Here is the discharge reaction for an alkaline battery:

\[
\text{Ni} + \text{H}_2 \text{O} + 2\text{e}^- \rightarrow \text{Ni(OH)}_2 + \text{H}^+ + \text{OH}^-
\]

The standard voltage of the cell:

\[
E^\circ = \frac{1}{2} (E_{\text{Ni}^2+/\text{Ni}} + E_{\text{OH}^-/\text{H}_2\text{O}}) = \frac{1}{2} (0.298 \text{ V} + 0.879 \text{ V}) = 0.578 \text{ V}
\]

Consider 3 electrolysis experiments:

1. When the following reactions occur at an electrode:
   - The electrolysis of an aqueous sodium chloride solution using inert electrodes produces gaseous chlorine at one electrode. At the other electrode gaseous hydrogen is produced.
   - The equilibrium constant for the reaction below:
     \[
     2\text{H}_2\text{O} \rightleftharpoons \text{O}_2 + 4\text{H}^+ + 4\text{e}^-; K = \text{?}
     \]
   - Calculate the cell potential for a cell based on the reaction below:
     \[
     \text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; E^\circ = \text{?}
     \]

2. The reaction producing the smallest mass of metal is that of the silver solution.

3. The reduction potential for \( \text{Ag}^+ / \text{Ag} \) is +0.22 V at 25°C. Calculate the equilibrium constant for the cell reaction:

4. You turn on a flashlight containing brand new NiCad batteries and keep it lit for a minute. The temperature is 25°C and \( E^\circ = 0.4624 \text{ V} \).

5. Consider the cell:

\[
\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}; E^\circ = \text{?}
\]

What is the unknown concentration for the following cell:

\[
\text{Al} + \text{Cu}^{2+} \rightarrow \text{Cu} + \text{Al}^{3+}; E^\circ = \text{?}
\]

6. What is the standard reduction potentials established by comparison to the potential of which half-reaction?

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; E^\circ = \text{?}
\]

7. Identify A and write the half-reaction that occurs in that compartment.

8. The batteries are at equilibrium.

9. If \( E^\circ \) for the cell is 0.36 V at 25°C, write the Nernst equation for the cell at this temperature when current is drawn from this cell.

10. Considering the cell:

\[
\frac{\text{Ni}^{2+} + 2\text{e}^-}{\text{MnO}}
\]

What would be the \( E^\circ \) of an electrolytic cell made from the half-reactions below?

\[
\text{AgCl(s)} + \text{e}^- \rightarrow \text{Ag} + \text{Cl}^-; E^\circ = \text{?}
\]

11. Each of the following species is reduced as the battery is discharged.

\[
\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}; E^\circ = \text{?}
\]

12. What is the operation of the cell?

\[
\text{Ni} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Ni(OH)}_2 + \text{H}^+ + \text{OH}^-
\]

13. Consider the cell:

\[
\text{Ni} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Ni(OH)}_2 + \text{H}^+ + \text{OH}^-
\]

What is the cathode half-reaction in the electrolytic cell?

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; E^\circ = \text{?}
\]

14. If a reaction has a free energy change of \( -20 \text{ kJ/mol} \) at 25°C, which of the following is its equilibrium constant?

\[
K = e^{-\Delta G/RT}
\]

15. What would be the free energy change for the reaction below?

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; \Delta G = \text{?}
\]

16. The reaction producing the smallest mass of metal is that of the silver solution.

17. If 2.90 \times 10^{-8} \text{ C} of charge were used, what was the original oxidation number of V?

\[
\text{V}^{3+} + 2\text{e}^- \rightarrow \text{V}^{2+}; E^\circ = \text{?}
\]

18. It is impossible to know without testing it empirically.

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; E^\circ = \text{?}
\]

19. The reaction producing the smallest mass of metal is that of the silver solution.

20. The equilibrium constant for the reaction below:

\[
2\text{H}_2\text{O} \rightleftharpoons \text{O}_2 + 4\text{H}^+ + 4\text{e}^-; K = \text{?}
\]

21. It physically separates the half-reactions.

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; E^\circ = \text{?}
\]

22. These half-reactions?

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; E^\circ = \text{?}
\]

23. Does \( \text{Cl}_2 \) react with \( \text{Na} \) under the operation of the cell?

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; E^\circ = \text{?}
\]

24. The reaction producing the smallest mass of metal is that of the silver solution.

25. The reaction producing the smallest mass of metal is that of the silver solution.

26. The reaction producing the smallest mass of metal is that of the silver solution.

27. For the reduction of \( \text{Cu}^2+ \) by \( \text{Zn} \),

\[
\text{Cu}^2+ + 2\text{e}^- \rightarrow \text{Cu}; E^\circ = \text{?}
\]

28. What is the operation of the cell?

\[
\text{Ni} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Ni(OH)}_2 + \text{H}^+ + \text{OH}^-
\]

29. Identify A and write the half-reaction that occurs in that compartment.

30. Consider the cell:

\[
\text{Al(s)} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Al(OH)}_2 + \text{H}^+ + \text{OH}^-
\]

What is the cathode half-reaction in the electrolytic cell?

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; E^\circ = \text{?}
\]

31. If a reaction has a free energy change of \( -20 \text{ kJ/mol} \) at 25°C, which of the following is its equilibrium constant?

\[
K = e^{-\Delta G/RT}
\]

32. What would be the free energy change for the reaction below?

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; \Delta G = \text{?}
\]

33. The reaction producing the smallest mass of metal is that of the silver solution.

34. The reaction producing the smallest mass of metal is that of the silver solution.

35. The reaction producing the smallest mass of metal is that of the silver solution.

36. The reaction producing the smallest mass of metal is that of the silver solution.

37. For the reaction producing the smallest mass of metal is that of the silver solution.

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; E^\circ = \text{?}
\]

38. What is the operation of the cell?

\[
\text{Ni} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Ni(OH)}_2 + \text{H}^+ + \text{OH}^-
\]

39. Identify A and write the half-reaction that occurs in that compartment.

40. Consider the cell:

\[
\text{Al(s)} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Al(OH)}_2 + \text{H}^+ + \text{OH}^-
\]

What is the cathode half-reaction in the electrolytic cell?

\[
\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-; E^\circ = \text{?}
\]

41. The reaction producing the smallest mass of metal is that of the silver solution.

42. The reaction producing the smallest mass of metal is that of the silver solution.

43. The reaction producing the smallest mass of metal is that of the silver solution.

44. The reaction producing the smallest mass of metal is that of the silver solution.

45. Which species is reduced as the battery is discharged?

\[
\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}; E^\circ = \text{?}
\]

46. An unknown species is reduced as the battery is discharged.

\[
\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}; E^\circ = \text{?}
\]

47. The reaction producing the smallest mass of metal is that of the silver solution.

48. The reaction producing the smallest mass of metal is that of the silver solution.

49. The reaction producing the smallest mass of metal is that of the silver solution.

50. The reaction producing the smallest mass of metal is that of the silver solution.