B9 · Extra practice

Worked solutions | Items 1-2

Extra practice for this lesson. Original questions, not released diploma items. Select one option for multiple choice; other tasks state the required response.

Use the givens and conditions in each prompt. Enter the requested count, coefficient, oxidation number or potential with the stated unit and precision.

B9-D01 · Multiple choice

In $NaNO_3(aq)$, why is water reduced at the cathode instead of Na^+?

A. Water has a higher table value than Na^+

B. Na^+ is a negative ion

C. Water is a solid

D. Na^+ has no charge

1. Water (−0.83 V) has a higher table value than Na^+ (−2.71 V), so it is the stronger oxidizing agent.

2. Sodium metal does not form from an aqueous solution.

B9-D02 · Multiple choice

In NaI(aq) with inert electrodes, which is oxidized at the anode, I^- (+0.54 V) or water (+1.23 V)?

A. Water, because it has the higher value

B. I^-, because it has the lower value

C. Neither

D. Na^+

1. Whatever has the lower table value is the stronger reducing agent, so I^- is oxidized.

2. At the anode the lowest value reacts.

B9 · Extra practice

Worked solutions | Items 3-4

B9-D03 · Numerical response

For the electrolysis of NaI(aq) with inert electrodes, what is E°cell in volts to two decimal places? Use water −0.83 V and I_2/I^- +0.54 V.

1. Water is reduced at the cathode (−0.83 V) and I^- is oxidized at the anode (+0.54 V). E°cell = −0.83 − 0.54 = −1.37 V.

2. A negative value means a power source is needed.

B9-D04 · Select all that apply

Select every correct statement about $CuSO_4$(aq) with inert electrodes.

A. Copper metal forms at the cathode
B. Oxygen gas forms at the anode
C. The pH near the anode rises
D. The blue colour fades

1. Copper forms at the cathode, oxygen forms at the anode and the blue colour fades as Cu^{2+} is used.

2. Hydrogen ions are made at the anode, so the pH falls there, not rises.

B9 · Extra practice

Worked solutions | Items 5-6

B9-D05 · Numerical response

In $2Cu^{2+} + 2H_2O \rightarrow 2Cu + O_2 + __H^+$, what coefficient of H^+ balances the equation? Enter an integer.

1. The left has 4 hydrogen atoms in $2H_2O$, so $4H^+$ are needed on the right. Charge is +4 on each side.

2. Check oxygen: 2 on the left and 2 in O_2.

B9-D06 · Matching

Match each solution (inert electrodes) to the product at the cathode.

Items to match:

1. $NaNO_3(aq)$
2. $CuSO_4(aq)$
3. $AgNO_3(aq)$

Targets:

A. H_2 gas
B. Cu metal
C. Ag metal

1. Water is reduced in $NaNO_3(aq)$. Cu^{2+} is reduced in $CuSO_4(aq)$. Ag^+ is reduced in $AgNO_3(aq)$.

2. Compare each cation with water (−0.83 V).

B9 · Extra practice

Worked solutions | Items 7-8

B9-D07 · Multiple choice

What is the chloride anomaly?

A. Chloride is reduced at the cathode
B. Chlorine forms at the anode of NaCl(aq) even though the table predicts oxygen
C. Chloride ions have no charge
D. Chlorine is never made

1. The table predicts that water is oxidized, but chlorine is observed because the overvoltage for water is greater.

2. It happens in solutions containing chloride ions and water.

B9-D08 · Numerical response

For the electrolysis of NaBr(aq) with inert electrodes, what is E°cell in volts to two decimal places? Use water −0.83 V and Br_2/Br^- +1.07 V.

1. E°cell = −0.83 − 1.07 = −1.90 V.

2. Water is reduced at the cathode and bromide is oxidized at the anode.

B9 · Extra practice

Worked solutions | Items 9-10

B9-D09 · Ordering / ranking

Arrange the steps for predicting an aqueous electrolysis.

First to last

1. Write the halves and match the electrons
2. List what is present, including water and the electrodes
3. Calculate E°cell and predict observations
4. Choose the cathode reaction from the highest value
5. Choose the anode reaction from the lowest value

1. List what is present, choose the cathode, choose the anode, write and match the halves, then calculate and predict observations.

2. Check for the chloride exception after the table prediction.

B9-D10 · Numerical response

In the electrolysis of $Na_2SO_4(aq)$, how many moles of H_2 form for each 1 mol of O_2? Enter an integer.

1. The overall reaction is $2H_2O \rightarrow 2H_2 + O_2$, so 2 mol of H_2 form for each 1 mol of O_2.

2. Read the coefficients of H_2 and O_2 in the balanced overall equation.

B9 · Extra practice

Worked solutions | Items 11-12

B9-D11 · Multiple choice

In $CuSO_4(aq)$ with inert electrodes, what happens to the pH near the anode?

A. It rises
B. It falls
C. It stays the same
D. It becomes 14

1. The anode reaction $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$ makes hydrogen ions, so the pH falls.

2. Hydroxide ions are not made at the anode.

B9-D12 · Written response

A student says the minimum voltage given by the table guarantees the predicted product. Use aqueous NaCl to explain what is wrong.

1. An overvoltage is also needed. In NaCl(aq) the table predicts oxygen from water.

2. Chlorine forms because the overvoltage for oxidizing water is greater than for chloride.