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**GCSE Combined Science**

**Student Revision Booklet**

**Energy changes**

**Contents:**

1. Student checklist and RAG sheet
2. Pre-revision Multiple Choice Quiz
3. Key Questions, 5 sentences, 5 words
4. Exam Question Practice
5. Progress checkpoint - Post-revision Multiple Choice Quiz

**Student Checklist and RAG Sheet**

**Energy Changes**

**Read each statement below and colour the box that best describes your current understanding.**

**(R – red: low understanding, A – amber: some understanding, G - green: good understanding)**

**GCSE Chemistry**

|  |  |  |  |
| --- | --- | --- | --- |
| **Checklist statement:**  | **R** | **A** | **G** |
|  Describe how energy is transferred to or from the surroundings during a chemical reaction  |  |  |  |
|  Explain exothermic and endothermic reactions on the basis of the temperature change of the surroundings and give examples of everyday uses |  |  |  |
| ***Required practical 10****: investigate the variables that affect temperature changes in reacting solutions*  |  |  |  |
|  Describe what the collision theory is and define the term activation energy |  |  |  |
|  Interpret and draw reaction profiles of exothermic and endothermic reactions, inc identifying the relative energies of reactants and products, activation energy and overall energy change |  |  |  |
|  **HT ONLY: Explain the energy changes in breaking and making bonds and calculate the overall energy change using bond energies** |  |  |  |

**Pre-Revision Multiple Choice Questions**

**Multiple Choice Questions**

**GCSE Chemistry – Energy changes**

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| **INSTRUCTIONS Score: /20** |

* **Read the question carefully.**
* **Circle the correct letter.**
* **Answer all questions.**

|  |  |
| --- | --- |
| 1. | An exothermic reaction: |
|  | a. | Gives out heat energy to its surroundings.  |
|  | b. | Takes in heat energy from its surroundings.  |
|  | c. | Needs bonds to form and then break.  |
|  | d. | Is an example of a physical reaction.  |
| 2. | An endothermic reaction: |
|  | a. | Gives out heat energy to its surroundings.  |
|  | b. | Takes in heat energy from its surroundings.  |
|  | c. | Needs bonds to form and then break.  |
|  | d. | Is an example of a physical reaction.  |
| 3. | Endothermic and exothermic reactions are examples of: |
|  | a. | Opposite physical reactions.  |
|  | b. | The same physical reactions.  |
|  | c. | Opposite chemical reactions.  |
|  | d. | The same chemical reactions.  |
| 4. | An exothermic reaction: |
|  | a. | Releases more energy to make the new bonds than it needs to break the old bonds.  |
|  | b. | Needs the same amount of energy for bond breaking and making. |
|  | c. | Has no excess energy.  |
|  | d. | Releases less energy to make the new bonds than it needs to break the old bonds. |
| 5. | An endothermic reaction: |
|  | a. | Releases more energy to make the new bonds than it needs to break the old bonds. |
|  | b. | Needs the same amount of energy for bond breaking and making. |
|  | c. | Has no energy requirements.  |
|  | d. | Releases less energy to make the new bonds than it needs to break the old bonds. |
| 6. | Activation energy is: |
|  | a. | The minimum amount of energy required to start a reaction.  |
|  | b. | The energy needed to activate atoms to move.  |
|  | c. | The maximum amount of energy required to start a reaction. |
|  | d. | The energy needed to ensure the reaction goes to completion. |
| 7. | A reaction profile shows: |
|  | a. | The actual energy of the reactants and the products.  |
|  | b. | The energy level of products only.  |
|  | c. | The relative energy of the reactants and the products. |
|  | d. | The energy level of reactants only.  |
| 8.  | Breaking bonds: |
|  | 1. Needs energy so is exothermic.
 |
|  | 1. Releases energy so is exothermic.
 |
|  | 1. Releases energy so is endothermic.
 |
|  | 1. Needs energy so is endothermic.
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|  |  |
| 9. | Making bonds: |
|  | a. | Needs energy so is exothermic.  |
|  | b. | Releases energy so is exothermic. |
|  | c. | Releases energy so is endothermic. |
|  | d. | Needs energy so is endothermic. |
|  |  |
| 10. | In an exothermic reaction, the bond energy for making bonds is: |
|  | a. | Greater than the energy needed to break the reactant bonds. |
|  | b. | Less than the energy needed to break the reactant bonds. |
|  | c. | The same as the energy needed to break the reactant bonds. |
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|  |  |

**Key questions, 5 sentences, 5 words**

**GCSE Chemistry – Energy changes**

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| **INSTRUCTIONS** |

* **For each statement, use either the suggested website or your own text book to write a 5-point summary. In examinations, answers frequently require more than 1 key word for the mark, so aim to include a few key words.**
* **It is important to stick to 5 sentences. It is the process of selecting the most relevant information and summarizing it that will help you remember it.**
* **Write concisely and do not elaborate unnecessarily, it is harder to remember and revise facts from a big long paragraph.**
* **Finally, identify 5 key words that you may have difficulty remembering and include a brief definition. You might like to include a clip art style picture to help you remember it.**

**Example:**

|  |  |
| --- | --- |
| **QUESTION:** | **Explain the difference between endothermic and exothermic reactions.** |
| **Sources:** | **Website –** 1. <http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/chemreac/energychangesrev1.shtml>
2. <https://www.youtube.com/watch?v=znsPa1BSaIM>
 |
| 1. **Exothermic reactions give out heat as it takes more energy to break the bonds than make new bonds.**
2. **Endothermic reactions take in heat as it takes more energy to make new bonds than it does break old ones.**
3. **Surplus energy given out causes the temperature to rise.**
4. **Energy taken in from the surroundings causes the temperature to fall.**
5. **Exothermic reactions are ones such as combustion, endothermic reactions are ice packs.**
 |
| **endothermic** | **exothermic** | **heat** | **energy** | **bonds** |

|  |  |
| --- | --- |
| **QUESTION 1:** | **Describe (draw) an energy profile for an exothermic reaction, identifying and explaining the relative energies of reactants and products, activation energy and overall energy change** |
| **Sources:** | **Website –** 1. [http://www.bbc.co.uk/schools/gcsebitesize/science/add\_aqa/exothermic/exothermic\_endothermicrev1**.shtml**](http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/exothermic/exothermic_endothermicrev1.shtml)
2. <http://www.sciencemadesimple.co.uk/curriculum-blogs/chemistry-blogs/exothermic-and-endothermic-reactions>
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| **QUESTION 2:** | **Describe (draw) an energy profile for an endothermic reaction, identifying and explaining the relative energies of reactants and products, activation energy and overall energy change.** |
| **Sources:** | **Website –** 1. <http://www.bbc.co.uk/schools/gcsebitesize/science/edexcel_pre_2011/chemicalreactions/preparinggasesrev4.shtml>
2. <https://www.youtube.com/watch?v=LiAvDpl5aJA>
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| **QUESTION 3:** | **Describe collision theory in relation to chemical reactions.** |
| **Sources:** | **Website –** 1. <https://www.bbc.com/education/clips/zh69jxs>
2. <https://www.bbc.com/education/guides/z2gccdm/revision/2>
3. <http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/chemical_synthesis/ratereactionrev3.shtml>
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**Energy Changes**

**Exam Practice**

**Question 1:**

This question is about energy changes in chemical reactions.

(a)     Complete the word equation for the combustion of hydrogen.

hydrogen          +          oxygen          →          \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(b)     **Figure 1** shows a simple energy level diagram.



(i)      Which arrow, **A**, **B** or **C**, shows the activation energy?

|  |  |
| --- | --- |
| Tick (✔) **one** box. |   |
| **A** | https://app.doublestruck.eu/content/AG_CHM/HTML/Q/Q16S3F03_files/img02.png |
| **B** | https://app.doublestruck.eu/content/AG_CHM/HTML/Q/Q16S3F03_files/img02.png |
| **C** | https://app.doublestruck.eu/content/AG_CHM/HTML/Q/Q16S3F03_files/img02.png |

**(1)**

(ii)     What type of reaction is shown by the energy level diagram in **Figure 1**?

Give a reason for your answer.

Type of reaction \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reason \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(iii)    For a reaction, the value of **A** is 1370 kJ and **C** is 3230 kJ.

Calculate the value of **B**.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**B** = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kJ

**(1)**

(c)     Alcohols are used as fuels.

A group of students investigated the amount of energy released when different alcohols are burned.

The students used the apparatus shown in **Figure 2**.



(i)      **Figure 3** shows the start temperature and the final temperature of the water.



Write the start temperature and the final temperature of the water in **Table 1**.

Work out the increase in temperature to complete **Table 1**.

|  |
| --- |
| **Table 1** |
| Start temperature of the water in °C |   |
| Final temperature of the water in °C |   |
| Increase in temperature in °C |   |

**(3)**

(ii)     The students worked out the heat energy released by burning 1 g of each alcohol.

The students used the equation:

                Heat energy released = m × 4.2 × increase in temperature

Look at **Figure 2**. What is the value of m?

m = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(1)**

(iii)     **Table 2** shows the students’ results.

|  |
| --- |
| **Table 2** |
| **Name of alcohol** | **Number of carbon atoms in one molecule of alcohol** | **Heat energy released when 1 g of alcohol is burned in kJ** |
| Methanol | 1 | 11.4 |
| Ethanol | 2 | 13.5 |
| Propanol | 3 | 20.1 |
| Butanol | 4 | 16.8 |
| Pentanol | 5 | 17.2 |

Which value of heat energy released is anomalous?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(iv)     Look at **Table 2**.

What is the relationship between the number of carbon atoms in one molecule of alcohol and the heat energy released when 1 g of the alcohol is burned?

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**(1)**

(v)     The value in a data book for the amount of heat energy released when 1 g of butanol is burned completely is 36.2 kJ.

Suggest two reasons why the students’ result for butanol is lower than the data book value.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(vi)     The displayed structure of butanol is:



What is the functional group of the alcohol?

|  |  |
| --- | --- |
| Tick (✔) **one** box. |   |
| –– C –– C | https://app.doublestruck.eu/content/AG_CHM/HTML/Q/Q16S3F03_files/img02.png |
| –– C –– H | https://app.doublestruck.eu/content/AG_CHM/HTML/Q/Q16S3F03_files/img02.png |
| –– O –– H | https://app.doublestruck.eu/content/AG_CHM/HTML/Q/Q16S3F03_files/img02.png |

**(1)**

**(Total 14 marks)**

**Question 2:**

This question is about the reaction of ethene and bromine.

The equation for the reaction is:

                                                 C2H4 + Br2  →  C2H4Br2

(a)     Complete the reaction profile in **Figure 1**.

Draw labelled arrows to show:

•        The energy given out (Δ*H*)

•        The activation energy.

**Figure 1**



**(3)**

(b)     When ethene reacts with bromine, energy is required to break covalent bonds in the molecules.

Explain how a covalent bond holds two atoms together.

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**(2)**

(c)     **Figure 2** shows the displayed formulae for the reaction of ethene with bromine.

**Figure 2**



The bond enthalpies and the overall energy change are shown in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | **C=C** | **C–H** | **C–C** | **C–Br** | **Overall energy change** |
| **Energy inkJ / mole** | 612 | 412 | 348 | 276 | −95 |

Use the information in the table above and **Figure 2** to calculate the bond energy for the Br–Br bond.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Bond energy \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kJ / mole

**(3)**

(d)     **Figure 3** shows the reaction between ethene and chlorine and is similar to the reaction between ethene and bromine.

**Figure 3**



“The more energy levels (shells) of electrons an atom has, the weaker the covalent bonds that it forms.”

Use the above statement to predict and explain how the overall energy change for the reaction of ethene with chlorine will differ from the overall energy change for the reaction of ethene with bromine.

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**(6)**

**(Total 14 marks)**

**Question 3:**

Exothermic reactions transfer energy to the surroundings.

(a)     Draw a reaction profile for an exothermic reaction using the axes in **Figure 1**.

Show the:

•        relative energies of the reactants and products

•        activation energy and overall energy change.

**Figure 1**



**(2)**

(b)     Combustion is an exothermic reaction.

Calculate the overall energy change for the complete combustion of one mole of methane in oxygen.



|  |  |
| --- | --- |
| Bond | Bond energy in kJ / mol |
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| https://app.doublestruck.eu/content/AG_SCC/HTML/Q/QSPTC1H06_files/img05.png | 498 |
| https://app.doublestruck.eu/content/AG_SCC/HTML/Q/QSPTC1H06_files/img06.png | 805 |
| https://app.doublestruck.eu/content/AG_SCC/HTML/Q/QSPTC1H06_files/img07.png | 464 |

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Overall energy change = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kJ / mol

**(3)**

**Post-Revision Multiple Choice Questions**

**Multiple Choice Questions**

**GCSE Chemistry – Energy changes**

|  |
| --- |
| **INSTRUCTIONS Score: /20** |

* **Read the question carefully.**
* **Circle the correct letter.**
* **Answer all questions.**

|  |  |
| --- | --- |
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|  | b. | Takes in heat energy from its surroundings.  |
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| 2. | An endothermic reaction: |
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|  | b. | Takes in heat energy from its surroundings.  |
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| 3. | Endothermic and exothermic reactions are examples of: |
|  | a. | Opposite physical reactions.  |
|  | b. | The same physical reactions.  |
|  | c. | Opposite chemical reactions.  |
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| 4. | An exothermic reaction: |
|  | a. | Releases more energy to make the new bonds than it needs to break the old bonds.  |
|  | b. | Needs the same amount of energy for bond breaking and making. |
|  | c. | Has no excess energy.  |
|  | d. | Releases less energy to make the new bonds than it needs to break the old bonds. |
| 5. | An endothermic reaction: |
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|  | c. | Has no energy requirements.  |
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| 6. | Activation energy is: |
|  | a. | The minimum amount of energy required to start a reaction.  |
|  | b. | The energy needed to activate atoms to move.  |
|  | c. | The maximum amount of energy required to start a reaction. |
|  | d. | The energy needed to ensure the reaction goes to completion. |
| 7. | A reaction profile shows: |
|  | a. | The actual energy of the reactants and the products.  |
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|  |  |
| 9. | Making bonds: |
|  | a. | Needs energy so is exothermic.  |
|  | b. | Releases energy so is exothermic. |
|  | c. | Releases energy so is endothermic. |
|  | d. | Needs energy so is endothermic. |
|  |  |
| 10. | In an exothermic reaction, the bond energy for making bonds is: |
|  | a. | Greater than the energy needed to break the reactant bonds. |
|  | b. | Less than the energy needed to break the reactant bonds. |
|  | c. | The same as the energy needed to break the reactant bonds. |
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