

# **Progression - Chemistry**

**Get ready for A-level!**

**A guide to help you get ready for A-level Chemistry,  
including everything from topic guides to days out  
and online learning courses.**

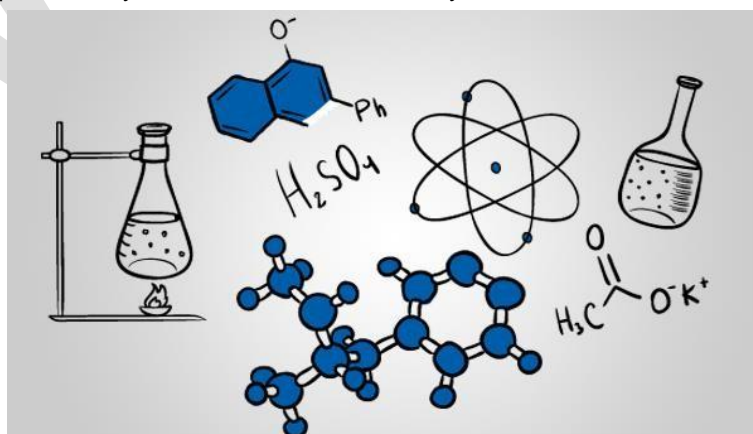
# Making the transition to A level Chemistry

This pack contains a programme of activities and resources to prepare you to start A level in Chemistry in September. It is aimed to be used after you complete your GCSE, throughout the remainder of the summer term and over the summer holidays to ensure you are ready to start your course in September.

It is split into 5 parts:

1. Thinking of studying A Level Chemistry at Worcester Sixth Form College?
2. Transition tasks including skills to be completed before September. Mark your work using a different coloured pen. Bring all completed & marked tasks with you to show your teacher.
3. Baseline assessment- to be completed by September and marked by your new teacher. Bring this with you.
4. Optional tasks – these are highly useful if you are considering studying Chemistry or a science related subject at University. Attempt a minimum of five **different** tasks from the list.
5. Mark scheme for transition tasks – please use to check and assess your work.

<https://www.my-mooc.com/en/mooc/chemistry1/>



# 1. Thinking of studying A Level Chemistry at Worcester Sixth Form College?

We teach the **OCR A** specification.

Here is a brief summary of the topics we cover over the two-year course. If you want to find out more about each of these topics, you can find the full specification on the OCR website:

<https://www.ocr.org.uk/qualifications/as-and-a-level/chemistry-a-h032-h432-from-2015/specification-at-a-glance/>

Content overview:

Module 1: Development of practical skills in chemistry

- Practical skills assessed in the practical endorsement and written exam

Module 2: Foundations in chemistry

- Atoms, compounds, molecules and equations
- Amount of substance
- Acid–base and redox reactions
- Electrons, bonding and structure

Module 3: Periodic table and energy

- The periodic table and periodicity
- Group 2 and the halogens
- Qualitative analysis
- Enthalpy changes
- Reaction rates and equilibrium

Module 4: Core organic chemistry

- Hydrocarbons
- Alcohols and haloalkanes
- Organic synthesis
- Analytical techniques (IR and MS)

Year 2:

Module 5: Physical chemistry and transition elements

Module 6: Organic chemistry and analysis

## 2. Tasks to complete before September

In order to prepare for the course, you need to complete all of the tasks in this section, including the baseline assessment. Before you begin, find a folder to store this booklet and all the notes that you make on the tasks. **You need to bring in this folder at the start of the course.** Make sure that your notes are neat and well-organised!



You **MUST complete** all GCSE questions. This is to help you recap and retrieve vital knowledge you have learned during your GCSE course that provides the foundation for A-Level Chemistry to build upon.

Use your normal GCSE revision resources to help you complete them, but here are some suggestions:

[www.tassomai.com](http://www.tassomai.com)

[www.senecalearning.com](http://www.senecalearning.com)

[www.bitesize.com](http://www.bitesize.com)

[Youtube - Free Science Lessons](#)

[Youtube - Primrose Kitten](#)

You **MUST attempt** the A-Level Questions. They are accessible to you with the GCSE content you have – you might just need to think outside the box a bit and stretch yourself! This gives insight into the style of questions at A-Level and shows the jump is not that large if you are fully prepared with all of your GCSE knowledge. You may find these websites helpful:

[CGP – 'Head start to Chemistry' and 'Essential Maths Skills' books](#)

[MaChemGuy – Prepare for A-Level Chemistry](#)

[ASFC Chemistry – Starting A-Level Chemistry](#)

## Atomic Structure

### GCSE questions

**Q1.** This question is about the structure of the atom.

(a) Complete the sentences. Choose answers from the box. Each word may be used once, more than once, or not at all.

|          |        |         |
|----------|--------|---------|
| electron | ion    | neutron |
| nucleus  | proton |         |

The centre of the atom is the \_\_\_\_\_.

The two types of particle in the centre of the atom are the proton and the \_\_\_\_\_.

James Chadwick proved the existence of the \_\_\_\_\_.

Niels Bohr suggested particles orbit the centre of the atom. This type of particle is the \_\_\_\_\_.

The two types of particle with the same mass are the neutron and the \_\_\_\_\_ (5)

The table below shows information about two isotopes of element **X**.

|           | Mass number | Percentage (%) abundance |
|-----------|-------------|--------------------------|
| Isotope 1 | 63          | 70                       |
| Isotope 2 | 65          | 30                       |

(b) Calculate the relative atomic mass ( $A_r$ ) of element **X** using the equation:

$$A_r = \frac{(\text{mass number} \times \text{percentage}) \text{ of isotope 1} + (\text{mass number} \times \text{percentage}) \text{ of isotope 2}}{100}$$

Use the table above. Give your answer to 1 decimal place.

\_\_\_\_\_

\_\_\_\_\_  $A_r =$  \_\_\_\_\_ (2)

(c) Suggest the identity of element **X**. Use the periodic table.

Element **X** is \_\_\_\_\_

(1)

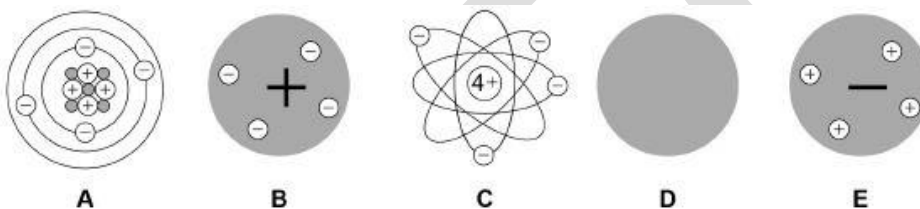
(d) The radius of an atom of element **X** is  $1.2 \times 10^{-10} \text{ m}$

The radius of the centre of the atom is  $\frac{1}{10000}$  the radius of the atom.

Calculate the radius of the centre of an atom of element **X**. Give your answer in standard form.

\_\_\_\_\_ Radius = \_\_\_\_\_ m (2)

**Q2.** The diagram below represents different models of the atom.



(a) Which diagram shows the plum pudding model of the atom? Tick **one** box.

|   |  |
|---|--|
| A |  |
|---|--|

|   |  |
|---|--|
| B |  |
|---|--|

|   |  |
|---|--|
| C |  |
|---|--|

|   |  |
|---|--|
| D |  |
|---|--|

|   |  |
|---|--|
| E |  |
|---|--|

 (1)

(b) Which diagram shows the model of the atom developed from the alpha particle scattering experiment? Tick **one** box.

|   |  |
|---|--|
| A |  |
|---|--|

|   |  |
|---|--|
| B |  |
|---|--|

|   |  |
|---|--|
| C |  |
|---|--|

|   |  |
|---|--|
| D |  |
|---|--|

|   |  |
|---|--|
| E |  |
|---|--|

 (1)

(c) Which diagram shows the model of the atom resulting from Bohr's work? Tick **one** box.

|   |  |
|---|--|
| A |  |
|---|--|

|   |  |
|---|--|
| B |  |
|---|--|

|   |  |
|---|--|
| C |  |
|---|--|

|   |  |
|---|--|
| D |  |
|---|--|

|   |  |
|---|--|
| E |  |
|---|--|

 (1)

(d) Define the mass number of an atom.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (1)

(e) Element **X** has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of  $^{69}\text{X}$
- 40% of  $^{71}\text{X}$

Estimate the relative atomic mass of element **X**. Tick **one** box.

< 69.5

☐

Between 69.5 and 70.0

☐

Between 69.5 and 70.0

☐

Between 70.0 and 70.5

☐

> 70.5

☐

(1)

**A-Level question to give a go!**

**Q1.** Which of these correctly shows the numbers of sub-atomic particles in a  $^{41}\text{K}^+$  ion?

|          | Number of electrons | Number of protons | Number of neutrons |                          |
|----------|---------------------|-------------------|--------------------|--------------------------|
| <b>A</b> | 19                  | 19                | 20                 | <input type="checkbox"/> |
| <b>B</b> | 18                  | 20                | 21                 | <input type="checkbox"/> |
| <b>C</b> | 18                  | 19                | 22                 | <input type="checkbox"/> |
| <b>D</b> | 19                  | 18                | 23                 | <input type="checkbox"/> |

(Total 1 mark)

**Q2.** Magnesium exists as three isotopes:  $^{24}\text{Mg}$ ,  $^{25}\text{Mg}$  and  $^{26}\text{Mg}$

(a) In terms of sub-atomic particles, state the difference between the three isotopes of magnesium.

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(1)

(b) State how, if at all, the chemical properties of these isotopes differ.

Give a reason for your answer.

Chemical properties

Reason

(2)

### Amount of Substance

#### GCSE questions

**Q3.** A student investigated the reactions of copper carbonate and copper oxide with dilute hydrochloric acid. In both reactions one of the products is copper chloride.

(a) A student wanted to make 11.0 g of copper chloride.

The equation for the reaction is:



Relative atomic masses,  $A_r$ : H = 1; C = 12; O = 16; Cl = 35.5; Cu = 63.5

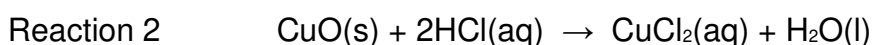
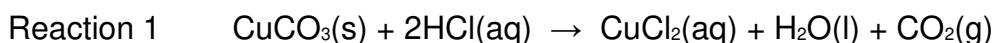
Calculate the mass of copper carbonate the student should react with dilute hydrochloric acid to make 11.0 g of copper chloride.

Mass of copper carbonate = \_\_\_\_\_ g (4)

(b) The percentage yield of copper chloride was 79.1 %. Calculate the mass of copper chloride the student actually produced.

Actual mass of copper chloride produced = \_\_\_\_\_ g (2)

(c) Look at the equations for the two reactions:



Reactive formula masses:  $\text{CuO} = 79.5$ ;  $\text{HCl} = 36.5$ ;  $\text{CuCl}_2 = 134.5$ ;  $\text{H}_2\text{O} = 18$

The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula masses of all reactants from equation}} \times 100$$

Calculate the percentage atom economy for Reaction 2.

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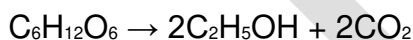
Percentage atom economy = \_\_\_\_\_ % (3)

(d) The atom economy for Reaction 1 is 68.45 %. Compare the atom economies of the two reactions for making copper chloride. Give a reason for the difference.

\_\_\_\_\_ (1)

**A-Level question to give a go!**

**Q3.** Ethanol can be made from glucose by fermentation.



In an experiment, 268 g of ethanol ( $M_r = 46.0$ ) were made from 1.44 kg of glucose ( $M_r = 180.0$ ).

What is the percentage yield?

- A** 18.6% ☐
- B** 36.4% ☐
- C** 51.1% ☐
- D** 72.8% ☐

(Total 1 mark)

**Q4.** A gas cylinder contains 5.0 kg of propane.

How many propane molecules are in the cylinder?

The Avogadro constant,  $L = 6.022 \times 10^{23} \text{ mol}^{-1}$

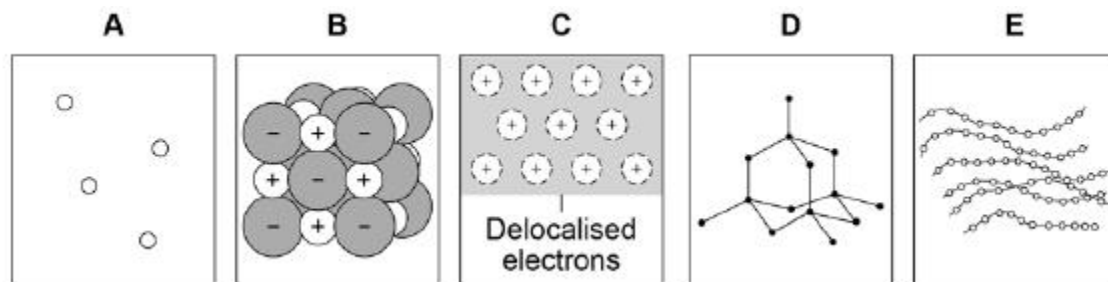
- A**  $6.8 \times 10^{22}$  ☐
- B**  $7.2 \times 10^{22}$  ☐
- C**  $6.8 \times 10^{25}$  ☐
- D**  $7.2 \times 10^{25}$  ☐

(Total 1 mark)

## Bonding

### GCSE questions

**Q4.** Figure 1 shows the structure of five substances.



(a) Which diagram shows a gas? Tick (✓) **one** box.

**A** ☐   
 **B** ☐   
 **C** ☐   
 **D** ☐   
 **E** ☐

(1)

(b) Which diagram shows the structure of diamond? Tick (✓) **one** box.

**A** ☐   
 **B** ☐   
 **C** ☐   
 **D** ☐   
 **E** ☐

(1)

(c) Which diagram shows a metallic structure? Tick (✓) **one** box.

**A** ☐   
 **B** ☐   
 **C** ☐   
 **D** ☐   
 **E** ☐

(1)

(d) Which diagram shows a polymer? Tick (✓) **one** box.

**A** ☐   
 **B** ☐   
 **C** ☐   
 **D** ☐   
 **E** ☐

(1)

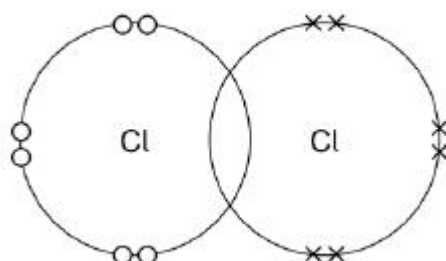
(e) A chlorine atom has 7 electrons in the outer shell.

Two chlorine atoms covalently bond to form a chlorine molecule,  $\text{Cl}_2$

**Figure 2** is a dot and cross diagram showing the outer shells and some electrons in a chlorine molecule.

Complete the dot and cross diagram. Show only the electrons in the outer shell.

**Figure 2**



(1)

(f) What is the reason for chlorine's low boiling point? Tick (✓) **one** box.

Strong covalent bonds ☐

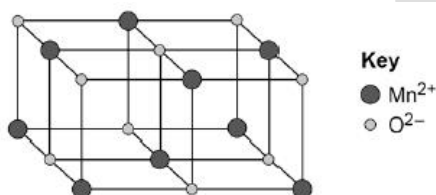
Strong forces between molecules ☐

Weak covalent bonds ☐

Weak forces between molecules ☐

(1)

**Figure 3** represents the structure of manganese oxide. Manganese oxide is an ionic compound.



(g) Determine the empirical formula of manganese oxide. Use **Figure 3**.

\_\_\_\_\_ Empirical  
 formula = \_\_\_\_\_ (1)

(h) Why does manganese oxide conduct electricity as a liquid? Tick (✓) **one** box.

Atoms move around in the liquid ☐

Electrons move around in the liquid ☐

Ions move around in the liquid ☐

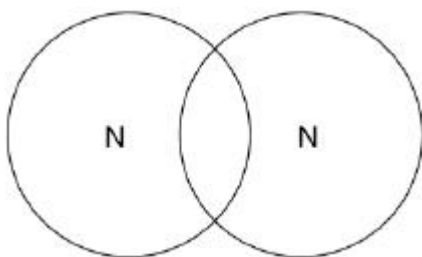
Molecules move around in the liquid ☐

(1)

**Q5.** This question is about structure and bonding.

(a) Complete the dot and cross diagram to show the covalent bonding in a nitrogen molecule,  $\text{N}_2$

Show only the electrons in the outer shell.



(2)

(b) Explain why nitrogen is a gas at room temperature. Answer in terms of nitrogen's structure.

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(3)

(c) Graphite and fullerenes are forms of carbon. Graphite is soft and is a good conductor of electricity.

Explain why graphite has these properties. Answer in terms of structure and bonding.

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(4)

**A-Level question to give a go!**

**Q5.** Which is the correct crystal structure for the substance named?

|          | Substance       | Structure        |                       |
|----------|-----------------|------------------|-----------------------|
| <b>A</b> | Iodine          | Simple molecular | <input type="radio"/> |
| <b>B</b> | Diamond         | Ionic            | <input type="radio"/> |
| <b>C</b> | Sodium chloride | Giant covalent   | <input type="radio"/> |
| <b>D</b> | Graphite        | Metallic         | <input type="radio"/> |

(Total 1 mark)

**Q6.** What is the formula of calcium nitrate(V)?

- A**  $\text{CaNO}_3$  ☐
- B**  $\text{Ca}(\text{NO}_3)_2$  ☐
- C**  $\text{Ca}_2\text{NO}_2$  ☐
- D**  $\text{Ca}(\text{NO}_2)_2$  ☐

(Total 1 mark)

**Q7.** The table shows some data about the elements bromine and magnesium.

| Element          | Melting point / K | Boiling point / K |
|------------------|-------------------|-------------------|
| <b>Bromine</b>   | 266               | 332               |
| <b>Magnesium</b> | 923               | 1383              |

In terms of structure and bonding explain why the boiling point of bromine is different from that of magnesium. Suggest why magnesium is a liquid over a much greater temperature range compared to bromine.

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(Total 5 marks)

## Energetics

### GCSE questions

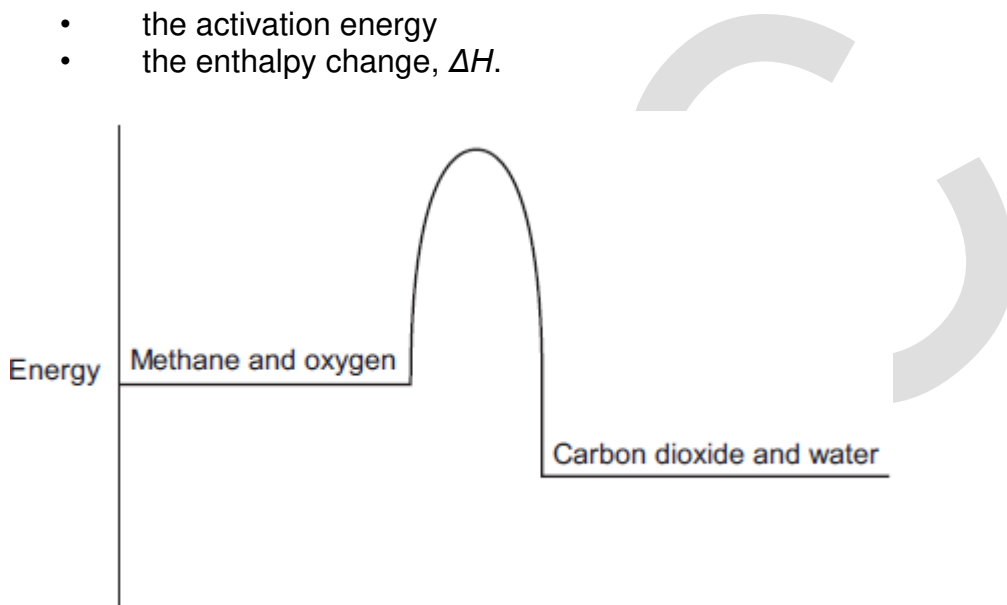
**Q6.** Methane ( $\text{CH}_4$ ) is used as a fuel.

(a) Methane burns in oxygen.

(i) The diagram below shows the energy level diagram for the complete combustion of methane.

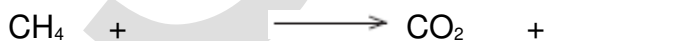
Draw and label arrows on the diagram to show:

- the activation energy
- the enthalpy change,  $\Delta H$ .



(2)

(ii) Complete and balance the symbol equation for the complete combustion of methane.



(2)

(ii) Explain why, in terms of the energy involved in bond breaking and bond making, the combustion of methane is exothermic.

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(3)

(b) Methane reacts with chlorine in the presence of sunlight. The equation for this reaction is:



Some bond dissociation energies are given in the table.

| Bond  | Bond dissociation energy in kJ per mole |
|-------|-----------------------------------------|
| C-H   | 413                                     |
| C-Cl  | 327                                     |
| Cl-Cl | 243                                     |
| H-Cl  | 432                                     |

(i) Show that the enthalpy change,  $\Delta H$ , for this reaction is  $-103$  kJ per mole.

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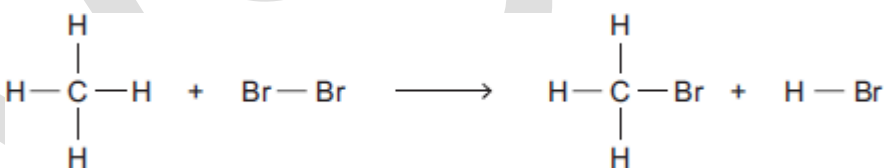
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(3)

(ii) Methane also reacts with bromine in the presence of sunlight.



This reaction is less exothermic than the reaction between methane and chlorine.

The enthalpy change,  $\Delta H$ , is  $-45$  kJ per mole.

What is a possible reason for this? Tick (✓) **one** box.

$\text{CH}_3\text{Br}$  has a lower boiling point than  $\text{CH}_3\text{Cl}$

☐

The C-Br bond is weaker than the C-Cl bond.

☐

The H-Cl bond is weaker than the H-Br bond.

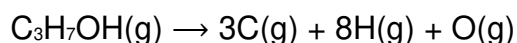
☐

Chlorine is more reactive than bromine.

☐

**A-Level question to give a go!**

**Q8.** Calculate the enthalpy change, in kJ, for this dissociation of mole of propan-1-ol.



|                                                        | C—H | C—C | C—O | O—H |
|--------------------------------------------------------|-----|-----|-----|-----|
| Mean bond dissociation enthalpy / kJ mol <sup>-1</sup> | 412 | 348 | 360 | 463 |

**A**    -4751   

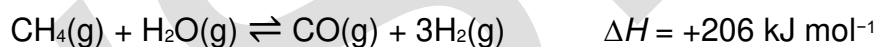
**B**    -4403   

**C**    +4403   

**D**    +4751   

(Total 1 mark)

**Q9.** Hydrogen is produced by the reaction of methane with steam. The reaction mixture reaches a state of dynamic equilibrium.



Some enthalpy data is given in the table.

| Bond                                 | C—H | O—H | H—H | C=O              |
|--------------------------------------|-----|-----|-----|------------------|
| Bond enthalpy / kJ mol <sup>-1</sup> | 413 | 463 | 436 | To be calculated |

Use the information in the table and the stated enthalpy change to calculate the missing bond enthalpy.

**A**    234   

**B**    1064   

**C**    1476   

**D**    1936   

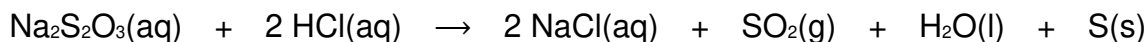
(Total 1 mark)

## Kinetics

### GCSE questions

**Q7.** When sodium thiosulfate solution reacts with dilute hydrochloric acid, the solution becomes cloudy.

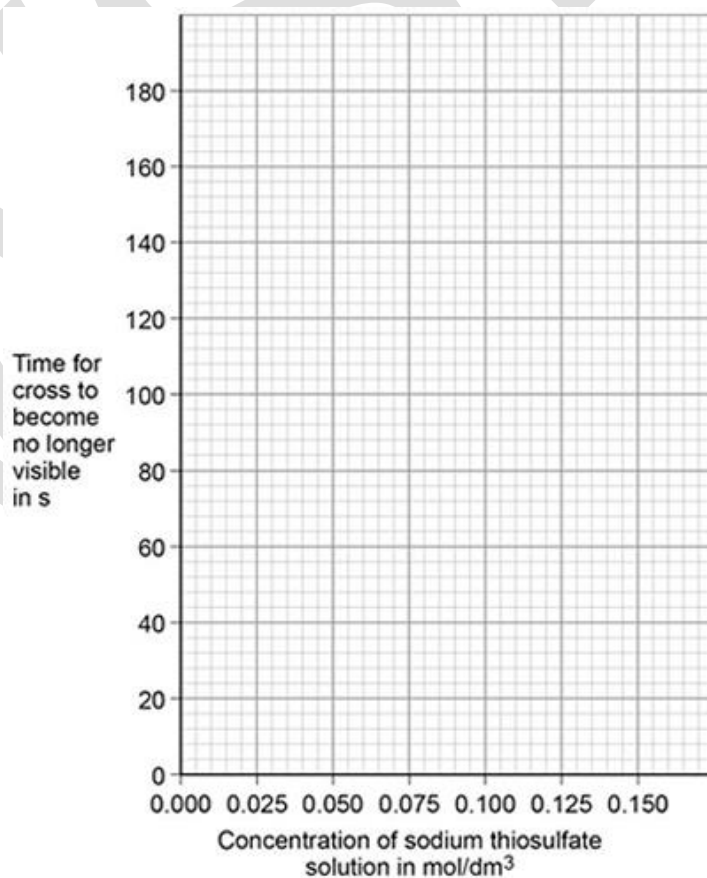
The equation for the reaction is:



Some students used this reaction to investigate the effect of concentration on rate of reaction. The table shows the students' results.

| Concentration of sodium thiosulfate solution in mol / dm <sup>3</sup> | Time for cross to become no longer visible in s |
|-----------------------------------------------------------------------|-------------------------------------------------|
| 0.020                                                                 | 170                                             |
| 0.040                                                                 | 90                                              |
| 0.060                                                                 | 82                                              |
| 0.080                                                                 | 42                                              |
| 0.100                                                                 | 34                                              |
| 0.120                                                                 | 30                                              |
| 0.140                                                                 | 28                                              |

- (a) Plot the data from the table above on the graph below. Draw a line of best fit.



The students repeated the investigation two more times. They obtained similar results each time.

(b) The students analysed their results to give a conclusion and an explanation for their investigation.

**Conclusion:** 'The higher the concentration, the lower the rate of reaction.'

**Explanation:** 'At higher concentrations, the particles have more energy, so they are moving faster. Therefore the collisions are more energetic.'

The students are not correct.

Give a **correct** conclusion **and** explanation for the results of the investigation.

Conclusion

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Explanation

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(3)

(c) A solution containing 0.18 g of sodium thiosulfate reacts with dilute hydrochloric acid in 2 minutes.

Calculate the mean rate of reaction in g / s. Give your answer in standard form.

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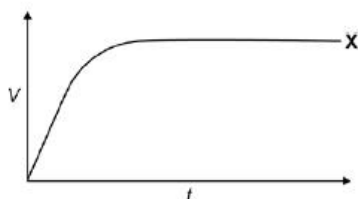
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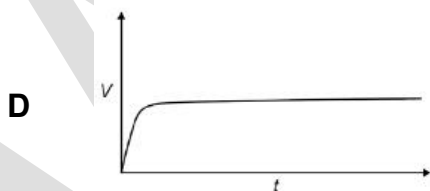
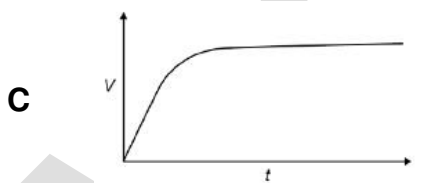
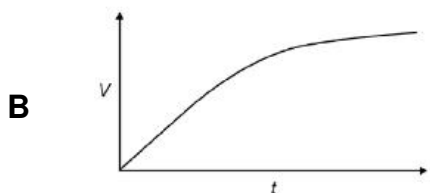
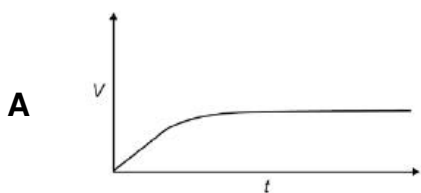
Mean rate of reaction = \_\_\_\_\_ g / s (3)

**A-Level question to give a go!**

**Q10.** Line **X** in the diagram represents the volume ( $V$ ) of gas formed with time ( $t$ ) in a reaction between an excess of magnesium and aqueous sulfuric acid.

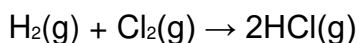


Which line represents the volume of hydrogen formed, at the same temperature and pressure, when the concentration of sulfuric acid has been halved?



(Total 1 mark)

**Q11.** The gas-phase reaction between hydrogen and chlorine is very slow at room temperature.



(a) Define the term *activation energy*.

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(2)

(b) Give **one** reason why the reaction between hydrogen and chlorine is very slow at room temperature.

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(1)

(c) Explain why an increase in pressure, at constant temperature, increases the rate of reaction between hydrogen and chlorine.

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(2)

(d) Explain why a small increase in temperature can lead to a large increase in the rate of reaction between hydrogen and chlorine.

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(2)

(e) Give the meaning of the term *catalyst*.

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(1)

(f) Suggest **one** reason why a solid catalyst for a gas-phase reaction is often in the form of a powder.

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(1)

## Chemical Equilibria, Le Chatelier's Principle and $K_c$

### GCSE questions

**Q8.** In industry ethanol is produced by the reaction of ethene and steam at 300°C and 60 atmospheres pressure using a catalyst.

The equation for the reaction is:  $\text{C}_2\text{H}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{C}_2\text{H}_5\text{OH}(\text{g})$

(a) The forward reaction is exothermic.

Use Le Chatelier's Principle to predict the effect of increasing temperature on the amount of ethanol produced at equilibrium. Give a reason for your prediction.

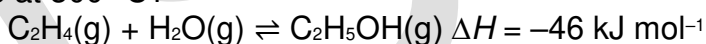
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)

(b) Explain how increasing the pressure of the reactants will affect the amount of ethanol produced at equilibrium.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)

### A-Level question to give a go!

**Q12.** Which statement is **not** correct about the industrial preparation of ethanol by the hydration of ethene at 300 °C?



- A** The reaction is catalysed by an acid.
- B** The higher the pressure, the higher the equilibrium yield of ethanol.
- C** The higher the temperature, the higher the equilibrium yield of ethanol.
- D** A low equilibrium yield of ethanol is acceptable because unreacted ethene is recycled.

☐☐☐☐

(Total 1 mark)

**Q13.** The forward reaction in this equilibrium is endothermic



Which statement is correct?

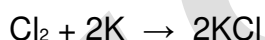
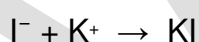
- A** If the total pressure is increased at constant temperature, the proportion of  $\text{COCl}_2$  in the equilibrium mixture will decrease ☐
- B** Use of a catalyst will increase the proportion of  $\text{COCl}_2$  in the equilibrium mixture at constant temperature and pressure ☐
- C** Reducing the equilibrium concentration of  $\text{CO}$  will increase the value of the equilibrium constant ☐
- D** Raising the temperature from 373 K to 473 K will increase the value of the equilibrium constant ☐

### Oxidation, Reduction and Redox equations

#### GCSE questions

**Q9.** This question is about halogens and their compounds.

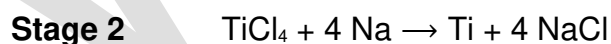
(a) What is the ionic equation for the reaction of chlorine with potassium iodide? Tick **one** box.

☐☐☐☐

(1)

**Q10.** Titanium is a transition metal.

Titanium is extracted from titanium dioxide in a two-stage industrial process.

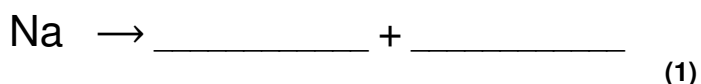


In **Stage 2**, sodium displaces titanium from titanium chloride.

(a) Sodium atoms are oxidised to sodium ions in this reaction. Why is this an oxidation reaction?

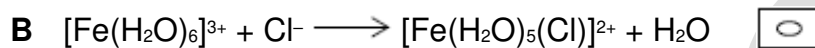
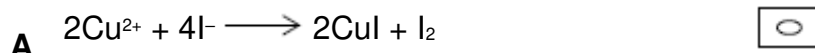
(1)

(b) Complete the half equation for the oxidation reaction.



**A-Level question to give a go!**

**Q14.** In which reaction is the metal oxidised?



(Total 1 mark)

**Periodicity**

**GCSE questions**

**Q11.** This question is about metals.

(a) Which unreactive metal is found in the Earth as the metal itself? Tick (✓) **one** box

aluminium ☐

gold ☐

magnesium ☐

(1)

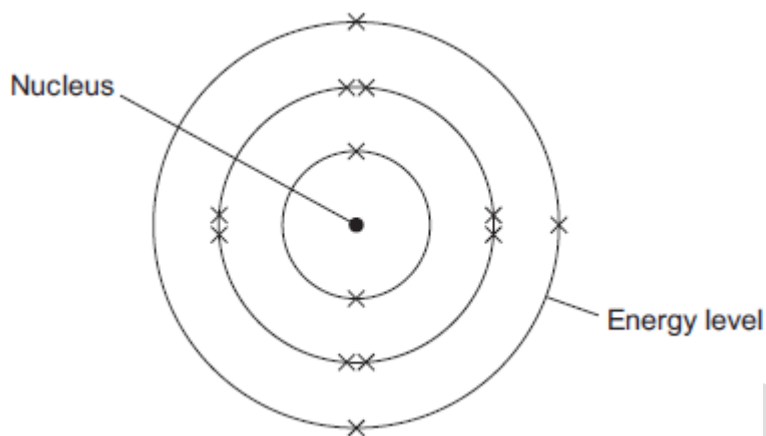
(b) Complete the sentence.

Aluminium is an element because aluminium is made of only one type of

\_\_\_\_\_.

(1)

(c) **Figure 1** shows the electronic structure of an aluminium atom.



- (i) Use the correct words from the box to complete the sentence.

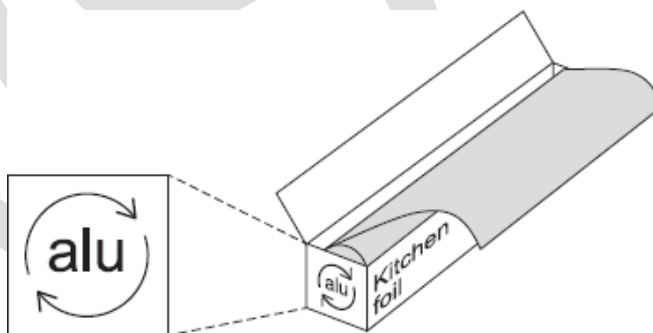
|           |      |         |          |        |
|-----------|------|---------|----------|--------|
| electrons | ions | protons | neutrons | shells |
|-----------|------|---------|----------|--------|

The nucleus of an aluminium atom contains \_\_\_\_\_ and \_\_\_\_\_.  
(2)

- (ii) Complete the sentence.

In the periodic table, aluminium is in Group \_\_\_\_\_.  
(1)

- (d) Aluminium is used for kitchen foil. **Figure 2** shows a symbol on a box of kitchen foil.



The symbol means that aluminium can be recycled. It does not show the correct chemical symbol for aluminium.

- (i) What is the correct chemical symbol for aluminium?  
\_\_\_\_\_. (1)

- (ii) Give **two** reasons why aluminium should be recycled.

\_\_\_\_\_  
\_\_\_\_\_ (2)

(e) Aluminium has a low density, conducts electricity and is resistant to corrosion.

Which **one** of these properties makes aluminium suitable to use as kitchen foil? Give a reason for your answer.

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(2)

**A-Level question to give a go!**

**Q15.** Which of the following is a correct statement about the trend in atomic radius across Period 3 of the Periodic Table?

- A** radius increases because the atoms have more electrons ☐
- B** radius decreases because nuclear charge increases ☐
- C** radius increases because shielding (screening) increases ☐
- D** radius decreases because shielding (screening) decreases ☐

(Total 1 mark)

**Group 2 – The Alkaline Earth Metals**

**GCSE questions**

**Q12.** This question is about compounds.

- (a) The table gives information about the solubility of some compounds.

| Soluble compounds                                           |
|-------------------------------------------------------------|
| All potassium and sodium salts                              |
| All nitrates                                                |
| Chlorides, bromides and iodides, except those of silver and |

Use information from the table to answer these questions.

- (i) Name a soluble compound that contains silver ions.

---

(1)

- (ii) Name a soluble compound that contains carbonate ions.

---

(1)

(b) Metal oxides react with acids to make salts. What type of compound is a metal oxide?

\_\_\_\_\_ (1)

(c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.

(i) State how solid lead nitrate can be obtained from lead nitrate solution.

\_\_\_\_\_ (1)

(ii) Balance the equation for the reaction.



(1)

(iii) Give the total number of atoms in the formula  $\text{Pb}(\text{NO}_3)_2$

\_\_\_\_\_ (1)

**A-Level question to give a go!**

**Q16.** (a) Nickel is a metal with a high melting point.

(i) Explain, in terms of its structure and bonding, why nickel has a high melting point.

\_\_\_\_\_ (2)

(ii) Draw a labelled diagram to show the arrangement of particles in a crystal of nickel.

In your answer, include at least six particles of each type.

(2)

(iii) Explain why nickel is ductile (can be stretched into wires).

\_\_\_\_\_ (1)

## Group 7 – The Halogens

### GCSE questions

**Q13.** The halogens are elements in Group 7.

(a) Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom.

\_\_\_\_\_ (1)

(b) Bromine reacts with hydrogen. The gas hydrogen bromide is produced.

What is the structure of hydrogen bromide? Tick **one** box.

Giant covalent ☐

Ionic lattice ☐

Metallic structure ☐

Small molecule ☐

(1)

(c) What is the formula for fluorine gas? Tick **one** box.

F ☐

F<sub>2</sub> ☐

F<sup>2</sup> ☐

2F ☐

(1)

A student mixes solutions of halogens with solutions of their salts.

The table below shows the student's observations.

|                          | Potassium chloride<br>(colourless) | Potassium bromide<br>(colourless) | Potassium iodide<br>(colourless) |
|--------------------------|------------------------------------|-----------------------------------|----------------------------------|
| Chlorine<br>(colourless) |                                    | Solution turns orange             | Solution turns brown             |
| Bromine<br>(orange)      | No change                          |                                   | Solution turns brown             |
| Iodine (brown)           | No change                          | No change                         |                                  |

(d) Explain how the reactivity of the halogens changes going down Group 7. Use the results in the table above.

(3)

**A-Level question to give a go!**

**Q17.** An aqueous solution of a white solid gives a yellow precipitate with aqueous silver nitrate. The formula of the white solid could be

- A AgBr
- B AgI
- C NaBr
- D NaI

(Total 1 mark)

**Q18.** What will you see when a solution of silver nitrate is added to a solution containing bromide ions, and concentrated aqueous ammonia is added to the resulting mixture?

- A a white precipitate soluble in concentrated aqueous ammonia
- B a white precipitate insoluble in concentrated aqueous ammonia
- C a cream precipitate soluble in concentrated aqueous ammonia
- D a yellow precipitate insoluble in concentrated aqueous ammonia

(Total 1 mark)

**Introduction to Organic Chemistry**

**GCSE questions**

**Q14.** Scientists found that a compound contained:

22.8% sodium; 21.8% boron; and 55.4% oxygen.

Use the percentages to calculate the empirical formula of the compound.

Relative atomic masses ( $A_r$ ): B = 11; O = 16; Na = 23

To gain full marks you **must** show all your working.

Empirical formula = \_\_\_\_\_ (Total 5 marks)

**A-Level question to give a go!**

**Q19.** An organic compound is found to contain 40.0% carbon, 6.7% hydrogen and 53.3% oxygen.

Which of the following compounds could this be?

**A** Ethanol

☐

**B** Ethanoic acid

☐

**C** Methanol

☐

**D** Methanoic acid

☐

(Total 1 mark)

**Alkanes**

**GCSE questions**

**Q15.** This question is about hydrocarbons.

The table gives information about four hydrocarbons. The hydrocarbons are four successive members of a homologous series.

| Hydrocarbon | Formula     | Boiling point in |
|-------------|-------------|------------------|
| <b>A</b>    | $C_4H_{10}$ | 0                |
| <b>B</b>    |             | 36               |
| <b>C</b>    | $C_6H_{14}$ | 69               |
| <b>D</b>    | $C_7H_{16}$ | 98               |

(a) What is the formula of hydrocarbon **B**? Tick (✓) **one** box.

$C_4H_{12}$  ☐

$C_5H_{12}$  ☐

$C_5H_{12}$  ☐

$C_6H_{12}$  ☐

(1)

(b) What is the simplest ratio of carbon : hydrogen atoms in a molecule of hydrocarbon **A**?

Ratio = 2 : \_\_\_\_\_  
(1)

(c) Which hydrocarbon is a gas at room temperature (25 °C)? Tick (✓) **one** box.

**A** ☐

**B** ☐

**C** ☐

**D** ☐

(1)

(d) Which hydrocarbon is most flammable? Tick (✓) **one** box.

**A** ☐

**B** ☐

**C** ☐

**D** ☐

(1)

(e) Which **two** substances are produced when a hydrocarbon **completely** combusts in air? Tick (✓) **two** boxes.

Carbon ☐

Carbon dioxide ☐

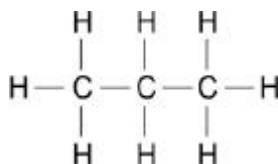
Hydrogen ☐

Sulfur dioxide ☐

Water ☐

(2)

The diagram shows the displayed structure of a hydrocarbon molecule.



- (f) What is the name of the hydrocarbon in the diagram above? Tick (✓) **one** box.

|         |                          |
|---------|--------------------------|
| Butane  | <input type="checkbox"/> |
| Ethane  | <input type="checkbox"/> |
| Methane | <input type="checkbox"/> |
| Propane | <input type="checkbox"/> |

(1)

**Q16.** This question is about hydrocarbons.

- (a) The names and formulae of three hydrocarbons in the same homologous series are:

|         |             |
|---------|-------------|
| Ethane  | $C_2H_6$    |
| Propane | $C_3H_8$    |
| Butane  | $C_4H_{10}$ |

The next member in the series is pentane. What is the formula of pentane?

\_\_\_\_\_  
\_\_\_\_\_ (1)

- (b) Which homologous series contains ethane, propane and butane? Tick **one** box.

|                  |                          |
|------------------|--------------------------|
| Alcohols         | <input type="checkbox"/> |
| Alkanes          | <input type="checkbox"/> |
| Alkenes          | <input type="checkbox"/> |
| Carboxylic acids | <input type="checkbox"/> |

(1)

- (c) Propane ( $C_3H_8$ ) is used as a fuel. Complete the equation for the complete combustion of propane.



(2)

- (d) Octane ( $C_8H_{18}$ ) is a hydrocarbon found in petrol. Explain why octane is a hydrocarbon.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)

- (e) The table below gives information about the pollutants produced by cars using diesel or petrol as a fuel.

| Fuel   | Relative amounts of pollutants |                    |                |
|--------|--------------------------------|--------------------|----------------|
|        | Oxides of Nitrogen             | Particulate matter | Carbon dioxide |
| Diesel | 31                             | 100                | 85             |
| Petrol | 23                             | 0                  | 100            |

Compare the pollutants from cars using diesel with those from cars using petrol.

(3)

(f) Pollutants cause environmental impacts. Draw **one** line from each pollutant to the environmental impact caused by the pollutant.

Pollutant

Oxides of nitrogen

Particulate matter

Environmental impact caused by the pollutant

Acid rain

Flooding

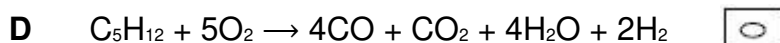
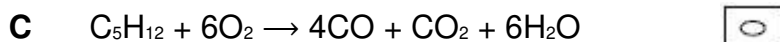
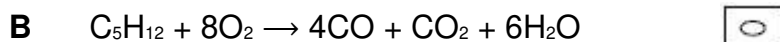
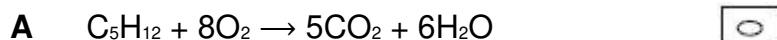
Global dimming

Global warming

Photosynthesis

**A-Level question to give a go!**

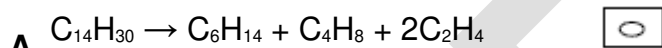
**Q20.** Which correctly represents an incomplete combustion of pentane?



(Total 1 mark)

**Q21.** Tetradecane ( $\text{C}_{14}\text{H}_{30}$ ) is an alkane found in crude oil. When tetradecane is heated to a high temperature, one molecule of tetradecane decomposes to form one molecule of hexane and three more molecules.

Which of the following could represent this reaction?



(Total 1 mark)

**Q22.** Petrol contains saturated hydrocarbons. Some of the molecules in petrol have the molecular formula  $\text{C}_8\text{H}_{18}$  and are referred to as octanes. These octanes can be obtained from crude oil by fractional distillation and by cracking suitable heavier fractions.

Petrol burns completely in a plentiful supply of air but can undergo incomplete combustion in a car engine.

(a) State the meaning of both the words *saturated* and *hydrocarbon* as applied to the term *saturated hydrocarbon*. Name the homologous series to which  $\text{C}_8\text{H}_{18}$  belongs.

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(3)

(b) Outline the essential features of the fractional distillation of crude oil that enable the crude oil to be separated into fractions.

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(4)

### Halogenalkanes

#### GCSE questions

**Q17.** During the test for unsaturation – a haloalkane is made. Describe the test for unsaturation

Test

Result

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(2)

### Alkenes

#### GCSE questions

**Q18.** This question is about organic compounds. Hydrocarbons can be cracked to produce smaller molecules.

The equation shows the reaction for a hydrocarbon,  $C_{18}H_{38}$



(a) Which product of the reaction shown is an alkane? Tick **one** box.

$C_2H_4$

☐

$C_3H_6$

☐

$C_4H_8$

☐

$C_6H_{14}$

☐

(1)

(b) The table below shows the boiling point, flammability and viscosity of  $C_{18}H_{38}$  compared with the other hydrocarbons shown in the equation.

|          | Boiling point | Flammability | Viscosity |
|----------|---------------|--------------|-----------|
| <b>A</b> | highest       | lowest       | highest   |
| <b>B</b> | highest       | lowest       | lowest    |
| <b>C</b> | lowest        | highest      | highest   |
| <b>D</b> | lowest        | highest      | lowest    |

Which letter, **A**, **B**, **C** or **D**, shows how the properties of  $C_{18}H_{38}$  compare with the properties of  $C_2H_4$ ,  $C_3H_6$ ,  $C_4H_8$  and  $C_6H_{14}$ ? Tick **one** box.

- A** ☐
- B** ☐
- C** ☐
- D** ☐

(1)

(c) The hydrocarbon  $C_4H_8$  was burnt in air. Incomplete combustion occurred.

Which equation, **A**, **B**, **C** or **D**, correctly represents the incomplete combustion reaction?

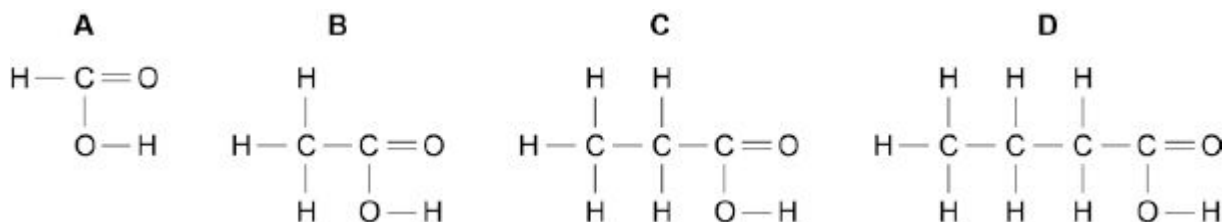
- A**  $C_4H_8 + 4O \rightarrow 4CO + 4H_2$
- B**  $C_4H_8 + 4O_2 \rightarrow 4CO + 4H_2O$
- C**  $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$
- D**  $C_4H_8 + 8O \rightarrow 4CO_2 + 4H_2$

Tick **one** box.

- A** ☐
- B** ☐
- C** ☐
- D** ☐

(1)

(d) Propanoic acid is a carboxylic acid. Which structure, **A**, **B**, **C** or **D**, shows propanoic acid?



Tick **one** box.

|          |                          |
|----------|--------------------------|
| <b>A</b> | <input type="checkbox"/> |
| <b>B</b> | <input type="checkbox"/> |
| <b>C</b> | <input type="checkbox"/> |
| <b>D</b> | <input type="checkbox"/> |

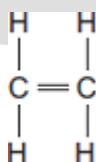
(1)

(e) Propanoic acid is formed by the oxidation of which organic compound? Tick **one** box.

|           |                          |
|-----------|--------------------------|
| Propane   | <input type="checkbox"/> |
| Propene   | <input type="checkbox"/> |
| Propanol  | <input type="checkbox"/> |
| Polyester | <input type="checkbox"/> |

(1)

**Q19.** A molecule of ethene ( $\text{C}_2\text{H}_4$ ) is represented as:



(a) A sample of ethene is shaken with bromine water. Complete the sentence.

The bromine water turns from orange to \_\_\_\_\_

(1)

(b) Most ethene is produced by the process of cracking.

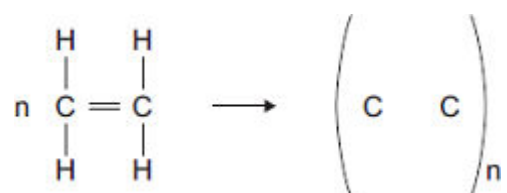
(i) Decane ( $\text{C}_{10}\text{H}_{22}$ ) can be cracked to produce ethene ( $\text{C}_2\text{H}_4$ ) and **one** other product.

Complete the equation to show the formula of the other product.



(c) Many molecules of ethene join together to produce poly(ethene).

(i) Complete the structure of the polymer in the equation.



(2)

(ii) Some carrier bags are made from poly(ethene). Some carrier bags are made from cornstarch.

Suggest **two** benefits of using cornstarch instead of poly(ethene) to make carrier bags.

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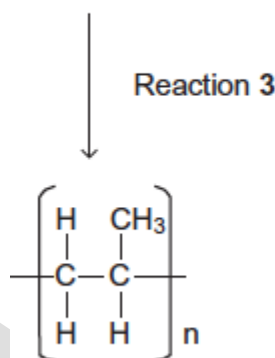
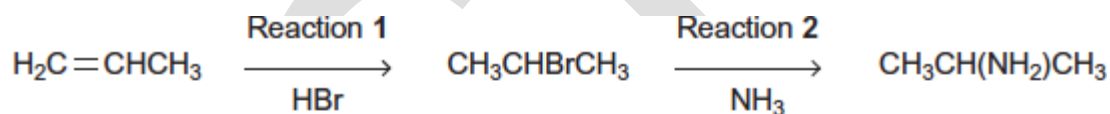
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(2)

**A-Level question to give a go!**

**Q23.** Consider the following reactions.



substance **X**

(a) State the type of reaction in Reaction 3. Give the name of substance **X**.

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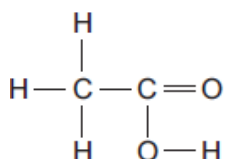
(2)

## Alcohols

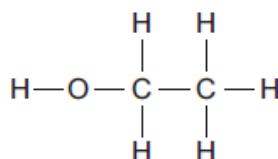
### GCSE questions

**Q20.** The diagrams represent two compounds, **A** and **B**.

**Compound A**



**Compound B**



- (a) (i) Compound **B** is an alcohol. Name compound **B**.

(1)

- (ii) Use the correct answer from the box to complete the sentence.

burned    decomposed    oxidised

To form compound **A**, compound **B** is

(1)

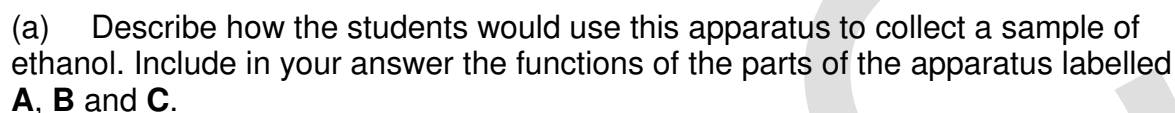
- (iii) Compounds **A** and **B** are both colourless liquids.

A test tube contains a colourless liquid, which could be either compound **A** or compound **B**. Describe a simple **chemical** test to show which compound, **A** or **B**, is in the test tube.

(2)

### A-Level question to give a go!

**Q24.** A group of students wanted to produce a biofuel to power the central heating system in their school. They collected scraps of fruits and vegetables from the kitchens and fermented them with yeast, in the absence of air, in order to produce ethanol. The aqueous mixture was filtered to remove the remaining solids. The students then set up the apparatus shown in the diagram below and placed the aqueous mixture in the round bottomed flask.

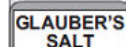
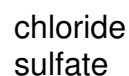
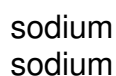
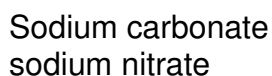


(a) Describe how the students would use this apparatus to collect a sample of ethanol. Include in your answer the functions of the parts of the apparatus labelled **A**, **B** and **C**.

## Organic Analysis

## GCSE questions

**Q21.** Four bottles of chemicals made in the 1880s were found recently in a cupboard during a Health and Safety inspection at Lovell Laboratories.



The chemical names are shown below each bottle.

(a) You are provided with the following reagents:

- aluminium powder
- barium chloride solution acidified with dilute hydrochloric acid
- dilute hydrochloric acid
- silver nitrate solution acidified with dilute nitric acid
- sodium hydroxide solution.
- limewater
- red litmus paper

(i) Describe tests that you could use to show that these chemicals are correctly named.

In each case give the reagent(s) you would use **and** state the result.

Test and result for carbonate ions:

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Test and result for chloride ions:

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Test and result for nitrate ions:

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Test and result for sulfate ions:

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(4)

(ii) Suggest why a flame test would **not** distinguish between these four chemicals.

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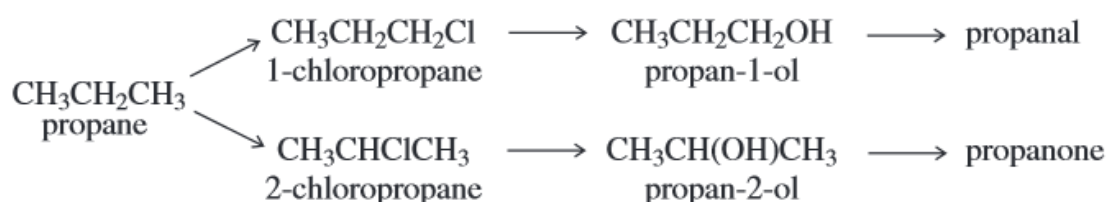
(1)

(b) Instrumental methods of analysis linked to computers can be used to identify chemicals. Give **two** advantages of using instrumental methods of analysis.

(2)

**A-Level question to give a go!**

**Q25.** Consider the following scheme of reactions.



(a) High resolution mass spectrometry of a sample of propane indicated that it was contaminated with traces of carbon dioxide.

Use the data in the table to show how precise  $M_r$  values can be used to prove that the sample contains both of these gases.

| Atom            | Precise relative atomic mass |
|-----------------|------------------------------|
| $^{12}\text{C}$ | 12.00000                     |
| $^1\text{H}$    | 1.00794                      |
| $^{16}\text{O}$ | 15.99491                     |

(2)

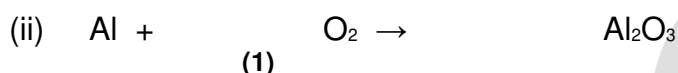
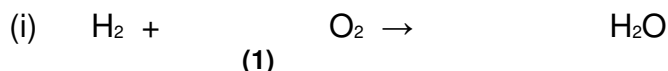
# GCSE to A-Level Chemistry – Skills Transition

## Balancing Equations

Use this method to help you <https://www.youtube.com/watch?v=ab0gYBdHU-k>

### GCSE questions

**Q1.** (a) Balance these chemical equations.



(b) Briefly explain why an unbalanced chemical equation cannot fully describe a reaction.

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(2)

**Q2.** The following passage was taken from a chemistry textbook.

Germanium is a white, shiny, brittle element. It is used in the electronics industry because it is able to conduct a small amount of electricity.

It is made from germanium oxide obtained from flue dusts of zinc and lead smelters. The impure germanium oxide from the flue dusts is changed into germanium by the process outlined below.

**STEP 1** The germanium oxide is reacted with hydrochloric acid to make germanium tetrachloride. This is a volatile liquid in which the germanium and chlorine atoms are joined by covalent bonds.

**STEP 2** The germanium tetrachloride is distilled off from the mixture.

**STEP 3** The germanium tetrachloride is added to an excess of water to produce germanium oxide and hydrochloric acid.

**STEPS 1 to 3** are repeated several times.

**STEP 4** The pure germanium oxide is reduced by hydrogen to form germanium.

(a) Balance the equation below which represents the reaction in step 1.



(b) Write a word equation for the reaction in step 4.

---

(1)

**Q3.** (a) Cola drinks contain phosphoric acid,  $\text{H}_3\text{PO}_4$ . The two equations show how phosphoric acid can be made from phosphorus.

Balance these two equations.

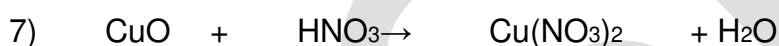
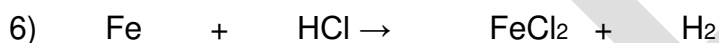


(1)



(1)

Some more practice

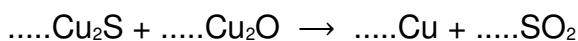


[Even more practice - Balancing Equations Game](#)

**A-Level question to give a go!**

**Q11.** Copper can be produced from rock that contains  $\text{CuFeS}_2$

(a) Balance the equations for the two stages in this process.



(2)

## Formula Literacy

For each of the following compounds;

- Identify the number of atoms of each element
- The formula of the ions it consists of
- Name it
- Calculate its RFM

e.g. the first one is done for you:

### 1. $\text{NaNO}_3$

1 x sodium atom, 1 x nitrogen atom, 3 x oxygen atoms

$\text{Na}^+$  and  $\text{NO}_3^-$

Sodium nitrate

**RFM:**  $(1 \times 23) + (1 \times 14) + (3 \times 16) = 85\text{g}$

### 2. $\text{Na}_2\text{O}$

### 3. $\text{K}_3\text{PO}_4$

### 4. $\text{CaBr}_2$

### 5. $\text{Al}_2\text{O}_3$

### 6. $\text{NH}_4\text{OH}$

### 7. $(\text{NH}_4)_2\text{SO}_4$

## SI units

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          |

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

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

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.

| 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  | $\mu$  | $10^{-6}$             | 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 |

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.

**For the following quantities, which SI unit and most appropriate prefix would you use?**

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.

***Rewrite the following quantities.***

7. 0.00122 metres in millimetres

8. 104 micrograms in grams

9. 1.1202 kilometres in metres

10. 70 decilitres in millilitres

11. 70 decilitres in litres

12.  $10 \text{ cm}^3$  in litres

## A-Level Chemistry Baseline Assessment

Name \_\_\_\_\_

The following 40 mark assessment is designed to test your recall, analysis and evaluative skills and knowledge.

Remember to use your exam technique: look at the command words and the number of marks each question is worth. This will be handed in to your chemistry teacher on your **first chemistry lesson**.

1. Write the formula of the ions:

- a. potassium ion
- b. silver ion
- c. ammonium ion
- d. zinc ion
- e. magnesium ion

[5]

2. Write the formula of the ions:

- a. sulfate ion
- b. hydride ion
- c. bromide ion
- d. sulfide ion
- e. phosphate ion

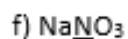
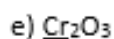
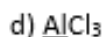
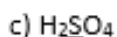
[5]

3. Write the formula of:

- a. sulfuric acid
- b. nitric acid
- c. ammonia
- d. calcium hydroxide
- e. sodium carbonate

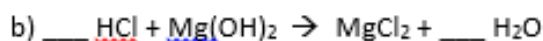
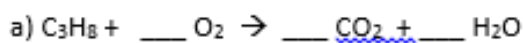
[5]

4. Give the oxidation state of the underlined atom in the following chemicals.  
Useful information: H=+1, K=+1, Na=+1, Mg=+2, O=-2, Cl=-1



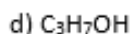
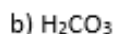
[7]

5. Balance the following equations:



6. Calculate the relative formula masses of the following:

Atomic masses: H=1, O=16, S=32.1, C=12, Ca=40.1, Na=23, Cl=35.5, Zn=64.4



[5]

7. Vinegar is a solution of ethanoic acid ( $\text{CH}_3\text{COOH}$ ) in water. A student carried out a titration of a sample of vinegar. He used a pipette to measure exactly  $25.0 \text{ cm}^3$  of vinegar into a flask, added an indicator and titrated it with a  $1.00 \text{ mol dm}^{-3}$  solution of sodium hydroxide ( $\text{NaOH}$ ).



The student found that his average titration was  $27.50 \text{ cm}^3$

$$c = n/v$$

$$v = \text{volume (dm}^3\text{)}$$

$c = \text{concentration (mol dm}^{-3}\text{)}, n = \text{amount in moles,}$

$$n = m/M$$

$n = \text{amount in moles, } m = \text{mass (g), } M = \text{formula mass}$

$$1 \text{ dm}^3 = 1000 \text{ cm}^3$$

a. Using the chemical equation, how many moles of sodium hydroxide will react with 1 mole of ethanoic acid?

[1]

b. How many moles of sodium hydroxide are in  $27.50 \text{ cm}^3$  of  $1.00 \text{ mol dm}^{-3}$  sodium hydroxide? [1]

c. How many moles of ethanoic acid are in  $25.0 \text{ cm}^3$  of the vinegar sample? [1]

d. How many moles of ethanoic acid are in 1 dm<sup>3</sup> of vinegar?

[1]

e. Ethanoic acid has a molecular mass of 60. What mass of ethanoic acid is present in 1dm<sup>3</sup> of vinegar?

[1]

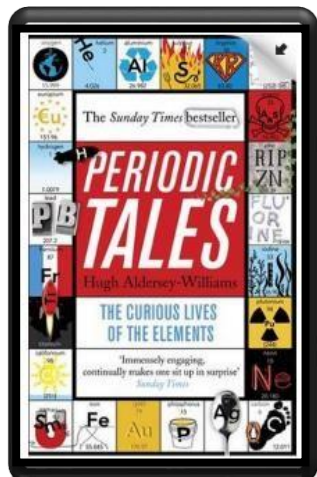
Total score \_\_\_\_\_

Teacher comment \_\_\_\_\_

## 4. Optional activities that you may enjoy:

### Book Recommendations

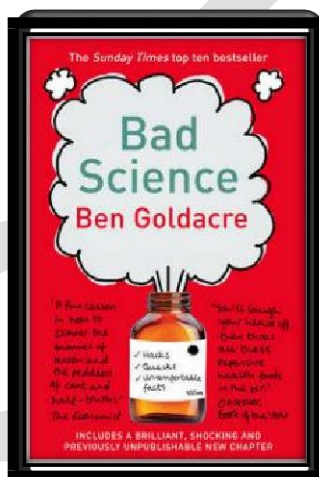
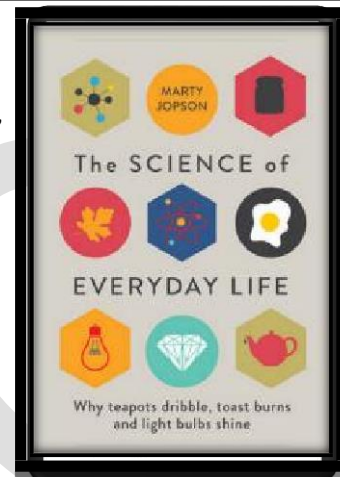
Kick back this summer with a good read. The books below are all popular science books and great for extending your understanding of chemistry



**Periodic Tales:  
The Curious Lives  
of the Elements**  
This book covers the chemical elements, where they come from and how they are used. There are loads of fascinating insights into uses for chemicals you would have never even thought about.

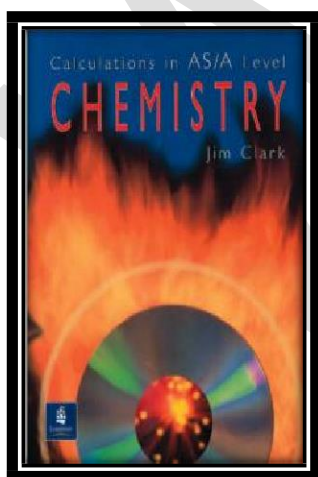
#### The Science of Everyday Life: Why Teapots Dribble, Toast Burns and Light Bulbs Shine

The title says it all really, lots of interesting stuff about the things around your home!



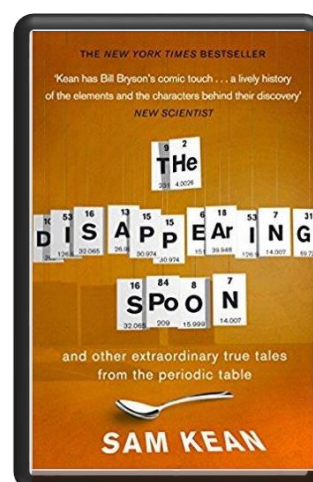
#### Bad Science

Here Ben Goldacre takes apart anyone who published bad / misleading or dodgy science – this book will make you think about everything the advertising industry tries to sell you by making it sound 'sciencey'. Bad Medicine is also worth a read.



#### Calculations in AS/A Level Chemistry

If you struggle with the calculations side of chemistry, this is the book for you. Covers all the possible calculations you are ever likely to come across. Brought to you by the same guy who wrote the excellent [chemguide.co.uk](http://chemguide.co.uk) website.



One of our crowning scientific achievements is also a treasure trove of passion, adventure, betrayal and obsession. **The Disappearing Spoon** follows the elements, their parts in human history, finance, mythology, conflict, the arts, medicine and the lives of the (frequently) mad scientists who discovered them.

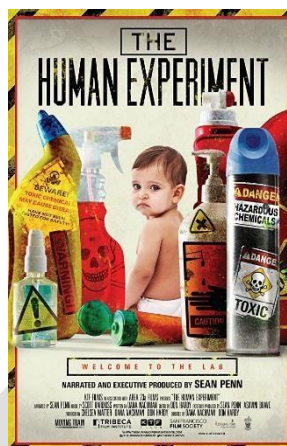
## Movie Recommendations

Everyone loves a good story and everyone loves some great science. Here are some of the picks of the best films based on real life scientists and discoveries. You won't find Jurassic Park on this list! Great watching for a rainy day.



### An Inconvenient Truth (2006)

Al Gore, former presidential candidate campaigns to raise public awareness of the dangers of global warming and calls for immediate action to curb its destructive effects on the environment. (See also: An Inconvenient Sequel, 2017)

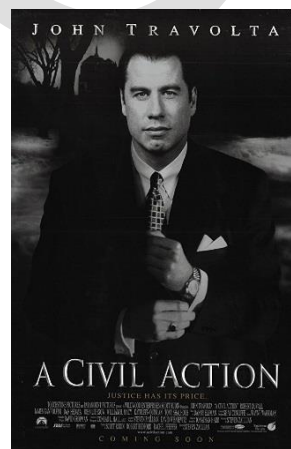


### The Human Experiment (2013)

A documentary that explores chemicals found in everyday household products.

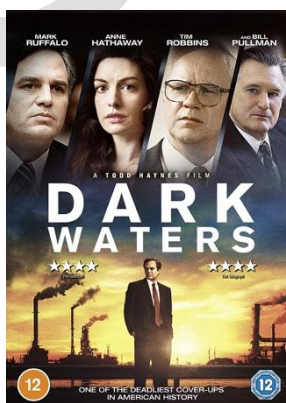
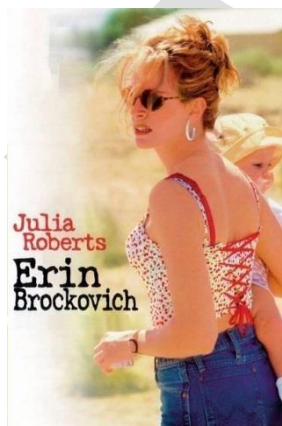
### A Civil Action (1998)

A tenacious lawyer takes on a case involving a major company responsible for causing several people to be diagnosed with leukemia due to the town's water supply being contaminated, at the risk of bankrupting his firm and career.



### Erin Brokovich (2000)

Based on a true story. An unemployed single mother becomes a legal assistant and almost single-handedly brings down a California power company accused of polluting a city's water supply.



### Dark Waters (2019)

A corporate defense attorney takes on an environmental lawsuit against Dupont (makers of Teflon) that exposes a lengthy history of pollution.

## TED Talks

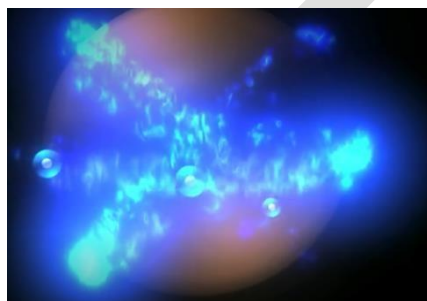
If you have 30 minutes to spare, here are some great presentations (and free!) from world leading scientists and researchers on a variety of topics. They provide some interesting answers and ask some thought-provoking questions. Use the link or scan the QR code to view:

### Play with Smart Materials

Available at :

[https://www.ted.com/talks/catarina\\_mota\\_play\\_with\\_smart\\_materials](https://www.ted.com/talks/catarina_mota_play_with_smart_materials)

Ink that conducts electricity; a window that turns from clear to opaque at the flip of a switch; a jelly that makes music. All this stuff exists, it's time to play with it. A tour of surprising and cool new materials.



### Just how small is an atom?

Available at :

[https://www.ted.com/talks/just\\_how\\_small\\_is\\_an\\_atom](https://www.ted.com/talks/just_how_small_is_an_atom)

Just how small are atoms? Really, really, really small. This fast-paced animation from TED-Ed uses metaphors (imagine a blueberry the size of a football stadium!) to give a visceral sense of just how small atoms are.

### Battling Bad Science

Available at :

[https://www.ted.com/talks/ben\\_goldacre\\_battling\\_bad\\_science#t-44279](https://www.ted.com/talks/ben_goldacre_battling_bad_science#t-44279)

Every day there are news reports of new health advice, but how can you know if they're right? Doctor and epidemiologist Ben Goldacre shows us, at high speed, the ways evidence can be distorted, from the blindingly obvious nutrition claims to the very subtle tricks of the pharmaceutical industry.



### How Spectroscopy Could Reveal Alien Life

Available at :

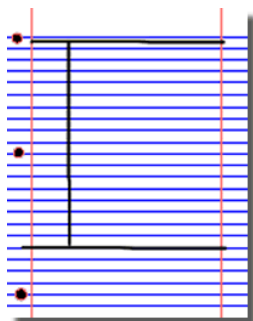
[https://www.ted.com/talks/garik\\_israelian\\_what\\_s\\_inside\\_a\\_star](https://www.ted.com/talks/garik_israelian_what_s_inside_a_star)

Garik Israelian is a spectroscopist, studying the spectrum emitted by a star to figure out what it's made of and how it might behave. It's a rare and accessible look at this discipline, which may be coming close to finding a planet friendly to life.

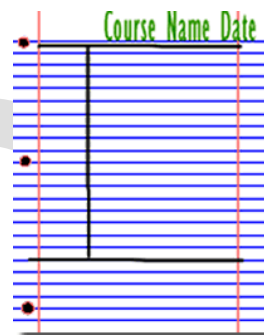
## Research Activities

Research, reading and note making are essential skills for A level chemistry study. For the following task you are going to produce 'Cornell Notes' to summarise your reading.

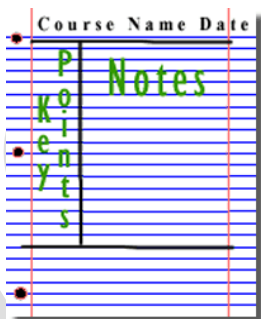
1. Divide your page into three sections like this



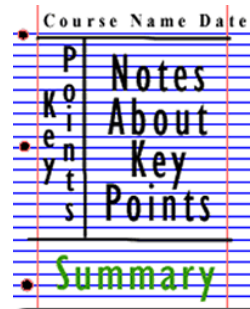
2. Write the name, date and topic at the top of the page



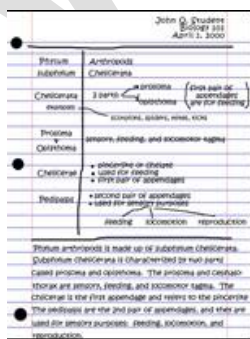
3. Use the large box to make notes. Leave a space between separate idea. Abbreviate where possible.



4. Review and identify the key points in the left hand box



5. Write a summary of the main ideas in the bottom space



## Research Activities

Aimed at students aged 14-19, Catalyst magazine is packed with interesting articles on cutting-edge science, interviews and new research written by leading academics. It also includes a booklet of teacher's notes, full of ideas and lesson plans to bring the articles to life in the classroom.

For each of the following topics you are going to use the resources to produce one page of Cornell style notes.

Use the links of scan the QR code to take you to the resources.



### Topic 1: Using Plastics in the Body

Available at:

<https://www.stem.org.uk/resources/elibrary/resource/382317/using-plastics-body>

This Catalyst article looks at how scientists are learning to use polymers for many medical applications, including implants, bone repairs and reduction in infections.



### Topic 2: Catching a Cheat

Available at:

<https://www.stem.org.uk/system/files/elibrary-resources/2017/03/Catching%20a%20cheat.pdf>

This Catalyst article looks at analytical chemists who are involved in many kinds of testing, including drug testing to catch cheats in sport.

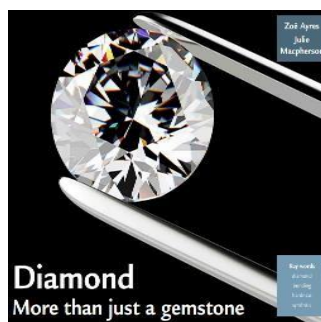


### Topic 3: Diamond: More than just a gemstone

Available at:

<https://www.stem.org.uk/system/files/elibrary-resources/2017/02/Diamond%20more%20than%20just%20a%20gemstone.pdf>

This Catalyst article looks at diamond and graphite which are allotropes of carbon. Their properties, which depend on the bonding between the carbon atoms, are also examined.



#### Topic 4: The Bizarre World of High Pressure Chemistry

Available at:

[https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27\\_1\\_the\\_bizarre\\_world\\_of\\_high\\_pressure\\_chemistry.pdf](https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27_1_the_bizarre_world_of_high_pressure_chemistry.pdf)

This Catalyst article investigates high pressure chemistry and discovers that, when put under extreme pressure, the properties of a material may change dramatically.



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#### Topic 5: Microplastics and the Oceans

Available at:

[https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27\\_1\\_microplastics\\_%20and\\_the\\_oceans.pdf](https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27_1_microplastics_%20and_the_oceans.pdf)

This Catalyst article looks at microplastics. Microplastics are tiny particles of polymer used in many products. They have been found to be an environmental pollutant especially in oceans.



## Science on Social Media

Science communication is essential in the modern world and all the big scientific companies, researchers and institutions have their own social media accounts. Here are some of our top tips to keep up to date with developing news or interesting stories:

### Follow on Twitter:

Salters' Institute - Our activities include Festivals of Chemistry; Chemistry Camps; Curricula; Awards for Technicians, Graduates, A Level Students; and Seminars  
@salters\_inst

Daily A Level Chemistry Facts – Daily Chemistry Facts (Based on the A-Level AQA spec but most facts work with all)  
@chemAlevels

Chemistry News –The latest chemistry news from only the best sources  
@chemistrynews

Compound Interest– Graphics exploring everyday #chemistry. Winner of @absw 2018 science blog award  
@compoundchem

Chemistry World – Chemistry magazine bringing you the latest chemistry news and research every day. Published by the Royal Society of Chemistry.  
@ChemistryWorld

Royal Society of Chemistry - Promote, support and celebrate chemistry. Follow for updates on latest activities  
@RoySocChem

Periodic Videos– Chemistry video series by @BradyHaran & profs at the Uni of Nottingham - also see @sixtysymbols & @numberphile  
@periodicvideos



### Find on Facebook:

Science Now - Science Now is a dedicated community that helps spread science news in all fields, from physics to biology, medicine to nanotechnology, space and beyond!

National Science Foundation – As an independent federal agency, NSF fund a significant proportion of basic research. For official source information about NSF, visit [www.nsf.gov](http://www.nsf.gov)

Science News Magazine - Science covers important and emerging research in all fields of science

BBC Science News - The latest BBC Science and Environment News: breaking news, analysis and debate on science and nature around the world

Scientific American - Scientific American is the authority on science and technology for a general audience, with coverage that explains how research changes our understanding of the world and shapes our lives.



## Useful Websites

These websites all offer an amazing collection of resources that you should use again and again throughout your course.

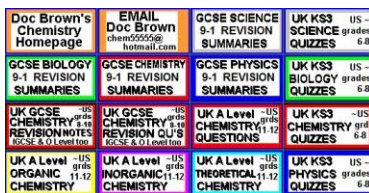
### chemguide

Helping you to understand Chemistry

MAIN MENU

This website is very detailed and identifies other resources which are sharing incorrect or outdated information and suggests the correct materials to use. The site also contains links to the syllabuses of many exam boards which means it is accessible and useful to all students.

<https://www.chemguide.co.uk/>



Doc Brown is a website dedicated to all three science subjects; physics, chemistry and biology. It provides the user with summarised notes (useful for making flash cards) and practice questions to further their knowledge and understanding.

The site provides resources from a wide range of exam boards including AQA, Edexcel, Chemistry, CCEA, OCR, WJEC, CIE and Salters from GCSE level to A2.

<http://www.docbrown.info/>

### chemrevise

Resources for A-level and GCSE Chemistry

HOME 1. AQA REVISION GUIDES 2. OCR REVISION GUIDES  
3. A-LEVEL TEXTBOOK 6. GCSE AQA GUIDES ABOUT

Updates to A-level Textbook

Revision guides for OCR Chemistry, we use them in our work booklets.

<https://chemrevise.org/>



Tons of awesome courses in one awesome channel! Check out the playlists for past courses in physics, philosophy, games, economics, U.S. government and politics, astronomy, anatomy & physiology, world history, biology, literature, ecology, psychology, and of course, chemistry!

<https://www.youtube.com/user/crashcourse/featured>



The free revision website for students studying GCSE and A-levels. S-cool provides revision guides, question banks, revision timetable and more

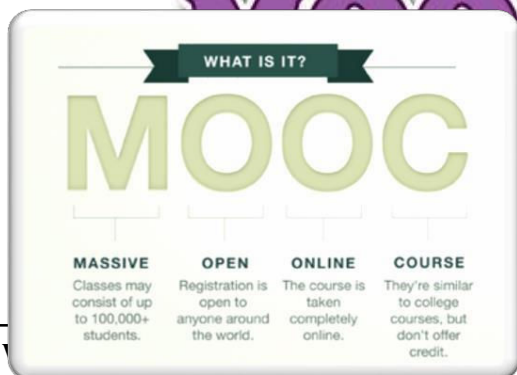
<https://www.s-cool.co.uk/a-level/chemistry>

### MaChemGuy

Machemguy videos on you-tube are based on the OCR specification and cover pretty much every topic.

<https://www.youtube.com/playlist?list=PLi6oabjl6coXUlfu8syK3K0iFXQljwDUM>

## Science: Things to do!



Completing a MOOC will look great on your Personal Statement and they are dead easy to take part in!

act.

**MOOCs are online courses run by nearly all universities. They are short FREE courses that you take part in. They are usually quite specialist, but aimed at the public, not the genius!**

**There are lots of websites that help you find a course, such as edX and Future learn.**

**You can take part in any course, but there are usually start and finish dates. They mostly involve taking part in web chats, watching videos and interactives.**



## 2. Mark scheme

### Atomic Structure

#### GCSE questions

**Q1.** This question is about the structure of the atom.

(a) Complete the sentences. Choose answers from the box. Each word may be used once, more than once, or not at all.

|          |        |         |
|----------|--------|---------|
| electron | ion    | neutron |
| nucleus  | proton |         |

The centre of the atom is the **nucleus**

The two types of particle in the centre of the atom are the proton and the **neutron**.

James Chadwick proved the existence of the **neutron**.

Niels Bohr suggested particles orbit the centre of the atom. This type of particle is the **electron**.

The two types of particle with the same mass are the neutron and the **proton**. (5)

The table below shows information about two isotopes of element **X**.

|           | Mass number | Percentage (%) abundance |
|-----------|-------------|--------------------------|
| Isotope 1 | 63          | 70                       |
| Isotope 2 | 65          | 30                       |

(b) Calculate the relative atomic mass ( $A_r$ ) of element **X** using the equation:

$$A_r = \frac{(\text{mass number} \times \text{percentage}) \text{ of isotope 1} + (\text{mass number} \times \text{percentage}) \text{ of isotope 2}}{100}$$

Use the table above. Give your answer to 1 decimal place.

$$A_r = \frac{(63 \times 70) + (65 \times 30)}{100} = \frac{6360}{100} = 63.65$$

$$A_r = 63.65$$

(2)

(c) Suggest the identity of element **X**. Use the periodic table.

Element **X** is **Copper, Cu**. (1)

(d) The radius of an atom of element **X** is  $1.2 \times 10^{-10} \text{ m}$

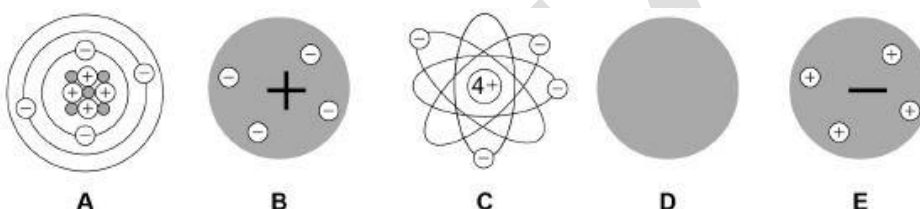
The radius of the centre of the atom is  $\frac{1}{10000}$  the radius of the atom.

Calculate the radius of the centre of an atom of element **X**. Give your answer in standard form.

$$\text{Radius of this atom} = (1/10000) \times 1.2 \times 10^{-10} = 1.2 \times 10^{-14}$$

$$\text{Radius} = 1.2 \times 10^{-14}$$

**Q2.** The diagram below represents different models of the atom.



(a) Which diagram shows the plum pudding model of the atom? Tick **one** box.

|   |  |   |                                     |   |  |   |  |   |  |
|---|--|---|-------------------------------------|---|--|---|--|---|--|
| A |  | B | <input checked="" type="checkbox"/> | C |  | D |  | E |  |
|---|--|---|-------------------------------------|---|--|---|--|---|--|

 (1)

(b) Which diagram shows the model of the atom developed from the alpha particle scattering experiment? Tick **one** box.

|   |  |   |  |   |                                     |   |  |   |  |
|---|--|---|--|---|-------------------------------------|---|--|---|--|
| A |  | B |  | C | <input checked="" type="checkbox"/> | D |  | E |  |
|---|--|---|--|---|-------------------------------------|---|--|---|--|

 (1)

(c) Which diagram shows the model of the atom resulting from Bohr's work? Tick **one** box.

|   |                                     |   |  |   |  |   |  |   |  |
|---|-------------------------------------|---|--|---|--|---|--|---|--|
| A | <input checked="" type="checkbox"/> | B |  | C |  | D |  | E |  |
|---|-------------------------------------|---|--|---|--|---|--|---|--|

 (1)

(d) Define the mass number of an atom.

Mass of an atom is equal to the number of protons and number of neutrons (in the nucleus).

(e) Element **X** has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of  $^{69}\text{X}$
- 40% of  $^{71}\text{X}$

Estimate the relative atomic mass of element **X**. Tick **one** box.

< 69.5

☐

Between 69.5 and 70.0

☒

Between 70.0 and 70.5

☐

> 70.5

☐

(1)

### A-Level question to give a go!

**Q1.** Which of these correctly shows the numbers of sub-atomic particles in a  $^{41}\text{K}^+$  ion?

|          | Number of electrons | Number of protons | Number of neutrons |                                  |
|----------|---------------------|-------------------|--------------------|----------------------------------|
| <b>A</b> | 19                  | 19                | 20                 | <input type="radio"/>            |
| <b>B</b> | 18                  | 20                | 21                 | <input type="radio"/>            |
| <b>C</b> | 18                  | 19                | 22                 | <input checked="" type="radio"/> |
| <b>D</b> | 19                  | 18                | 23                 | <input type="radio"/>            |

Use the P.T to look up the atomic number, which is 19 and equals no. of protons. Take this away from the mass number, 41 and you are left with 22 neutrons. Because the particle is a cation, it has lost an electron so there should be

(Total 1 mark)

**Q2.** Magnesium exists as three isotopes:  $^{24}\text{Mg}$ ,  $^{25}\text{Mg}$  and  $^{26}\text{Mg}$

(a) In terms of sub-atomic particles, state the difference between the three isotopes of magnesium.

Each atom differs in the number of neutrons.

Magnesium-24 has 12 neutrons, magnesium-25 has 13 neutrons and magnesium-26 has 14 neutrons.

(b) State how, if at all, the chemical properties of these isotopes differ.

Give a reason for your answer.

Chemical properties there is no change in their chemical reactivity...

Reason ...this is because chemical reactivity/ property is determined by the electron configuration / number of outer electrons and not neutrons. (2)

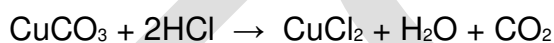
### Amount of Substance

#### GCSE questions

**Q3.** A student investigated the reactions of copper carbonate and copper oxide with dilute hydrochloric acid. In both reactions one of the products is copper chloride.

(a) A student wanted to make 11.0 g of copper chloride.

The equation for the reaction is:



?

11.0g

Relative atomic masses,  $A_r$ : H = 1; C = 12; O = 16; Cl = 35.5; Cu = 63.5

Calculate the mass of copper carbonate the student should react with dilute hydrochloric acid to make 11.0 g of copper chloride.

Moles  $\text{CuCl}_2 = \text{mass}/M_r = 11.0 / (63.5 + (35.5 \times 2)) = 11.0 / 134.5 = 0.081784 \dots \text{mol}$   
(keep value in calculator)

Molar ratio:  $\text{CuCl}_2 : \text{CuCO}_3$  is 1:1 therefore, moles  $\text{CuCO}_3 = 0.081784 \dots \text{mol}$

$\therefore \text{Mass CuCO}_3 = M_r \times \text{moles} = (63.5 + 12 + (16 \times 3)) \times 0.081784 \dots$

$= 123.5 \times 0.081784 \dots$

$= 10.10037$

Mass  $\text{CuCO}_3 = 10.1\text{g}$  (4)

*Give answers to 3sf*

(b) The percentage yield of copper chloride was 79.1 %. Calculate the mass of copper chloride the student actually produced.

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{expected yield}} \times 100$$

$$79.1 = \frac{\text{actual yield}}{\text{expected yield}} \times 100$$

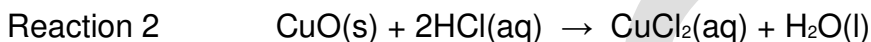
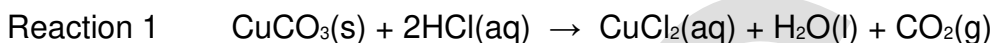
10.1

$$(79.1 \times 10.1)/100 = \text{actual yield}$$

$$= 7.9891$$

Actual mass of copper chloride produced = 8.00 g (2)

(c) Look at the equations for the two reactions:



Reactive formula masses: CuO = 79.5; HCl = 36.5; CuCl<sub>2</sub> = 134.5; H<sub>2</sub>O = 18

The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula masses of all reactants from equation}} \times 100$$

Calculate the percentage atom economy for Reaction 2.

Desired product here is copper (II) chloride and you need to use the big numbers, too.

$$\% \text{atom economy} = \frac{63.5 + (35.5 \times 2)}{(63.5 + 16) + 2 \times (1 + 35.5)} \times 100$$

$$= \frac{134.5}{(79.15 + 73)} \times 100$$

$$= 88.399\ldots$$

Percentage atom economy = 88.4% (3)

(d) The atom economy for Reaction 1 is 68.45 %. Compare the atom economies of the two reactions for making copper chloride. Give a reason for the difference.

There are more by-products in reaction 1, as there are two, whereas in reaction 2 there is only 1. This means that less reactant atoms make up the desired product in reaction 1 thus having a lower %atom economy. (1)

**A-Level question to give a go!**

**Q3.** Ethanol can be made from glucose by fermentation.



In an experiment, 268 g of ethanol ( $M_r = 46.0$ ) were made from 1.44 kg of glucose ( $M_r = 180.0$ ).

What is the percentage yield?

- A** 18.6% ☐
- B** 36.4% ☒
- C** 51.1% ☐
- D** 72.8% ☐

Glucose moles =  $1440/180 = 8$   
Molar ratio 1:2 therefore, moles ethanol =  $8 \times 2 = 16$   
Expected mass of ethanol =  $16 \times 46 = 736\text{g}$   
%yield =  $(268/736) \times 100 = 36.4\%$

(Total 1 mark)

**Q4.** A gas cylinder contains 5.0 kg of propane.  
How many propane molecules are in the cylinder?

The Avogadro constant,  $L = 6.022 \times 10^{23} \text{ mol}^{-1}$

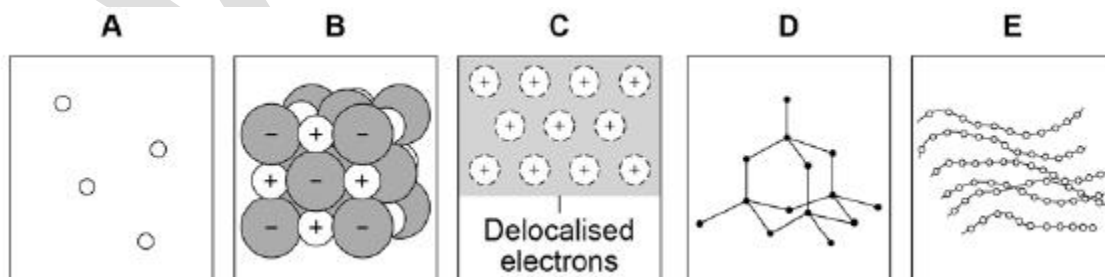
- A**  $6.8 \times 10^{22}$  ☒
- B**  $7.2 \times 10^{22}$  ☐
- C**  $6.8 \times 10^{25}$  ☐
- D**  $7.2 \times 10^{25}$  ☐

1 mole = Avogadro's constant  
Mr propane,  $\text{C}_3\text{H}_8 = (3 \times 12) + (8 \times 1) = 44\text{g}$   
Moles propane =  $5.0 / 44 = 0.1136$   
Propane molecules =  $0.1136 \times 6.022 \times 10^{23} = 6.84 \times 10^{22}$

(Total 1 mark)

**Bonding****GCSE questions**

**Q4.** Figure 1 shows the structure of five substances.



(a) Which diagram shows a gas? Tick (✓) **one** box.

- A** ☒ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(b) Which diagram shows the structure of diamond? Tick (✓) **one** box.

A ☐ B ☐ C ☐ D ☒ E ☐

(1)

(c) Which diagram shows a metallic structure? Tick (✓) **one** box.

A ☐ B ☐ C ☒ D ☐ E ☐

(1)

(d) Which diagram shows a polymer? Tick (✓) **one** box.

A ☐ B ☐ C ☐ D ☐ E ☒

(1)

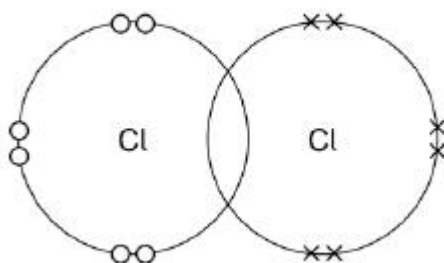
(e) A chlorine atom has 7 electrons in the outer shell.

Two chlorine atoms covalently bond to form a chlorine molecule,  $\text{Cl}_2$

**Figure 2** is a dot and cross diagram showing the outer shells and some electrons in a chlorine molecule.

Complete the dot and cross diagram. Show only the electrons in the outer shell.

**Figure 2**



(1)

(f) What is the reason for chlorine's low boiling point? Tick (✓) **one** box.

Strong covalent bonds ☐

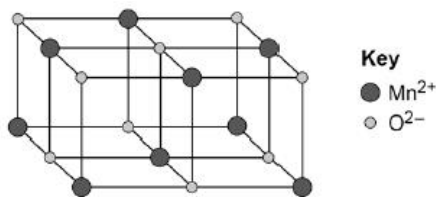
Strong forces between molecules ☐

Weak covalent bonds ☐

Weak forces between molecules ☒

(1)

**Figure 3** represents the structure of manganese oxide. Manganese oxide is an ionic compound.



(g) Determine the empirical formula of manganese oxide. Use **Figure 3**.

Each manganese ion is bonded to four oxygen ions, and vice versa, therefore molecular formula is  $\text{Mn}_4\text{O}_4$ . This simplest ratio of 4:4 is 1:1 therefore  $\text{MnO}$  is the empirical formula.

Empirical formula =  $\text{MnO}$  (1)

(h) Why does manganese oxide conduct electricity as a liquid? Tick (✓) **one** box.

- Atoms move around in the liquid ☐
- Electrons move around in the liquid ☐
- Ions move around in the liquid ☒
- Molecules move around in the liquid ☐

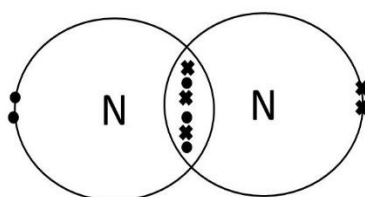
(1)

**Q5.** This question is about structure and bonding.

(a) Complete the dot and cross diagram to show the covalent bonding in a nitrogen molecule,  $\text{N}_2$

Show only the electrons in the outer shell.

Nitrogen  $\text{N}_2$



There is a triple bond, so a total of 3 pairs of electrons are shared

Each N only has 3 of its electrons accounted for. N has 5 in its outer shell, so there must be one pair outside the bond.



Each N "thinks" it has 8 electrons in its outer shell, the diagram is complete.

(2)

1 mark for the correct number of electrons shared

1 mark for the remaining outer electrons.

(b) Explain why nitrogen is a gas at room temperature. Answer in terms of nitrogen's structure.

Nitrogen has a simple covalent structure whereby small  $\text{N}_2$  molecules are held together by weak intermolecular forces.

These require a small amount of energy to overcome, which accounts for the low boiling point. (3)

(c) Graphite and fullerenes are forms of carbon. Graphite is soft and is a good conductor of electricity.

Explain why graphite has these properties. Answer in terms of structure and bonding.

Graphite is soft (lubricant) because the hexagonal carbon layers are held together by weak intermolecular forces. So when pressure is applied to graphite, e.g. when writing with a pencil, the layers slide over each other easily, leaving a mark.

Graphite conducts electricity because there are delocalised / free moving electrons that move through the structure when it is used, e.g. as an electrode. The delocalised electrons carry the charge through the structure.

(4)

### A-Level question to give a go!

Q5. Which is the correct crystal structure for the substance named?

|   | Substance       | Structure        |                                     |
|---|-----------------|------------------|-------------------------------------|
| A | Iodine          | Simple molecular | <input checked="" type="checkbox"/> |
| B | Diamond         | Ionic            | <input type="checkbox"/>            |
| C | Sodium chloride | Giant covalent   | <input type="checkbox"/>            |
| D | Graphite        | Metallic         | <input type="checkbox"/>            |

(Total 1 mark)

Q6. What is the formula of calcium nitrate(V)?

A  $\text{CaNO}_3$

B  $\text{Ca}(\text{NO}_3)_2$

C  $\text{Ca}_2\text{NO}_2$

D  $\text{Ca}(\text{NO}_2)_2$



Nitrate (V) means the nitrogen in this ion has a charge of +5, which means it is the  $\text{NO}_3^-$  ion. Because each O is -2 and so total negative charge = -6 and if the overall charge is -1 then N must be +5.

Ca is in group 2 so it has a +2 charge:

$\text{Ca}^{2+}$   $\text{NO}_3^-$

The charges must balance so we need 1  $\text{Ca}^{2+}$  ion and 2  $\text{NO}_3^-$  ions.

(Total 1 mark)

**Q7.** The table shows some data about the elements bromine and magnesium.

| Element   | Melting point / K | Boiling point / K |
|-----------|-------------------|-------------------|
| Bromine   | 266               | 332               |
| Magnesium | 923               | 1383              |

In terms of structure and bonding explain why the boiling point of bromine is different from that of magnesium. Suggest why magnesium is a liquid over a much greater temperature range compared to bromine.

(Total 5 marks)

Structures

**M1** Bromine is (simple) molecular / simple molecules

**M2** Magnesium is metallic / consists of (positive) ions in a (sea) of delocalised electrons

Strength

**M3** Br<sub>2</sub> has weak (van der Waals) forces between the molecules / weak IMFs

**M4** so more energy is needed to overcome the Stronger (metallic) bonds or converse. The comparison could be direct or implied.

Liquid range

**M5** Mg has a much greater liquid range because forces of attraction in liquid / molten metal are strong(er) OR converse argument for Br<sub>2</sub>

1

Chemical Error penalties

1

If Br<sub>2</sub> (covalent) bonds broken lose M3 and M4

1

If eg Mg molecules or Mg ionic bonds lose M2 and M4

1

1

Must refer to liquid range to score M5

## Energetics

### GCSE questions

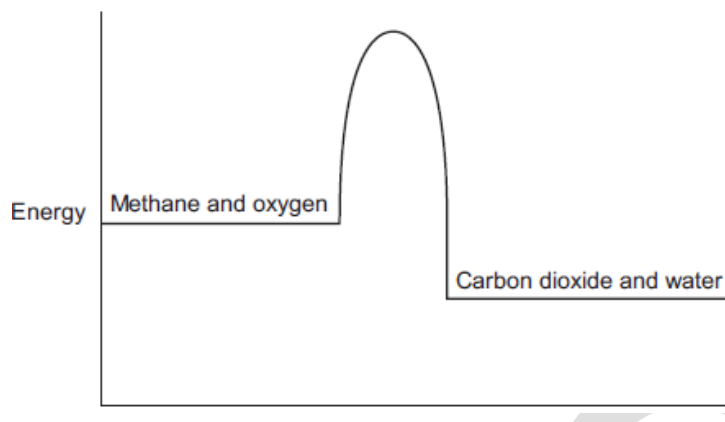
**Q6.** Methane (CH<sub>4</sub>) is used as a fuel.

(a) Methane burns in oxygen.

(i) The diagram below shows the energy level diagram for the complete combustion of methane.

Draw and label arrows on the diagram to show:

- the activation energy
- the enthalpy change,  $\Delta H$ .



(2)

(ii) Complete and balance the symbol equation for the complete combustion of methane.



(ii) Explain why, in terms of the energy involved in bond breaking and bond making, the combustion of methane is exothermic. (3)

More energy has been released from bonds forming (in the products)...

.....than is being taken in for bonds breaking (in reactants).

Therefore, overall the reaction loses heat energy to the surroundings.

(b) Methane reacts with chlorine in the presence of sunlight. The equation for this reaction is:



Some bond dissociation energies are given in the table.

| Bond  | Bond dissociation energy in kJ per mole |
|-------|-----------------------------------------|
| C-H   | 413                                     |
| C-Cl  | 327                                     |
| Cl-Cl | 243                                     |
| H-Cl  | 432                                     |

(i) Show that the enthalpy change,  $\Delta H$ , for this reaction is  $-103$  kJ per mole. (3)

$$\text{Bonds breaking} = (4 \times \text{C-H}) + (1 \times \text{Cl-Cl})$$

$$= (4 \times 413) + (1 \times 243) = 1895$$

$$\text{Bonds forming} = (3 \times \text{C-H}) + (1 \times \text{C-Cl}) + (1 \times \text{H-Cl})$$

$$= (3 \times 413) + (1 \times 327) + (1 \times 432) = 1998$$

$$\text{Energy change or enthalpy change} = \Sigma \text{bonds breaking} - \Sigma \text{bonds forming}$$

$$= 1895 - 1998 = -103 \text{ kJ/mol}$$

(ii) Methane also reacts with bromine in the presence of sunlight.



This reaction is less exothermic than the reaction between methane and chlorine.

The enthalpy change,  $\Delta H$ , is  $-45 \text{ kJ}$  per mole.

What is a possible reason for this? Tick (✓) **one** box.

$\text{CH}_3\text{Br}$  has a lower boiling point than  $\text{CH}_3\text{Cl}$

☐

The C-Br bond is weaker than the C-Cl bond.

☒

The H-Cl bond is weaker than the H-Br bond.

☐

Chlorine is more reactive than bromine.

So this means that less energy was given out than was taken in. So either the bonds formed in the products here are weaker or the bonds in reactants are stronger.

(1)

|                                                        | C-H | C-C | C-O | O-H |
|--------------------------------------------------------|-----|-----|-----|-----|
| Mean bond dissociation enthalpy / $\text{kJ mol}^{-1}$ | 412 | 348 | 360 | 463 |

**A**  $-4751$

☐

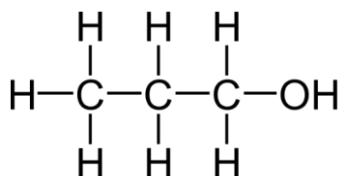
**B**  $-4403$

☐

**C**  $+4403$

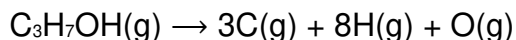
☒

**D**  $+4751$

☐


### A-Level question to give a go!

**Q8.** Calculate the enthalpy change, in kJ, for this dissociation of mole of propan-1-ol.



It's useful to draw the molecule out! See above.

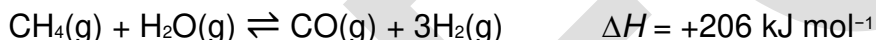
$$\text{Bonds breaking} = (7 \times \text{C-H}) + (2 \times \text{C-C}) + (1 \times \text{C-O}) + (1 \times \text{O-H})$$

$$= (7 \times 412) + (2 \times 348) + 360 + 463 = +4403$$

(and because energy is needed it is a positive value)

(Total 1 mark)

**Q9.** Hydrogen is produced by the reaction of methane with steam. The reaction mixture reaches a state of dynamic equilibrium.



Some enthalpy data is given in the table.

| Bond                                 | C-H | O-H | H-H | C=O              |
|--------------------------------------|-----|-----|-----|------------------|
| Bond enthalpy / $\text{kJ mol}^{-1}$ | 413 | 463 | 436 | To be calculated |

Use the information in the table and the stated enthalpy change to calculate the missing bond enthalpy.

**A** 234

☐

**B** 1064

☒

**C** 1476

☐

**D** 1936

☐

(Total 1 mark)

Enthalpy/energy change = bonds breaking – bonds forming

$$+206 = ((413 \times 4) + (2 \times 463)) - ((3 \times 436) + \text{C}\equiv\text{O})$$

$$+206 = 2578 - (1308 + \text{C}\equiv\text{O})$$

$$+206 = 2578 - 1308 - \text{C}\equiv\text{O}$$

$$\text{C}\equiv\text{O} = 2578 - 1308 - 206$$

$$= 1064$$

### Kinetics

#### GCSE questions

**Q7.** When sodium thiosulfate solution reacts with dilute hydrochloric acid, the solution becomes cloudy.

The equation for the reaction is:

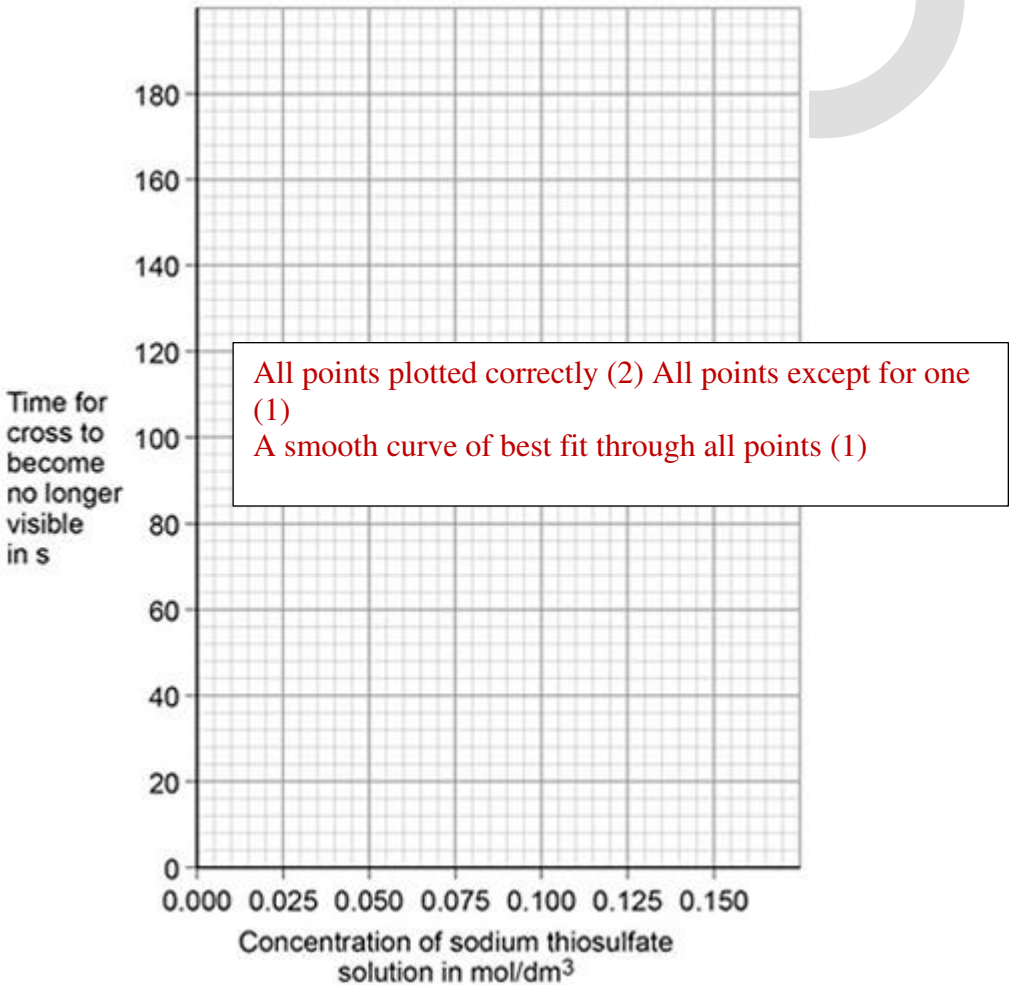


Some students used this reaction to investigate the effect of concentration on rate

of reaction. The table shows the students' results.

| Concentration of sodium thiosulfate solution in mol / dm <sup>3</sup> | Time for cross to become no longer visible in s |
|-----------------------------------------------------------------------|-------------------------------------------------|
| 0.020                                                                 | 170                                             |
| 0.040                                                                 | 90                                              |
| 0.060                                                                 | 82                                              |
| 0.080                                                                 | 42                                              |
| 0.100                                                                 | 34                                              |
| 0.120                                                                 | 30                                              |
| 0.140                                                                 | 28                                              |

(a) Plot the data from the table above on the graph below. Draw a line of best fit.



(3)

The students repeated the investigation two more times. They obtained similar results each time.

(b) The students analysed their results to give a conclusion and an explanation for their investigation.

**Conclusion:** 'The higher the concentration, the lower the rate of reaction.'

**Explanation:** 'At higher concentrations, the particles have more energy, so they are moving faster. Therefore the collisions are more energetic.'

The students are not correct.

Give a **correct** conclusion **and** explanation for the results of the investigation.

Conclusion **The higher the concentration, the higher the rate of reaction (or the quicker the reaction).**

Explanation **The higher the concentration, the more particles there are in a given volume, which means that they are more likely to collide with each other/higher chances of collisions happening. This leads to more frequent collisions between particles /an increase in the number of collisions between particles and the reaction happens quicker.**

3)

(c) A solution containing 0.18 g of sodium thiosulfate reacts with dilute hydrochloric acid in 2 minutes.

Calculate the mean rate of reaction in g / s. Give your answer in standard form.

Mean rate = quantity of reactant (or product)

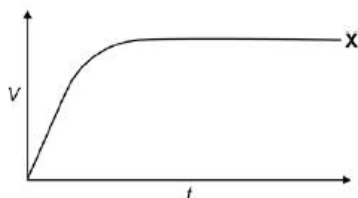
time

$$= 0.18 / (60 \times 2) \quad \text{time needs to be converted to seconds}$$

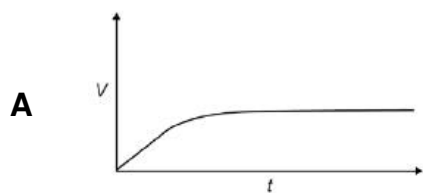
$$\text{Mean rate of reaction} = 1.5 \times 10^{-3} \text{ g / s (3)}$$

### A-Level question to give a go!

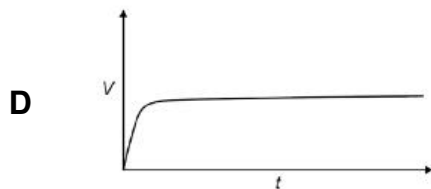
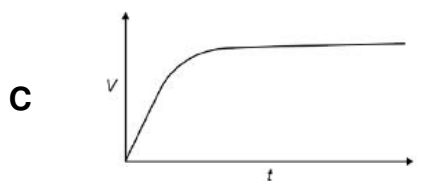
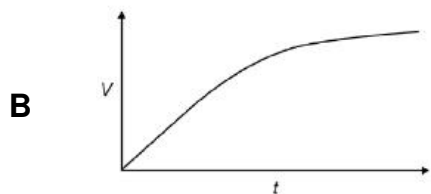
**Q10.** Line X in the diagram represents the volume (V) of gas formed with time (t) in a reaction between an excess of magnesium and aqueous sulfuric acid.



Which line represents the volume of hydrogen formed, at the same temperature and pressure, when the concentration of sulfuric acid has been halved?

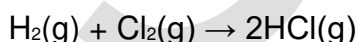


X



(Total 1 mark)

**Q11.** The gas-phase reaction between hydrogen and chlorine is very slow at room temperature.



(a) Define the term *activation energy*.

It is the minimum amount of energy needed to start a reaction. (2)

(b) Give **one** reason why the reaction between hydrogen and chlorine is very slow at room temperature.

The reaction does not have the activation energy needed at room temperature. (1)

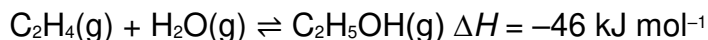
(c) Explain why an increase in pressure, at constant temperature, increases the rate of reaction between hydrogen and chlorine.

At a higher pressure, the hydrogen and chlorine gas molecules are closer together in a given volume. Therefore, they are more likely to collide with each other leading to more frequent collisions. (2)



### A-Level question to give a go!

**Q12.** Which statement is **not** correct about the industrial preparation of ethanol by the hydration of ethene at 300 °C?



- A** The reaction is catalysed by an acid. ☐
- B** The higher the pressure, the higher the equilibrium yield of ethanol. ☐
- C** The higher the temperature, the higher the equilibrium yield of ethanol. ☒
- D** A low equilibrium yield of ethanol is acceptable because unreacted ethene is recycled. ☐

(Total 1 mark)

A high temperature would favour the backward reaction. Clue was enthalpy change value given which is -46, and if it is negative, this means the reaction is exothermic.

**Q13.** The forward reaction in this equilibrium is endothermic



Which statement is correct?

- A** If the total pressure is increased at constant temperature, the proportion of  $\text{COCl}_2$  in the equilibrium mixture will decrease ☐
- B** Use of a catalyst will increase the proportion of  $\text{COCl}_2$  in the equilibrium mixture at constant temperature and pressure ☐
- C** Reducing the equilibrium concentration of  $\text{CO}$  will increase the value of the equilibrium constant ☐
- D** Raising the temperature from 373 K to 473 K will increase the value of the equilibrium constant ☒

(Total 1 mark)

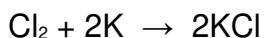
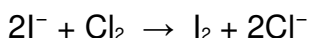
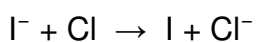
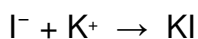
Any condition that will shift equilibrium to the products side or RHS will increase the equilibrium constant. You will learn about this next year!

## Oxidation, Reduction and Redox equations

### GCSE questions

**Q9.** This question is about halogens and their compounds.

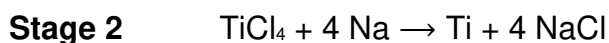
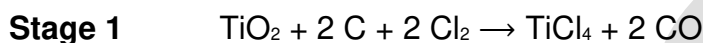
(a) What is the ionic equation for the reaction of chlorine with potassium iodide? Tick **one** box.


☐

☒

☐

☐

(1)

**Q10.** Titanium is a transition metal.

Titanium is extracted from titanium dioxide in a two-stage industrial process.



In **Stage 2**, sodium displaces titanium from titanium chloride.

(a) Sodium atoms are oxidised to sodium ions in this reaction. Why is this an oxidation reaction?

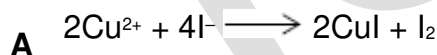
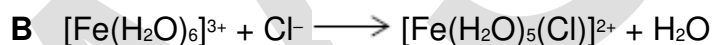
**Na has lost an electron. Loss of electrons is oxidation so sodium has been oxidised.** (1)

(b) Complete the half equation for the oxidation reaction.



**A-Level question to give a go!**

**Q14.** In which reaction is the metal oxidised?


☐

☐

☐

☒

(Total 1 mark)

## Periodicity

### GCSE questions

**Q11.** This question is about metals.

(a) Which unreactive metal is found in the Earth as the metal itself? Tick (✓) **one** box

aluminium

☐

gold

x

magnesium



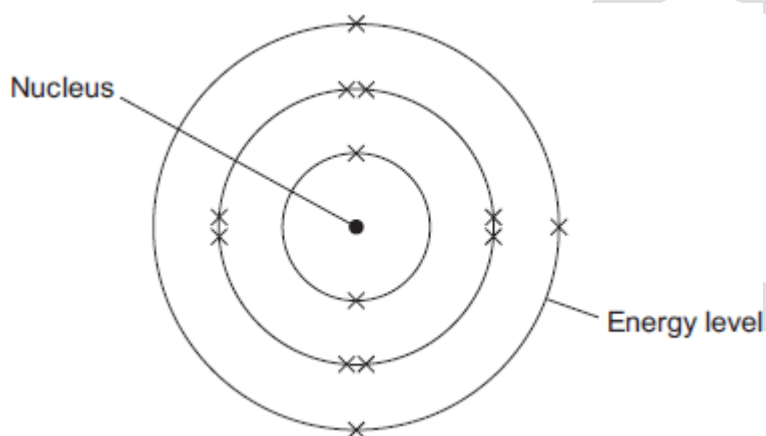
(1)

(b) Complete the sentence.

Aluminium is an element because aluminium is made of only one type of **atom**.

(1)

(c) **Figure 1** shows the electronic structure of an aluminium atom.



(i) Use the correct words from the box to complete the sentence.

electrons

ions

protons

neutrons

shells

The nucleus of an aluminium atom contains **protons** and **neutrons**.

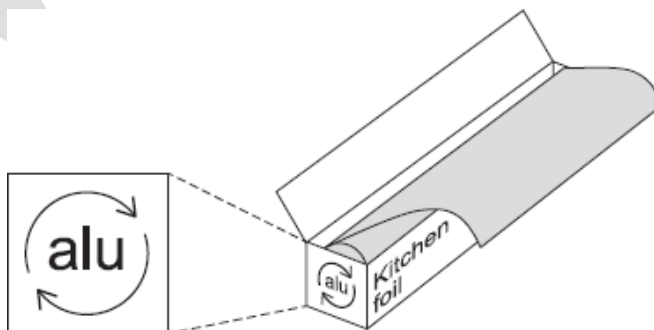
(2)

(ii) Complete the sentence.

In the periodic table, aluminium is in Group **3 (3 outer electrons)**.

(1)

(d) Aluminium is used for kitchen foil. **Figure 2** shows a symbol on a box of kitchen foil.



The symbol means that aluminium can be recycled. It does not show the correct chemical symbol for aluminium.

- (i) What is the correct chemical symbol for aluminium? **Al** . (1)
- (ii) Give **two** reasons why aluminium should be recycled.

Any two of the following:

Because, the cost of extracting aluminium from its ore is very high compared to recycling it (recycling saves around 90% of the cost of extracting it).

Also, the ore is a finite resource which means that recycling aluminium will conserve ores in the Earth's crust.

Mining ores damages the environment, leaving eye sores and destroying animal habitats. (2)

- (e) Aluminium has a low density, conducts electricity and is resistant to corrosion. Which **one** of these properties makes aluminium suitable to use as kitchen foil? Give a reason for your answer.

It is resistant to corrosion which means that it is safe to use for covering food and will last thus protecting the food.

OR It has a low density which means that it is practical to use in the kitchen when handling it. (2)

**A-Level question to give a go!**

**Q15.** Which of the following is a correct statement about the trend in atomic radius across Period 3 of the Periodic Table?

- |          |                                                          |                                     |
|----------|----------------------------------------------------------|-------------------------------------|
| <b>A</b> | radius increases because the atoms have more electrons   | <input type="checkbox"/>            |
| <b>B</b> | radius decreases because nuclear charge increases        | <input checked="" type="checkbox"/> |
| <b>C</b> | radius increases because shielding (screening) increases | <input type="checkbox"/>            |
| <b>D</b> | radius decreases because shielding (screening) decreases | <input type="checkbox"/>            |

Yes! The atoms do get smaller as we go across a Period. This is due to the increase in the number of protons, as one is added each time, and because shielding stays the same as each Period shares the same energy level/shell. This means that the electrons are pulled in more strongly each time, reducing the atomic radius. We will cover this next year!

## Group 2 – The Alkaline Earth Metals

### GCSE questions

**Q12.** This question is about compounds.

(a) The table gives information about the solubility of some compounds.

| Soluble compounds                                           |
|-------------------------------------------------------------|
| All potassium and sodium salts                              |
| All nitrates                                                |
| Chlorides, bromides and iodides, except those of silver and |

Use information from the table to answer these questions.

- (i) Name a soluble compound that contains silver ions. **Silver nitrate** (1)
- (ii) Name a soluble compound that contains carbonate ions. **Potassium carbonate or sodium carbonate.** (1)
- (b) Metal oxides react with acids to make salts. What type of compound is a metal oxide? **Base.** (1)
- (c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.
- (i) State how solid lead nitrate can be obtained from lead nitrate solution. **Lead nitrate is a soluble solid, as all nitrates are soluble. Therefore, by heating and evaporating the water in the solution, we should be able to separate the lead nitrate out as a solid.** (1)
- (ii) Balance the equation for the reaction.



- (iii) Give the total number of atoms in the formula  $\text{Pb}(\text{NO}_3)_2$ . **1 + 2 + 6 = 9** (1)

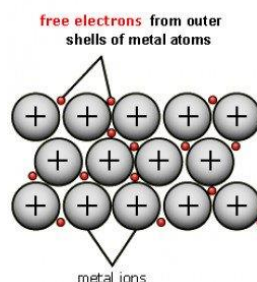
### A-Level question to give a go!

**Q16.** (a) Nickel is a metal with a high melting point.

- (i) Explain, in terms of its structure and bonding, why nickel has a high melting point. **Nickel cations are held together in a giant metallic structure, surrounded by delocalised electrons. There is a strong electrostatic attraction between the cations and the delocalised electrons, and this attraction is known as metallic bonding, which requires a high amount of energy to overcome.** (2)

- (ii) Draw a labelled diagram to show the arrangement of particles in a crystal of nickel.

In your answer, include at least six particles of each type.



(2)

(iii) Explain why nickel is ductile (can be stretched into wires).

Because, the layers of ions (or atoms) in a giant metallic structure are able to slide over each other, which means that the metal can be pulled into wires. (1)

### Group 7 – The Halogens

#### GCSE questions

**Q13.** The halogens are elements in Group 7.

(a) Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom. 7 (1)

(b) Bromine reacts with hydrogen. The gas hydrogen bromide is produced. What is the structure of hydrogen bromide? Tick **one** box.

Giant covalent ☐

Ionic lattice ☐

Metallic structure ☐

Small molecule ☒

(1)

(c) What is the formula for fluorine gas? Tick **one** box.

F ☐

F<sub>2</sub> ☒

F<sup>2</sup> ☐

2F ☐

(1)

A student mixes solutions of halogens with solutions of their salts.

The table below shows the student's observations.

|                          | Potassium chloride<br>(colourless) | Potassium bromide<br>(colourless) | Potassium iodide<br>(colourless) |
|--------------------------|------------------------------------|-----------------------------------|----------------------------------|
| Chlorine<br>(colourless) |                                    | Solution turns orange             | Solution turns brown             |
| Bromine<br>(orange)      | No change                          |                                   | Solution turns brown             |
| Iodine (brown)           | No change                          | No change                         |                                  |

(d) Explain how the reactivity of the halogens changes going down Group 7. Use

the results in the table above.

Halogens become less reactive as we go down group 7. This is shown by the reactions above, whereby chlorine is the most reactive being the highest in the group (of the three). It has reacted with both bromide and iodide ions and displaced them – this is evident from the reactions that have occurred as the solution has changed colour. (1)

Bromine is in the middle, as it is unable to displace chloride ions (no change) because it is less reactive than chlorine, whereas it has managed to displace iodide ions (solution turns brown), showing that it is more reactive than iodine. (1)

Iodine is the least reactive because it is unable to displace either chloride or bromide ions, as both times there has been no change. (1)

(3)

**A-Level question to give a go!**

**Q17.** An aqueous solution of a white solid gives a yellow precipitate with aqueous silver nitrate. The formula of the white solid could be

- A AgBr
- B AgI ☐
- C NaBr
- D NaI

(Total 1 mark)

**Q18.** What will you see when a solution of silver nitrate is added to a solution containing bromide ions, and concentrated aqueous ammonia is added to the resulting mixture?

- A a white precipitate soluble in concentrated aqueous ammonia
- B a white precipitate insoluble in concentrated aqueous ammonia
- C a cream precipitate soluble in concentrated aqueous ammonia ☐
- D a yellow precipitate insoluble in concentrated aqueous ammonia

(Total 1 mark)

## Introduction to Organic Chemistry

### GCSE questions

**Q14.** Scientists found that a compound contained:

22.8% sodium; 21.8% boron; and 55.4% oxygen.

Use the percentages to calculate the empirical formula of the compound.

Relative atomic masses ( $A_r$ ): B = 11; O = 16; Na = 23

To gain full marks you **must** show all your working.

|                                 | Na              | B               | O                 |
|---------------------------------|-----------------|-----------------|-------------------|
| %by mass = mass                 | 22.8            | 21.8            | 55.4              |
| Ar                              | 23              | 11              | 16                |
| Moles (mass/Ar)                 | 0.99            | 1.98            | 3.46              |
| ÷by smallest                    | $0.99/0.99 = 1$ | $1.98/0.99 = 2$ | $3.46/0.99 = 3.5$ |
| Ratio (x2 to get whole numbers) | 2               | 4               | 7                 |

**Answer: Na<sub>2</sub>B<sub>4</sub>O<sub>7</sub>**

### A-Level question to give a go!

**Q19.** An organic compound is found to contain 40.0% carbon, 6.7% hydrogen and 53.3% oxygen.

Which of the following compounds could this be?

**A** Ethanol

☐

**B** Ethanoic acid

☒

**C** Methanol

☐

**D** Methanoic acid

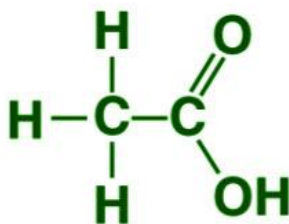
☐

(Total 1 mark)

**Working out:**

|                                 | C             | H             | O             |
|---------------------------------|---------------|---------------|---------------|
| %by mass = mass                 | 40.0          | 6.7           | 53.3          |
| Ar                              | 12            | 1             | 16            |
| Moles (mass/Ar)                 | 3.3           | 6.7           | 3.3           |
| ÷by smallest                    | $3.3/3.3 = 1$ | $6.7/3.3 = 2$ | $3.3/3.3 = 1$ |
| Ratio (x2 to get whole numbers) | 1             | 2             | 1             |

$C_1H_2O_1$  is the empirical formula which is the simplest ratio and does not meet any of the molecular formulae of the molecules above. If we double it, we get  $C_2H_4O_2$  which is the molecular formula of ethanoic acid.



## Alkanes

### GCSE questions

**Q15.** This question is about hydrocarbons.

The table gives information about four hydrocarbons. The hydrocarbons are four successive members of a homologous series.

| Hydrocarbon | Formula     | Boiling point in |
|-------------|-------------|------------------|
| <b>A</b>    | $C_4H_{10}$ | 0                |
| <b>B</b>    |             | 36               |
| <b>C</b>    | $C_6H_{14}$ | 69               |
| <b>D</b>    | $C_7H_{16}$ | 98               |

(a) What is the formula of hydrocarbon **B**? Tick (✓) **one** box.

$C_4H_{12}$  ☐

$C_5H_{12}$  ☒

$C_5H_{10}$  ☐

$C_6H_{12}$  ☐

(1)

(b) What is the simplest ratio of carbon : hydrogen atoms in a molecule of hydrocarbon **A**?

Ratio = 2 : **5**  
(1)

(c) Which hydrocarbon is a gas at room temperature (25 °C)? Tick (✓) **one** box.

**A** ☒

**B** ☐

**C** ☐

**D** ☐

(1)

(d) Which hydrocarbon is most flammable? Tick (✓) **one** box.

**A** ☒

**B** ☐

**C** ☐

**D** ☐

(1)

(e) Which **two** substances are produced when a hydrocarbon **completely** combusts in air? Tick (✓) **two** boxes.

Carbon ☐

Carbon dioxide ☒

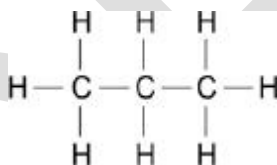
Hydrogen ☐

Sulfur dioxide ☐

Water ☒

(2)

The diagram shows the displayed structure of a hydrocarbon molecule.



(f) What is the name of the hydrocarbon in the diagram above? Tick (✓) **one** box.

Butane ☐

Ethane ☐

Methane ☐

Propane ☒

(1)

**Q16.** This question is about hydrocarbons.

(a) The names and formulae of three hydrocarbons in the same homologous series are:

|         |             |
|---------|-------------|
| Ethane  | $C_2H_6$    |
| Propane | $C_3H_8$    |
| Butane  | $C_4H_{10}$ |

The next member in the series is pentane. What is the formula of pentane?

$C_5H_{12}$

(1)

(b) Which homologous series contains ethane, propane and butane? Tick **one** box.

Alcohols

☐

Alkanes

☒

Alkenes

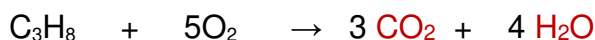
☐

Carboxylic acids

☐

(1)

(c) Propane ( $C_3H_8$ ) is used as a fuel. Complete the equation for the complete combustion of propane.



(2)

(d) Octane ( $C_8H_{18}$ ) is a hydrocarbon found in petrol. Explain why octane is a hydrocarbon.

Because it is a molecule that is made up of carbon and hydrogen atoms **only**. (2)

(e) The table below gives information about the pollutants produced by cars using diesel or petrol as a fuel.

| Fuel   | Relative amounts of pollutants |                    |                |
|--------|--------------------------------|--------------------|----------------|
|        | Oxides of Nitrogen             | Particulate matter | Carbon dioxide |
| Diesel | 31                             | 100                | 85             |
| Petrol | 23                             | 0                  | 100            |

Compare the pollutants from cars using diesel with those from cars using petrol.

Any 3 points:

Diesel cars cause more pollution than petrol cars (1)

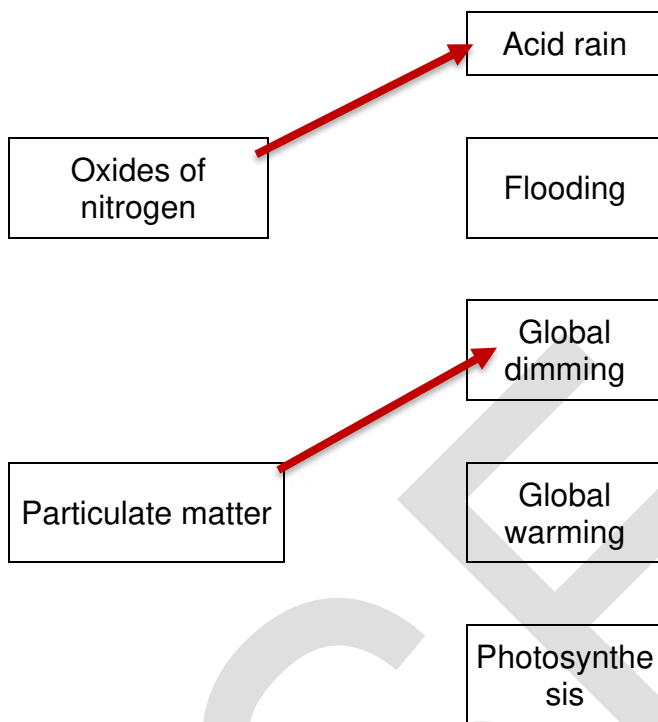
Diesel cars produce more nitrogen oxides than petrol cars which causes acid rain (1)

Diesel cars produce particulates whereas petrol cars do not; particulates cause breathing problems and global dimming, etc (1)

Diesel cars cause less global warming as they produce less carbon dioxide than petrol cars (1).

(f) Pollutants cause environmental impacts. Draw **one** line from each pollutant to the environmental impact caused by the pollutant.

| Pollutant | Environmental impact caused by the pollutant |
|-----------|----------------------------------------------|
|-----------|----------------------------------------------|



(2)

**A-Level question to give a go!**

**Q20.** Which correctly represents an incomplete combustion of pentane?

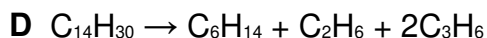
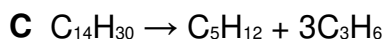
- |          |                                                          |                                  |
|----------|----------------------------------------------------------|----------------------------------|
| <b>A</b> | $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$             | <input type="radio"/>            |
| <b>B</b> | $C_5H_{12} + 8O_2 \rightarrow 4CO + CO_2 + 6H_2O$        | <input type="radio"/>            |
| <b>C</b> | $C_5H_{12} + 6O_2 \rightarrow 4CO + CO_2 + 6H_2O$        | <input checked="" type="radio"/> |
| <b>D</b> | $C_5H_{12} + 5O_2 \rightarrow 4CO + CO_2 + 4H_2O + 2H_2$ | <input type="radio"/>            |

(Total 1 mark)

**Q21.** Tetradecane ( $C_{14}H_{30}$ ) is an alkane found in crude oil. When tetradecane is heated to a high temperature, one molecule of tetradecane decomposes to form one molecule of hexane and three more molecules.

Which of the following could represent this reaction?

- |          |                                                           |                                  |
|----------|-----------------------------------------------------------|----------------------------------|
| <b>A</b> | $C_{14}H_{30} \rightarrow C_6H_{14} + C_4H_8 + 2C_2H_4$   | <input checked="" type="radio"/> |
| <b>B</b> | $C_{14}H_{30} \rightarrow C_6H_{14} + C_6H_{12} + C_2H_4$ | <input type="radio"/>            |



(Total 1 mark)

**Q22.** Petrol contains saturated hydrocarbons. Some of the molecules in petrol have the molecular formula  $C_8H_{18}$  and are referred to as octanes. These octanes can be obtained from crude oil by fractional distillation and by cracking suitable heavier fractions.

Petrol burns completely in a plentiful supply of air but can undergo incomplete combustion in a car engine.

(a) State the meaning of both the words *saturated* and *hydrocarbon* as applied to the term *saturated hydrocarbon*. Name the homologous series to which  $C_8H_{18}$  belongs.

Saturated compounds only have single covalent bonds between carbon atoms (1)

A hydrocarbon molecule is made up of carbon and hydrogen atoms **only**. (1)

Alkanes (1)

(b) Outline the essential features of the fractional distillation of crude oil that enable the crude oil to be separated into fractions.

Any 4 points from the following:

Crude oil is heated and enters the fractionating column as a gas/vapour (1)

The fractionating column is hot at the bottom and gets cooler as you go up the column (1)

The vapour cools down in the column and as each fraction reaches a temperature below its boiling point, it condenses...(1)

Each fraction is made up of different sized hydrocarbons which have different boiling points. (1).

Each fraction is separated based on its boiling point. The shorter hydrocarbon molecules with lower boiling points are distilled at the top whilst the longer hydrocarbon with higher boiling points are distilled nearer the bottom of the column. (1)

## Halogenalkanes

### GCSE questions

**Q17.** During the test for unsaturation – a haloalkane is made. Describe the test for unsaturation

Test with bromine water. Add bromine water and shake (1)

Result bromine water is decolourised: changes from an orange solution to a colourless solution (1)

## Alkenes

### GCSE questions

**Q18.** This question is about organic compounds. Hydrocarbons can be cracked to produce smaller molecules.

The equation shows the reaction for a hydrocarbon,  $C_{18}H_{38}$



(a) Which product of the reaction shown is an alkane? Tick **one** box.

$C_2H_4$

☐

$C_3H_6$

☐

$C_4H_8$

☐

$C_6H_{14}$

☒

(1)

(b) The table below shows the boiling point, flammability and viscosity of  $C_{18}H_{38}$  compared with the other hydrocarbons shown in the equation.

|          | Boiling point | Flammability | Viscosity |
|----------|---------------|--------------|-----------|
| <b>A</b> | highest       | lowest       | highest   |
| <b>B</b> | highest       | lowest       | lowest    |
| <b>C</b> | lowest        | highest      | highest   |
| <b>D</b> | lowest        | highest      | lowest    |

Which letter, **A**, **B**, **C** or **D**, shows how the properties of  $C_{18}H_{38}$  compare with the properties of  $C_2H_4$ ,  $C_3H_6$ ,  $C_4H_8$  and  $C_6H_{14}$ ? Tick **one** box.

**A**

☒

**B**

☐

**C**

☐

**D**

☐

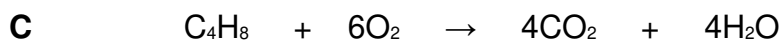
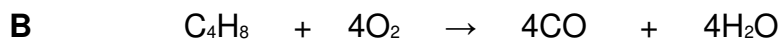
As hydrocarbon molecules get bigger, their boiling point increases, they become less flammable and they become more viscous, i.e. thicker liquids (less runny).

(1)

(c) The hydrocarbon  $C_4H_8$  was burnt in air. Incomplete combustion occurred.

Which equation, **A**, **B**, **C** or **D**, correctly represents the incomplete combustion reaction?





Tick **one** box.

**A**

☐  
☒

**B**

☐

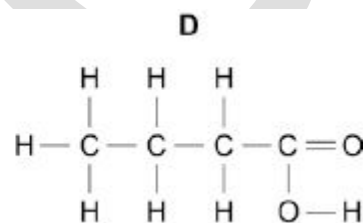
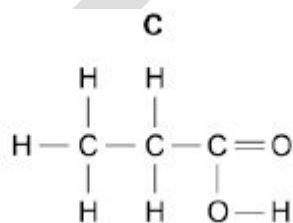
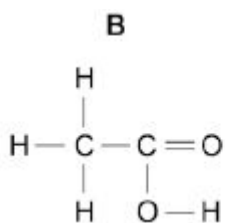
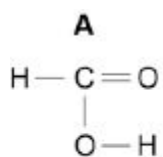
**C**

☐

**D**

(1)

(d) Propanoic acid is a carboxylic acid. Which structure, **A**, **B**, **C** or **D**, shows propanoic acid?



Tick **one** box.

**A**

☐

**B**

☐

**C**

☒

**D**

☐

(1)

(e) Propanoic acid is formed by the oxidation of which organic compound? Tick **one** box.

Propane

☐

Propene

☐

Propanol

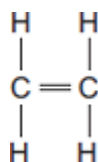
☒

Polyester

☐

(1)

**Q19.** A molecule of ethene ( $\text{C}_2\text{H}_4$ ) is represented as:



(a) A sample of ethene is shaken with bromine water. Complete the sentence.

The bromine water turns from orange to **a colourless solution (1)**

(b) Most ethene is produced by the process of cracking.

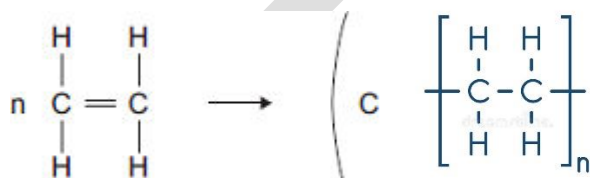
(i) Decane ( $C_{10}H_{22}$ ) can be cracked to produce ethene ( $C_2H_4$ ) and **one** other product.

Complete the equation to show the formula of the other product.



(c) Many molecules of ethene join together to produce poly(ethene).

(i) Complete the structure of the polymer in the equation.



**polyethene**

**(2)**

(ii) Some carrier bags are made from poly(ethene). Some carrier bags are made from cornstarch.

Suggest **two** benefits of using cornstarch instead of poly(ethene) to make carrier bags.

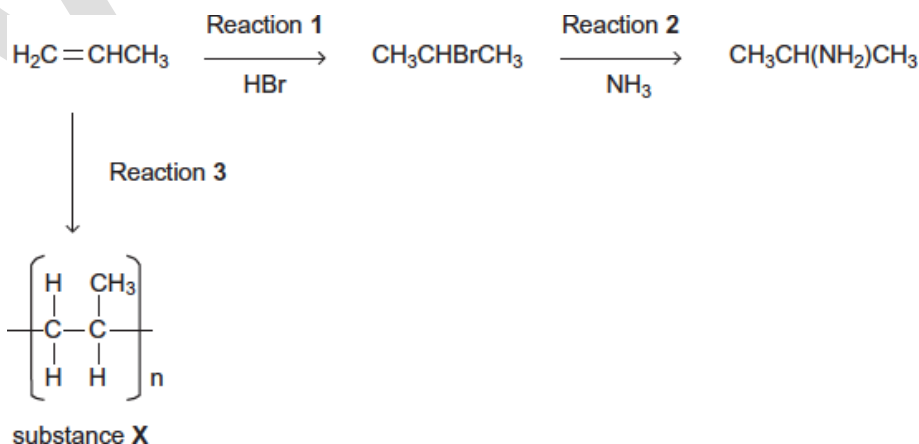
**Constarch is a natural compound, which means that it will biodegrade over time**

**(whereas polyethene is non-biodegradable) (1)**

**This means that constarch carrier bags will not end up in landfill sites (as they will break down) (1).**

### **A-Level question to give a go!**

**Q23.** Consider the following reactions.



(a) State the type of reaction in Reaction 3. Give the name of substance X.

Addition polymerisation (1)

Polypropene (1)

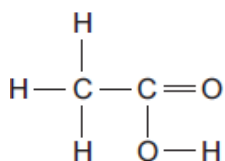
(the monomer is propene so to name a polymer you simply add poly in front of the monomer name)

## Alcohols

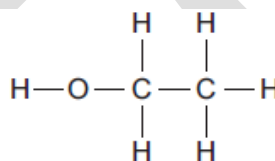
### GCSE questions

**Q20.** The diagrams represent two compounds, **A** and **B**.

**Compound A**



**Compound B**



(a) (i) Compound **B** is an alcohol. Name compound **B**. **Ethanol (1)**

(ii) Use the correct answer from the box to complete the sentence.

|        |            |          |
|--------|------------|----------|
| burned | decomposed | oxidised |
|--------|------------|----------|

To form compound **A**, compound **B** is **oxidised (1)**

(iii) Compounds **A** and **B** are both colourless liquids.

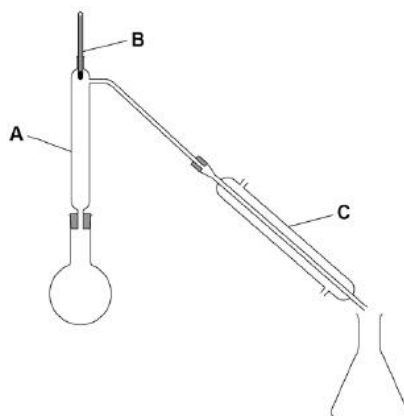
A test tube contains a colourless liquid, which could be either compound **A** or compound **B**. Describe a simple **chemical** test to show which compound, **A** or **B**, is in the test tube.

Add a metal carbonate such as sodium carbonate or calcium carbonate. **(1)**

Fizzing/bubbles/effervescence is observed with compound A whereas no visible change occurs with compound B **(1)**

### A-Level question to give a go!

**Q24.** A group of students wanted to produce a biofuel to power the central heating system in their school. They collected scraps of fruits and vegetables from the kitchens and fermented them with yeast, in the absence of air, in order to produce ethanol. The aqueous mixture was filtered to remove the remaining solids. The students then set up the apparatus shown in the diagram below and placed the aqueous mixture in the round bottomed flask.



(a) Describe how the students would use this apparatus to collect a sample of ethanol. Include in your answer the functions of the parts of the apparatus labelled **A**, **B** and **C**.

This question is marked using levels of response.

### Level 3

All stages are covered and the explanation of each stage is generally correct and virtually complete.

Answer communicates the whole process coherently and shows a logical progression through the distillation apparatus. The first two points in stage 1 are in the correct order and all other steps are in a logical order for carrying out the practical.

**5-6 marks**

### Level 2

All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies.

Answer is mainly coherent and shows a progression through the distillation apparatus.

Some steps in each stage may be out of order and incomplete but the first two points in stage 1 are in the correct order.

**3-4 marks**

### Level 1

Most points are covered but the explanation of each stage may be incomplete or may contain inaccuracies.

Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning. The first two points in stage 1 are present but not necessarily in the correct order.

**1-2 marks**

### Level 0

Insufficient correct chemistry to warrant a mark.

Omission of heating of the apparatus.

**Indicative content:****Stage 1**

- Turn on the water.
- Heat the flask, with a Bunsen burner.
- This causes water and ethanol vapours to be produced.

**Stage 2**

- Vapours pass up the fractionating column A.
- Water and ethanol are separated in column A.
- Water condenses back into the flask in column A.

**Stage 3**

- Observe the thermometer at B to keep the temperature at or below the boiling point of ethanol.

**Organic Analysis****GCSE questions**

**Q21.** Four bottles of chemicals made in the 1880s were found recently in a cupboard during a Health and Safety inspection at Lovell Laboratories.



sodium carbonate  
sodium nitrate



sodium  
sodium



chloride  
sulfate



The chemical names are shown below each bottle.

(a) You are provided with the following reagents:

- aluminium powder
- barium chloride solution acidified with dilute hydrochloric acid
- dilute hydrochloric acid
- silver nitrate solution acidified with dilute nitric acid
- sodium hydroxide solution.
- limewater
- red litmus paper

(i) Describe tests that you could use to show that these chemicals are correctly named.

In each case give the reagent(s) you would use **and** state the result.

Test and result for carbonate ions:

**Reagent:** dilute hydrochloric acid

**Result:** fizzing/bubbles/effervescence

Test and result for chloride ions:

**Reagent:** nitric acid followed by silver nitrate solution

**Result:** white precipitate

Test and result for nitrate ions:

**Reagent:** aluminium & sodium hydroxide solution then heat gently. Test the fumes that are released with damp red litmus paper

**Result:** red litmus paper turns blue as ammonia gas is released which is an alkaline gas

Test and result for sulfate ions:

**Reagent:** hydrochloric acid followed by barium chloride

**Result:** white precipitate

(ii) Suggest why a flame test would **not** distinguish between these four chemicals.

Because each solution contains sodium ions,  $\text{Na}^+$  ions and they will all give the same result: an orange/yellow flame. (1)

(b) Instrumental methods of analysis linked to computers can be used to identify chemicals. Give **two** advantages of using instrumental methods of analysis.

Any two from the following:

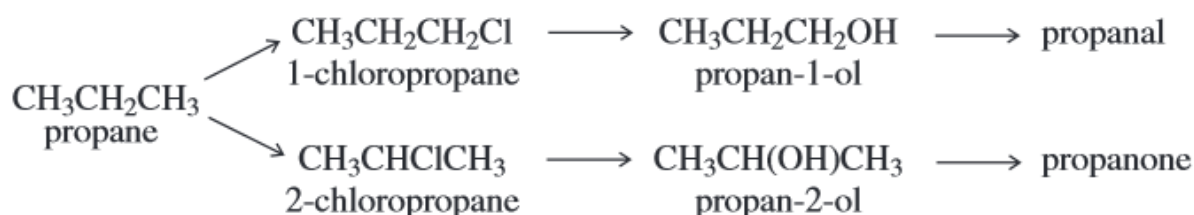
They are quicker (1)

They are more sensitive (1) therefore only small amounts of the sample are required (1)

The results are generated by the computer rather than manually (1)

### A-Level question to give a go!

**Q25.** Consider the following scheme of reactions.



(a) High resolution mass spectrometry of a sample of propane indicated that it was contaminated with traces of carbon dioxide.

Use the data in the table to show how precise  $M_r$  values can be used to prove that the sample contains both of these gases.

| Atom            | Precise relative atomic mass |
|-----------------|------------------------------|
| $^{12}\text{C}$ | 12.00000                     |
| $^1\text{H}$    | 1.00794                      |
| $^{16}\text{O}$ | 15.99491                     |

If the sample is contaminated then there would be two peaks in the spectrum: one peak would indicate the presence of propane with  $M_r = 44.06352\text{g}$  and the other peak would show the presence of carbon dioxide if it equals its  $M_r = 43.98982\text{g}$ .

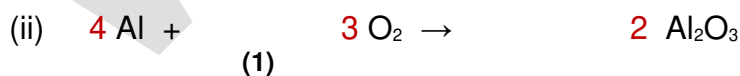
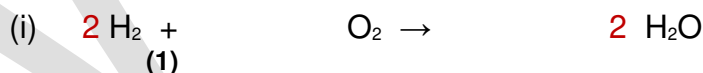
## GCSE to A-Level Chemistry – Skills Transition

### Balancing Equations

Use this method to help you <https://www.youtube.com/watch?v=ab0gYBdHU-k>

#### GCSE questions

**Q1.** (a) Balance these chemical equations.



(b) Briefly explain why an unbalanced chemical equation cannot fully describe a reaction.

An unbalanced equation implies that atoms may have been lost or gained, and mass is conserved in a chemical reaction, i.e. the number of reactant atoms should equal the number of product atoms. (1)

A balanced equation also tells us how many moles of each reactant react with each other completely and how many moles of product are formed. (1)

(2)

**Q2.** The following passage was taken from a chemistry textbook.

Germanium is a white, shiny, brittle element. It is used in the electronics industry because it is able to conduct a small amount of electricity.

It is made from germanium oxide obtained from flue dusts of zinc and lead smelters. The impure germanium oxide from the flue dusts is changed into germanium by the process outlined below.

**STEP 1** The germanium oxide is reacted with hydrochloric acid to make germanium tetrachloride. This is a volatile liquid in which the germanium and chlorine atoms are joined by covalent bonds.

**STEP 2** The germanium tetrachloride is distilled off from the mixture.

**STEP 3** The germanium tetrachloride is added to an excess of water to produce germanium oxide and hydrochloric acid.

**STEPS 1 to 3** are repeated several times.

**STEP 4** The pure germanium oxide is reduced by hydrogen to form germanium.

(a) Balance the equation below which represents the reaction in step 1.



(b) Write a word equation for the reaction in step 4.



**Q3.** (a) Cola drinks contain phosphoric acid,  $\text{H}_3\text{PO}_4$ . The two equations show how phosphoric acid can be made from phosphorus.

Balance these two equations.

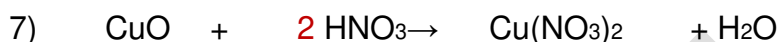


(1)



(1)

Some more practice

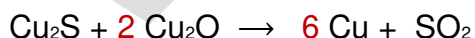
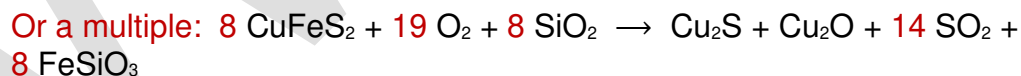


[Even more practice - Balancing Equations Game](#)

**A-Level question to give a go!**

**Q11.** Copper can be produced from rock that contains  $\text{CuFeS}_2$

(a) Balance the equations for the two stages in this process.



(2)

### Formula Literacy

For each of the following compounds;

- Identify the number of atoms of each element
- The formula of the ions it consists of
- Name it

- Challenge yourself: calculate its RFM

e.g. the first one is done for you:

### 1. $\text{NaNO}_3$

1 x sodium atom, 1 x nitrogen atom, 3 x oxygen atoms

$\text{Na}^+$  and  $\text{NO}_3^-$

Sodium nitrate

**Challenge:**  $(1 \times 23) + (1 \times 14) + (3 \times 16) = 85$

### 2. $\text{Na}_2\text{O}$

No. of atoms =  $2 + 1 = 3$

Formulae of ions =  $\text{Na}^+$   $\text{O}^{2-}$

Name = sodium oxide

RFM =  $(2 \times 23) + (1 \times 16) = 62\text{g}$

### 3. $\text{K}_3\text{PO}_4$

No. of atoms =  $3 + 1 + 4 = 8$

Formulae of ions =  $\text{K}^+$   $\text{PO}_4^{3-}$

Name = potassium phosphate

RFM =  $(3 \times 39.1) + (1 \times 31) + (4 \times 16) = 212.3\text{g}$

### 4. $\text{CaBr}_2$

No. of atoms =  $1 + 2 = 3$

Formulae of ions =  $\text{Ca}^{2+}$   $\text{Br}^-$

Name = calcium bromide

RFM =  $(1 \times 40.1) + (2 \times 79.9) = 199.9\text{g}$

### 5. $\text{Al}_2\text{O}_3$

No. of atoms =  $2 + 3 = 5$

Formulae of ions =  $\text{Al}^{3+}$   $\text{O}^{2-}$

Name = aluminium oxide

RFM =  $(2 \times 27) + (3 \times 16) = 102\text{g}$

### 6. $\text{NH}_4\text{OH}$

No. of atoms =  $1 + 4 + 1 + 1 = 7$

Formulae of ions =  $\text{NH}_4^+$   $\text{OH}^-$

Name = ammonium hydroxide

RFM =  $(1 \times 14) + (5 \times 1) + (1 \times 16) = 35\text{g}$

### 7. $(\text{NH}_4)_2\text{SO}_4$

No. of atoms =  $(5 \times 2) + 1 + 4 = 15$  or  $2 + 8 + 1 + 4 = 15$

Formulae of ions =  $\text{NH}_4^+$   $\text{SO}_4^{2-}$

Name = ammonium sulfate

RFM =  $(2 \times 14) + (8 \times 1) + 32.1 + (16 \times 4) = 132.1\text{g}$

## SI units

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          |

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

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

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.

| 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  | $\mu$  | $10^{-6}$             | 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 |

**For the following quantities, which SI unit and most appropriate prefix would you use?**

1. The mass of water in a test tube. **grams**
2. The time taken for a solution to change colour. **seconds**

3. The radius of a gold atom. **nanometres / picometres**
4. The volume of water in a burette. **centimetres cubed,  $\text{cm}^3$**
5. The amount of substance in a beaker of sugar. **mole**
6. The temperature of the blue flame from a Bunsen burner. **Kelvin or kilo Kelvin**

***Rewrite the following quantities.***

7. 0.00122 metres in millimetres     **$1000\text{mm} = 1\text{ m}$     therefore  $0.00122\text{m} \times 1000 = 1.22\text{ mm}$**
8. 104 micrograms in grams     **$1000\ 000\text{ mg} = 1\text{ g}$     therefore  $104\text{g} / 1000\ 000 = 0.000104\text{ g}$**
9. 1.1202 kilometres in metres     **$1000\text{ m} = 1\text{ km}$     therefore  $1.1202\text{km} \times 1000 = 1120.2\text{ m}$**
10. 70 decilitres in millilitres     **$100\text{ml} = 1\text{ dl}$     therefore  $70\text{ dl} \times 100 = 7000\text{ ml}$**
11. 70 decilitres in litres     **$7\text{l or } 7\text{dm}^3$      $10\text{dl} = 1\text{ l}$     therefore  $70\text{dl} / 10 = 7\text{l}$**
12.  $10\text{ cm}^3$  in litres     **$0.01\text{ dm}^3$      $1000\text{cm}^3 = 1\text{ dm}^3$     therefore  $10\text{cm}^3 / 1000 = 0.01\text{ dm}^3$**