Questions

Q1.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A chemical cell can be made by placing two metals into an electrolyte.

Figure 3 shows how the voltage of a simple chemical cell can be measured.

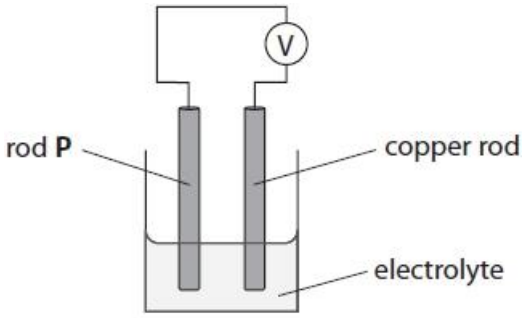

Figure 3

A student investigated how the voltage of this cell was affected by the metal used for the rods.

Which is the only variable that should be changed in the investigation?

(1)

- ☒ **A** the size of the beaker
- ☒ **B** the element used for rod **P**
- ☒ **C** the concentration of the electrolyte
- ☒ **D** the temperature of the electrolyte

(Total for question = 1 mark)

Q2.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Hydrogen and oxygen are reactants in some fuel cells.

Which word equation shows the overall reaction that occurs in these fuel cells?

(1)

- ☐ **A** hydrogen + oxygen → hydroxide
- ☐ **B** hydrogen + oxygen → sulfuric acid
- ☐ **C** hydrogen + oxygen → water
- ☐ **D** hydrogen + oxygen → hydrochloric acid

(Total for question = 1 mark)

Q3.

Complete the half-equation for the reaction taking place at one of the electrodes in a hydrogen-oxygen fuel cell.

(2)

O_2 + ... H^+ + ... →
..... H_2O

(Total for question = 2 marks)

Q4.

Chemical cells produce a voltage.

A chemical cell can be made by placing the metals copper and zinc in a beaker of sodium chloride solution.

Figure 1 shows a diagram of this chemical cell.

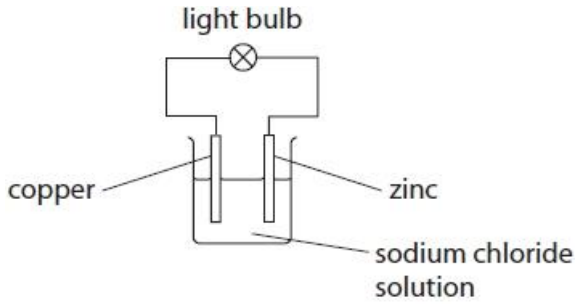

Figure 1

Describe what will happen to the brightness of the light bulb over a long period of time.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q5.

A torch contains a chemical cell.
The torch is turned on and then left on for many hours.

Describe what you would see happen when the torch is turned on and then left for many hours.

(2)

.....

.....

(Total for question = 2 marks)

Q6.

*Hydrogen-oxygen fuel cells can be used to provide electrical energy in a spacecraft.

The reaction that takes place in the fuel cell is

hydrogen + oxygen → water

Evaluate the advantages and disadvantages of providing electrical energy in a spacecraft using hydrogen-oxygen fuel cells rather than chemical cells.

(6)

(Total for question = 6 marks)

Q7.

The voltage of a cell is 1.5 V.

Give a reason why this voltage of the cell decreases when the cell is left connected in a circuit.

(1)

.....

.....

(Total for question = 1 mark)

Q8.

Hydrogen-oxygen fuel cells, rather than chemical cells, can be used to power some vehicles.

Give **one** advantage of using a hydrogen-oxygen fuel cell, rather than using a chemical cell, to power a vehicle.

(1)

.....

.....

(Total for question = 1 mark)

Q9.

Hydrogen can be used in a hydrogen-oxygen fuel cell.

Give the name of the product formed in this fuel cell.

(1)

.....

(Total for question = 1 mark)

Q10.

Transition metals have many uses.

Many transition metals are used to make the reactants in chemical cells.

Figure 8 shows a graph of the voltage produced by a chemical cell as it is used in a torch for many hours.

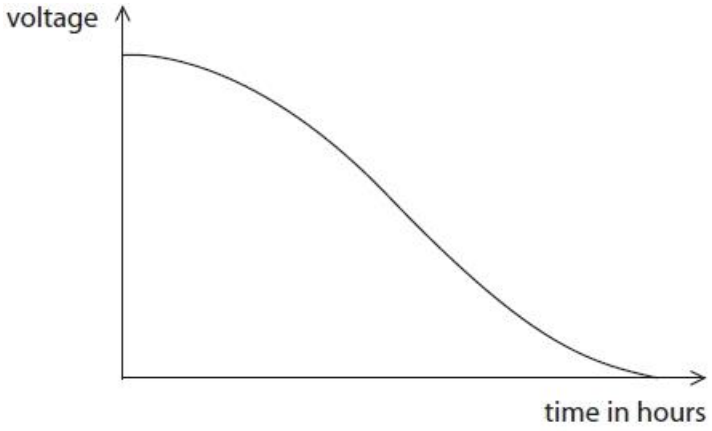

Figure 8

Suggest an explanation for the shape of the graph.

(2)

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.....

.....

.....

(Total for question = 2 marks)

Q11.

In a hydrogen-oxygen fuel cell, hydrogen and oxygen react at the electrodes.

The overall reaction occurring in this fuel cell is a reaction of hydrogen with oxygen.

Write the balanced equation for this reaction.

(2)

.....

.....

(Total for question = 2 marks)

Mark Scheme

Q1.

Question number	Answer	Mark
	B the element used for rod P is the only correct answer **A**, **C** and **D** are incorrect because the electrode material must be changed	**(1)** **AO2**

Q2.

Question number	Answer	Mark
	C hydrogen + oxygen – water is the only correct answer **A**, **B** and **D** are incorrect as water is the product	**(1)** **AO1**

Q3.

Question number	Answer	Additional guidance	Mark
	$O_2 + 4H^+ + 4e^{(-)} \rightarrow 2H_2O$ (2) $e^{(-)}$ (on left) (1) balancing (1)	allow equation with e^+ to score MP2 if this is only error allow equation missing electrons but with no extraneous substances to score MP2 if correctly balanced	**(2)** **AO2**

Q4.

Question number	Answer	Additional Guidance	Mark
	A description to include any two in the correct sequence from • starts bright (1) • becomes dimmer (1) • goes out (over time) (1)	Ignore gets brighter allow bulb stops working	**(2)** AO1-1

Q5.

Question number	Answer	Mark
	A description to include any two from • bright light at start (1) • fades/ gets dimmer (1) • then goes out (1)	**(2)** **AO2**

Q6.

Question number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **A01 and A02 (6 marks)** advantages • once set up, fuel cells require no maintenance • chemical cells will need to be replaced / chemical cells have a limited lifetime • fuel cells operate as long as reactants are supplied • voltage drops in chemical cells as reactants are used up • once used chemical cells cannot be used again or need re-charging • used chemical cells take up valuable space on spacecraft • new chemical cells need to be transported to spacecraft • used chemical cells need to be transported back to earth • water produced in the fuel cell is the only product • water can be used on the spacecraft as drinking water disadvantages • hydrogen and oxygen must be supplied • gas tanks need to transported by spacecraft • storage of hydrogen is difficult because it is a gas • hydrogen is flammable • fuel cells are expensive to manufacture conclusion • either cell can be chosen as the preferable one but suitable reasons must be given	**(6)**

Level	Mark	Additional Guidance	General additional guidance Eq - At each level, as well as content, the scientific coherency of what is stated backed up by planning detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Describes an advantage or disadvantage or states two advantages and/or disadvantages	Possible candidate responses • hydrogen is flammable (1) • new chemical cells need to be brought to the spacecraft (1) • water is the (only) product and can be used by astronauts as drinking water (2) • storage of hydrogen is difficult as hydrogen is a gas (2)
Level 2	3–4	Additional guidance Describes two advantages and/or disadvantages	Possible candidate responses • fuel cells are expensive to manufacture and are difficult to repair if they stop working, but fuels cells will continue to work whilst hydrogen and oxygen are supplied (3) • voltage of chemical cells drops as they are used so the energy produced decreases over time. Fuel cells produce water which can be used on the space craft (4)
Level 3	5–6	Additional guidance Describes three advantages and/or disadvantages **and** Evaluates the advantages and disadvantages to form a conclusion	Possible candidate responses • fuel cells are better than chemical cells. This is because water is the only product from the reaction of hydrogen and water. This water can be used on the space craft as drinking water. Chemical cells will become obsolete when reactants have been used up, therefore more chemical cells will be needed and the waste cells will take up valuable space on the space craft (6)

Q7.

Question number	Answer	Mark
	reactants are being used up (1)	**(1)**

Q8.

Question number	Answer	Additional guidance	Mark
	voltage constant OR chemical cells contain harmful/toxic substances (which need careful disposal after use)	allow produces a voltage as long as hydrogen/oxygen/reactants are supplied fuel cells have longer lifetime does not discharge when left unused	**(1)** **AO1**

Q9.

Question number	Answer	Additional guidance	Mark
	water	allow H_2O reject H^2O / OH^2	**(1)**

Q10.

Question number	Answer	Additional guidance	Mark
	An explanation linking • voltage decreases • as {reactant / transition metal} used up	 allow highest rate of reaction at the beginning of the reaction gives most voltage (1) allow reaction is complete when voltage = 0 (1)	**(2)**

Q11.

Question number	Answer	Additional guidance	Mark
	$2H_2 + O_2 \rightarrow 2H_2O$ (2) fully correct balanced equation (2) If not (2), then H_2O as product in an equation format, regardless of any other errors (1)	Allow =, ⇌ for → Ignore all words and state symbols Allow multiples reject formulae with charges Do not penalise small letters e.g allow h_2O If H2O or H^2O in otherwise fully correct equation, allow (1)	**(2)**