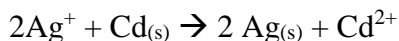


AP Chemistry: Electrochemistry

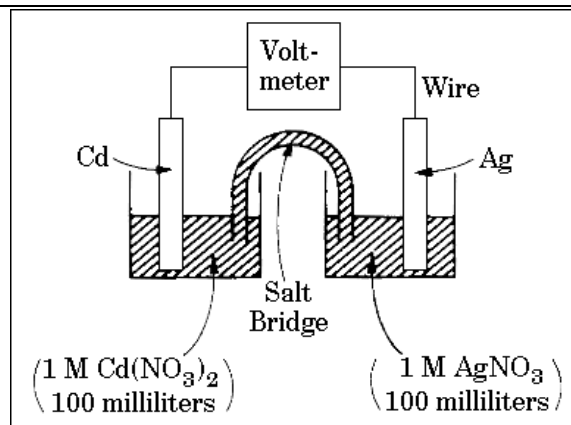
Multiple Choice

14. Questions 14-17

The spontaneous reaction that occurs when the cell in the picture operates is as follows:

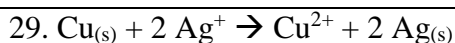


- (A) Voltage increases.
 (B) Voltage decreases but remains > zero.
 (C) Voltage becomes zero and remains at zero.
 (D) No change in voltage occurs.
 (E) Direction of voltage change cannot be predicted without additional information.



Which of the above occurs for each of the following circumstances?

14. A 50-milliliter sample of a 2-molar Cd(NO₃)₂ solution is added to the left beaker.
 15. The silver electrode is made larger.
 16. The salt bridge is replaced by a platinum wire.
 17. Current is allowed to flow for 5 minutes.



If the equilibrium constant for the reaction above is 3.7×10^{15} , which of the following correctly describes the standard voltage, E° , and the standard free energy change, ΔG° , for this reaction?

- (A) E° is positive and ΔG° is negative. (B) E° is negative and ΔG° is positive.
 (C) E° and ΔG° are both positive. (D) E° and ΔG° are both negative.
 (E) E° and ΔG° are both zero

46. If 0.060 faradays are passed through an electrolytic cell containing a solution of In³⁺ ions, the maximum number of moles of In that could be deposited at the cathode is...

- (A) 0.010 mole (B) 0.020 mole (C) 0.030 mole (D) 0.060 mole (E) 0.18 mole

75. If a copper sample containing some zinc impurity is to be purified by electrolysis, the anode and the cathode must be which of the following?

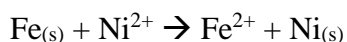
	Anode	Cathode
(A)	Pure copper	Pure zinc
(B)	Pure zinc	Pure copper
(C)	Pure copper	Impure copper sample
(D)	Impure copper sample	Pure copper
(E)	Impure copper sample	Pure zinc

$\text{Fe}^{2+} + 2\text{e}^- \rightarrow \text{Fe}_{(\text{s})}$	$E^\circ = -0.44 \text{ volt}$
$\text{Ni}^{2+} + 2\text{e}^- \rightarrow \text{Ni}_{(\text{s})}$	$E^\circ = -0.23 \text{ volt}$

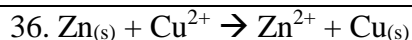
60. The standard reduction potentials for two half reactions are given above. The Nernst equation for a galvanic cell at 25° C in which $\text{Fe}_{(\text{s})}$ reduces Ni^{2+} is the following:

$$E = E^\circ - 0.059/2 \log [\text{Fe}^{2+}] / [\text{Ni}^{2+}]$$

What is the equilibrium constant for the reaction below?



- (A) 1.9×10^{-23} (B) 7.6×10^{-8} (C) $3.6 \times 10^{+3}$ (D) $1.3 \times 10^{+7}$ (E) $5.2 \times 10^{+22}$



An electrolytic cell based on the reaction represented above was constructed from zinc and copper half-cells. The observed voltage was found to be 1.00 volt instead of the standard cell potential, E° , of 1.10 volts. Which of the following could correctly account for this observation?

- (A) The copper electrode was larger than the zinc electrode.
 (B) The Zn^{2+} electrolyte was $\text{Zn}(\text{NO}_3)_2$, while the Cu^{2+} electrolyte was CuSO_4 .
 (C) The Zn^{2+} solution was more concentrated than the Cu^{2+} solution.
 (D) The solutions in the half-cells had different volumes.
 (E) The salt bridge contained KCl as the electrolyte.

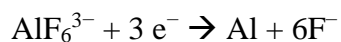
63. Which of the following expressions is correct for the maximum mass of copper, in grams, that could be plated out by electrolyzing aqueous CuCl_2 for 16 hours at a constant current of 3.0 amperes? (1 faraday = 96,500 coulombs)

- (A) $[(16)(3,600)(3.0)(63.55)(2)] / (96,500)$
 (B) $[(16)(3,600)(3.0)(63.55)] / [(96,500)(2)]$
 (C) $[(16)(3,600)(3.0)(63.55)] / (96,500)$
 (D) $[(16)(60)(3.0)(96,500)(2)] / (63.55)$
 (E) $[(16)(60)(3.0)(96,500)] / [(63.55)(2)]$

75. A direct-current power supply of low voltage (less than 10 volts) has lost the markings that indicate which output terminal is positive and which is negative. A chemist suggests that the power supply terminals be connected to a pair of platinum electrodes that dip into 0.1-molar KI solution. Which of the following correctly identifies the polarities of the power supply terminals?

- (A) A gas will be evolved only at the positive electrode.
 (B) A gas will be evolved only at the negative electrode.
 (C) A brown color will appear in the solution near the negative electrode.
 (D) A metal will be deposited on the positive electrode.
 (E) None of the methods above will identify the polarities of the power supply terminals.

Questions 34-35 refer to an electrolytic cell that involves the following half-reaction:

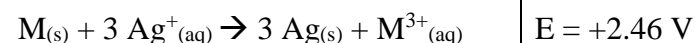
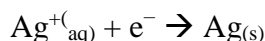


34. Which of the following occurs in the reaction?

- (A) AlF_6^{3-} is reduced at the cathode.
- (B) Al is oxidized at the anode.
- (C) Aluminum is converted from the -3 oxidation state to the 0 oxidation state.
- (D) F^- acts as a reducing agent.
- (E) F^- is reduced at the cathode.

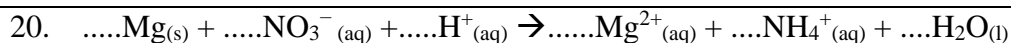
35. As steady current of 10 amperes is passed through an aluminum-production cell for 15 minutes. Which of the following is the correct expression for calculating the number of grams of aluminum produced? (1 faraday = 96,500 coulombs)

- (A) $\frac{(10)(15)(96,500)}{(27)(60)} \text{ g}$
- (B) $\frac{(10)(15)(27)}{(60)(96,500)} \text{ g}$
- (C) $\frac{(10)(15)(60)(27)}{(96,500)(3)} \text{ g}$
- (D) $\frac{(96,500)(27)}{(10)(15)(60)(3)} \text{ g}$
- (E) $\frac{(27)(3)}{(96,500)(10)(15)(60)} \text{ g}$

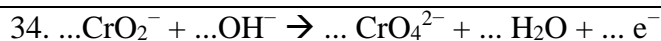
57. According to the information above, what is the standard reduction potential for the half-reaction $\text{M}^{3+}_{(\text{aq})} + 3 \text{e}^- \rightarrow \text{M}_{(\text{s})}$?

- (A) -1.66 V (B) -0.06 V (C) 0.06 V (D) 1.66 V (E) 3.26 V



When the skeleton equation above is balanced and all coefficients reduced to their lowest whole-number terms, what is the coefficient for H^+ ?

- (A) 4 (B) 6 (C) 8 (D) 9 (E) 10



When the equation for the half-reaction above is balanced, what is the ratio of the coefficients $\text{OH}^- / \text{CrO}_2^-$?

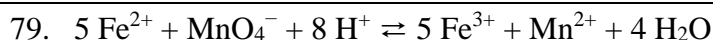
- (A) 1:1 (B) 2:1 (C) 3:1 (D) 4:1 (E) 5:1

61. When a solution of potassium dichromate is added to an acidified solution of iron (II) sulfate, the products of the reaction are...

- (A) $\text{FeCr}_2\text{O}_7(\text{s})$ and H_2O (B) $\text{FeCrO}_4(\text{s})$ and H_2O (C) Fe^{3+} , CrO_4^{2-} , and H_2O
(D) Fe^{3+} , Cr^{3+} , and H_2O (E) $\text{Fe}_2(\text{SO}_4)_3(\text{s})$, Cr^{3+} and H_2O

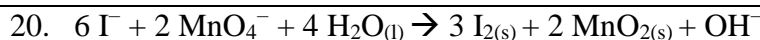
65. Which of the following species CANNOT function as an oxidizing agent?

- (A) $\text{Cr}_2\text{O}_7^{2-}$ (B) MnO_4^- (C) NO_3^- (D) S (E) I^-



In a titration experiment based on the equation above, 25.0 milliliters of an acidified Fe^{2+} solution requires 14.0 milliliters of standard 0.050-molar MnO_4^- solution to reach the equivalence point. The concentration of Fe^{2+} in the original solution is...

- (A) 0.0010 M (B) 0.0056 M (C) 0.028 M (D) 0.090 M (E) 0.14 M



Which of the following statements regarding the reaction represented by the equation above is correct?

- (A) Iodide ion is oxidized by hydroxide ion.
(B) MnO_4^- is oxidized by iodide ion.
(C) The oxidation number of manganese changes from +7 to +2.
(D) The oxidation number of manganese remains the same.
(E) The oxidation number of iodine changes from -1 to 0.

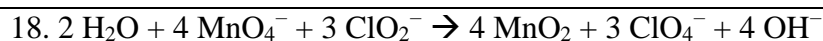


When the equation for the half reaction above is balanced with the lowest whole-number coefficients, the coefficient for H_2O is...

- (A) 2 (B) 4 (C) 6 (D) 7 (E) 14

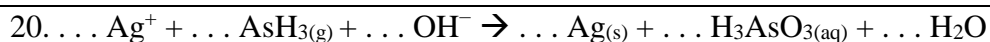
61. When acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution is added to Na_2S solution, green Cr^{3+} ions and free S are formed. When acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution is added to NaCl , no change occurs. Of the substances involved in these reactions, which is the best reducing agent?

- (A) $\text{K}_2\text{Cr}_2\text{O}_7$ (B) Na_2S (C) Cr^{3+} (D) S (E) NaCl



Which species acts as an oxidizing agent in the reaction represented above?

- (A) H_2O (B) ClO_4^- (C) ClO_2^- (D) MnO_2 (E) MnO_4^-



When the equation above is balanced with lowest whole-number coefficients, the coefficient for OH^- is...

- (A) 2 (B) 4 (C) 5 (D) 6 (E) 7

29. When an aqueous solution of NaOH is added to an aqueous solution of potassium dichromate, $\text{K}_2\text{Cr}_2\text{O}_7$ the dichromate ion is converted to...

- (A) CrO_4^{2-} (B) CrO_2 (C) Cr^{3+} (D) $\text{Cr}_2\text{O}_3(\text{s})$ (E) $\text{Cr}(\text{OH})_3(\text{s})$

71 ... $\text{Fe}(\text{OH})_2 + \dots \text{O}_2 + \dots \text{H}_2\text{O} \rightarrow \dots \text{Fe}(\text{OH})_3$

If 1 mole of O_2 oxidizes $\text{Fe}(\text{OH})_2$ according to the reaction represented above, how many moles of $\text{Fe}(\text{OH})_3$ can be formed?

- (A) 2 (B) 3 (C) 4 (D) 5 (E) 6

20. What mass of Au is produced when 0.0500 mol of Au_2S_3 is reduced completely with excess H_2 ?

- (A) 9.85 g (B) 19.7 g (C) 24.5 g (D) 39.4 g (E) 48.9 g

42. ... $\text{Li}_3\text{N}(\text{s}) + \dots \text{H}_2\text{O}(\text{l}) \rightarrow \dots \text{Li}^+(\text{aq}) + \dots \text{OH}^-(\text{aq}) + \dots \text{NH}_3(\text{g})$

When the equation above is balanced and all coefficients reduced to lowest whole number terms, the coefficient for $\text{OH}^-(\text{aq})$ is...

- (A) 1 (B) 2 (C) 3 (D) 4 (E) 6



30. Which of the following is true regarding the reaction represented above?

- (A) The oxidation number of O does not change.
(B) The oxidation number of H changes from -1 to $+1$.
(C) The oxidation number of F changes from $+1$ to -1 .
(D) The oxidation number of Se changes from -2 to $+6$.
(E) It is a disproportionation reaction for F.

71. In the electroplating of nickel, 0.200 faraday of electrical charge is passed through a solution of NiSO_4 . What mass of nickel is deposited?

- (A) 2.94 g (B) 5.86 g (C) 11.7 g (D) 58.7 g (E) 294 g

19. In which of the following species does sulfur have the same oxidation number as it does in H_2SO_4 ?

- (A) H_2SO_3 (B) $\text{S}_2\text{O}_3^{2-}$ (C) S^{2-} (D) S_8 (E) SO_2Cl_2