**Overall energy change**

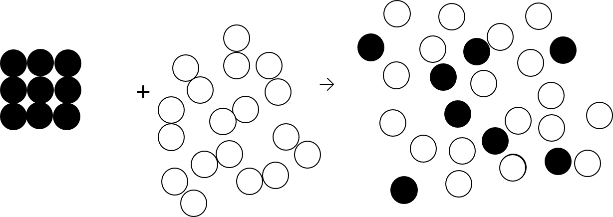
Carbon reacts with oxygen.

C+O2→ CO2

During the chemical reaction atoms are rearranged. This requires the transfer of energy from and to the surroundings.

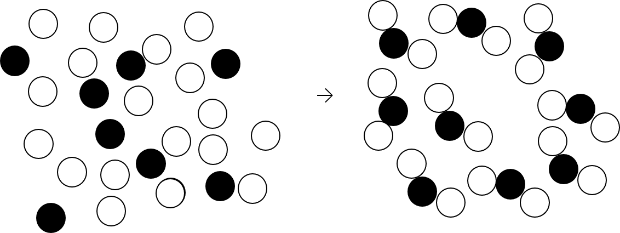
**Energy change A**

The separation of carbon and oxygen atoms requires the transfer of energy **from** the surroundings.



**Energy change B**

The combining of atoms to form carbon dioxide results in the transfer of energy **to** the surroundings.



Overall, the chemical reaction results in the transfer of energy **to** the surroundings.

How do the sizes of the energy change A and B compare?

Put a tick (✓) in the box next to the best answer.

|  |  |  |
| --- | --- | --- |
| **A** | A=B |  |
|  |  |  |
| **B** | A >B |  |
|  |  |  |
| **C** | A<B |  |
|  |  |  |

*Chemistry > Big idea CCR: Chemical reactions > Topic CCR3: Energy and reactions > Key concept CCR3.1: Exothermic and endothermic reactions*

|  |
| --- |
| **Diagnostic question** |
| **Overall energy change** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | During a chemical reaction energy may be transferred to or from the surroundings. |
| Observable learning outcome: | Recognise that the overall energy change of a chemical reaction depends on the relative amount of energy needed to separate and combine atoms during the reaction. |
| Question type: | Diagnostic, simple multiple choice |
| Key words: | atom, energy change |

|  |  |
| --- | --- |
| **B** | **BRIDGING**  This diagnostic question probes understanding of ideas that are usually taught at age 14-16, to build a bridge to later stages of learning. |

**What does the research say?**

Research into student misconceptions (Kind, 2004) found that everyday language such as “fuels contain energy” may lead to the misconception that “a fuel is an energy store” and hence the inference that energy is stored in chemical bonds.

As part of their research Cooper and Klymkowsky (2013) reported on a survey of general chemistry texts which showed that the most common approach was to place the macroscopic (temperature changes) in a section on “thermochemistry” and behaviour at atomic level (bonding) in a different section on “bonding”. This approach, if used in teaching, does not help students move from one level of thinking about energy changes of reaction to another.

**Ways to use this question**

Students should complete the question individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

The answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

If students are not confident with the use of mathematical symbols < and > you may wish to write the answer options as sentences.

**Expected answers**

C

**How to respond - what next?**

A student who selects option A (that the energy changes are equal) may not understand that the energy changes needed to separate or combine atoms are dependent upon the type of atom and the structure in which the atoms are joined (or are making). As a consequence, the energy required to separate the atoms of the reactants may be different to the energy transferred to the surroundings when the atoms combine.

Alternatively, they may not have understood that the overall energy change results depends upon the relative size of the energy changes needed to separate and combine the atoms.

Students are less likely to select option C but it is included for completeness.

If students have misunderstandings about how the two energy changes result in an overall energy change it may help to introduce students to a basic energy change diagram so that they can seem more clearly the opposite directions of the energy changes. The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Energy diagrams

**Acknowledgments**

Developed by Helen Harden (UYSEG)

Images: Helen Harden (UYSEG)

**References**

Cooper, M. M. and Klymkowsky, M. W. (2013). The trouble with chemical energy: Why understanding bond energies requires an interdisciplinary systems approach. *CBE-Life Sciences Education,* 12(2)**,** 306-312.

Kind, V. (2004). Beyond appearances: Students' misconceptions about basic chemical ideas. [Online]. Available at: <http://www.rsc.org/learn-chemistry/resource/res00002202/beyond-appearances?cmpid=CMP00007478>.