

FUEL CELLS

1 The Periodic Table is very useful to chemists.

Refer only to elements with atomic numbers 1 to 36 in the Periodic Table provided when answering **Question 1**.

One element in the first 36 elements is used as the fuel in a fuel cell.

(i) Name this element.

..... [1]

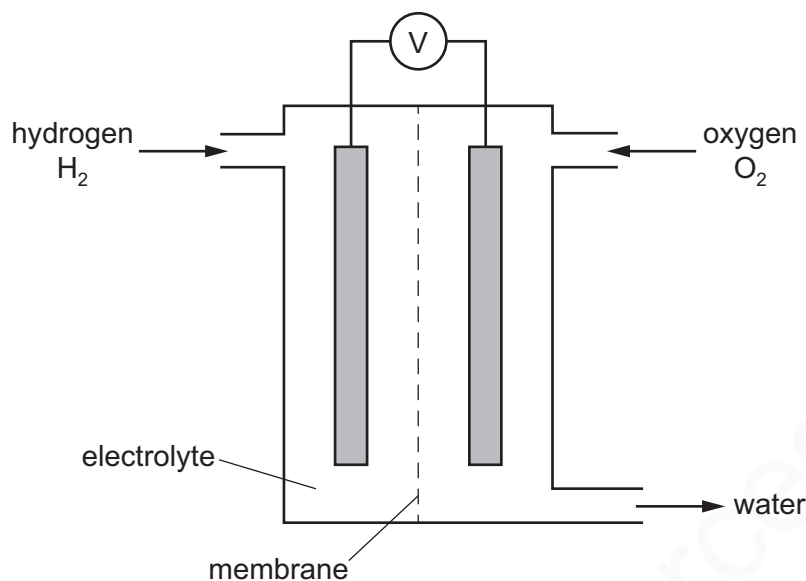
(ii) Write the overall chemical equation for the reaction which occurs when the element in (c)(i) reacts in a fuel cell.

..... [2]

MARKING SCHEME:

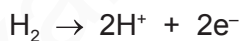
(i)	hydrogen / H	1
(ii)	$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ water as product from reaction of hydrogen and oxygen (1) balanced (1)	2

- 2 Hydrogen and oxygen react together in a hydrogen fuel cell. A hydrogen fuel cell is shown in the diagram.



- (a) Name the process by which oxygen is obtained from air.
 [1]

- (b) (i) In a hydrogen fuel cell, the hydrogen molecules are converted into hydrogen ions, H^+ , according to the ionic half-equation shown.



What type of reaction does this ionic half-equation represent?

..... [1]

- (ii) What **type** of substance reacts by donating hydrogen ions, H^+ ?

..... [1]

- (c) Write a chemical equation for the overall reaction that occurs in a hydrogen fuel cell.

..... [1]

- (d) Hydrogen fuel cells are being developed as alternatives to petrol engines in cars.

- (i) Give **one** advantage of hydrogen fuel cells compared to petrol engines.

..... [1]

- (ii) Give **one** disadvantage of hydrogen fuel cells compared to petrol engines.

..... [1]

(e) Some fuel cells use ethanol, C_2H_5OH , instead of hydrogen. Carbon dioxide and water are products of the reaction in an ethanol fuel cell.

(i) Write a chemical equation for the overall reaction occurring in an ethanol fuel cell.

..... [2]

(ii) State an environmental problem caused by the release of carbon dioxide into the atmosphere.

..... [1]

(iii) Name the process by which ethanol can be manufactured from a renewable resource.

..... [1]

(f) Name the process occurring when electrical energy is used to break down an ionic compound.

..... [1]

MARKING SCHEME:

(a)	fractional distillation	1
(b)(i)	oxidation	1
(b)(ii)	acid(ic)	1
(c)	$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$	1
(d)(i)	no carbon dioxide produced / more efficient	1
(d)(ii)	storage of hydrogen is difficult / takes more space to store (hydrogen) / high likelihood of (hydrogen) leaks / lack of availability of hydrogen	1
(e)(i)	$\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$ M1 species correct M2 balanced	2
(e)(ii)	climate change / greenhouse effect / consequence of climate change	1
(e)(iii)	fermentation	1
(f)	electrolysis	1