

Problem Set 3.2

Galvanic cell

1) A voltaic cell is constructed with an Ag/Ag^+ half-cell and a Pb/Pb^{2+} half-cell. The silver electrode is positive.

- Write balanced half-reactions and the overall cell reaction.
- Diagram the cell, labeling electrodes with their charges and showing the directions of electron flow in the circuit and of cation and anion flow in the salt bridge

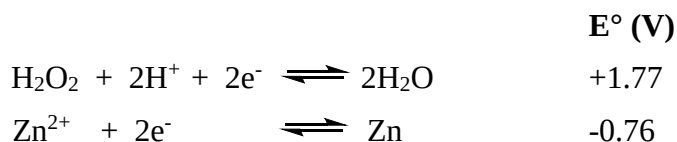
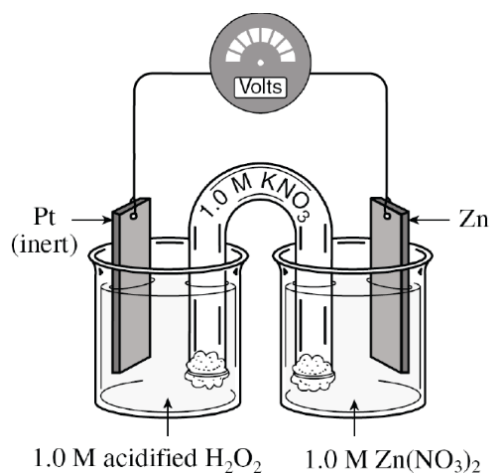
2) A voltaic cell is constructed with an Fe/Fe^{2+} half-cell and an Mn/Mn^{2+} half-cell. The iron electrode is positive.

- Write balanced half-reactions and the overall cell reaction.
- Diagram the cell, labeling electrodes with their charges and showing the directions of electron flow in the circuit and of cation and anion flow in the salt bridge.

MULTIPLE CHOICE QUESTION

- Which one of the following statements about electrochemical cells is correct?
 - In a salt bridge, current is carried by cations moving toward the anode, and anions toward the cathode.
 - In the external wire, electrons travel from cathode to anode.
 - The anode of a voltaic cell is labeled minus (–).
 - Oxidation occurs at the cathode, in an electrolytic cell.
 - None of the above statements is correct.
- Which of the following solids is commonly used as an inactive electrode in electrochemical cells?
 - zinc
 - graphite
 - copper
 - iron
 - sodium

Use the following electrochemical cell diagram to answer questions 3 to 5.

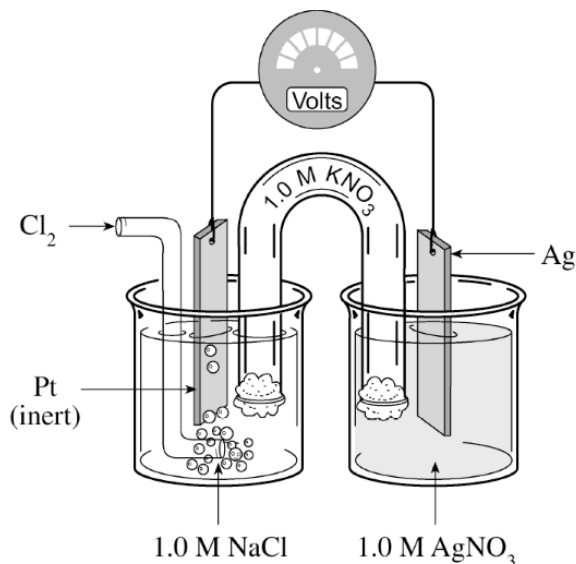


- 3) Which one of the following statements about electrochemical cells is correct?
- A) In a salt bridge, current is carried by cations moving toward the anode, and anions toward the cathode.
 B) In the external wire, electrons travel from cathode to anode.
 C) The anode of a voltaic cell is labeled minus (–).
 D) Oxidation occurs at the cathode, in an electrolytic cell.
 E) None of the above statements is correct.
- 4) Which of the following solids is commonly used as an inactive electrode in electrochemical cells?
- A) zinc B) graphite C) copper D) iron E) sodium
- 5) What is the overall cell reaction?
- a) $\text{Zn}^{2+} + 2\text{H}_2\text{O} \rightarrow \text{Zn} + \text{H}_2\text{O}_2 + 2\text{H}^+$
 b) $\text{Zn} + \text{H}_2\text{O}_2 + 2\text{H}^+ \rightarrow \text{Zn}^{2+} + 2\text{H}_2\text{O}$
 c) $\text{Zn} + \text{H}_2\text{O}_2 + 2\text{H}^+ + 4\text{e}^- \rightarrow \text{Zn}^{2+} + 2\text{H}_2\text{O}$
 d) $\text{Zn}^{2+} + \text{H}_2\text{O}_2 \rightarrow \text{Zn} + \text{H}_2\text{O} + 1/2\text{O}_2$
- 6) Consider the following reaction:
- $$\text{Ni}^{2+} + 2\text{Ag} \rightarrow 2\text{Ag}^+ + \text{Ni}$$

Which of the following is true?

	E°	Reaction
A.	+1.06 V	spontaneous
B.	–1.06 V	non-spontaneous
C.	–0.54 V	non-spontaneous
D.	+0.54 V	spontaneous

Use the following diagram to answer questions 7 to 9.



- 7) Which of the following represents the anode half-cell reaction?
- A. $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$
 B. $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$
 C. $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$
 D. $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$

8) What changes in mass occur to the anode and cathode?

	Anode Mass	Cathode Mass
A.	increases	no change
B.	decreases	increases
C.	decreases	no change
D.	increases	decreases

9) What is the voltage for this cell under standard conditions?

- A. +2.16 V
- B. -0.24 V
- C. -0.56 V
- D. +0.56 V

10) Which component of the following cell notation is the anode?



- A) P B) Q C) R D) S E) One of the | symbols is the anode.

11) A voltaic cell prepared using aluminum and nickel has the following cell notation.



Which of the following represents the correctly balanced spontaneous reaction equation for the cell?

- A) $Ni^{2+}(aq) + Al(s) \rightarrow Al^{3+}(aq) + Ni(s)$
- B) $3Ni^{2+}(aq) + 2Al(s) \rightarrow 2Al^{3+}(aq) + 3Ni(s)$
- C) $Ni(s) + Al^{3+}(aq) \rightarrow Ni^{2+}(aq) + Al(s)$
- D) $3Ni(s) + 2Al^{3+}(aq) \rightarrow 3Ni^{2+}(aq) + 2Al(s)$
- E) none of the above

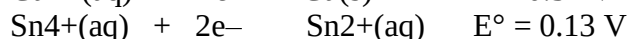
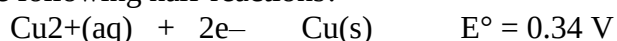
12) The line notation, $Al(s) \mid Al^{3+}(aq) \parallel Co^{2+}(aq) \mid Co(s)$, indicates that

- A) Co is the reducing agent. D) Al^{3+} is the reducing agent.
- B) Co^{2+} ions are oxidized. E) aluminum metal is the cathode.
- C) Al is the reducing agent.

13) The line notation, $Pt \mid H_2(g) \mid H^+(aq) \parallel Cu^{2+}(aq) \mid Cu(s)$, indicates that

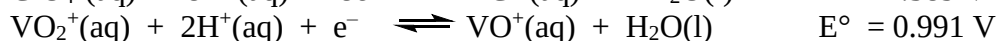
- A) copper metal is a product of the cell reaction.
- B) hydrogen gas (H_2) is a product of the cell reaction.
- C) Cu is the anode.
- D) Pt is the cathode.
- E) Cu^{2+} is the reducing agent.

14) A cell can be prepared from copper and tin. What is the E°_{cell} for the cell that forms from the following half-reactions?



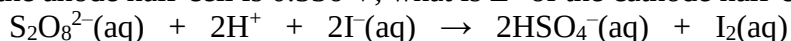
- A) 0.47 V B) 0.21 V C) -0.21 V D) -0.47 V E) 0.42 V

15) What is the E°_{cell} for the cell represented by the combination of the following half-reactions?

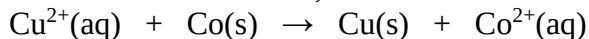


- A) -0.398 V B) -2.380 V C) 0.398 V D) 2.380 V E) none of the above

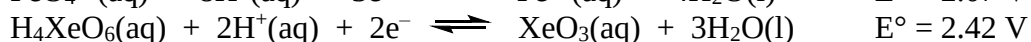
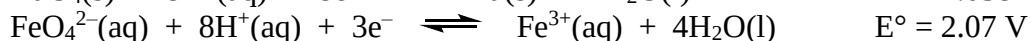
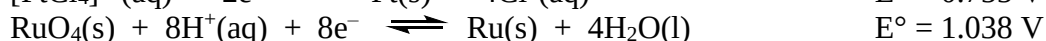
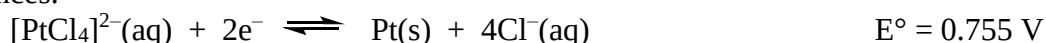
- 16) The redox reaction of peroxydisulfate with iodide has been used for many years as part of the iodine clock reaction which introduces students to kinetics. If $E^\circ_{\text{cell}} = 1.587 \text{ V}$ and E° of the anode half-cell is 0.536 V , what is E° of the cathode half-cell?



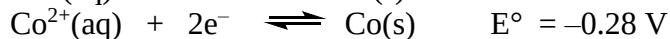
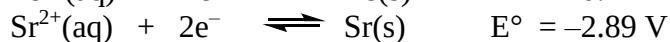
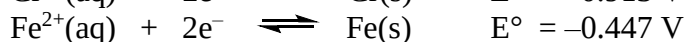
- A) -1.051 V B) -2.123 V C) 1.051 V D) 2.123 V E) none of the above
- 17) The voltaic cell made up of cobalt, copper, and their M^{2+} ions, has $E^\circ_{\text{cell}} = 0.62 \text{ V}$. If E° of the cathode half-cell is 0.34 V , what is E° of the anode half-cell?



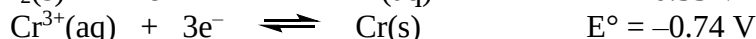
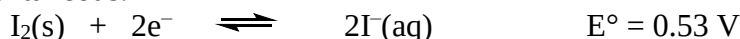
- A) -0.28 V B) -0.96 V C) 0.28 V D) 0.96 V E) none of the above
- 18) Examine the following half-reactions and select the strongest oxidizing agent among the substances.



- A) $[\text{PtCl}_4]^{2-}(\text{aq})$ B) $\text{RuO}_4(\text{s})$ C) $\text{HFeO}_4^-(\text{aq})$ D) $\text{H}_4\text{XeO}_6(\text{aq})$ E) $\text{Cl}^-(\text{aq})$
- 19) Examine the following half-reactions and select the strongest oxidizing agent among the species listed.



- A) $\text{Cr}^{2+}(\text{aq})$ B) $\text{Fe}(\text{s})$ C) $\text{Fe}^{2+}(\text{aq})$ D) $\text{Sr}^{2+}(\text{aq})$ E) $\text{Co}^{2+}(\text{aq})$
- 20) Calculate E°_{cell} and indicate whether the overall reaction shown is spontaneous or nonspontaneous.



Overall reaction:



- A) $E^\circ_{\text{cell}} = -1.27 \text{ V}$, spontaneous
 B) $E^\circ_{\text{cell}} = -1.27 \text{ V}$, nonspontaneous
 C) $E^\circ_{\text{cell}} = 1.27 \text{ V}$, spontaneous
 D) $E^\circ_{\text{cell}} = 1.27 \text{ V}$, nonspontaneous
 E) $E^\circ_{\text{cell}} = 1.54 \text{ V}$, spontaneous