CHEMISTRY A-Level

Summer Work 2023

Welcome to A-level Chemistry! We hope you will enjoy the challenges offered by this fascinating subject and come to find it a rewarding and worthwhile experience. We follow the OCR-B (Salters) course, which is both academically rigorous and always set in a real-life context so that you can see how the theory is relevant.

The A-Level chemistry course is very demanding and some thorough preparation work is vital. Throughout the course it will be very important that you plan your time effectively to meet deadlines and continue to develop your independent working skills. We therefore want you to attempt three tasks before starting the A-Level chemistry course. These tasks will help you review some important concepts from GCSE that will be encountered again during the first term of A-Level chemistry and help you assess what you have understood. We hope that Task C will introduce an important and recurring theme which will be significant throughout the A-Level course.

You should complete **all** the tasks **A-C:**

- **A:** Multiple choice questions on basic concepts
- **B:** Balancing chemical equations
- **C:** The "Scale of chemistry"

You will need to bring the completed summer work with you for checking on the Year 1 induction day in **September** and it will be used in subsequent lessons. We estimate that the work should take about 5-7 hours to complete.

Feel free to contact us using the email address below if you need any guidance in completing this work, or any additional information about preparing for the A-Level chemistry course. There is a copy of the periodic table on the next page to help you complete this work, but you might also like investigating the extremely interesting and interactive version of the periodic table accessible via this link: **http://www.ptable.com**

The chemistry team would like to wish you a great summer holiday and we very much look forward to meeting you in September!

Simon Colebrooke	Course Team Leader Chemistry	**scolebrooke@longroad.ac.uk**
Zoë Thorn	Chemistry Teacher	

The Periodic Table of the Elements

Key
atomic number
Symbol
name
relative atomic mass

(1)	(2)											(3)	(4)	(5)	(6)	(7)	(0)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1 **H** hydrogen 1.0																	2 **He** helium 4.0
3 **Li** lithium 6.9	4 **Be** beryllium 9.0											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
11 **Na** sodium 23.0	12 **Mg** magnesium 24.3											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
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	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

Task A: Multiple Choice

Name: ....

For each question there are four possible answers; **A**, **B**, **C** or **D**. For each question, circle the answer which you think is correct. You can find a copy of the periodic table at the following website:

http://www.ptable.com

Atoms, ions and sub-atomic particles

Table 1 shows the sub-atomic particles in different atoms and ions. The table includes an “unknown” atom / ion in the bottom row.

Table 1					
Particle	**Proton number**	**Mass Number**	**Number of protons**	**Number of neutrons**	**Number of electrons**
Mg	12	24	12	**W**	12
Mg^{2+}	**X**	24	12	12	10
Cl	17	35	17	**Y**	17
Cl^-	17	35	17	**Z**	18
Unknown	8	16	8	8	10

1. Which particles in Table 1 are ions?

A Mg^{2+} and Cl^- only

B Mg and Mg^{2+} only

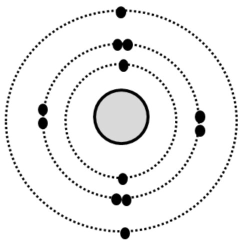
C Cl^- only

D Unknown, Mg^{2+} and Cl^- only

2. Select a row **A-D** from the options below that shows the correct values of **W**, **X**, **Y** and **Z** that could be used to complete **Table1** above:

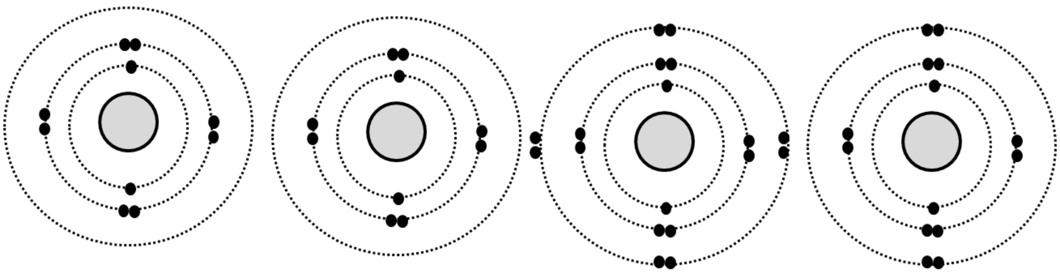
	Value of W	**Value of X**	**Value of Y**	**Value of Z**
A	11	10	18	18
B	12	14	17	18
C	12	12	18	18
D	12	12	18	17

3. The diagram below shows the electron arrangement in an atom of magnesium:



Which of these diagrams correctly shows the electron arrangement in the ion formed by magnesium **and** gives the correct charge on the ion?

A	B	C	D



Mg^{2+}	Mg^{2-}	Mg^{6-}	Mg^{2+}

Chemical Formulae

4. Look at the list of substances below;

P	N_2	**Q**	$C_6H_{12}O_6$	**R**	Ar
S	C_8H_{18}	**T**	NH_3		

Which statement is true?

A **P** and **R** are the only elements

B All the substances are composed of molecules

C Substance **T** is made from 4 elements

D **Q** contains more atoms than **S**

5. The “Relative Formula Mass” allows chemists to compare the mass of different substances, e.g. the RFM of H_2O is 18 and the RFM of CO_2 is 44.

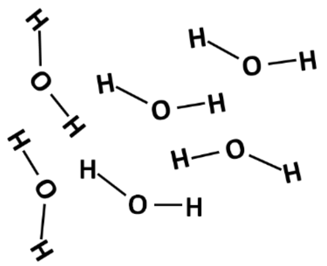
What is the Relative Formula Mass of Cu_2O?

A	95.5	**B**	143
C	66	**D**	45

6. What is the Relative Formula Mass of $(NH_4)_2SO_4$?

A	118	**B**	146
C	132	**D**	46

7. The picture shows molecules in liquid water. If the water is heated it will eventually boil and turn into a gas (steam). Which of the statements below are true about the formation of steam?



W When the steam is formed some of the covalent bonds between H and O atoms are broken

X The steam contains hydrogen and oxygen gas

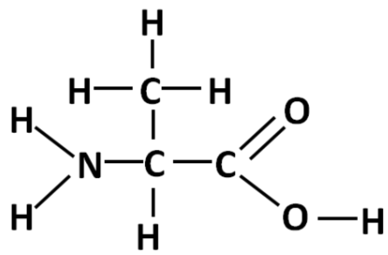
Y Forces between water molecules are broken but not the covalent bonds

Z Steam is made of H_2O molecules

Select **A-D** to show the true statements:

A	Y and Z are true	**B**	All statements are true
C	W and X are true	**D**	Only Y is true

8. The diagram below shows the structure of the amino acid alanine and four statements, **P-S**.



P Alanine is made from 4 different elements

Q Alanine is made from 13 different elements

R Each alanine molecule has 4 atoms

S Each alanine molecule has 13 atoms

Which statements are true?

A	P, R and S	**B**	P and S
C	R only	**D**	Q only

9. Compounds **W-Z** are ionic and made from the ions listed below. The list shows the formula of the ions and their charges. Which formulae **W-Z** are correct?

Potassium	K^+	Nitrate (V)	NO_3^-
Aluminium	Al^{3+}	Hydroxide	OH^-
Oxide	O^{2-}	Ammonium	NH_4^+
Magnesium	Mg^{2+}		

W $AlOH_3$ **X** NH_4OH **Y** KO_2 **Z** $Mg(NO_3)_2$

A X and W **B** X and Y

C Y and Z **D** X and Z

Mathematics for Chemistry

10. An important equation in chemistry links the energy **E** of a photon of radiation to the frequency, **f**:

E = hf

In this equation **E** is the photon energy, **f** is the frequency and **h** is a number called "Planck's constant" and has a value of 6.63×10^{-34}.

If a photon has energy of 1.31×10^{-19} J, what is the frequency (do not worry about units)?

A 1.98×10^{-16} **B** 8.69×10^{-53}

C 0.198 **D** 1.98×10^{14}

11. Which of the following numbers are shown to three significant figures?

F 0.1204 **G** 1.24 **H** 0.124

I 0.12 **J** 1.240 **K** 1.24×10^3 **L** 0.00124

A G and I **B** G, H and J

C G, H, K and L **D** All except F

12. The most common unit for measuring volumes in chemistry is the "decimetre-cubed", given the symbol dm^3. One dm^3 is commonly referred to as a litre and 1 dm^3 = 1000 cm^3. If a chemist measures out 25.0cm^3 of hydrochloric acid, what is this volume in dm^3?

A 0.025 dm^3 **B** 25,000 dm^3

C 40 dm^3 **D** 0.25 dm^3

The next two questions refer to the ideal gas equation, PV = nRT.

In this equation: P = pressure of the gas

V = volume of the gas

n = number of moles of gas (ie how many gas particles there are)

R = a constant called the “gas constant”

T = the temperature of the gas

13. A student needs to rearrange the ideal gas equation in order to calculate a value for **n**. Which is the correct rearrangement?

A $n = PVRT$

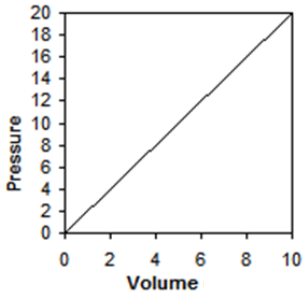
B $n = \frac{RT}{PV}$

C $n = \frac{PV}{RT}$

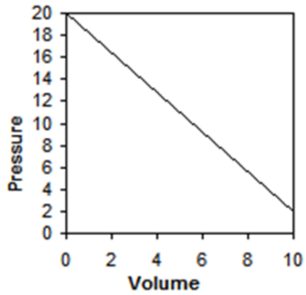
D $n = RTPV$

14. A chemist has a sample of an ideal gas at 25 ^{O}C. Without changing the temperature, the student increases the volume of the container the gas is stored in. Choose which graph best shows the effect of increasing the **volume**, **V**, on the **pressure**, **P**, of the gas:

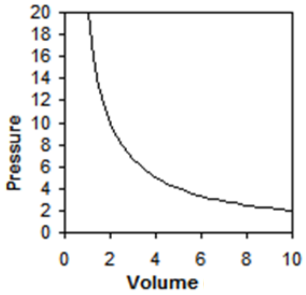
A



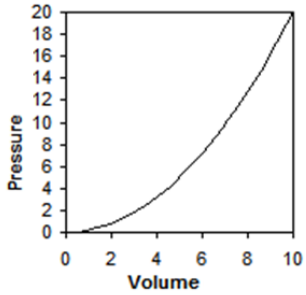
C



B



D



TASK B: Balancing chemical equations

Balance the following equations by adding the correct number **in-front** of each chemical formula. You can assume that all the formulae are correct already. Some equations may already be balanced.

1. $CH_4 + O_2 \longrightarrow CO_2 + H_2O$

2. $Na + O_2 \longrightarrow Na_2O$

3. $H_2O_2 \longrightarrow H_2O + O_2$

4. $N_2 + H_2 \longrightarrow NH_3$

5. $Mg + H_2O \longrightarrow Mg(OH)_2 + H_2$

6. $Fe + Br_2 \longrightarrow FeBr_3$

7. $C_3H_8 + O_2 \longrightarrow CO_2 + H_2O$

8. $BaCO_3 + H_2SO_4 \longrightarrow BaSO_4 + CO_2 + H_2O$

9. $Al + Fe_3N_2 \longrightarrow AlN + Fe$

10. $BF_3 + Li_2SO_3 \longrightarrow B_2(SO_3)_3 + LiF$

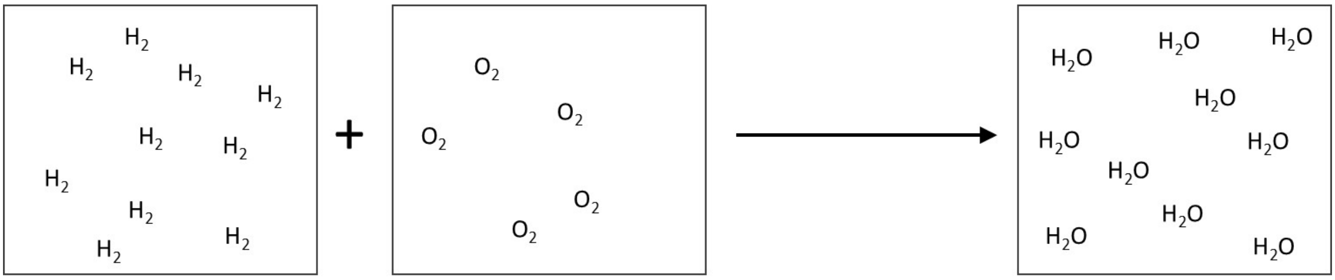
Now practice turning the information below into balanced equations:

11. One molecule of chlorine (Cl_2) reacts with one molecule of bromine (Br_2) to form bromine chloride (BrCl). Write a balanced equation for the reaction.

12. Two molecules of hydrogen sulphide (H_2S) react with one molecule of sulphur dioxide (SO_2) to form sulphur (usually just given the symbol S in equations) and water.

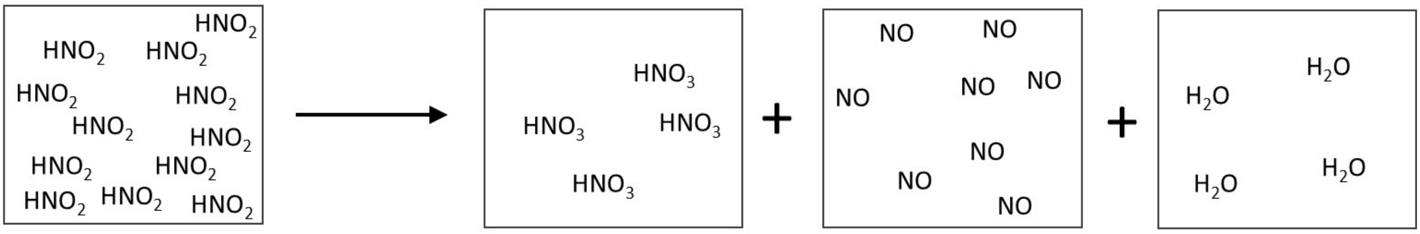
Finally, convert the diagrams shown below into balanced equations. Simplify the equations as much as possible:

13. The reaction of hydrogen with oxygen (write your equation beneath the boxes).



Balanced equation:

14. The decomposition of nitric (III) acid (write your equation beneath the boxes).

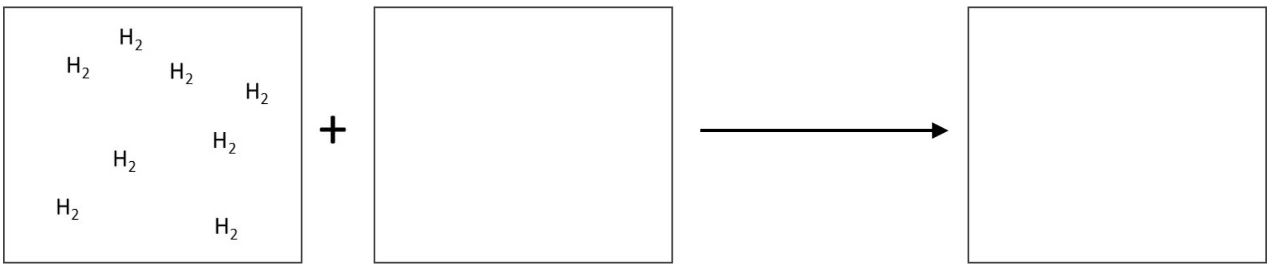


Balanced equation:

15. Hydrogen and bromine react together to form hydrogen bromide as shown by the balanced equation:

$$H_2 + Br_2 \longrightarrow 2HBr$$

Use this balanced equation to complete the diagram below, showing the reaction:



TASK C: The “scale of chemistry”

Understanding the relative sizes of things in chemistry, both compared to one another and to other objects encountered in everyday life is one of the big challenges associated with studying A-level chemistry. This task is intended to help you develop an understanding of that scale.

1. Do some research to find the size of each of the objects listed below. You will no doubt find the information recorded in a range of difference distance units, but that does not matter, simply note the value you find. Record the source of the information. For some objects you may be able to estimate the size yourself and if so, simply write “estimate” in the source column.

Object	Size	Unit	Size in metres	Source
Palisade leaf cell				
SARS-Cov-2 Virus (virus causing Covid-19)				
Human hair width				
Nits (egg of the head louse)				
Gold atom				
Grain of salt				
e-coli bacteria				
Nucleus of a gold atom				
Dust mite				
Drop of water				
Human skin cell nucleus				
Red blood cell				
Diameter of proton				
Diamond in a piece of jewellery				
Haemoglobin molecule				
Snowflake				

2. Convert all of your findings into metres, so that they can be more readily compared. You might find the following relationships useful:

Millimetre mm = 1×10^{-3} m

Micrometre μm = 1×10^{-6} m

Nanometre nm = 1×10^{-9} m

Angstrom Å = 1×10^{-10} m

Picometre pm = 1×10^{-12} m

Femtometre fm = 1×10^{-15} m

Attometre am = 1×10^{-18} m

3. Produce a PowerPoint (or equivalent alternative) that summarises your findings. Your PowerPoint should:

- Include an image of each object
- Include a table with the information from Q1 and Q2
- Separately to the table, list the objects in order of increasing size
- Show the size of each object in metres
- You should also include a slide showing the objects grouped according to whether they are macroscopic / microscopic / sub-microscopic**
- A slide which shows some interesting comparisons between one object and another, or one object and something everyday (for example – how many gold atoms could be laid end to end along a 1p coin).

** Macroscopic means that the object can be seen unaided with the naked eye. Microscopic means the object is too small to see with the naked eye, but can be seen using a microscope. For our purposes, we will assume that by "microscope" we mean a standard light microscope that can resolve objects as small as approximately 1×10^{-6} m in length. Sub-microscopic means objects that could not be seen using a normal light microscope, smaller than 1×10^{-6} m. This distinction is a bit approximate as light microscopes vary somewhat!

You will need to bring a printed copy of your PowerPoint to your first chemistry lesson to help with discussions (colour printing is not essential and you can put more than one slide on a page if necessary). We will give instructions for submitting the electronic version of your PowerPoint once college has started.