AQA A Level Chemistry — 3.1 Physical Chemistry

3.1.11 Electrode Potentials and Electrochemical Cells

★ A-LEVEL ONLY — not examined at AS level

3.1.11.1 *Electrode potentials, standard hydrogen electrode, electrochemical series. Calculate EMF. Cell notation.*

Standard electrode potential (E■): measured under standard conditions (298 K, 100 kPa, 1.00 mol dm■³) relative to SHE = 0.00 V.

SHE: Pt electrode, H■ at 100 kPa, 1.00 mol dm■³ H■(aq), 298 K.

EMF = E■(cathode) – E■(anode) = E■(more positive) – E■(less positive).

Positive EMF → reaction is feasible.

Cell notation: anode LEFT || cathode RIGHT. E.g. Zn(s)|Zn²■(aq)||Cu²■(aq)|Cu(s)

| = phase boundary, || = salt bridge.

Limitations: E■ only predicts thermodynamic feasibility, not rate. Non-standard conditions change E.

3.1.11.2 *Commercial cells: non-rechargeable, rechargeable, fuel cells. Lithium ion cells. Alkaline H■/O■ fuel cell.*

Non-rechargeable: irreversible; once reactants used, cell is dead.

Rechargeable: reversible; external voltage reverses the reaction.

Lithium ion cell: Positive: Li■ + CoO■ + e■ → Li■[CoO■]■. Negative: Li → Li■ + e■.

Alkaline H■/O■ fuel cell:

Anode: 2H■ + 4OH■ → 4H■O + 4e■

Cathode: O■ + 2H■O + 4e■ → 4OH■

Overall: 2H■ + O■ → 2H■O (only product is water).

Benefits: clean, efficient. Risks: H■ storage (flammable), cost, infrastructure.

★ REQUIRED PRACTICAL RP8

Measuring the EMF of an Electrochemical Cell

Method: Set up two half-cells (e.g. Zn/ZnSO■ and Cu/CuSO■, each 1.00 mol dm■³). Connect with salt bridge (KNO■-soaked filter paper). Connect electrodes to high-resistance voltmeter. Record EMF and polarity. Repeat with different half-cells. Vary concentration or temperature to investigate effect on EMF.

Uncertainties: voltmeter ±0.01 V; concentration may not be exactly 1.00 mol dm■³; temperature may differ from 298 K.

Common errors: poor salt bridge contact (low EMF); unclean electrodes (oxide layer); non-standard concentration; salt bridge drying out; drawing current.

Improvements: sand electrodes before use; freshly prepared solutions; good salt bridge contact; high-resistance voltmeter; repeat and take mean.