ICSE CLASS 10 CHEMISTRY – PRACTICE PAPER

STEP-BY-STEP SOLUTIONS AND MARKING SCHEME

Chapter 6: Electrolysis | Maximum Marks: 40

SECTION A (20 Marks)

Question 1 [8 × 1 = 8]

Part	Ans	Step-by-step reasoning
(i)	(c)	Sugar (cane sugar) is a covalent compound which has no ions in solution (only molecules), so it is a non-electrolyte. The other three are electrolytes.
(ii)	(b)	A weak electrolyte is only partly ionised, so the solution has few ions and the bulb glows dimly (Q). P and S glow brightly (strong electrolytes); R does not glow (non-electrolyte).
(iii)	(d)	Reduction is the gain of electrons. $Cu^{2+} + 2e^- \rightarrow Cu$ is a gain of electrons. The other three show loss of electrons (oxidation).
(iv)	(a)	At the cathode Cu^{2+} ions are deposited as Cu. At the copper anode, $Cu - 2e^- \rightarrow Cu^{2+}$. For each ion removed an ion is added, so the Cu^{2+} concentration and the blue colour remain unchanged.
(v)	(c)	Na^+ and H^+ migrate to the cathode. H^+ is lower in the electrochemical series, so it is discharged in preference: $2H^+ + 2e^- \rightarrow H_2$.
(vi)	(c)	(A) is true. (R) is true and explains (A): the ions are fixed, so no charge can flow.
(vii)	(a)	In electroplating the anode is a block of the plating metal. Nickel dissolves as Ni^{2+} and replaces the ions deposited at the cathode.
(viii)	(d)	$2H_2O \rightarrow 2H_2 + O_2$: 2 volumes of hydrogen to 1 volume of oxygen, i.e. 2 : 1.

Question 2 [3 + 3 = 6]

(i) **[3 × 1]**

(a) **anode** – anions lose electrons at the anode (oxidation).

(b) **ionisation** – polar covalent HCl has no ions initially; it forms H^+ (H_3O^+) and Cl^- in water. Dissociation applies to ionic compounds whose ions already exist.

(c) **more** – the lower a metal is in the series, the more easily its cation gains electrons.

(ii) **[3 × 1]**

(a) Electroplating with silver → electrolyte is **2** (sodium argentocyanide solution).

(b) Anode in refining of copper → **1** (impure copper).

(c) Electrolyte in Hoffman's voltameter → **3** (acidified water).

Statement 4 (pure silver) is the extra option.

Question 3 [3 + 3 = 6]

(i) **[3 × 1]**

(a) Tube P holds 20 cm^3 and tube Q holds 10 cm^3; hydrogen is twice the volume of oxygen, so P holds **hydrogen**, formed at the **cathode** (the battery shows P joined to the negative terminal).

(b) Tube Q holds oxygen at the anode: $\mathbf{4OH^- \rightarrow 2H_2O + O_2 + 4e^-}$ (or $4OH^- - 4e^- \rightarrow 4OH$, then $4OH \rightarrow 2H_2O + O_2$).

(c) Pure water is almost a non-conductor (very few ions). Dilute H_2SO_4 supplies ions and makes it conduct. Sulphuric acid is used because it is non-volatile.

(ii) **[3 × 1]**

(a) In the solid the Na^+ and Cl^- ions are held in fixed positions by strong electrostatic forces. On melting, the ions become free to move and carry the current.

(b) Graphite is inert and is not attacked by the reactive bromine vapour produced at the anode.

(c) At the anode $Cu \rightarrow Cu^{2+} + 2e^-$, and at the cathode $Cu^{2+} + 2e^- \rightarrow Cu$. The number of Cu^{2+} ions in the solution remains the same, so the blue colour does not fade.

SECTION B (20 Marks)

Question 4 [4 + 3 + 3 = 10]

(i) **[4 × 1]**

(a) P is joined to the positive terminal: **P = anode (pure silver plate)**. Q is joined to the negative terminal: **Q = cathode (brass spoon)**.

(b) At Q (cathode): $\mathbf{Ag^+ + e^- \rightarrow Ag}$.

(c) At P (anode): $\mathbf{Ag - e^- \rightarrow Ag^+}$.

(d) Silver nitrate would give a very fast deposit which is not smooth or uniform. The complex salt gives a very low concentration of Ag^+ ions, so the coating is firm, smooth and uniform.

(ii) **[3 × 1]**

(a) The metal is deposited at the cathode by the gain of electrons, since the cations move to the cathode.

(b) A high current causes uneven deposition. A low current for a longer time gives a thick, uniform coating.

(c) A.C. reverses direction, so discharge and ionisation alternate at the electrode and no effective coating is formed.

(iii) **[3 × 1]**

(a) Aqueous **nickel(II) sulphate** ($NiSO_4$) with a little dilute sulphuric acid.

(b) **Pure nickel** block. $Ni - 2e^- \rightarrow Ni^{2+}$.

(c) To protect iron from rusting and corrosion (or for a decorative finish).

Question 5 [4 + 3 + 3 = 10]

(i) **[4 × 1]**

(a) **Hydrogen** ($H^+ + e^- \rightarrow H$, then $2H \rightarrow H_2$).

(b) **Oxygen** (OH^- is discharged in preference to SO_4^{2-}).

(c) **Nothing is liberated; the copper anode dissolves** to give Cu^{2+} ions ($Cu - 2e^- \rightarrow Cu^{2+}$).

(d) **Bromine** ($2Br^- \rightarrow Br_2 + 2e^-$).

(ii) **[3 × 1]**

(a) Hydrogen is much lower than sodium in the electrochemical series (**position in the series**), so H^+ is discharged in preference to Na^+.

(b) The **concentration** of Cl^- is much higher than that of OH^- in concentrated NaCl solution, so Cl^- is discharged.

(c) Because of the **nature of the electrode**: the active copper anode loses electrons more easily than SO_4^{2-} or OH^-, so the anode itself dissolves.

(iii) **[3 × 1]**

(a) Oxidation is the process in which an atom or ion **loses electron(s)** (e.g. $Zn - 2e^- \rightarrow Zn^{2+}$).

(b) Reduction is the process in which an atom or ion **gains electron(s)** (e.g. $Cu^{2+} + 2e^- \rightarrow Cu$).

(c) **$Pb^{2+} + 2e^- \rightarrow Pb$**; it is **reduction** (gain of electrons).

Question 6 [4 + 3 + 3 = 10]

(i) **[4 × 1]**

(a) **P** is the anode because it is connected to the positive terminal of the battery.

(b) At P (anode): dark reddish brown fumes of **bromine**. At Q (cathode): a greyish white **metal (lead)** is formed.

(c) $Pb^{2+} + 2e^- \rightarrow Pb$

(d) $2Br^- - 2e^- \rightarrow Br_2$ ($Br^- - e^- \rightarrow Br$, then $Br + Br \rightarrow Br_2$).

(ii) **[3 × 1]**

(a) In the solid state the ions are held in fixed positions by strong electrostatic forces and are not free to move.

(b) The temperature must be kept above the melting point of $PbBr_2$ (380 °C) so that it stays molten and the ions remain free.

(c) Silica is non-reactive, withstands high temperature and is almost a non-conductor of electricity.

(iii) **[3 × 1]**

(a) A solution of copper(II) sulphate containing some dilute sulphuric acid.

(b) **Anode:** impure copper, $Cu - 2e^- \rightarrow Cu^{2+}$. **Cathode:** a thin strip of pure copper, $Cu^{2+} + 2e^- \rightarrow Cu$.

(c) Insoluble impurities such as silver and gold which do not dissolve and settle near the anode as a sludge.

Marks summary	Section A: Q1 = 8, Q2 = 6, Q3 = 6 → **20** | Section B: any two of Q4, Q5, Q6 at 10 each → **20** | Total = **40**