B4 · 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.

B4-D01 · Multiple choice

In a test, zinc metal turns Cu^{2+} ions into copper metal. Which comparison does this show?

A. Cu > Zn as reducing agents

B. Zn > Cu as reducing agents

C. Zn^{2+} > Cu^{2+} as oxidizing agents

D. Nothing can be compared

1. B is correct, because zinc gives electrons to the copper ions. Zinc is the stronger reducing agent in this test.

2. For the ions, Cu^{2+} is a stronger oxidizing agent than Zn^{2+}. Keep a metal and its ion apart. They do different jobs.

B4-D02 · Numerical response

Use these rows from the Data Booklet table of standard electrode potentials: $Ag^{+} + e^{-} \rightarrow Ag$, +0.80 V; $Cu^{2+} + 2e^{-} \rightarrow Cu$, +0.34 V; $Zn^{2+} + 2e^{-} \rightarrow Zn$, -0.76 V. The conditions are standard: 25 °C and 1.0 mol/L solutions. Calculate E° for $Cu + 2Ag^{+} \rightarrow Cu^{2+} + 2Ag$. Enter the value in volts, with its sign, to two decimal places.

1. Ag^{+} is the oxidizing agent and Cu is the reducing agent. E° = +0.80 - (+0.34) = +0.46 V.

2. Do not multiply +0.80 by two. The 2 in front of Ag^{+} balances the electrons. It does not change E°.

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Worked solutions | Items 3-4

B4-D03 · Numerical response

Use these rows from the Data Booklet table of standard electrode potentials: $Ag^{+} + e^{-} \rightarrow Ag$, +0.80 V; $Cu^{2+} + 2e^{-} \rightarrow Cu$, +0.34 V; $Zn^{2+} + 2e^{-} \rightarrow Zn$, -0.76 V. The conditions are standard: 25 °C and 1.0 mol/L solutions. Calculate E° for $Cu + Zn^{2+} \rightarrow Cu^{2+} + Zn$. Enter the value in volts, with its sign, to two decimal places.

1. In the reaction as written, Zn^{2+} is the oxidizing agent. So E° = -0.76 - (+0.34) = -1.10 V.

2. The value is negative, so the reaction as written is not spontaneous. Subtracting the other way round would answer for the reverse reaction.

B4-D04 · Ordering / ranking

The metals are in the order Zn > Cu > Ag as reducing agents. Put the three metals in order from the strongest to the weakest reducing agent.

Strongest to weakest reducing agent

1. Cu
2. Ag
3. Zn

1. The order is Zn, Cu, Ag, which are items 3, 1 and 2 in the list shown.

2. These are the metals. Their ions rank the opposite way.

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Worked solutions | Items 5-6

B4-D05 · Ordering / ranking

The metals are in the order Zn > Cu > Ag as reducing agents. Put their ions in order from the strongest to the weakest oxidizing agent.

Strongest to weakest oxidizing agent

1. Zn^{2+}
2. Ag^{+}
3. Cu^{2+}

1. The order is Ag^{+}, Cu^{2+}, Zn^{2+}. It is the reverse of the order of the metals as reducing agents.

2. The oxidizing agent is the ion, so write each one with its charge.

B4-D06 · Multiple choice

A beaker contains Cu metal, Ag^{+} ions and nitrate ions. The nitrate ions do not change. Which pair can react in a redox reaction?

A. Zn and Ag^{+}
B. Cu and Ag^{+}
C. Cu^{2+} and Ag
D. Zn^{2+} and Cu^{2+}

1. B lists the reducing agent and the oxidizing agent that are in the beaker. Nitrate is a spectator ion here.

2. The other choices use something that is not in the beaker at the start, or use the products.

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Worked solutions | Items 7-8

B4-D07 · Select all that apply

Select everything that should be kept the same when two tests of a metal in a solution are compared.

A. The concentration of the ion
B. The surface area of the metal
C. The time
D. Which metal and which ion are tested

1. A, B and C should be kept the same in this comparison. Temperature and volume should also be matched.

2. D is the one thing changed on purpose. Keeping it the same would test nothing.

B4-D08 · Matching

Match each record to what kind of evidence it is.

Items to match:

1. A visible coating forms
2. An equation shows which particle gained electrons
3. A simulation gives the same result every time

Targets:

A. The simulation follows fixed rules; it is not new evidence
B. An observation: something seen
C. An inference about particles

1. Coating: an observation. Electron gain: an inference about particles. Same result every time: the simulation follows fixed rules.

2. The three are different kinds of evidence. A simulation result is not a new measurement.

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Worked solutions | Items 9-10

B4-D09 · Numerical response

Use these rows from the Data Booklet table of standard electrode potentials: $Ag^+ + e^- \rightarrow Ag$, +0.80 V; $Cu^{2+} + 2e^- \rightarrow Cu$, +0.34 V; $Zn^{2+} + 2e^- \rightarrow Zn$, -0.76 V. The conditions are standard: 25 °C and 1.0 mol/L solutions. Calculate E° for $Zn + 2Ag^+ \rightarrow Zn^{2+} + 2Ag$. Enter the value in volts to two decimal places.

1. Ag^+ is the oxidizing agent, at +0.80 V. Zinc is the reducing agent, and its row has the value -0.76 V.

2. Subtract the value for the reducing agent: +0.80 - (-0.76) = +1.56 V. The reaction as written is spontaneous under standard conditions.

B4-D10 · Multiple choice

A balanced reaction has a negative E° under standard conditions. Which conclusion is correct?

A. The equation cannot be balanced
B. The reaction must happen instantly
C. The reverse reaction is spontaneous
D. No reaction can ever happen under any conditions

1. C is supported. The sign tells the spontaneous direction under standard conditions.

2. Balancing, speed and other conditions are separate questions. A negative E° does not mean the equation is unbalanced.

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Worked solutions | Items 11-12

B4-D11 · Multiple choice

Test results, under the same conditions: metal A gives electrons to B^{2+}, and metal B gives electrons to C^{2+}. Which other comparison of reducing agents follows?

A. C > A

B. A > C

C. A = C

D. B > A

1. The results show A > B and B > C, so A > C. B is correct.

2. Metal B is in both results, so it links them. This works because the conditions were the same.

B4-D12 · Written response

One short lab test shows no visible change. Give one conclusion that is reasonable. Give one conclusion that this observation alone cannot prove.

1. Reasonable: no sign of a reaction was seen in that time, under those conditions.

2. It does not prove that the reaction is impossible, or that other concentrations and temperatures would act the same. A slow reaction or a coating on the metal can hide a change.

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Worked solutions | Items 13-13

B4-D13 · Multiple choice

In the symbol E° for a table value, what does the degree sign ° tell you?

A. The value was measured at 0 °C
B. The value is given at standard conditions
C. The value is an angle between electrodes
D. The value is the same at every concentration

1. The degree sign means the value is given at standard conditions: 1.0 mol/L, 25.00 °C (298.15 K) and 101.325 kPa for gases. E is electric potential, in volts.

2. A changed concentration or temperature can change the tendency, so the value does not hold at every concentration. The ° has no connection to angles or to 0 °C.