

تجميع أسئلة اختبارات سابقة حول وحدة Electrochemistry الكيمياء الكهربائية



تم تحميل هذا الملف من موقع المناهج الإماراتية

موقع المناهج ← المناهج الإماراتية ← الصف الثاني عشر المتقدم ← كيمياء ← الفصل الثاني ← ملفات متنوعة ← الملف

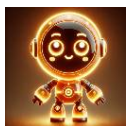
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المزيد من مادة
كيمياء:

إعداد: Abdelbari Ahmed Mohamed

التواصل الاجتماعي حسب الصف الثاني عشر المتقدم



صفحة المناهج
الإماراتية على
فيسبوك

الرياضيات

اللغة الانجليزية

اللغة العربية

التربية الاسلامية

المواد على تلغرام

المزيد من الملفات حسب الصف الثاني عشر المتقدم والمادة كيمياء في الفصل الثاني

حل تجميع أسئلة مراجعة وفق الهيكل الوزاري

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ملزمة وفق الهيكل الوزاري باللغة العربية

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ملزمة وفق الهيكل الوزاري باللغة الانجليزية

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مراجعة مختصرة منهج انسباير الخطه 101-M

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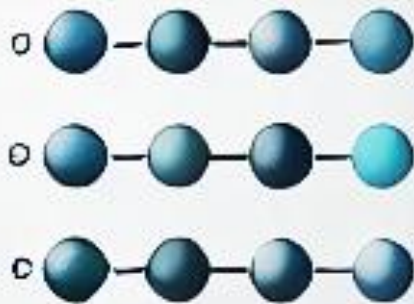
حل أسئلة مراجعة هيكل مختصرة ليلة الامتحان

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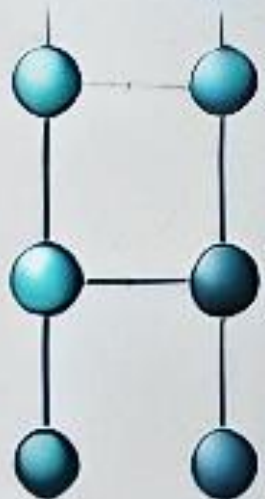
Electrochemistry

PRACTICE QUESTIONS FROM PAST EXAMS

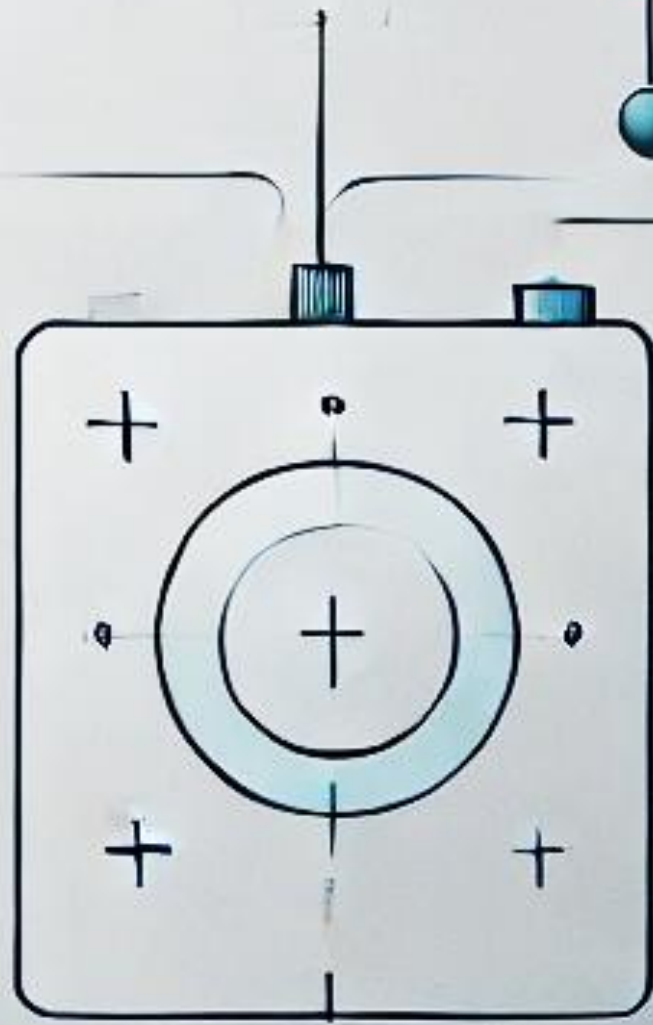
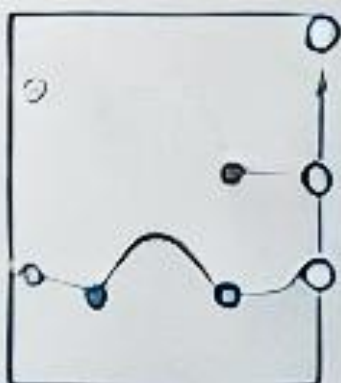
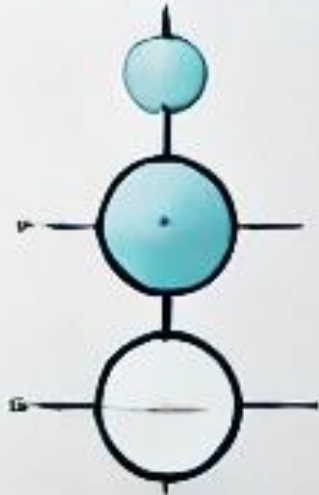
Galvanic Cell



BATTERY



GALVANA CELL



ION

مع خالص الشكر والامتنان للأستاذ محمد محسن
من بذل جهدا فوق العادة في تجميع الأسئلة باللغة العربية

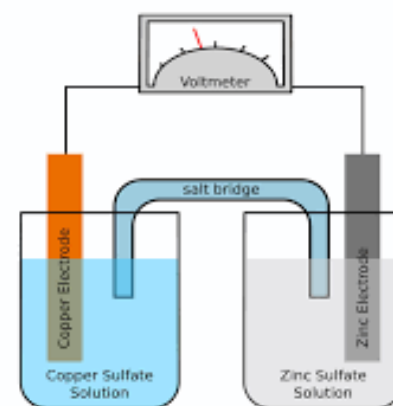
- 1) The following half-reduction reactions represent half-cells for a voltaic cell. Which of the data in the table below is correct?

Half-Reaction	E° (V)
$\text{Fe}^{3+} + 3\text{e}^- \rightarrow \text{Fe}$	-0.037
$\text{Pt}^{2+} + 2\text{e}^- \rightarrow \text{Pt}$	+1.18

	Spontaneity	Overall Cell Reaction	Cell Notation	Cell Potential E° (V)
A	Spontaneous	$2\text{Fe}^{3+} + 3\text{Pt} \rightarrow 2\text{Fe} + 3\text{Pt}^{2+}$	$\text{Pt} \text{Pt} \text{Fe}^{3+} \text{Fe}$	+1.217 V
B	Non-spontaneous	$3\text{Pt}^{2+} + 2\text{Fe} \rightarrow 3\text{Pt} + 2\text{Fe}^{3+}$	$\text{Fe} \text{Fe} \text{Pt}^{2+} \text{Pt}$	-1.217 V
C	Spontaneous	$2\text{Fe}^{3+} + 3\text{Pt} \rightarrow 2\text{Fe} + 3\text{Pt}^{2+}$	$\text{Pt} \text{Pt} \text{Fe}^{3+} \text{Fe}$	+1.143 V
D	Non-spontaneous	$2\text{Fe}^{3+} + 3\text{Pt} \rightarrow 2\text{Fe} + 3\text{Pt}^{2+}$	$\text{Fe} \text{Fe} \text{Pt}^{2+} \text{Pt}$	-1.143 V

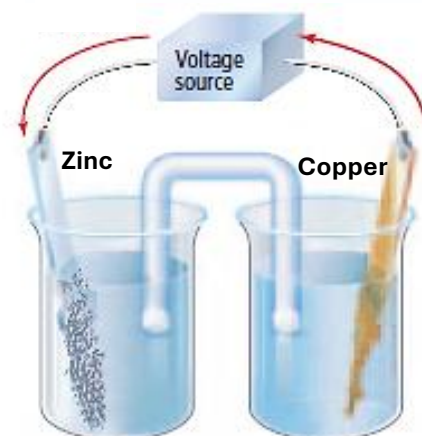
- 2) Regarding the cell shown in the figure below, which of the following is incorrect?

- (A) The salt bridge allows ions to pass from one side to the other.
 (B) Electrons move through the wire from the oxidation half-reaction to the reduction half-reaction.
 (C) This cell converts electrical energy to chemical energy.
 (D) Oxidation and reduction reactions occur spontaneously.

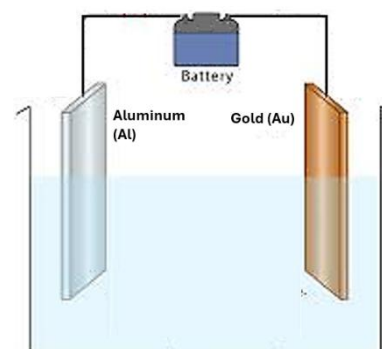


- 3) Regarding the cell shown in the figure below, which of the following is correct?

- (A) The reaction continues until the zinc electrode is consumed, then the reaction stops.
 (B) Oxidation occurs at the zinc electrode.
 (C) Reduction occurs at the copper electrode.
 (D) An external power source (electrical potential) is used to regenerate the cell and return it to its original strength approximately.



- 4) In the process of electroplating an aluminum sheet with a layer of gold as shown in the figure below, which of the following is correct?



	Change in the mass of the aluminum sheet	Cathode Reaction	Anode Reaction	Electrolyte Used
A	Increases	$\text{Au}^{3+} + 3\text{e}^- \rightarrow \text{Au}$	$\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$	Contains Au^{3+}
B	Decreases	$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	$\text{Au} \rightarrow \text{Au}^{3+} + 3\text{e}^-$	Contains Al^{3+}
C	Increases	$\text{Al} + 3\text{e}^- \rightarrow \text{Al}$	$\text{Au}^{3+} + 3\text{e}^- \rightarrow \text{Au}$	Contains Au^{3+}
D	Decreases	$\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$	$\text{Au}^{3+} + 3\text{e}^- \rightarrow \text{Au}$	Contains Al^{3+}

5) The following half-reduction reactions represent half-cells for a voltaic cell. What is the standard cell potential (E°_{cell}) for this voltaic cell?

- (A) +1.32 V
(B) +1.04 V
(C) -1.04 V
(D) -1.32 V

Half-Reaction	E°
$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn}(\text{s})$	-0.1375 V
$\text{Pt}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Pt}(\text{s})$	+1.18 V

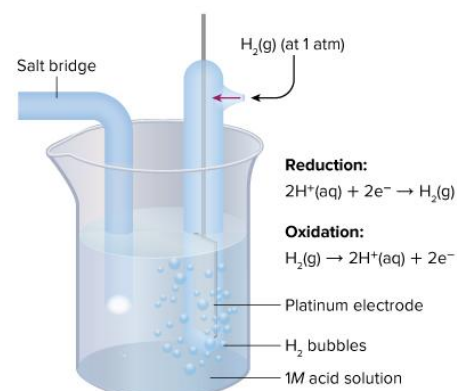
6) Which of the following represents the cell notation for a voltaic cell composed of aluminum and copper electrodes?

- (A) $\text{Al} \mid \text{Al}^{3+} \parallel \text{Cu}^{2+} \mid \text{Cu}$
(B) $\text{Cu} \mid \text{Cu}^{2+} \parallel \text{Al}^{3+} \mid \text{Al}$
(C) $\text{Al}^{3+} \mid \text{Al} \parallel \text{Cu} \mid \text{Cu}^{2+}$
(D) $\text{Cu}^{2+} \mid \text{Cu} \parallel \text{Al} \mid \text{Al}^{3+}$

Half-Reaction	E°
(A) $\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s})$	-1.662 V
(C) $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.3419 V

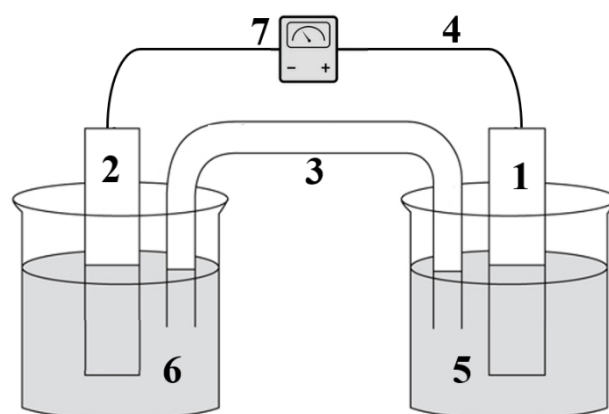
7) What is the standard reduction potential (E°) of the standard hydrogen electrode shown below?

- (A) 0.000 V
(B) +0.500 V
(C) +1.000 V
(D) -1.000 V



8) What is the number of the part that allows ions to pass from one side to the other in the voltaic cell shown below?

- (A) 3
(B) 4
(C) 5
(D) 7



9) Which of the reactions shown in the table below is non-spontaneous under standard conditions?

- (A) A, B
(B) A, C
(C) B, D
(D) C, D

	Reaction	E° (V)
A	$2\text{Fe}^{3+}(\text{aq}) + 3\text{Mn}(\text{s}) \rightarrow 3\text{Mn}^{2+}(\text{aq}) + 2\text{Fe}(\text{s})$	+1.148
B	$2\text{BrO}_3^-(\text{aq}) + \text{Co}^{2+}(\text{aq}) \rightarrow \text{Co}(\text{s}) + \text{S}_2\text{O}_7^{2-}(\text{aq})$	+2.29
C	$\text{Hg}^{2+}(\text{aq}) + 2\text{Cu}^+(\text{aq}) \rightarrow 2\text{Cu}^{2+}(\text{aq}) + \text{Hg}(\text{l})$	+0.698
D	$\text{Zn}(\text{s}) + \text{Ca}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Ca}(\text{s})$	-2.106

10) Which of the following is correct regarding voltaic cells?

- (A) 1 only
(B) 2 only
(C) 2 and 3
(D) 1 and 2

1	Oxidation occurs at the anode and reduction occurs at the cathode.
2	Electrons move from the poles that are oxidized to the poles that are reduced
3	Oxidation occurs at the cathode and reduction occurs at the anode.

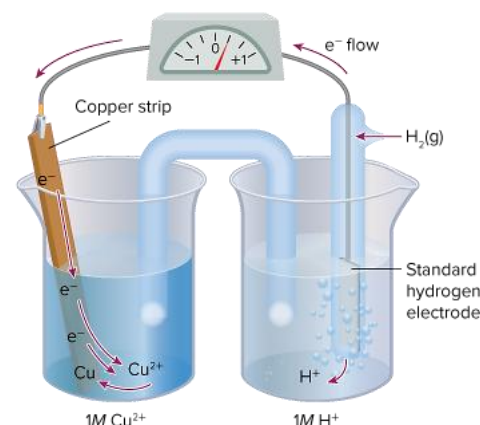
11) Which ion is the easiest to reduce?

- (A) Fe^{2+}
(B) Au^{3+}
(C) Ni^{2+}
(D) Cu^{2+}

Half-Reaction	E° (V)
$\text{Fe}^{2+} + 2e^- \rightarrow \text{Fe}$	-0.447
$\text{Au}^{3+} + 3e^- \rightarrow \text{Au}$	+1.498
$\text{Ni}^{2+} + 2e^- \rightarrow \text{Ni}$	-0.257
$\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$	+0.3419

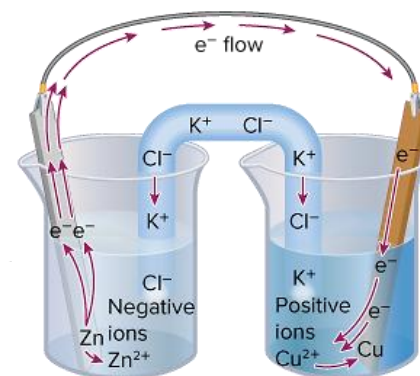
12) When a $\text{Cu}|\text{Cu}^{2+}$ electrode is connected to a standard hydrogen electrode as shown in the figure below, which of the following represents the half-reduction reaction?

- (A) $\text{Cu}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Cu}(\text{s})$
(B) $\text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2e^-$
(C) $\text{H}_2(\text{g}) \rightarrow 2\text{H}^+(\text{aq}) + 2e^-$
(D) $2\text{H}^+(\text{aq}) + 2e^- \rightarrow \text{H}_2(\text{g})$



13) Which of the following is the anode in the voltaic cell shown below?

- (A) Cu
(B) Zn
(C) Cu^{2+}
(D) Zn^{2+}



14) What is the standard cell potential (E°_{cell}) for the oxidation-reduction reaction between cobalt and copper?

- (A) +0.622 V
(B) +0.062 V
(C) -0.062 V
(D) -0.622 V

Half-Reaction	E° (V)
$\text{Co}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Co}(\text{s})$	-0.28
$\text{Cu}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Cu}(\text{s})$	+0.3419

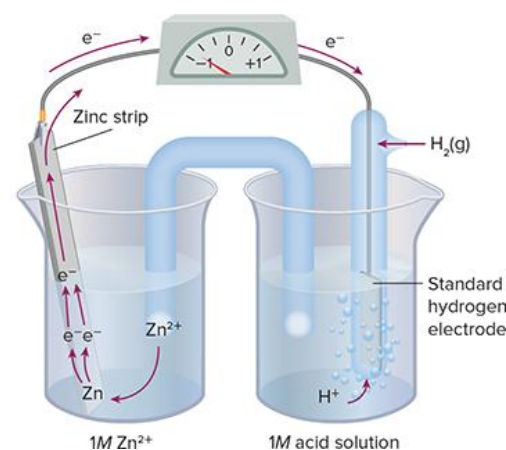
15) Which metal ion is the easiest to reduce?

- (A) Pt^{2+}
 (B) Fe^{3+}
 (C) Hg^{2+}
 (D) Cu^{2+}

Half-Reaction	E° (V)
$\text{Pt}^{2+} + 2e^- \rightarrow \text{Pt}$	+1.18
$\text{Fe}^{3+} + e^- \rightarrow \text{Fe}^{2+}$	+0.771
$\text{Hg}^{2+} + 2e^- \rightarrow \text{Hg}$	+0.851
$\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$	+0.3419

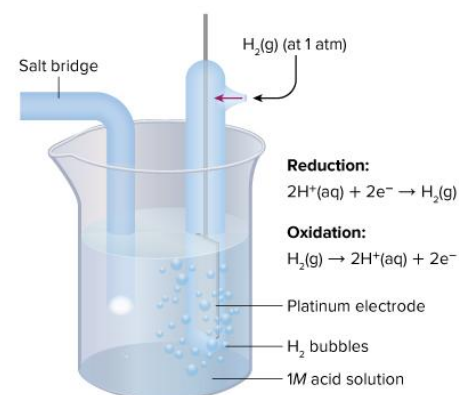
16) When a $\text{Zn}|\text{Zn}^{2+}$ electrode is connected to a standard hydrogen electrode as shown in the figure below, which of the following represents the half-oxidation reaction?

- (A) $\text{Zn}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Zn}(\text{s})$
 (B) $\text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2e^-$
 (C) $\text{H}_2(\text{g}) \rightarrow 2\text{H}^+(\text{aq}) + 2e^-$
 (D) $2\text{H}^+(\text{aq}) + 2e^- \rightarrow \text{H}_2(\text{g})$



17) Regarding the standard hydrogen electrode shown below, which of the following is incorrect?

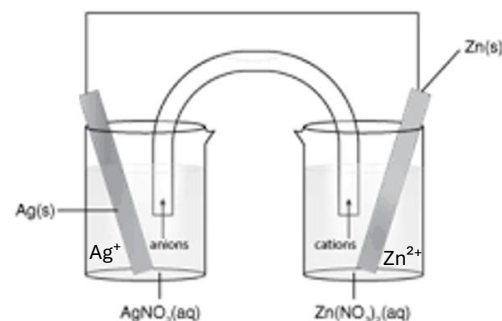
- (A) Hydrogen gas (H_2) is pumped into the solution at 1 atm and 25°C)
 (B) The standard reduction potential is 0.000 V.
 (C) The platinum electrode is immersed in an acidic solution with a concentration of 1 M.
 (D) The standard hydrogen electrode always acts as a half-reduction reaction.



18) Which of the following is the cathode in the voltaic cell shown below?

- (A) Zn^{2+}
 (B) Ag^+
 (C) Zn
 (D) Ag

Half-Reaction	E° (V)
$\text{Zn}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Zn}(\text{s})$	-0.7618
$\text{Ag}^+(\text{aq}) + e^- \rightarrow \text{Ag}(\text{s})$	+0.7996



19) Which of the following represents the cell notation for a voltaic cell composed of magnesium and lead electrodes?

- (A) $\text{Pb} | \text{Pb}^{2+} || \text{Mg}^{2+} | \text{Mg}$
 (B) $\text{Mg} | \text{Mg}^{2+} || \text{Pb} | \text{Pb}^{2+}$
 (C) $\text{Pb}^{2+} | \text{Pb} || \text{Mg} | \text{Mg}^{2+}$
 (D) $\text{Mg} | \text{Mg}^{2+} || \text{Pb}^{2+} | \text{Pb}$

Half-Reaction	E° (V)
$\text{Pb}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Pb}(\text{s})$	-0.1262
$\text{Mg}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Mg}(\text{s})$	-2.372

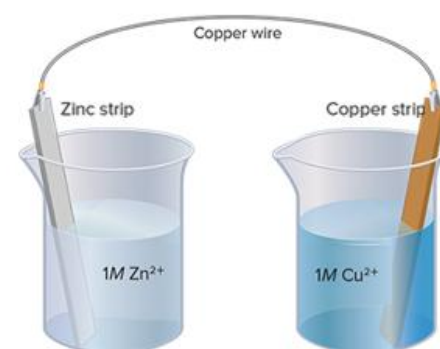
20) Regarding the cell notation and its standard potential (E°_{cell}) shown below, which of the following is correct?

Cell Notation for the Voltaic Cell	E° (V)
$\text{Zn} \text{Zn}^{2+} \text{Ca}^{2+} \text{Ca}$	-2.106

- (A) The reaction is non-spontaneous and the metal produced from the reaction is CA)
 (B) The reaction is non-spontaneous and the metal produced from the reaction is Zn.
 (C) The reaction is spontaneous and the metal produced from the reaction is CA)
 (D) The reaction is spontaneous and the metal produced from the reaction is Zn.

21) What prevents the oxidation-reduction reaction from producing electrical energy in the voltaic cell shown below?

- (A) There is no way to transfer electrons.
 (B) There is no lamp or voltmeter.
 (C) Ion buildup around the electrodes.
 (D) The solutions mix with each other.



22) How do electrons move in a voltaic cell?

- (A) Through the salt bridge from the anode to the cathode.
 (B) Through a metal wire from the anode to the cathode.
 (C) Through a metal wire from the electrode that is reduced to the electrode that is oxidized
 (D) Through the salt bridge from the electrode that is reduced to the electrode that is oxidized

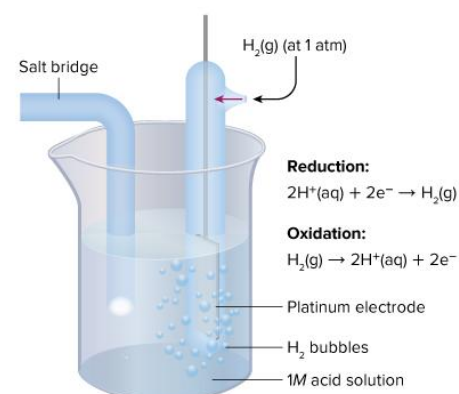
23) Which of the following occurs in a voltaic cell?

- (A) A non-spontaneous oxidation-reduction reaction.
 (B) Electrical energy is converted into chemical energy.
 (C) A spontaneous reaction continues until one of the electrodes is consumed
 (D) Electrons flow from the cathode to the anode.

24) Which of the following electrodes will be the anode when connected to a standard hydrogen electrode?

- (A) $\text{Zn} | \text{Zn}^{2+}$
 (B) $\text{F}_2 | \text{F}^-$
 (C) $\text{Cu} | \text{Cu}^{2+}$
 (D) $\text{Au} | \text{Au}^{3+}$

Half-Reaction	E° (V)
$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	-0.762
$\text{F}_2 + 2\text{e}^- \rightleftharpoons 2\text{F}^-$	+2.87
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0.342
$\text{Au}^{3+} + 3\text{e}^- \rightleftharpoons \text{Au}$	+1.498



25) Which metal ion is the easiest to reduce?

- (A) Mg^{2+}
 (B) Hg^{2+}
 (C) Al^{3+}
 (D) Ag^+

Half-Reaction	E° (V)
$\text{Mg}^{2+} + 2e^- \rightleftharpoons \text{Mg}$	-2.372
$\text{Hg}^{2+} + 2e^- \rightleftharpoons \text{Hg}$	+0.851
$\text{Al}^{3+} + 3e^- \rightleftharpoons \text{Al}$	-1.662
$\text{Ag}^+ + e^- \rightleftharpoons \text{Ag}$	+0.7996

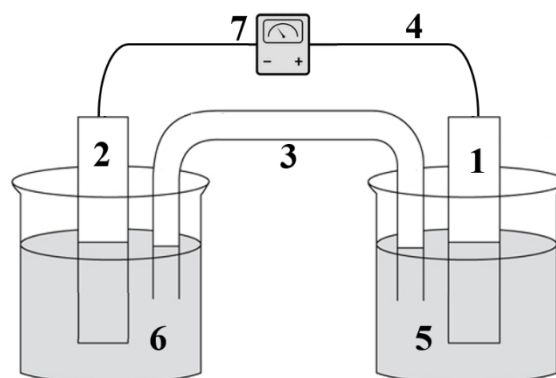
26) Which of the following represents the cell notation for a voltaic cell composed of magnesium and tin electrodes?

- (A) $\text{Sn} \mid \text{Sn}^{2+} \parallel \text{Mg}^{2+} \mid \text{Mg}$
 (B) $\text{Mg} \mid \text{Mg}^{2+} \parallel \text{Sn} \mid \text{Sn}^{2+}$
 (C) $\text{Sn} \mid \text{Sn}^{2+} \mid \text{Mg} \mid \text{Mg}^{2+}$
 (D) $\text{Mg} \mid \text{Mg}^{2+} \parallel \text{Sn}^{2+} \mid \text{Sn}$

Half-Reaction	E° (V)
$\text{Sn}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Sn}$	-0.1375
$\text{Mg}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Mg}(\text{s})$	-2.372

27) What is the role of part number (3) in the voltaic cell shown below?

- (A) Allows ions to pass from one side to the other.
 (B) Transfers electrons from one pole to another.
 (C) Oxidation occurs at it.
 (D) Reduction occurs at it.



28) What conditions are used to measure the standard reduction potential (E°) for an electrode immersed in a solution containing 1M of its ions?

- (A) 0°C and 1 atm pressure
 (B) 25°C and 1 atm pressure
 (C) 25°C and 100 atm pressure
 (D) 0°C and 0 atm pressure

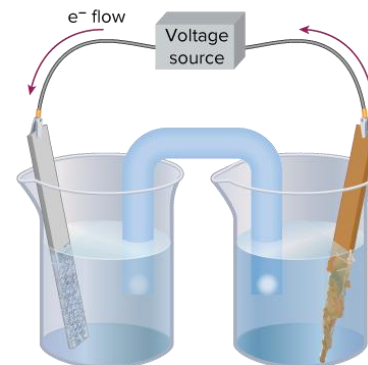
29) What is the standard cell potential (E°_{cell}) for the oxidation-reduction reaction that occurs between chromium and nickel?

- A) +0.48 V
 B) +1.00 V
 C) -0.48 V
 D) -1.00 V

Half-Reaction	E° (V)
$\text{Ni}^{2+} + 2e^- \rightleftharpoons \text{Ni}$	-0.26
$\text{Cr}^{3+} + 3e^- \rightleftharpoons \text{Cr}$	-0.74

30) What is the energy conversion in the cell shown in the figure below?

- A) Chemical energy to thermal energy
- B) Thermal energy to chemical energy
- C) Electrical energy to chemical energy
- D) Chemical energy to electrical energy



31) The figure below shows an electroplating process where a key is coated with a layer of copper in an electrolytic cell. What do the numbers in the figure indicate?

A)

1	2	3
Anode	Cathode	Cu^{2+}

C)

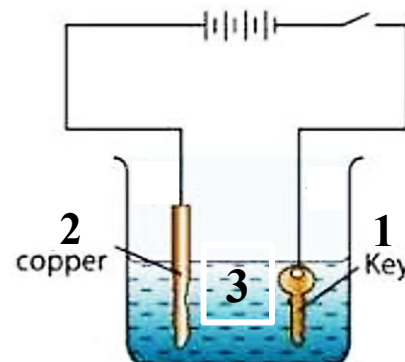
1	2	3
Cathode	Anode	Cu^{2+}

B)

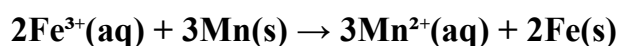
1	2	3
Cathode	Anode	Cu^{2+}

D)

1	2	3
Anode	Cathode	Cu



32) Which of the following is correct regarding the following oxidation-reduction reaction under standard conditions?



Half-Reaction	E° (V)
$\text{Fe}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.037
$\text{Mn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mn}(\text{s})$	-1.185

- A) The standard cell potential (E°_{cell}) is -1.148 V, and the reaction is non-spontaneous.
- B) The standard cell potential (E°_{cell}) is +1.222 V, and the reaction is spontaneous.
- C) The standard cell potential (E°_{cell}) is +1.148 V, and the reaction is spontaneous.
- D) The standard cell potential (E°_{cell}) is -1.222 V, and the reaction is non-spontaneous.

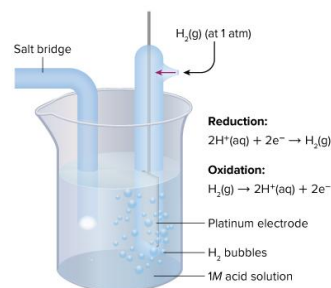
33) In the figure below, what do the half-cells need to convert chemical energy to electrical energy?

- A) Only connecting the zinc and copper plates with a copper wire to provide a pathway for electron transfer.
- B) Only a salt bridge to provide a pathway for ion transfer.
- C) A salt bridge to transfer electrons and a copper wire to transfer ions.
- D) A salt bridge and a copper wire together to provide an uninterrupted pathway for the transfer of electrical charges.



34) Regarding the standard hydrogen electrode in the figure below, which of the following is correct?

Half-Reaction	E° (V)
$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$	+0.3419
$\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$	-0.7618



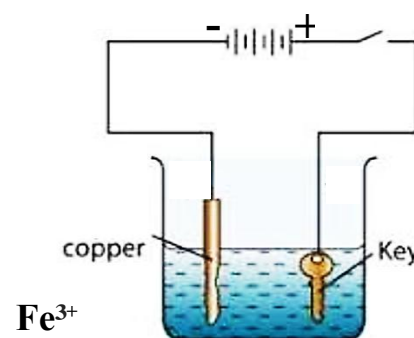
- A) It acts as a cathode when connected to a $(\text{Cu}|\text{Cu}^{2+})$ electrode.
 B) It acts as an anode when connected to a $(\text{Zn}|\text{Zn}^{2+})$ electrode.
 C) The standard reduction potential E° for the hydrogen electrode is 0.000V.
 D) The standard reduction potential E for the hydrogen electrode is 1.104V.

Given Half-Reactions and E° Values:

35) Khalifa attempted to electroplate an iron key with a layer of copper. He designed the electroplating cell shown in the figure below. What is/are the error(s) in the cell?

1	Connecting the battery poles.
2	The electrolyte used does not contain Cu^{2+} ions.
3	The key was not connected with an electrical lamp.

- A) 1 only
 B) 3 only
 C) 1 and 2 together
 D) 1 and 3 together

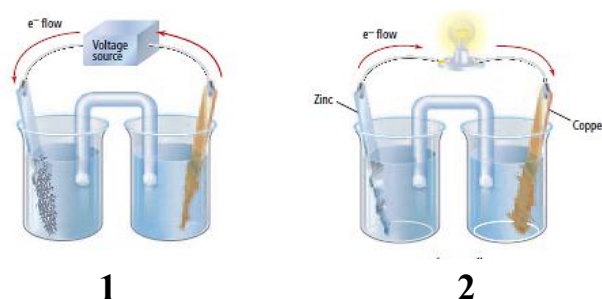


36) A voltaic half-cell represented by the following reaction was connected to one of the half-cells listed in the table below, and it was found that the standard cell potential of the resulting cell was (+3.89 V) Which half-cell was connected?

- A) $\text{Pt}^{2+} + 2\text{e}^- \rightarrow \text{Pt}$
 B) $\text{Na}^+(\text{aq}) + \text{e}^- \rightarrow \text{Na}(\text{s})$
 C) $\text{Mn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mn}(\text{s})$
 D) $\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Cr}(\text{s})$
 E. $\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$

Half-Reaction	E° (V)
$\text{Pt}^{2+} + 2\text{e}^- \rightarrow \text{Pt}$	+1.18
$\text{Na}^+(\text{aq}) + \text{e}^- \rightarrow \text{Na}(\text{s})$	-2.71
$\text{Mn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mn}(\text{s})$	-1.185
$\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Cr}(\text{s})$	-0.744
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.447

37) Regarding the two cells in the figure below, which of the following is correct?

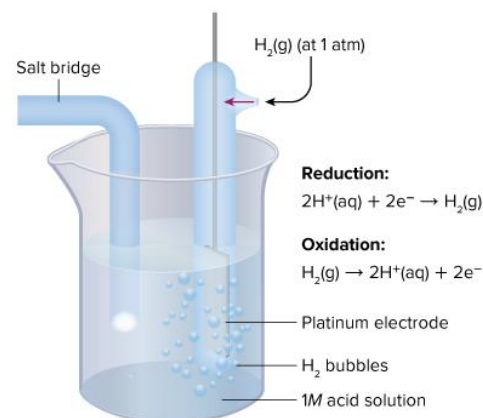


- A) Cell (1) is voltaic and converts chemical energy to electrical energy.
 B) Cell (2) is electrolytic and converts chemical energy to electrical energy.
 C) In Cell (1), the reaction is spontaneous.
 D) In Cell (2), the reaction continues until the zinc electrode is consumed, then the reaction stops.

38) Regarding the figure below, which of the following conditions must be met for the standard reduction potential (E°) of the hydrogen electrode to be equal to 0.000 V?

1	Maintaining a constant temperature of 25°C)
2	Pumping hydrogen gas ($P(H_2)$) into the solution at a pressure of 1 atm.
3	Using a hydrochloric acid (HCl) solution containing hydrogen ions at a concentration of 1 M.

- A) 1 only
 B) 1 and 2
 C) 3 ONLY
 D) 1, 2, and 3



39) In the figure below, which of the following is NOT a function of the salt bridge?

- A) Allows ions to pass from one side to the other.
 B) Allows electrons to pass from one side to the other.
 C) Prevents the accumulation of ions around the electrodes.
 D) Prevents the mixing of the two solutions.



40) The following half-reduction reactions represent half-cells for a voltaic cell. What is the standard cell potential for the cell?

- A) +3.027 V
 B) -3.027 V
 C) +0.667 V
 D) -0.667 V

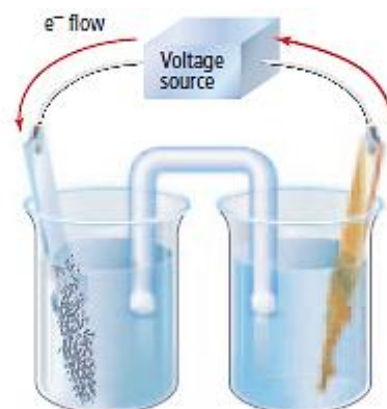
Half-Reaction	E° (V)
$Be^{2+} + 2e^- \rightleftharpoons Be$	-1.847
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+1.18

41) Based on the figure below, which of the following is correct?

- A) Reduction of copper ions occurs at the anode.
- B) Oxidation of zinc atoms occurs at the cathode.
- C) The mass of the copper electrode decreases.
- D) The mass of the zinc electrode decreases.

42) Regarding the cell in the figure below, which of the following is correct?

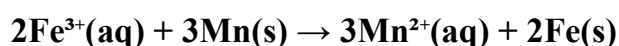
- A) It is an electrolytic cell and spontaneous oxidation-reduction reactions occur in it.
- B) It is a voltaic cell and spontaneous oxidation-reduction reactions occur in it.
- C) It is an electrolytic cell and non-spontaneous oxidation-reduction reactions occur in it.
- D) It is a voltaic cell and non-spontaneous oxidation-reduction reactions occur in it.



43) What conditions are used to measure standard reduction potentials?

- A) 1 M ionic solution, 1 atm, 25°C
- B) 1 M ionic solution, 0°C, 1 atm
- C) 0.5 M ionic solution, 0°C, 0.5 atm
- D) 0.1 M ionic solution, 100°C, 100 atm

44) The following reaction occurs in a voltaic cell:



Which of the following occurs at the anode?

- A) Oxidation of iron atoms
- B) Reduction of iron ions
- C) Oxidation of manganese atoms
- D) Reduction of manganese ions

45) The figure below shows the electroplating of an iron fork with silver in an electrolytic cell. Which of the following statements is correct?

- A) The fork is the positive electrode.
- B) The fork is the cathode.
- C) The silver electrode is the cathode
- D) The solution is non-Electrolytic

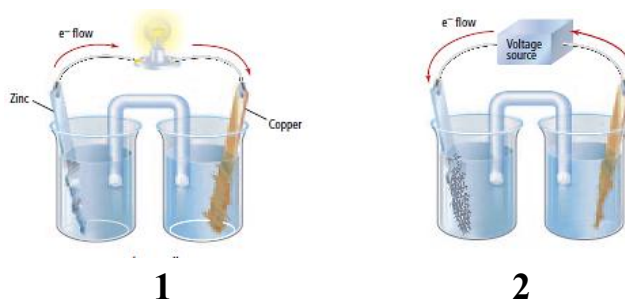


46) Using the data in the table below, which ion is the easiest to reduce?

- A) Mg^{2+}
 B) Ag^+
 C) Al^{3+}
 D) Hg^{2+}

Half-Reaction	E° (V)
$\text{Mg}^{2+} + 2e^- \rightarrow \text{Mg}$	-2.372
$\text{Ag}^+ + e^- \rightarrow \text{Ag}$	+0.7996
$\text{Al}^{3+} + 3e^- \rightarrow \text{Al}$	-1.662
$\text{Hg}^{2+} + 2e^- \rightarrow \text{Hg}$	+0.851

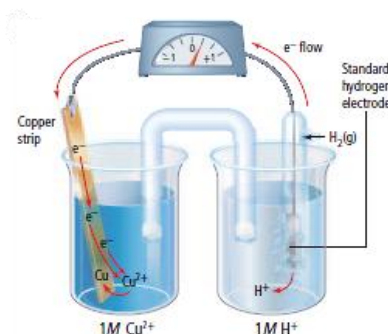
47) Regarding the two cells in the figure below, which of the following is correct?



- A) Cell (1) represents an electrolytic cell.
 B) Cell (2) represents a voltaic cell.
 C) Electrons flow in voltaic cell (1) from Cu.
 D) Electrons flow in electrolytic cell (2) from Cu.

48) What is the half-reduction reaction that occurs in the cell shown in the figure below?

- A) $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$
 B) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2e^-$
 C) $\text{H}_2 \rightarrow 2\text{H}^+ + 2e^-$
 D) $2\text{H}^+ + 2e^- \rightarrow \text{H}_2$



49) Which of the following correctly describes the parts of an electrochemical cell?

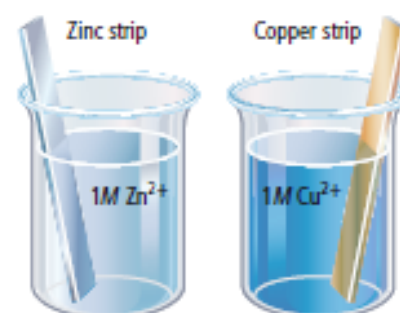
- (A) 1, 2, and 3
 (B) 1 and 2
 (C) 2 and 3
 (D) 1 and 3

1	Half-cells	Two parts where oxidation and reduction reactions occur separately.
2	Anode	Electrode where oxidation occurs.
3	Cathode	Electrode where reduction occurs.

50) What parts are missing in the voltaic cell diagram below for it to be complete?

- (A) 1, 2, and 3
 (B) 1 and 2
 (C) 2 and 3
 (D) 1 and 3

1	Metal wire
2	Salt bridge
3	Metal electrode



51) Which of the reactions listed in the table below is non-spontaneous under standard conditions?

- (A) $2\text{Au}^{3+} + 3\text{Cu} \rightarrow 3\text{Cu}^{2+} + 2\text{Au}$
 (B) $2\text{Fe}^{3+} + 3\text{Mn} \rightarrow 3\text{Mn}^{2+} + 2\text{Fe}$
 (C) $\text{Fe} + 2\text{Cu}^{2+} \rightarrow \text{Fe}^{2+} + 2\text{Cu}$
 (D) $\text{Ni} + \text{Fe}^{2+} \rightarrow \text{Ni}^{2+} + \text{Fe}$

Reaction	$E^\circ(\text{V})$
$2\text{Au}^{3+} + 3\text{Cu} \rightarrow 3\text{Cu}^{2+} + 2\text{Au}$	+1.16
$2\text{Fe}^{3+} + 3\text{Mn} \rightarrow 3\text{Mn}^{2+} + 2\text{Fe}$	+1.148
$\text{Fe} + 2\text{Cu}^{2+} \rightarrow \text{Fe}^{2+} + 2\text{Cu}$	+0.96
$\text{Ni} + \text{Fe}^{2+} \rightarrow \text{Ni}^{2+} + \text{Fe}$	-0.218

52) What is the standard cell potential (E°_{cell}) for the reaction that occurs when the two half-cells below are connected?

- (A) +1.5724 V
 (B) +3.9712 V
 (C) +0.7728 V
 (D) +3.1716 V

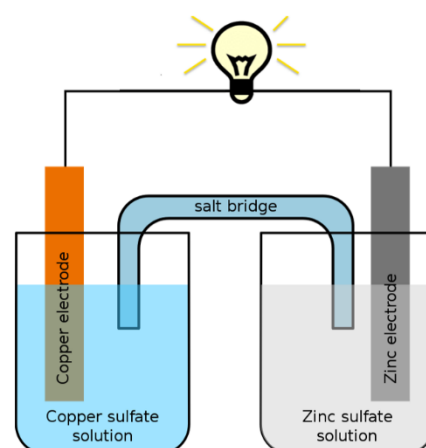
Half-Reaction	$E^\circ(\text{V})$
$\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$	-2.372
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	+0.7996

53) The study of oxidation-reduction processes through which chemical energy is converted into electrical energy and vice versa is called:

- (A) Electrochemistry
 (B) Nuclear chemistry
 (C) Physical chemistry
 (D) Organic chemistry

54) In the voltaic cell shown in the figure below, which of the following statements is correct?

- A) Electrical energy is used to cause a chemical reaction.
 B) The wire acts as a pathway for electron transfer from the zinc plate to the copper plate.
 C) Electrons move through the salt bridge to the copper side.
 D) Positive zinc ions accumulate around the zinc electrode.



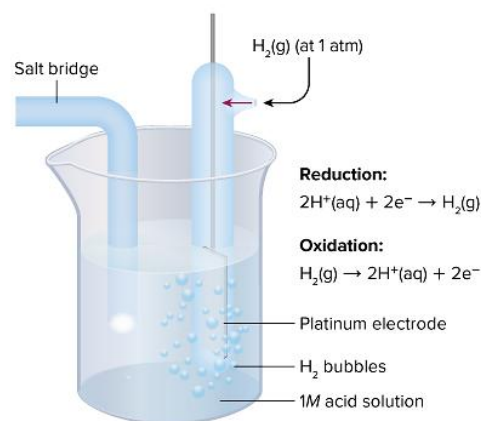
55) The following half-reduction reactions represent a voltaic cell. Which of the following is correct?

Half-Reaction	$E^\circ(\text{V})$
$\text{Co}^{2+} + 2\text{e}^- \rightarrow \text{Co}$	-0.28
$\text{Pt}^{2+} + 2\text{e}^- \rightarrow \text{Pt}$	+1.18

	Anode	Cathode	Cell Potential E°	Reaction Type
A	Pt	Co	+0.9 V	Spontaneous
B	Co	Pt	+1.46 V	Spontaneous
C	Pt	Co	-0.9 V	Non-spontaneous
D	Co	Pt	-1.46 V	Non-spontaneous

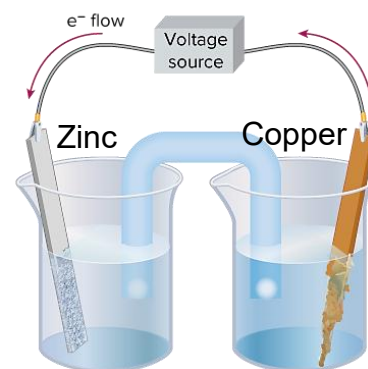
56) Which of the following is correct regarding the standard hydrogen electrode shown in the figure below?

- A) It acts as an anode in all voltaic cells it is connected to.
- B) It acts as a cathode in all voltaic cells it is connected to.
- C) The reduction potential of this electrode is 0.000 V under all conditions.
- D) The reduction potential of this electrode is 0.000 V when the acid solution concentration is 1 M, hydrogen gas is pumped at 1 atm, and the temperature is constant at 25°C)



57) Which of the following is correct regarding the electrochemical cell in the figure below?

- A) The reaction continues until the zinc electrode is consumed, then the reaction stops.
- B) Chemical energy is converted into electrical energy.
- C) Spontaneous oxidation-reduction reactions occur.
- D) Non-spontaneous oxidation-reduction reactions occur.



58) Objects are electroplated by depositing a thin and uniform layer to form a protective or decorative coating, as shown in the figure below. Which of the following is correct?

- A) The object to be plated is the anode.
- B) The metal to be plated is the cathode.
- C) Silver is oxidized to silver ions at the cathode.
- D) Silver is oxidized to silver ions at the anode.

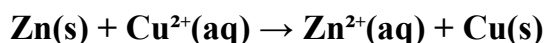


59) Which of the following represents the cell notation for a voltaic cell composed of nickel and calcium electrodes?

- A) $\text{Ni}^{2+} | \text{Ni} || \text{Ca}^{2+} | \text{Ca}$
- B) $\text{Ca} | \text{Ca}^{2+} || \text{Ni}^{2+} | \text{Ni}$
- C) $\text{Ca}^{2+} | \text{Ca} || \text{Ni} | \text{Ni}^{2+}$
- D) $\text{Ni} | \text{Ni}^{2+} || \text{Ca} | \text{Ca}^{2+}$

Half-Reaction	E° (V)
$\text{Ni}^{2+} + 2e^- \rightarrow \text{Ni}$	-0.257
$\text{Ca}^{2+} + 2e^- \rightarrow \text{Ca}$	-2.868

60) In the following voltaic cell reaction:



Which of the following occurs at the anode?

- A) Oxidation of Cu
- B) Oxidation of Zn
- C) Reduction of Cu^{2+}
- D) Reduction of Zn^{2+}

61) The figure below shows the electroplating of an iron fork with silver in an electrolytic cell. What is the cathode in the cell?

- A) Iron fork
- B) Electrolyte solution
- C) Silver plate
- D) Battery



62) What is the similarity between the two cells shown below?

- A) Occurrence of an oxidation-reduction reaction
- B) Occurrence of a spontaneous reaction
- C) Occurrence of a non-spontaneous reaction
- D) Occurrence of a neutralization reaction



63) Using the data in the table below, which half-reaction is most likely to be a half-reduction reaction?

- A) $\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$
- B) $\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$
- C) $\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$
- D) $\text{Hg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Hg}$

Half-Reaction	E° (V)
$\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$	-2.372
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	+0.7996
$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	-1.662
$\text{Hg}^{2+} + 2\text{e}^- \rightarrow \text{Hg}$	+0.851

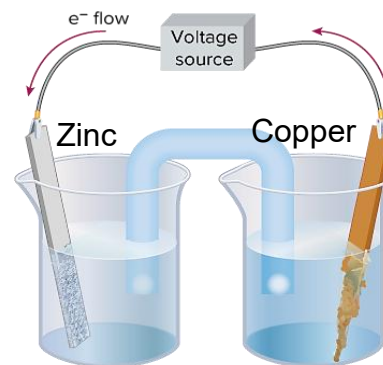
64) In the voltaic cell shown below, where do ions move from one side to the other?

- A) Through the copper wire
- B) Through the salt bridge
- C) Through the zinc electrode
- D) Through the silver electrode



65) What does the figure below represent?

- A) Electrolytic cell
- B) Voltaic cell
- C) Standard hydrogen electrode
- D) Salt bridge



66) Which of the following statements is incorrect regarding electrochemistry?

- A) It deals with the conversion of chemical energy to electrical energy and vice versa
- B) It studies oxidation and reduction processes.
- C) It deals with the conversion of mechanical energy to electrical energy and vice versa
- D) It is useful in industry and important in biological functions.

67) In the voltaic cell shown below, where are electrons gained?

- A) At the silver electrode
- B) At the zinc electrode
- C) At the salt bridge
- D) At both electrodes



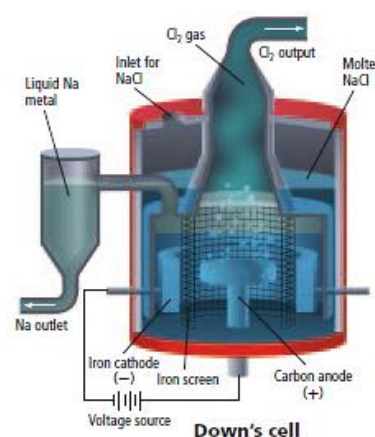
68) Which of the reactions shown in the table below is non-spontaneous under standard conditions?

- A) $2\text{Au}^{3+} + 3\text{Cu} \rightarrow 3\text{Cu}^{2+} + 2\text{Au}$
- B) $2\text{Fe}^{3+} + 3\text{Mn} \rightarrow 3\text{Mn}^{2+} + 2\text{Fe}$
- C) $\text{Fe} + 2\text{Cu}^{2+} \rightarrow \text{Fe}^{2+} + 2\text{Cu}$
- D) $\text{Ni} + \text{Fe}^{2+} \rightarrow \text{Ni}^{2+} + \text{Fe}$

Half-Reaction	E° (V)
$2\text{Au}^{3+} + 3\text{Cu} \rightarrow 3\text{Cu}^{2+} + 2\text{Au}$	+1.16
$2\text{Fe}^{3+} + 3\text{Mn} \rightarrow 3\text{Mn}^{2+} + 2\text{Fe}$	+1.148
$\text{Fe} + 2\text{Cu}^{2+} \rightarrow \text{Fe}^{2+} + 2\text{Cu}$	+0.96
$\text{Ni} + \text{Fe}^{2+} \rightarrow \text{Ni}^{2+} + \text{Fe}$	-0.218

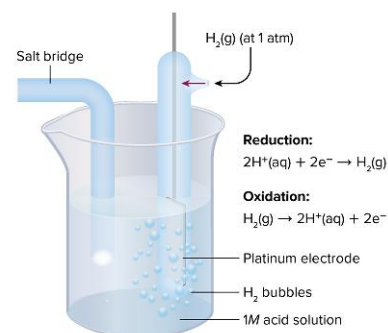
69) During the electrolysis of molten sodium chloride (NaCl) in a Downs cell as shown in the figure below, what happens to sodium ions?

- A) They are oxidized at the anode.
- B) They are reduced at the anode.
- C) They are oxidized at the cathode.
- D) They are reduced at the cathode.



70) In the figure shown below, what is the reduction potential E° for this electrode at 1 atm pressure and 25°C?

- A) 0.000 V
- B) 0.500 V
- C) 1.000 V
- D) 1.500 V



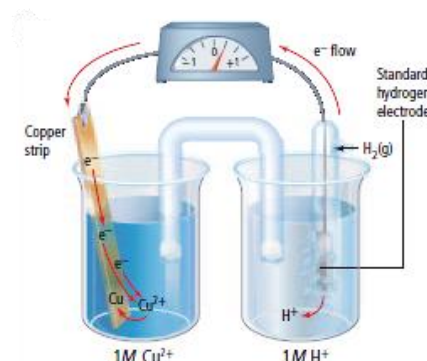
71) What is the standard cell potential E°_{cell} for the spontaneous oxidation-reduction reaction that occurs between magnesium and silver?

- A) +1.573 V
- B) +3.172 V
- C) +0.773 V
- D) +2.971 V

Half-Reaction	E° (V)
$\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$	-2.372
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	+0.7996

72) What does the positive value of the voltaic cell potential $E^\circ_{\text{Cu}} = +0.342$ V shown in the figure below indicate?

- A) Cu^{2+} ions gain electrons more easily than H^+ ions.
- B) H^+ ions gain electrons more easily than Cu^{2+} ions.
- C) Oxidation occurs at the copper electrode and reduction occurs at the hydrogen electrode.
- D) Electrons flow from the copper electrode to the hydrogen electrode.



73) Which of the following is NOT a benefit of the salt bridge in a voltaic cell?

- (A) Preventing charge buildup around the electrodes.
- (B) Completing the pathway for charge transfer.
- (C) Allowing ions to pass from one side to the other.
- (D) Providing a pathway for electron transfer.

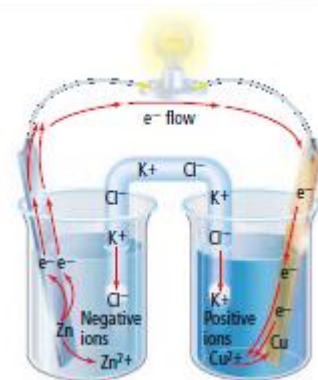
74) A voltaic cell is composed of the half-cells shown in the table below. What is the correct cell notation?

- (A) $\text{Ag} | \text{Ag}^+ || \text{Cd} | \text{Cd}^{2+}$
- (B) $\text{Ag} | \text{Ag}^+ || \text{Cd}^{2+} | \text{Cd}$
- (C) $\text{Cd} | \text{Cd}^{2+} || \text{Ag}^+ | \text{Ag}$
- (D) $\text{Cd}^{2+} | \text{Cd} || \text{Ag} | \text{Ag}^+$

Half-Reaction	E° (V)
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	+0.7996
$\text{Cd}^{2+} + 2\text{e}^- \rightarrow \text{Cd}$	-0.403

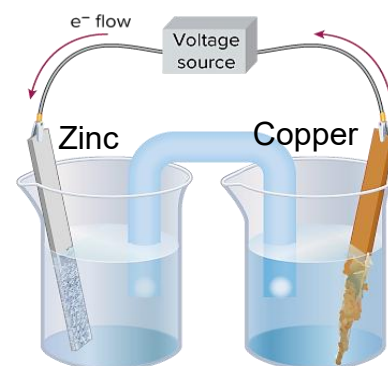
75) In the figure below, which number is responsible for maintaining ionic balance in the cell and transferring ions?

- (A) 1
(B) 2
(C) 3
(D) 4



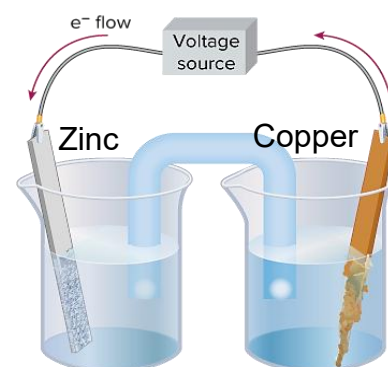
76) Which of the following is correct regarding the electrolytic cell in the figure below?

- (A) The presence of a power source makes the oxidation-reduction reaction spontaneous.
(B) The copper electrode is the cathode.
(C) The zinc electrode is the anode.
(D) Electrical energy is converted into chemical energy.



77) Which reaction occurs at the anode in the electrolytic cell shown below?

- (A) $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$
(B) $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
(C) $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$
(D) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$



78) Using the table below, calculate the standard cell potential for a voltaic cell composed of magnesium and gold electrodes.

- (A) -0.874 V
(B) +3.87 V
(C) -3.87 V
(D) +0.874 V

Half-Reaction	E° (V)
$\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$	-2.372
$\text{Au}^{3+} + 3\text{e}^- \rightarrow \text{Au}$	+1.489

79) In the electroplating process, a metal is coated with a layer of another metal to make it more resistant to rust or to give it a beautiful appearance. Which of the following metals is NOT used to plate other metals?

- (A) Gold
(B) Silver
(C) Iron
(D) Nickel

80) What describes the use of electrical energy to obtain a chemical reaction?

- (A) Voltaic cell
- (B) Cathode
- (C) Anode
- (D) Electrolysis

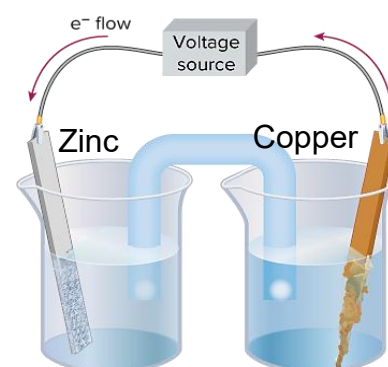
81) A voltaic cell is composed of the half-cells shown in the table below. What is the correct cell notation?

- (A) $\text{Pb} \mid \text{Pb}^{2+} \parallel \text{Co}^{2+} \mid \text{Co}$
- (B) $\text{Co} \mid \text{Co}^{2+} \parallel \text{Pb}^{2+} \mid \text{Pb}$
- (C) $\text{Co}^{2+} \mid \text{Co} \parallel \text{Pb}^{2+} \mid \text{Pb}$
- (D) $\text{Co} \mid \text{Co}^{2+} \parallel \text{Pb} \mid \text{Pb}^{2+}$

Half-Reaction	E° (V)
$\text{Co}^{2+} + 2\text{e}^- \rightarrow \text{Co}$	-0.28
$\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$	-0.1262

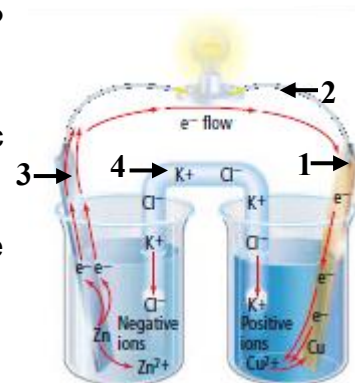
82) Which of the following statements is correct regarding the cell shown below?

- (A) Spontaneous oxidation-reduction reactions occur.
- (B) The cell potential is negative.
- (C) Chemical energy is converted into electrical energy.
- (D) The cell potential is positive.

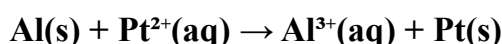


83) Which of the following is correct regarding the figure shown below?

- (A) Part number (3) represents the cell cathode.
- (B) Part number (4) provides a pathway for electron transfer from the zinc plate to the copper plate.
- (C) Part number (4) provides a pathway for ion transfer from one side to the other.
- (D) Part number (1) represents the cell anode.



84) What is the standard cell potential for the electrochemical cell whose overall reaction is represented by the equation below?

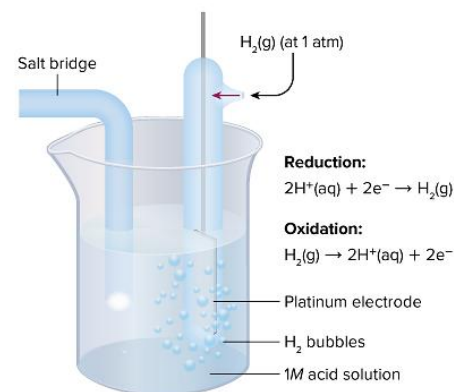


- (A) -2.84 V
- (B) +0.482 V
- (C) +2.84 V
- (D) -0.482 V

Half-Reaction	E° (V)
$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	-1.662
$\text{Pt}^{2+} + 2\text{e}^- \rightarrow \text{Pt}$	+1.18

85) Which of the following is incorrect regarding the figure shown below?

- (A) It is used to measure standard reduction potentials for all electrodes.
 (B) It represents the standard hydrogen electrode.
 (C) The reduction potential of this electrode is 0.000 V.
 (D) It acts as an anode in all voltaic cells it is part of.



86) Which of the following represents the cell notation for a voltaic cell composed of iron and sodium electrodes?

- (A) $\text{Fe} \mid \text{Fe}^{2+} \parallel \text{Na}^+ \mid \text{Na}$
 (B) $\text{Fe}^{2+} \mid \text{Fe} \parallel \text{Na} \mid \text{Na}^+$
 (C) $\text{Na} \mid \text{Na}^+ \parallel \text{Fe}^{2+} \mid \text{Fe}$
 (D) $\text{Na}^+ \mid \text{Na} \parallel \text{Fe} \mid \text{Fe}^{2+}$

Half-Reaction	E° (V)
$\text{Fe}^{2+} + 2e^- \rightarrow \text{Fe}$	-0.447
$\text{Na}^+ + e^- \rightarrow \text{Na}$	-2.71

87) What is the standard cell potential (E°_{cell}) for the spontaneous oxidation-reduction reaction that occurs between platinum and iron?

- (A) -1.143 V
 (B) +1.143 V
 (C) +1.217 V
 (D) +1.148 V

Half-Reaction	E° (V)
$\text{Fe}^{3+} + 3e^- \rightarrow \text{Fe}$	-0.037
$\text{Pt}^{2+} + 2e^- \rightarrow \text{Pt}$	+1.18

88) Using the data in the table below, which ion is the easiest to reduce?

- (A) Cu^+
 (B) Au^{3+}
 (C) Fe^{2+}
 (D) Ni^{2+}

Half-Reaction	E° (V)
$\text{Fe}^{2+} + 2e^- \rightarrow \text{Fe}$	-0.447
$\text{Au}^{3+} + 3e^- \rightarrow \text{Au}$	+1.498
$\text{Ni}^{2+} + 2e^- \rightarrow \text{Ni}$	-0.257
$\text{Cu}^+ \rightarrow \text{Cu}$	+0.52

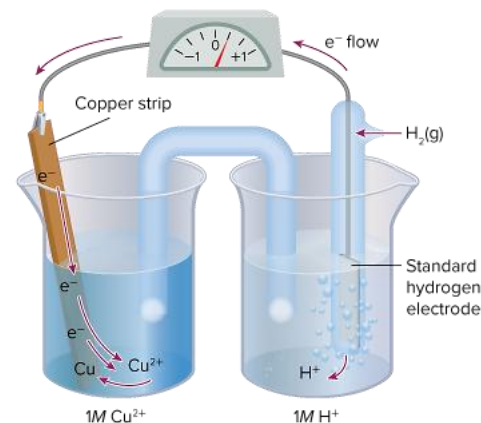
89) Which of the reactions shown in the table below is non-spontaneous under standard conditions?

- (A) $2\text{Fe}^{3+} + 3\text{Mn} \rightarrow 3\text{Mn}^{2+} + 2\text{Fe}$
 (B) $\text{I}_2 + \text{Fe}^{2+} \rightarrow 2\text{I}^- + \text{Fe}^{3+}$
 (C) $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$
 (D) $\text{Zn} + \text{Ca}^{2+} \rightarrow \text{Zn}^{2+} + \text{Ca}$

Reaction	E° (V)
$2\text{Fe}^{3+} + 3\text{Mn} \rightarrow 3\text{Mn}^{2+} + 2\text{Fe}$	+1.148
$\text{I}_2 + \text{Fe}^{2+} \rightarrow 2\text{I}^- + \text{Fe}^{3+}$	+0.983
$\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$	+1.104
$\text{Zn} + \text{Ca}^{2+} \rightarrow \text{Zn}^{2+} + \text{Ca}$	-2.106

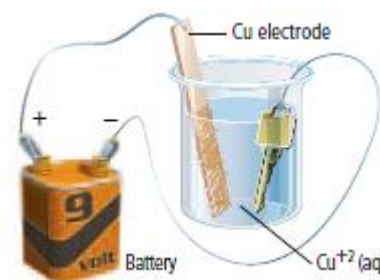
90) What does the positive value of the voltaic cell potential ($E^\circ_{\text{Cu}} = +0.342 \text{ V}$) shown in the figure below indicate?

- (A) Cu^{2+} ions gain electrons more easily than H^+ ions.
- (B) H^+ ions gain electrons more easily than Cu^{2+} ions.
- (C) Oxidation occurs at the copper electrode and reduction occurs at the hydrogen electrode.
- (D) Electrons flow from the copper electrode to the hydrogen electrode.

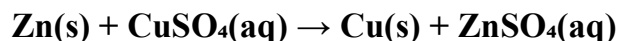


91) The figure below shows the electroplating of a key with copper in an electrolytic cell. Which of the following statements is correct?

- (A) The key is the anode in the cell.
- (B) Copper is oxidized to Cu^{2+} ions at the anode.
- (C) The mass of the copper plate increases.
- (D) The mass of the key decreases.



92) The following reaction occurs in a voltaic cell:

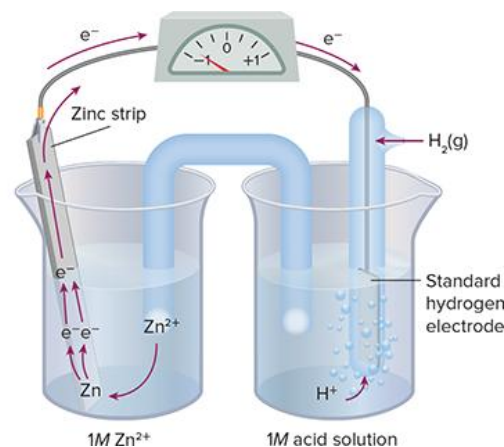


Which of the following occurs?

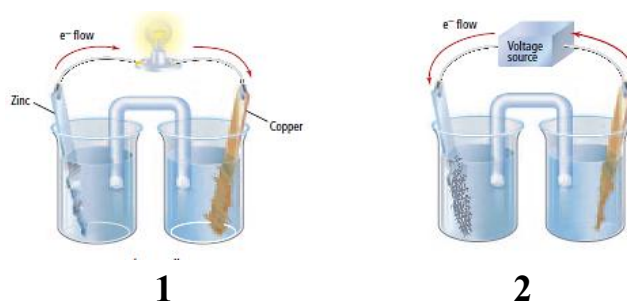
- (A) Oxidation of zinc atoms and reduction of copper ions.
- (B) Reduction of zinc atoms.
- (C) Electron transfer from copper ions (Cu^{2+}) to zinc atoms.
- (D) Oxidation of copper ions (Cu^{2+})

93) What does the negative value of the standard cell potential ($E^\circ_{\text{cell}} = -0.762 \text{ V}$) shown in the figure below indicate?

- (A) Zn^{2+} ions gain electrons more easily than H^+ ions.
- (B) H^+ ions gain electrons more easily than Zn^{2+} ions.
- (C) Oxidation occurs at the hydrogen electrode and reduction occurs at the zinc electrode.
- (D) Electrons flow from the hydrogen electrode to the zinc electrode.



94) Which of the following is correct regarding the two cells shown below?



- (A) Cell (1) converts electrical energy to chemical energy.
 (B) In cell (1), a spontaneous oxidation-reduction reaction occurs.
 (C) Cell (2) converts chemical energy to electrical energy.
 (D) In cell (2), a spontaneous oxidation-reduction reaction occurs.

95) Using the data in the table below, which ion is the easiest to reduce?

- (A) Mg^{2+}
 (B) Ag^+
 (C) Al^{3+}
 (D) Hg^{2+}

Half-Reaction	E° (V)
$\text{Mg}^{2+} + 2e^- \rightleftharpoons \text{Mg}$	-2.372
$\text{Ag}^+ + e^- \rightleftharpoons \text{Ag}$	+0.7996
$\text{Al}^{3+} + 3e^- \rightleftharpoons \text{Al}$	-1.662
$\text{Hg}^{2+} + 2e^- \rightleftharpoons \text{Hg}$	+0.851

96) What is the standard cell potential (E°_{cell}) for the spontaneous oxidation-reduction reaction that occurs between magnesium and silver?

- (A) +1.5724 V
 (B) +0.7728 V
 (C) +3.9712 V
 (D) +3.1716 V

Half-Reaction	E° (V)
$\text{Mg}^{2+} + 2e^- \rightleftharpoons \text{Mg}$	-2.372
$\text{Ag}^+ + e^- \rightleftharpoons \text{Ag}$	+0.7996

97) The following reaction occurs in a voltaic cell: $2\text{Fe}^{3+}(\text{aq}) + 3\text{Mn}(\text{s}) \rightarrow 3\text{Mn}^{2+}(\text{aq}) + 2\text{Fe}(\text{s})$

Which of the following occurs at the anode?

- (A) Reduction of manganese ions.
 (B) Reduction of iron ions.
 (C) Oxidation of manganese atoms.
 (D) Oxidation of iron atoms.

98) Which of the following represents the cell notation for a voltaic cell composed of nickel and calcium electrodes?

- (A) $\text{Ni} \mid \text{Ni}^{2+} \parallel \text{Ca}^{2+} \mid \text{Ca}$
 (B) $\text{Ni}^{2+} \mid \text{Ni} \parallel \text{Ca}^{2+} \mid \text{Ca}$
 (C) $\text{Ca} \mid \text{Ca}^{2+} \parallel \text{Ni}^{2+} \mid \text{Ni}$
 (D) $\text{Ca}^{2+} \mid \text{Ca} \parallel \text{Ni}^{2+} \mid \text{Ni}$

Half-Reaction	E° (V)
$\text{Ni}^{2+} + 2e^- \rightarrow \text{Ni}$	-0.257
$\text{Ca}^{2+} + 2e^- \rightarrow \text{Ca}$	-2.868

99) Which of the reactions listed in the table below is non-spontaneous under standard conditions?

- (A) $\text{Ni} + \text{Fe}^{2+} \rightarrow \text{Ni}^{2+} + \text{Fe}$
 (B) $\text{Fe} + 2\text{Cu}^+ \rightarrow \text{Fe}^{2+} + 2\text{Cu}$
 (C) $2\text{Fe}^{3+} + 3\text{Mn} \rightarrow 3\text{Mn}^{2+} + 2\text{Fe}$
 (D) $2\text{Au}^{3+} + 3\text{Cu} \rightarrow 3\text{Cu}^{2+} + 2\text{Au}$

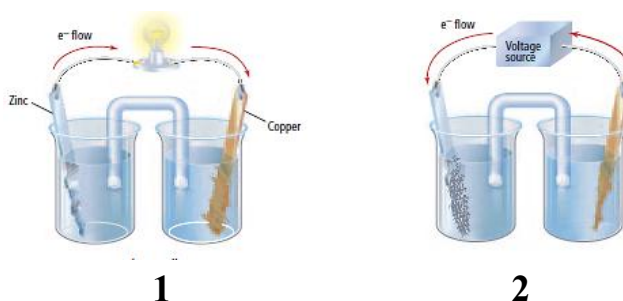
Reaction	E° (V)
$\text{Ni} + \text{Fe}^{2+} \rightarrow \text{Ni}^{2+} + \text{Fe}$	+0.218
$\text{Fe} + 2\text{Cu}^+ \rightarrow \text{Fe}^{2+} + 2\text{Cu}$	+0.96
$2\text{Fe}^{3+} + 3\text{Mn} \rightarrow 3\text{Mn}^{2+} + 2\text{Fe}$	+1.148
$2\text{Au}^{3+} + 3\text{Cu} \rightarrow 3\text{Cu}^{2+} + 2\text{Au}$	+1.16

100) The figure below shows the electroplating of an iron fork with silver in an electrolytic cell. Which of the following statements is correct?

- (A) The fork is the cathode in the cell.
 (B) The fork is the positive electrode in the cell.
 (C) The silver electrode is the cathode.
 (D) The solution is non-Electrolytic



101) Which of the following is correct regarding the two cells shown below?



- (A) Electrons flow spontaneously in cell (1) from the Cu side.
 (B) The spontaneous reaction in cell (1) continues until the Cu electrode is consumed)
 (C) Electrons flow in cell (2) from the Cu side.
 (D) A spontaneous oxidation-reduction reaction occurs in cell (2)

102) A voltaic cell is composed of the half-cells shown in the table below. What is the correct cell notation?

- (A) $\text{Ag} | \text{Ag}^+ || \text{Ni}^{2+} | \text{Ni}$
 (B) $\text{Ag}^+ | \text{Ag} || \text{Ni}^{2+} | \text{Ni}$
 (C) $\text{Ni} | \text{Ni}^{2+} || \text{Ag}^+ | \text{Ag}$
 (D) $\text{Ni}^{2+} | \text{Ni} || \text{Ag}^+ | \text{Ag}$

Half-Reaction	E° (V)
$\text{Ni}^{2+} + 2\text{e}^- \rightarrow \text{Ni}$	-0.2570
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	+0.7996

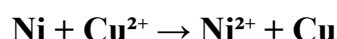
103) Which of the following reactions is non-spontaneous under standard conditions?

	Reaction	E° (V)
(A)	$2\text{Al}^{3+}(\text{aq}) + 3\text{Cu}(\text{s}) \rightarrow 2\text{Al}(\text{s}) + 3\text{Cu}^{2+}(\text{aq})$	-2.004
(B)	$\text{Mg}(\text{s}) + \text{Ni}^{2+}(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{Ni}(\text{s})$	+2.115
(C)	$\text{Sn}(\text{s}) + \text{Pt}^{2+}(\text{aq}) \rightarrow \text{Sn}^{2+}(\text{aq}) + \text{Pt}(\text{s})$	+1.32
(D)	$\text{Sn}(\text{s}) + 2\text{Ag}^+(\text{aq}) \rightarrow \text{Sn}^{2+}(\text{aq}) + 2\text{Ag}(\text{s})$	+0.94

104) In an electrolytic cell when a metal is plated with silver, what happens to Ag^+ ?

- (A) It is oxidized at the anode.
- (B) It is oxidized at the cathode.
- (C) It is reduced at the anode.
- (D) It is reduced at the cathode.

105) The following reaction occurs in a voltaic cell:



Which of the following occurs at the anode?

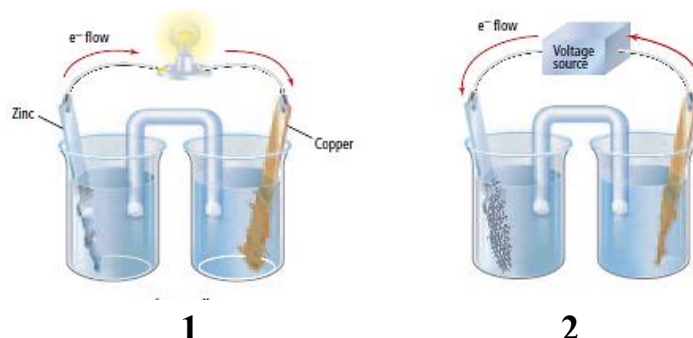
- (A) Reduction of copper ions
- (B) Reduction of nickel ions
- (C) Oxidation of nickel atoms
- (D) Oxidation of copper atoms

106) Using the data in the table below, which ion is the easiest to reduce?

- (A) Fe^{3+}
- (B) Cu^{2+}
- (C) Mg^{2+}
- (D) Ag^+

Half-Reaction	E° (V)
$\text{Fe}^{3+} + 3\text{e}^- \rightarrow \text{Fe}$	-0.037
$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$	+0.3419
$\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$	-2.372
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	+0.7996

107) Which of the following is correct regarding the two cells shown below?



- (A) In cell (1), the anode produces electrons from Zn.
- (B) In cell (1), electrons flow from Cu to Zn.
- (C) In cell (2), the anode produces electrons from Zn.
- (D) In cell (2), electrons flow from Zn to Cu.

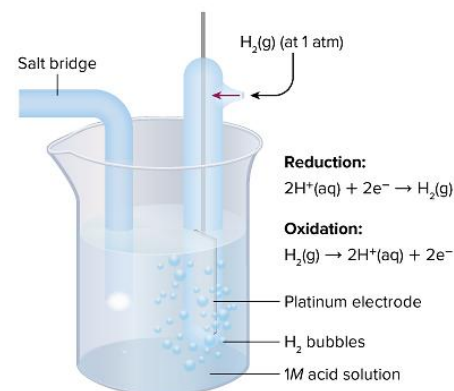
108) What is the standard cell potential (E°_{cell}) for the spontaneous oxidation-reduction reaction that occurs between aluminum and silver?

- (A) +0.8624 V
 (B) -2.4646 V
 (C) +2.4616 V
 (D) -0.8624 V

Half-Reaction	E° (V)
$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	-1.6620
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	+0.7996

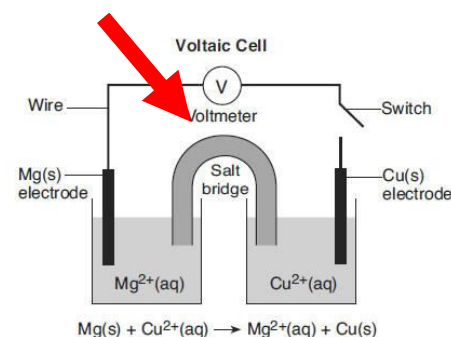
109) When the electrode shown in the adjacent figure is connected to a half-cell consisting of a cadmium electrode (Cd) in a cadmium nitrate solution ($E^\circ = -0.4030$ V), which of the following is correct? (Ministry - Final 2017)

- (A) The mass of the cadmium electrode increases.
 (B) The cadmium electrode acts as a cathode and electrons move towards it.
 (C) The standard hydrogen electrode acts as an anode.
 (D) The cadmium electrode acts as an anode and electrons move away from it.



110) Which of the following is NOT a function of the component indicated by the red arrow in the voltaic cell in the adjacent figure? (Ministry - Final 2017)

- (A) Prevents the mixing of the two solutions.
 (B) Provides a pathway for electron transfer.
 (C) Prevents the accumulation of ions around the electrodes.
 (D) Allows ions to move from one side to the other.



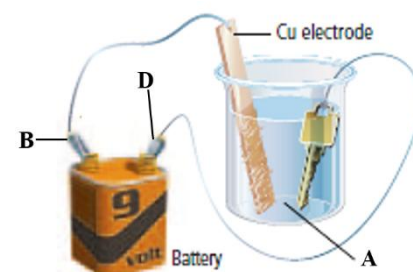
111) What is the cell notation for a voltaic cell composed of a copper electrode and a standard hydrogen electrode? (Ministry - Final 2017)

- (A) $\text{Cu}^{2+} | \text{Cu} || \text{H}^+ | \text{H}_2$
 (B) $\text{H}_2 | \text{H}^+ || \text{Cu}^{2+} | \text{Cu}$
 (C) $\text{Cu} | \text{Cu}^{2+} || \text{H}_2 | \text{H}^+$
 (D) $\text{Cu} | \text{Cu}^{2+} || \text{H}^+ | \text{H}_2$

Half-Reaction	E° (V)
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.3419
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	+0.00

112) In the adjacent figure showing an iron key being electroplated with copper in an electrolytic cell, which of the following is correct? (Ministry - Final 2017)

- (A) (B) acts as a cathode, and (A) is a Cu^{2+} solution.
 (B) (D) acts as a cathode, and Cu atoms are oxidized at it.
 (C) (B) acts as an anode, and (A) is a Cu^{2+} solution.
 (D) (D) acts as a cathode, and (A) is an Fe^{2+} solution.



113) Based on the adjacent standard reduction potential table, which of the following ions is the easiest to reduce? (Ministry - Final 2017)

- (A) Fe^{2+}
(B) Sn^{2+}
(C) Au^{3+}
(D) Hg^{2+}

Half-Reaction	E° (V)
$\text{Fe}^{2+} + 2e^- \rightarrow \text{Fe}$	-0.45
$\text{Sn}^{2+} + 2e^- \rightarrow \text{Sn}$	-0.14
$\text{Hg}^{2+} + 2e^- \rightarrow \text{Hg}$	+0.851
$\text{Au}^{3+} + 3e^- \rightarrow \text{Au}$	+1.49

114) Using the standard reduction potential values (E°) in the table, which of the following metals is the easiest to oxidize? (Board - Training 2017)

- (A) Pt
(B) Co
(C) Cr
(D) Mn

Half-Reaction	E° (V)
$\text{Pt}^{2+} + 2e^- \rightarrow \text{Pt}$	+1.18
$\text{Co}^{2+} + 2e^- \rightarrow \text{Co}$	-0.28
$\text{Cr}^{3+} + 3e^- \rightarrow \text{Cr}$	-0.744
$\text{Mn}^{2+} + 2e^- \rightarrow \text{Mn}$	-1.185

115) Which of the following represents the correct cell notation for a voltaic cell? (Board - Training 2017)

- (A) $\text{Cr} \mid \text{Cr}^{3+} \parallel \text{Co}^{2+} \mid \text{Co}$
(B) $\text{Co} \mid \text{Co}^{2+} \parallel \text{Mn}^{2+} \mid \text{Mn}$
(C) $\text{Pt} \mid \text{Pt}^{2+} \parallel \text{Cr}^{3+} \mid \text{Cr}$
(D) $\text{Mn} \mid \text{Mn}^{2+} \parallel \text{Co}^{2+} \mid \text{Co}$

116) A voltaic cell is represented by the cell notation: $\text{Zn} \mid \text{Zn}^{2+} \parallel \text{Cu}^{2+} \mid \text{Cu}$. Which of the following occurs? (Board - Final 2017)

- (A) Oxidation of copper ions.
(B) Oxidation of zinc ions.
(C) Oxidation of the copper electrode.
(D) Oxidation of the zinc electrode.

117) Which of the following indicates the direction and medium for electron transfer in a voltaic cell? (Final 2015)

- (A) From the anode to the cathode through the external wire.
(B) From the anode to the cathode through the salt bridge.
(C) From the cathode to the anode through the external wire.
(D) From the cathode to the anode through the salt bridge.

- 118)** What conductor is used to make an electrical connection with a non-metallic (ionic) part in an electrochemical cell circuit? (Final 2015)
- (A) Salt bridge
 - (B) Electrode
 - (C) External wire
 - (D) Electrolyte solution
- 119)** Which of the following represents a correct half-cell? (Training 2014)
- (A) $\text{NaNO}_3 / \text{Zn}$
 - (B) $\text{CuSO}_4 / \text{Cu}$
 - (C) $\text{AgNO}_3 / \text{Ag}^+$
 - (D) $\text{CuSO}_4 / \text{CuB}$
- 120)** What electrodes make up a cell with $E^\circ = 0.05 \text{ V}$? (Training 2014)
- $(\text{Ag}^+ = +0.80 \text{ V}), (\text{Hg}_2^{2+} = +0.85 \text{ V}), (\text{Cu}^{2+} = +0.34 \text{ V}), (\text{Mg}^{2+} = -2.37 \text{ V})$
- (A) Ag & Cu
 - (B) Mg & Cu
 - (C) Hg & Ag
 - (D) Hg & Mg
- 121)** Which of the following represents the half-cell reaction for a cell composed of magnesium and copper?
- $(E^\circ \text{ Cu}^{2+} = 0.34 \text{ V}, E^\circ \text{ Mg}^{2+} = -2.37 \text{ V})$ (Training 2014)
- (A) $\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$
 - (B) $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$
 - (C) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$
 - (D) $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
- 122)** What type of energy is released when electrons move between two connected materials in an oxidation-reduction reaction? (Training 2013)
- (A) Light
 - (B) Heat
 - (C) Kinetic
 - (D) Light and kinetic

123) Which of the following electrolytes is used in the electroplating of an iron ring with silver?

- (A) FeSO_4
- (B) $\text{Fe}(\text{NO}_3)_2$
- (C) AgNO_3
- (D) HNO_3

124) Which of the following is NOT a function of the salt bridge or porous barrier? (Training 2013)

- (A) Allows ion movement in the solution.
- (B) Prevents charge buildup at the electrodes.
- (C) Converts thermal energy to electrical energy.
- (D) Allows free movement of electrons in the solution.

125) Electrons cannot flow in a voltaic cell if the half-cells are: (Postponed 2012)

- (A) Made of different materials.
- (B) Isolated from each other.
- (C) Connected by a porous barrier.
- (D) Have different reduction potentials.

126) Which of the following is NOT a function of the salt bridge? (Training 2012)

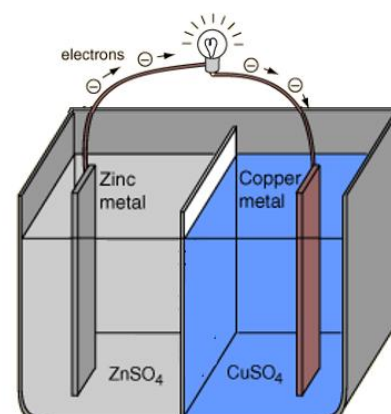
- (A) Allows electron flow in the cell.
- (B) Allows ion flow between the half-cells.
- (C) Prevents mixing between the metal atoms of the half-cell and other ions.
- (D) Maintains ionic balance between the half-cells.

127) If a metal (X) reacts with HCl acid according to the equation $\text{X} + 2\text{HCl} \rightarrow \text{XCl}_2 + \text{H}_2$, what is the reduction potential of metal (X)? (Training 2011)

- (A) Greater than zero
- (B) Less than zero
- (C) Equal to zero
- (D) Cannot be determined

128) In the cell shown in the adjacent figure: (Training 2011)

- (A) Zinc cations move towards the copper half-cell.
- (B) Zinc cations move towards the zinc electrode.
- (C) Copper cations move towards the zinc half-cell.
- (D) Sulfate ions move towards the copper half-cell.



129) In a voltaic cell where the reaction $3\text{Ni}^{2+} + 2\text{Cr} \rightarrow 3\text{Ni} + 2\text{Cr}^{3+}$ occurs, what happens?

(Postponed 2011)

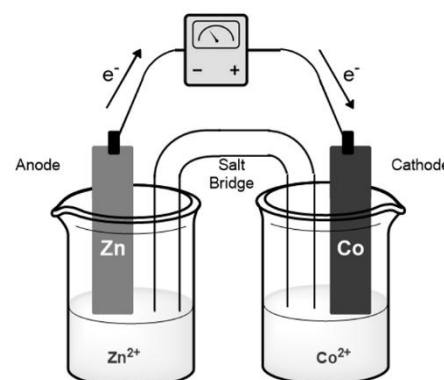
- (A) A decrease in the concentration of chromium ions.
- (B) Oxidation of the nickel electrode.
- (C) Reduction of nickel ions.
- (D) Reduction of the chromium electrode.

130) A voltaic cell is composed of two half-cells, one Co/Co^{2+} and the other Cu/Cu^{2+} . The reduction potential of Co^{2+} is -0.28 V , and the reduction potential of Cu^{2+} is 0.34 V . What happens? (Final 2011)

- (A) Oxidation of the cobalt electrode.
- (B) Oxidation of the copper electrode.
- (C) Oxidation of cobalt ions.
- (D) Reduction of the copper electrode.

131) The figure below represents an electrochemical cell. Which of the following describes the direction of Co^{2+} ion movement and the change in the mass of the zinc plate? (Final 2009)

	Change in Zn mass	Direction of Co^{2+} ions
(A)	Increases	Move towards the Co electrode
(B)	Decreases	Move towards the Co electrode
(C)	Increases	Move towards the Zn electrode
(D)	Decreases	Move towards the Zn electrode



132) Calculate E° for the spontaneous reaction when the following half-cells are connected:

Hg^{2+}/Hg ($+0.85\text{ V}$) and Ag^+/Ag ($+0.80\text{ V}$)

Which metal is produced? (Training 2009)

- (A) Hg ($+0.05\text{ V}$)
- (B) Ag ($+0.05\text{ V}$)
- (C) Hg ($+1.65\text{ V}$)
- (D) Ag ($+1.65\text{ V}$)

133) In the electroplating of a copper bracelet with silver, what is the appropriate electrolyte? (Final 2008)

- (A) CuSO_4
- (B) $\text{Cu}(\text{NO}_3)_2$
- (C) AgNO_3
- (D) H_2SO_4

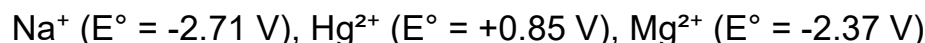
Rank the following elements in descending order according to their strength as reducing agents:
 Ag ($E^\circ = +0.80 \text{ V}$), Pb ($E^\circ = -0.13 \text{ V}$), Cu ($E^\circ = +0.34 \text{ V}$)

A stronger reducing agent has a **more negative** standard reduction potential (E°).

- Pb ($E^\circ = -0.13 \text{ V}$)
- Cu ($E^\circ = +0.34 \text{ V}$)
- Ag ($E^\circ = +0.80 \text{ V}$)

Ranking (strongest to weakest reducing agent): $\text{Pb} > \text{Cu} > \text{Ag}$

Rank the following elements in ascending order according to their strength as oxidizing agents:

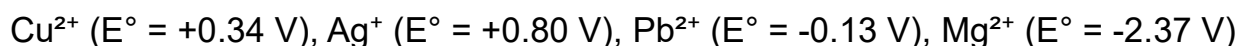


A stronger oxidizing agent has a **more positive** standard reduction potential (E°).

- Na^+ ($E^\circ = -2.71 \text{ V}$)
- Mg^{2+} ($E^\circ = -2.37 \text{ V}$)
- Hg^{2+} ($E^\circ = +0.85 \text{ V}$)

Ranking (weakest to strongest oxidizing agent): $\text{Na}^+ < \text{Mg}^{2+} < \text{Hg}^{2+}$

Rank the following ions in ascending order according to their strength as oxidizing agents, given the following standard reduction potentials:



A stronger oxidizing agent has a **more positive** standard reduction potential (E°).

- Mg^{2+} ($E^\circ = -2.37 \text{ V}$)
- Pb^{2+} ($E^\circ = -0.13 \text{ V}$)
- Cu^{2+} ($E^\circ = +0.34 \text{ V}$)
- Ag^+ ($E^\circ = +0.80 \text{ V}$)

Ranking (weakest to strongest oxidizing agent): $\text{Mg}^{2+} < \text{Pb}^{2+} < \text{Cu}^{2+} < \text{Ag}^+$

Rank the following cations in ascending order according to their ease of reduction:

Reduction Potentials:

Mg^{2+} : -2.37 V

Pb^{2+} : -0.13 V

Cu^{2+} : $+0.34 \text{ V}$

H^+ : 0.00 V

A cation with a **higher** standard reduction potential (E°) is more easily reduced.

- Mg^{2+} ($E^\circ = -2.37 \text{ V}$)
- Pb^{2+} ($E^\circ = -0.13 \text{ V}$)
- H^+ ($E^\circ = 0.00 \text{ V}$)
- Cu^{2+} ($E^\circ = +0.34 \text{ V}$)

Ranking (hardest to easiest reduction): $\text{Mg}^{2+} < \text{Pb}^{2+} < \text{H}^+ < \text{Cu}^{2+}$

Rank the following ions in ascending order according to their ease of oxidation:

Ag, Ca, Fe

Reduction Potentials:

Ag: +0.8 V

Ca: -2.76 V

Fe: -0.41 V

The **stronger reducing agent** (i.e., the element with the **more negative E°**) is more easily oxidized.

- Ag ($E^\circ = +0.80$ V)
- Fe ($E^\circ = -0.41$ V)
- Ca ($E^\circ = -2.76$ V)

Ranking (hardest to easiest oxidation): Ag < Fe < Ca

Rank the following cells in ascending order according to their cell potential:

Al(s)|Al³⁺(aq)||Zn²⁺(aq)|Zn(s)

2Al(s)|2Al³⁺(aq)||6H⁺(aq)|3H₂(g)

Zn(s)|Zn²⁺(aq)||2Ag⁺(aq)|2Ag(s)

2H₂(g)|2H⁺(aq)||2Ag⁺(aq)|2Ag(s)

Element	Reduction Potentials
Al ³⁺	-1.66 V
Ag ⁺	+0.80 V
Cu ²⁺	+0.34 V
Zn ²⁺	-0.76 V

The cell potential (E°_{cell}) is given by:

$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$$

Cell	Cell potential E°_{cell}
1 Al(s) Al ³⁺ (aq) Zn ²⁺ (aq) Zn(s)	$(-0.76) - (-1.66) = 0.90$ V
2 2Al(s) 2Al ³⁺ (aq) 6H ⁺ (aq) 3H ₂ (g)	$(0.00) - (-1.66) = 1.66$ V
3 Zn(s) Zn ²⁺ (aq) 2Ag ⁺ (aq) 2Ag(s)	$(0.80) - (-0.76) = 1.56$ V
4 2H ₂ (g) 2H ⁺ (aq) 2Ag ⁺ (aq) 2Ag(s)	$(0.80) - (0.00) = 0.80$ V

Ranking (ascending order of cell potential): Cell 4 (0.80V) < Cell 1 (0.90V) < Cell 3 (1.56V) < Cell 2 (1.66V)

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