



A-LEVEL CHEMISTRY TRANSITION WORK 2023

Complete the 15 Activities. Check your answers at the back of the pack as you go.

Activity 7 is a project, so no answers supplied

Please hand all work to your teacher at the start of term

CONTENT

1. SI units
2. Important vocabulary for practical work
3. Precise language
4. The periodic table
5. Research skills
6. Relative atomic mass
7. Relative formula mass
8. Common ions
9. Diatomic molecules and formula o common compounds
10. Balancing equations
11. Moles
12. Empirical formula

1.SI units

Every measurement must have a size (eg 2.7) and a unit (eg metres or °C). Sometimes there are different units available for the same type of measurement, for example ounces, pounds, kilograms, and tonnes are all used as units for mass. To reduce confusion and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes. These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China. The seven SI base units are

Physical quantity	Usual quantity symbol	Unit	Abbreviation
mass	m	kilogram	kg
length	l or x	metre	m
time	t	second	s
electric current	I	ampere	A
temperature	T	kelvin	K
amount of substance	n	mole	mol
luminous intensity	(not used at A-level)	candela	cd

All other units can be derived from the SI base units.

For example, area is measured in square metres (written as m^2) and speed is measured in metres per second (written as ms^{-1}).

It is not always appropriate to use a full unit. For example, measuring the width of a hair or the distance from Manchester to London in metres would cause the numbers to be difficult to work with.

Prefixes are used to multiply each of the units. You will be familiar with centi (meaning 1/100), kilo (1000) and milli (1/1000) from centimetres, kilometres and millimetres.

There is a wide range of prefixes. The majority of quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, a distance of 33 000 m would be quoted as 33 km.

The most common prefixes you will encounter are:

Prefix	Symbol	Multiplication factor		
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^9	1 000 000 000	
Mega	M	10^6	1 000 000	
kilo	k	10^3	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	μ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Activity 1

Which SI unit and prefix would you use for the following quantities?

1. The mass of water in a test tube.
2. The time taken for a solution to change colour.
3. The radius of a gold atom.
4. The volume of water in a burette.
5. The amount of substance in a beaker of sugar.
6. The temperature of the blue flame from a Bunsen burner.

Sometimes, there are units that are used that are not combinations of SI units and prefixes. These are often multiples of units that are helpful to use. For example, one litre is 0.001 m^3 .

Activity 2

Rewrite the following in SI units.

1. 5 minutes
2. 2 days
3. 5.5 tonnes

Activity 3

Rewrite the following quantities.

1. 0.00122 metres in millimetres
2. 104 micrograms in grams
3. 1.1202 kilometres in metres
4. 70 decilitres in millilitres
5. 70 decilitres in litres
6. 10 cm^3 in litres

2. Important vocabulary for practical work

Activity 4

Join the boxes to link the word to its definition.

Accurate

A statement suggesting what may happen in the future.

Data

An experiment that gives the same results when a different person carries it out, or a different technique or set of equipment is used.

Precise

A measurement that is close to the true value.

Prediction

An experiment that gives the same results when the same experimenter uses the same method and equipment.

Range

Physical, chemical or biological quantities or characteristics.

Repeatable

A variable that is kept constant during an experiment.

Reproducible

A variable that is measured as the outcome of an experiment.

Resolution

This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.

Uncertainty

The interval within the true value can be expected to lie.

Variable

The spread of data, showing the maximum and minimum values of the data.

Control
variable

Measurements where repeated measurements show very little spread.

Dependent
variable

Information, in any form, that has been collected.

3. Precise language

It is essential to use precise language when you write reports and when you answer examination questions. You must always demonstrate that you understand a topic by using the correct and appropriate terms.

For example, you should take care when discussing bonding to refer to the correct particles and interactions between them.

Also, when discussing the interaction between particles in an ionic solid, you would demonstrate a lack of understanding if you referred to the particles as atoms or molecules instead of ions or the interaction between these ions as intermolecular forces rather than electrostatic forces. In this case, use of the incorrect terms would result in the loss of all the marks available for that part of a question.

Take care also to use the word 'chloride' and not 'chlorine' when referring to the ions in a compound such as sodium chloride. The word 'chlorine' should only be used for atoms or molecules of the element.

4. The periodic table

The periodic table of elements is shown on the back page of this booklet. The A-level course will build on what you've learned in your GCSE studies.

Activity 5

On the periodic table on the following page:

- Draw a line showing the metals and non-metals.
- Colour the transition metals blue.
- Colour the halogens yellow.
- Colour the alkali metals red.
- Colour the noble gases green.
- Draw a blue arrow showing the direction of periods.
- Draw a red arrow showing the direction of groups.
- Draw a blue ring around the symbols for all gases.
- Draw a red ring around the symbols for all liquids.

The Periodic Table of the Elements

(1)	(2)	Key atomic number Symbol name relative atomic mass																(3)	(4)	(5)	(6)	(7)	(0)
1																		13	14	15	16	17	18
1 H hydrogen 1.0																		5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
3 Li lithium 6.9	4 Be beryllium 9.0																	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
11 Na sodium 23.0	12 Mg magnesium 24.3																	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3						
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids		72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium	85 At astatine	86 Rn radon					
87 Fr francium	88 Ra radium	89–103 actinoids		104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	114 Fl flerovium	116 Lv livermorium									
57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium 144.9	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.2	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.0	71 Lu lutetium 175.0									
89 Ac actinium	90 Th thorium 232.0	91 Pa protactinium	92 U uranium 238.1	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium									

Activity 6

Use the periodic table to find the following:

1. The atomic number of: osmium, sodium, lead, chlorine.
2. The relative atomic mass of: helium, barium, europium, oxygen.
3. The number of protons in: mercury, iodine, calcium.
4. The symbol for: gold, lead, copper, iron.
5. The name of: Sr, Na, Ag, Hg.
6. THInK can be written using a combination of the symbols for Thorium, Indium and Potassium (ThInK). Which combinations of element symbols could be used to make the following words?

AMERICA, FUN, PIRATE, LIFESPAN, FRACTION, EROSION, DYNAMO

5. Research skills

Activity 7: research activity

Use your online searching abilities to see if you can find out as much about the topic as you can. Remember if you are a prospective A level chemist, you should aim to push your knowledge.

Choose 2 of the following tasks and make a 1-page summary for each one you research

Task 1: The chemistry of fireworks

What are the component parts of fireworks? What chemical compounds cause fireworks to explode? What chemical compounds are responsible for the colour of fireworks?

Task 2: Why is copper sulfate blue?

Copper compounds like many of the transition metal compounds have got vivid and distinctive colours – but why?

Task 3: Aspirin

What was the history of the discovery of aspirin, how do we manufacture aspirin in a modern chemical process?

Task 4: The hole in the ozone layer

Why did we get a hole in the ozone layer? What chemicals were responsible for it? Why were we producing so many of these chemicals? What is the chemistry behind the ozone destruction?

Task 5: ITO and the future of touch screen devices

ITO – indium tin oxide is the main component of touch screen in phones and tablets. The element indium is a rare element and we are rapidly running out of it. Chemists are desperately trying to find a more readily available replacement for it. What advances have chemists made in finding a replacement for it?

6. Relative atomic mass (A_r)

If there are several isotopes of an element, the relative atomic mass will take into account the proportion of atoms in a sample of each isotope. For example, chlorine gas is made up of 75% of chlorine-35 $^{35}_{17}\text{Cl}$ and 25% of chlorine-37 $^{37}_{17}\text{Cl}$. The relative atomic mass of chlorine is therefore the mean atomic mass of the atoms in a sample, and is calculated by:

$$A_r = \left(\frac{75.0}{100} \times 35 \right) + \left(\frac{25.0}{100} \times 37 \right) = 26.25 + 9.25 = 35.5$$

Activity 8

Use the example above to help you work out the answers to the following questions

1. What is the relative atomic mass of Bromine, if the two isotopes, ^{79}Br and ^{81}Br , exist in equal amounts?
2. Neon has three isotopes. ^{20}Ne accounts for 90.9%, ^{21}Ne accounts for 0.3% and the last 8.8% of a sample is ^{22}Ne . What is the relative atomic mass of neon?
3. Magnesium has the following isotope abundances: ^{24}Mg : 79.0%; ^{25}Mg : 10.0% and ^{26}Mg : 11.0%. What is the relative atomic mass of magnesium?
4. Boron has two isotopes, ^{10}B and ^{11}B . The relative atomic mass of boron is 10.8. What are the percentage abundances of the two isotopes?
5. Copper's isotopes are ^{63}Cu and ^{65}Cu . If the relative atomic mass of copper is 63.5, what are the relative abundances of these isotopes?

7. Relative formula mass (M_r)

Carbon dioxide, CO_2 has 1 carbon atom ($A_r = 12.0$) and two oxygen atoms ($A_r = 16.0$). The relative formula mass is therefore

$$M_r = (12.0 \times 1) + (16.0 \times 2) = 44.0$$

Magnesium hydroxide $\text{Mg}(\text{OH})_2$ has one magnesium ion ($A_r = 24.3$) and two hydroxide ions, each with one oxygen ($A_r = 16.0$) and one hydrogen ($A_r = 1.0$). The relative formula mass is therefore:

$$M_r = (24.3 \times 1) + (2 \times (16.0 + 1.0)) = 58.3$$

Activity 9

Use one of the periodic tables in this booklet to calculate the relative formula mass of the following compounds your answers should all be to 1dp:

1. Magnesium oxide MgO
2. Sodium hydroxide NaOH
3. Copper sulfate CuSO_4
4. Ammonium chloride NH_4Cl
5. Ammonium sulfate $(\text{NH}_4)_2\text{SO}_4$

8. Common ions

Positive ions (cations)		Negative ions (anions)	
Name	Symbol	Name	Symbol
Hydrogen	H ⁺	Hydroxide	OH ⁻
Sodium	Na ⁺	Chloride	Cl ⁻
Lithium	Li ⁺	Bromide	Br ⁻
Silver	Ag ⁺	Oxide	O ²⁻
Magnesium	Mg ²⁺	Hydrogencarbonate	HCO ₃ ⁻
Calcium	Ca ²⁺	Nitrate	NO ₃ ⁻
Zinc	Zn ²⁺	Sulfate	SO ₄ ²⁻
Aluminium	Al ³⁺	Carbonate	CO ₃ ²⁻
Ammonium	NH ₄ ⁺	Phosphate	PO ₄ ³⁻

Some elements have more than one charge. For example, iron can form ions with a charge of +2 or +3. Compounds containing these are named Iron(II) and Iron(III) respectively. Other common elements with more than one charge include:

Chromium(II) and chromium(III)

Copper(I) and copper(II)

Lead(II) and lead(IV)

Activity 10

On the periodic table on the following page, colour elements that form one atom ions (eg Na⁺ or O²⁻) according to the following key:

Charge	Colour
+1	red
+2	yellow
+3	green
-1	blue
-2	brown

The Periodic Table of the Elements

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(0)
1 H hydrogen 1.0	2 He helium 4.0	3 B boron 10.8	4 C carbon 12.0	5 N nitrogen 14.0	6 O oxygen 16.0	7 F fluorine 19.0	8 Ne neon 20.2
9 Li lithium 6.9	10 Be beryllium 9.0	11 B boron 10.8	12 C carbon 12.0	13 N nitrogen 14.0	14 O oxygen 16.0	15 F fluorine 19.0	16 Ne neon 20.2
17 Cl chlorine 35.5	18 Ar argon 39.9	19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0
25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6
33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8	37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2
41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium 101.1	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4
49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3	55 Cs caesium 132.9	56 Ba barium 137.3
57-71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1
79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium
109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium
117 Ts tennessine	118 Og oganesson	119 Uut ununtrium	120 Uub ununbium	121 Uuq ununquadium	122 Uub ununhexium	123 Uuh ununheptium	124 Uuo ununoctium
125 Db dubnium	126 Lr lawrencium	127 Uus ununseptium	128 Uub ununbium	129 Uuq ununquadium	130 Uub ununhexium	131 Uuh ununheptium	132 Uuo ununoctium
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509 Uut ununtrium	510 Uub ununbium	511 Uuq ununquadium	512 Uub ununhexium	513 Uuh ununheptium	514 Uuo ununoctium	515 Uuh ununheptium	516 Uuo ununoctium
517 Uut ununtrium	518 Uub ununbium	519 Uuq ununquadium	520 Uub ununhexium	521 Uuh ununheptium	522 Uuo ununoctium	523 Uuh ununheptium	524 Uuo ununoctium
525 Uut ununtrium	526 Uub ununbium	527 Uuq ununquadium	528 Uub ununhexium	529 Uuh ununheptium	530 Uuo ununoctium	531 Uuh ununheptium	532 Uuo ununoctium
533 Uut ununtrium	534 Uub ununbium	535 Uuq ununquadium	536 Uub ununhexium	537 Uuh ununheptium	538 Uuo ununoctium	539 Uuh ununheptium	540 Uuo ununoctium
541 Uut ununtrium	542 Uub ununbium	543 Uuq ununquadium	544 Uub ununhexium	545 Uuh ununheptium	546 Uuo ununoctium	547 Uuh ununheptium	548 Uuo ununoctium
549 Uut ununtrium	550 Uub ununbium	551 Uuq ununquadium	552 Uub</				

NaCl	
Na ⁺	Cl ⁻
+1	-1

MgO	
Mg ²⁺	O ²⁻
+2	-2

MgCl ₂	
Mg ²⁺	Cl ⁻
	Cl ⁻
+2	-2

Activity 11

Work out what the formulas for the following ionic compounds should be:

1. Magnesium bromide
2. Barium oxide
3. Zinc chloride
4. Ammonium chloride
5. Ammonium carbonate
6. Aluminium bromide
7. Iron(II) sulfate
8. Iron(III) sulfate

9. Diatomic molecules and formula of common compounds

A number of atoms exist in pairs as diatomic (two atom) molecules. The common ones that you should remember are:

Hydrogen H_2 , Oxygen O_2 , Fluorine F_2 , Chlorine Cl_2 , Bromine Br_2 , Nitrogen N_2 and Iodine I_2

There are several common compounds from your GCSE studies that have names that do not help to work out their formulas. For example, water is H_2O .

Activity 12: Research activity

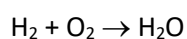
Use the internet or your knowledge to state the formulas of the following compounds?

1. Methane
2. Ammonia
3. Hydrochloric acid
4. Sulfuric acid
5. Sodium hydroxide
6. Potassium manganate(VII)
7. Hydrogen peroxide

10. Balancing equations

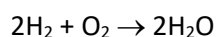
Chemical reactions never create or destroy atoms. They are only rearranged or joined in different ways. When hydrogen and oxygen react to make water:

hydrogen + oxygen \rightarrow water



There are two hydrogen atoms on both sides of this equation, but two oxygen atoms on the left and only one on the right. This is not balanced.

This can be balanced by writing:



The reactants and products in this reaction are known and you can't change them. The compounds can't be changed, and neither can the subscripts because that would change the compounds. So, to balance the equation, a number must be added in front of the compound or element in the equation. This is a coefficient. Coefficients show how many atoms or molecules there are.

Activity 13

Write balanced symbol equations for the following reactions. You'll need to use the information on the previous pages to work out the formulas of the compounds. Remember some of the elements may be diatomic molecules.

1. Aluminium + oxygen \rightarrow aluminium oxide
2. Methane + oxygen \rightarrow carbon dioxide + water
3. Aluminium + bromine \rightarrow aluminium bromide
4. Calcium carbonate + hydrochloric acid \rightarrow calcium chloride + water + carbon dioxide
5. Aluminium sulfate + calcium hydroxide \rightarrow aluminium hydroxide + calcium sulfate

Harder:

6. Silver nitrate + potassium phosphate \rightarrow silver phosphate + potassium nitrate

More challenging:

7. Potassium manganate(VII) + hydrochloric acid \rightarrow
potassium chloride + manganese(II) chloride + water + chlorine

11. Moles

A mole is the amount of a substance that contains 6.02×10^{23} particles.

The mass of 1 mole of any substance is the relative formula mass (M_r) in grams.

Examples:

One mole of carbon contains 6.02×10^{23} particles and has a mass of 12.0 g

Two moles of copper contain 12.04×10^{23} particles, and has a mass of 127 g

1 mole of water contains 6.02×10^{23} particles and has a mass of 18 g

The amount in moles of a substance can be found by using the formula:

$$\text{Amount in moles of a substance} = \frac{\text{mass of substance}}{\text{relative formula mass}}$$

Activity 14

Fill in the table.

Substance	Mass of substance	Amount/moles	Number of particles
Helium			18.12×10^{23}
Chlorine	14.2		
Methane		4	
Sulfuric acid	4.905		

12. Empirical formula

(You may not have covered this at GCSE - give it a go and we will go over it again at A level)

If you measure the mass of each reactant used in a reaction, you can work out the ratio of atoms of each reactant in the product. This is known as the empirical formula. This may give you the actual chemical formula, as the actual formula may be a multiple of this. For example, hydrogen peroxide is H_2O_2 but would have the empirical formula HO .

Use the following to find an empirical formula:

1. Write down reacting masses
2. Find the amount in moles of each element
3. Find the ratio of moles of each element

Example: A compound contains 2.232 g of iron, 1.284 g of sulfur and 1.920 g of oxygen. What is the empirical formula?

Element	Iron	Sulfur	Oxygen
mass/relative atomic mass	2.232/55.8	1.284/32.1	1.920/16.0
Amount in moles	0.040	0.040	0.120
Divide by smallest value	0.040/0.040	0.040/0.040	0.120/0.040
Ratio	1	1	3

So the empirical formula is FeSO_3 .

If the question gives the percentage of each element instead of the mass, replace mass with the percentage of an element present and follow the same process.

Activity 15

Work out the following empirical formulas:

1. The smell of a pineapple is caused by ethyl butanoate. A sample is known to contain only 0.180 g of carbon, 0.030 g of hydrogen and 0.080 g of oxygen. What is the empirical formula of ethyl butanoate?
2. Find the empirical formula of a compound containing 0.0578 g of titanium, 0.288 g of carbon, 0.012 g of hydrogen and 0.384 g of oxygen.
3. 300 g of a substance are analysed and found to contain only carbon, hydrogen and oxygen. The sample contains 145.9 g of carbon and 24.32 g of hydrogen. What is the empirical formula of the compound?
4. Another 300 g sample is known to contain only carbon, hydrogen and oxygen. The percentage of carbon is found to be exactly the same as the percentage of oxygen. The percentage of hydrogen is known to be 5.99%. What is the empirical formula of the compound?

Answers to activities in Transition guide

You can find answers to the activities in the Transition guide in the tables below.

Activity 1

1. Grams
2. Seconds
3. Nanometres/picometres
4. cm^3
5. Mole
6. kelvin/kilo kelvin

Activity 2

1. 300 seconds
2. 172 800 seconds
3. $5500 \text{ kg} / 5.5 \times 10^3 \text{ kg}$

Activity 3

1. 1.22 mm
2. 0.000 104 g
3. 1120.2 m
4. 7000 ml
5. 7 l (also written as 7 dm^3)
6. 0.01 l (0.01 dm^3)

It is worth stressing to students here that in Chemistry, dm^3 is used rather than litres.

Activity 4

Join the boxes to link the word to its definition.

Accurate	A statement suggesting what may happen in the future. (Prediction)
Data	An experiment that gives the same results when a different person carries it out or a different set of equipment or technique is used. (Reproducible)
Precise	A measurement that is close to the true value. (Accurate)
Prediction	An experiment that gives the same results when the same experimenter uses the same method and equipment. (Repeatable)
Range	Physical, chemical or biological quantities or characteristics. (Variable)
Repeatable	A variable that is kept constant during an experiment. (Control variable)
Reproducible	A variable that is measured as the outcome of an experiment. (Dependent variable)
Resolution	This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading. (Resolution)
Uncertainty	The interval within the true value can be expected to lie. (Uncertainty)
Variable	The spread of data, showing the maximum and minimum values of the data. (Range)
Control variable	Measurements where repeated measurements show very little spread. (Precise)
Dependent variable	Information, in any form, that has been collected. (Data)

Activity 5

Key		relative atomic mass symbol name atomic (proton) number																																																																																																																																																																																																																																																																																																																																																																																																																																										
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)																																																																																																																																																																																																																																																																																																																																																																																																																											
6.9 Li lithium 3	9.0 Be beryllium 4	23.0 Na sodium 11	24.3 Mg magnesium 12	39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	83.8 Kr krypton 36	85.4 Rb rubidium 37	87.6 Sr strontium 38	137.3 Ba barium 56	132.9 Cs caesium 55	178.5 Hf hafnium 72	178.5 Ta tantalum 73	180.9 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	208.9 Po polonium 84	210.0 At astatine 85	210.0 Rn radon 86	223.0 Fr francium 87	226.0 Ra radium 88	227.0 Ac actinium 89	232.0 Th thorium 90	231.0 Pa protactinium 91	238.0 U uranium 92	237.0 Np neptunium 93	244.0 Pu plutonium 94	243.0 Am americium 95	247.0 Cm curium 96	254.0 Bk berkelium 97	257.0 Cf californium 98	261.0 Es einsteinium 99	265.0 Fm fermium 100	269.0 Md mendelevium 101	270.0 No nobelium 102	289.0 Lr lawrencium 103	294.0 Rf rutherfordium 104	297.0 Db dubnium 105	301.0 Sg seaborgium 106	312.0 Bh bohrium 107	315.0 Hs hassium 108	318.0 Mt meitnerium 109	320.0 Ds darmstadtium 110	324.0 Rg roentgenium 111	348.0 Uu unnilium 112	349.0 Uub ununium 113	361.0 Uut ununium 114	364.0 Uuq ununium 115	375.0 Uuh ununium 116	384.0 Uus ununium 117	394.0 Uuo ununium 118	401.0 Uuh ununium 119	409.0 Uus ununium 120	420.0 Uub ununium 121	430.0 Uut ununium 122	438.0 Uuq ununium 123	448.0 Uuh ununium 124	457.0 Uus ununium 125	468.0 Uuo ununium 126	478.0 Uuh ununium 127	488.0 Uus ununium 128	497.0 Uuo ununium 129	507.0 Uuh ununium 130	517.0 Uus ununium 131	527.0 Uuo ununium 132	537.0 Uuh ununium 133	547.0 Uus ununium 134	557.0 Uuo ununium 135	567.0 Uuh ununium 136	577.0 Uus ununium 137	587.0 Uuo ununium 138	597.0 Uuh ununium 139	607.0 Uus ununium 140	617.0 Uuo ununium 141	627.0 Uuh ununium 142	637.0 Uus ununium 143	647.0 Uuo ununium 144	657.0 Uuh ununium 145	667.0 Uus ununium 146	677.0 Uuo ununium 147	687.0 Uuh ununium 148	697.0 Uus ununium 149	707.0 Uuo ununium 150	717.0 Uuh ununium 151	727.0 Uus ununium 152	737.0 Uuo ununium 153	747.0 Uuh ununium 154	757.0 Uus ununium 155	767.0 Uuo ununium 156	777.0 Uuh ununium 157	787.0 Uus ununium 158	797.0 Uuo ununium 159	807.0 Uuh ununium 160	817.0 Uus ununium 161	827.0 Uuo ununium 162	837.0 Uuh ununium 163	847.0 Uus ununium 164	857.0 Uuo ununium 165	867.0 Uuh ununium 166	877.0 Uus ununium 167	887.0 Uuo ununium 168	897.0 Uuh ununium 169	907.0 Uus ununium 170	917.0 Uuo ununium 171	927.0 Uuh ununium 172	937.0 Uus ununium 173	947.0 Uuo ununium 174	957.0 Uuh ununium 175	967.0 Uus ununium 176	977.0 Uuo ununium 177	987.0 Uuh ununium 178	997.0 Uus ununium 179	1007.0 Uuo ununium 180	1017.0 Uuh ununium 181	1027.0 Uus ununium 182	1037.0 Uuo ununium 183	1047.0 Uuh ununium 184	1057.0 Uus ununium 185	1067.0 Uuo ununium 186	1077.0 Uuh ununium 187	1087.0 Uus ununium 188	1097.0 Uuo ununium 189	1107.0 Uuh ununium 190	1117.0 Uus ununium 191	1127.0 Uuo ununium 192	1137.0 Uuh ununium 193	1147.0 Uus ununium 194	1157.0 Uuo ununium 195	1167.0 Uuh ununium 196	1177.0 Uus ununium 197	1187.0 Uuo ununium 198	1197.0 Uuh ununium 199	1207.0 Uus ununium 200	1217.0 Uuo ununium 201	1227.0 Uuh ununium 202	1237.0 Uus ununium 203	1247.0 Uuo ununium 204	1257.0 Uuh ununium 205	1267.0 Uus ununium 206	1277.0 Uuo ununium 207	1287.0 Uuh ununium 208	1297.0 Uus ununium 209	1307.0 Uuo ununium 210	1317.0 Uuh ununium 211	1327.0 Uus ununium 212	1337.0 Uuo ununium 213	1347.0 Uuh ununium 214	1357.0 Uus ununium 215	1367.0 Uuo ununium 216	1377.0 Uuh ununium 217	1387.0 Uus ununium 218	1397.0 Uuo ununium 219	1407.0 Uuh ununium 220	1417.0 Uus ununium 221	1427.0 Uuo ununium 222	1437.0 Uuh ununium 223	1447.0 Uus ununium 224	1457.0 Uuo ununium 225	1467.0 Uuh ununium 226	1477.0 Uus ununium 227	1487.0 Uuo ununium 228	1497.0 Uuh ununium 229	1507.0 Uus ununium 230	1517.0 Uuo ununium 231	1527.0 Uuh ununium 232	1537.0 Uus ununium 233	1547.0 Uuo ununium 234	1557.0 Uuh ununium 235	1567.0 Uus ununium 236	1577.0 Uuo ununium 237	1587.0 Uuh ununium 238	1597.0 Uus ununium 239	1607.0 Uuo ununium 240	1617.0 Uuh ununium 241	1627.0 Uus ununium 242	1637.0 Uuo ununium 243	1647.0 Uuh ununium 244	1657.0 Uus ununium 245	1667.0 Uuo ununium 246	1677.0 Uuh ununium 247	1687.0 Uus ununium 248	1697.0 Uuo ununium 249	1707.0 Uuh ununium 250	1717.0 Uus ununium 251	1727.0 Uuo ununium 252	1737.0 Uuh ununium 253	1747.0 Uus ununium 254	1757.0 Uuo ununium 255	1767.0 Uuh ununium 256	1777.0 Uus ununium 257	1787.0 Uuo ununium 258	1797.0 Uuh ununium 259	1807.0 Uus ununium 260	1817.0 Uuo ununium 261	1827.0 Uuh ununium 262	1837.0 Uus ununium 263	1847.0 Uuo ununium 264	1857.0 Uuh ununium 265	1867.0 Uus ununium 266	1877.0 Uuo ununium 267	1887.0 Uuh ununium 268	1897.0 Uus ununium 269	1907.0 Uuo ununium 270	1917.0 Uuh ununium 271	1927.0 Uus ununium 272	1937.0 Uuo ununium 273	1947.0 Uuh ununium 274	1957.0 Uus ununium 275	1967.0 Uuo ununium 276	1977.0 Uuh ununium 277	1987.0 Uus ununium 278	1997.0 Uuo ununium 279	2007.0 Uuh ununium 280	2017.0 Uus ununium 281	2027.0 Uuo ununium 282	2037.0 Uuh ununium 283	2047.0 Uus ununium 284	2057.0 Uuo ununium 285	2067.0 Uuh ununium 286	2077.0 Uus ununium 287	2087.0 Uuo ununium 288	2097.0 Uuh ununium 289	2107.0 Uus ununium 290	2117.0 Uuo ununium 291	2127.0 Uuh ununium 292	2137.0 Uus ununium 293	2147.0 Uuo ununium 294	2157.0 Uuh ununium 295	2167.0 Uus ununium 296	2177.0 Uuo ununium 297	2187.0 Uuh ununium 298	2197.0 Uus ununium 299	2207.0 Uuo ununium 300	2217.0 Uuh ununium 301	2227.0 Uus ununium 302	2237.0 Uuo ununium 303	2247.0 Uuh ununium 304	2257.0 Uus ununium 305	2267.0 Uuo ununium 306	2277.0 Uuh ununium 307	2287.0 Uus ununium 308	2297.0 Uuo ununium 309	2307.0 Uuh ununium 310	2317.0 Uus ununium 311	2327.0 Uuo ununium 312	2337.0 Uuh ununium 313	2347.0 Uus ununium 314	2357.0 Uuo ununium 315	2367.0 Uuh ununium 316	2377.0 Uus ununium 317	2387.0 Uuo ununium 318	2397.0 Uuh ununium 319	2407.0 Uus ununium 320	2417.0 Uuo ununium 321	2427.0 Uuh ununium 322	2437.0 Uus ununium 323	2447.0 Uuo ununium 324	2457.0 Uuh ununium 325	2467.0 Uus ununium 326	2477.0 Uuo ununium 327	2487.0 Uuh ununium 328	2497.0 Uus ununium 329	2507.0 Uuo ununium 330	2517.0 Uuh ununium 331	2527.0 Uus ununium 332	2537.0 Uuo ununium 333	2547.0 Uuh ununium 334	2557.0 Uus ununium 335	2567.0 Uuo ununium 336	2577.0 Uuh ununium 337	2587.0 Uus ununium 338	2597.0 Uuo ununium 339	2607.0 Uuh ununium 340	2617.0 Uus ununium 341	2627.0 Uuo ununium 342	2637.0 Uuh ununium 343	2647.0 Uus ununium 344	2657.0 Uuo ununium 345	2667.0 Uuh ununium 346	2677.0 Uus ununium 347	2687.0 Uuo ununium 348	2697.0 Uuh ununium 349	2707.0 Uus ununium 350	2717.0 Uuo ununium 351	2727.0 Uuh ununium 352	2737.0 Uus ununium 353	2747.0 Uuo ununium 354	2757.0 Uuh ununium 355	2767.0 Uus ununium 356	2777.0 Uuo ununium 357	2787.0 Uuh ununium 358	2797.0 Uus ununium 359	2807.0 Uuo ununium 360	2817.0 Uuh ununium 361	2827.0 Uus ununium 362	2837.0 Uuo ununium 363	2847.0 Uuh ununium 364	2857.0 Uus ununium 365	2867.0 Uuo ununium 366	2877.0 Uuh ununium 367	2887.0 Uus ununium 368	2897.0 Uuo ununium 369	2907.0 Uuh ununium 370	2917.0 Uus ununium 371	2927.0 Uuo ununium 372	2937.0 Uuh ununium 373	2947.0 Uus ununium 374	2957.0 Uuo ununium 375	2967.0 Uuh ununium 376	2977.0 Uus ununium 377	2987.0 Uuo ununium 378	2997.0 Uuh ununium 379	3007.0 Uus ununium 380	3017.0 Uuo ununium 381	3027.0 Uuh ununium 382	3037.0 Uus ununium 383	3047.0 Uuo ununium 384	3057.0 Uuh ununium 385	3067.0 Uus ununium 386	3077.0 Uuo ununium 387	3087.0 Uuh ununium 388	3097.0 Uus ununium 389	3107.0 Uuo ununium 390	3117.0 Uuh ununium 391	3127.0 Uus ununium 392	3137.0 Uuo ununium 393	3147.0 Uuh ununium 394	3157.0 Uus ununium 395	3167.0 Uuo ununium 396	3177.0 Uuh ununium 397	3187.0 Uus ununium 398	3197.0 Uuo ununium 399	3207.0 Uuh ununium 400	3217.0 Uus ununium 401	3227.0 Uuo ununium 402	3237.0 Uuh ununium 403	3247.0 Uus ununium 404	3257.0 Uuo ununium 405	3267.0 Uuh ununium 406	3277.0 Uus ununium 407	3287.0 Uuo ununium 408	3297.0 Uuh ununium 409	3307.0 Uus ununium 410	3317.0 Uuo ununium 411	3327.0 Uuh ununium 412	3337.0 Uus ununium 413	3347.0 Uuo ununium 414	3357.0 Uuh ununium 415	3367.0 Uus ununium 416	3377.0 Uuo ununium 417	3387.0 Uuh ununium 418	3397.0 Uus ununium 419	3407.0 Uuo ununium 420	3417.0 Uuh ununium 421	3427.0 Uus ununium 422	3437.0 Uuo ununium 423	3447.0 Uuh ununium 424	3457.0 Uus ununium 425	3467.0 Uuo ununium 426	3477.0 Uuh ununium 427	3487.0 Uus ununium 428	3497.0 Uuo ununium 429	3507.0 Uuh ununium 430	3517.0 Uus ununium 431	3527.0 Uuo ununium 432	3537.0 Uuh ununium 433	3547.0 Uus ununium 434	3557.0 Uuo ununium 435	3567.0 Uuh ununium 436	3577.0 Uus ununium 437	3587.0 Uuo ununium 438	3597.0 Uuh ununium 439	3607.0 Uus ununium 440	3617.0 Uuo ununium 441	3627.0 Uuh ununium 442	3637.0 Uus ununium 443	3647.0 Uuo ununium 444	3657.0 Uuh ununium 445	3667.0 Uus ununium 446	3677.0 Uuo ununium 447	3687.0 Uuh ununium 448	3697.0 Uus ununium 449	3707.0 Uuo ununium 450	3717.0 Uuh ununium 451	3727.0 Uus ununium 452	3737.0 Uuo ununium 453	3747.0 Uuh ununium 454	3757.0 Uus ununium 455	3767.0 Uuo ununium 456	3777.0 Uuh ununium 457	3787.0 Uus ununium 458	3797.0 Uuo ununium 459	3807.0 Uuh ununium 460	3817.0 Uus ununium 461	3827.0 Uuo ununium 462	3837.0 Uuh ununium 463	3847.0 Uus ununium 464	3857.0 Uuo ununium 465	3867.0 Uuh ununium 466	3877.0 Uus ununium 467	3887.0 Uuo ununium 468	3897.0 Uuh ununium 469	3907.0 Uus ununium 470	3917.0 Uuo ununium 471	3927.0 Uuh ununium 472	3937.0 Uus ununium 473	3947.0 Uuo ununium 474	3957.0 <

Activity 6

1. Os: 76 Na: 11 Pb: 82 Cl: 17
2. He: 4.0 Ba: 137.3 Eu: 152.0 O: 16.0
3. Hg: 80 I: 53 Ca: 20
4. Gold: Au Lead: Pb Copper: Cu Iron: Fe
5. Sr: Strontium Na: Sodium Ag: Silver Hg: Mercury
6. AMERICA: Americium; Erbium; Iodine; Calcium
FUN: Fluorine; Uranium; Nitrogen
PIRATE: Phosphorus; Iodine; Radium; Tellurium
LIFESPAN: Lithium; Iron; Sulfur; Protactinium; Nitrogen
FRACTION: Francium; Actinium; Titanium; Oxygen; Nitrogen
EROSION: Erbium; Oxygen; Sulfur; Iodine; Oxygen; Nitrogen
DYNAMO: Dysprosium; Sodium; Molybdenum

Activity 7 is an individual project.

Activity 8

1. 80.0
2. 20.179 (20.2)
3. 24.32 (24.3)
4. 20% ^{10}B and 80% ^{11}B
5. 75% ^{63}Cu and 25% ^{65}Cu

Activity 9

1. 40.3
2. 40.0
3. 159.6
4. 53.5
5. 132.1

1.0	(18)
4.0	

(1)	(2)	Key										(13)	(14)	(15)	(16)	(17)	(18)
6.9 Li lithium 3	9.0 Be beryllium 4	relative atomic mass symbol name atomic (proton) number										10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.7 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	96.0 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac† actinium 89	[267] Rf rutherfordium 104	[268] Db dubnium 105	[271] Sg seaborgium 106	[272] Bh bohrium 107	[270] Hs hassium 108	[276] Mt meitnerium 109	[281] Ds darmstadtium 110	[280] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

140.1 Ce cerium 58	140.9 Pr praseodymium 59	144.2 Nd neodymium 60	[145] Pm promethium 61	150.4 Sm samarium 62	152.0 Eu europium 63	157.3 Gd gadolinium 64	158.9 Tb terbium 65	162.5 Dy dysprosium 66	164.9 Ho holmium 67	167.3 Er erbium 68	168.9 Tm thulium 69	173.1 Yb ytterbium 70	175.0 Lu lutetium 71
232.0 Th thorium 90	231.0 Pa protactinium 91	238.0 U uranium 92	[237] Np neptunium 93	[244] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[247] Bk berkelium 97	[251] Cf californium 98	[252] Es einsteinium 99	[257] Fm fermium 100	[258] Md mendelevium 101	[259] No nobelium 102	[262] Lr lawrencium 103

groups 1, 2, 16 and 17

Activity 12

1. CH_4
2. NH_3
3. HCl
4. H_2SO_4
5. NaOH
6. KMnO_4
7. H_2O_2

Activity 13

1. $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$
2. $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
3. $2\text{Al} + 3\text{Br}_2 \rightarrow 2\text{AlBr}_3$
4. $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$
5. $\text{Al}_2(\text{SO}_4)_3 + 3\text{Ca}(\text{OH})_2 \rightarrow 2\text{Al}(\text{OH})_3 + 3\text{CaSO}_4$
6. $3\text{AgNO}_3 + \text{K}_3\text{PO}_4 \rightarrow \text{Ag}_3\text{PO}_4 + 3\text{KNO}_3$
7. $2\text{KMnO}_4 + 16\text{HCl} \rightarrow 2\text{KCl} + 2\text{MnCl}_2 + 8\text{H}_2\text{O} + 5\text{Cl}_2$

Activity 14

Substance	Mass of substance/g	Amount/moles	Number of particles
Helium	12.0	3	1.812×10^{24}
Chlorine	14.2	0.2	1.204×10^{23}
Methane	64.0	4	2.408×10^{24}
Sulfuric acid	4.905	0.05	3.0×10^{22}

Activity 15

1.

Element	Carbon	Hydrogen	Oxygen
Mass/relative atomic mass	0.180/12.0	0.030/1.0	0.080/16.0
Amount in moles	0.015	0.030	0.005
Divide by smallest value	0.015/0.005	0.030/0.005	0.005/0.005
Ratio	3	6	1

Empirical formula: $\text{C}_3\text{H}_6\text{O}$ (Chemical formula: $\text{C}_6\text{H}_{12}\text{O}_2$).

2.

Element	Titanium	Carbon	Hydrogen	Oxygen
mass/relative atomic mass	0.0578/ 47.9	0.288/12.0	0.012/1.0	0.384/16.0
Amount in moles	0.00121	0.024	0.012	0.024
Divide by smallest value	0.00121/ 0.00121	0.024/ 0.00121	0.012/ 0.00121	0.024/ 0.00121
Ratio	1	19.8	9.9	19.8

Empirical formula: $\text{TiC}_{20}\text{H}_{10}\text{O}_{20}$.

3.

Element	Carbon	Hydrogen	Oxygen
Mass/relative atomic mass	145.9/12.0	24.32/1.0	129.78/16.0
Amount in moles	12.16	24.3243	8.11
Divide by smallest value	12.16/8.11	24.32/8.11	8.11/8.11
Ratio	1.5	3	1

Empirical formula: $\text{C}_3\text{H}_6\text{O}_2$

4.

Element	Carbon	Hydrogen	Oxygen
% mass	$(100-5.99)/2$ =47.005	5.99	$(100-5.99)/2$ =47.005
% mass/relative atomic mass	3.9171	5.99	2.9378
Divide by smallest value	1.33	2.04	1
Ratio	4	6	3

Empirical formula: $C_4H_6O_3$