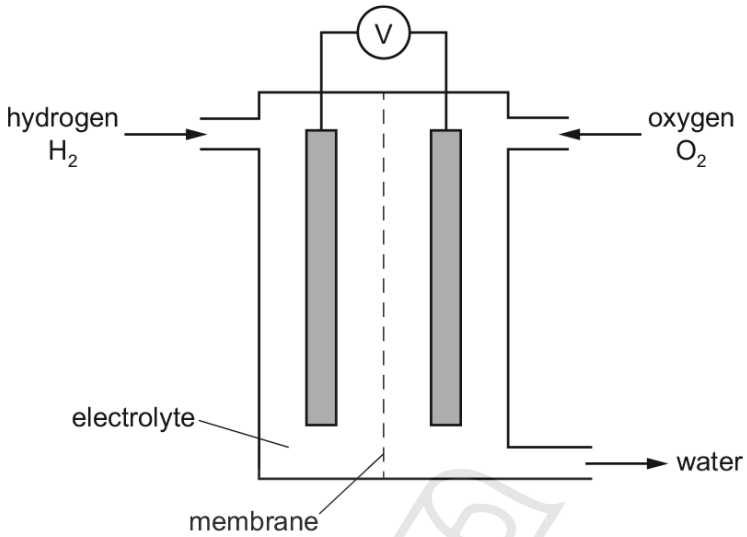
6.2 Energy transfer

01. 0620_w17_qp_43 Q: 4

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.

$$H_2 \rightarrow 2H^+ + 2e^-$$

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]

[Total: 11]

02. 0620_w16_qp_42 Q: 2

This question is about atoms, ions and isotopes.

(a) Define the term *nucleon number*.

.....

..... [2]

(b) Give the electronic structure of the following atom and ion.

Na .....

P^{3-} .....

[2]

(c) State **one** medical use of radioactive isotopes.

..... [1]

(d) What is meant by the term *relative atomic mass*?

.....

.....

..... [2]

(e) Suggest why the relative atomic mass of chlorine is **not** a whole number.

.....

.....

..... [2]

(f) Aluminium is a metal in Group III.

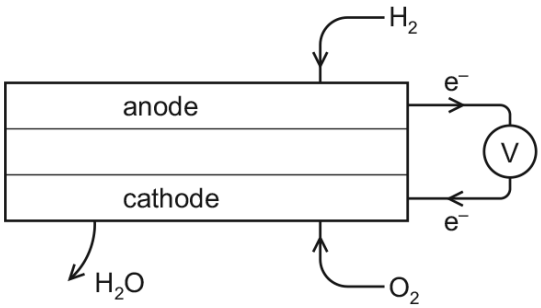
Describe the bonding in aluminium.
Include a labelled diagram and any appropriate charges in your answer.

[3]

[Total: 12]

03. 0620_w14_qp_33 Q: 4

A fuel cell produces electrical energy by the oxidation of a fuel by oxygen.
The fuel is usually hydrogen but methane and methanol are two other fuels which may be used.
A diagram of a hydrogen fuel cell is given below.



(a) When the fuel is hydrogen, the only product is water.
What additional product would be formed if methane was used?

..... [1]

(b) Write the equation for the chemical reaction that takes place in a hydrogen fuel cell.

..... [1]

(c) **(i)** At which electrode does oxidation occur? Explain your choice.

..... [1]

(ii) Write an ionic equation for the reaction at this electrode.

..... [2]

(d) Fuel cells are used to propel cars.
Give **two** advantages of a fuel cell over a gasoline-fuelled engine.

.....

..... [2]

[Total: 7]

01. 0620_w17_ms_43 Q: 4

(a)	fractional distillation	1
(b)(i)	oxidation	1
(b)(ii)	acid(ic)	1
(c)	$2H_2 + O_2 \rightarrow 2H_2O$	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)	$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ **M1** species correct **M2** balanced	2
(e)(ii)	climate change / greenhouse effect / consequence of climate change	1
(e)(iii)	fermentation	1
(f)	electrolysis	1

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(a)	(total) number of protons and neutrons in a nucleus (of an atom)	2
(b)	Na 2 : 8 : 1 P^{3-} 2 : 8 : 8	2
(c)	radiotherapy **OR** treatment of cancer	1
(d)	average mass of (naturally occurring) atom(s) (of an element) (compared to an atom of) ^{12}C	2
(e)	chlorine must have more than one isotope the masses of these isotopes / (any given) mass numbers are averaged	2
(f)	lattice of labelled Al^{3+} ions electrons seen on the diagram between the ions attraction between (positive) ions and (sea of / delocalised) electrons	3

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(a) carbon dioxide/CO_2 [1]

(b) $2H_2 + O_2 \rightarrow 2H_2O$ [1]

(c) **(i)** anode/negative electrode **and** electrons lost(by hydrogen/H/H_2)/electrons move from this electrode [1]

(ii) $H_2 \rightarrow 2H^+ + 2e(^-)$ / $H_2 - 2e(^-) \rightarrow 2H^+$ / $H_2 + 2OH^- \rightarrow 2H_2O + 2e(^-)$ / $H_2 + 2OH^- - 2e(^-) \rightarrow 2H_2O$ [2]
Species (1) Balancing (1)

(d) Any **two** from:

CELL:	lightweight
	quieter
	fewer working parts/less maintenance
	more efficient **or** less energy wasted **or** more energy produced
SUSTAINABILITY:	conserves a limited resource/petroleum/fossil fuels
	unlimited supplies of renewable resource(of hydrogen from water)
POLLUTION:	No or less greenhouse effect
	No or less acid rain
	No or less toxic gases
	No or less smog
POLLUTANTS:	No or less C/soot
	No or less CO_2
	No or less CO
	No or less SO_2
	No or less oxides of nitrogen/NO/NO_2/N_2O_4/NO_x
	No or less (unburnt) hydrocarbons
	No or less low level ozone
	H_2O is the **only** product [2]

[Total: 7]