# Unit 8 · Electrolysis

**HARDER PRACTICE QUESTIONS**

Full marks 42

Write your answers on separate paper. Show your working. The charge on an electron is $1.6 \times 10^{-19}$ C, and Q = It. As in the unit, 0.1 g of copper is deposited by about 300 C.

## 1 Spot the error [3]

Nirajan wrote the electrode equations for the electrolysis of molten magnesium chloride, $MgCl_2$: "Cathode: $Mg^{2+} \rightarrow Mg + 2e^-$. Anode: $Cl^- + e^- \rightarrow Cl_2$."
Find what is wrong with each equation and write them correctly. Which is reduction and which oxidation?

## 2 Predict every cell [5]

Copy and complete the table. For each cell give what forms at each electrode, using the three things that decide which ions are discharged.

| Cell | Electrodes | At the cathode | At the anode |
|---|---|---|---|
| (a) molten potassium chloride | carbon | | |
| (b) concentrated potassium chloride solution | carbon | | |
| (c) very dilute sodium chloride solution | platinum | | |
| (d) sodium sulphate solution | platinum | | |
| (e) silver nitrate solution | silver | | |

## 3 Check the claim [4]

These are the unit's values for ethanoic acid at 25 °C.

| Strength (mol/L) | Degree of ionization | Ionized acid in each liter (mol) |
|---|---|---|
| 0.1 | 1.3% | |
| 0.01 | 4.2% | |
| 0.001 | 12.5% | |

Chandra says: "**The more water I add, the more ions there are in each liter, so 0.001 mol/L vinegar must light a bulb best of all.**"

i. Copy the table and fill in the last column.
ii. Which part of her claim is right, and which is wrong?
iii. So in what sense does a weak electrolyte conduct "better" when it is diluted?

## 4 Two cells, one current [5]

A jeweler's helper plates a key with copper, at a current of 0.25 A, with a copper anode.

i. How long does it take to deposit 0.50 g of copper?
ii. What happens to the mass of the anode, and to the color of the solution, in that time?
iii. A second cell with silver nitrate and silver electrodes is joined in series with it, so the same charge passes through both. Compare the number of silver atoms and copper atoms deposited. Give each number for 300 C of charge.

## 5 Hydrogen from Dhulikhel [4]

The station at Dhulikhel makes about 2 kg of hydrogen a day, using about 10 L of water and 40 to 45 units of electricity for each kilogram. 2 g of hydrogen is one mole (Unit 7: 22.4 L at STP).

i. How many units of electricity does it use a day?
ii. What volume would a day's hydrogen fill at STP?
iii. What volume would that be at 86 kPa and 20 °C? (Standard pressure is 101.3 kPa.)
iv. What volume of oxygen comes off in the same time, at the same conditions?

## 6 Which explanation fits the evidence? [3]

Faraday thought a current tears molecules into ions. Arrhenius said the ions are there before any current flows.

Copper sulphate, copper chloride and copper nitrate solutions, with no current through them, are all blue. All acids taste sour.

Which idea do these facts support? Explain. Then say why a dry salt crystal doesn't count against the idea you chose.

## 7 Fix the plan [4]

The plan has four mistakes. Write each mistake and correct it.

Santosh plans to silver plate a brass spoon. He writes: "I will wash the spoon, then join it to the + terminal. The other electrode will be a copper plate. For the liquid I will use copper sulphate solution. To finish quickly, I will use the biggest current I can."

## 8 Where does it all go? [4]

A slab of 200 kg of impure copper is refined until it is all used up. It is 99.0% copper, 0.6% iron and nickel, and 0.4% silver and gold (made up for this question).

i. What mass of metal ends up on the cathode, in the solution and in the anode mud?
ii. Does the cathode gain as much as the anode loses? Explain.
iii. Over many months, what slowly happens to the amount of $Cu^{2+}$ in the solution? Why?

## 9 Reading the tubes [3]

Karma ran a voltameter and read these volumes (made up for this question):

| Time (min) | 3 | 6 | 9 | 12 |
|---|---|---|---|---|
| Hydrogen ($cm^3$) | 16 | 32 | 48 | 64 |
| Oxygen ($cm^3$) | 7 | 15 | 23 | 31 |

He says: "**At 3 minutes the ratio is 16 : 7, so water can't be 2 : 1.**"

i. Find how much of each gas formed in each 3-minute stretch.
ii. Is his claim right? Use your numbers.
iii. Why is the first stretch different?

## 10 Design a fair test [4]

Asmita wants to find out whether salt water conducts better when it is warmer. She has carbon rods, a battery, an ammeter, a thermometer, a beaker, salt and a way to warm the water. Plan a fair test.

i. What will she change, and what will she measure?
ii. Name three things she must keep the same.
iii. What result do you predict? Why?
iv. Why should she keep each reading short?

## 11 Predict, then explain [3]

Write your prediction first, then explain it.

Copper sulphate solution is electrolyzed with two carbon rods, A and B, until rod A, the cathode, has a good coat of copper. The battery is then turned round, so that A is the anode. Predict what you would see at A and at B, at first and then after a long time.