Beatty Secondary School
Science Department (Chemistry Unit)
Chemistry 6092

Name: ________________________________ (      )        Date: ______________

Class: 4E___

**TOPIC: ELECTROCHEMISTRY (WORKSHEET 1) – ELECTRICAL CONDUCTION & ELECTROLYSIS OF MOLTEN COMPOUNDS**

**Learning Objectives:**

(a) Describe electrolysis as the conduction of electricity by an ionic compound (an electrolyte), when molten or dissolved in water, leading to the decomposition of the electrolyte.

(b) Describe electrolysis as evidence for the existence of ions which are held in a lattice when solid but which are free to move when molten or in solution.

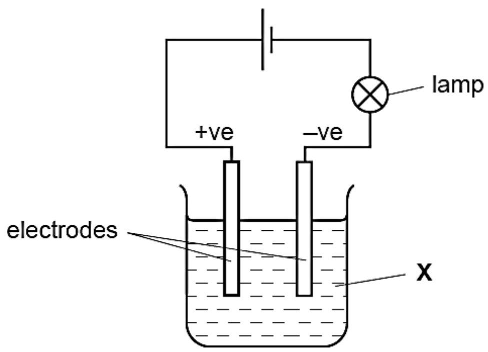
(c) Describe, in terms of the mobility of ions present and the electrode products, the electrolysis of molten sodium chloride, using inert electrodes.

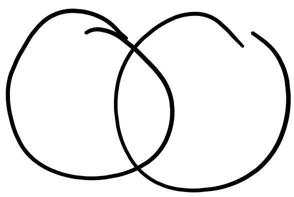
(d) Predict the likely products of the electrolysis of a molten binary compound.

(e) Construct ionic equations for the reactions occurring at the electrodes during the electrolysis, given relevant information.

## Multiple-Choice Questions

**1** When the experiment shown was set up, the bulb lit, but there were no decomposition products at the electrodes.



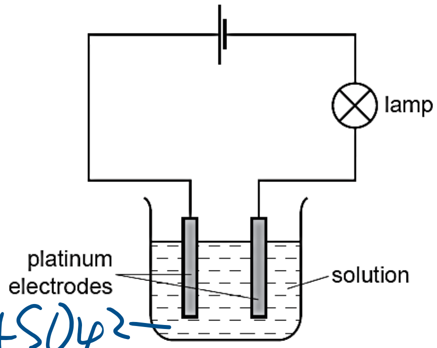
What is **X**?

**A** aqueous sodium chloride   **B** bromine
**C** molten sodium chloride   **D** mercury   ( D )

**2** Which substance, when added to water, makes a solution that is a good electrolyte?

**A** calcium carbonate   **B** copper
**C** ethanol, $C_2H_5OH$   **D** sodium hydroxide   ( D )

**3** The diagram shows apparatus used to investigate the conductivity of different solutions.




$H_2SO_4 \rightarrow \underbrace{H^+ + H^+ + SO_4^{2-}}_{3\ ion}$

$NH_3 + H_2O \rightleftharpoons \underbrace{NH_4^+ + OH^-}_{2\ moles\ ion}$

Which substance, in aqueous solution of concentration 1 mol/dm$^3$, would cause the lamp to give the brightest light?

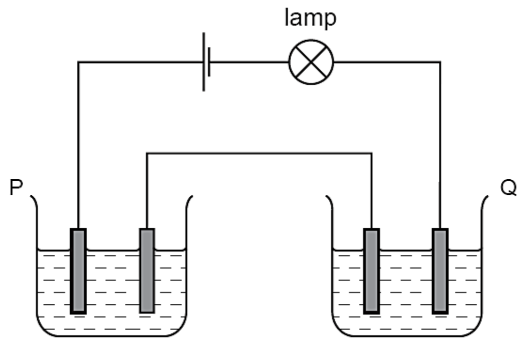
**A** ammonia  **B** ethanoic acid

**C** ethanol, $C_2H_5OH$  **D** sulfuric acid

$CH_3COOH \downarrow CH_3COO^- + H^+$

( **D** )

**4** Two cells, P and Q, containing different liquids, were connected in the series with a battery, a suitable lamp and inert electrodes, as shown in a diagram.




For which pair of liquids did the lamp light up?

| | in P | in Q |
|---|---|---|
| **A** | concentrated sodium chloride solution | concentrated sugar solution |
| **B** | copper(II) sulfate solution | propanol |
| **C** | ethanol | molten lead(II) bromide |
| **D** | mercury | dilute hydrochloric acid |

( **D** )

**5** What are the products formed at the electrodes during electrolysis of molten magnesium chloride between carbon electrodes?

| | positive electrode | negative electrode |
|---|---|---|
| **A** | oxygen | magnesium |
| **B** | magnesium | chlorine |
| **C** | chlorine | magnesium |
| **D** | chlorine | hydrogen |

( **C** )

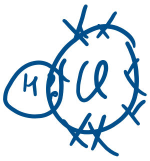
**6** Which pair of statements correctly describe the differences between the conduction of electricity during electrolysis and the conduction of electricity by metals?

| | conduction during electrolysis | conduction by metals |
|---|---|---|
| 1 | The current is due to the movement of both positive and negative ions | The current is due to the movement of electrons. |
| 2 | Charged particles move towards both electrodes | Charged particles move only in one direction only |
| 3 | It results in a chemical change. | It does not result in a chemical change. |

**A** 1, 2 and 3 are correct **B** 1 and 2 only are correct
**C** 2 and 3 only are correct **D** 1 only is correct ( **A** )

## Structured Questions

**7** For each of the following substances, put a tick (✓) if it is a conductor of electricity. Put another tick if the substance is also an electrolyte. Put a cross (×) if the substance is a non-conductor or a non-electrolyte. (The first row has been done for you as an example)




| substance | is it a conductor of electricity? | is it an electrolyte? |
|---|---|---|
| magnesium ribbon | ✓ | × |
| solid magnesium chloride | × | × |
| aqueous hydrogen chloride (hydrochloric acid) | ✓ | ✓ |
| liquid hydrogen chloride | × | × |
| molten aluminium oxide | ✓ | ✓ |
| solid zinc | ✓ | × |

**8** The following questions are based on the conduction of electricity.

**(a)** Explain why monatomic and simple molecular substances do not conduct electricity.

**Monatomic substances have fully filled electron shells and simple molecular substances have simple molecular / covalent structures. Hence, in both structures, there are no mobile electrons or mobile ions to function as charge carriers to conduct electricity.**

**(b)** Explain why giant covalent substances, apart from graphite, do not conduct electricity.

**Giant covalent substances have giant molecular structures where most of the valence electrons are used in covalent bonding. Hence, there are no mobile electrons or ions to function as charge carriers to conduct electricity.**

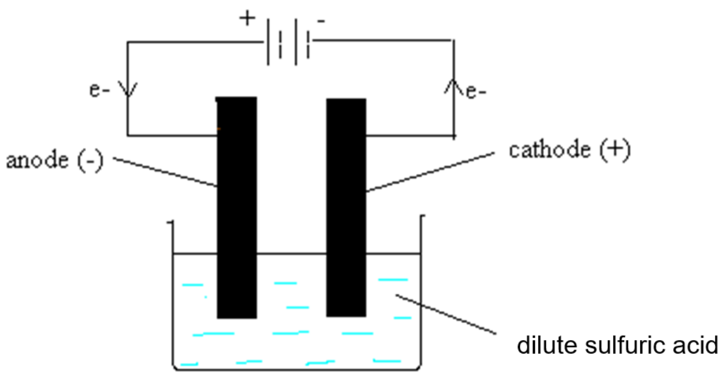
**(c)** Explain why ionic substances do not conduct electricity as solids but do so when molten or dissolved in water.

In the solid state, the ions are held together at its fixed positions by strong electrostatic forces of attraction. As a result, there are no mobile ions to function as charge carriers to conduct electricity.
When dissolved in water or molten state, the giant ionic lattice is broken down, and there are mobile ions to conduct electricity.

**9** In the box below, state **two** differences between the conduction of electricity in the external circuit (metal wire) and within the electrolyte.

| | **electrical conduction** | |
|---|---|---|
| | in the external circuit | in the electrolyte |
| how electricity is conducted | The 'sea of delocalised electrons' present in the metal wire are mobile and function as charge carriers to allow the metals to conduct electricity. | There are mobile ions to function as charge carriers to conduct electricity. |
| effect on conducting material | Metal wire remains chemically unchanged. | Electrolyte decomposes to form new substances. |

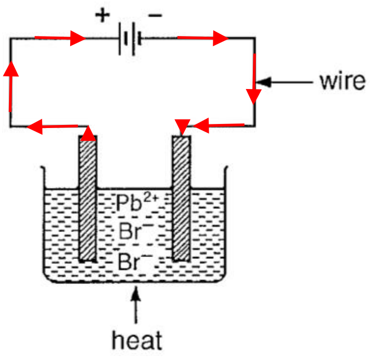
**10** The figure below shows an electrolytic cell. Identify **two** errors in the diagram.




error 1: The signs of the electrodes are reversed. The cathode should be negatively charged, while the anode should be positively charged.

error 2: The direction of electron flow is reversed. Electron should flow from the negative terminal to the positive terminal.

**11** This question is about the electrolysis of molten lead(II) bromide.




Match **(a)** to **(j)** using the words in the box with the correct description given below.

| | | | |
|---|---|---|---|
| anode | bromide ions | bromine | cathode |
| carbon | lead | lead(II) ions | |
| molten lead(II) bromide | | oxidation | reduction |

**(a)** An electrolyte. **molten lead(II) bromide**

**(b)** The material of the electrodes used for the electrolysis. **carbon**

**(c)** A negatively charged electrode. **cathode**

**(d)** The particles that move towards the cathode during electrolysis of lead(II) bromide. **lead(II) ions**

**(e)** The process that occurs at the anode. **oxidation**

**(f)** The process that lead(II) ions undergo during electrolysis. **reduction**

**(g)** The electrode where bromide ions are discharged. **anode**

**(h)** The particles that lose electrons at the electrode during electrolysis. **bromide ion**

**(i)** The substance that is produced at the cathode. **lead**

**(j)** The substance that is produced at the anode. **bromine**

---

**(k)** **Label** on the diagram to show the movement of the electrons in the wire.

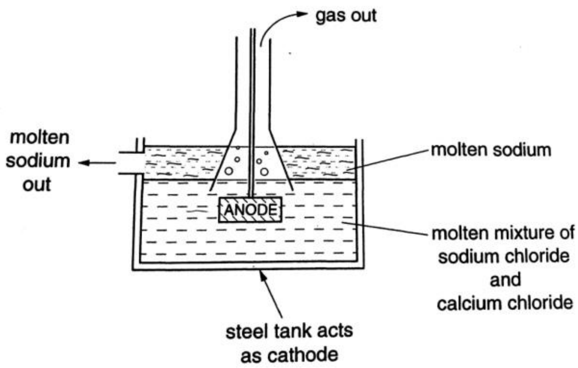
**(l)** Describe what you would observe after some time.

**Effervescence of reddish-brown gas at the surface of the anode. Grey molten liquid formed at the bottom of the beaker.**

**(m)** Write the chemical equation with state symbols for the overall reaction.

**$PbBr_2(l) \rightarrow Pb(l) + Br_2(g)$**

12 Sodium metal is extracted from molten sodium chloride by electrolysis. The diagram shows how the process works.




**(a) (i)** Write an ionic half equation, with state symbols, to show the reaction that happens at the anode.

$2Cl^{-} (l) \rightarrow Cl_2 (g) + 2e^{-}$

**(ii)** Describe a simple test and its result that would identify the gas given off at the anode.

**Test the gas with a piece of moist blue litmus paper. If the gas is chlorine, the moist blue litmus paper will turn red and then bleached.**

**(b)** Calcium chloride is added to the sodium chloride to lower its melting point of the mixture.

**(i)** Explain why lowering the melting point makes the process cheaper to run.

**Lowering the melting point would mean that less heat energy is required to melt the solid and keep it molten. Thus, less fuel is required and the cost is made cheaper.**

**(ii)** The molten sodium contains metallic impurities. Name the main metal impurity you would expect to find and explain how it forms.

**The metal impurity is calcium. Calcium ions from calcium chloride accept electrons and gets discharged at the cathode forming calcium metal.**

13 Complete the table below involving the electrolysis of some molten compounds.

| name of compound | ionic half-equation at | | products formed at | |
|---|---|---|---|---|
| | anode | cathode | anode | cathode |
| zinc chloride | $2Cl^{-} (l) \rightarrow Cl_2 (g) + 2e^{-}$ | $Zn^{2+} (l) + 2e^{-} \rightarrow Zn (l)$ | **chlorine gas** | **molten zinc metal** |
| magnesium oxide | $2O^{2-} (l) \rightarrow O_2 (g) + 4e^{-}$ | $Mg^{2+} (l) + 2e^{-} \rightarrow Mg (l)$ | **oxygen gas** | **molten magnesium metal** |
| aluminium iodide | $2I^{-} (l) \rightarrow I_2 (g) + 2e^{-}$ | $Al^{3+} (l) + 3e^{-} \rightarrow Al (l)$ | **iodine gas** | **molten aluminium metal** |