

Energy producing and consuming reactions

Critical teaching ideas - Science Continuum F to 10

Level: Moving to level 10

Student everyday experiences

Students at this stage of their schooling have been exposed to the concept of energy in a number of different contexts. From these experiences, many students believe that energy (which includes heat, light and electricity) is a type of matter. (Stavy,1991). Packets of food list the energy content (in kJ), along with quantities of ingredients such as proteins, fats and sugar etc, further reinforcing this view. The idea that the total energy of the system before and after a chemical reaction is the same is not one that is borne out by everyday observations. There are two problems here; the first is that while students do build a meaning for energy from their everyday experiences, this meaning involves a more restricted view of what are forms of energy than is needed for the view that energy is conserved in all changes. Students often restrict energy to living things, movement, heat and electricity. The second, and related, problem is that chemical energy is a difficult concept for many students to grasp - they may understand that heat, light and electricity are different from matter, but unseen stored chemical energy is much more difficult to understand. This means that they are likely to believe that energy is created (or used up) in chemical reactions.



Students in classrooms have seen the pop of hydrogen burning and the blinding flash of magnesium and this encourages them to happily convert energy into matter and vice versa. Indeed, it is the energy change in many examples of reactions that holds the focus of students' attentions, not the new substances produced (Fensham Gunstone & White,1994).

Students often have trouble appreciating that chemical reactions are not driven by external interventions such as heating. They do not appreciate that heat is often only needed to initiate a reaction (activation energy) and that it will proceed without further energy input and may overall produce energy. Since so many reactions they have seen involve the application of heat, it is not surprising that many students consider examples like the burning of paper or a candle to be energy consuming reactions (endothermic).

The scientific view

- In any change, physical or chemical the total amount of energy remains the same (the only measurable exception to this occurs in nuclear reactions).
- Chemical energy is an important way of storing energy in foods, fat reserves and fuels
- In energy producing reactions (exothermic) the total energy of the products is less than that of the reactants - energy is released to the surroundings. Combustion and respiration in biological systems are the most obvious examples.
- In energy consuming reactions (endothermic) the total energy of the products is more than that of the reactants - heat is taken from the surrounding substances. The

reactions involved in photosynthesis are perhaps the most important of these. The production of Aluminium is another example important to Victoria

- Some exothermic reactions require some energy to get them started, but then they release more energy than they originally took in. A match requires initial energy, provided by the friction between it and the sandpaper on the matchbook, to start burning. Once the match starts burning, it releases more energy than it took in, so the reaction is still exothermic. The products still have less chemical energy than the reactants.

Critical teaching ideas

- Energy, particularly chemical energy, is not a form of matter
- Energy is not created or destroyed in chemical reactions
- Most of society's energy needs are supplied by energy producing chemical reactions
- Many chemical processes we see every day e.g. combustion, require energy to initiate them, but overall release energy, so are energy producing reactions
- Energy consuming reactions produce many of the materials (e.g. metals, plastics) we use every day.

Because of widely held alternative conceptions in this area students will need to observe and reflect on a wide range of chemical reactions which consume and produce energy. They will need to be encouraged to examine their existing views in the light of new evidence and to reflect on how these views have changed as a result of their investigations.

Teaching activities

Open up discussion via a shared experience.

An initial activity could seek to establish existing student ideas about energy changes involved in burning.

Students in small groups could be asked to draw a diagram of the burning of a candle and with arrows show the energy changes that take place. Students could record their views in a journal or book which is not marked or assessed, (this helps in ensuring students state their own current views without worrying whether they are correct.) They can then attempt to explain where the heat and light energy come from. Groups then share their ideas with the rest of the class. At this stage the teacher should delay judgment on "incorrect comments". For more detail on what happens when a candle burns can be found on the following website: <http://home.howstuffworks.com/question267.htm>

Other example demonstrations which students can do to help to further consolidate or challenge students' existing ideas:

- The burning of Magnesium ribbon ignited with a Bunsen burner – where does the energy come from that is released?
- Observing and comparing the amount of energy released in burning different types of food (e.g. peanuts, bacon pieces, bread, and marshmallow) by heating small amounts of each in a holder - a peanut once ignited will burn for surprisingly long time, releasing copious amounts of heat energy.
- Treadmills have information on the amount of kilojoules expended during exercise.

