = ...

.....

3. $CuSO_4$ in $CuO + H_2SO_4 \rightarrow \mathbf{CuSO_4} + H_2O$

..... / ..... × 100 = ...

.....

4. Fe in $2Fe_2O_3 + 3C \rightarrow 3CO_2 + \mathbf{4Fe}$

..... / ..... × 100 = ...

.....

5. SO_3 in $2SO_2 + O_2 \rightarrow \mathbf{2SO_3}$

..... / ..... × 100 = ...

.....

Activity 4: True or false?

State whether each of the following statements is true or false, and explain why a

Percentage yield will decrease if less starting material is used. .....
Atom economy will decrease if less starting mat[illegible] is [illegible]ed to make the same a product. .....
Atom econo[illegible] is [illegible] representing the number of atoms wasted. .....
Side reactions usually increase the **percentage yield**. .....
Reactions with high **percentage yields** always have high atom economies. .....
Many companies will attempt to find processes with high **atom economies**. .....
A reversible reaction which does not go to completion will have a lower **percen** than one which does. .....
It is important to retain as much product as possible when [illegible]rifying the produc **percentage yield** is high. .....
It is important to retain as m[illegible] pro[illegible] as possible when purifying the produc **atom economy** is high .....

Activity 5: Exam-style questions

Exam-style questions

1. Which of the following is **not** a reason why a high atom economy is importa

   A increases the yield
   B reduces waste
   C saves money
   D is more sustainable

2. Look at the equations for reactions A and B [illegible]e used to make amm

   Reac[illegible] $NO_3 + NH_3 \rightarrow NH_4NO_3$

   [illegible] $NH_4Cl + AgNO_3 \rightarrow NH_4NO_3 + AgC$

   a) Calculat[illegible]entage atom economy for making NH_4NO_3 using Re

   [illegible]e formula masses: $NH_4Cl = 53.5$, $AgNO_3 = 170$, $NH_4NO_3 = 80$, A

   .....

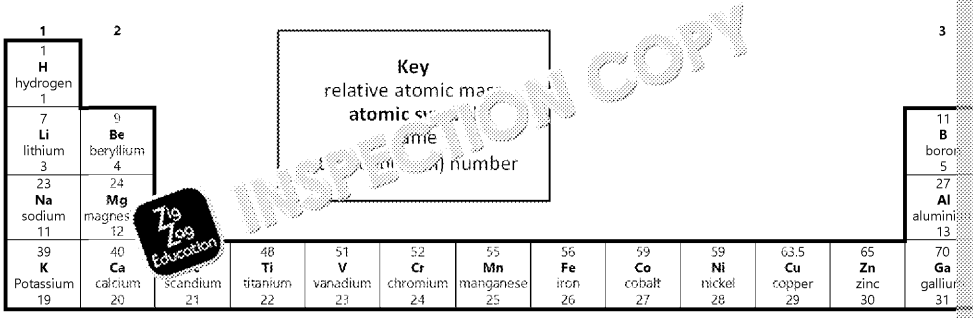
   b) Most ammonium nitrate is made using Reaction A. Suggest why.

   .....

Quantitative chemistry (FT mat

Specification Reference: 4.3.1.1 - 4.3.1.4 & 4.3.3.1 - 4.3.3.2 High

Activity 1: Relative formula mass calculations



1. Calculate the relative formula mass of:

   a) Nitrogen dioxide, NO_2

   .....

   b) Iron(III) oxide, Fe_2O_3

   .....

   c) Copper nitrate, $Cu(NO_3)_2$

   .....

2. A solution has a concentration of [illegible] dm^3. A student doubles the volume of the solution. Predict the concentration in g / dm^3 of the new solution.

   .....

   .....

3. A solution with a concentration of 6.4 g / dm^3 is left out until half of the water has evaporated. Calculate the concentration of the remaining solution in g / dm^3.

   .....

   .....

4. 5 g of a compound is added to 0.2 dm^3 of water. Calculate the concentration

   .....

   .....

5. 2.4 g of Mg is heated in a crucible so that it all reacts with oxygen. It is then found that the substance has a mass of 4.0 g. Calculate the mass of oxygen which reacted with the magnesium.

   .....

   .....

Activity 2: Percentage yield calculations

Use the equation below to calculate the following:

$$\text{percentage yield} = \frac{\text{actual mass}}{\text{theoretical mass}} \times 100$$

1. Calculate the percentage yield for a reaction which produces 4.5 g of product a

.....

.....

2. Calculate the percentage yield for a reaction which produces 4.2 g of product a

.....

.....

3. Calculate the actual mass produced in a reaction with a percentage yield of 75

.....

.....

4. Calculate the theoretical mass of a reaction which produces 68.0 g and has a

.....

.....

Activity 3: Atom economy calculations

For the reactions below, calculate the atom economies for the desired products in

$$\text{Atom economy} = \frac{\text{relative formula mass of desired product}}{\text{relative formula mass of all products}} \times 1$$

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..... / ..... × 100 = ...

.....

2. C_2H_5Cl in $C_2H_4 + HCl \rightarrow \mathbf{C_2H_5Cl}$

..... / ..... × 100 = ...

.....

3. $CuSO_4$ in $CuO + H_2SO_4 \rightarrow \mathbf{CuSO_4} + H_2O$

..... / ..... × 100 = ...

.....

4. Fe in $2Fe_2O_3 + 3C \rightarrow 3CO_2 + \mathbf{4Fe}$

..... / ..... × 100 = ...

.....

5. SO_3 in $2SO_2 + O_2 \rightarrow \mathbf{2SO_3}$

..... / ..... × 100 = ...

.....

Activity 4: True or false?

State whether each of the following statements is true or false, and explain why a

Percentage yield will decrease if less starting material is used. .....
Atom economy will decrease if less starting mat[illegible] is [illegible]ed to make the same a product. .....
Atom econo[illegible] is [illegible] representing the number of atoms wasted. .....
Side reactions usually increase the **percentage yield**. .....
Reactions with high **percentage yields** always have high atom economies. .....
Many companies will attempt to find processes with high **atom economies**. .....
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Activity 5: Exam-style questions

Exam-style questions

1. Which of the following is **not** a reason why a high atom economy is importa

   A increases the yield
   B reduces waste
   C saves money
   D is more sustainable

2. Look at the equations for reactions A and B [illegible]e used to make amm

   Reac[illegible] A [illegible]NO_3 + NH_3 → NH_4NO_3

   [illegible] NH_4Cl + $AgNO_3$ → NH_4NO_3 + AgC

   a) Calculat[illegible]entage atom economy for making NH_4NO_3 using Re

   [illegible]e formula masses: NH_4Cl = 53.5, $AgNO_3$ = 170, NH_4NO_3 = 80, A

   .....

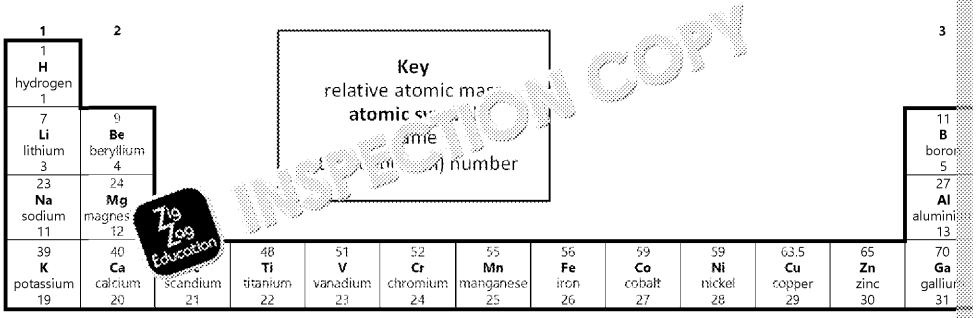
   b) Most ammonium nitrate is made using Reaction A. Suggest why.

   .....

Moles and concentrations (HT

Specification reference: 4.3.2.1 – 4.3.2.5 Avocado's number: the n

Activity 1: Mole calculations



Calculate the following. You may need to use and rearrange the following equatio

$$\text{moles} = \frac{\text{mass}}{\text{relative formula mass}}$$

1. Relative formula mass of:
   a. nitrogen dioxide, NO_2

   .....

   b. *iron*(III) *oxide*, Fe_2O_3

   .....

   c. copper nitrate, $Cu(NO_3)_2$

   .....

2. Moles
   a. ca , in 24 g

   Use the equation above. ($\frac{\text{mass}}{\text{relative formula mass}}$ means m

   .....

   b. lithium chloride, LiCl, in 85 g

   .....

   c. water, H_2O, in 72 g

   .....

3. Mass of:
   a. 3 moles of titanium, Ti

   You need to r
   mass = m

   .....

   b. 0.5 moles of s e, SO_2

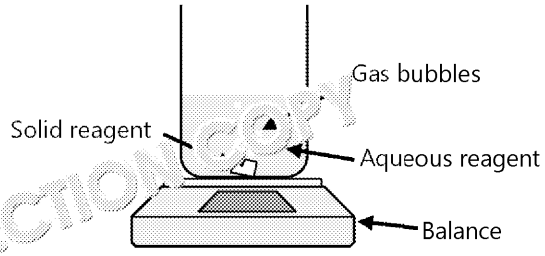
   .....

   c. 0.2 moles of chlorine, Cl_2

   .....

Activity 2: Predicting mass changes

Sometimes, if a reaction gives off a gas, you can measure the amount of gas given on a balance, as shown in this diagram.



As the reaction happens, gas leaves the beaker and the reading on the balance decreases.

Predict the mass of gas given off in the reactions on the following page.

1. **$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$,** using 2.30 g of $CaCO_3$

Mass of $CaCO_3$ .....

Relative formula mass of $CaCO_3$ .....

Moles of $CaCO_3$ .....

Moles of CO_2 .....

Relative formula mass of CO_2 .....

Mass of CO_2 .....

2. **$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$,** using 0.[illegible] g of Mg

Mass of Mg .....

Relative formula mass of Mg .....

Moles of Mg .....

Moles of H_2 .....

Relative formula mass of H_2 .....

Mass of H_2 .....

3. **$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$,** using 4.2 g of H_2O_2

Mass of H_2O_2 .....

Relative formula mass of H_2O_2 .....

Moles of H_2O_2 .....

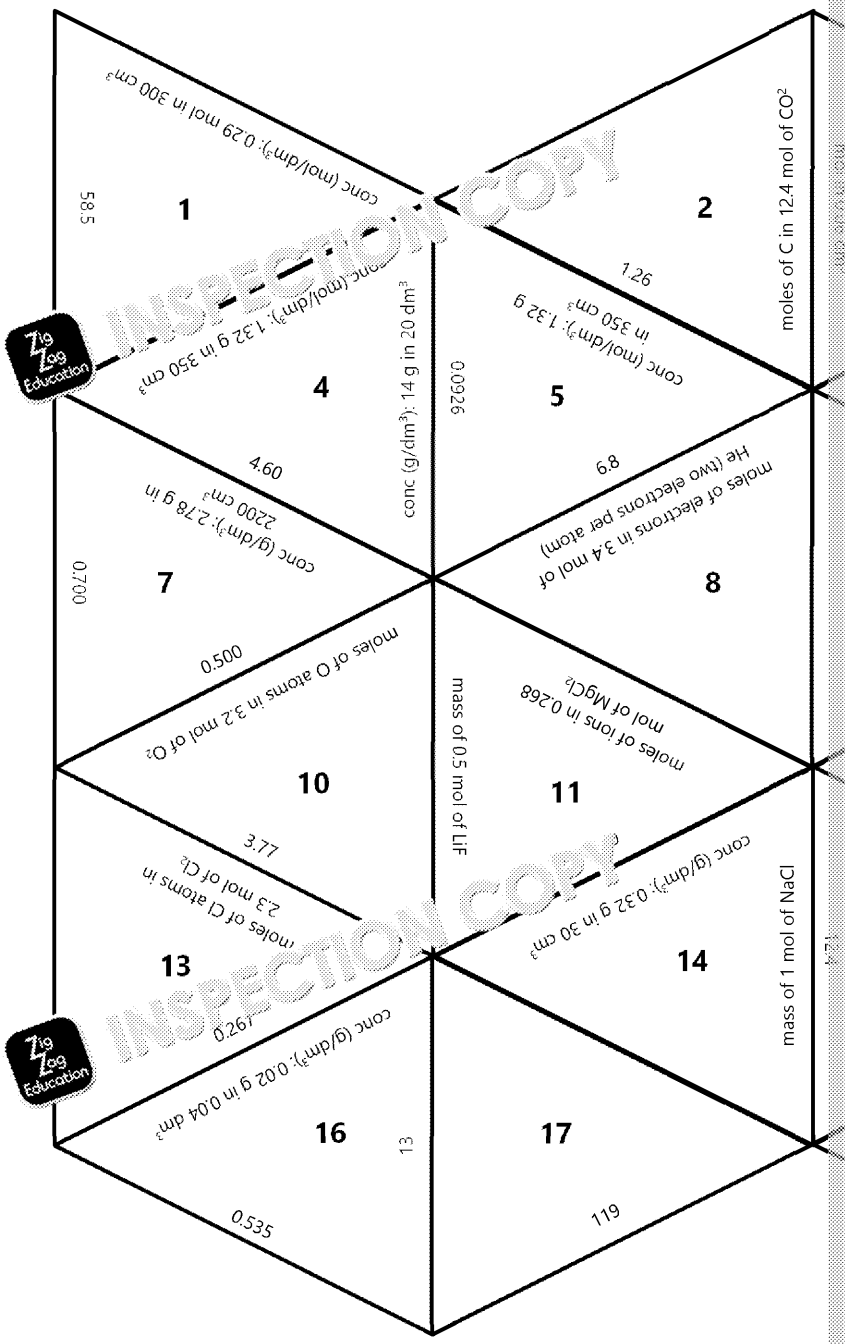
Moles of O_2 .....

Relative formula mass of O_2 .....

Mass of O_2 .....

Activity 3: Question tessellate

Cut out the following triangles and arrange them so that the questions match the



Activity 4: Exam-style questions

Exam-style questions

1. How many moles of carbon are in 0.5 moles of CO_2?

   A 1 **B** 2 **C** 5 **D**

2. A student uses the following reaction to make copper sulfate:

   $H_2SO_4 + CuO \rightarrow CuSO_4 + H_2O$

   a) Calculate the mass of copper oxide required to make 8.0 g of $CuSO_4$. Relative atomic masses: H = 1, S = 32, O = 16, Cu = 63.5. Relative formula mass of $CuSO_4$ = 159.5

   .....

   b) In the reaction above, copper oxide is added until the copper oxide stops reacting. The oxide is filtered off. Identify the limiting reagent in the reaction, and give a reason why.

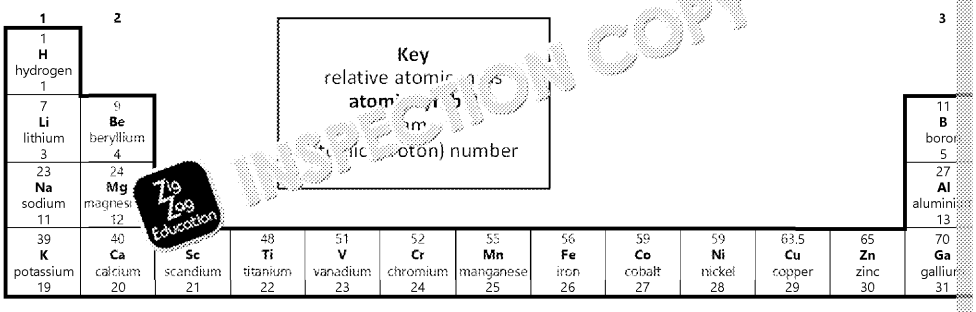
   .....

   .....

Moles and concentrations (HT

Specification Reference: 4.3.2.1 - 4.3.2.5 Avocado's number: the n

Activity 1: Mole calculations



Calculate the following. You may need to use and rearrange the following equation:

$$\text{moles} = \frac{\text{mass}}{\text{relative formula mass}}$$

1. Relative formula mass of:
   a. nitrogen dioxide, NO_2

      .....

   b. iron(III) oxide, Fe_2O_3

      .....

   c. copper nitrate, $Cu(NO_3)_2$

      .....

2. Moles
   a. carbon, C, in 24 g

      .....

   b. lithium chloride, LiCl, in 85 g

      .....

   c. water, H_2O, in 72 g

      .....

3. Mass of:
   a. 3 moles of titanium, Ti

      .....

   b. 0. s c ulfur dioxide, SO_2

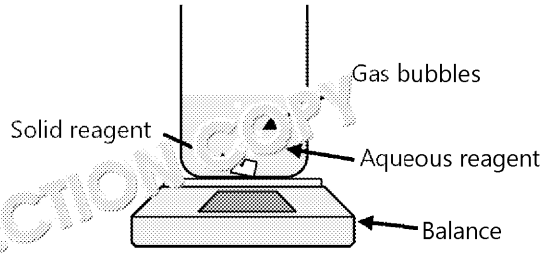
      .....

   c. 0.2 moles of chlorine, Cl_2

      .....

Activity 3: Predicting mass changes

Sometimes, if a reaction gives off a gas, you can measure the amount of gas given on a balance, as shown in this diagram.



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Mass of $CaCO_3$ .....

Relative formula mass of $CaCO_3$ .....

Moles of $CaCO_3$ .....

Moles of CO_2 .....

Relative formula mass of CO_2 .....

Mass of CO_2 .....

2. $Mg_{(s)} + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$, using 2.35 g of Mg

.....

.....

.....

.....

3. $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$, using 4.2 g of H_2O_2

.....

.....

.....

.....

Activity 3: Question tessellate

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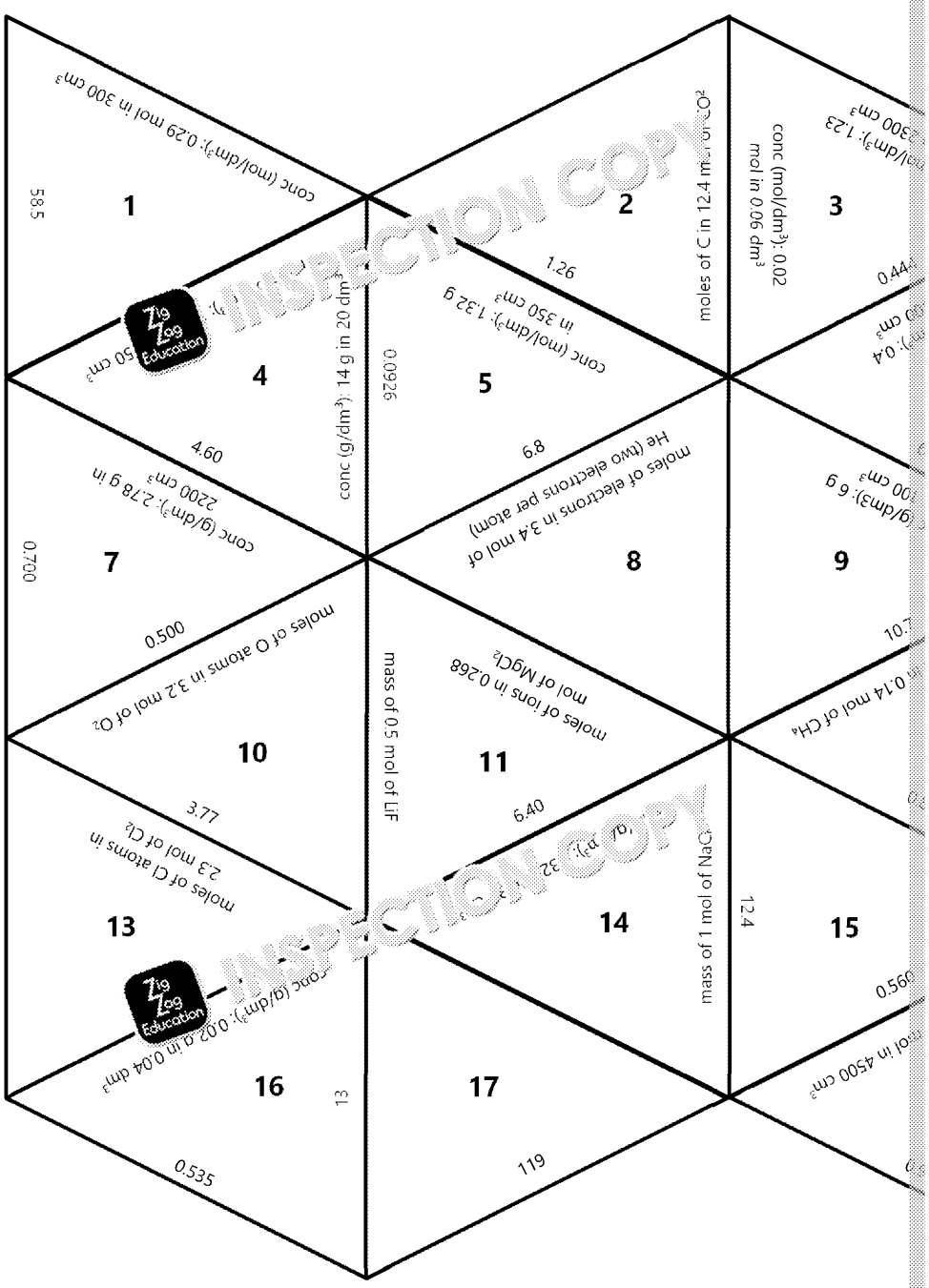

Activity 4: Exam-style questions

Exam-style questions

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   A 1 **B** 2 **C** 5 **D**

2. A student uses the following reaction to make copper sulfate:

   $H_2SO_4 + CuO \rightarrow CuSO_4 + H_2O$

   a) Calculate the mass of copper oxide required to make 8.0 g of $CuSO_4$. Relative atomic masses: H = 1, S = 32, O = 16, Cu = 63.5. Relative formula mass of $CuSO_4$ .....

   b) In the reaction above, copper oxide is added until the copper oxide stops dissolving. The excess copper oxide is filtered off. Identify the limiting reagent in the reaction, and give

   .....

   .....

Percentage yield and atom economy (HT material)

Specification reference: 4.3.3.1 – 4.3.3.2

Trust me, a homework like this is one in a ~~million~~ hundred.

Activity 1: Equation practice

Use the equation below to calculate the following:

$$\text{percentage yield} = \frac{\text{actual mass}}{\text{theoretical mass}} \times 100$$

Tip: You might have to use the rearranged version of this equation:

$$\text{actual mass} = \frac{\text{theoretical mass} \times \text{percentage yield}}{100} \qquad \text{theoretical mass} = \frac{\text{actual mass}}{\text{percentage yield}} \times 100$$

1. Calculate the percentage yield for a reaction which produces 4.5 g of product and has a theoretical yield of 5.0 g.

.....

2. Calculate the percentage yield for a reaction which produces 4.2 g of product and has a theoretical yield of 8.4 g.

.....

3. Calculate the actual mass produced in a reaction with a percentage yield of 75 % and a theoretical mass of 3.6 g.

.....

4. Calculate the theoretical mass of a reaction which produces 68 g of product and has a percentage yield of 40 %.

.....

Activity 2: Percentage yield calculations

Answer the following questions **to two significant figures**. You may need to use or rearrange the percentage yield formula.

1. Calculate the percentage yield when 2.3 g of HNO_3 produces 2.5 g of KNO_3.

$$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

relative formula mass of HNO_3	.....	add up the mass of the atoms in HNO_3
moles of HNO_3	.....	moles = mass ÷ M_r
theoretical moles of KNO_3	.....	use the mole ratio in the equation
theoretical mass of KNO_3	.....	mass = moles × M_r
percentage yield of KNO_3	.....	use the % yield equation

2. Calculate the percentage yield when 1.87 g of C_2H_5Cl is produced using 1.45 g of C_2H_4.

$$C_2H_4 + HCl \rightarrow C_2H_5Cl$$

relative formula mass of C_2H_4 .....

moles of C_2H_4 .....

theoretical moles of C_2H_5Cl .....

theoretical mass of C_2H_5Cl .....

percentage yield of C_2H_5Cl .....

3. Calculate the mass of $CuSO_4$ produced when 2.3 g of CuO reacts with a 76 % y

$$CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$$

relative formula mass of CuO .....

moles of CuO .....

theoretical moles of $CuSO_4$ .....

theoretical mass of $CuSO_4$ .....

actual mass of $CuSO_4$ (hint: rearrange the formula for percentage yield) .....

4. Calculate the percentage yield when 34 g of Fe_2O_3 produces 12 g of Fe. (**Hint**

$$2Fe_2O_3 + 3C \rightarrow 3CO_2 + 4Fe$$

.....

.....

5. Calculate the mass of O_2 used to produce 4.9 g of SO_3 with a 56 % yield.

$$2SO_2 + O_2 \rightarrow 2SO_3$$

.....

.....

Activity 3: Atom economy calculations

For the reactions below, calculate the atom economies for the desired products in

$$\text{Atom economy} = \frac{\text{relative formula mass of desired product}}{\text{relative formula mass of all products}} \times 1$$

1. $HNO_3 + KOH \rightarrow \mathbf{KNO_3} + H_2O$

$$\frac{\text{.....}}{\text{.....}} \times 100 = \text{.....}$$

2. $C_2H_4 + HCl \rightarrow \mathbf{C_2H_5Cl}$

$$\frac{\text{.....}}{\text{.....}} \times 100 = \text{.....}$$

3. $CuO + H_2SO_4 \rightarrow \mathbf{CuSO_4} + H_2O$

$$\frac{\text{.....}}{\text{.....}} \times 100 = \text{.....}$$

4. $2Fe_2O_3 + 3C \rightarrow 3CO_2 + 4\mathbf{Fe}$

$$\frac{\text{.....}}{\text{.....}} \times 100 = \text{.....}$$

5. $2H_3PO_4 + 3Cu \rightarrow \mathbf{Cu_3(PO_4)_2} + 3H_2$

$$\frac{\text{.....}}{\text{.....}} \times 100 = \text{.....}$$

Activity 4: True or false?

State whether each of the following statements is true or false.

Percentage yield will decrease if less starting material is used.
.....
Atom economy will decrease if less starting material is [illegible] make the same amo
.....
Atom economy is a way of representing the number of atoms wasted.
.....
Side reactions may increase the **percentage yield**.
.....
Reactions with high **percentage yields** always have high atom economies.
.....
Many companies will attempt to find processes with high **atom economies**.
.....
A reversible reaction which does not go to completion will have a lower **percenta** one which does.
.....
It is important to retain as much product as possible when purifying the product **percentage yield** is high.
.....
It is important to retain as much product as possible when purifying the product **atom economy** is high.
.....

Activity 5: Exam style questions

Exam-style questions

1. Which of the following is **not** a reason why a high atom economy is importa

   A increases the yield
   B reduces waste
   C saves money
   D is more sustainable

2. Look at the equations for reactions A and B, which are used to make ammo

   Reaction A $HNO_3 + NH_3 \rightarrow NH_4NO_3$

   Reaction B $NH_4Cl + AgNO_3 \rightarrow NH_4NO_3 + AgCl$

   a) Calculate the percentage atom economy for Reaction B.

   Relative formula masses: NH_4Cl = 53.5, $AgNO_3$ = 170, NH_4NO_3 = 80, A

   .....

   b) Ma[illegible] nitrate is made using Reaction A. Suggest why.

   .....

   c) 5.0 g of NH_4Cl reacts with an excess of $AgNO_3$ to form 4.9 g of NH_4NO_3

   Calculate the percentage yield of this reaction.

   .....

Percentage yield and atom ec (HT material)

Specification reference: 4.3.3.1 – 4.3.3.2 Trust me, a homew

Activity 1: Equation practice

Use or rearrange the equation below to calculate the following:

$$\text{percentage yield} = \frac{\text{actual mass}}{\text{theoretical mass}} \times 100$$

1. Calculate the percentage yield for a reaction which produces 4.5 g of product a

   ....

2. Calculate the percentage yield for a reaction which produces 4.2 g of product a

   ....

3. Calculate the actual mass produced in a reaction with a percentage yield of 75

   ....

4. Calculate the theoretical mass of a reaction which produces 68 g of product a

   ....

Activity 2: Percentage yield calculations

Answer the following questions **to two significant figures**. You may need to use formula.

1. Calculate the percentage yield when 2.3 g of HNO_3 produces 2.5 g of KNO_3.

   $$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

   relative formula mass of HNO_3 ....

   moles of HNO_3 ....

   theoretical moles of KNO_3 ....

   theoretical mass of KNO_3 ....

   percentage yield of KNO_3 ....

2. Calculate the percentage yield when 1.87 g of C_2H_5Cl is produced using 1.45 g

   $$C_2H_4 + HCl \rightarrow C_2H_5Cl$$

   ....

   ....

3. Calculate the mass of $CuSO_4$ produced when 2.3 g of CuO reacts with a 76 % y

   $$CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$$

   ....

   ....

4. Calculate the percentage yield when 34 g of Fe_2O_3 produces 12 g of Fe. (Hint

$$2Fe_2O_3 + 3C \rightarrow 3CO_2 + 4Fe$$

.....

.....

5. Calculate the mass of Cu used to produce 4.9 g of $Cu_3(PO_4)_2$ with a 56 % yield

$$2H_3PO_4 + 3Cu \rightarrow Cu_3(PO_4)_2 + 3H_2$$

.....

.....

Activity 3: Atom economy calculations

For the reactions below, calculate the atom economies for the desired products in

$$\text{Atom economy} = \frac{\text{relative formula mass of desired product}}{\text{relative formula mass of all products}} \times 1$$

1. $HNO_3 + KOH \rightarrow \mathbf{KNO_3} + H_2O$ .....
2. $C_2H_4 + HCl \rightarrow \mathbf{C_2H_5Cl}$ .....
3. $CuO + H_2SO_4 \rightarrow \mathbf{CuSO_4} + H_2O$ .....
4. $2Fe_2O_3 + 3C \rightarrow 3CO_2 + 4\mathbf{Fe}$ .....
5. $2H_3PO_4 + 3Cu \rightarrow \mathbf{Cu_3(PO_4)_2} + 3H_2$ .....

Activity 4: True or false?

Explain whether each of the following statements is true or false.

Percentage yield will decrease if less starting material is used.
Atom economy will decrease if less starting material is used to make the same amount
Atom economy is a way of representing the number of atoms wasted.
Side reactions usually increase the **percentage yield**.
Reactions with high **percentage yields** always have high atom economies.
Many companies will attempt to find processes with high **atom economies**.
A reversible reaction which does not go to completion will have a lower **percentage** one which does.
It is important to retain as much product as possible when purifying the product since **percentage yield** is high.
It is important to retain as much product as possible when purifying the product since **atom economy** is high.

Exam-style questions

1. Which of the following is **not** a reason why a high atom economy is importa

   A increases the yield

   B reduces waste

   C saves mone

   D is sustainable

2. Look at the equations for reactions A and B, which are used to make ammo

   Reaction A $HNO_3 + NH_3 \rightarrow NH_4NO_3$

   Reaction B $NH_4Cl + AgNO_3 \rightarrow NH_4NO_3 + AgCl$

   a) Calculate the percentage atom economy for Reaction B.

   .....

   .....

   .....

   .....

   b) M mi nitrate is made using Reaction A.

   S st why.

   .....

   c) 5.0 g of NH_4Cl reacts with an excess of $AgNO_3$ to form 4.9 g of NH_4NO_3

   Calculate the percentage yield of this reaction.

   .....

   .....

   .....

   .....

Moles in volumes of solutions a
(HT material)

Specification reference: 4.3.4 & 4.3.5

Activity 1: Match-up

By drawing lines, match each word to its definition, value and unit.

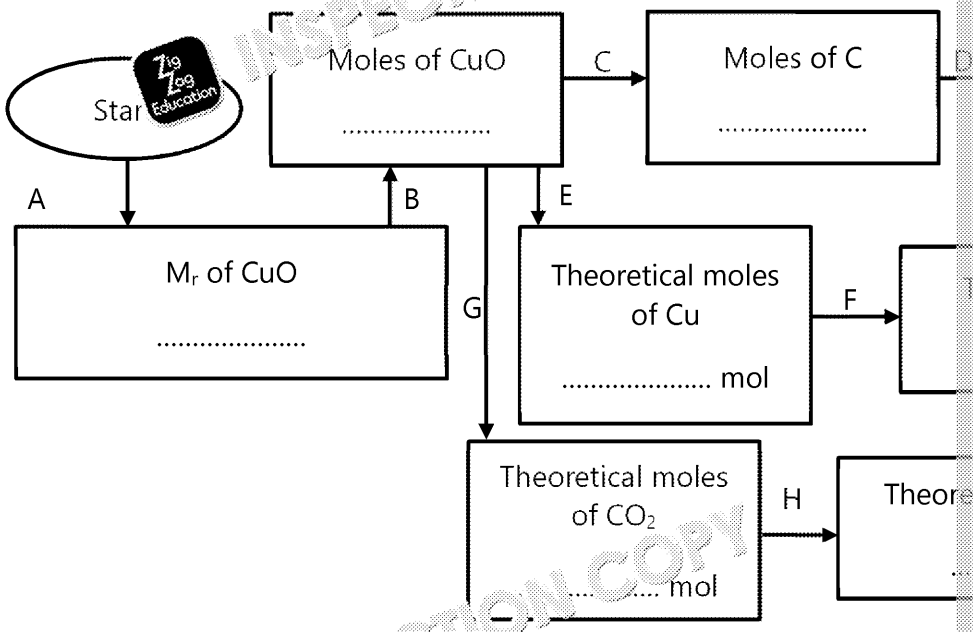
Word	Avo... number	molar gas volume	room tempe...
Definition	the assumed pressure of a room	the assumed temperature of a room	the number o... in a mo...
Value	25	6.02 × 1023	100
Unit	kPa	dm^3	°C

Activity 2: Calculation path

A scientist uses 3.5 g of CuO to make pure Cu using the following reaction:

$$2CuO(s) + C(s) \rightarrow CO_2(g) + 2Cu(s)$$

Follow the arrows through the flow chart to calculate the value in each box.

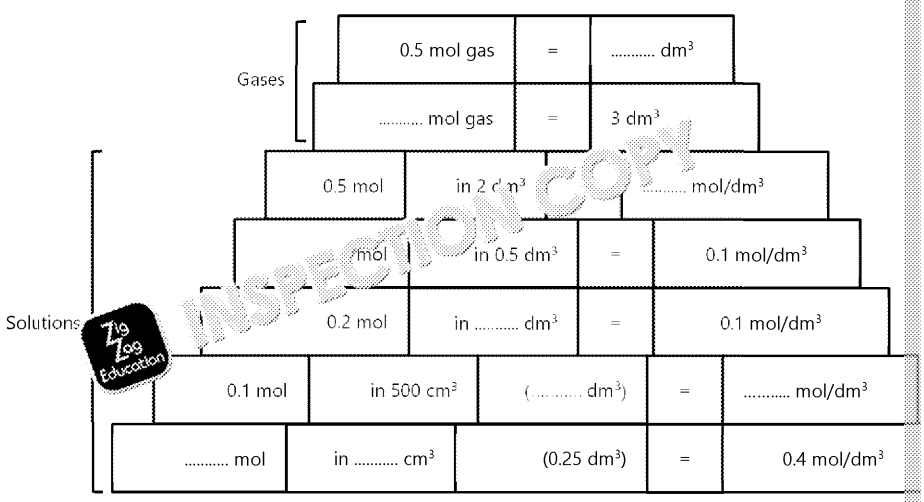


Hints

A Add up the relative atomic masses of the atoms.
B Use the equation: moles = mass ÷ M_r
C Use the ratio of CuO to C in the reaction equation
D Use the equation: mass = moles × M_r
E Use ratio of Cu...
F Use the equat...
G Use the ratio of ...
H Use the formu...

Activity 3: Conversion tower

Complete the progressively more difficult conversions:



Activity 4: Reacting mass calculations

1. 0.84 g of $MgCO_3$ is added to an excess of HCl.

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + CO_2(g) + H_2O$$

Calculate the volume of CO_2 produced in the reaction at room temperature.

relative formula mass of $MgCO_3$ .....

mol $MgCO_3$ .....

mol CO_2 .....

vol CO_2 .....

2. 1.59 g of CuO is added to 200 cm^3 of H_2SO_4 and all of the H_2SO_4 reacted.

$$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$$

Calculate the concentration of H_2SO_4 used in the reaction.

relative formula mass of CuO .....

mol CuO .....

mol H_2SO_4 .....

conc H_2SO_4 .....

3. An excess of sodium is reacted with chlorine, producing 2.34 g of NaCl.

$$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$$

Calculate the volume of Cl_2 used in making this mass of NaCl.

relative formula mass of NaCl .....

mol NaCl .....

mol Cl_2 .....

vol Cl_2 .....

4. A 0.500 dm^3 solution of KCl is added to $AgNO_3$, producing 7.175 g of A

$$AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$$

Calculate the concentration of the 0.500 dm^3 solution of KCl in mol dm

.....

.....

.....

.....

Activity 5: Exam-style question

Exam-style questions

1. An experiment is performed to determine the rate of the following reaction:

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + CO_2(g) + H_2O$$

a) Which of the following could be used to measure the volume of carbon

A pH meter

B thermometer

C timer

D gas syringe

b) 0.050 mol of $MgCO_3$ was added to an excess of HCl.

Calculate the volume of CO_2 produced in this reaction at room temperatu

(One mole of a gas takes up a volume of 24 dm^3 at room temperature.)

.....

.....

.....

.....

.....

volume = .

c) Calculate the mass of $MgCO_3$ in 0.050 moles.

.....

.....

.....

Moles in volumes of solutions a
(HT material)

Specification reference: 4.3.4 & 4.3.5

Activity 1: Match-up

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Word	Avo[illegible]mber	molar gas volume	room tempe
Definition	the assumed pressure of a room	the assumed temperature of a room	the number o in a mo
Value	25	6.02 × 1023	100
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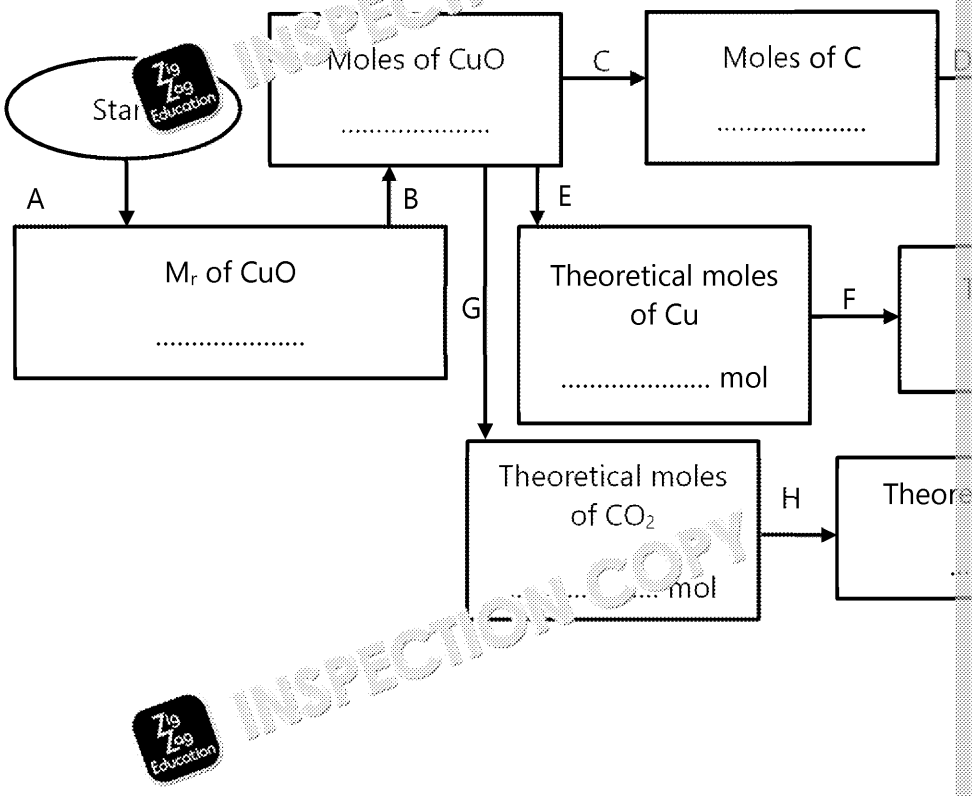
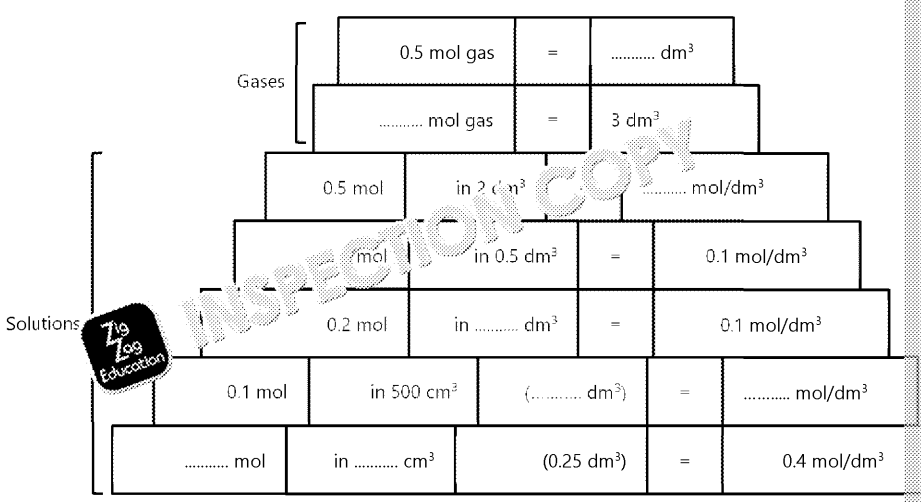
Follow the arrows through the flow chart to calculate the value in each box.



Activity 3: Conversion tower

Complete the progressively more difficult conversions:



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$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + CO_2(g) + H_2O$$

Calculate the volume of CO_2 produced in the reaction at room temperature.

relative formula mass of $MgCO_3$ .....

mol $MgCO_3$ .....

mol CO_2 .....

vol CO_2 .....

2. 1.59 g of CuO is added to 200 cm^3 of H_2SO_4 and all of the H_2SO_4 reacted.

$$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$$

Calculate the concentration of H_2SO_4 used in the reaction.

relative formula mass of CuO .....

mol CuO .....

mol H_2SO_4 .....

conc H_2SO_4 .....

3. An excess of sodium is reacted with chlorine, producing 2.34 g of NaCl.

$$2Na + Cl_2 \rightarrow 2NaCl$$

Calculate the volume of Cl_2 used in making this mass of NaCl.

.....

.....

4. A 0.500 dm^3 solution of KCl is added to $AgNO_3$, producing 7.175 g of A

$$AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$$

Calculate the concentration of the 0.500 dm^3 solution of KCl in mol dm

.....

.....

.....

.....

Activity 5: Exam-style question

Exam-style questions

1. An experiment is performed to determine the rate of the following reaction:

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + CO_2(g) + H_2O$$

a) Which of the following could be used to measure the volume of carbon

A pH meter

B thermometer

C timer

D gas syringe

b) 0.050 mol of $MgCO_3$ was added to an excess of HCl.

Calculate the volume of CO_2 produced in this reaction at room temperature

(1 mole of a gas takes up a volume of 24 dm^3 at room temperature)

.....

.....

.....

.....

.....

volume = ...

c) Calculate the mass of HCl which is required to react with the 0.050 mol solution.

.....

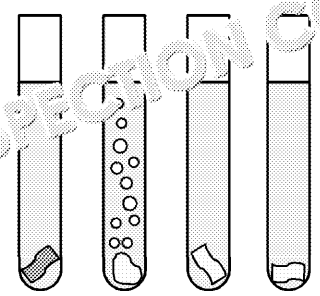
.....

Reactivity series

Specification reference: 4.4.1.1 - 4.4.1.2 I tried to start a fight with a

Activity 1: Observations

Pieces of iron, zinc, calcium and copper were placed in water. This was the observation:



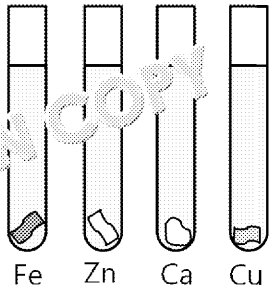
Use your knowledge of these elements to answer these questions:

1. Which metal can be identified? .....

2. Complete the word equation for the reaction.

..... + water → ..... +

3. Draw the expected observations with the same metals and dilute hydrochlori



4. Circle th things from the list below that should be kept the same to make co metals a fair test.

Mass of metal	Time	Temp
Surface area of metal	Test tube	Concentratio

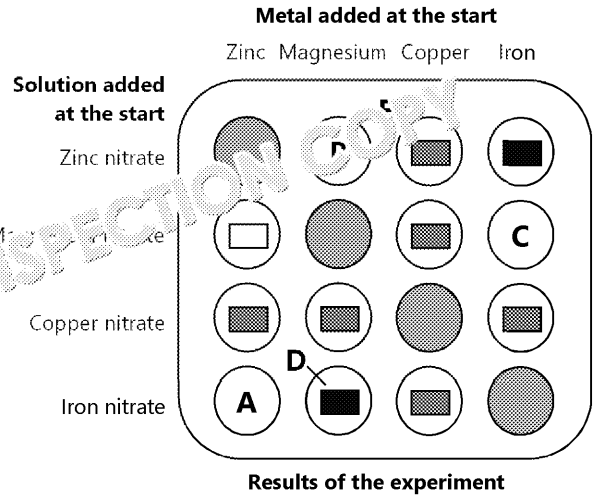
Activity 2: This or that?

For each row, say whether the answer is 'this' or 'that' and explain your answer.

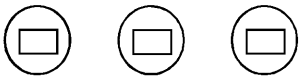
This	That	Th
Potassium is more reactive than sodium	Sodium is more reactive than potassium	
Potassium oxide is K_2O because it is made from K^+ and O^{2-}	Potassium oxi $_2O$ because it is mad K^{2-} and O^-	
Oxidation means gaining oxy	xidation means losing oxygen	
lithium oxid cal calcium oxide + lit	lithium + calcium oxide → calcium + lithium oxide	
lithium + w → lithium hydroxide + oxygen	lithium + water → lithium hydroxide + hydrogen	
Aluminium is more reactive than lead because aluminium forms positive ions less easily	Aluminium is more reactive than lead because aluminium forms positive ions more easily	

Activity 3: Reactivity experiment

The results of the following experiment can be used to determine a reactivity serie
magnesium, copper and iron were added to solutions of metal nitrates and the re



1. Using the results of other experiments shown in the tray, shade the rectangle observed in A, B and C.



2. Write a word equation or write no reaction for the reactions occurring in:

   D .....

   E .....

3. Explain why zinc was added to zinc nitrate in the experiment.

   .....

   .....

4. Explain why iron doesn't react with zinc nitrate.

   .....

   .....

5. Complete the table below with ticks and crosses to show the results of the re
   ✓ = a reaction occurs
   × = a reaction does not occur

	zinc	magnesium	copper
zinc nitrate			
magnesium nitrate			
copper nitrate			
iron nitrate			

Activity 4: Exam-style question

Exam-style questions

1. A student performed an investigation into the reactivity of zinc, copper

   1. placed metal in the columns of a spotting tile tray
   2. added a few drops of each metal sulfate in the rows of the tray
   3. [illegible] a tick or a cross in the table to show if a reaction occurred

	zinc	copper	iron
zinc sulfate	×	×	×
copper sulfate	✓	×	✓
iron sulfate	✓	×	×

   a) Identify the dependent variable in this experiment.

   .....

   b) Complete the reactivity series below based on the results of this
   explain why you have placed them in this order.

   most reactive .....

   .....

   least reactive .....

   Explanation:

   .....

   .....

   c) The student also found that iron reacts with hydrochloric acid, HCl

   Predict whether zinc will react with HCl.

   Give a reason.

   .....

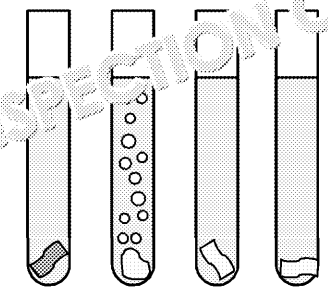
   .....

Reactivity series

Specification reference: 4.4.1.1 - 4.4.1.2 I tried to start a fight with

Activity 1: Observations

Pieces of iron, zinc, calcium and copper were placed in wat[illegible] his was the observation:



Use your knowledge of these elements to answer these questions:

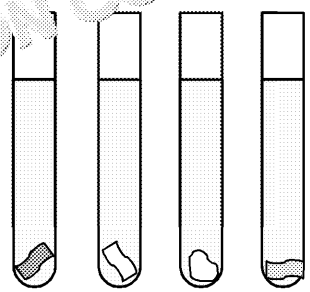
1. Which metal can be identified? .....

2. Complete the word equation for the reaction.

..... + water → ..... +

..... + H_2O → ..... +

3. Draw the expected observations with the same meta[illegible] dilute hydrochlori[illegible]



4. Identify three things that should be kept the same to make this experiment a f

.....

.....

.....

.....

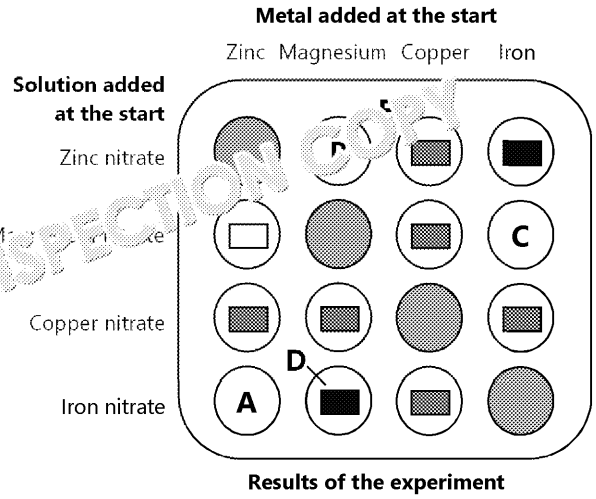
Activity 2: This or that?

For each row, say whether the answer is 'this' or 'that' and explain your answer.

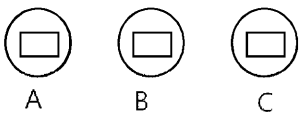
This	That	This
Potassium is more reactive than sodium	Sodium is more reactive than potassium	
Potassium oxide is K_2O because it is made from K^{2+} and O^{-}	Potassium oxide is K_2O because it is made from K^{2+} and O^{-}	
Oxidation means gaining oxygen	Oxidation means losing oxygen	
lithium oxide + calcium → calcium oxide + lithium	lithium + calcium oxide → calcium + lithium oxide	
lithium + water → lithium hydroxide + oxygen	lithium + water → lithium hydroxide + hydrogen	
Aluminium is more reactive than lead because aluminium forms positive ions more easily	Aluminium is more reactive than lead because aluminium forms positive ions more easily	
$Mg + 2HCl \rightarrow MgCl_2 + H_2$	$Mg + 2HCl \rightarrow MgH_2 + Cl_2$	
Potassium is higher in the reactivity series than lithium because potassium loses electrons more easily	Potassium is higher in the reactivity series than lithium because potassium loses electrons less easily	
$Pb + ZnBr_2 \rightarrow PbBr_2 + Zn$	$Zn + PbBr_2 \rightarrow ZnBr_2 + Pb$	

Activity 3: Reactivity experiment

The results of the following experiment can be used to determine a reactivity serie
magnesium, copper and iron were added to solutions of metal nitrates and the re



1. Using the results of other experiments shown in the tray, shade the rectangle observed in A, B and C.



2. Write a word equation or write no reaction for the re... is occurring in:

   D .....

   E .....

3. Explain... nc is not added to zinc nitrate in the experiment.

   .....

   .....

4. Explain why iron doesn't react with zinc nitrate.

   .....

   .....

5. Complete the table below with ticks and crosses to s... he results of the re...
   ✓ = a reaction occurs
   × = a reaction does not occur

	zinc	magnesium	copper
...nc nitrate			
magnesium nitrate			
copper nitrate			
iron nitrate			

Activity 4: Exam-style question

Exam-style questions

1. A student performed an investigation into the reactivity of zinc, copper and iron.

   1. placed metal in the columns of a spotting tile tray
   2. added a few drops of each metal sulfate in the rows of the tray
   3. recorded a tick or a cross in the table to show if a reaction occurred

	zinc	copper	iron
zinc sulfate	×	×	×
copper sulfate	✓	×	✓
iron sulfate	✓	×	×

   a) Identify the dependent variable in this experiment.

   .....

   b) Complete the reactivity series below based on the results of this experiment and explain why you have placed them in this order.

   most reactive .....

   .....

   least reactive .....

   Explanation:

   .....

   .....

   c) The student also found that iron reacts with hydrochloric acid, HCl.

      i) Predict whether zinc will react with HCl.

      Give a reason.

      .....

      .....

      ii) Explain why the student has enough information from the student's results to predict whether copper will react with hydrochloric acid.

      .....

Extracting metals

Specification reference: 4.4.1.3 – 4.4.1.4

Activity 1: Decode the letters

Using each of the following letters only once, make words w[illegible]h match the descri[illegible]

C M ~~I~~ N N ~~S~~ O Z [illegible] R [illegible] B C ~~L~~ I U L

A reactive met[illegible]	[illegible]n unreactive metal	A metal which is slightly reactive	[illegible] incl[illegible]
_ _ _ _ _ _ _ _ _ _ _	S I L V E R	_ _ _ _	

Activity 2: Fact wheel

Complete the boxes to form a fact wheel about extraction of metals using carbon.

[illegible]action using carbon

The equation for the extraction of tin from tin oxide, SnO_2, with carbon, C, is:

Carbon replaces metals in metal oxides in reactions called r...............

co[illegible] ....

[illegible] co[illegible] [illegible] extracting [illegible]al using carbon are e............... to heat the furnace and cost of r............... m............... such as the metal ore

The metal is reduced because it .... oxygen

[illegible] use[illegible] .... reacti[illegible]

Activity 3: Formula practice

Predict the formula of each of the following substances based on the ions given i[illegible]

I[illegible]s	
magnesium Mg^{2+}	ammonium NH_{4+}
chloride Cl^-	aluminium Al^{3+}
[illegible]iu[illegible]	fluoride F^-
[illegible]e O^{2-}	nitrate NO_3^-

sodium chloride	sodium oxide	magnesium fluoride	lithium hydroxide	calcium hydroxide	aluminium nitrate	alu[illegible] o[illegible]

Exam-style questions

1. Which of the following is most likely to be found pure in nature?

   A sodium
   B gold
   C aluminium
   D calcium

2. In a furnace, copper oxide, CuO, is heated with carbon, and the follow

   $$2CuO + C \rightarrow 2Cu + CO_2$$

   a) Oxidation is when an element gains oxygen.

   Write the symbol of the element which is **oxidised** in this reaction.

   .....

   b) Magnesium **cannot** be extracted from its oxide by heating it with carb

   Explain why not.

   .....

   .....

   c) Suggest the formula of magnesium oxide (made from the ions Mg^{2+} a

   .....

3. Iron is found as a rock. When iron oxide is heated with carbon, the following

   a) Balance the symbol equation for this reaction:

   $$2Fe_2O_3 + ...C \rightarrow .....Fe + 3CO_2$$

   b) Complete the word equation for the reaction.

   iron oxide + ... → iron + carbon dioxide

Extracting metals

Specification reference: 4.4.1.3 - 4.4.1.4

Activity 1: Decode the letters

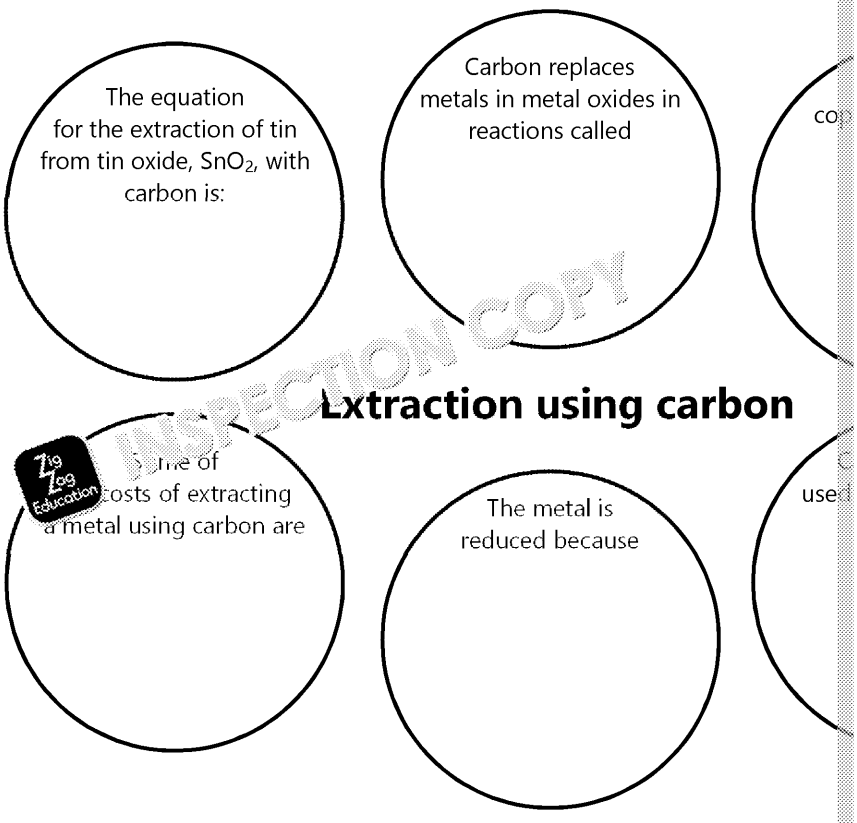
Using each of the following letters only once, make words which match the descri

C M I N N S O Z A R B C K I U L

A reacti... me...	...n unreactive metal	A metal which is slightly reactive	incl...
_ _ _ _ _ _ _	S _ L _ _ _	_ _ _ _	

Activity 2: Fact wheel

Complete the boxes to form a fact wheel about extraction of metals using carbon



Activity 3: Formula practice

Predict the formula of each of the following substances based on the ions given i

magnesium Mg^{2+} | a...monium NH_4^+
chloride Cl^- | aluminium Al^{3+}
lithium Li^+ | fluoride F^-
...de ... | nitrate NO_3^-

sodium chloride	sodium oxide	magnesium fluoride	lithium hydroxide	calcium hydroxide	aluminium nitrate	alu...

Activity 3b: Complete the gaps

For each equation, fill in any gaps, and state which element is being oxidised and w

	Oxidised
.....CuO +.....C →.....CO_2 +.....Cu	.....
.....Fe_2O_3 +..... →.....CO_2 +.....Fe	.....
.....PbO +..... →..... +...	.....
.....C +... → CO_2	.....
Fe +.....O_2 →.....Fe_2O_3	.....
Mg + $CuSO_4$ → $MgSO_4$ + Cu	.....
.....Na +.....Cl_2 →.....NaCl	.....

Activity 4: Exam-style questions

Exam-style questions

1. Which of the following is most likely to be found pure in nature?

   A sodium
   B gold
   C aluminium
   D calcium

2. In a blast furnace, copper oxide, CuO, is heated with carbon, and the follow

   $$2CuO + C \rightarrow 2Cu + CO_2$$

   a) he element which is **oxidised** in this reaction.

   .....

   b) Magnesium **cannot** be extracted from its oxide by heating it with carb

   .....

   c) Suggest the formula of magnesium oxide.

   .....

3. Iron(III) oxide is a rock. When iron(III) oxide is heated with carbon, the foll

   iron(III) oxide + carbon → n + carbon dioxide

   a) Balance the symbol equation for this r ac or

   .....Fe_2O_3 + ...C → .....Fe + ...CO_2

   b) Write the ha d -equation for the production of iron, Fe, from ir

   .....

   c) Explain whether iron is being oxidised or reduced in this half-equation of electrons.

   .....

Reactions of acids and produc

Specification reference: 4.4.2.1 – 4.4.2.3 Why were the acid ar

Activity 1: Names and formulae

Match the names of the compounds and ions to the co[illegible]mulae.

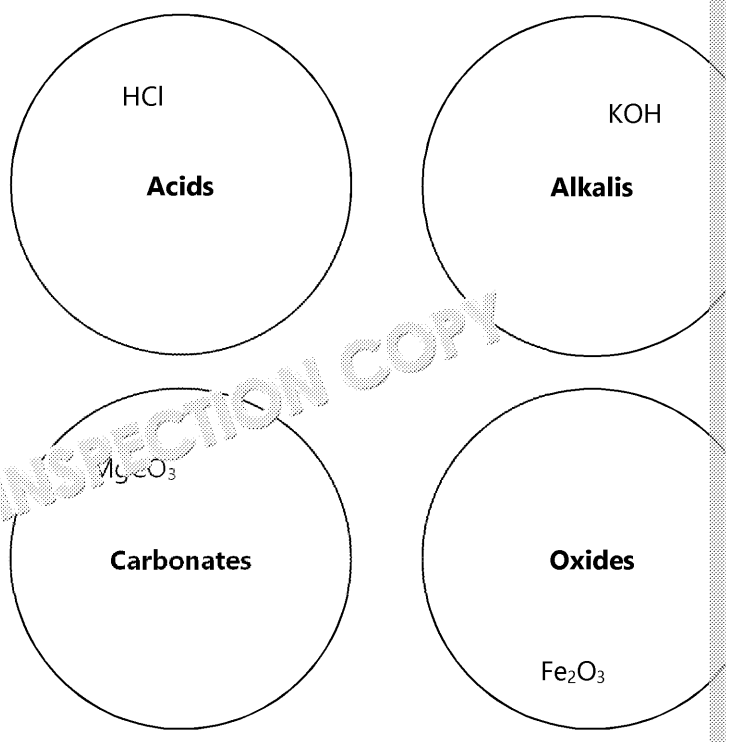
Mg^{2+}
Cl^-
NO[illegible]
[illegible]
$PbSO_4$
$NaNO_3$
NH_4Cl
KNO_3
CaO

Activity 2: Classify

Write each of the compounds in the box into the correct circle.

⚠	**Hint:** OH^- is the hydroxide ion. It is found in alkalis. Carbonates contain the carbonate ion CO_3^{2-}.

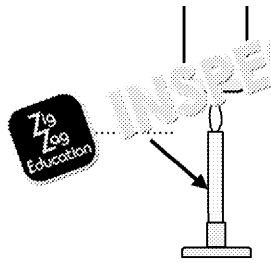
Compounds		
HCl	[illegible]	K_2O
NaOH	NH_4OH	Al_2O_3
Fe_2O_3	$MgCO_3$	LiOH
KOH	H_2SO_4	MgO



Activity 3: Storyboard

Here is an incomplete storyboard describing how to create soluble copper sulfate
acid. Complete the storyboard by **drawing diagrams** to show what is happening

Equipment you should include: Bunsen burner, beaker, funnel, filter paper, evapor

Step 1	
	
Heat some dilute sulfuric acid using a Bunsen burner. Add copper oxide to sulfuric acid until the copper oxide stops reacting/dissolving.	Filter the copper

Step 3	
Evapora olution using a Bunsen burner until crystals begin to form.	Leave the re crystallisation/evapor e

Activity 4: Neutralisation sudoku

The following table is a puzzle involving reactions of acids.

- The columns are either a metal or a base (a metal oxide, a metal carbonate o
- The rows' headers are the acids HCl, H_2SO_4 and HNO_3.
- The cells contain the products of the reactions of the acid and the base.

Complete the table.

base/metal / acid	Fe	$Cu(NO_3)_2$	ZnO
HCl	$FeCl_2$ + H_2	..... +..... +.....	$ZnCl_2$ +
HNO_3	..... +.....*	$Ca(NO_3)_2$ +..... +.....	$Zn(NO_3)_2$
H_2SO_4	..... +.....	..... + CO_2 +.....	..... +

N.B: This reaction is not the one observed in practice.

Exam-style questions

1. Which of the following is one of the products of the reaction between sulfuric
   A water
   B chlorine
   C sulfur dioxide
   D hydrogen

2. Name a gas which could react with magnesium hydroxide to produce magn

.....

3. Describe a method to make a pure, dry sample of magnesium nitrate salt fro and a suitable acid.

   Magnesium hydroxide is insoluble.

   You should name all key equipment used.

.....

.....

.....

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Reactions of acids and produc

Specification reference: 4.4.2.1 - 4.4.2.3 Why were the acid ar

Activity 1: Names and formulae

Match the names of the compounds and ions to the co mulae.

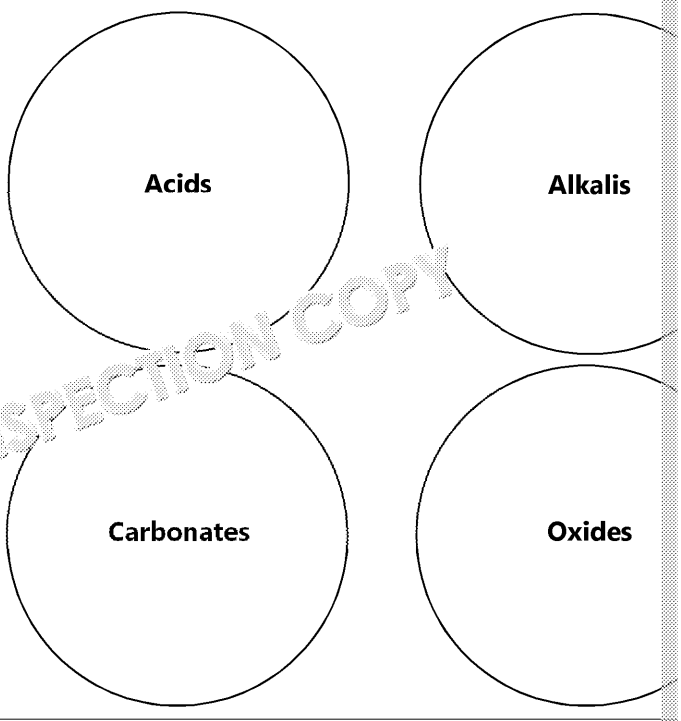
Mg^{2+}
Cl^-
$FeCl_2$
$PbSO_4$
$NaNO_3$
NH_4Cl
KNO_3
CaO

Activity 2: Classify

Firstly, write each of the compounds in the box below i correct circle.

Secondly, using only the elements in the l unds, write the balanced fo and oxide in the circles below.

	Compounds	
	$CaCO_3$	K_2O
NaOH	NH_4OH	Al_2O_3
Fe_2O_3	$MgCO_3$	LiOH
KOH	H_2SO_4	MgO



Activity 3: Storyboard

Here is an incomplete storyboard describing how to create soluble copper sulfate fr

Complete the storyboard by **drawing diagrams** to show what is happening in ea

Step 1	
Heat some dilute sulfuric acid using a Bunsen burner. Add copper oxide to sulfuric acid until the copper oxide stops reacting/dissolving.	Filter the copper

Step 3	
Evaporate the solution using a Bunsen burner until crystals begin to form.	Leave the re crystallisation/evapor e

Activity 4: Neutralisation sudoku

The following table is a puzzle involving reactions of acids.

- The columns are either a metal or a base (a metal oxide, a metal carbonate o
- The rows' headers are the acids HCl, H_2SO_4 and HNO_3.
- The cells contain the products of the reactions of the acid and the base.

Complete the table.

base/metal / acid	Fe or $FeCO_3$?	$CaCO_3$ or CaO?	ZnO or .....
HCl	$FeCl_2 + H_2$	..... +.....	..... +
H_2SO_4 or HNO_3?	..... *	$Ca(NO_3)_2$ +..... +.....	Zn..... +
H_2SO_4 or H	$FeSO_4 + H_2$	..... + CO_2 +.....	..... +

***N.B:** This reaction is not the one observed in practice.

Activity 5: Exam-style questions

Exam-style questions

1. Which of the following is one of the products of the reaction between sulfuric
   A water
   B chlorine
   C sulfur dioxide
   D hydrogen

2. Name a gas which could react with magnesium hydroxide to produce magn

.....

3. Describe a method to make a pure, dry sample of magnesium nitrate salt fro and a suitable acid.

   Magnesium hydroxide is insoluble.

   You should name all key equipment used.

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pH scale, titrations, and stro
weak acids

Specification reference: 4.4.2.4 - 4.4.2.6 How do you find the pH of

Activity 1: Acid fact file

Describe an acid...

1. ... using only one sente

.....

.....

2. ... using exactly eight words:

....

....

3. ... using exactly three words:

....

Activity 2: Indicators Ltd.

The chemical company Indicators Ltd. wants to p[illegible] a new label for the bottle new label for the universal indicator b[illegible].

Brief

We want to produce a new label for our flagship product, *Universal Indicator*.

You should include on the label:

- what the product does
- why it is useful

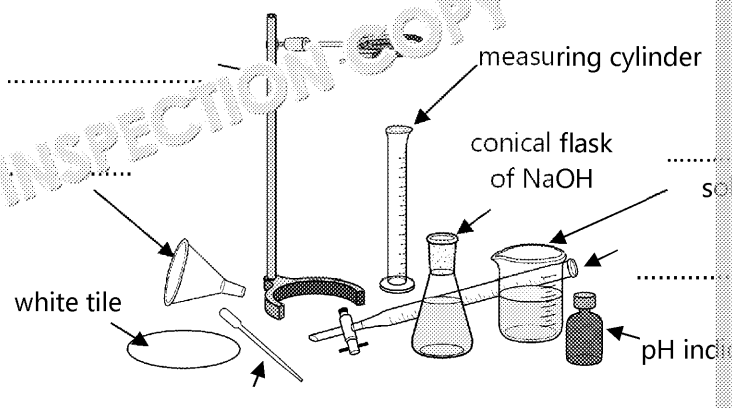
It might also be helpful to tell our customers:

- a little bit about the pH scale
- how to use the product
- the different colo[illegible] and w[illegible]ey mean

Activity 3: Titration

A laboratory technician has spilt water on her lab book and needs help rewriting t
titration. She has managed to save some information, including the titles and one
glassware out in front of her but isn't sure how to use it all. She has also left sticky

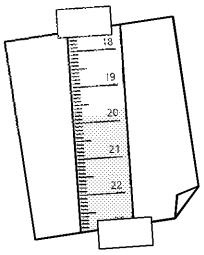
Help the laboratory technician by writing instructions with diagrams and instructio



Step 1 – preparing the base (NaOH)	Step 3 – adding the
Step 2 – filling the burett	Step 4 – taking a re

Reminder: don't forget the indicator!

Reminder: how will I stop spills?



Activity 4: Titration results

Here are some results from a titration experiment between 0.1 mol/dm^3 HCl and 5
unknown concentration:

	1	2	3
Start reading (cm^3)	0.10		
End reading (cm^3)			22.85
V[illegible] (cm^3)		22.80	22.85

The reaction titration is:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

1. Complete the table.

2. Circle the results which you will use in calculating the mean.

3. Find the mean titre (only include concordant results).

.....

.....

4. One method by which the uncertainty in this titre can be judged is by finding
State the uncertainty in this titre using this method

.....

.....

Activity 5 n-style question

Exam-style questions

1. A solution is tested with a pH meter and displays a reading of 7.

a) Which of the following could the solution be?

A pure water
B hydrochloric acid
C sodium hydroxide
D sulfuric acid

b) Suggest what colour the solution would go when tested with universal

.....

c) A student performed a titration experiment usin ic acid (HNO_3) to fi
of potassium hydroxide (KOH). Each titr s 100 cm^3 of the potas

The reaction occurring in the titration is:

$$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

Here are the student's results:

	Rough	Titration 1	Titra
Volume of 0.200 mol / dm^3 nitric acid (cm^3)	16.60	14.70	15

Concordant results are within 0.10 cm^3 of each other.

i) Find the mean value of the concordant results.

.....

.....

ii) Use the mean value to find the concentration of the potassium hy

.....

.....

.....

.....

iii) Nitric acid is a strong acid. Explain what is meant by a 'strong ac

.....

.....

pH scale, titrations and stro
weak acids

Specification reference: 4.4.2.4 - 4.4.2.6 How do you find the pH of

Activity 1: Acid fact file

Describe an acid...

1. ... using only one sentence:

.....

2. ... using ... eight words:

....

....

3. ... using exactly three words:

....

4. Describe the difference between a strong acid and a weak acid.

.....

5. An acid with a pH of 4 is diluted from 0.1 mol / dm^3 to 0.01 mol / dm^3. Predict t

.....

Activity 2: Indicators Ltd

The chemical company ... Ltd. wants to produce a new label for the bottle
new label f... indicator below.

Chief

We want you to produce a new label for our flagship product, *Universal Indicator*.

You should include on the label:

- what the product does
- why it is useful

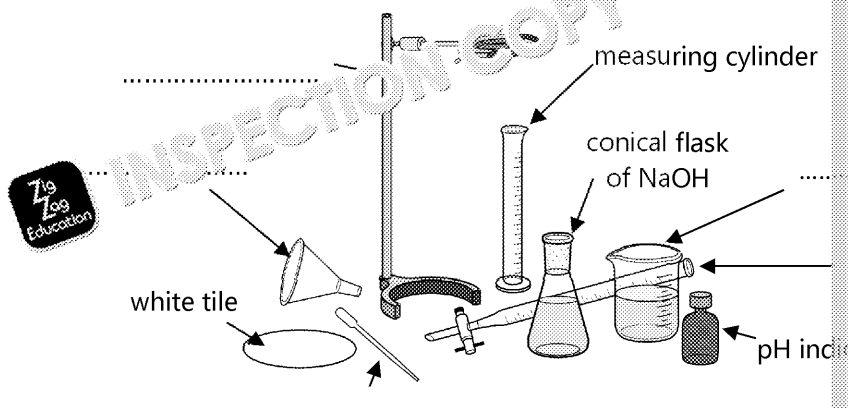
It might also be helpful to tell our customers:

- a little bit about the pH scale
- how to use the produ...
- the di... colours and what they mean

Activity 3: Titration

A laboratory technician has spilt water on her lab book and needs help rewriting t titration. She has managed to save some information, including the titles and one glassware out in front of her but isn't sure how to use it all. She has also left sticky

Help the laboratory technician by writing instructions with diagrams and instructio



Step 1 – preparing the base (NaOH)	Step 3 – adding the
Step 2 – filling the burette	Step 4 – taking a re

Reminder: don't forget the indicator!

Activity 4: Titration results

Here are some results from a titration experiment between 0.1 mol/dm^3 HCl and 5 unknown concentration:

	1	2	3	4
Start reading (cm^3)	0.10	23.65		22.85
End reading (cm^3)	23.65		22.85	45 .75
Volume of HCl (cm^3)		22.80	22.85	

Th

1.
2.

3. Find the mean titre (only include concordant results). .....
4. Find the number of moles of HCl in one titre. .....
5. Find the number of moles of NaOH in one titre. .....
6. Find the concentration of NaOH in the 50 cm^3 samples in mol/dm^3. .....
7. One method by which the uncertainty in this titre can be judged is by finding State the uncertainty in this titre using this method.

.....

Activity 5: Exam-style question

Exam-style questions

1. A solution is tested with a pH meter and displays a reading of 7.

   a) Which of the following could the solution be?

   A pure water
   B hydrochloric acid
   C sodium hydroxide
   D sulfuric acid

   b) Suggest what colour the solution would go when tested with universal indicator.

   .....

   c) A student performed a titration experiment using nitric acid (HNO_3) to find the concentration of potassium hydroxide (KOH). Each titration uses 100 cm^3 of the potassium hydroxide.

   The reaction occurring in the titration is:

   $$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

   Here are the student's results:

	Rough	Titration 1	Titration 2
Volume of 0.200 mol / dm^3 nitric acid (cm^3)	16.60	14.70	15.60

   Concordant results are within 0.20 cm^3 of each other.

   i) Find the mean value of the concordant results.

   .....

   .....

   ii) Use the mean value to find the concentration of the potassium hydroxide.

   .....

   .....

   .....

   .....

   iii) Nitric acid is a strong acid. Explain what is meant by a 'strong acid'.

   .....

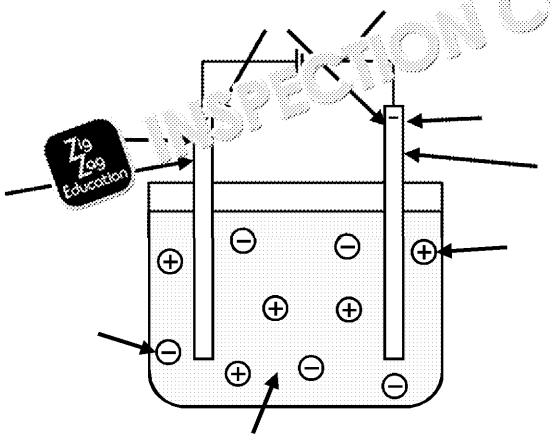
   .....

Electrolysis

Specification reference: 4.4.3.2 - 4.4.3.5 The only way to stop urani

Activity 1: Labelling

This diagram shows electrolysis using a molten electrolyte. Add the labels in the b



electrons flowing

cathode

anode

electrode

Activity 2: Visualise it

Draw diagrams to go with the following statements.

When an ionic compound is solid, the ions are in a regular arrangement of positive and negative ions. The ions cannot move.	When melted to form a liquid (or dissolved to form a liquid), the giant structure breaks down and the ions can flow past each other.	Du pla e att
The positive ions gain electrons to form atoms or molecules that are neutral (have no charge).	The negative ions lose electrons to form atoms or molecules that are neutral (have no charge).	Ove io be

Activity 3: Product predictor

Use the rules below to predict the products of the electrolysis of the following co

Molten

	$ZnCl_2$ (l)	$PbBr_2$ (l)	NaCl (l)	Al_2O_3 (l)	Ag_3N (l)
Positive electrode	Cl_2				
Negative electrode	Zn				

Aqueous

	NaCl (aq)	KBr (aq)	$CuCl_2$ (aq)	NaOH (aq)	$CuSO_4$ (aq)	Na_2S (aq)
Positive electrode	Cl_2					
Negative electrode	H_2					

Rule 1: If it is a **molten** compound (has the state symbol (l) meaning liquid), the compound is split to form the two elements used in the compound's name:

e.g. $PbBr_2(l) \rightarrow Pb + Br_2$

lead bromide → lead + bromine

The metal goes to the negative electrode and the non-metal goes to the positive electrode.

Rule 2: If it is a compound dissolved in water **(aqueous)**:

- you get the metal at the negative electrode if it is less reactive than hydrogen
- you get hydrogen at the negative electrode if the metal is more reactive that hydrogen

Rule 3: If it is a compound dissolved in water **(aqueous)**:

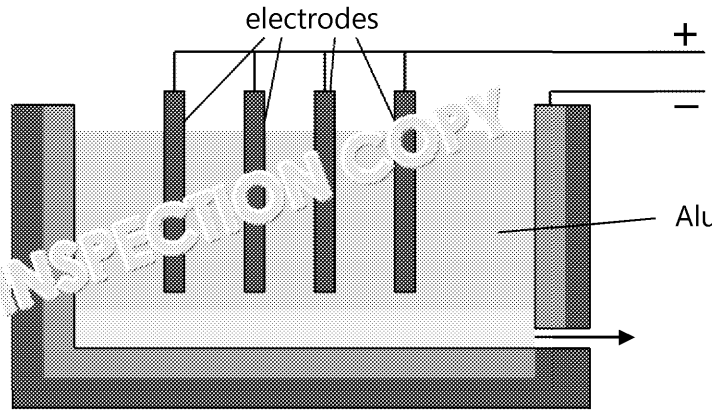
- you get a halogen at the positive electrode if there is a halogen ion in the compound's name (fluoride, bromide, chloride, iodide)
- you get oxygen at the positive electrode (if it is not a fluoride, bromide, chloride or iodide)

e.g. $MgCl_2(aq) \rightarrow Mg + Cl_2$

magnesium chloride → magnesium + chlorine

Activity 4: Tour aound an aluminium plant

You are taking a tour around an aluminium plant. Answer these students' questio
aluminium.



Why does the aluminium oxide have to be heated?

What's th

What are the produ[illegible] do they go?

What are

Why do the electrodes look worn away? Do they need replacing?

Why are there s

Exam-style questions

1. What are the correct products when aqueous magnesium chloride is electrol

	cathode	anode
A	magnesium	chlorine
B	[illegible]	oxygen
C	hydrogen	chlorine
D	hydrogen	oxygen

2. When molten zinc chloride, $ZnCl_2$, is electrolysed, the products are zinc and

   a) Write a balanced chemical equation for this process.

   .....

   .....

   b) In this process, ions move towards electrodes.

   Identify the ion which would move towards the positive electrode.

   .....

3. Aluminium oxide can be electrolysed to produce pure aluminium.

   The ions present are Al^{3+} and O^{2-}.

   a) A gas is formed at one of the electrodes. Suggest which gas is produced

   .....

   b) State the material used for the positive electrode in this process.

   .....

   c) What substance is added to lower the melting point of the mixture?

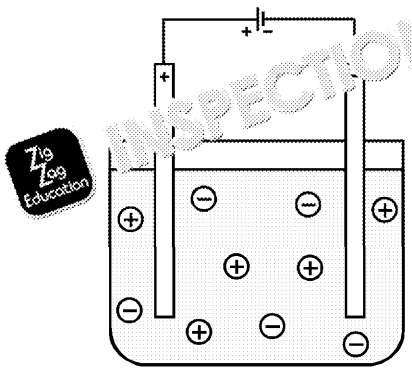
   .....

Electrolysis

Specification reference: 4.4.3.2 - 4.4.3.5 The only way to stop urani

Activity 1: Labelling

This diagram shows electrolysis using a molten electrolyte. Add the labels in the b



electrons flowi

electrodes

cathode

anode

positive ion

Activity 2: Visualise it

Draw diagrams to go with the following statements.

When an ionic compound is ....., the ions are in a regular arrangement of positive and negative ions. The ions cannot move.	When melted to form a liquid (or dissolved in water), the giant structure breaks down and the ..... can flow past each other.	Du are .. ne
Th ve ... gain ..... to form atoms or molecules that are neutral (have no charge).	The negative ions lose ..... to form atoms or molecules that are neutral (have no charge).	Ove ic Pl

Activity 3a: Product predictor

Use the rules below to predict the products of the electrolysis of the following co

	$ZnCl_2$ (l)	NaCl (aq)	$PbBr_2$ (l)	$CuCl_2$ (aq)	Al_2O_3 (l)	NaOH (aq)	$NaNO_3$ (aq)	Ag_3N (l)
Anode	Cl_2	Cl_2						
Cathode	Zn	H_2						

Rule 1: If it is a **molten** co[illegible] (has the state symbol (l) meaning liquid), the compo[illegible] to form the two elements used in the compou[illegible]m).

e.g. [illegible]$PbBr_2$(l) → Pb + Br_2

lead bromide → lead + bromine

The metal goes to the negative electrode and the non-metal goes to the positive electrode.

Rule 2: If it is a compound dissolved in water:

- you get the metal at the negative electrode if it is less reactive than hydrogen
- you get hydrogen at the negative electrode if the metal is more reactive that hydrogen

Rule 3: If it is a compound dissolved in water:

- you get a halogen at the positive electrode if there is a halogen ion in the compound's name (fluoride, bromide, chloride, iodide)
- you get oxygen at the positive electrode if it is not a fluoride, bromide, chloride or iodide

e.g. [illegible] → Mg + Cl_2

[illegible] chloride → magnesium + chlorine

Activity 3b: Half-equations

Complete the half-equations for these reactions:

$PbBr_2$

Pb^{2+} +..... e^- → Pb

..... Br^- → Br_2 +..... e^-

Na_2S

Na^+ +..... e^- → Na

S^{2-} →..... +..... e^-

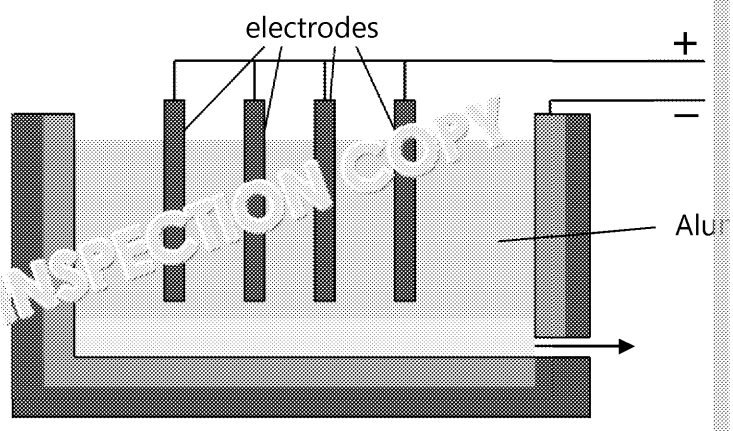
K_3N

..... +..... e^- → K

[illegible]$^{3-}$ → ..... e^-

Activity 4: Tour around an aluminium plant

You are taking a tour around an aluminium plant. Answer these students' questio
aluminium.



Why does the aluminium oxide have to be heated?

What's th

What are the produ[illegible] do they go?

What are

Why do the electrodes look worn away? Do they need replacing?

Why are there s

Exam-style questions

1. What are the correct products when aqueous magnesium chloride is electrol

	cathode	anode
A	magnesium	chlorine
B	[illegible]	oxygen
C	hydrogen	chlorine
D	hydrogen	oxygen

2. When molten zinc chloride, $ZnCl_2$, is electrolysed, the products are zinc and

   a) Write a balanced chemical equation for this process.

   .....

   .....

   b) Zinc is oxidised in this reaction.

   Complete the half-equation for the production of zinc.

   $Zn^{2+} \rightarrow$ ..... + ...e^-

3. Aluminium oxide can be electrolysed to produce pure aluminium.

   Aluminium oxide is mixed with cryolite in this process.

   a) Explain why cryolite is used.

   .....

   .....

   .....

   b) State the material used for the positive electrode in this process, and e

   .....

   .....

Exothermic and endothermic r

Specification reference: 4.5.1.1

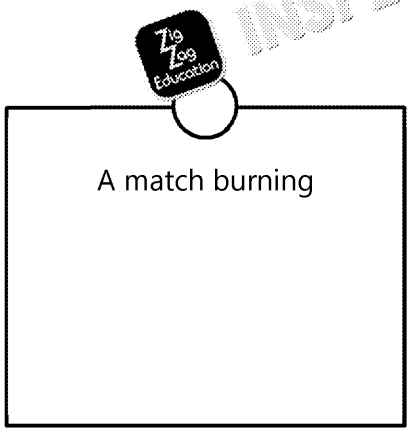
I can't believe y

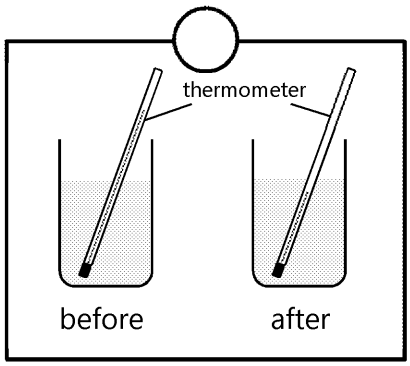
Activity 1: Endo or exo?

Some reactions are shown. Write an X or an N in each of the circles to show whet endothermic, and then draw the missing diagrams in the spaces.

eNdothermic

N





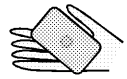
neutralisation reaction

oxidatio magnesium

Activity 2: Uses of exothermic and endothermic reactions

The pictures below show two items which use exothermic or endothermic reactio sentences about the items.

Handwarmer



Self-co

These packs are useful for...

.....

These packs are use

.....

When the button is clicked inside the hand w he

.....

When the bag is sh

.....

This reacti ermic. You can tell because...

.....

This reaction is .....

.....

I would also use the same technology for...

.....

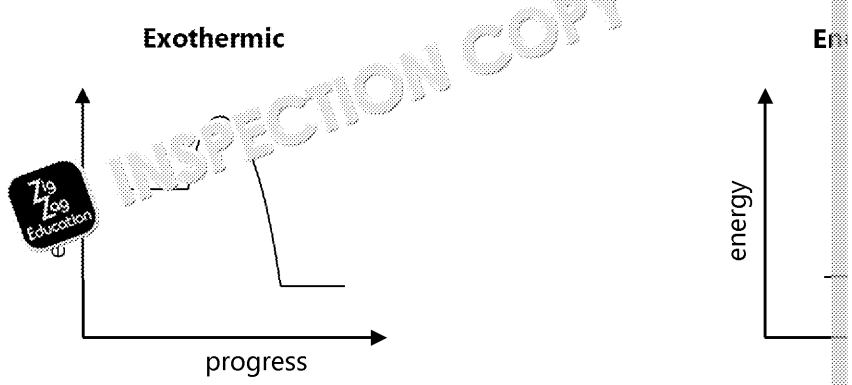
I would also use the

.....

Activity 3: Reaction profiles

Draw two reaction profiles on the axes below: one exothermic and one endotherm

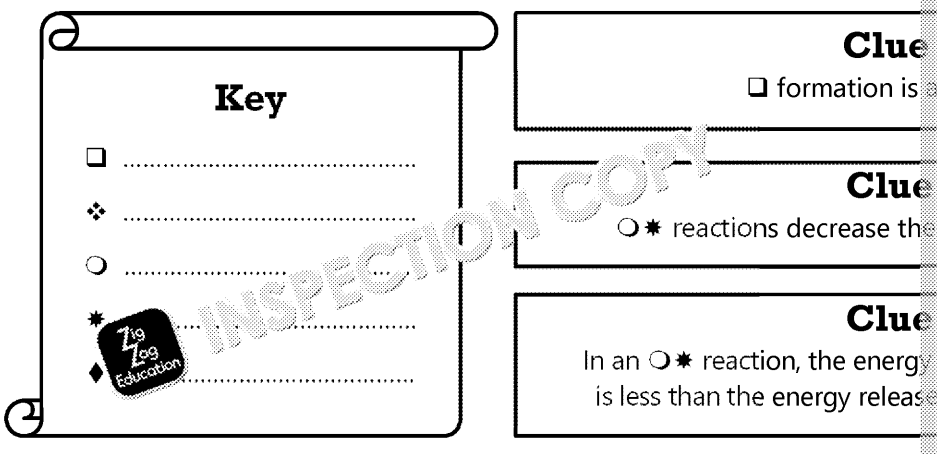
- reaction curve
- products and reactants
- activation energy
- energy change



Activity 4: Codebreaker

Read the following passage, and complete the key by matching the symbols to th

exo, endo, thermic, temperature, bond



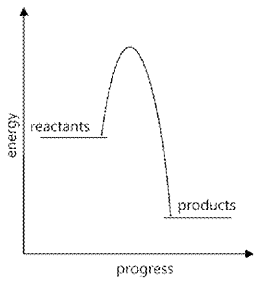
Activity 5: Exam-style questions

Exam-style questions

1. In an investigation, a student heated a sample of copper carbonate. Over
salt changed colour. Name the type of reaction where a metal carbonate is

.....

2. Here is the reaction profile for the rea n between zinc carbonate and hy
arrows to show the energy ch a the activation energy.



Exothermic and endothermic r

Specification reference: 4.5.1.1

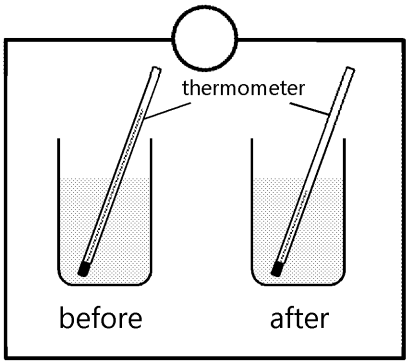
I can't believe y

Activity 1: Endo or exo?

Some reactions are shown. Write an X or an N in each of the circles to show whet endothermic, and then draw the missing diagrams in the spaces.

exothermic (X) eNdothermic (N)

A match burning



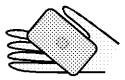
neutralisation reaction

oxidation of magnesium

Activity 2: Uses of exothermic and endothermic reactions

The pictures below show two items which use exothermic or endothermic reaction sentences about the items.

Handwarmer



Why are these packs useful?

.....

What kind of reaction occurs when the button is clicked inside the hand warmer?

How can you tell?

.....

What else could you use the same technology for?

.....

Self-co

Why are these pack

.....

What kind of reacti shaken?

How can you tell?

.....

What else could yo

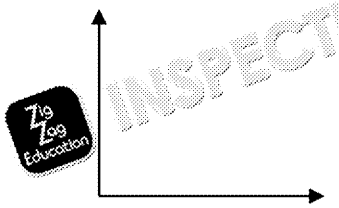
.....

Activity 3: Reaction profiles

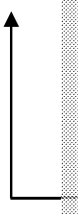
Draw two reaction profiles on the axes below: one exothermic and one endotherm

- reaction curve
- energy of products and reactants
- activation energy
- energy change

Exothermic



En



Activity 4: Codebreaker

Read the following passage, and complete the key by identifying the words replac

exo, endo, thermic, break, form, temperature, bon

Key

❑ .....

❖ .....

⌘ .....

❍ .....

◎ .....

.....

.....

Cl

❑ ⌘ation

Cl

❍✷ reactions decrease

Cl

In an ❍✷ reaction, the e
is less than the energy

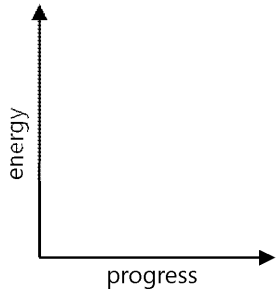
Activity 5: Exam-style questions

Exam-style questions

1. In an investigation, a student heated a sample of copper carbonate. Over
salt changed colour. Name the type of reaction where a metal carbonate is

.....

2. Here is the reaction profile for the
reaction profile, and draw



Energy changes

Specification reference: 4.5.1.2 - 4.5.1.3

You're hot then you're
energy in or energy

Activity 1: Practical design

A student has been asked to design a practical to find h temperature change wh
of zinc are added to a solution of hydroc ric.

For this experiment:

Equipmen
Write a list of equipment.

Safety
Name **three** safet
when using the ch

1.

2.

3.

Prediction
How do you think adding more zinc will affect the temperature change?

Variables
What is the independent variable (the one you choos

What is the dependent variable (the e easure in the experiment)?

Name **two** control va (things you will keep the same between experiment
1.
2.

Method
What are you going to do? What will you measure, and when?

.....

.....

.....

.....

.....

.....

.....

.....

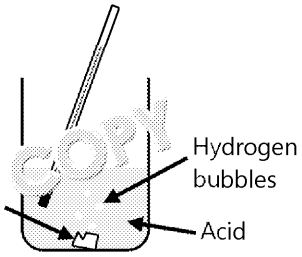
Results
Here is the

Complete
the table.

Start

Activity 2: Graph-drawing

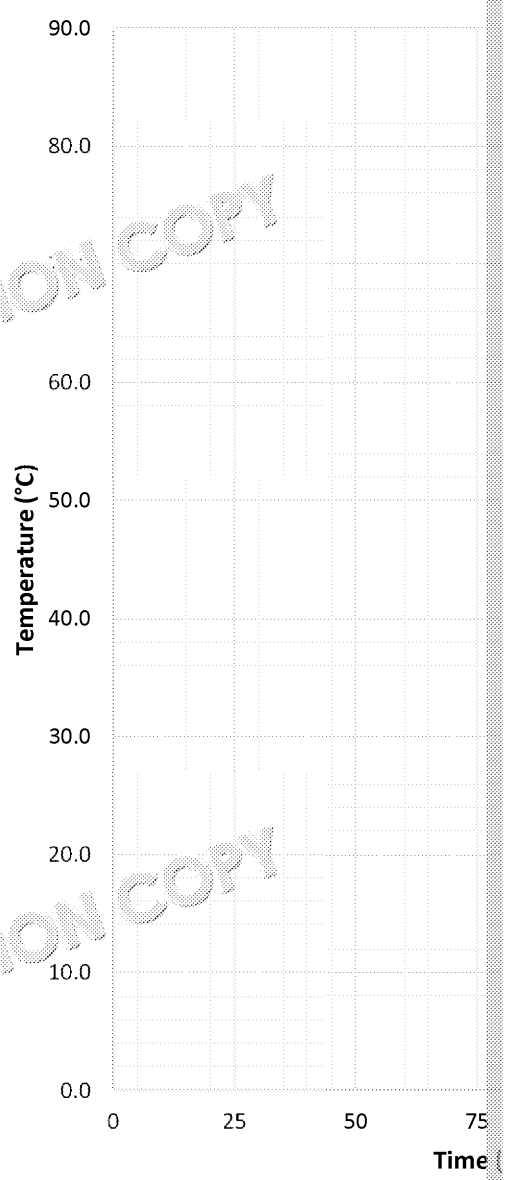
An experiment is done to measure the temperature change during a reaction. The acid and magnesium.



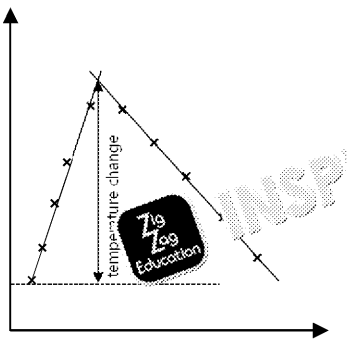
The results [illegible] temperature over the reaction for the three metals.

Time (s)	Temperature (°C)
0	25.0
5	27.9
10	35.8
15	42.9
20	55.0
25	61.7
30	68.6
35	76.3
40	84.1
45	84.2
50	82.3
55	80.4
60	[illegible]
70	78.6
80	74.7
90	72.8
100	70.9
110	69.0
120	67.1

1. Plot the data on the graph paper.
2. Draw **two** straight lines of best fit. One s[illegible] the increasing points, and one should be[illegible] decreasing points. (See example below.)
3. Find the temperature of the point where [illegible] work out the temperature change.



Tip: the graph will look similar to this when it is plotted.



Exam-style questions

1. A student measured the temperature change of a neutralisation reaction b hydroxide.

   a) The temperature increases in reaction. What word is given to a r temperature of the surroundings to increase?

   .....

   b) Here are the student's results:

	Repeat 1	Repeat 2
Temperature change (°C)	12.5	12.9

   Calculate the mean temperature change of this reaction.

   .....

   .....

2. A student investigated the reaction between hydrochloric acid and three d

   Method
   1. Measure 4 g of the metal carbonate into an insulated beaker
   2. Add 20 cm^3 of hydrochloric acid
   3. Measure the maximum temperature

   Here are the student's results:

metal carbonate	maximum temperature (°C)
iron carbonate	28.4
zinc carbonate	26.5
magnesium carbonate	32.8

   a) Explain why the insulated beaker makes the result more accurate tha a normal glass beaker.

   .....

   b) In this experiment, the student measured the maximum temperature

   What else should the student measure if they want to calculate the te

   .....

Energy changes

Specification reference: 4.5.1.2 - 4.5.1.3

You're hot then you're
energy in or energy

Activity 1: Practical design

A student has been asked to design a practical to find the
erature change wh
of zinc are added to a solution of hydrochloric aci

For this experiment:

Equipmer
Write a lis
ipment.

Safety
Name **three** safet
when using the ch

1.

2.

3.

Prediction
How do you think adding more zinc will affect the temperature change?

Variables
What is the independent variable (the one you choose)?

What is the dependent variable (the one you me
e
he experiment)?

Name **two** control variables (thi
keep the same between experiment
1.

2.

Method
What are you going to do? What will you measure, and when?

.....

.....

.....

.....

.....

.....

.....

.....

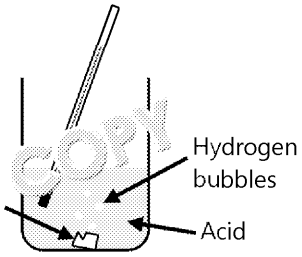
Results
Here is the

Complete
the table.

Start	

Activity 2: Graph-drawing

An experiment is done to measure the temperature change during a reaction. The acid and magnesium.



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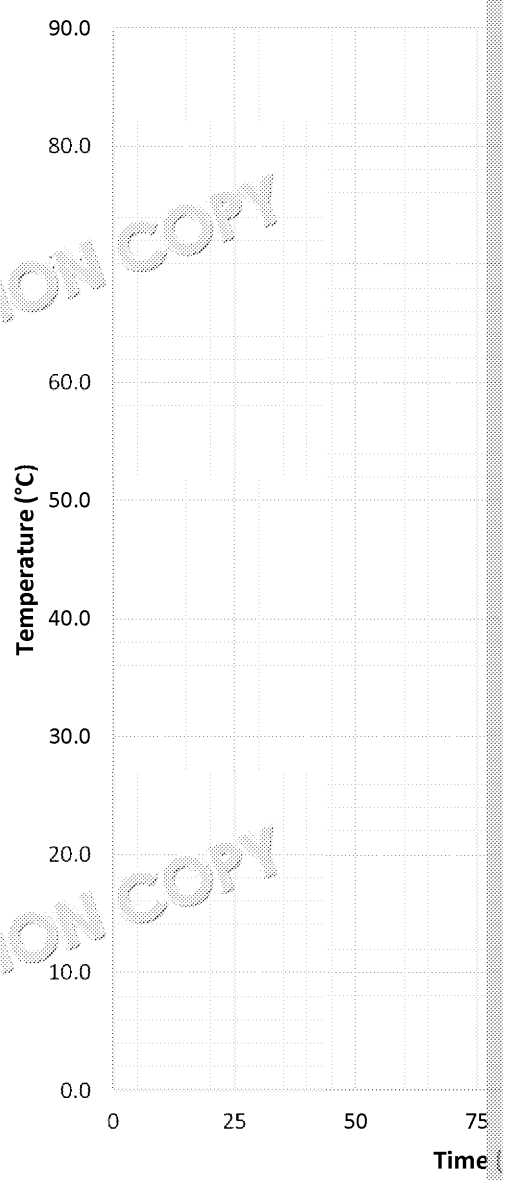
30	68.6
35	76.3
40	84.1
45	84.2
50	82.3
55	80.4
60	[illegible]
70	78.6
80	74.7
90	72.8
100	70.9
110	69.0
120	67.1

1. Plot the data on the graph paper.
2. Draw **two** straight lines of best fit. One s[illegible] the increasing points, and one should be[illegible] decreasing points. (See example below.)
3. Find the temperature of the point where [illegible] work out the temperature change.



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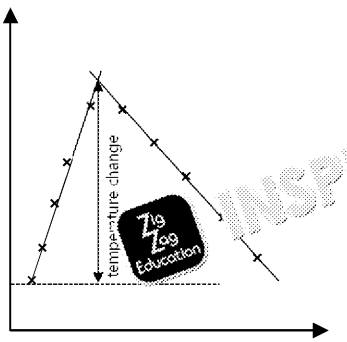
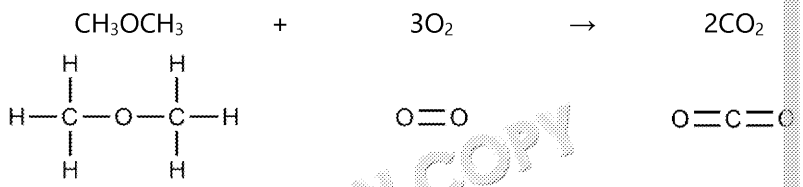


Activity 3: Bond energy calculations

This diagram shows the structures of the molecules in the following reaction.



Here is a table of bond energies for the same reaction.

Bond	Bond energy (kJ / mol)
C–H	413
C–O	358
O=O	498
C=O	799
O–H	463

1. Draw the reaction again, drawing the correct number of molecules to make t

2. Write out the number of bonds on each side of the equation.

Left-hand side	Right-hand side
2 × C–O	

3. Calculate the energy required to break the bonds on the left-hand side.

.....

.....

4. Calculate the energy given out when the bonds form in the products.

.....

.....

5. Calculate the energy change in the reaction, using the equation:

energy change = bonds broken – bonds formed

.....

Exam-style questions

1. A student measured the temperature change of a neutralisation reaction b hydroxide.

   a) Predict whether this is an exothermic reaction or an endothermic reac

   .....

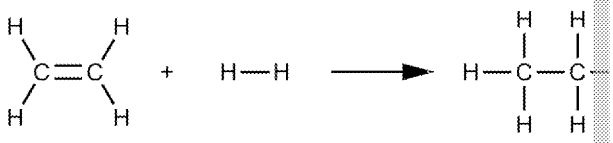
   b) re the student's results:

	Repeat 1	Repeat 2
Temperature change (°C)	12.5	12.9

   Calculate the mean temperature change of this reaction.

   .....

2. Calculate the energy change of this reaction using the bond energies in th



bond	nergy (kJ/mol)
C–H	413
	602
C–C	346
H–H	436

   .....

   .....

   .....

3. A student investigated the reaction between hydrochloric acid and three di

   Method

   1. Measure 4 g of the metal carbonate into an insulated beaker
   2. Add 20 cm^3 of hydrochloric acid
   3. Measure the maximum temperature

   Here are the student's results:

metal carbonate	num temperature
iron carbonate	28.4
zinc carbonate	26.5
magnesium carbonate	32.8

   a) st e way that the student could make this investigation a **fair**

   .....

   b) What should be used instead of maximum temperature to calculate th

   .....

Chemical cells and fuel c

Specification reference: 4.5.2.1 - 4.5.2.2 Sit down t

Activity 1: Chemical cells vs fuel cells

Look at the statements and decide whether they are about f cells, chemical cell

When you are sure, add the number of each to the Venn diagram. For both chemical cells and fuel cells, added to the overlapping section.

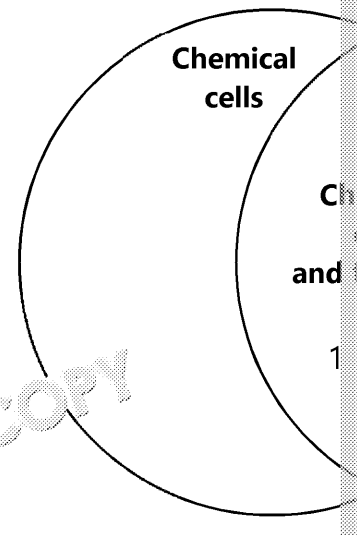
Hint: go in the 'chemical cells' section, three go in the mi 'fue ection.

Statements

1. Produce electricity
2. Can power a motor
3. Could be used in cars
4. Non-rechargeable
5. Can be recharged
6. Use hydrogen gas
7. Use oxygen from the air
8. Contain their reagents
9. Voltage depends on the type of electrode
10. Are an alternative to batteries
11. Involves the oxidation of hydrogen
12. Water is a product
13. Can be made by placing two connecte metal electrodes in an electr

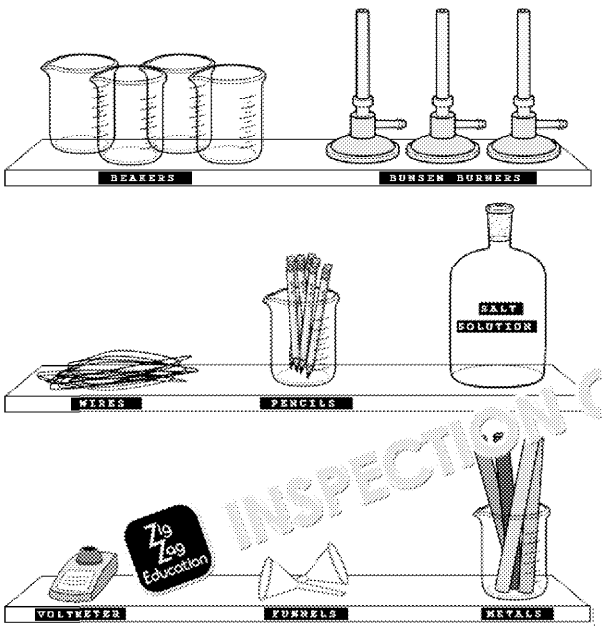
Ven

Statements which are abou



Activity 2: Set up a chemical cell

A laboratory ician has been given some instructions. Here are the instructio Complete and label the diagram below of the experiment which the technician ha



To do

- Find the equipment needed to make a chemical cell, including a way of meas
- Draw a labelled diagram of the cell.

Activity 3: Classroom discussion

Students in a classroom are having a discussion about an electrochemical cell with
Copper is less reactive than zinc.

Evaluate the statements made by the students, by writing in the boxes:

- stating whether you agree or disagree
- explaining why you agree or disagree

True or false? .....

What kind[Zig Zag Education] is this? .....

.....

.....

Is the electrolyte a fuel? .....

.....

.....

The cell is a fuel cell. The electrolyte is the fuel.

True or false? .....

How would the voltage c

.....

.....

What is the word for mul

.....

.....

If I put another cell in
battery, I could

Different metals might mak[Zig Zag Education] change, dependi[Zig Zag Education] reactivity.

The voltmeter will ever
no ch

True or false? .....

What effect would changing the metals have? Refer to their reactivity. .....

.....

.....

What kind of metals would you choose for the largest voltage? Refer to their reactivity. .....

.....

.....

.....

True or false? .....

What reagents are used u

.....

What would happen to th
reagents are used up? ....

.....

.....

.....

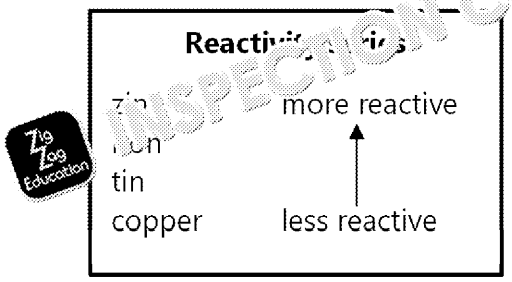
.....

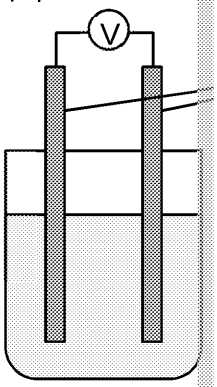
.....

Activity 4: Exam-style question

Exam-style questions

1. A student is investigating simple cells using the following equipment:





The student has the metals iron, copper, zinc and tin.

a) Which of these pairs of metals will give the largest reading on the voltm

A iron and copper
B copper and zinc
C iron and tin
D zinc and iron

b) Explain whether this is a fuel cell or a chemical

.....

.....

.....

c) Some cars are powered by hydrogen fuel cells. In these cells, hydroge

What other reagent is required for hydrogen fuel cell cars to work?

.....

d) Give **one** advantage of using fuels cells rather than a battery to power

.....

.....

Chemical cells and fuel c

Specification reference: 4.5.2.1 - 4.5.2.2 Sit down t

Activity 1: Chemical cells vs fuel cells

Look at the statements and decide whether they are about f cells, chemical cell

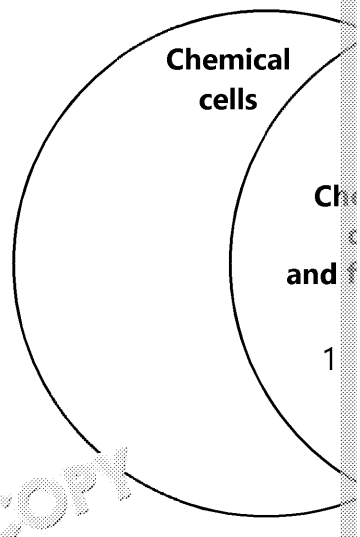
When you are sure, add the number of each t to the Venn diagram. For both chemical cells and fuel cells, a added to the overlapping section.

ents

1. Produ tricity
2. Can power a motor
3. Could be used in cars
4. Non-rechargeable
5. Can be recharged
6. Use hydrogen gas
7. Use oxygen from the air
8. Contain their reagents
9. Voltage depends on the type of electrode
10. Are an alternative to batteries
11. Involves the oxidation of hydrogen
12. Water is a product
13. Can be made by placing two connected metal electrodes in an electrolyte

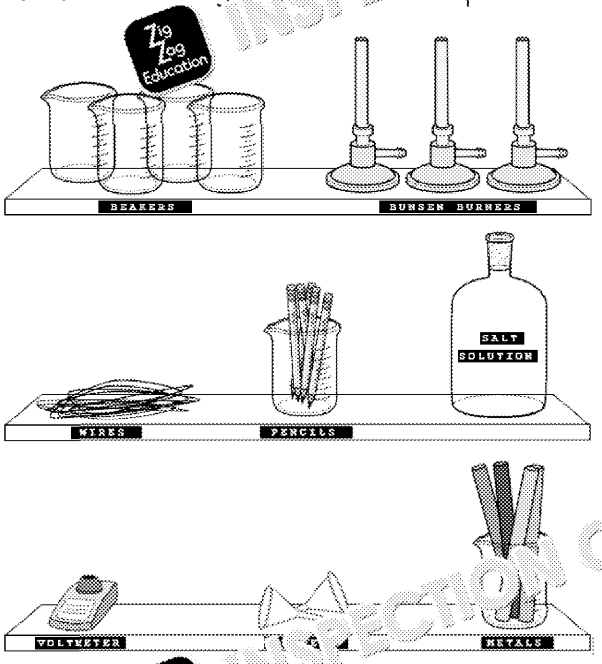
Venn

Statements which are abou



Activity 2: Set up a chemical cell

A laboratory technician has be ive some instructions. Here are the instructio Draw a labelled diagra w the experiment which the technician has been a



To do

- Find the quipment needed to make a chemical cell, including a way of meas
- Draw a labelled diagram of the cell.

Activity 3: Classroom discussion

Students in a classroom are having a discussion about an electrochemical cell with

For each statement made by the students, state whether you agree or disagree and

The cell is a fuel cell. The electrolyte is the fuel.

If I put another cell in ser

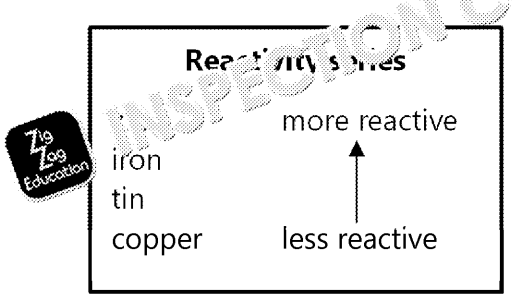
Different metals might make the voltage change.

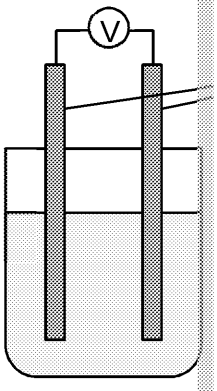
Eventually the

Activity 4: Exam-style question

Exam-style questions

1. A student is investigating simple cells using the following equipment:





The student has the metals iron, copper, zinc and tin.

a) Which of these pairs of metals will give the largest reading on the voltm

A iron and copper
B copper and zinc
C iron and tin
D zinc and iron

b) Explain whether this is a fuel cell or a ch ell.

.....

.....

.....

c) Some cars are powered by hydrogen fuel cells. In these cells, hydroge

Write the half-equation for the reaction which occurs at the positive ele cell.

.....

.....

Answers

Atoms, elements, compounds and mixtures (43 / 49)

Activity 1: Word unscramble [8]

atoms	a method which produces crystals from a solution
element	a substance made from two or more types of atom, chemically bonded
compound	a method of separating liquids with different boiling points
mixture	elements are made up of one type of these
filtration	a method of separating a solvent from a solution by evaporation and condensation
crystallisation	two or more substances together which are not chemically joined
simple distillation	a substance containing one type of atom
fractional distillation	a method of removing a solid from a solution using filter paper
chromatography	a method of separation which uses a stationary phase and a mobile phase

Activity 2: Categorise the matter [11]

E M E C
M E C M
M E C E

E M M C
M E C M
M E M E

Activity 3: Compound interest [7]

Name	Ions	Formula	Name	Ions	Formula
sodium oxide	Na^+ and O^{2-}	Na_2O	zinc oxide	Zn^{2+} and O^{2-}	ZnO
potassium iodide	K^+ and I^-	KI	aluminium chloride	Al^{3+} and Cl^-	$AlCl_3$
calcium bromide	Ca^{2+} and Br^-	$CaBr_2$	copper iodide	Cu^{2+} and I^-	CuI_2
lithium iodide	Li^+ and I^-	LiI			

Activity 3: Compound interest [9]

Name	Ions	Formula	Name	Ions	Formula
sodium oxide	Na^+ and O^{2-}	Na_2O	aluminium chloride	Al^{3+} and Cl^-	$AlCl_3$
potassium iodide	K^+ and I^-	KI	copper iodide	Cu^{2+} and I^-	CuI_2
calcium bromide	Ca^{2+} and Br^-	$CaBr_2$	zinc sulfate	Zn^{2+} and SO_4^{2-}	$ZnSO_4$
lithium iodide	Li^+ and I^-	LiI	magnesium nitrate	Mg^{2+} and NO_3^-	$Mg(NO_3)_2$
zinc oxide	Zn^{2+} and O^{2-}	ZnO			

Activity 4: Label the apparatus [12]

	Experiment
A	Fractional distillation
B	Simple distillation
C	Filtration
D	Crystallisation

	Name	What it is used for
1	thermometer	measuring temperature
2	fractionating column	separating components of the mixture
3	(Liebig) condenser	condensing the vapour to a liquid
4	beaker	collecting the liquid (distillate)
5	round-bottomed flask	holding the liquid reaction mixture
6	filter paper	separating the solid and liquid components
7	funnel	making sure the liquid doesn't spill / holding the filter paper in place
8	crystallisation dish	holding a solution while the water evaporates

Activity 5: Exam-style questions

1. A ✓
2. calcium + chlorine ✓→ calcium chloride ✓

   $Ca + Cl_2$ ✓ → $CaCl_2$ ✓
3.

		Level of response
Level 3	5–6 marks	Correct name of the method, all equipment named, and method
Level 2	3–4 marks	Correct name of the method or 4–5 pieces of equipment named clarity and with some detail
Level 1	1–2 marks	Incorrect name of the method, few pieces of equipment named, minimal detail.

Indicative content ✓

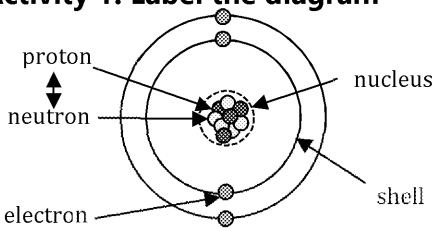
Name of method
- Simple distillation

Key equipment:
- Round-bottomed flask
- Liebig condenser

Method:
- Seawater in round-bottomed flask
- Attach Liebig condenser
- Place beaker under end of Liebig condenser
- Heat
- Water evaporates leaving
- Pure water condenses
- Pure water collects in

Atomic structure (36 / 36)

Activity 1: Label the diagram



Activity 2: Particle personals

Student answers should include the correct relative charge for each particle (see below).

subatomic particle	charge	mass
proton	+1	1
neutron	0	1
electron	-1	negligible

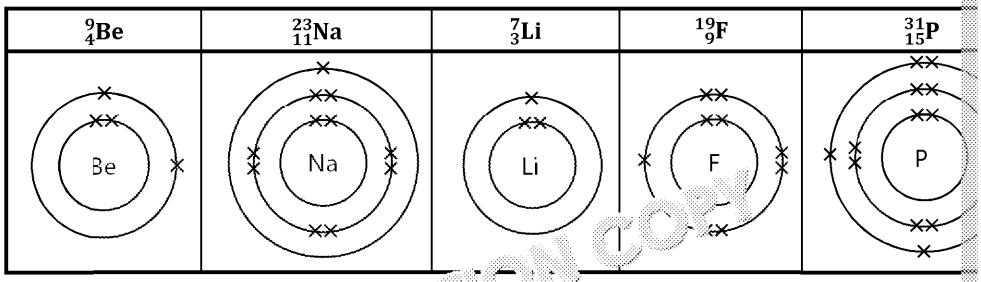
Activity 3: Atomic numbers

atom	$^{9}_{4}Be$	$^{23}_{11}Na$	$^{7}_{3}Li$	
atomic number	4	11	3	
atomic mass	9	23	7	
number of protons	4	11	3	
number of neutrons	5	12	4	
number of electrons	4	11	3	

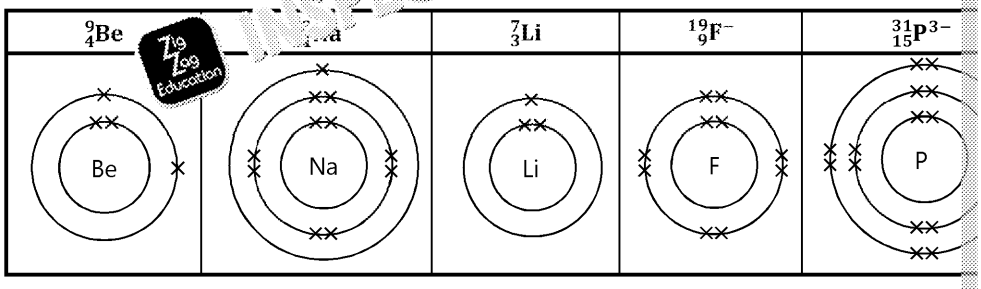
Activity 3: Atomic numbers

atom	$^{9}_{4}Be$	$^{23}_{11}Na$	$^{7}_{3}Li$	
atomic number	4	11	3	
atomic mass	9	23	7	
number of protons	4	11	3	
number of neutrons	5	12	4	
number of electrons	4	11	3	

Activity 4: Drawing electronic structures



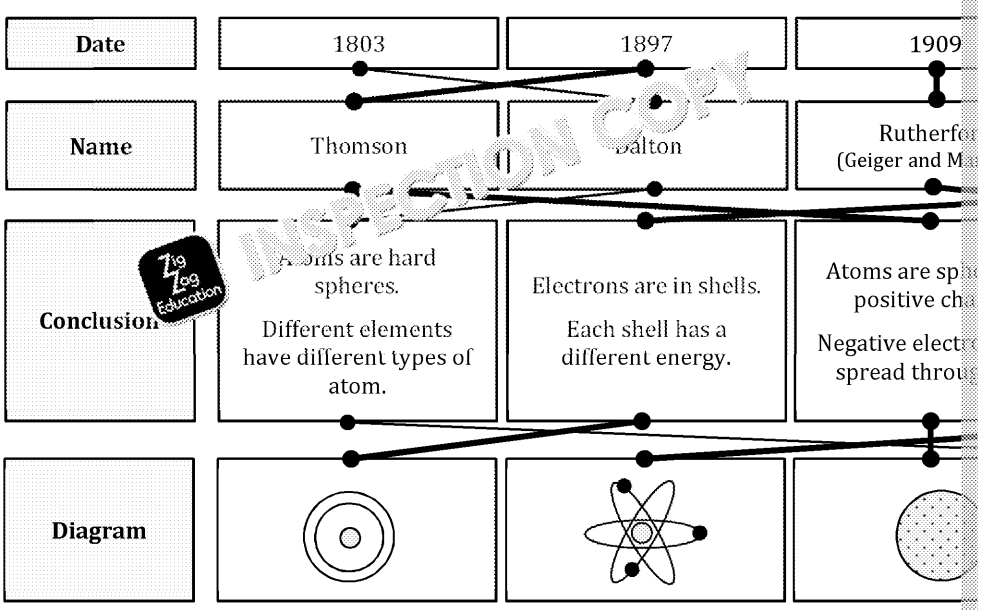
Activity 4: Drawing electronic structures



Activity 5: Ant vs atom

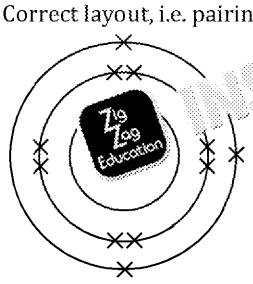
1. 1 cm = 0.01 m
2. 0.1 nm = 0.000 000 000 1 m
3. Eight orders of magnitude (100 000 000 times bigger)

Activity 6: Atomic model timeline



Activity 7: Exam-style questions

1. 6 ✓
2. 1 ✓
3. Three shells ✓
   13 electrons ✓
   Correct layout, i.e. pairing and positi



4.

		Level of response
Level 3	5–6 marks	Detailed description of the history of the atomic model includin
Level 2	3–4 marks	Description of the history of the atomic model is mostly correct
Level 1	1–2 marks	An attempt at a description of the atomic models with some co

Indicative content

Dalton:
- each element has a different type of atom
- atoms are hard spheres

Thomson:
- atoms are positive sphe[illegible] with [illegible]ons embedded in them

Rutherford:
- ato[illegible] av[illegible] [illegible]ei
- [illegible]he [illegible]ss of an atom is in the nucleus
- el[illegible] orbit the nucleus

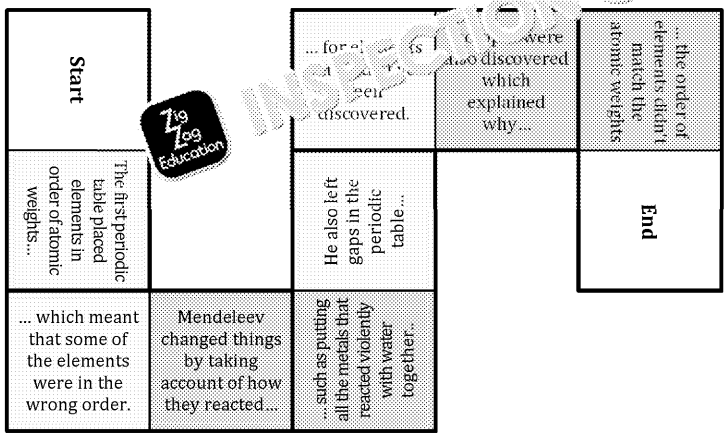
Bohr:
- electrons have different energy levels / are in shells

The periodic table (36 / 37)

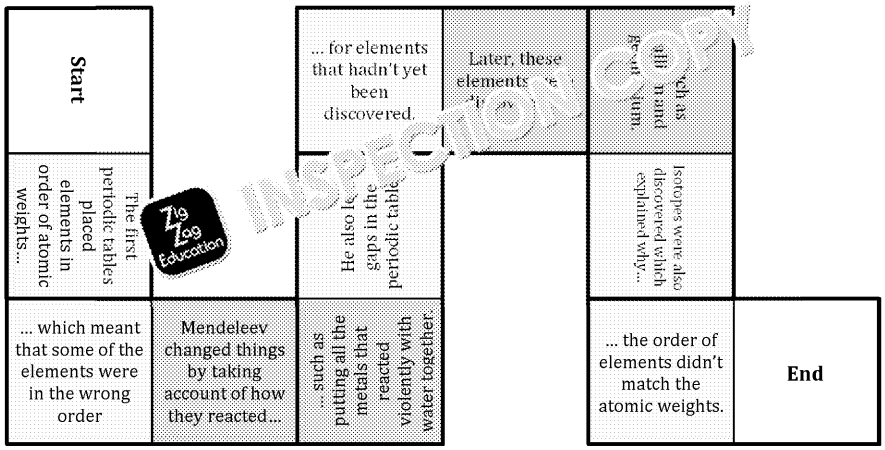
Activity 1: Periodic table quote hunt

N	O	O	Ne	N	O	Ra	N	Y
1	2	3	4	5	6	7	8	9
Th	I	N	G	Ca	N	... silence me.		
10	11	12	13	14	15			

Activity 2: Dominoes



Activity 2: Fill in the Gaps



Activity 3: Quick-fire questions

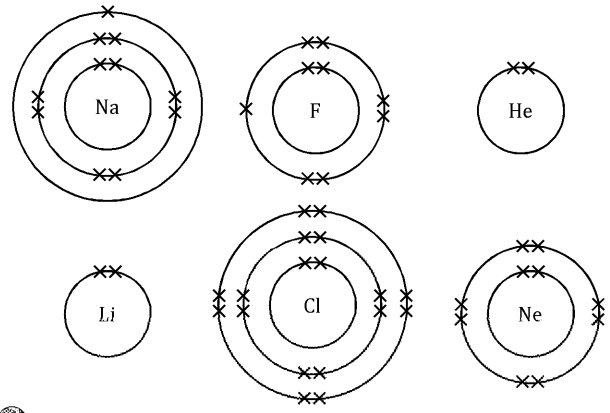
only	and			
Groups Periods	Mendeleev Proton	Protons and neutrons Protons and electrons	Positive / + Negative / –	• They are order protons / neut • Number of elec

Activity 4: Exam-style questions

1. D ✓
2. a) Neutron ✓
   b) Isotopes ✓
3. He used the reactivity of elem to p elements in groups ✓
   e.g. he put reactive met dium and potassium in the same group OR he put re
   as chlorin om ine in the same group ✓

Groups & their reactivity (32 / 33)

Activity 1: Electronic structure drawing



Activity 2: Spot the odd one out

These are suggestions. Other answers may al correct.

2. Ar – F and Cl are in group 7
3. Cl – He and Ne are in gro
4. Ar – Li and F have t
5. He – Ne ha electrons in their outer shell
6. Li^+ – He e uncharged / F – Li^+ and He have two electrons
7. Cl_2 – LiF NaBr are compounds of group 7 elements; chlorine is a group 7 element
8. Xe – Li and F have the same number of electron shells
9. Ar – K and F can form ions

Activity 2: Spot the odd one out

These are suggestions. Other answers may also be correct.

2. At – Cs and Rb are in group 1
3. Cl – He and Ne are in group 0
4. Ar – Li and F have two shells
5. He – Ne and Ar have eight electrons in their outer shell
6. C^{2-} – N^{3-} and F^- both have the same number of electrons
7. Cl_2 – LiF and NaBr are compounds of group 7 elements; chlorine is a group 7 element
8. Xe – Li and F have the same number of electron shells
9. Ar – K and F can form ions

Activity 3: Who am I?

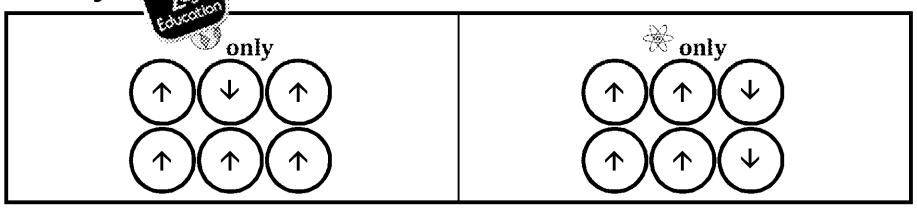
Ne
Li
Cl
He

Student's own poem should:

- include a reference to co property of the chosen elem
- be applicabl one element

Bonus if it rhymes!

Activity 4: as or decrease?



Activity 5: Exam-style questions

1. D ✓
2. a) Group 1 ✓

   b) Slower / Less vigorous ✓

   c) potassium + water → potassium hydroxide + hydrogen
   left-hand side ✓
   right-hand side ✓

b) Slower / Less vigorous ✓
Sodium is higher in the group and so is less reactive ✓

c) i) potassium + water → potassium hydroxide + hydrogen ✓
ii) $KOH + H_2$ ✓

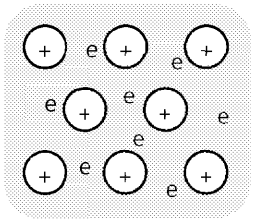
Ionic, covalent and metallic bonds (31 / 33)

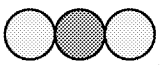
Activity 1: Predict the bonding

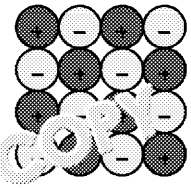
C	M	M	I	I
C	I	C	C	M

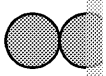
Activity 2: Codebreaker

❑ element	⌘ covalent	◎ atom	♦
❖ metal	❍ ion	✸ delocalised	



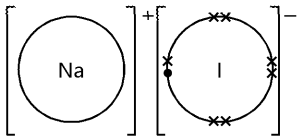


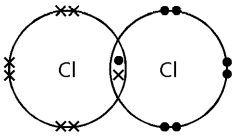


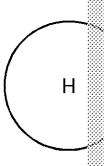


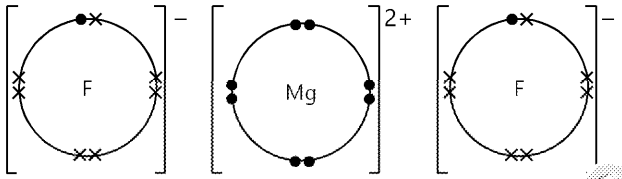
D C A

Activity 3: Dot-and-cross diagrams







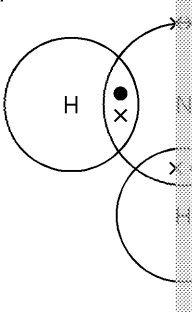


Activity 4: Exam-style questions

1. D ✓
2. Correct layout of electrons ✓
   Five crosses and three dots (or vice versa) ✓

   Correct number of atoms ✓
   Correct layout of electrons ✓
   Five crosses and three dots (or vice versa) ✓

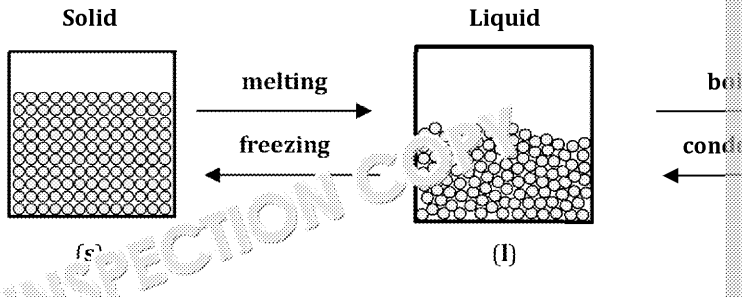
i.e.



3. Aluminium ions ✓
   Sea of delocalised electrons ✓
   Attraction between positive ions and negative electrons ✓

Properties of matter (31 / 44)

Activity 1: Add labels to the diagram



Activity 2: [illegible] descriptions

regular arra[illegible]	random / not regular	rand[illegible]
very close / touching	very close / touching	far a[illegible]
vibrate in place	move around each other	mov[illegible]

Activity 3: What substance?

a) Giant ionic
b) Metal
c) Metal
d) Simple molecular
e) [illegible]

Activity 3: Gridlock

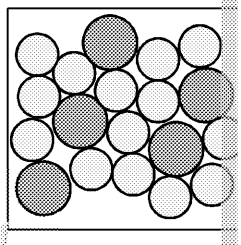
	Giant ionic	Small molecule	Polyme[illegible]
Covalent bonding	A	W	H
Ionic bonding	T	K	Q
Metallic bonding	D	W	L
Electrons are shared between atoms	Y	I	N
Sea of delocalised electrons	U	J	T
Contains ions	F	L	R
Long chains	F	F	U
Only conducts electricit[illegible] (aq)	B	S	Z
Usually soli[illegible] t[illegible]perature	S	T	T
Normally co[illegible]electricity when (s)	O	F	S
Contains intermolecular forces	E	E	I
Contains only non-metal atoms	F	S	D
Bonds can be represented using lines which represent a pair of electrons	R	A	M
Attractions between particles act in all directions	N	S	J
Bonds break when this is dissolved	?	A	D

Question: What kind of substance is diamond?
Answer: Giant covalent

Activity 4: Exam-style questions

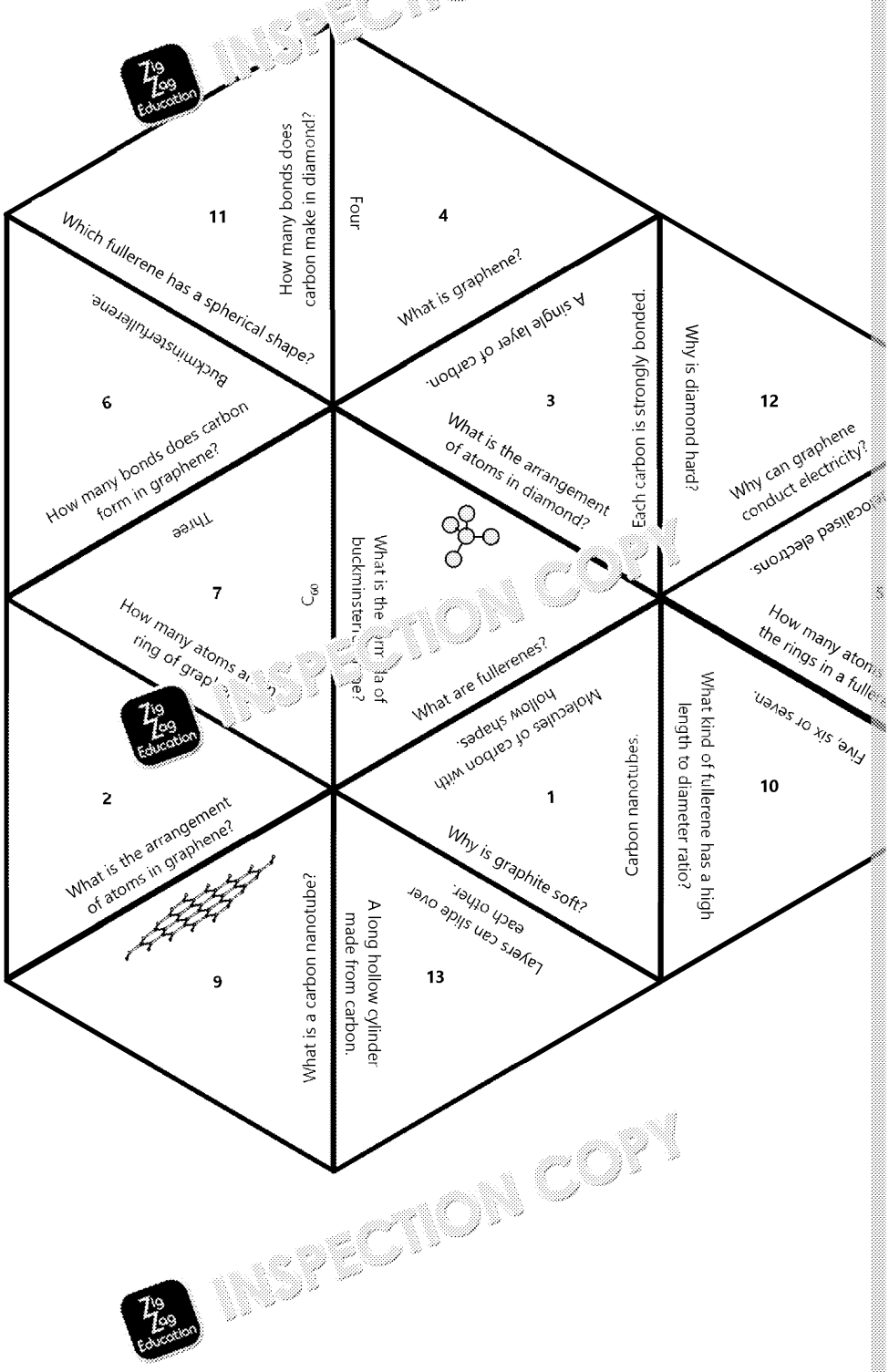
1. C ✓
2. Regularly arranged and touching ✓
   Vibrate in one position ✓
3. **Aqueous:**
   Ions are free to move ✓
   Charge can flow ✓
   Solid:
   Ions are[illegible] position ✓
   Charge c[illegible]ow ✓
4. a) Layers of ✓
      Ions can slide over each other ✓
   b) Mixture of metals ✓
      Is harder than pure metal ✓
      because layers cannot slide over each other ✓

4. a) Layers of✓
Ions can slide over each other ✓
b) Different sized ions ✓
Disrupts layer structure ✓
Layers cannot slide over each other ✓
Mixtures of metals (alloys) are harder than pure metals ✓

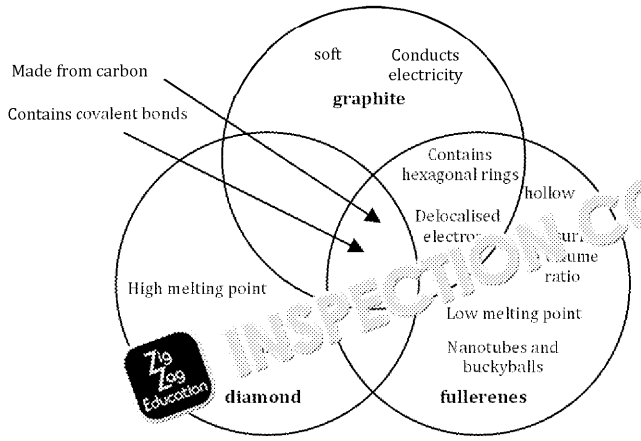


Forms of carbon (43 / 47)

Activity 1: Question tessellate **[13]**



Activity 2: Venn diagram



Activity 3: Explaining the properties

	Graphite	
Hardness	Soft	Hard
Reason	Atoms are arranged in layers Layers can slide over each other	Every atom is co Regular arrange Difficult to brea
Electrical conductivity	Conductive	Not conductive
Reason	Each atom is covalently bonded to three others Each atom has one electron which is not involved in bond ag Electrons are delocalised and can move thro h e structure, carrying charge	Each atom is bo Each atom has fo No electrons (or

Activity 4: Exam-style questi ns

1. D ✓
2. Each carb on to four others ✓
   To brea nd, many strong bonds must break ✓
3. (a) He rings ✓
   Layers ✓
   (b) Delocalised electrons between layers ✓
   Electrons can move along the structure and carry charge ✓

all one quest

Nanoparticles (23 / 27)

Activity 1: Standard form calculations

Big numbers			Sm	
1.	1450	1.45×10^3	1.	0.0045
2.	34 000	3.4×10^4	2.	0.000000345
3.	3 000 000	3×10^6	3.	0.00000000000006
4.	50 800 000	5.08×10^7	4.	0.0040003
5.	700 040 000 000	7.0004×10^{11}	5.	0.00000501003

Activity 2: If this is the answer, wha was the question?

e.g. 'Why are nanoparticles more effe g ular materials?'

e.g. 'Give an advantage and d ge to using nanoparticles.'
'Evaluate en mitations of the increased use of nanoparticles.'

Activity noparticles in deodorant

higher surface area to volume ratio
more effective at their function / reducing odour
they have a high surface area to volume ratio / not very much is needed to have a large effect
very small so can enter the body through the skin

Activity 3: Newspaper article

1. Particles between 1 nm and100 nm ✓
2. Zinc oxide and cerium oxide ✓
3. Zinc oxide increased their growth ✓
   Cerium oxide decreased their growth – killed bacteria they rely on to grow ✓
4. Fuels, fertilisers and cosmetics ✓
5. Through the roots ✓
6. Cerium oxide ✓

Activity 3: Newspaper article

1. Zinc oxide and cerium oxide ✓
2. Zinc oxide increased their growth
   Cerium oxide decreased th[illegible] killed bacteria they rely on to grow ✓
3. Fuels, fertilisers and c[illegible]cs
4. Cerium [illegible] ✓
   They w[illegible]d in the soybean plants ✓
   They are[illegible] humans ✓
5. *One positive and one negative. Answer may include:* ✓✓
   Positives:
   zinc oxide nanoparticles make the soybean plants grow bigger
   zinc oxide is not found in soybean plants so is unlikely to enter the food chain
   Negatives:
   zinc oxide nanoparticles in the soil might affect other plants / animals
   zinc oxide nanoparticles could enter humans through other routes (water, etc.)

Activity 4: Exam-style questions

1. D ✓
2. High surface area to volume ratio ✓
   More area for reactants to bind / less material is required ✓
3. a) More effective / kills more bacteria ✓
   b) Could enter the body and cause damage / could damage the environment ✓
   c) : 5×10^9 : Seven

Mass changes in reactions (35 / [illegible])

Activity 1: Balance chemical equations

1. $H_2 + Br_2 \rightarrow 2HBr$
2. $Na_2O + H_2O \rightarrow 2NaOH$
3. $Mg(OH)_2 + 2HCl \rightarrow$ [illegible]
4. $CaCO_3 + 2$[illegible] $\rightarrow$ [illegible]$_2CO_3$
5. $CaCO_3 \rightarrow$ [illegible]$a_2 + CO_2 + H_2O$
6. $Cl_2 + 2Na \rightarrow 2$[illegible]
7. $MgBr_2 + 2K \rightarrow$ [illegible]
8. $N_2 + 3H_2 \rightarrow 2N$[illegible]
9. $Br_2 + 2KI \rightarrow 2K$[illegible]

Activity 2: Graph interpretation

1. Measuring cylinder (or burette/pipette)
2. 0.45 g
3. 17 s
4. 0.56 g
5. Because gas is [illegible]
6. No mass chang[illegible]
7. At the beginni[illegible]
   Steepest slope [illegible]

Activity 3: Design the experiment

Answer may include:

Equipment
- Bunsen burner to burn the copper
- tongs to hold the copper
- balance

Measure the change in mass
- balance
- before and aft[illegible]

Safety precautions
- goggles
- tie back long hair
- safety flame on when not in use
- use tongs
- allow copper t[illegible]

Variables
- independent variable: [illegible] copper
- dependent [illegible]iab[illegible]n mass
- control [illegible]s: [illegible]t of flame (blue flame vs safety flame), heating time, mass of coppe[illegible]

Prediction

C B A D

lowest surface area → highest surface area

Largest change in mass according to student's hypothesis is D as it has the largest surface area

Activity 4: Exam-style questions

1. B ✓
2. a) Gas ✓
   b) Gas is produced / CO_2 leaves the flask ✓
   Mass of those atoms is no longer measured ✓
   c) $2HCl(aq) + MgCO_3(s) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$ ✓

Activity 4: Exam-style questions

1. B ✓
2. a) Decrease ✓
   b) Gas is produced ✓
   Mass of those atoms is no long[illegible] ✓
   c) $2HCl(aq) + MgCO_3(s) \rightarrow [illegible]_2(aq) + H_2O(l) + CO_2(g)$ ✓

Quantitative chemistry (FT material only) (29 / 2

Activity 1: [illegible]ve formula mass calculations

1. a) $14 + (16 \times 2) = 46$
   b) $(2 \times 56) + (3 \times 16) = 160$
   c) $63.5 + 2 \times (14 + 3 \times 16) = 187.5$
2. 0.2 g/dm³
3. 12.8 g/dm³
4. 5 / 0.2 = 25 g/
5. 4.0 – 2.4 = 1.6

Activity 2: Percentage yield calculations

1. % yield $= \frac{4.5}{5.0} \times 100 = 90\ \%$
2. % yield $= \frac{4.2}{8.4} \times 100 = 50\ \%$
3. mass $= \frac{3.6 \times}{10}$ = 2.7
4. mass $= \frac{68}{40}$ = 170

Activity 3: Atom economy calculations

1. $\frac{101}{119} \times 100 = 85\ \%$
2. 100 %
3. $\frac{159.5}{177.5} \times 100 = 90\ \%$
4. $\frac{224}{356} \times 100 = 63$
5. 100 %

Activity 4: True or false?

False – The theoretical yield and the act[illegible]ld will both be lower but the percentage stays
False – **Percentage yield** will **inc[illegible]se** if [illegible] starting material is used to make the same am
True – Atom economy m[illegible] many atoms are used to make useful products, and all
False – Side re[illegible] the percentage yield, because they lower the actual yield.
False – Per[illegible]vie[illegible]s completely different from atom economy.
True – High[illegible]conomy is better for companies because the reactions form fewer unwan
to dis[illegible] of or could cause pollution.
True – This reaction will have a lower actual yield so the percentage yield will be lower.
True – Having a large amount of product increases the actual yield so the percentage yield is
False – Atom economy measures atoms in an equation, not actual mass.

Activity 5: Exam-style questions

1. A ✓
2. a) Mass of desired products = 80 ✓
   Mass of all products = 80 + 143.5 = 223.5 ✓
   % atom economy $= \frac{80}{223.5} \times 100 = 35.8\ \%$ ✓
   b) Higher atom economy / 100 % atom economy ✓

Moles and concentrations (HT material) (48 / 49)

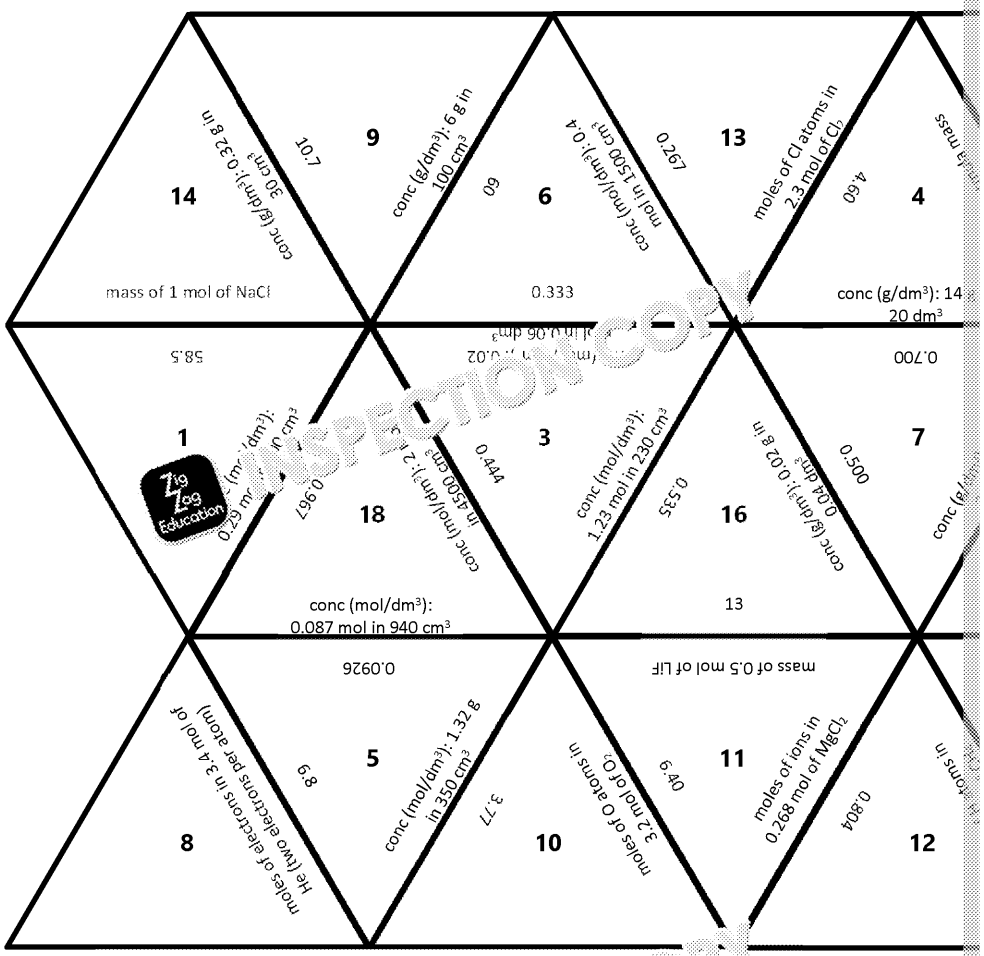
Activity 1: Mole calculations

1. a) $14 + (16 \times 2) = 46$
   b) $(2 \times 56) + (3 \times 16) = 160$
   c) $63.5 + 2 \times (14 + 3 \times 16) = 187.5$
2. a) $24 \div 12 = 2$ mol
   b) $85 \div 42.5 = 2$ mol
   c) $72 \div 18 = 4$ mol
3. a) $3 \times 48 = 14$
   b) $0.5 \times 64 =$
   c) $0.2 \times 71 =$

Activity 2: Predicting mass changes

Mass of $CaCO_3$	2.3 g
Relative formula mass of $CaCO_3$	100
Moles of $CaCO_3$	$\frac{2.3}{100} = 0.023$ mol
Moles of CO_2	1:1 ratio, so 0.023 mol
Relative formula mass of CO_2	44
Mass of CO_2	$44 \times 0.023 = 1.01$ g
Mass of Mg	0.63 g
Relative formula mass of Mg	24
Moles of Mg	$\frac{0.63}{24} = 0.02625$ mol
Moles of H_2	1:1 ratio, so 0.02625 mol
Relative formula mass of H_2	2
Mass of H_2	$2 \times 0.02625 = 0.05$ g
Mass of H_2O_2	4.2 g
Relative formula mass of H_2O_2	34
Moles of H_2O_2	$\frac{4.2}{34} = 0.1235$ mol
Moles of O_2	2:1 ratio, so $\frac{0.1235}{2} = 0.06176$ mol
Relative formula mass of O_2	32
Mass of O_2	$32 \times 0.06176 = 1.98$ g

Activity 3: Question tessellate [18]



Activity 4: Exam-style questions

1. C ✓
2. a) (✱ **only** Relative formula mass of $CuSO_4 = 63.5 + 32 + 16 \times 4 = 159.5$ ✓)
   Moles of $CuSO_4 = 0.05016$ ✓
   Moles of CuO = 0.05016
   Relative formula mass of CuO = 63.5 + 16 = 79.5 ✓
   Mass of CuO = $0.05016 \times 79.5 = 3.99$ g ✓
   b) Sulfuric acid ✓
   Because it all reacts / copper oxide is left over ✓

Percentage yield and atom economy (HT material) (

Activity 1: Equation practice

1. % yield $= \frac{4.5}{5.0} \times 100$
   $= 90\ \%$

2. % yield $= \frac{4.2}{8.4} \times 100$
   $= 50\ \%$

3. mass =

4. mass =

Activity 2: Percentage yield calculations

1. relative formula mass of HNO_3 [illegible]
   moles of HNO_3 $\frac{2}{63} = 0.0365$
   theoretical moles of [illegible] 1:1, so 0.0365
   theoretical [illegible] $0.0365 \times 101 = 3.69$ g
   percentage [illegible] of KNO_3 $\frac{2.5}{3.69} \times 100 = 68\ \%$

2. relative formula mass of C_2H_4 28
   moles of C_2H_4 $\frac{1.45}{28} = 0.0518$
   theoretical moles of C_2H_5Cl 1:1, so 0.0518
   theoretical mass of C_2H_5Cl $0.0518 \times 64.5 = 3.34$ g
   percentage yield of C_2H_5Cl $\frac{1.87}{3.34} \times 100 = 56\ \%$

3. relative formula mass of CuO 79.5
   moles of CuO $\frac{2.3}{79.5} = 0.0289$
   theoretical moles of $CuSO_4$ 1:1, so 0.0289
   theoretical mass of $CuSO_4$ $0.0289 \times 159.5 = 4.61$ g
   actual mass of $CuSO_4$ $= \frac{percentage\ yield \times theoretical\ yield}{100}$
   $= \frac{76 \times 4.61}{100}$
   $= 3.5$ g

4. relative formula mass of Fe_2O_3 160
   moles of Fe_2O_3 0.213
   theoretical moles of Fe 2:4 ratio = 1:2 ratio [illegible] $\times 2 = 0.425$
   theoretical mass of Fe $0.425 \times 56 = 23.8$ g
   percentage yield of Fe $\frac{12}{[illegible]} \times [illegible]\ \%$

only

5. relative [illegible] mass of SO_3 80
   actual [illegible] of SO_3 4.9 g
   theoretical [illegible] of SO_3 $= \frac{actual\ yield}{percentage\ yield} \times 100$
   $= \frac{4.9}{56} \times 100$
   $= 8.75$
   theoretical moles of SO_3 $\frac{8.75}{80} = 0.109$
   moles of O_2 2:1 ratio, so $0.109 \div 2 = 0.0547$
   mass of O_2 $0.0547 \times 32 = 1.75$ g

only

5. relative formula mass of $Cu_3(PO_4)_2$ 380.5
   actual mass of $Cu_3(PO_4)_2$ 4.9 g
   theoretical mass of $Cu_3(PO_4)_2$ $= \frac{actual\ yield}{percentage\ yield} \times 100$
   $= \frac{4.9}{56} \times 100$
   $= 8.75$
   theoretical moles of $Cu_3(PO_4)$ $\frac{8.75}{380.5} = 0.0230$
   moles of Cu 3:1 ratio, so [illegible] 0.0690
   mass of Cu $0.0690 \times 63.5 = 4.4$ g

Activity 3: Atom economy calculations

1. $\frac{101}{119} \times 100 = 85\ \%$
2. 100 %
3. $\frac{159.5}{177.5} \times 100 = [illegible]\ \%$
4. $\frac{224}{356} \times 100 = 63$ [illegible]
5. $\frac{380.5}{386.5} \times 100 = 98$ [illegible]

Activity 4: True or false?

False – The theoretical yield and the actual yield will both be lower but the percentage stays
False – **Percentage yield** will **increase** if less starting material is used to make the same am
True – Atom economy measures how many atoms are used to make useful products, and all
False – Side reactions decrease the percentage yield, because they lower the actual yield.
False – Percentage yield is completely different from atom economy.
True – High atom economy is better for companies because the reactions form fewer unwan
to dispose of or could cause pollution.
True – This reaction will have a lower actual yield so the percent eld will be lower.
True – Having a large amount of product increases the ac so he percentage yield is
False – Atom economy measures atoms in an equati n, ot mass.

Activity 5: Exam-style questi

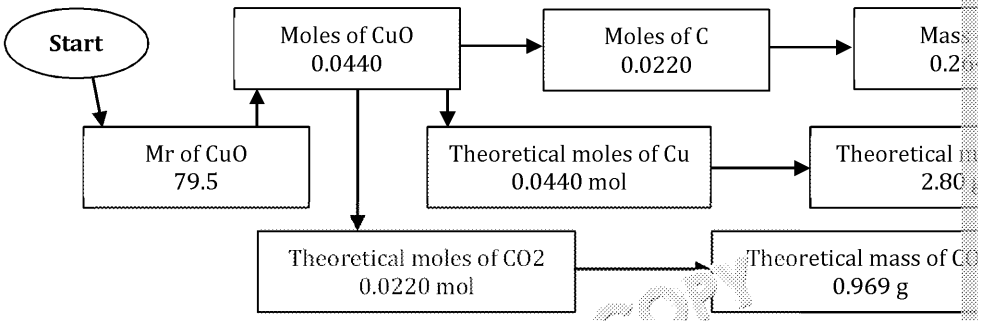
1. A ✓
2. a) Mass cles cts = 80 ✓
   M pr ucts = 80 + 143.5 = 223.5 ✓
   % onomy = $\frac{80}{223.5} \times 100 = 35.8\ \%$ ✓
   b) Higher atom economy / 100 % atom economy ✓
   c) moles of $NH_4Cl = \frac{5.0}{53.5} = 0.09346$ ✓
   theoretical moles of $NH_4NO_3 = 0.09346$
   theoretical mass of $NH_4NO_3 = 0.09346 \times 80 = 7.477$ ✓
   percentage yield of $NH_4NO_3 = \frac{4.9}{7.477} \times 100 = 65.5\ \%$ ✓

Moles in volumes of solutions and gases (44/ 44)

Activity 1: Match-up

Word	Avogadro's number	molar gas volume	room tempe
Definition	the assumed pressure of a room	the assumed temperature of room	the number of in a mo
Value		6.02 × 1023	100
Unit	kPa	dm^3	°C

Activity 2: Calculation path



Activity 3: Conversion tower

12 dm^3
0.125 mol gas
0.25 mol/dm^3
0.05 mol
2 dm^3
0.5 dm^3 0.2 mol/dm^3
0.1 mol 250 cm^3

Activity 4: Reacting mass calculations

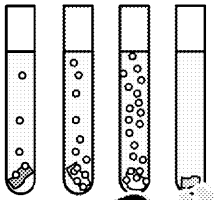
1. relative formula mass of $MgCO_3$ = 24 + 12 + (3 × 16) = 84
   mol $MgCO_3$ = 0.84 ÷ 84 = 0.01 mol
   mol CO_2 = 0.01 (1:1 ratio)
   vol CO_2 = 0.01 × 24 = 0.024 dm^3
2. relative formula mas
   mol CuO = 1.59 ÷ 79.
   mol H_2SO_4 = 0.02 mo
   conc H_2SO_4 = 0.02 ÷ 0.
3. relative formula mass of NaCl = 23 + 35.5 = 58.5
   mol NaCl = 2.34 ÷ 58.5 = 0.04 mol
   mol Cl_2 = 0.04 ÷ 2 = 0.02 mol (2:1 ratio)
   vol Cl_2 = 0.02 × 24 = 0.48 dm^3
4. relative formula mas
   mol AgCl = 7.175 ÷ 1
   mol KCl = 0.05 mol
   conc KCl = 0.05 ÷ 0.5

Activity 5: Exam-style questio

1. a) D ✓
   b) 1:1 ra so
   v CO = 0.05 × 24 ✓
   = 1.2 dm^3 ✓
   c) relative formula mass of $MgCO_3$ = 84 ✓
   mass of $MgCO_3$ = 84 × 0.05 ✓
   = 4.2 g ✓
   c) 1:2 ratio, so moles HCl = 2 × 0.05 = 0.1 mol ✓
   relative formula mass of HCl = 36.5 ✓
   mass of HCl = 36.5 × 0.1 = 3.65 g ✓

Reactivity series (🌍 25 / ⚛ 30)

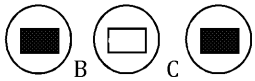
Activity 1: Observations

1. Calcium
2. calcium + water → calcium hydroxide + hydrogen
   Ca + H_2O → $Ca(OH)_2$ + H_2
3. 
   Fe Z
4. Concen acid, mass of metal, temperature, surface area of metal (accept other va

Activity 2: This or that?

This	That	This
Potassium is more reactive than sodium	Sodium is more reactive than potassium	**This – pota series**
Potassium oxide is K_2O because it is made from K^+ and O^{2-}	Potassium oxide is K_2O because it is made from K^{2+} and O^-	**This – $2K^+$ charge on**
Oxidation means gaining oxygen	Oxidation means losing oxygen	**This – oxid**
lithium oxide + calcium → calcium oxide + lithium	lithium + calcium oxide → calcium + lithium oxide	**That – lith so will disp**
lithium + water → lithium hydroxide + oxygen	lithium + water → lithium hydroxide + hydrog	**That – gro form a me**
Aluminium is more reactive than lead because aluminium forms positive ions less easily	Aluminium is more reactive than le aluminium forms ions more easily	**That – alu easily and**
⚛ Mg + 2HCl → MgCl + H	Mg + 2HCl → MgH_2 + Cl_2	**This – met chloride a**
⚛ Pota higher in the reactivity serie thium because it loses electrons more easily	Potassium is higher in the reactivity series than lithium because it loses electrons less easily	**This – pota positive io**
⚛ Pb + $ZnBr_2$ → $PbBr_2$ + Zn	Zn + $PbBr_2$ → $ZnBr_2$ + Pb	**That – zinc displace le**

Activity 3: Reactivity experiment

1. A  B C
2. D iron nitrate + magnesium → magnesium nitrate + iron
   E zinc nitrate + copper → no reaction
3. No reaction will occur
4. Iron is less reactive than zinc
5.

	zinc	magnesium	copper	iron
zinc nitrate		✓	×	×
magnesium nitrate			×	×
copper nitrate	✓	✓		✓
iron nitrate	✓	✓	×	

Activity 4: Exam-style question

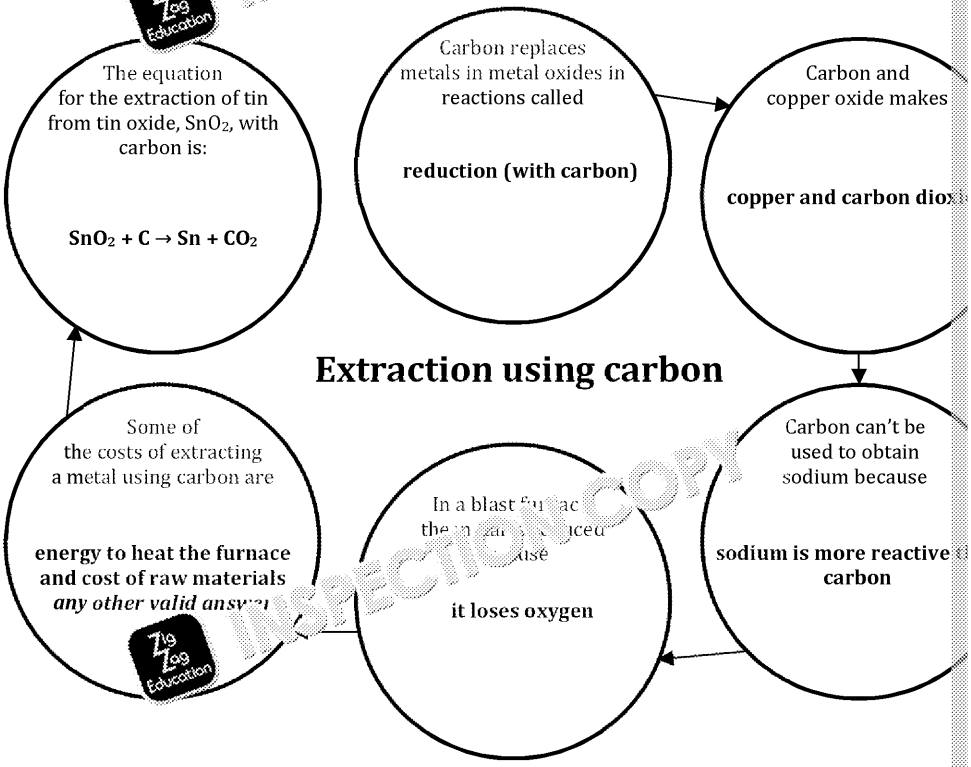
1. a) Whether the reaction occurred ✓
   b) Correct order: ✓
   zinc
   iron
   copper
   Iron is more reactive than copper and zinc is more reactive than iron and copper ✓
   c) i) Yes: zinc is more reactive than hydrogen OR zinc will displace anything iron c
   only
   ii) Cannot tell if copper is more reactive than hydrogen ✓

Extracting metals (34 / 36)

Activity 1: Decode the letters

A reactive metal	An unreactive metal	An element which is slightly reactive	A no
CALCIUM	SILVER	ZINC	

Activity 2:



Activity 3(a): Formula practice

sodium chloride	sodium oxide	magnesium fluoride	lithium hydroxide	calcium hydroxide	aluminium nitrate	alu
NaCl	Na_2O	MgF_2	LiOH	$Ca(OH)_2$	$Al(NO_3)_3$	

Activity 3b: Complete the gaps

	Oxidised	Reduc
$2CuO + ...C \rightarrow .....CO_2 + 2Cu$	C	Cu
$2Fe_2O_3 + 3C \rightarrow 3CO_2 + 4Fe$	C	Fe
$2PbO + C \rightarrow CO_2 + 2Pb$	C	Pb
$.....C + ... \rightarrow .....$	C	O
$4Fe + ... \rightarrow ...Fe_2O_3$	Fe	O
$Mg + CuSO... \rightarrow ...MgSO_4 + Cu$	Mg	Cu
$2Na + ...Cl_2 \rightarrow 2NaCl$	Na	Cl

Activity 4: Exam-style questions

1. B ✓
2. a) : C, : carbon ✓
   b) Magnesium is more reactive than carbon ✓
   Carbon will not displace magnesium ✓
   c) MgO ✓
3. a) $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$
   Left-hand side ✓
   Right-hand side ✓
   b) carbon ✓
   b) $Fe^{3+} + 3e^- \rightarrow Fe$
   Species ✓
   Balancing ✓
   c) Reduced – gains electrons

Reactions of acids ... producing salts (51 / 56)

Activity 1: ... formulae

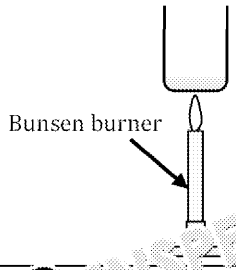
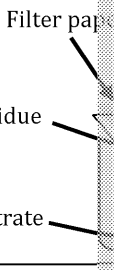
M...
Cl^-
NO_3^-
$FeCl_2$
$PbSO_4$
$NaNO_3$
NH_4Cl
KNO_3
CaO

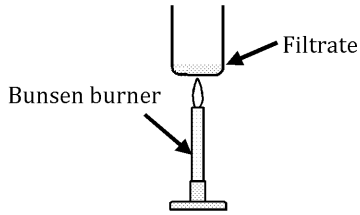
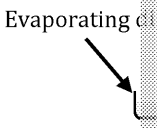
Activity 2: Classify

Acids	Alkalis
HNO_3 HCl H_2SO_4	LiOH NaO... ...

Carbonates	Alkalis
CaCO $MgCO_3$ Na_2CO_3	Fe_2O_3 Al_2O_3 MgO K_2O FeO

Activity 3: Storyboard [8] dedu

Step 1	
	
Heat sc te acid using a **Bunsen burner**. Add copper sulfuric acid until **the copper oxide stops reacting/dissolving**.	Filter the copper

Step 3	
	
Evaporate the solution using a **Bunsen burner** until **crystals** begin to form.	Leave the remaining solut **dish** until all

Activity 4: Neutralisation Sudoku

base/metal / acid	Fe	$CaCO_3$	ZnO
HCl	$FeCl_2 + H_2$	$CaCl_2 + CO_2 + H_2O$	$ZnCl_2 +$
HNO	$Fe(NO_3)_2 + H_2$	$Ca(NO_3)_2 + CO_2 + H_2O$	$Zn(NO_3)_2$
H_2SO_4	$FeSO_4 + H_2$	$CaSO_4 + CO_2 + H_2O$	$ZnSO_4 +$

Activity 5: Exam-style questions

1. D ✓
2. nitric acid ✓
3.

		Level of response
Level 3	5–6 marks	All equipment named, and method described clearly with full d
Level 2	3–4 marks	Two or three pieces of equipment named, and method described v
Level 1	1–2 marks	Few pieces of equipment named, and method described unclea

Indicative content:

- Gently warm acid in a beaker using a Bunsen burner
- Add magnesium hydroxide slowly using a spatula
- Stir with a glass rod
- Keep adding until no more magnesium hydrox acid dissolves
- Cool and filter excess magnesium hydro
- Heat magnesium nitrate solutio ra over a Bunsen burner until crystals begi
- Leave solution to evapo rem ng water

pH scale, itr & strong and weak acids (33 /

Activity 1: act file

1–3. Students may include some of the following points in their descriptions:

- Have H^+ ions
- Contain a negative ion
- Can react with bases/alkalis, carbonates and oxides to form salts
- Have a low pH / a pH less than 7
- Are red in universal indicator

only

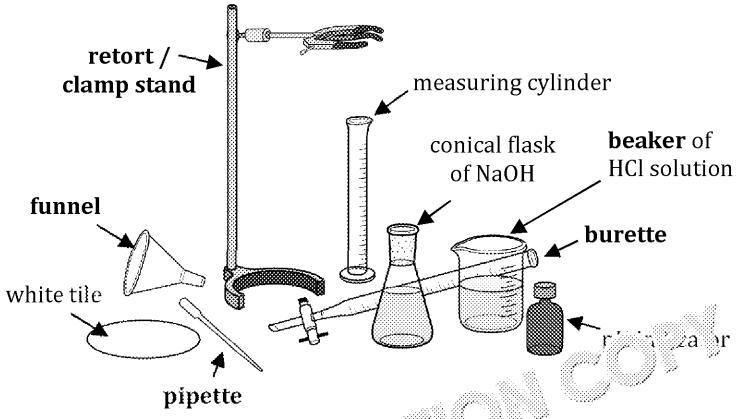
4. Strong acids ionise/dissociate more in a solution
   Higher concentration of H^+ ions (for the same concentration of acid)
5. Ten times lower concentration of H^+ ions
   pH is higher by 1
   New pH is 5

Activity 2: Indicators Ltd.

Label should include:

- Universal indicator changes colour depending on the pH of a solution
- Goes red/orange in acid
- Goes purple/blue in alkali
- Goes green for neutral
- pH related to concentration of H^+ ions
- pH scale (0-14) goes from 1 to 14
- Acids are low pH
- Alkalis are high pH

Activity 3: Titration



Step 1 – preparing the flask add an indicator to the NaOH solution so that you can see the pH change	**Step 3 – adding the acid** drip HCl carefully into the flask of NaOH and until the indicator changes
Step 2 – filling the burette Close the tap on the burette add HCl to the burette using a funnel to the 0.00 cm^3 mark	**Step 4 – taking a reading** the reading is taken from the bottom of the meniscus (this burette reads 19.85 c

Activity 4: Titration results

1 & 2

	2	3	4
Start reading (cm^3)	0.10	23.65	0.00	22.85
End reading (cm^3)	23.65	46.45	22.85	45.75
Volume of HCl (cm^3)	23.55	(22.80)	(22.85)	(22.90)

3. $\frac{22.80 + 22.85 + 22.90}{3} = 22.85\ cm^3$

only

4. volume of HCl — 22.85 cm^3 = 0.02285 dm^3
   moles of HCl — 0.02285 × 0.1 = 0.002285 mol
5. moles of NaOH — 1:1 ratio, so 0.002285 mol
6. concentration of NaOH — $\frac{0.002285}{0.05}$ = 0.0457 mol/dm^3

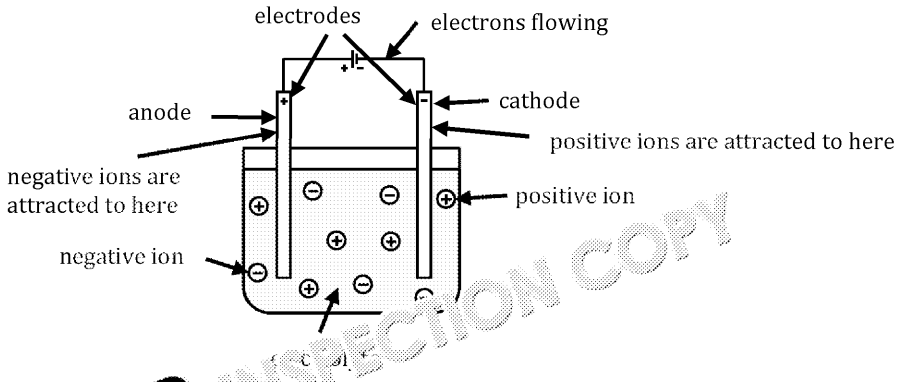
4./7. Uncertainty = $\frac{22.90 - 22.80}{2}$ = 0.05 cm^3

Activity 5: Exam-style question

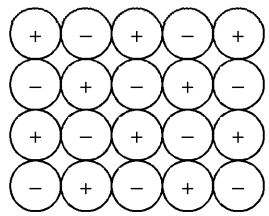
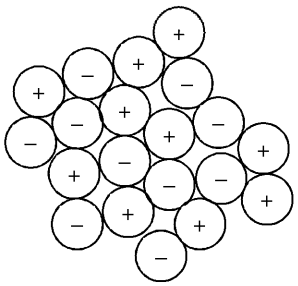
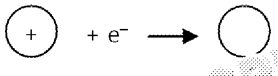
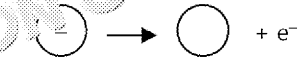
1. a) A ✓
   b) green ✓
   c) i) $\frac{14.70 + 14.65}{2}$ = 6[illegible]
   ii) [illegible]s of nitric acid: $\frac{14.68}{1000} \times 0.2 = 0.002936$ mol ✓
   moles of potassium hydroxide: 0.002936 mol ✓ (since 1:1 ratio of potassium
   concentration of KOH: 0.002936 ÷ $\frac{100}{1000}$ = 0.0294 mol/dm^3 ✓
   iii) An acid that ionises completely ✓

Electrolysis (46 / 50)

Activity 1: Labelling



Activity 2: [illegible]lise it

		
When an ionic compound is solid, the ions are in a regular arrangement of positive and negative ions. The ions cannot move.	When melted to form a liquid (or dissolved to form a liquid), the giant structure breaks down and the ions can flow past e[illegible]ther.	Du[illegible] in t[illegible] to [illegible] ions [illegible]
		
The positive [illegible]s gain electrons to form atoms or molecules that are neutral (have no charge).	The negative ions lose electrons to form atoms or molecules that are neutral (have no charge).	Ove[illegible] lead[illegible] ele[illegible]

[1] for each diagram, [1] [illegible]

Activity 3: Product predictor

	$ZnCl_2$ (l)	$PbBr_2$ (l)	NaCl (l)	
Positive electrode	Cl_2	Br_2	Cl_2	
Negative electrode	Zn	Pb	Na	

	NaCl (aq)	KBr (aq)	$CuCl_2$ (aq)	NaOH (aq)
Positive electrode	Cl_2	Br_2	Cl_2	O_2
Negative electrode	H_2	H_2	Cu	H_2

Activity 3a: Product prediction

	$ZnCl_2$ (aq)	$PbBr_2$ (l)	$CuCl_2$ (aq)	Al_2O_3 (l)	NaOH (aq)	$NaNO_3$ (aq)	Ag_3N (l)
Anode	Cl_2	Br_2	Cl_2	O_2	O_2	O_2	N_2
Cathode	Zn	H_2	Pb	Cu	Al	H_2	Ag

Activity 3b: Half-equations

$PbBr_2$	$Pb^{2+} + 2\ e^- \rightarrow Pb$ $2\ Br^- \rightarrow Br_2 + 2\ e^-$
Na_2S	$Na^+ + e^- \rightarrow Na$ $S^{2-} \rightarrow S + 2\ e^-$
K_3N	$K^+ + e^- \rightarrow K$ $2\ N^{3-} \rightarrow N_2 + 6\ e^-$

Activity 4: Tour around an aluminium plant

Question	Answer ma
Why does the aluminium have to be heated?	• So that ions are mobile • ... can move past each other
What's the cryolite being put in for?	• Forms a mixture with the aluminium • Makes the melting point lower • Less energy required to melt the al
What are the products? Where do they go?	• Aluminium – out the bottom • Oxygen – reacts with the electrode
What are those electrodes made of?	• Graphite (carbon)

Question	Answer ma
Why do the electrodes look worn away? Do they need replacing?	• They react with oxygen • Forming carbon dioxide • They regularly need replacing
Why are there so many power lines outside the factory?	• Aluminium extraction requires a lo • Energy for heating to high tempera • Energy required for electrolysis to

Activity 5: Exam-style questions

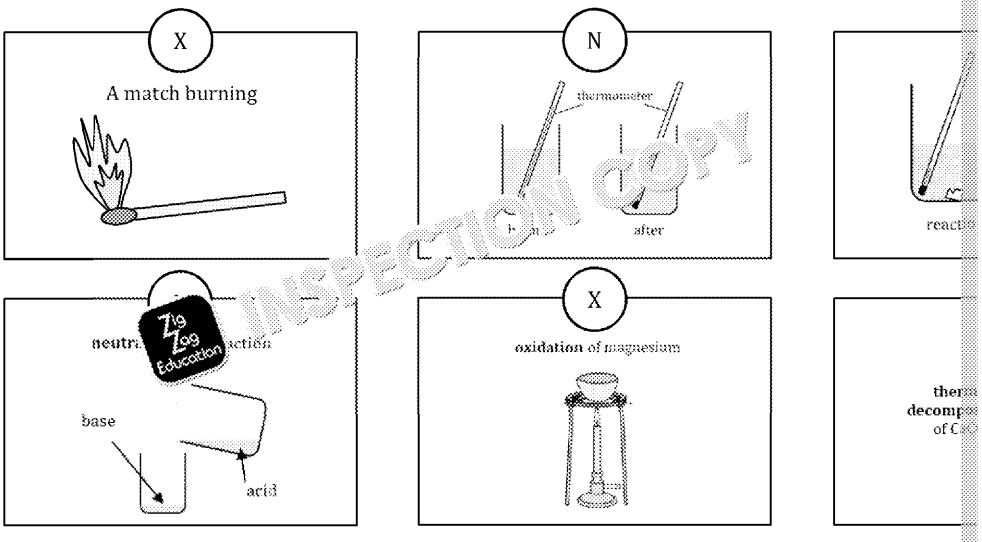
1. C ✓
2. a) $ZnCl_2 \rightarrow Zn$ ✓ + Cl_2 ✓
   b) Cl^- ✓
3. a) Oxygen/O_2 ✓
   b) Graphite/carbon ✓
   c) Cryolite ✓

1. C ✓
2. a) Zn... + Cl_2 ✓
   b) Zn^{2+}... ✓ + $2e^-$ ✓
3. a) To dissolve the aluminium ✓
   at a lower temperature than aluminium's melting point ✓
   b) Graphite/carbon ✓
   It is unreactive ✓

Exothermic and endothermic reactions (38 / 41)

Activity 1: Endo or exo?

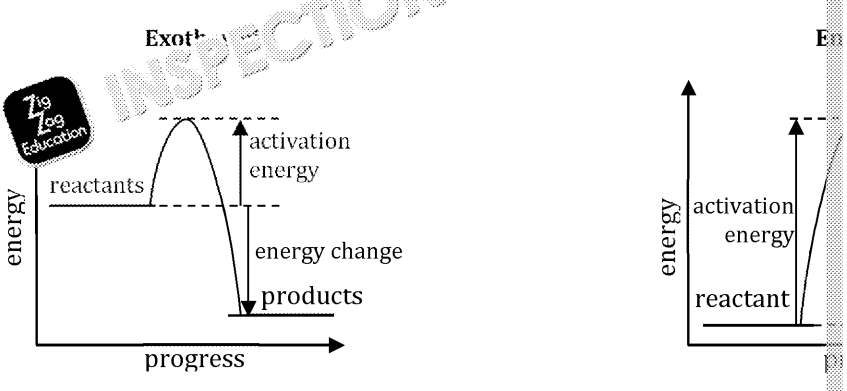
[1] per corre



Activity 2: Uses of exothermic and endothermic reactions

Hand warmer	Self-
• These packs are useful for **warming up hands, e.g. during sports**. • When the button is clicked inside the hand warmer, a **chemical reaction** begins. • This reaction is **exothermic**. • You can tell because **the pack/hand heats up**. • I would also use the same technology for, **e.g. heating up food** *or any other answer which involves a heating process.*	• These packs are • When the bag is • This reaction is • You can tell bec • I would also use **down drinks** *or cooling process.*

Activity 3: Reaction profiles



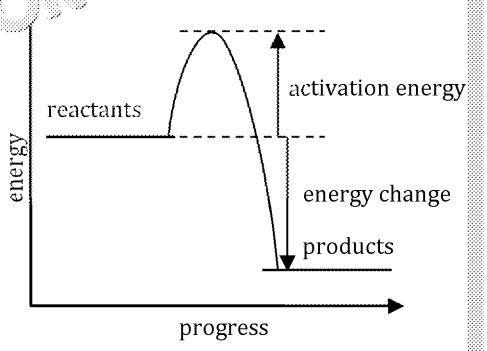
Activity 4: Codebreaker

❑ bond	◎ break
❖ exo	✸ thermic
⌘ form	♦ temperature
❍ endo	

Activity 5: Exam-style questions

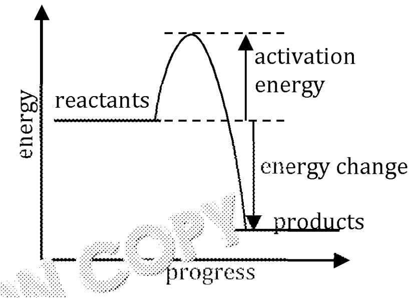
1 Thermal decomposition ✓

2. Activation energy ✓
   Energy change ✓



Activity 5: Exam-style questions

1. Thermal decomposition ✓
2. Reactants and products ✓
   Correct curve ✓
   Activation energy ✓
   Energy change ✓
   i.e.



Energy changes ([illegible] / [illegible]33)

Activity 1: Practical design

Equipment
Beaker, thermometer, measuring cylinder, balance

Prediction
Prediction should relate the mass of zinc to the temperature ***change****, e.g. a higher mass will lead [illegible] will make the temperature increase more.*

Variables
Independent variable: mass of zinc
Dependent variable: temperature change
Control variables: concentration of acid, insulation of beaker, volume of acid, shape of piece of [illegible]

Safety precautions
Goggles, care when handling acid, add zinc slowly, tie back long hair, etc.

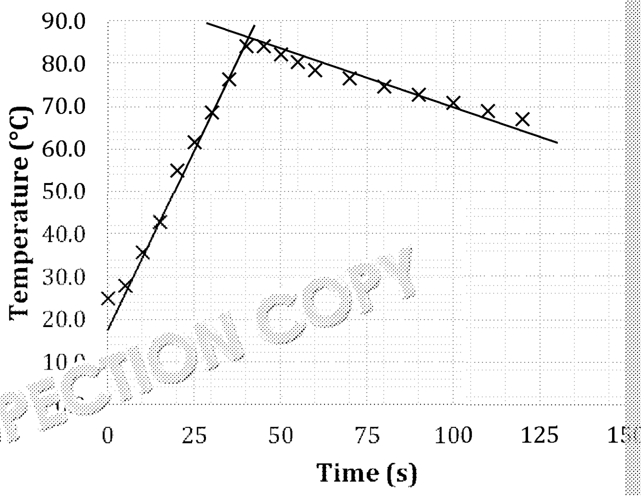
Method
- measure the temperature change at the start
- add known mass of zinc
- record highest temperature
- repeat with different masses of zinc

Results

Temperature (°C)		
Start	End	Change
35.5	36.9	[illegible]

Activity 2: Graph-drawing

3. Correctly plotted points
   Two lines of best fit
   Cross at 84–86 °C
   Temperature rise = ~60 °C



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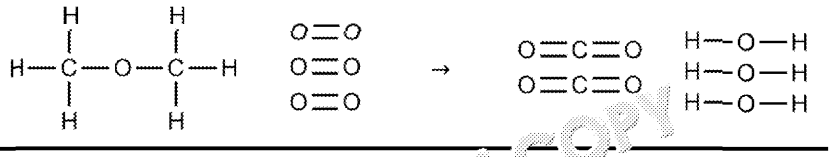
Activity 3: Bond energy calculations

1.



2.

Left-hand side	Right-hand side
2 × C–O 6 3	6 × O–H

3. 2 × (358) + 6 × (413) + 3 × (498)
= 4688

4. 4 × (799) + 6 × (463)
= 5974

5. 4688 – 5974
= -1286 kJ / mol

Activity 3: Exam-style questions

1. a) Exothermic ✓
b) 12.7 ✓
2. a) Less heat is lost during the reaction ✓
b) Start temperature / minimum temperature ✓

Activity 4: Exam-style questions

1. a) Exothermic – all neutralisation reactions are exothermic ✓
b) 12.7 ✓
2.

Reactants	Products
1 × C 4 1	1 × C–C 6 × C–H

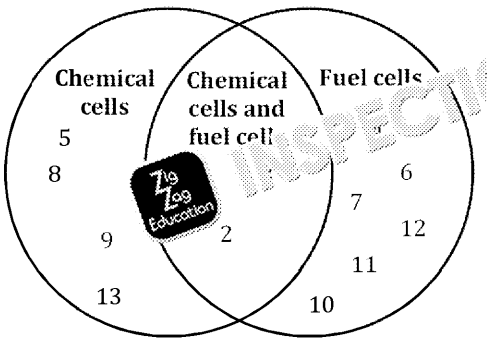
Reactants = 602 + (4 × 413) + 436 = 2690 ✓
Products = 346 + (6 × 413) = 2824 ✓

Energy change = Bonds broken – bonds formed
= 2690 – 2824
= -134 kJ/mol ✓

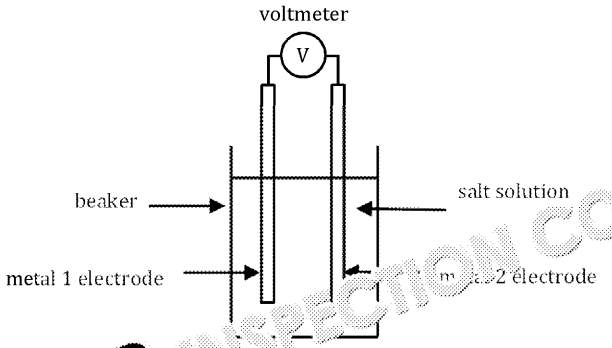
3. a) Same starting temperature / any other control variable ✓
b) The temperature change ✓

Chemical cells and fuel cells (31 / 31)

Activity 1: Chemical cells vs fuel cells



Activity 2: Set up a chemical cell



Activity 3: [illegible]oom discussion [1]

Bullet points are possible statements.

The cell is a fuel cell. The electrolyte is the fuel.

- This is false.
- The cell is a chemical cell, not a fuel cell.
- The electrolyte isn't a fuel (it doesn't get used up).

If I put another cell in series, I could increase the voltage.

- This is true.
- Another of the same cell in series would double the voltage.
- This is a battery.

Different metals might make the voltage change.

- This is true.
- The voltage depends on the reactivity of the metals.
- A larger difference in reactivity gives a greater voltage.

Eventually the voltmeter will read 0.

- This is true.
- The reagents are the metals in the electrodes [illegible] the [illegible] in the electrolyte / salt solution.
- As the reagents are used up, the volt[illegible]ll [illegible]rease.

Activity 4: Exa[illegible] question

1. a) B
   b) Ch[illegible]ell, because it contains its reagents ✓
   c) Oxygen ✓
   d) Can refuel faster ✓

Activity 4: Exam-style question

1. a) B ✓
   b) Chemical cell, because it contains its reagents ✓
   c) $H_2 \rightarrow 2H^+ + 2e^-$
   species ✓
   balancing ✓