Chemistry A Level | Edexcel | 9CH0


# Starters and Plenaries

## for A Level Edexcel Chemistry Year 2

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# Teacher’s Introduction

> **Remember!**
> Always check the exam board website for new information, including changes to the specification and sample assessment material.

This resource provides activities for all major topics under the A Level Year 2 specification for Edexcel Chemistry. While most activities cover ideas from one topic only, occasionally two or three related topics may be grouped into one activity. Each activity is designed to be used as either a starter or a plenary, but many are suitable for use in either situation. Additional notes and guidance often provide suggestions on how to use the activity differently in a starter or plenary situation, and may also provide extension ideas.

On the next page you will find an overview table, providing the name and contents of each activity. This table also provides a syllabus reference for each activity and highlights how the activities are distributed across the A Level Year 2 specification.

For each activity, there is a page of teacher’s notes and a photocopiable student sheet.* Teacher’s notes provide instructions, suggestions and answers for each activity, as well as additional notes, timings and other information. Many of the activities are not specific to any one topic and therefore can be adapted to other topics. You should also bear in mind that some types of activities will work better with certain student groups than with others, and therefore some experimentation will be needed to find the most effective starter and plenary strategies.

* Activity 5: Agreement line and Activity 14: Memory game do not require a student sheet.

*May 2024*

 

# Overview Table

| Activity number | Topic | Activity title | Intended use | Time (minutes) | Edexcel specification reference | |
|---|---|---|---|---|---|---|
| 1 | Rate equations | Introducing orders | S | 10 | Topic 16, subtopics 1–2 | Kinetics II |
| 2 | Rate constant and temperature | Answer splat | P | 10 | Topic 16, subtopic 12 | Kinetics II |
| 3 | Equilibrium | Moles, volume and pressure | S | 10 | Topic 11 | Equilibrium II |
| 4 | $K_p$ calculations | Sequencing | P | 5 | Topic 11, subtopics 1–2 | Equilibrium II |
| 5 | Acid and base strength | Agreement line | S | 10 | Topic 12, subtopics 7–12 | Acid-base Equilibria |
| 6 | Acids and bases | Taboo! | P | 10 | Topic 12 | Acid-base Equilibria |
| 7 | Acids and bases | Correct the mistakes | P | 5 | Topic 12, subtopics 7–12 | Acid-base Equilibria |
| 8 | Born–Haber cycles | Thumbs up or down | S | 5 | Topic 13, subtopics 1–5 | Energetics II |
| 9 | Enthalpy | SWOT analysis | S | 5 | Topic 13 | Energetics II |
| 10 | Entropy | Candle flame | S | 10 | Topic 13B | Energetics II – Entropy |
| 11 | Electrochemical cells | Fruit batteries | S | 15 | Topic 14 | Redox II |
| 12 | Electrochemical cells | Making a revision map | P | 15 | Topic 14 | Redox II |
| 13 | Transition metals | Diamond 9 | P | 10 | Topic 15 | Transition metals |
| 14 | Transition metals | Memory game | P | 5 | Topic 15 | Transition metals |
| 15 | Zinc and scandium | Advice for the next class | P | 15 | Topic 15 | Transition metals |
| 16 | Benzene | Teaching the structure | P | 15 | Topic 18A | Organic Chemistry II – Arenes – benzene |
| 17 | Aldehydes and ketones | Noughts and crosses | P | 5 | Topic 17B | Organic Chemistry II – Carbonyl compounds |

*Table continued overleaf*

 

| Activity number | Topic | Activity title | Intended use | Time (minutes) | Edexcel specification reference | |
|---|---|---|---|---|---|---|
| 18 | Aldehydes and ketones | Matching | P | 5 | Topic 17B | Organic Chemistry II – Carbonyl compounds |
| 19 | Esters and amides | Keyword tennis | P | 5 | Topic 17C, subtopics 12, 13 & 15 | Organic Chemistry II – Carboxylic acids |
| 20 | Carboxylic acids, amides and esters | Just a minute… | P | 5 | Topic 17C<br>Topic 18B | Organic Chemistry II – Carboxylic acids<br>Organic Chemistry III – Amines, amides, amino acids and proteins |
| 21 | Amino acids | Questions for answers | P | 15 | Topic 18B | Organic Chemistry III – Amines, amides, amino acids and proteins |
| 22 | Optical isomerism | Model building | S | 10 | Topic 17A | Organic Chemistry II – Chirality |
| 23 | Polymers | What's in the room? | S | 5 | Topic 18B, subtopic 15 | Organic Chemistry III – Amines, amides, amino acids and proteins |
| 24 | The Friedel–Crafts acylation reaction | Mechanism jigsaw | S/P | 10 | Topic 18A, subtopic 5 | Organic Chemistry II – Arenes – benzene |
| 25 | Chromatography | Countdown | S | 5 | Topic 19C | Modern Analytical Techniques II – Chromatography |
| 26 | NMR spectroscopy | Identifying environments | S | 5 | Topic 19B | Modern Analytical Techniques II – Nuclear Magnetic Resonance (NMR) |

**Notes:**
S/P = intended for use as either a starter or a plenary
S (P) = intended for use as a starter but possible to adapt for use as a plenary with a suggestion provided

 

## Activity 1: Rate equations

| | |
|---|---|
| **Activity name** | Introducing orders |
| **Aim** | To revise what orders (powers) of 0, 1 and 2 mean in relationshi |
| **Instructions** | • Allow students some time to use their calculators, if necess a simple number, such as 3, is raised to the power of 0, 1 or<br>• Remind students that an alternative word for power here is<br>• Work through the two examples that are given in the addit section below with the class. Encourage students to make r doing their own tasks.<br>• Provide students with the accompanying sheet that contain linked by these powers. They work in pairs to determine th |
| **Timings** | 10 minutes |
| **Required prior learning** | An understanding of raising numbers to powers from, for exam |
| **Intended use** | Starter |
| **Specification reference** | Topic 16, subtopics 1–2: Kinetics II |
| **Additional notes and guidance** | Use these values, set out in a vertical table on the board:<br>• Example 1: x values 0, 1, 2, 3, 4. y values 0.5, 0.5, 0.5, 0.5, 0.5 Now, if an equation linking these is $y = ax^n$, what must n be? (Answer 0) We say 'The order of y with respect to x is zero order.' A mnemonic for this is 'if there is zero effect, the order is ze<br>• Example 2: x values 0, 1, 2, 3, 4. y values 0, 5, 10, 15, 20. Now, if an equation linking these is $y = ax^n$, what must n be? (Answer 1) We say 'The order of y with respect to x is first order.' So, if the effect is direct proportion, i.e. the difference betwe same, and increases linearly, then the order is 1.<br>• Example 3: x values 0, 1, 2, 3, 4. y values 0, 1, 4, 9, 16. Now, if an equation linking these is $y = ax^n$, what must n be? (Answer 2) We say 'The order of y with respect to x is second order.' A mnemonic for this is 'if there is a greater effect than just d difference between consecutive terms is not constant, then t<br><br>Eventually, students will need to work with two variables chang reinforce at this stage that these rules only work when one varial |
| **Answers** | 1. 1 or first order<br>2. 1 or first order<br>3. 0 or zero order<br>4. 2 or second order<br>5. 1 or first order<br>6. 2 or second order |

## Activity 1: Rate equations – Introducing

Use the worked examples that you have seen to work out the orders that connect
column to the variable in the first.

1.

| A | B |
|---|---|
| 1 | 4 |
| 2 | 8 |
| 3 | 12 |

Order of B with respect to A is ………….

2.

| X | Y |
|---|---|
| 5 | 1 |
| 10 | 2 |
| 15 | 3 |

Order of Y with resp

3.

| P | Q |
|---|---|
| 0.4 | 6.5 |
| 0.8 | 6.5 |
| 1.6 | 6.5 |

Order of Q with respect to P is ………….

4.

| C | D |
|---|---|
| 0.01 | 0.2 |
| 0.02 | 0.8 |
| 0.03 | 1.8 |

Order of D with resp

5.

| φ | κ |
|---|---|
| $2.5 \times 10^{-3}$ | 0.04 |
| $7.5 \times 10^{-3}$ | 0.12 |
| $1.5 \times 10^{-2}$ | 0.24 |

Order of κ with respect to φ is ………….

6.

| M / $\times 10^{-6}$ | N |
|---|---|
| 20 | |
| 15 | |
| 10 | |

Order of N with resp

## Activity 2: Rate constant and temperature

| | |
|---|---|
| **Activity name** | Answer splat |
| **Aim** | To assess understanding of the Arrhenius equation. |
| **Instructions** | • Two students volunteer to start the activity. Each is given<br>• You can provide students with the accompanying sheet if t course because recall of the Arrhenius equation is not requi<br>• You write two answers on the board. When you read the q splat close to the correct answer with their Post-it note. Th<br>• The student who was first then picks the next student from competitor for question 2. This repeats as necessary.<br>• Suggested questions and answer pairs are provided below. |
| **Timings** | 10 minutes |
| **Required prior knowledge** | The topic of rate equations and the Arrhenius equation. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 16, subtopic 12: Kinetics II |
| **Additional notes and guidance** | Suggested questions for the activity include:<br>1. Which of these are constants in the Arrhenius equation?<br>2. What is the unit of temperature in the Arrhenius equation?<br>3. Which of these will give a straight line with a negative grad<br>4. Which of these is '*c*' when the Arrhenius equation is writte<br>5. Which of these is '*m*' when the Arrhenius equation is writt<br>6. True or false? The rate constant in any experiment is indep |
| **Answers** | Suggested answer pairs for the questions above (correct answers<br>1. *k* and *T* / <u>e and *R*</u><br>2. <u>K</u> / °C<br>3. <u>ln *k* against 1/*T*</u> / *T* against ln 1/*k*<br>4. ln *k* / <u>ln *A*</u><br>5. <u>$-E_a/R$</u> / -ln*k*/*T*<br>6. True / <u>False</u> |

## Activity 2: Rate constant and temperature – A

Use information on this sheet if you need hints for the answers!

The Arrhenius equation is

$$k = Ae^{\frac{-E_a}{RT}}$$

It can be rearranged to

$$\ln k = \frac{-E_a}{R}\left(\frac{1}{T}\right) + \ln A$$

Use the space below for notes or working.

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## Activity 3: Equilibrium

| | |
|---|---|
| **Activity name** | Moles, volume and pressure |
| **Aim** | Attempt to overcome the difficulty some students have with eq |
| **Instructions** | • The objective is to get students thinking about the concepts in gases from first principles so that calculations of $K_p$ are n<br>• Limit the activity to dealing with one gas, at least initially.<br>• Ask the class<br>o to volunteer their ideas about what 1 mole means<br>o whether they can recall the volume occupied by 1 mol and pressure<br>o what the rules for the volume of 1 mole of different ga different conditions<br>o how pressure is related to volume for a fixed quantity<br>• Students should make notes on these on the accompanying the remaining questions. The idea is that they do this indiv working on their own in this topic. |
| **Timings** | 10 minutes |
| **Required prior learning** | GCSE and AS understanding of the mole, volume and pressure of matter. |
| **Intended use** | Starter |
| **Specification reference** | Topic 11: Equilibrium II |
| **Additional notes and guidance** | • The activity could be extended to introduce mole fraction a students are secure in their understanding of moles, volum<br>• The last question in this activity involves two gases to allow |
| **Answers** | 1. Idea of a fixed quantity of molecules or particles equal to the students may not recall the numerical value of this (it is 6.02<br>2. 24 $dm^3$<br>3. 1 mole of any gas will occupy the same volume as any other students may quote one of the ideal gas equations such as *p*<br>4. Pressure and volume are inversely proportional, or as volur or students may quote one of the ideal gas equations such as<br>5. a) $2p$<br>b) $2V$<br>c) $2V$<br>d) $2p$ |

## Activity 3: Equilibrium – Moles, volume an

1. What do you understand by '1 mole'?

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2. What volume does 1 mole of gas occupy at room temperature and atmospheric pressure?

   ..................................................................................................................

3. State the rule for the volume occupied by 1 mole of different gases under th

   For example, the volume occupied by 1 mole of argon at 100 °C and 5.0 kPa c occupied by 1 mole of nitrogen at 100 °C and 5.0 kPa.

   ..................................................................................................................

4. Describe how pressure and volume are related for a fixed number of moles o

   ..................................................................................................................

   ..................................................................................................................

5. Now think of a gas sealed in a cylinder that can change volume.

   There is *n* moles of gas in the cylinder.

   The pressure in the cylinder is *p* and the volume of gas in the cylinder is *V*.

   Answer these questions in terms of the letters *n*, *p* and *V*.

   Through each of the changes, the temperature remains constant.

   a) State the pressure when the volume is decreased to $\frac{V}{2}$

      ..................................................................................................................

   b) State the volume when the number of moles of gas is increased to 2*n* a

      ..................................................................................................................

   c) State the volume when the number of moles of gas is *n* and the pressu

      ..................................................................................................................

   d) State the pressure when the number of moles of gas is *n* and the volum gas is added.

      Assume there is no reaction between the two gases.

      ..................................................................................................................

## Activity 4: $K_p$ calculations

| | |
|---|---|
| **Activity name** | Sequencing |
| **Aim** | To enable students to think through the steps involved in a calc |
| **Instructions** | • Students work individually or in pairs.<br>• Provide students with the accompanying sheet which has s but not in the correct order.<br>• Students cut out each statement and arrange them in the co |
| **Timings** | 10 minutes |
| **Required prior knowledge** | Calculation of $K_p$ |
| **Intended use** | Plenary |
| **Specification reference** | Topic 11, subtopics 1–2: Equilibrium II |
| **Additional notes and guidance** | Students can do this as a cut-and-stick activity, or they can numb |
| **Answers** | 1. Write a balanced chemical equation for the reaction.<br>2. Calculate the number of moles of each substance.<br>3. Calculate the mole fraction of each substance.<br>4. Calculate the partial pressure of each substance.<br>5. Write an expression for $K_p$ using symbols.<br>6. Substitute values and calculate $K_p$.<br>7. Determine the units of $K_p$.<br><br>or<br><br>1. Write a balanced chemical equation for the reaction.<br>2. Write an expression for $K_p$ using symbols.<br>3. Calculate the number of moles of each substance.<br>4. Calculate the mole fraction of each substance.<br>5. Calculate the partial pressure of each substance<br>6. Substitute values and calculate $K_p$.<br>7. Determine the units of $K_p$.<br><br>Other variations are possible, but the student's sequence must be |

## Activity 4: $K_p$ calculations – Sequenc

Below are the stages in the calculation of $K_p$, but they are not in the correct order.

Cut out the stages and arrange them in the correct order.

✂ **Calculate the number of moles of each substance**

✂ **Determine the units of $K_p$**

✂ **Calculate the mole fraction of each substance**

✂ **Write an expression for $K_p$ using symbols**

✂ **Write a balanced chemical equation for the reacti**

✂ **Substitute values and calculate $K_p$**

✂ **Calculate the partial pressure of each substance**

## Activity 5: Acid and base strength

| | |
|---|---|
| **Activity name** | Agreement line |
| **Aim** | To assess existing understanding of acid and base strength and and concentrated equate to strength. |
| **Instructions** | • Allocate a space in the room where students can form a lin of the room. Explain that one end represents 'strongly agre 'strongly disagree' and the middle is 'do not know'.<br>• Initially, and before each statement, students assemble in th<br>• Explain that you will make statements about acid and base individuals, must listen and decide whether they agree, dis They position themselves along the line accordingly.<br>• Emphasise that staying in the 'do not know' position is per<br>• Also explain that you could ask any student to explain why |
| **Timings** | 10 minutes |
| **Required prior knowledge** | Students should have covered the part of the topic that deals wi strong and weak in terms of acids and bases. Amines, if questio |
| **Intended use** | Starter (see Required prior knowledge above) |
| **Specification reference** | Topic 12, subtopics 7–12: Acid-base Equilibria |
| **Additional notes and guidance** | Statements should be true/false and of varying challenge and inc Suggestions are:<br>1. Hydrochloric acid is a strong acid.<br>2. A 10 mol $dm^{-3}$ solution of sulfuric acid is a strong acid.<br>3. A 0.001 mol $dm^{-3}$ solution of nitric acid is a strong acid.<br>4. Solid sodium hydroxide is a strong alkali.<br>5. A saturated aqueous solution of ethanoic acid is a strong aci<br>6. A solution of propanoic acid is a weak acid regardless of its<br>7. A 0.001 mol $dm^{-3}$ solution of potassium hydroxide is a stron<br>8. Organic bases, such as amines, all have the same pH when a in water. |
| **Answers** | 1. True – HCl completely dissociates in aqueous solution.<br>2. True – $H_2SO_4$ completely dissociates in aqueous solution; th is irrelevant.<br>3. True – $HNO_3$ mol $dm^{-3}$ completely dissociates in aqueous so solution is irrelevant.<br>4. False – NaOH is only classed as an alkali when in aqueous s<br>5. False – ethanoic acid only slightly dissociates in water, maki concentration of the solution is irrelevant.<br>6. True – propanoic acid only slightly dissociates in water, ma concentration of the solution is irrelevant.<br>7. True – KOH completely dissociates to provide $OH^-$ ions in w solution is irrelevant.<br>8. False – amines are weak bases, but they vary in their ability $OH^-$ ions in water. |

## Activity 6: Acids and bases

| | |
|---|---|
| **Activity name** | Taboo! |
| **Aim** | To review students' understanding of the keywords associated |
| **Instructions** | • Students work in groups of three.<br>• Each student in turn thinks of a keyword or key term from other two in the group. They must not say the keyword or taboo. They should be given 1–2 minutes to plan these. Th accompanying sheet, but the other members of their group<br>• The other two students can interrupt when they think they The first student of the other two to guess what the keywor |
| **Timings** | 10 minutes (approximately) |
| **Required prior learning** | The topic of acids, bases and buffers. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 12: Acid-base Equilibria |
| **Additional notes and guidance** | • An alternative to allowing students to choose their own key student in the group with different keywords sealed in an e duplicated across groups.<br>• Try to listen to as many explanations as you can during the information, do not interrupt but ask about this after the act |
| **Answers** | Keywords / key terms that could be used include:<br>• Weak acid<br>• NaOH<br>• Titration<br>• $pK_a$<br>• Hydrogen ion concentration<br>• $K_w$<br>• Conjugate base<br>• Brønsted–Lowry base<br>• HCl<br>These can be given as the cut-outs from below.<br>If the activity is done as suggested, then these should not be shar whole group. |

✂

| | | |
|---|---|---|
| **Weak acid** | **NaOH** | |
| **$pK_a$** | **Hydrogen ion concentration** | |
| **Conjugate base** | **Brønsted–Lowry base** | |

## Keyword Taboo!

Choose up to four keywords or key terms associated with the topic of acids, bases

You will explain these to the rest of your group ***without*** saying the keyword itself,

***For example:***

**Student 1:** 'A solution where the concentration of $H^+$ ions is different from th
**Student 2:** 'Acid!'
**Student 1:** 'No. The concentration of $OH^-$ ions is greater than that of water...
**Student 2:** 'Base!'
**Student 1:** 'No.'
**Student 3:** 'Alkali!'
**Student 1:** 'Yes.'

Use this sheet to plan what keywords or key terms you will use. Make some note not show this to the others!

| | |
|---|---|
| **Keyword:** ____________________<br><br>**Notes for explanation:** | **Keyword:** __<br><br>**Notes for explanation:** |
| **Keyword:** ____________________<br><br>**Notes for explanation:** | **Keyword:** __<br><br>**Notes for explanation:** |

## Activity 7: Acids and bases

| | |
|---|---|
| **Activity name** | Correct the mistakes |
| **Aim** | To assess understanding of acids and bases. |
| **Instructions** | • Students work individually.<br>• The accompanying sheet contains statements about acids a correct the mistakes. There may be more than one way to c but if the correction is chemically correct then it is acceptab |
| **Timings** | 5 minutes |
| **Required prior knowledge** | Acids and bases. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 12, subtopics 7–12: Acid-base Equilibria |
| **Additional notes and guidance** | - |
| **Answers** | An acid is a substance that donates **hydrogen ions / protons / H** measure of the concentration of **hydrogen ions / protons / $H^+$** an equation **pH** = **$-log_{10}$** [$H^+$]. In the equation, the square brackets m **$dm^3$ / concentration**.<br><br>**An alkali** is a soluble **base**. In **aqueous** solution, it will produce To calculate the **pH** of a solution of alkali, the constant $K_W$ is use **water**. The numerical value of $K_W$ is **$10^{-14}$ / of p$K_W$** is 14.<br><br>Sulfuric acid is an example of a **strong** acid because it complete solution. Its formula is **$H_2SO_4$** which means each mole of sulfur **two moles** of protons.<br><br>Sodium hydroxide is an example of a **strong** base. Its formula is each mole of sodium hydroxide will produce ~~less than~~ one mole **aqueous** solution. |

## Activity 7: Acids and bases – Correct the r

There are statements about acids and bases below, some of which contain mistak

Your job is to find and correct the mistakes. There may be more than one way to should aim to make the chemistry correct whatever option you choose.

The line spacing has been increased to give you space to add your corrections.

*An acid is a substance that donates hydrogen in solution. pH is a measure*

*of hydrogen and can be calculated using the equation pH = -**ln** [$H^+$]. In th*

*brackets mean number of moles.*

*A base is a soluble alkali. In solution, it will produce OH ions. To calculat*

*of alkali, the constant $K_W$ is used. $K_W$ is the ionic product of alkali. The m*

*$K_W$ is 14.*

*Sulfuric acid is an example of a weak acid because it completely dissociates*

*Its formula is $H_2SO_2$ which means each mole of sulfuric acid in solution w*

*of protons.*

*Sodium hydroxide is an example of a weak base. Its formula is NaOH wh*

*sodium hydroxide will produce less than one mole of hydroxide ions in sol*

## Activity 8: Born–Haber cycles

| | |
|---|---|
| **Activity name** | Thumbs up or down |
| **Aim** | To assess students' understanding of the Born–Haber cycle. |
| **Instructions** | • Students work individually.<br>• Give students the accompanying sheet of true/false stateme<br>• You can either read the statements aloud before students h or students can have time to fill in the sheet first.<br>• To each statement that is read aloud, students respond ind<br>  o thumb up – for true<br>  o thumb down – for false<br>  o thumb sideways – for don't know<br>• If using the first method, remember to give students appro statement, and time to change their mind. One suggestion in your mind after each statement.<br>• Whether or not a student is correct, they can be asked to ju<br>• If time permits, students can compose their own true/false read theirs to the class. |
| **Timings** | 10 minutes |
| **Required prior knowledge** | The Born–Haber cycles and related calculations. |
| **Intended use** | Starter for the lesson that follows the one on the Born–Haber cy at the end of the Born–Haber cycle lesson. |
| **Specification reference** | Topic 13, subtopics 1–5: Energetics II |
| **Additional notes and guidance** | Students should be encouraged to use a thumb sideways rather t doing. They may need reminding that it's OK not to be sure at th |
| **Answers** | 1. The enthalpy change of ionisation is always positive. (True remove an electron from an atom, so it is an endothermic pr<br>2. You can measure lattice enthalpy experimentally. (False. It crystal from separate ions, or carry out the reverse process, i<br>3. Enthalpy of hydration is one of the stages in a Born–Haber c stage in the cycle.)<br>4. Electron affinity during the formation of $MgCl_2$ is shown by Born–Haber cycle. (True. The acceptance of an electron by be an exothermic process, so has a negative enthalpy.)<br>5. The solid ionic compound is always at the bottom of a Born at the bottom because it is the most stable substance in the c<br>6. The enthalpy of atomisation/vaporisation of the metal elem up arrow or a down arrow in the cycle. (False. It will alway splitting a metal element into separate atoms is an endother |

## Activity 8: Born–Haber cycles – Thumbs u

Below are six statements about Born–Haber cycles.

Decide whether each statement is true or false and use these signs to show your

- Thumb up, if you think a statement is true. 👍
- Thumb down, if you think a statement is false. 👎
- Thumb sideways, if you are not sure. 👉

1. The enthalpy change of ionisation is always positive.

   ..........................................................................................................................

   ..........................................................................................................................

2. You can measure lattice enthalpy in an experiment.

   ..........................................................................................................................

   ..........................................................................................................................

3. Enthalpy of hydration is one of the stages in a Born–Haber cycle.

   ..........................................................................................................................

   ..........................................................................................................................

4. Electron affinity during the formation of $MgCl_2$ is shown by a down arrow on

   ..........................................................................................................................

   ..........................................................................................................................

5. The solid ionic compound is always at the bottom of a Born–Haber cycle.

   ..........................................................................................................................

   ..........................................................................................................................

6. The enthalpy of atomisation/vaporisation of the metal element can be show or a down arrow in the cycle.

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If you have time, you can add your own true/false statement about the Born–Ha

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## Activity 9: Enthalpy

| | |
|---|---|
| **Activity name** | SWOT analysis |
| **Aim** | To assess prior understanding of the enthalpy topic from AS / Y |
| **Instructions** | • Students work individually.<br>• Remind them about the topic of enthalpy from Year 1.<br>• Tell them that they will perform a SWOT analysis of their u topic, where:<br>o S means strengths, W means weaknesses, O means op<br>o S and W should focus on the past and present state of T should look to the future of what the topic might ho<br>• They can write their responses on the accompanying sheet. possible, to the specifics of the topic and individual learnin general statements.<br>• At the end of the activity, ask students to volunteer one thi at least one statement from each of the four areas from the<br>• Students can retain the sheet and review this at the end of t |
| **Timings** | 5 minutes |
| **Required prior learning** | AS or equivalent understanding of the topic of enthalpy. |
| **Intended use** | Starter |
| **Specification reference** | Topic 13: Energetics II |
| **Additional notes and guidance** | S and W should focus on the past and present state of students' should look to the future of what the topic might hold. |
| **Answers** | Responses will vary, but each student should have written at lea areas, even if their understanding is secure.<br>• S – these should be the parts of the topic where the student or understanding<br>• W – these should be specific parts of the topic where the stu<br>• O – this could refer to extending existing understanding or t on a weakness from above<br>• T – this could refer to areas of weakness possibly causing di the topic becoming more complex |

## Activity 9: Enthalpy – SWOT analys

In this activity, you recall the topic of enthalpy and the concepts that were cover

It is important that you work by yourself as the activity relates to your *individual*

SWOT stands for <u>S</u>trengths, <u>W</u>eaknesses, <u>O</u>pportunities and <u>T</u>hreats.

Use each of these four prompts to write at least one thing for each. Try to be sp making general statements.

Think of S and W as referring to the past and present, and O and T as referring to

| | |
|---|---|
| **S**<br>strength | Example: I found it really easy to remember the wording of Hess's |
| **W**<br>weakness | Example: I found it difficult to calculate enthalpy changes using p |
| **O**<br>opportunity | |
| **T**<br>threat | |

Keep this completed sheet and review it again at the end of the enthalpy topic th

## Activity 10: Entropy

| | |
|---|---|
| **Activity name** | Candle flame |
| **Aim** | To start students thinking about order and disorder. |
| **Instructions** | • Carry out the activity as a demonstration:<br>o Show students an unlit candle and ask them to descri in it.<br>o Ask how a candle works (many will just say that the w<br>o Light the candle and, if necessary, explain what is hap elicit this from students via prompting (see additiona Ask students to observe that the flame does not touch<br>• After observing this, ask students to work in pairs to summ happen and list the reactants and products.<br>• Then ask them to consider how order or disorder changes t You do not need to introduce the term entropy yet.<br><br>**Safety point** – ensure that there are no flammable materials clo over a tray to collect any dripping wax. After extinguishing the onto the wick to prevent excessive smoking. |
| **Timings** | 10 minutes |
| **Required prior learning** | The only prior understanding required is changes of state and b together with some basic understanding of combustion. |
| **Intended use** | Starter |
| **Specification reference** | Topic 13B: Energetics II – Entropy |
| **Additional notes and guidance** | The candle works as follows:<br>• The wick initially burns on its own using oxygen from the ai wax at the top of the candle.<br>• Liquid wax is drawn up the wick and vaporises in the heat o<br>• Wax vapour then burns just as it leaves the wick (explaining the wick).<br>• As wax is mostly hydrocarbon, the products of the reaction v dioxide and water vapour, assuming mostly complete comb |
| **Answers** | 1. solid → liquid → gas<br>2. hydrocarbon + oxygen → carbon dioxide + water (vapour)<br>3. a) Disorder increases<br>b) In the candle, the solid wax has particles that are vibra contact with their neighbours. In melted wax, the parti still in contact with their neighbours. In the vapour, th moving randomly in straight lines.<br>Because of the change from solid to liquid and then to g with each change. Some students may know that in a f increasing disorder further. |

## Activity 10: Entropy – Candle flam

1. Describe all of the changes of state that are necessary for a candle to burn.

   Start with the wax when it is a solid.

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2. Assume that wax is 100 % hydrocarbon and ignore the wick.

   Write a simple word equation to show the combustion process.

   ........................................................................................................

3. Now consider the level of order and disorder in the particles that are involve

   a) State how this changes during the burning process.

   ........................................................................................................

   b) Explain your answer.

   ........................................................................................................

   ........................................................................................................

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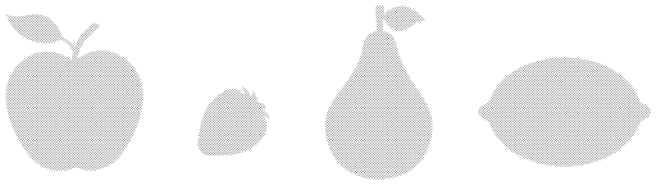
## Activity 11: Electrochemical cells

| | |
|---|---|
| **Activity name** | Fruit batteries |
| **Aim** | To remove any barriers to a topic perceived as complex by revis students possibly did when they were younger, but to begin to |
| **Instructions** | Do the activity as a demonstration:<br>• Ask students if they ever made fruit batteries before. It is u problem if not.<br>• Use a fresh citrus fruit such as an orange or a grapefruit. C pieces of different metals into the cut part of the fruit. Atta these pieces of metal and measure the potential difference ( multimeter. It does not matter if the reading is negative, bu to start with a positive reading.<br>• Ask students to suggest what may be happening to make th different charges.<br>• If necessary, prompt them about redox reactions and the ga<br>• Show which way real (as opposed to conventional) current negative and out at the positive, if the reading is positive) a gaining electrons and which metal must be losing electrons |
| **Timings** | 15 minutes |
| **Required prior learning** | Redox reactions from the previous year. |
| **Intended use** | Starter |
| **Specification reference** | Topic 14: Redox II |
| **Additional notes and guidance** | • At the start of the activity, it does not matter if the reading but it may be conceptually easier to start with a positive rea if this is the case.<br>• The voltage is small, so some adjustment of the meter may<br>• Students may ask if it is possible to light a small bulb with th that the current is too small for this, but a large number of su parallel could be used to light a bulb.<br>• Some students may find the concept of gain and loss of elect charge on a metal because electrons are themselves negative negative electrons that are gained, the more negative someth |
| **Answers** | 1. The diagram should include the type of fruit and the two m<br>2. The metals used will vary, but the one connected to the neg the one that is positive is oxidised.<br>3. The metal being reduced will eventually all react / the metal all react / the substance in the fruit that is involved in the re concentration will become too low. |

## Activity 11: Electrochemical cells – Fruit b



1. Draw a labelled diagram of the fruit battery that was demonstrated. Use the circle) for the meter that was used.

2. Complete the table below by adding the names of the metals used, and addi

| | Connected to the negative of the meter | Connected to the positive of the meter | Meta ox |
|---|---|---|---|
| Metal 1: | | | |
| Metal 2: | | | |

3. What would cause this fruit battery to, eventually, stop producing a voltage?

   Assume the fruit stays in good condition.

   List as many factors as you can.

   ....................................................................................................................

   ....................................................................................................................

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   ....................................................................................................................

## Activity 12: Electrochemical cells

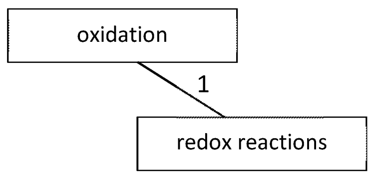
| | |
|---|---|
| **Activity name** | Making a revision map |
| **Aim** | For students to link concepts in the topic of electrochemical cell |
| **Instructions** | • Allow students to work in groups of three or four.<br>• Provide them with the accompanying sheet which has the<br>• Students work in their groups to complete the mind map.<br>• Every line on the map should have a number; the first one The next number should be 2, and so on.<br>• After the mind map is complete, students write brief descr connect the concepts. This can be just a few words in each section below. |
| **Timings** | 15 minutes |
| **Required prior knowledge** | Redox reactions, electrochemical cells and electrode potentials. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 14: Redox II |
| **Additional notes and guidance** | • Students can have access to any resources during the activi an assessment of recall.<br>• Students could easily forget to include any aspect of organi They should be encouraged to use a textbook or get a remi stage of constructing the map.<br>• Some students find the process of constructing a map like t learning than looking at it afterwards. If that is the case, th apply this activity to other topics. |
| **Answers** | Students will construct their maps in different ways, but another reactions' will probably be 'reduction' and given the number 2. could then be 'gain of electrons' or 'change in oxidation state' an |

## Activity 12: Electrochemical cells – Makin

Use this space to make a mind map of electrochemical cells. Turn this into a revision map by:

- putting a number on each line connecting two concepts
- writing a short description of each number

The first one has been done for you.




1. e.g. *oxidation is part of the redox process*
2. ..........
3. ..........
4. ..........
5. ..........
6. ..........
7. ..........
8. ..........
9. ..........
10. ..........
11. ..........
12. ..........

*continue on th*

## Activity 13: Transition metals

| | |
|---|---|
| **Activity name** | Diamond 9 |
| **Aim** | To allow students to evaluate concepts in the transition metals t |
| **Instructions** | • Students work individually.<br>• They use the accompanying sheet to complete the Diamon learning outcomes from the transition metals topic.<br>• At the top, they place what is, to them, the most importan the least important.<br>• Other resources should be used, such as their notes, any as a textbook.<br>• If time permits, students can compare their responses and |
| **Timings** | 10 minutes |
| **Required prior knowledge** | The transition metals topic. |
| **Intended use** | Plenary at the end of the topic |
| **Specification reference** | Topic 15: Transition metals |
| **Additional notes and guidance** | - |
| **Answers** | Students should be told that it is their opinion that counts and th wrong way to complete the template. For example, they may ch challenging concept at the top because it is important for them to it. Similarly, they may place a concept that appears important at it well because it will have a lower priority for revision. |

## Activity 13: Transition metals – Diam

In this activity, you rank the concepts in the topic of transition metals from most i

Your choice is personal to you – there is no right or wrong way to fill this in.

**Most important**

**Least important**

## Activity 14: Transition metals

| | |
|---|---|
| **Activity name** | Memory game |
| **Aim** | To play a game where students memorise a set of words or term transition elements. |
| **Instructions** | • Students must work individually.<br>• Have a set of words (suggested list in the Answers section a limited time, either on a flip chart or that can be projected<br>• Tell the students that they will have 15 seconds to look at th they cannot write anything and cannot capture any image Do not tell them the number of words that were displayed.<br>• At the end of 15 seconds, remove the list from view.<br>• Give the students a further 5 seconds before they can write<br>• Then give the students 60 seconds to write down as many memory. They can write the words on the accompanying s |
| **Timings** | 5 minutes |
| **Required prior learning** | The topic of transition metals. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 15: Transition metals |
| **Additional notes and guidance** | The words should be spaced out either in a table-like arrangeme positions. They should not be in a vertical or horizontal list. Th can be shown on a projector on the additional sheet which shou Students can write their recalled words on their own paper. |
| **Answers** | Suggested keywords for this activity include: |

| | |
|---|---|
| catalysts | d subshell |
| iron | shiny |
| redox titration | manganese |
| coloured compounds | $3d^5$ |
| ligand | blue solution |
| coordinate bond | variable oxidation state |
| copper | cobalt |

## Activity 14: Transition metals – Memory game (additi

| | |
|---|---|
| catalysts | d subshell |
| iron | shiny |
| redox titration | manganese |
| coloured compounds | $3d^5$ |
| ligand | blue solution |
| coordinate bond | variable oxidation state |
| copper | cobalt |

## Activity 15: Zinc and scandium

| | |
|---|---|
| **Activity name** | Advice for the next class |
| **Aim** | For students to consolidate understanding and produce notes fo |
| **Instructions** | • Students work in groups of two or three to produce guidan zinc and scandium are not classed as transition metals.<br>• The guidance should include:<br>  o properties of transition metals<br>  o recognising the d block in the periodic table<br>  o why zinc and scandium are not transition metals even<br>  o any other advice they think would be useful<br>• Plans should be outlined on the accompanying sheet.<br>• If time permits, some groups could show their finished pro the class. |
| **Timings** | 15 minutes |
| **Required prior knowledge** | The d block, properties of transition metals and why zinc and sc transition metals. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 15: Transition metals |
| **Additional notes and guidance** | • Creativity should be encouraged and the notes can be in an rap, cartoon storyboard, blog, social media post, podcast…<br>• Ensure that students do not violate copyright (e.g. by takin website and using it as if it were their own).<br>• If students are going to make a video of themselves actually then this can be planned in written form only. |
| **Answers** | • Students will choose different methods to present the infor correct information from the bullet points in the instructio<br>• Properties of transition metals are (besides those of other m make good catalysts, their compounds or ions are coloured paramagnetic compounds.<br>• Zinc and scandium do not show variable oxidation state an compounds or ions. |

## Activity 15: Zinc and scandium – Advice for t

Use this sheet to plan your advice for next year's class.

**Step 1**

- List the properties of transition metals.

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- Explain why zinc and scandium are not classed as transition metals, even tho

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**Step 2**

Describe what extra advice you would like to give. Think about your topic and anything you found challenging.

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**Step 3**

Describe what form and style your guide will take. Be as creative as yo something that will appeal to next year's class.

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**Step 4**

Outline your plan here. Remember to include how the class will access your guid

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## Activity 16: Benzene

| | |
|---|---|
| **Activity name** | Teaching the structure |
| **Aim** | To allow students to explain the structure of benzene to each ot |
| **Instructions** | • Students work in groups of four.<br>• Set students a task of planning a 3-minute lesson on the str why it does not have three double bonds like cyclohexa-1,3 within their group to three other students. When planning use active learning techniques and a short activity rather th<br>• Students then teach their lessons in turn within their group so they all start at the same time. If one student in one grou use the additional time to give feedback to each other befor |
| **Timings** | 15 minutes, excluding planning time |
| **Required prior learning** | The topic of benzene and its structure. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 18A: Organic Chemistry II – Arenes – benzene |
| **Additional notes and guidance** | To save time during the lesson, the planning can take place as a h |
| **Answers** | Students should include key terms such as:<br>• delocalised<br>• π bond<br>• bond lengths<br>• Kekulé<br>• regular hexagon |

## Activity 16: Benzene – Teaching the str

Use this sheet to plan your teaching, which should last no more than three minut

**Main thing(s) I want them to learn:** ..........................................

..........................................

..........................................

..........................................

**Lesson starter activity and timing:** ..........................................

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**Main lesson activity and timing:** ..........................................

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**Questions I will ask:** ..........................................

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..........................................

**Lesson plenary (summary) and timing:** ..........................................

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**How I will assess their learning:** ..........................................

..........................................

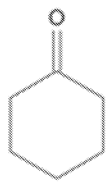
..........................................

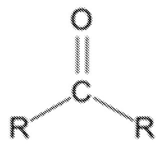
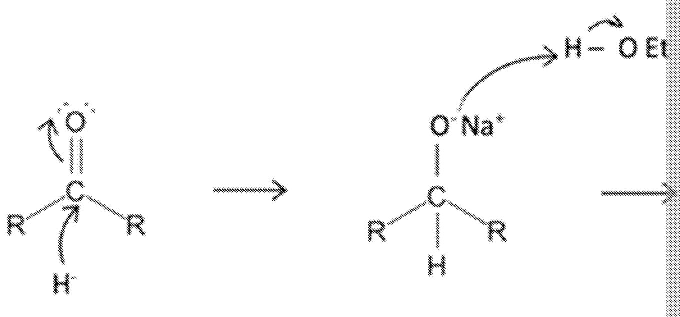
**Resources required:** ..........................................

..........................................

..........................................

## Activity 17: Aldehydes and ketones

| | |
|---|---|
| **Activity name** | Noughts and crosses |
| **Aim** | To assess students' understanding of the aldehydes and ketones |
| **Instructions** | • Divide the class into two teams and allocate one team as no<br>• Draw a noughts and crosses grid on the board and number<br>• Toss a coin to see which team goes first.<br>• They then choose the square number.<br>• You read out a question that you have already assigned to the accompanying sheet, but this should **not** be given to stu<br>• If they answer correctly, their symbol (a nought or a cross) it wrong, then the opposite team's symbol goes in that squa<br>• Teams take questions in turn, whether they got the previou |
| **Timings** | 5 minutes |
| **Required prior learning** | The topic of aldehydes and ketones. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 17B: Organic Chemistry II – Carbonyl compounds |
| **Additional notes and guidance** | • Other than the guidance above, the usual noughts and cros<br>• An alternative is to let the students play it themselves, but the questions. |
| **Answers** | Suggested questions are (numbers refer to grid positions):<br>1. Come to the board and draw the structural formula of prop<br>**Answer:** $CH_3COCH_3$ (the displayed formula is not acceptab<br>2. How many hydrogen atoms are there in a molecule of butar<br>**Answer:** 8<br>3. (Draw the skeletal formula of cyclohexanone on the board, l<br><br>Ask – What class of compound is this?<br>**Answer:** ketone / cyclic ketone<br>4. Why is the name butan-2-one wrong?<br>**Answer:** a ketone group on a chain of four carbons can only either end, so the numbering is not needed |

| | |
|---|---|
| **Answers continued** | 5. Come up to the board and draw a mechanism for the reac<br>with $NaBH_4$<br>(Draw the structure below to get them started)<br><br>Answer:<br><br>6. What class of compound will be oxidised to a ketone in o<br>**Answer:** a secondary alcohol<br>7. What test will distinguish between an aldehyde and a ket<br>**Answer:** an aldehyde gives a silver mirror with Tollens' r<br>change / an aldehyde gives a red-brown precipitate with F<br>shows no change<br>8. Name the test reagent that will give the same result for et<br>the result.<br>**Answer:** 2,4-Dinitrophenylhydrazine – orange precipitate<br>9. What does Tollens' reagent contain?<br>**Answer:** ammoniacal silver nitrate |

## Activity 17: Aldehydes and ketones – Noughts

This is a copy of the questions used for the noughts and crosses game. Fill in the
this topic.

1. Draw the structural formula of propanone.

2. How many hydrogen atoms are there in a molecule of butanal?

   ..........................................................................................................

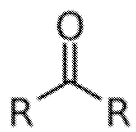
3. What class of compound is shown here?

   ..........................................................................................................

4. Why is the name butan-2-one wrong?

   ..........................................................................................................

5. Draw a mechanism for the reaction of a generalised ketone with $NaBH_4$.
   The first substance has been drawn for you.




6. What class of compound will be oxidised to a ketone in one step?

   ..........................................................................................................

7. What test will distinguish between an aldehyde and a ketone, and what is th

   ..........................................................................................................

   ..........................................................................................................

8. Name the test reagent that will give the same result for ethanal and propano

   Reagent: ..........................................................................................

   Result: ..........................................................................................

9. What does Tollens' reagent contain?

   ..........................................................................................................

## Activity 18: Aldehydes and ketones

| | |
|---|---|
| **Activity name** | Matching |
| **Aim** | To consolidate information on the topic of aldehydes and keton |
| **Instructions** | • Students work individually.<br>• The accompanying sheet contains a set of questions and a s ketones, but they are not matched.<br>• Students can draw straight lines, colour in the boxes or cut |
| **Timings** | 5 minutes, or more if done as a cut-and-stick activity |
| **Required prior knowledge** | Aldehydes and ketones and their reactions. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 17B: Organic Chemistry II – Carbonyl compounds |
| **Additional notes and guidance** | If time permits, students can create more questions and answers with others. |
| **Answers** | • Which compound is oxidised to form propanoic acid? – Pro<br>• What is 2,4-dinitrophenylhydrazine used to test for? – Carb<br>• What is one of the compounds in Tollens' reagent? – Silver<br>• What can be used for nucleophilic addition of an aldehyde?<br>• What is the ketone with the lowest Mr? – Propanone<br>• What does Fehling's reagent test for? – Aldehydes<br>• Which substance exists as a deep blue solution? – Fehling's<br>• What is the product of oxidation of $CH_3COHCH_2CH_3$? – Bu |

## Activity 18: Aldehydes and ketones – M

Below are some questions and some answers on the topic of aldehydes and keto

Your task is to match them. You can do this by drawing lines, colour-coding or cu

| Answers | Ques |
|---|---|
| Fehling's reagent | Which compound is oxidis |
| HCN | What is 2,4-dinitrophenyl |
| Propanal | What is one of the comp |
| Butanone | What can be used for nucleo |
| Carbonyl groups | What is the ketone |
| Propanone | What does Fehling |
| Silver nitrate | Which substance exists |
| Aldehydes | What is the product of ox |

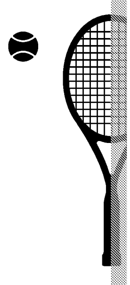
## Activity 19: Esters and amides

| | |
|---|---|
| **Activity name** | Keyword tennis |
| **Aim** | To recall keywords from the topic. |
| **Instructions** | • Decide whether the topic will be esters or amides, or both.<br>• Students work in groups of three – two players and an um<br>• The umpire tosses a coin to see which player will serve.<br>• That player 'serves' by saying a keyword associated with t<br>• The other player returns by saying a different keyword.<br>• The umpire decides whether, in their opinion, the time tak This can be awarded as a point to the opponent.<br>• Use tennis scoring, which advances when one player cann an incorrect or irrelevant one (as decided by the umpire). |
| **Timings** | 5 minutes |
| **Required prior learning** | The topic of esters or amides. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 17C, subtopics 12, 13 & 15: Organic Chemistry II – Carboxyl |
| **Additional notes and guidance** | The challenge of the activity can be reduced by allowing keywo and amides. |
| **Answers** | The umpire should decide whether, in their opinion, a keyword For example, the word 'nitrogen' is relevant to amides but not t but acyl chloride is. |

# Activity 19: Esters and amides – Keywor

The scoring system used in most professional tennis matches is:

| | |
|---|---|
| 0 points – | love |
| 1 point – | 15 |
| 2 points – | 30 |
| 3 points – | 40 |
| **4 points –** | **game** |
| 3 points each – | deuce |
| 1 point after deuce – | advantage |
| 1 point after advantage – | game |



If more than one game is played, then a set can be won on a best of three basis. U
keep score.

## Score sheet

| Game | Server's name | Points (S = server, R = opponent) |
|---|---|---|
| 1 | | **Server:** 15 30 40 S S S S S S S S<br>**Opponent:** 15 30 40 R R R R R R R |
| 2 | | **Server:** 15 30 40 S S S S S S S S<br>**Opponent:** 15 30 40 R R R R R R R |
| 3 | | **Server:** 15 30 40 S S S S S S S S<br>**Opponent:** 15 30 40 R R R R R R R |
| 4 | | **Server:** 15 30 40 S S S S S S S S<br>**Opponent:** 15 30 40 R R R R R R R |
| 5 | | **Server:** 15 30 40 S S S S S S S S<br>**Opponent:** 15 30 40 R R R R R R R |

## Activity 20: Carboxylic acids, amides and esters

| | |
|---|---|
| **Activity name** | Just a minute… |
| **Aim** | To assess students' understanding of acids, amides and esters. |
| **Instructions** | • This game is a variation of 'hot seat' and the rules are base *Just a Minute*.<br>• Students should be given 2–3 minutes to make some notes amides and esters on the accompanying sheet.<br>• One student volunteers to come to the front and sit in the ' the class for 60 seconds on the topic of carboxylic acids, an reference to their notes and:<br>  o no repetition (except for words like 'the', 'a', 'an', etc. i<br>  o no deviation from the topic<br>  o no hesitation or pauses<br>  o no scientific errors<br>• The clock starts as soon as the student starts to speak.<br>• Any other member of the class can challenge by clapping o above things have happened. The clock then stops.<br>• If the challenge is incorrect (judged by you) then the stude 60 seconds to continue speaking.<br>• If the challenge is correct (judged by you) then the challen 'hot seat' and continues to speak. In this case, the repetitio can repeat any of the words the previous student has used.<br>• The winner is the student speaking in the hot seat when th |
| **Timings** | 10 minutes, including explaining the rules |
| **Required prior knowledge** | The carboxylic acids, amides and esters topics. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 17C: Organic Chemistry II – Carboxylic acids & Topic 18B: O amides, amino acids and proteins |
| **Additional notes and guidance** | To add challenge, the game could be restricted to one or two top speaks on carboxylic acids only, or on carboxylic acids and amid |
| **Answers** | • Students will obviously speak about different aspects of th given should be chemically correct.<br>• An example of deviation would be listing compound name<br>• An example of repetition could be reciting the formula of n homologous series. |

## Activity 20: Carboxylic acids, amides and esters -

Use this sheet to make some preparation notes on carboxylic acids and their deri

List things that you would speak about if you were in the 'hot seat'. Remember, y
you to the 'hot seat'.

Possibly include information about:

- the functional groups

  ..........................................................................................................................

- how amides or esters are prepared

  ..........................................................................................................................

- the chemical properties of the compounds

  ..........................................................................................................................

  ..........................................................................................................................

- the physical properties of the compounds

  ..........................................................................................................................

  ..........................................................................................................................

- some uses of these compounds

  ..........................................................................................................................

  ..........................................................................................................................

- anything else you consider relevant

  ..........................................................................................................................

  ..........................................................................................................................

  ..........................................................................................................................

  ..........................................................................................................................

## Activity 21: Amino acids

| | |
|---|---|
| **Activity name** | Questions for answers |
| **Aim** | To assess understanding of amino acid chemistry. |
| **Instructions** | • Students work in pairs but do not confer until the last part<br>• Each student is given 5 minutes to write some answers.<br>• After this time, the answers are swapped and the other stu a question that would correctly elicit that answer.<br>• Then the completed questions and answers are swapped b and discussion. |
| **Timings** | 15 minutes |
| **Required prior learning** | The topic of amino acids. |
| **Intended use** | Plenary |
| **Specification reference** | Topic 18B: Organic Chemistry III – Amines, amides, amino acids a |
| **Additional notes and guidance** | The topic could be expanded to include proteins, but should be course and not require Biology knowledge for those students w |
| **Answers** | In this activity, students will create their own answers to their p<br>An example answer could be – The $NH_2$ group becomes $NH_3^+$<br>To which the question could be – State one change that happens is changed from neutral to acidic. |

## Activity 21: Amino acids – Questions for

You have 5 minutes to write some answers.

Your partner will then have another 5 minutes to compose the questions that wo

Hence, you do not write the questions to your own answers!

**Answer 1:** ..........................................................................................................

..........................................................................................................

**Question for answer 1:** ..........................................................................................

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**Answer 2:** ..........................................................................................................

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**Question for answer 2:** ..........................................................................................

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**Answer 3:** ..........................................................................................................

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**Question for answer 3:** ..........................................................................................

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**Answer 4:** ..........................................................................................................

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**Question for answer 4:** ..........................................................................................

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**Answer 5:** ..........................................................................................................

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**Question for answer 5:** ..........................................................................................

..........................................................................................................

**Answer 6:** ..........................................................................................................

..........................................................................................................

**Question for answer 6:** ..........................................................................................

..........................................................................................................

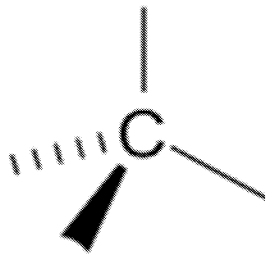
## Activity 22: Optical isomerism

| | |
|---|---|
| **Activity name** | Model building |
| **Aim** | To introduce optical isomerism. |
| **Instructions** | • Students work in pairs.<br>• Each pair will need a ball-and-stick molecular modelling ki different 'atoms', one of which must be a carbon, or have fo sockets. If not available, students can use coloured modelli small spheres, and matchsticks to hold them together. The Either way, they will need enough to make two tetrahedral<br>• Ask students how many different arrangements they can m the *same* central one.<br>• Then ask students to draw their two different models usin they will have used when drawing molecular 3D shapes be a bond coming out of the plane, a solid line for a bond on t a bond receding into the plane. |
| **Timings** | 10 minutes |
| **Required prior learning** | An understanding of the tetrahedral molecular shape would be |
| **Intended use** | Starter |
| **Specification reference** | Topic 17A: Organic Chemistry II – Chirality |
| **Additional notes and guidance** | Students can be shown the Fischer projection that uses solid lin the paper, wedges for bonds coming out of the paper, and dash the paper. |
| **Answers** | There are only two different arrangements of four different atom tetrahedral centre. These are mirror images of each other. |

# Activity 22: Optical isomerism – Model b

Make a model of a molecule that has four different atoms, or four different chem
carbon atom.

The four bonds that you use to connect them should be arranged to make a tetra




Now make another model, again with carbon at the centre and with the same fo

How many ways can you arrange the four atoms around the central carbon of on
from the other?

If you think your models are different, then prove that to yourself by trying to rot
If you cannot do that, then they are different.

When you have finished, draw your different models in the space below.

Use the Fischer projection for a tetrahedral molecule.

## Activity 23: Polymers

| | |
|---|---|
| **Activity name** | What's in the room? |
| **Aim** | To introduce the diversity of polymers, both natural and synthe |
| **Instructions** | • Students work in pairs to make a list of polymers that can b These should be divided into natural or synthetic.<br>• Set a time limit of 1–2 minutes according to the level of cha consider appropriate.<br>• Students can then compare their lists and discuss their choi |
| **Timings** | 5 minutes, to include comparisons and discussion |
| **Required prior learning** | Previous courses such as GCSE, possibly AS Chemistry and gen |
| **Intended use** | Starter |
| **Specification reference** | Topic 18B, subtopic 15: Organic Chemistry III – Amines, amides, ar |
| **Additional notes and guidance** | • Guidance can be given by looking at students' lists as they A substance wrongly identified as a polymer should be poi<br>• Polymers such as DNA should not be included because the protein could be included as it can be seen, e.g. in skin and<br>• Students may consider substances such as graphite in penc repeating 'unit' which is the carbon atom. Explain that the compound and not just an atom. The same applies to meta |
| **Answers** | Typical polymers that could be seen in a classroom include:<br><br>**Natural**: • wool in fabrics • cotton in fabrics • cellulose (if plants are in the room) • lignin in wood • protein in skin, hair and nails, also in leather • rubber (natural or synthetic) in Bunsen tubing, bungs, etc.<br><br>(second column): • polyester i • nylon in fa • plastics in fixtures ar named exa polyethene • polystyren • rubber (na tubing, bu |

## Activity 23: Polymers – What's in the r

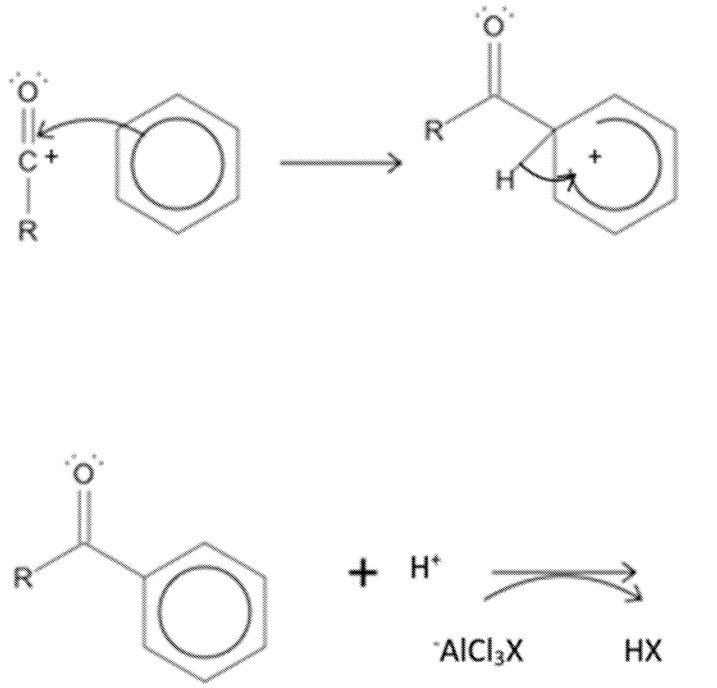
Work with a partner to make a list of polymers that can be seen in the room arou
Classify each of them as either natural or synthetic.

**Rate your list:**

- 10 or more – awesome!
- 6–9 – very good indeed
- 2–5 – good, but you probably missed some
- Fewer than 2 – wow, an almost empty room!

| Natural | S |
|---|---|
| 1. | 1. |
| 2. | 2. |
| 3. | 3. |
| 4. | 4. |
| 5. | 5. |
| *(continue numbering here)* | *(continue numbering he* |

# Activity 24: The Friedel–Crafts acylation reaction

| | |
|---|---|
| **Activity name** | Mechanism jigsaw |
| **Aim** | To assess students' recall of the Friedel–Crafts acylation reaction |
| **Instructions** | • The accompanying sheet contains the jigsaw pieces that stu<br>• They then work in pairs to assemble the jigsaw pieces to co reaction mechanism.<br>• Ideally, this should be done without reference to other sou a textbook. |
| **Timings** | 10 minutes |
| **Required prior knowledge** | The Friedel–Crafts acylation reaction mechanism. |
| **Intended use** | Plenary. Alternatively, this can be used as a starter for the next l the mechanism was taught. |
| **Specification reference** | Topic 18A, subtopic 5: Organic Chemistry III – Arenes – benzene |
| **Additional notes and guidance** | Students can work individually or in larger groups depending o |
| **Answers** |  |

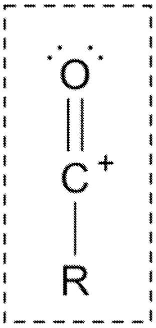
## Activity 24: The Friedel–Crafts acylation reaction –

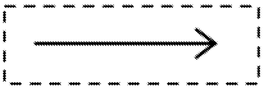
This sheet contains the jigsaw pieces that you will need to make a display of the F
reaction mechanism.

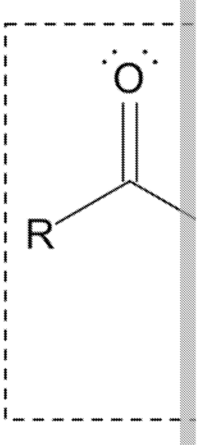
Start by cutting out the pieces. Cut along the dashed lines.

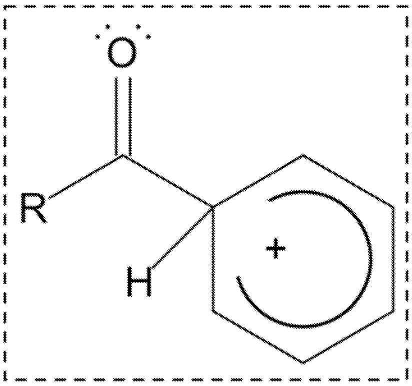
Try to assemble them without looking at your notes or a textbook.

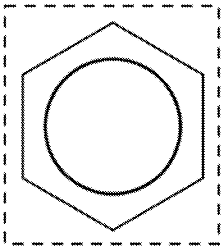
Once the pieces are in place, you should draw the curly arrows to show moveme











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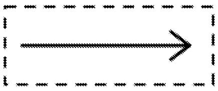
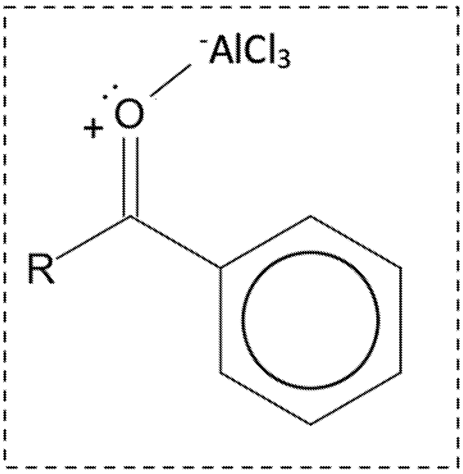


$^{-}AlCl_3X$



# Activity 25: Chromatography

| Activity name | Countdown |
|---|---|
| Aim | Students solve an anagram and make other words from the lett |
| Instructions | • Jumble the letters of the word 'chromatography' (some sug write this in capitals on the board.<br>• Tell students that they have 60 seconds to make as many w and the longest word is the winner.<br>• If students already know that the topic is chromatography, without scrambling the letters. |
| Timings | 5 minutes in total |
| Required prior learning | None |
| Intended use | Starter |
| Specification reference | Topic 19C: Modern Analytical Techniques II – Chromatography |
| Additional notes and guidance | Some suggestions for the chromatography anagram are:<br>• actorgaryhomph<br>• gothmyrahparco<br>• archgoatmorphy |
| Answers | The longest words (except chromatography itself) that can be ma<br>• 13 letters – chromatograph<br>• 12 letters – chartography<br>• 11 letters – cartography, orthography<br>• 10 letters – comparator, tachograph<br><br>For a complete list search online for 'words from letters' and typ Other examples include:<br>• 9 letters – cartogram, cryptogram, homograph, photogram<br>• 8 letters – chatroom, moratory, motorcar, pharmacy<br>• 7 letters – atrophy, carport, pharaoh, program<br>• 6 letters – apathy, captor, carrot, cohort, martyr, mortar, or<br>• 5 letters – aorta, apart, armor, aroma, array, cargo, carry, ch<br>• 4 letters – arch, army, atom, atop, camp, carp, cart, chap, ch coop, copy<br>• 3 letters – act, ago, amp, apt, arc, arm, art, cap, car, cat, cog, hag, ham |

## Activity 25: Chromatography – Countc

Your teacher will show you 14 letters which form a chemistry keyword.

Can you make this word? If not, you can still make other words from the letters.

Use this sheet to record your words:

**14-letter keyword:** ..........................................................................................

**Words of 13 letters:** ..........................................................................................

**Words of 12 letters:** ..........................................................................................

**Words of 11 letters:** ..........................................................................................

**Words of 10 letters:** ..........................................................................................

**Words of 9 letters:** ..........................................................................................

**Words of 8 letters:** ..........................................................................................

**Words of 7 letters:** ..........................................................................................

..........................................................................................

**Words of 6 letters:** ..........................................................................................

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**Words of 5 letters:** ..........................................................................................

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**Words of 4 letters:** ..........................................................................................

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**Words of 3 letters:** ..........................................................................................

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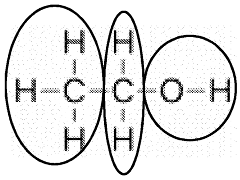
## Activity 26: NMR spectroscopy

| | |
|---|---|
| **Activity name** | Identifying environments |
| **Aim** | To introduce the concept of proton environments for the topic o |
| **Instructions** | • Go through three worked examples by drawing the display methane (one proton environment), propane (two) and eth See additional notes and guidance below.<br>• Then give students the accompanying sheet.<br>• Ideally, they should work on this individually, but they car benefit from support. |
| **Timings** | 10 minutes |
| **Required prior learning** | None |
| **Intended use** | Starter |
| **Specification reference** | Topic 19B: Modern Analytical Techniques II – Nuclear Magnetic Re |
| **Additional notes and guidance** | • If students struggle with the concept of identifying proton en imagine they are in the position of one proton in the molecul position of another. What can they 'see' from each of their p those protons are in the same environment. If different, ther<br>• Question 6 may be challenging for some because there are tw groups, each equidistant from the same functional group. H using the above suggestion. |
| **Answers** | 1. 1<br>2. 2<br>3. 4<br>4. 3<br>5. 2<br>6. 4 |

## Activity 26: NMR spectroscopy – Identifying e

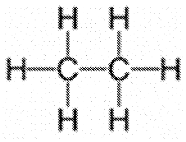
Look at this example, which is ethanol:



There are three proton environments here: one on the $CH_3$ group, one on the $CH_2$

Next, identify the number of proton (hydrogen) environments in each of these:

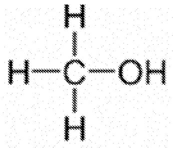
1.



**Number of proton envi**

...................................

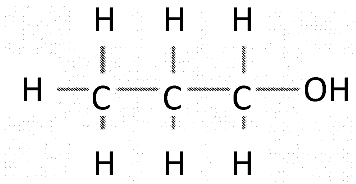
2.



**Number of proton envi**

...................................

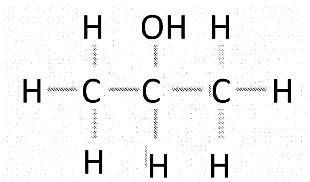
3.



**Number of proton envi**

...................................

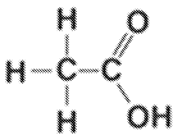
4.



**Number of proton envi**

...................................

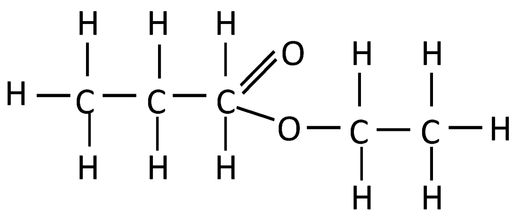
5.



**Number of proton envi**

...................................

6.



**Number of proton envi**

...................................