Introduction

This activity is in the style of a Unit 3 exam question. The context is related to ideas met in the ‘Transport issues’ topic of the AS course but the ideas assessed feature in topics 4 and 5 of the A2 course.

Note that this activity, while being in the style of an exam question, has not be subject to the careful evaluation and revision of questions undertaken by AQA during the preparation of operational exam papers.

Paste in dotted answer lines under each of the parts of the question if you want your students to answer the question in writing as in an examination. Allow at least 2 lines for each part of the question and not less than one line per mark.

The mark scheme assumes that credit will be given for valid answers even where these are not stated in the scheme. The mark scheme shows which science explanations (SEs) and ideas about how science works (HSW) are being tested. As in the scheme of work, the code letters are those found in sections 3.5 and 3.6 of the specification.

Questions with answers and a suggested mark scheme
(a) Describe two problems which make it necessary to research an alternative to fossil fuels for powering vehicles. For each explain how hydrogen would solve the problem.

- Petrol and diesel vehicles give out carbon dioxide/ greenhouse gases - Hydrogen only forms water when it reacts with oxygen.
- Fossil fuels are running out – electricity can be made using renewable sources
- Petrol and diesel cause local air pollution/ fine particles/ nitrogen oxides - Hydrogen only forms water when it reacts with oxygen.

(any 2 for 1 or 2 marks each) (SE Ee, Mb)

(b) Hydrogen and electricity are examples of secondary sources of energy. What is the difference between a primary and a secondary source of energy?

Primary energy is directly available from fossil or nuclear fuels or from renewables. (1) A secondary energy source is made by a conversion process using energy from primary energy. (1) (2 marks) (SE Oi)

(c) (i) According to figure 1, what is the overall efficiency of the system for powering a vehicle based on batteries recharged from the mains?

69% (69 kWh from 100 kWh). (1) (1 mark) (SE Oj)
(ii) Identify two reasons why the system based on hydrogen is much less efficient than that based on a battery powered electric vehicle.

In the hydrogen economy:
• there are more stages that involve losses
• storage and transport of hydrogen uses energy
• chemical changes/ fuel cells are particularly inefficient.

(2 marks for any two points) (SE Oj)

(d) Apart from the question of efficiency suggest and explain two other advantages to a system based on rechargeable batteries rather than a system based on hydrogen and fuel cells.

The system based on batteries uses technologies that:
• are tried and tested - they are more likely to be reliable
• familiar not new risks - a gas that is known to be flammable or explosive
• do not require significant changes to the infrastructure – hydrogen transport and storage.

(any 2 for 1 or 2 marks each) (HSW Gd, Ge)

(e) Give your opinion on these new technologies for powering vehicles and discuss some of the implications for Britain if we were to adopt hydrogen or electricity as the main vehicle fuel.

The points that might be included. Look also for a well structured argument

• Large increase in demand for electricity
• will add to climate change if generated by fossil fuels
• essential to develop renewable
• nuclear an option
• large investment needed
• land area needed for solar/wind/hydro
• environmental costs of renewable
• cleaner cities
• major need for new vehicle technologies
• will boost manufacturing

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Exam-style question: A hydrogen economy for transport?

Introduction

This activity is in the style of a question that you might find in a Unit 3 exam paper for this course. You are expected to apply what you have learnt in the course to answer questions set in a context which may be unfamiliar. Study the information at the start of the question carefully before you start to answer the questions.

Questions

Scientists around the world are exploring the possibility of establishing a hydrogen economy to provide the energy needed for transport. One way of making hydrogen is by electrolysis. This splits water into hydrogen and oxygen. The hydrogen can be stored either as compressed gas under pressure or as a very cold liquid. The hydrogen can then be used to produce electricity in a vehicle with a fuel cell. In a fuel cell, the hydrogen reacts with oxygen from the air to produce water and electricity.

Figure 1: A chart comparing systems for powering an electric vehicle using either hydrogen and a fuel cell (left) or batteries charged from the mains (right). (AC-DC conversion produces the direct current needed to make hydrogen from water by electrolysis or to charge batteries).
(a) Describe two problems which make it necessary to research an alternative to fossil fuels for powering vehicles. For each explain how hydrogen would solve the problem.

(4 marks)

(b) Hydrogen and electricity are examples of secondary sources of energy. What is the difference between a primary and a secondary source of energy?

(2 marks)

(c) (i) According to figure 1, what is the overall efficiency of a system that uses mains electricity to power a vehicle run on rechargeable batteries.

(1 mark)

(ii) Identify two reasons why the system based on hydrogen is much less efficient than that based on a battery powered electric vehicle.

(2 marks)

(d) Apart from the question of efficiency suggest and explain two other advantages to a system based on rechargeable batteries rather than a system based on hydrogen and fuel cells.

(4 marks)

(e) Give your opinion on these new technologies for powering vehicles and discuss some of the implications for Britain if we were to adopt hydrogen or electricity as the main vehicle fuel.

(8 marks)

21 marks