Electrolytic Cells Review Key **Honors Chemistry**

An Ox red cat

1. An electric current can be used to cause a redox reaction to occur. Such a process is called electrolysis. In an electrolytic cell, oxidation occurs at the anode and reduction occurs at the cathode. In an electrolytic cell the anode is the + terminal while the cathode is the − terminal. The cathode can always be identified because it is connected to the negative of the battery.

ELECTROLYSIS OF FUSED (MELTED) SALT

2. Write the equation for the electrolysis of fused (melted) sodium chloride.

$$2NaCl(\ell) \rightarrow 2Na(s) + Cl_2(g)$$

3. Which substance is oxidized? Cl^- Which substance is reduced? Na^+

4. Write the equation for the anode half-reaction. $2Cl^-(\ell) \rightarrow Cl_2(g) + 2e^-$

5. Write the equation for the cathode half-reaction. $Na^+(\ell) + e^- \rightarrow Na(s)$

6. What observation would support the product formed at the anode?

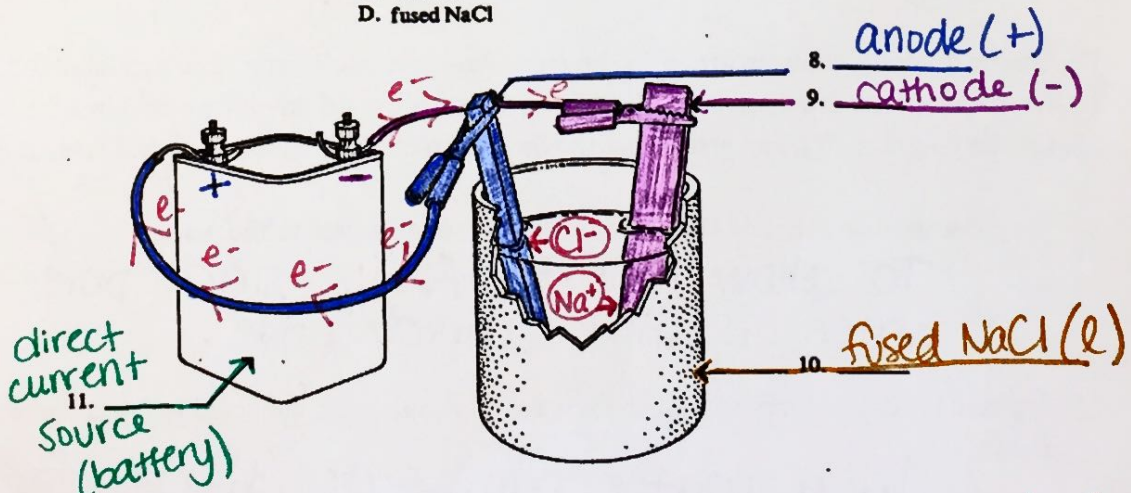
Gas bubbles due to formation of $Cl_2(g)$

7. Is this reaction endothermic or exothermic? endothermic – requires energy input from battery

The following diagram shows an apparatus that can be used to electrolyze fused sodium chloride. On each numbered line in the diagram, write the letter of the appropriate label from the list below.

Labels

A. anode
B. direct current source
C. cathode
D. fused NaCl



12. On the diagram, draw an arrow to show the direction of the electron flow and label it e. anode → cathode
13. Draw an arrow that shows the direction of the anion flow and label it Cl^-. towards anode
14. Draw and arrow that shows the direction of cation flow and label it Na^+. towards cathode

ELECTROLYSIS OF WATER

15. Write the equation for the electrolysis of water.

$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

16. Is the reaction endothermic or exothermic? endothermic

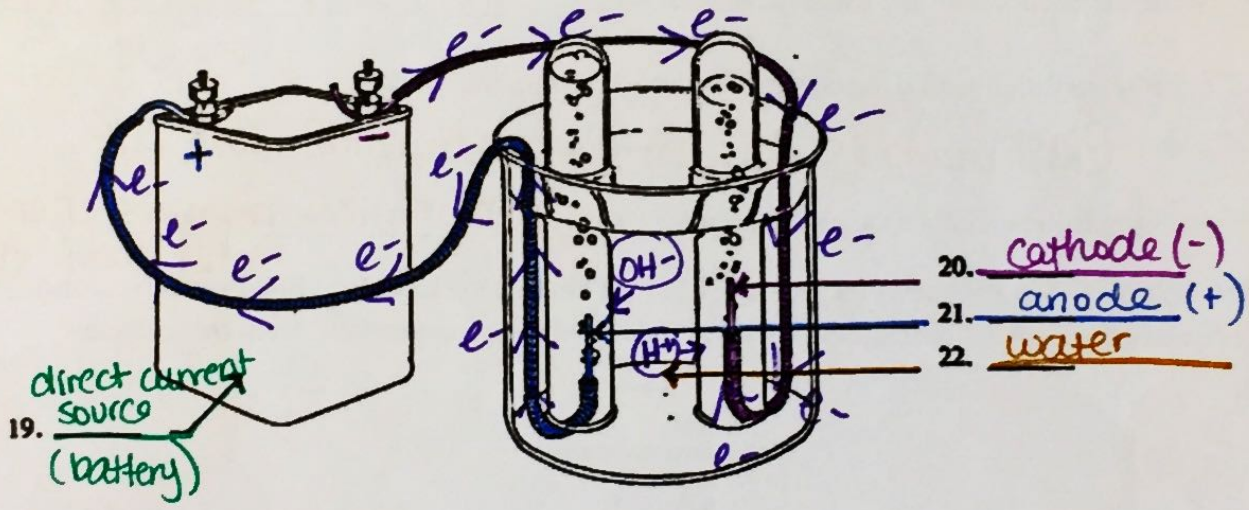
17. Write the equation for the anode half reaction. $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$

18. Write the equation for the cathode half reaction. $4H_2O(l) + 4e^- \rightarrow 2H_2(g) + 4OH^-(aq)$

The apparatus in the following diagram is used for the electrolysis of water. On each numbered line, write the letter of the appropriate label from the list below.

Labels

A. anode
B. cathode
C. direct current source
D. water



19. On the diagram, draw an arrow to show the direction of electron flow and label it e. anode → cathode
20. On the diagram, draw an arrow that shows the direction of anion flow and label it OH^-. towards anode
21. On the diagram, draw an arrow that shows the direction of cation flow and label it H^+. towards cathode

22. Why is a small amount of H_2SO_4 or other electrolyte added to the water?

To allow ions to flow, since pure water is not conductive.

23. Explain, in terms of moles, why there is twice as much gas collected at the cathode than at the anode.

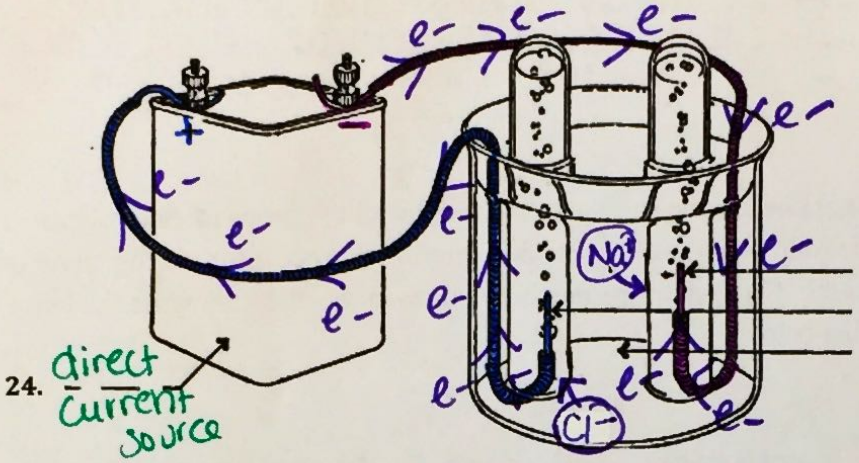
In a water molecule (H_2O), for every 1 mol of O, there are 2 moles of H.

ELECTROLYSIS OF BRINE (SALT WATER)

The apparatus in the following diagram can be used for the electrolysis of a solution of sodium chloride. On each numbered line, write the letter of the appropriate label from the list below.

Labels

A. direct current source **B. anode** **C. cathode** **D. ions in solution**



24. direct current source
25. cathode (-)
26. anode (+)
27. ions in solution

28. On the diagram, draw an arrow that shows the direction of electron flow and label it e. anode → cathode
29. On the diagram, draw an arrow that shows the direction of the anion flow and label it Cl^-. towards anode
30. On the diagram, draw an arrow that shows the direction of the cation flow and label it Na^+. towards cathode

31. In the electrolysis of a saltwater solution, there is a competition at the cathode because there is both Na^+ and H_2O present. Which chemical is more likely to be reduced? How do you know?

H_2O – has a higher E° value.
(can use yellow table for reduction only!
↳ higher up = will be reduced)

32. Write the equation for the half reaction that occurs at the cathode.

look on yellow table! $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$

33. In the electrolysis of a saltwater solution, there is a competition at the anode because there is both Cl^- and H_2O present. Which chemical is more likely to be oxidized? How do you know?

Cl^- because it has a strong – charge.
(can't use yellow table to figure out what will be oxidized. Just need to remember.

34. Write the equation for the half reaction that occurs at the anode.

on yellow table. Just reverse since ox.! $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

35. Write the full equation for the reaction that occurs.

$2H_2O(\ell) + 2Cl^-(aq) \rightarrow H_2(g) + Cl_2(g) + 2OH^-(aq)$ ← makes the solution basic.

As the electrolysis of sodium chloride solution proceeds, how do the quantities listed change?
To complete the table, write: I – for increases D – for decreases R – for remains the same.
Then provide a reason for each answer.

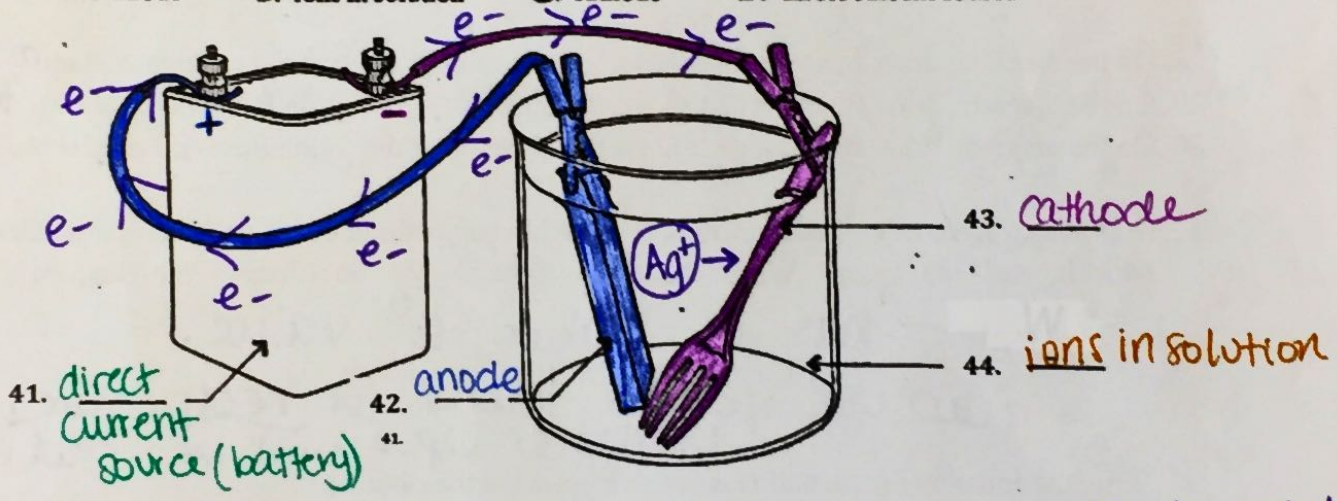
	Quantity	*Change*	*Reason*
37.	Na^+	R	Na^+ is neither oxidized nor reduced.
38.	Cl^-	D	Cl^- is oxidized to form Cl_2 (g) @ anode.
39.	OH^-	I	OH^- is a production of the reduction of H_2O @ cathode
40.	pH	I	pH increases (becomes more basic), because the OH^- ions created @ the cathode ↑.

ELECTROPLATING

A thin layer of metal can be applied to the surface of another metal by means of electrolysis. This process is called electroplating. The following diagram shows a simplified process for plating silver onto a fork made of a less expensive metal. On each of the numbered lines in the diagram, write the letter of the appropriate label from the list below.

Labels

A. anode **B. ions in solution** **C. cathode** **D. direct current source**



45. On the diagram, draw an arrow that shows the direction of electron flow and label it e. anode → cathode
46. On the diagram, draw an arrow that shows the direction of cation flow and label it Ag^+. towards cathode

47. Write the equation for the anode half reaction. $Ag^0(s) \rightarrow Ag^+(aq) + e^-$

48. Write the equation for the cathode half reaction. $Ag^+(aq) + e^- \rightarrow Ag^0$

As the electroplating process proceeds, how to the quantities listed in the following table change?
To complete the table write: I – for increases D – for decreases R – for remains the same
Then, give a reason for each answer.

	Quantity	*Change*	*Reason*
49.	Mass of anode	D	Metal @ anode is oxidized + ions dissolve.
50.	Mass of cathode	I	Cations from solution are reduced @ cathode + resulting metal atoms coat cathode.
51.	$[Ag^+]$	R	As Ag^+ ions from solution are reduced to Ag atoms @ cathode, more Ag^+ ions are dissolved from the oxidation @ anode