ANSWER KEY.

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9.8 Galvanic (Voltaic) and Electrolytic Cells

AP Chemistry | ANSWER KEY

Use the terms anode, cathode, oxidation, and reduction in your answers. Electrons flow through the wire; ions flow through the salt bridge.

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1. A galvanic cell runs the reaction $Ni(s) + 2Ag^+(aq) \rightarrow Ni^{2+}(aq) + 2Ag(s)$. The Ni electrode is in $Ni(NO_3)_2(aq)$, the Ag electrode is in $AgNO_3(aq)$, and the salt bridge holds $KNO_3(aq)$.

(a) Write the half-reaction at the anode and at the cathode. Label which electrode is which.

(b) In which direction do electrons flow in the wire? (c) Which way do K^+ and NO_3^- move in the salt bridge?

(d) Which electrode gains mass? Which ion concentration decreases as the cell runs?

(a) **Anode (Ni): $Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$** (oxidation). **Cathode (Ag): $Ag^+(aq) + e^- \rightarrow Ag(s)$** (reduction).

(b) **From Ni to Ag** (anode to cathode). (c) **K^+ moves toward the Ag cathode; NO_3^- moves toward the Ni anode.** This keeps each half-cell neutral.

(d) **The Ag electrode gains mass** as Ag^+ is reduced. **$[Ag^+]$ decreases** (and $[Ni^{2+}]$ increases).

2. Label each description as galvanic or electrolytic.

Description	Galvanic or electrolytic?
(a) A flashlight battery is in use.	**Galvanic**
(b) A phone battery is recharging.	**Electrolytic**
(c) The cell reaction is thermodynamically unfavored.	**Electrolytic**
(d) The cell makes electricity on its own.	**Galvanic**
(e) Electricity is used to plate copper onto a key.	**Electrolytic**

Galvanic cells run favored reactions and make electricity. Electrolytic cells use outside power to drive unfavored reactions.

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3. The Ni/Ag cell in problem 1 is connected to an outside power source that forces the reaction to run in reverse: $2Ag(s) + Ni^{2+}(aq) \rightarrow 2Ag^{+}(aq) + Ni(s)$.

(a) Is this a galvanic or electrolytic cell? (b) Which electrode is now the anode, and which gains mass? (c) Why is a power source needed?

(a) **Electrolytic.**

(b) **Ag is now the anode** (Ag is oxidized). **The Ni electrode gains mass** as Ni^{2+} is reduced to Ni.

(c) **The reverse reaction is thermodynamically unfavored**, so it only runs when outside energy is supplied.

4. A cell runs $Zn(s) + 2Fe^{3+}(aq) \rightarrow Zn^{2+}(aq) + 2Fe^{2+}(aq)$. The Fe^{3+}/Fe^{2+} half-cell uses a platinum (Pt) wire as its electrode.

(a) Which electrode is the cathode? Write its half-reaction. (b) Why is Pt used, and does the Pt electrode gain or lose mass?

(a) **Pt is the cathode: $Fe^{3+}(aq) + e^{-} \rightarrow Fe^{2+}(aq)$.** Zn is the anode.

(b) **Neither ion is a solid metal, so an inert electrode carries the electrons.** Pt does not react, so its mass does not change.

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