

Beatty Secondary School Science Department (Chemistry Unit) Chemistry 6092

Name:

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Date: \_\_\_\_\_

Class: 4E\_\_\_\_

# TOPIC: ELECTROCHEMISTRY (WORKSHEET 4) – ELECTRIC / SIMPLE CELLS

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### Learning Objectives:

- (a) Describe the production of electrical energy from simple cells (i.e. two electrodes in an electrolyte) linked to the reactivity series and redox reactions (in terms of electron transfer).
- (b) Describe hydrogen, derived from water or hydrocarbons, as a potential fuel, reacting with oxygen to generate electricity directly in a fuel cell (details of the construction and operation of a fuel cell are not required).

#### **Multiple-Choice Questions**

1 Apparatus was set up as shown. For which pair of metals would electrons flow in the direction shown?

	metal X	metal Y
Α	copper	zinc
В	iron	aluminium
С	iron	magnesium
D	zinc	silver



2 The diagram below shows a 'lemon cell'.



Which of the following statements concerning this 'lemon cell' is not correct?

- A Electrons flow from the zinc rod to the copper rod.
- **B** The light bulb will also light up if the lemon is replaced by an orange.
- **C** The light bulb will not light up if the copper rod is replaced by a magnesium rod.
- **D** The electrolyte in a lemon cell is the organic acid and mineral salts in the lemon.

( **C** )

3 In an experiment, rods of copper and zinc are dipped into dilute sulfuric acid, with their top ends touching. Hydrogen bubbles collect around the copper rod.

Which statement about the experiment is correct?

- A Copper reacts with the acid.
- **B** Electrons flow from zinc to copper.
- **C** The zinc becomes coated with copper.
- **D** The zinc is less reactive than copper.



#### **Structured Questions**

4 The diagram represents a simple cell to produce electrical energy. One electrode is copper and the other one is aluminium, copper, iron, magnesium or zinc.



(a) Suggest a suitable solution to be used as the electrolyte in this cell.

copper(II) sulfate solution / dilute sulfuric acid

(b) Give an ionic equation for the reaction taking place in this cell when zinc is used as the other electrode.

<u>Zn (s) + Cu<sup>2+</sup> (aq)  $\rightarrow$  Zn<sup>2+</sup> (aq) + Cu (s) [for copper(II) sulfate]</u> Zn (s) + 2H<sup>+</sup> (aq)  $\rightarrow$  Zn<sup>2+</sup> (aq) + H<sub>2</sub> (g) [for sulfuric acid]

(c) Complete the table below by inserting the names of the metals, aluminium, copper, iron, magnesium and zinc.

meter reading / V	metal
2.72	magnesium
2.00	aluminium
1.10	zinc
0.78	iron
0.00	copper

5 The diagram shows a cell that can be used to make electrical energy.



(ii) Copper was used in place of magnesium.

Voltmeter reading is zero.

(iii) Silver was used in place of copper.

Voltmeter reading increases.

(e) A number of metals are given below in order of reactivity.

calcium	magnesium	iron	nickel	tin	silver

Name two metals which would give the biggest voltage in a simple cell.

Glum

calcium and silver



6 The NASA space shuttle uses fuel cells to generate electricity. The diagram below shows a hydrogen-oxygen fuel cell.



At the negative electrode, hydrogen reacts with hydroxide ions as shown:

$$0 \text{ Xight } H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(l) + 2e^- \text{ OS/ye}^-$$

The overall reaction in the fuel cell is the reaction between hydrogen and oxygen to make water.

(a) Give one source for hydrogen and one source for oxygen for use in a fuel cell.

source of hydrogen: cracking of petroleum source of oxygen: fractional distillation of liquefied air

(b) What is the name of the electrolyte used in the fuel cell?

(c) A tuel cell uses 240 dm<sup>3</sup> of hydrogen. Calculate the volume of oxygen needed, and the mass of water formed. All gas volumes measured at room temperature and pressure

no of mol of H<sub>2</sub> =  $\frac{240}{24}$  = 10.0 mol comparing mole ratio: H<sub>2</sub>: O<sub>2</sub> 10:5 volume of  $O_2 = 5 \times 24 = 120 \text{ dm}^3$ 

$$\begin{array}{c} 0 & 5 & 0 \\ \mathbf{2H}_{2} + \mathbf{O}_{2} \rightarrow \mathbf{2H}_{2} \mathbf{O}(\lambda) \end{array}$$

mass of water = 
$$10 \times 18 = 180g$$

(d) What type of reaction takes place, reduction or oxidation, at the positive electrode? Explain your answer.

Reduction. There is gain of electrons at the positive electrode to form hydroxide ions.

(e) Describe one advantage and two disadvantages of using a fuel cell to generate electricity.

Advantages: Water is the only product and it is a cleaner fuel.

Disadvantages: There may be storage problems with hydrogen as we would need to liquefy hydrogen. Hydrogen is easily flammable which may lead to explosion.

7 The diagram shows a cell that can be used to make electrical energy.



- (a) Draw an arrow on the diagram to show the direction of the flow of electrons in the wire.
- (b) Explain why distilled water is **not** used as the electrolyte.

Distilled water is a simple covalent molecule, hence it is a poor conductor of electricity / weak electrolyte.

(c) This table shows the results when the rods of three metals, X, Y and Z are used in separate experiments. All the metals are less reactive than magnesium.

rod 1	rod 2	voltmeter reading / V
magnesium	Х	2.72
magnesium	Y	0.78
magnesium	Z	1.10

Place the metals in order of decreasing reactivity.

magnesium,  $\underline{\mathbf{Y}}$ ,  $\underline{\mathbf{Z}}$ ,  $\underline{\mathbf{X}}$ 

- (d) A student places a rod of magnesium in aqueous silver nitrate.
  - (i) Write an ionic equation, with state symbols, for the reaction happened.

 $\underline{Mg} (s) + 2Ag^+ (aq) \rightarrow Mg^{2+} (aq) + 2Ag (s)$ 

(ii) What would you expect to see after the reaction had been taking place for some time?

Magnesium solid dissolves and grey deposit is formed.

8 The apparatus shown below was used to determine the reactivity of four metals, P, Q, R and S. The metal strips and the copper sheet were first cleaned with sandpaper. The metal strips were then placed in turn onto the moist filter paper.



In each case, the voltmeter reading was recorded.

metal under test	direction of electron flow in the external wire	voltage recorded / V
Р	P to Cu	+0.62
Q	<b>Q</b> to Cu	+0.75
R	Cu to <b>R</b>	-1.08
S	Cu to <b>S</b>	-0.31

(a) Based on the results obtained, arrange the five metals (including copper) in order of decreasing reactivity.

## <u>Q, P, Cu, S, R</u>

(b) When metal R was under test, which metal acts as the negative electrode? Explain your answer and write the equation for the reaction at the negative electrode.

<u>Copper is the negative electrode. Electrons are lost from Cu to R, implying that Cu is more reactive than R.</u>

Equation:  $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^{-}$