Balancing Redox Equations 1

A Level

Essential Pre-Uni Chemistry K3.1

Balance the following redox equations.

Use the lowest possible **integer** coefficients your answers.

Part A (a)

$$\mathrm{H_2\,(g)} + \mathbf{?}\mathrm{Ag^+\,(aq)} \longrightarrow \mathbf{?}\mathrm{H^+\,(aq)} + \mathbf{?}\mathrm{Ag\,(s)}$$

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

Part B (b)

$$\mathbf{?}\mathrm{Fe\,(s)} + \mathbf{?}\mathrm{Cl_2\,(g)} \longrightarrow \mathbf{?}\mathrm{FeCl_3\,(s)}$$

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

Part C (c)

$$\mathrm{I_2\,(aq)} + \mathbf{?}\mathrm{S_2O_3^{2-}\,(aq)} \longrightarrow \mathbf{?}\mathrm{I^-\,(aq)} + \mathrm{S_4O_6^{2-}\,(aq)}$$

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

Part D **(d)**

$$\mathrm{CH_4\,(g)} + \mathbf{?}\mathrm{Cl_2\,(g)} \longrightarrow \mathrm{CCl_4\,(g)} + \mathbf{?}\mathrm{HCl\,(g)}$$

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

Part E **(e)**

$$\mathrm{C_6H_{12}O_6\,(aq)} + \mathbf{?}\mathrm{O_2\,(g)} \longrightarrow \mathbf{?}\mathrm{CO_2\,(g)} + \mathbf{?}\mathrm{H_2O\,(l)}$$

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

Part F **(f)**

$$\mathbf{?}\mathrm{K\,(s)} + \mathbf{?}\mathrm{H_2O\,(l)} \longrightarrow \mathbf{?}\mathrm{KOH\,(aq)} + \mathrm{H_2\,(g)}$$

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

Part G **(g)**

$$\mathbf{?}\mathrm{Co^{3+}\,(aq)} + \mathbf{?}\mathrm{H_2O\,(l)} \longrightarrow \mathbf{?}\mathrm{Co^{2+}\,(aq)} + \mathbf{?}\mathrm{H^{+}\,(aq)} + \mathrm{O_2\,(g)}$$

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

Part H (h)

$$a\,\mathrm{Fe^{2+}\,(aq)} + b\,\mathrm{MnO_4{}^-\,(aq)} + c\,\mathrm{H^+\,(aq)} \longrightarrow d\,\mathrm{Fe^{3+}\,(aq)} + e\,\mathrm{Mn^{2+}\,(aq)} + f\,\mathrm{H_2O\,(l)}$$

This chemical equation is too long to fit on your screen, so please balance the equation and give your answer as a string of numbers in the order of $abcdef$. For example, if the question is

$$a\,\mathrm{H_2\,(g)} + b\,\mathrm{Ag^+\,(aq)} \longrightarrow c\,\mathrm{H^+\,(aq)} + d\,\mathrm{Ag\,(s)},$$

and you think the answer is

$$3\,\mathrm{H_2\,(g)} + 1\,\mathrm{Ag^+\,(aq)} \longrightarrow 6\,\mathrm{H^+\,(aq)} + 5\,\mathrm{Ag\,(s)},$$

then input 3165.

Part I (i)

$$a\,\mathrm{Zn\,(s)} + b\,\mathrm{VO_2{}^+\,(aq)} + c\,\mathrm{H^+\,(aq)} \longrightarrow d\,\mathrm{Zn^{2+}\,(aq)} + e\,\mathrm{V^{2+}\,(aq)} + f\,\mathrm{H_2O\,(l)}$$

This chemical equation is too long to fit on your screen, so please balance the equation and give your answer as a string of numbers in the order of $abcdef$. For example, if the question is

$$a\,\mathrm{H_2\,(g)} + b\,\mathrm{Ag^+\,(aq)} \longrightarrow c\,\mathrm{H^+\,(aq)} + d\,\mathrm{Ag\,(s)},$$

and you think the answer is

$$3\,\mathrm{H_2\,(g)} + 1\,\mathrm{Ag^+\,(aq)} \longrightarrow 6\,\mathrm{H^+\,(aq)} + 5\,\mathrm{Ag\,(s)},$$

then input 3165.

Part J (j)

$$\mathrm{C_2O_4H_2\,(aq)} + \mathrm{H_2O_2\,(aq)} \longrightarrow \mathbf{?}\mathrm{CO_2\,(g)} + \mathbf{?}\mathrm{H_2O\,(l)}$$

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

Part K (k)

$$a\,\mathrm{BaFeO_4\,(s)} + b\,\mathrm{HCl\,(aq)} \longrightarrow c\,\mathrm{BaCl_2\,(aq)} + d\,\mathrm{FeCl_3\,(aq)} + e\,\mathrm{H_2O\,(l)} + f\,\mathrm{Cl_2\,(g)}$$

This chemical equation is too long to fit on your screen, so please balance the equation and give your answer as a string of numbers in the order of $abcdef$. For example, if the question is

$$a\,\mathrm{H_2\,(g)} + b\,\mathrm{Ag^+\,(aq)} \longrightarrow c\,\mathrm{H^+\,(aq)} + d\,\mathrm{Ag\,(s)},$$

and you think the answer is

$$3\,\mathrm{H_2\,(g)} + 1\,\mathrm{Ag^+\,(aq)} \longrightarrow 6\,\mathrm{H^+\,(aq)} + 5\,\mathrm{Ag\,(s)},$$

then input 3165.

Part L (l)

$$a\,\mathrm{CH_3CH_2CH_2OH\,(l)} + b\,\mathrm{Cr_2O_7{}^{2-}\,(aq)} + c\,\mathrm{H^+(aq)} \longrightarrow d\,\mathrm{CH_3CH_2CHO\,(l)} + e\,\mathrm{Cr^{3+}\,(aq)} + f\,\mathrm{H_2O\,(l)}$$

This chemical equation is too long to fit on your screen, so please balance the equation and give your answer as a string of numbers in the order of $abcdef$. For example, if the question is

$$a\,\mathrm{H_2\,(g)} + b\,\mathrm{Ag^+\,(aq)} \longrightarrow c\,\mathrm{H^+\,(aq)} + d\,\mathrm{Ag\,(s)},$$

and you think the answer is

$$3\,\mathrm{H_2\,(g)} + 1\,\mathrm{Ag^+\,(aq)} \longrightarrow 6\,\mathrm{H^+\,(aq)} + 5\,\mathrm{Ag\,(s)},$$

then input 3165.

Balancing Redox Equations 2

A Level

Essential Pre-Uni Chemistry K3.2

Complete the balanced equations to show the reactions between the following pairs of substances in acidic aqueous conditions (no fractions).

Part A Manganate(VII) and hydrogen peroxide

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

$$5\,H_2O_2\,(aq) + 2\,MnO_4^-\,(aq) + \ ? \longrightarrow 2\,Mn^{2+}\,(aq) + 8\,H_2O\,(l) + \ ?$$

Part B Scandium and ethanoic acid

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

$$2\,Sc\,(s) + \ ?CH_3COOH\,(aq) \longrightarrow \ ? + 3\,H_2\,(g)$$

Part C Ethanol and boiling dichromate(VI)

$$3\,\mathrm{CH_3CH_2OH\,(aq)} + 2\,\mathrm{Cr_2O_7}^{2-}\,\mathrm{(aq)} + a\,\mathrm{H^+\,(aq)} \longrightarrow 3\,\mathrm{CH_3COOH\,(aq)} + b\,\mathrm{Cr^{3+}\,(aq)} + c\,\mathrm{H_2O\,(l)}$$

This chemical equation is too long to fit on your screen, so please balance the equation and give your answer as a string of numbers in the order of abc. For example, if the question is

$$a\,\mathrm{H_2\,(g)} + b\,\mathrm{Ag^+\,(aq)} \longrightarrow 6\,\mathrm{H^+\,(aq)} + c\,\mathrm{Ag\,(s)},$$

and you think the answer is

$$3\,\mathrm{H_2\,(g)} + 1\,\mathrm{Ag^+\,(aq)} \longrightarrow 6\,\mathrm{H^+\,(aq)} + 5\,\mathrm{Ag\,(s)},$$

then input 315.

Part D Chlorate(V) and chloride

Please **click on and drag** the pre-loaded species to create a balanced chemical equation.

$$\mathrm{ClO_3}^-\,\mathrm{(aq)} + \ ?\mathrm{Cl^-\,(aq)} + \ ?\mathrm{H^+\,(aq)} \longrightarrow \ ?\mathrm{Cl_2\,(g)} + \ ?$$

Gameboard:

STEM SMART Chemistry Week 11

Balancing Redox Equations 3

A Level

Essential Pre-Uni Chemistry K3.3

Complete the balanced equations to show the reactions between the following pairs of substances in alkaline aqueous conditions (no fractions).

Part A Sulfite and bromate(V)

sulfite and bromate(V)

$$3\,SO_3^{2-}(aq) + \ ?BrO_3^{-}(aq) \longrightarrow 3\,SO_4^{2-}(aq) + \ ?$$

Part B Hydrogen peroxide and chromium(III)

hydrogen peroxide and chromium(III)

$$3\,H_2O_2\,(aq) \ + \ ?Cr^{3+}(aq) \ + \ ?OH^{-}(aq) \longrightarrow \ ?CrO_4^{2-}(aq) \ + \ ?$$

Part C Chlorate(I) and iron(III)

chlorate(I) and iron(III)

$$?ClO^{-}(aq) \ + \ ?Fe(OH)_3\,(s) \longrightarrow \ ?FeO_4^{2-}(aq) \ + \ ?Cl_2\,(g) + \ ? \ + \ ?$$

Part D Manganate(VI) and methanoate

manganate(VI) and methanoate

$$?\mathrm{HCOO^-\,(aq)} + \mathrm{MnO_4{}^{2-}\,(aq)} \longrightarrow \mathrm{MnO_2\,(s)} + \mathrm{OH^-\,(aq)} + \ ?$$

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Oxidation of Thiosulfate

A Level

C C C

An aqueous solution contains $1\,\mathrm{mol}$ of $S_2O_3^{2-}$ ions and this reduces $4\,\mathrm{mol}$ of Cl_2 molecules to Cl^- ions. What is the sulfur-containing product of this reaction?

- SO_3^{2-}
- $S_4O_6^{2-}$
- SO_2
- SO_4^{2-}
- S

Adapted with permission from UCLES, A-Level Chemistry, June 1989, Paper 3, Question 20

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Disproportionation 1

A Level

Essential Pre-Uni Chemistry K4.1

The following are all examples of disproportionation reactions.

Part A **(a)**

$$\mathrm{Cl_2\,(aq) + H_2O\,(l) \longrightarrow HCl\,(aq) + HOCl\,(aq)}$$

State the symbol of the element that is disproportionated in the reaction.

State the element's oxidation state when it first appears in the chemical equation.

State the element's oxidation state the second time it appears in the chemical equation.

State the element's oxidation state the third time it appears in the chemical equation.

Part B **(b)**

$$\mathrm{Cu_2SO_4\,(aq) \longrightarrow Cu\,(s) + CuSO_4\,(aq)}$$

State the symbol of the element that is disproportionated in the reaction.

State the element's oxidation state when it first appears in the chemical equation.

State the element's oxidation state the second time it appears in the chemical equation.

State the element's oxidation state the third time it appears in the chemical equation.

Part C **(c)**

$$2\,\mathrm{CO}\,(\mathrm{g}) \longrightarrow \mathrm{C}\,(\mathrm{s}) + \mathrm{CO_2}\,(\mathrm{g})$$

State the symbol of the element that is disproportionated in the reaction.

State the element's oxidation state when it first appears in the chemical equation.

State the element's oxidation state the second time it appears in the chemical equation.

State the element's oxidation state the third time it appears in the chemical equation.

Part D **(d)**

$$2\,\mathrm{HOF}\,(\mathrm{aq}) \longrightarrow \mathrm{H_2O}\,(\mathrm{l}) + \mathrm{OF_2}\,(\mathrm{g})$$

State the symbol of the element that is disproportionated in the reaction.

State the element's oxidation state when it first appears in the chemical equation.

State the element's oxidation state the second time it appears in the chemical equation.

State the element's oxidation state the third time it appears in the chemical equation.

Part E **(e)**

$$5\,\mathrm{MnO_4}^{2-}\,(\mathrm{aq}) + 8\,\mathrm{H}^{+}\,(\mathrm{aq}) \longrightarrow \mathrm{Mn}^{2+}\,(\mathrm{aq}) + 4\,\mathrm{MnO_4}^{-}\,(\mathrm{aq}) + 4\,\mathrm{H_2O}\,(\mathrm{l})$$

State the symbol of the element that is disproportionated in the reaction.

State the element's oxidation state when it first appears in the chemical equation.

State the element's oxidation state the second time it appears in the chemical equation.

State the element's oxidation state the third time it appears in the chemical equation.

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STEM SMART Chemistry Week 11

Disproportionation 2

A Level

Essential Pre-Uni Chemistry K4.2

Complete and balance the following equations that represent disproportionation reactions.

Part A **(a)**

$$?\mathrm{H_2O_2\,(aq)} \longrightarrow ?\mathrm{H_2O\,(l)} + \_\_\_\_\_$$

Part B **(b)**

$$?\mathrm{I_2\,(aq)} + ?\mathrm{OH^-\,(aq)} \longrightarrow \_\_\_\_\_ + 5\,\mathrm{I^-\,(aq)} + 3\,\mathrm{H_2O\,(l)}$$

Please **click on and drag** the pre-loaded species in the equation editor to create your chemical equation.

Part C **(c)**

$$8\,\mathrm{S_2O_3{}^{2-}\,(aq)} + 16\,\mathrm{H^+\,(aq)} \longrightarrow \mathrm{S_8\,(s)} + \_\_\_\_\_ + 8\,\mathrm{H_2O\,(l)}$$

Please **click on and drag** the pre-loaded species in the equation editor to create your chemical equation.

Gameboard:

STEM SMART Chemistry Week 11

Iron in a Nail

A Level

A nail of mass $1.40\,\mathrm{g}$ was dissolved in an excess of dilute sulfuric acid to form $100\,\mathrm{cm}^3$ of solution. A $10\,\mathrm{cm}^3$ sample of this solution required $4.0 \times 10^{-4}\,\mathrm{mol}$ of manganate (VII) for complete oxidation.

In acidic solution:

$$\mathrm{MnO_4}^- + 8\,\mathrm{H}^+ + 5\,\mathrm{e}^- \longrightarrow \mathrm{Mn}^{2+} + 4\,\mathrm{H_2O}$$

By assuming that, in dissolving in sulfuric acid, the iron in the nail was converted entirely into $\mathrm{Fe}^{2+}\,(\mathrm{aq})$ and that manganate (VII) oxidises Fe^{2+} to Fe^{3+}, calculate:

Part A Moles of Fe^{2+}

The number of moles of Fe^{2+} produced from the nail.

Part B % of Fe

The percentage of iron in the nail.

Adapted with permission from UCLES, A-Level Chemistry, June 1992, Paper 3, Question 2

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STEM SMART Chemistry Week 11

Sodium Nitrite

A Level

P P P

Nitrogen can be obtained in the laboratory by warming a mixture of ammonium chloride and sodium nitrite, $\mathrm{NaNO_2}$. Water is also produced and a solid is left.

Part A Ammonium chloride and sodium nitrite

Suggest an identity for the solid.

Part B Equation

Write a balanced equation for the reaction, including state symbols, balancing to obtain the lowest integer coefficients possible.

Part C Ammonium chloride and sodium nitrate

A similar reaction takes place when ammonium chloride is heated with sodium nitrate $\mathrm{NaNO_3}$ but this time the only different product is an oxide of nitrogen. Suggest a formula for this oxide, and the oxidation state of nitrogen in it.

Formula:

Oxidation state:

Adapted with permission from UCLES, A-Level Chemistry, June 1994, Paper 1, Question 7

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High Oxidation States

A Level

C C C

The maximum possible oxidation state of an element could occur if all the outermost electrons, the so-called valence electrons, were used in bonding. The maximum number of valence electrons is equal to the group number for Groups 1 to 11, and the group number minus 10 for elements from Groups 12 to 18. Note the maximum possible oxidation state is not always achievable; however, each of the following elements forms an oxide exhibiting the theoretical maximum oxidation state for that element. Give the formula for each oxide.

Part A **Xenon** (Xe)

Part B **Polonium** (Po)

Part C **Chlorine** (Cl)

Part D **Niobium** (Nb)

Part E Osmium (Os)

Part F Yttrium (Y)

Adapted with permission from the Cambridge Chemistry Challenge 2021, Question 2