National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard

Chemistry Level 2

This exemplar supports assessment against:

Achievement Standard 91167

Demonstrate understanding of oxidation-reduction

An annotated exemplar is an extract of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade boundaries.

New Zealand Qualifications Authority

To support internal assessment

	Grade Boundary: Low Excellence
1.	For Excellence, the student needs to demonstrate comprehensive understanding of oxidation-reduction. This involves justifying, evaluating, comparing and contrasting, or analysing links between oxidation-reduction reactions, observations and equations. This requires the consistent use of chemistry vocabulary, symbols and conventions. This student has identified and described oxidation and reduction reactions by using change in oxidation numbers (1). Species have been linked to observations (2). Both half equations are balanced (3) and the correctly balanced overall equation is written (4). There is consistent use of chemistry vocabulary, symbols and conventions. For a more secure Excellence, the student could indicate the actual oxidation number change when Fe^{2+} is oxidised to Fe^{3+} (5).

Student 1: Low Excellence

NZQA Intended for teacher use only

When fresh iron (II) sulfate solution is added to acidified potassium permanganate solution, a pale green solution and a purple solution react to form an orange solution.

Justify why this is an oxidation-reduction reaction. Your answer should include:

- Species linked to the provided observations
- An explanation of oxidation and reduction in terms of electron transfer or oxidation number change
- Balanced half and full equations

Answer:

Reduction reaction:

2 The purple potassium permanganate solution reacts according to the following half equation and changes to colourless Mn^{2+} solution.

3 $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

1 Each MnO_4^- gains five electrons and the Mn in the MnO_4^- has an oxidation number of +7 and this decreases to +2 in Mn^{2+}, so the MnO_4^- is reduced.

Oxidation reaction:

The pale green iron (II) solution changes to an orange Fe^{3+} solution according to the following half equation:

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

3

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

5 Each Fe^{2+} loses one electron. The oxidation number of Fe^{2+} increases when it is oxidised to Fe^{3+}.

The overall balanced equation for the redox reaction is:

4 $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$

	Grade Boundary: High Merit
2.	For Merit, the student needs to demonstrate in-depth understanding of oxidation-reduction. This involves making and explaining links between oxidation-reduction reactions, observations and equations. This requires explanations that use chemistry vocabulary, symbols and conventions. This student has identified and described oxidation and reduction reactions by stating the actual number of electrons lost and gained (1). Species have been linked to observations (2). Both half equations are correctly balanced (3). Chemistry vocabulary, symbols and conventions are used in explanations. To reach Excellence, the student could correctly balance the full equation (4).

Student 2: High Merit

NZQA Intended for teacher use only

When fresh iron(II) sulfate solution is added to acidified potassium permanganate solution, a pale green solution and a purple solution react to form an orange solution.

Justify why this is an oxidation-reduction reaction. Your answer should include:

- Species linked to the provided observations
- An explanation of oxidation and reduction in terms of electron transfer or oxidation number change
- Balanced half and full equations

Answer:

(2) The purple potassium permanganate changes to colourless Mn^{2+}.

(1) Each MnO_4^- gains five electrons, so the MnO_4^- is reduced.

(3) $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

(2) The pale green Fe^{2+} changes to orange Fe^{3+}.

(1) Each Fe^{2+} loses one electron, so the Fe^{2+} is oxidised.

(3) $Fe^{2+} \rightarrow Fe^{3+} + e^-$ (x 5)

The overall balanced equation for the redox reaction is:

(4) $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + Fe^{3+}$

	Grade Boundary: Low Merit
3.	For Merit, the student needs to demonstrate in-depth understanding of oxidation-reduction. This involves making and explaining links between oxidation-reduction reactions, observations and equations. This requires explanations that use chemistry vocabulary, symbols and conventions. The student has identified and described the reduction half reaction by stating that electrons are gained and has identified that the oxidation number decreases (1). Species have been linked to observations for the reduction half reaction (2). The balanced reduction half equation is written (3). Chemistry vocabulary, symbols and conventions are used in explanations. For a more secure Merit, the student could indicate the number of electrons gained in the reduction half reaction or the oxidation number change for both species (4).

Student 3: Low Merit

NZQA Intended for teacher use only

When fresh iron(II) sulfate solution is added to acidified potassium permanganate solution, a pale green solution and a purple solution react to form an orange solution.

Justify why this is an oxidation-reduction reaction. Your answer should include:

- Species linked to the provided observations
- An explanation of oxidation and reduction in terms of electron transfer or oxidation number change
- Balanced half and full equations

Answer:

4

The potassium permanganate is purple. Each MnO_4^- gains electrons, so the MnO_4^- changes to Mn^{2+}. The purple MnO_4^- changes to colourless Mn^{2+}. 2 1
The oxidation number decreases and MnO_4^- is reduced.

3 $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

1 The Fe^{2+} changes to orange Fe^{3+}. Each Fe^{2+} loses an electron and its oxidation number increases. This is oxidation.

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

The overall balanced equation for the redox reaction is:

$MnO_4^- + 8H^+ + Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + Fe^{3+}$

	Grade Boundary: High Achieved
4.	For Achieved, the student needs to demonstrate understanding of oxidation-reduction. This involves describing, identifying, naming, giving an account of oxidation-reduction and describing oxidation-reduction reactions. This requires the use of chemistry vocabulary, symbols and conventions. The student has identified the formulae of species from observations (colour of species) (1). The reduction reaction is correctly identified and described by the gain of electrons (2). Chemistry vocabulary, symbols and conventions are used. To reach Merit, the student could provide the balanced reduction half equation (3).

Student 4: High Achieved

NZQA Intended for teacher use only

When fresh iron(II) sulfate solution is added to acidified potassium permanganate solution, a pale green solution and a purple solution react to form an orange solution.

Justify why this is an oxidation-reduction reaction. Your answer should include:

- Species linked to the provided observations
- An explanation of oxidation and reduction in terms of electron transfer or oxidation number change
- Balanced half and full equations

Answer:

1 The potassium permanganate is purple because of the MnO_4^- ion.
The purple MnO_4^- ion changes to colourless Mn^{2+}.

2 MnO_4^- is reduced because it has gained five electrons.
Reduction is a gain of electrons.

3 Reduction: $MnO_4^- + 5e^- \rightarrow Mn^{2+} + 4H_2O$

1 The pale green Fe^{2+} is oxidised to orange Fe^{3+} because it loses an electron.
This is an oxidation reaction because there is a loss of electrons and an increase in oxidation number.

Oxidation: $Fe^{2+} \rightarrow Fe^{3+} + e^-$

	Grade Boundary: Low Achieved
5.	For Achieved, the student needs to demonstrate understanding of oxidation-reduction. This involves describing, identifying, naming, giving an account of oxidation-reduction and describing oxidation-reduction reactions. This requires the use of chemistry vocabulary, symbols and conventions. The student has identified the formulae of species from observations (colour of species) for both half reactions (1). The reduction half reaction is correctly identified and described by the gain of electrons (2). Chemistry vocabulary, symbols and conventions are used. For a more secure Achieved, the student could provide evidence for oxidation number change or loss or gain of electrons. This evidence could be in the form of half equations.

Student 5: Low Achieved

When fresh iron(II) sulfate solution is added to acidified potassium permanganate solution, a pale green solution and a purple solution react to form an orange solution.

Justify why this is an oxidation-reduction reaction. Your answer should include:

- Species linked to the provided observations
- An explanation of oxidation and reduction in terms of electron transfer or oxidation number change
- Balanced half and full equations

Answer:

The potassium permanganate is purple because the MnO_4^- ion is purple. During the reaction purple permanganate ions changes to colourless Mn^{2+} ions. (1)
When this change happens the MnO_4^- ion gains electrons and is reduced. Reduction is a gain of electrons. (2)

The electrons that the MnO_4^- ion gains comes from the Fe^{2+} ion.

The pale green Fe^{2+} ion loses electrons and changes to the Fe^{3+} ion which is orange. The loss of electrons by the Fe^{2+} ion means that it is the reductant. (1)

	Grade Boundary: High Not Achieved
6.	For Achieved, the student needs to demonstrate understanding of oxidation-reduction. This involves describing, identifying, naming, giving an account of oxidation-reduction and describing oxidation-reduction reactions. This requires the use of chemistry vocabulary, symbols and conventions. The student has identified the formulae of species from observations (colour of species) for both half reactions (1). The reduction half reaction is correctly identified and described by the gain of electrons (2). Chemistry vocabulary is used (2). To reach Achieved, the student could identify the oxidation reaction with reasons (3).

Student 6: High Not Achieved

When fresh iron(II) sulfate solution is added to acidified potassium permanganate solution, a pale green solution and a purple solution react to form an orange solution.

Justify why this is an oxidation-reduction reaction. Your answer should include:

- Species linked to the provided observations
- An explanation of oxidation and reduction in terms of electron transfer or oxidation number change
- Balanced half and full equations

Answer:

(1)

The potassium permanganate is purple because the permanganate ion is purple. During the reaction purple permanganate ions changes to colourless manganese ions.
When this change happens the permanganate ion gains 5 electrons and is reduced. (2)
Reduction occurs when there is a gain of electrons.

The pale green iron (ii) ion changes to the iron (iii) ion which is orange. (1) (3)