B3 · 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.

B3-D01 · Numerical response

In $Al \rightarrow Al^{3+} + ne^{-}$, what is n? Enter a whole number.

1. The charge is 0 on the left and +3 - n on the right. Set 0 = 3 - n.

2. n = 3 makes the charge equal. Counting atoms alone would not give the number of electrons.

B3-D02 · Numerical response

A reduction half-reaction takes two electrons. An oxidation half-reaction gives three. What is the lowest number of electrons both can move before you add them? Enter a whole number.

1. The lowest number that 2 and 3 both go into is 6.

2. Multiply the two-electron half by 3 and the three-electron half by 2. Multiply every part of each half.

B3 · Extra practice

Worked solutions | Items 3-4

B3-D03 · Numerical response

In acidic solution, balance MnO_4^- → Mn^{2+}. After you balance O with water, how many H^+ are needed? Enter a whole number.

1. Four O need four H_2O on the right. Four waters have eight H atoms.

2. Add $8H^+$ on the left. This balances hydrogen. Electrons are added after that, to balance the charge.

B3-D04 · Multiple choice

For $MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O$, how many electrons must be added, and on which side?

A. Seven on the left
B. Five on the right
C. Two on the right
D. Five on the left

1. The charge is +7 on the left and +2 on the right. Five electrons on the left bring it down to +2.

2. D is correct. Seven would make the left side zero, and the two sides would not be equal.

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Worked solutions | Items 5-6

B3-D05 · Select all that apply

Select every correct step when you balance in acidic solution.

A. Use H_2O to balance oxygen
B. Use H^+ to balance hydrogen
C. Change the formula of a product to fix oxygen
D. Make the electrons equal before you add the halves

1. A, B and D keep the particles that were given and balance the counts.

2. C changes the question. You may change coefficients. You may not change subscripts or the products you were given.

B3-D06 · Ordering / ranking

Put the steps in order for balancing a half-reaction in acid. The reactant and the product are already written.

First to last

1. Balance the charge with electrons
2. Balance oxygen with H_2O
3. Check the atoms and the charge
4. Balance elements other than O and H
5. Balance hydrogen with H^+

1. Balance the other elements, then O with water, then H with H^+, then the charge with electrons. Then check.

2. Water adds hydrogen. So the water must be right before you balance hydrogen.

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Worked solutions | Items 7-8

B3-D07 · Matching

Match each failed check to the mistake it shows.

Items to match:

1. $Zn \rightarrow Zn^{2+} + e^-$ has one Zn on each side, but the charge is 0 and +1
2. $Al + Cu^{2+} \rightarrow Al^{3+} + Cu$ has a charge of +2 and +3
3. $MnO_4^- \rightarrow Mn^{2+}$ has no oxygen in the products

Targets:

A. Oxygen count missing

B. Electron coefficient wrong in a half

C. Unequal electron exchange in a net equation

1. The first has the wrong number of electrons in a half-reaction. In the second, the electrons lost and gained are not equal. The third is missing a product that contains oxygen.

2. Use the atom check and the charge check together. Passing one does not prove the other.

B3-D08 · Numerical response

In acidic solution, balance $Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$. How many electrons are in the balanced half-reaction? Enter a whole number.

1. Add $7H_2O$ on the right and $14H^+$ on the left. Before the electrons, the charge is +12 on the left and +6 on the right.

2. Six electrons on the left make both sides +6. Each of the two Cr goes from +6 to +3, which is also six electrons gained.

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Worked solutions | Items 9-10

B3-D09 · Multiple choice

A student multiplies $Fe^{2+} \rightarrow Fe^{3+} + e^-$ by five, but writes $Fe^{2+} \rightarrow Fe^{3+} + 5e^-$. Which choice is correct?

A. $5Fe^{2+} \rightarrow 5Fe^{3+} + 5e^-$

B. $Fe^{10+} \rightarrow Fe^{15+} + 5e^-$

C. $Fe^{2+} + 5e^- \rightarrow Fe^{3+}$

D. The original is already correct

1. A multiplies every part. Five iron(II) ions each give one electron.

2. The charges on the ions stay +2 and +3. Having more ions does not change the charge of each one.

B3-D10 · Multiple choice

Check this half-reaction in basic solution: $OCl^- + H_2O + 2e^- \rightarrow Cl^- + 2OH^-$. What is the total charge on each side?

A. 0

B. -1

C. -2

D. -3

1. Left: -1 + 0 - 2 = -3. Right: -1 + 2(-1) = -3. So D is correct.

2. Cl 1, O 2 and H 2 also match. Atoms and charge must balance in basic solution too.

B3 · Extra practice

Worked solutions | Items 11-12

B3-D11 · Written response

Join the half-reactions $H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$ and $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$. Write the net equation and explain everything you cancelled.

1. Both halves move two electrons, so add them as they are.

2. Cancel the $2e^-$ and the $2H^+$ that are on both sides. Net: $2H_2O_2 \rightarrow O_2 + 2H_2O$. The atoms match and the charge is 0 on each side.

3. Do not cancel H_2O_2. Both are reactants, on the same side, so they add up to $2H_2O_2$.

B3-D12 · Select all that apply

Select every correct final check for a whole redox equation.

A. Each element has the same number of atoms on both sides

B. The total charge is the same on both sides

C. No electrons are left after the halves are added

D. Both sides must add to zero

1. A, B and C are correct. Also divide all the coefficients by a common number if you can.

2. D is not needed. Many correct net ionic equations have equal charges that are not zero.

B3 · Extra practice

Worked solutions | Items 13-14

B3-D13 · Numerical response

In acidic solution, two halves were added and the electrons were cancelled. The result is $2MnO_4^- + 16H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2 + 10H^+$. H^+ is on both sides. After you cancel it, how many H^+ are left on the left side? Enter a whole number.

1. H^+ is on both sides: 16 on the left and 10 on the right. Take 10 away from each side. That leaves 16 - 10 = 6 on the left and none on the right.

2. Net equation: $2MnO_4^- + 6H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$. Check: the charge is -2 + 6 = +4 on the left and +4 on the right. O is 18 on each side. H is 16 on each side.

B3-D14 · Numerical response

$Cu^+(aq)$ reacts with itself. Given two half-reactions: $Cu^+ \rightarrow Cu^{2+} + e^-$ and $Cu^+ + e^- \rightarrow Cu$. Add them and cancel the electrons. What is the coefficient of Cu^+ in the equation with the lowest whole numbers? Enter a whole number.

1. One electron is given and one is taken, so nothing needs to be multiplied. Adding gives $2Cu^+ \rightarrow Cu^{2+} + Cu$ after the electrons cancel.

2. Check: Cu is 2 on each side. The charge is 2(+1) = +2 on the left and +2 + 0 = +2 on the right. The same reactant is oxidized (to Cu^{2+}) and reduced (to Cu). This is disproportionation.