AP CHEMISTRY • EXERCISE SHEET

9.10 Cell Potential Under Nonstandard Conditions

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

KEY WORDS cell potential 电池电势

Objective

Build the skills to answer exam questions on **cell potential under nonstandard conditions**.

You must be able to:

- use the **Nernst** idea: E falls as products build up
- predict how changing concentrations changes E_{cell}
- relate $E = 0$ to equilibrium

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Nonstandard conditions

The measured cell potential E differs from E° when concentrations are not 1 M. As the cell runs, reactants deplete and products build, so Q rises and E **falls**.

■ Qualitative Nernst reasoning

- Increasing **reactant** concentration (or decreasing product) makes Q smaller $\rightarrow$ E **larger** (more favorable).
- Increasing **product** (or decreasing reactant) makes Q larger $\rightarrow$ E **smaller**.

■ At equilibrium

When the cell reaches equilibrium, $Q = K$ and $E = 0$ — the battery is "dead" (no more driving force).

■ A worked prediction

For $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$: raising $[Cu^{2+}]$ (a reactant) lowers Q, so E **increases** above E°.

2 Practice

Now apply the methods above.

2.1 As a battery runs, does E rise or fall? [1]

2.2 What is E when the cell reaches equilibrium? [1]

2.3 Increasing a reactant's concentration does what to E? [1]

3 Exam-style questions

3.1 When a galvanic cell reaches equilibrium, its cell potential is [1]

- **A** at a maximum
- **B** zero
- **C** negative
- **D** equal to E°

3.2 For $\mathrm{Zn} + \mathrm{Cu}^{2+} \rightarrow \mathrm{Zn}^{2+} + \mathrm{Cu}$:

(a) State the effect on E of increasing $[\mathrm{Cu}^{2+}]$. [2]

(b) State the effect on E of increasing $[\mathrm{Zn}^{2+}]$. [1]

3.3 Explain why the voltage of a battery gradually drops to zero as it is used. [2]

Solutions

2.1 Falls.

2.2 Zero.

2.3 Increases it.

3.1 B — zero.

3.2 (a) Increasing $[Cu^{2+}]$ (a reactant) lowers Q, so E increases. (b) Increasing $[Zn^{2+}]$ (a product) raises Q, so E decreases.

3.3 As the cell runs, reactants are used up and products accumulate, so Q rises toward K and E falls; at equilibrium $Q = K$ and $E = 0$.