HL Paper 1

A reaction takes place when a rechargeable battery is used:

$$Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$$

Which statements are correct?

I. H^+ is reduced
II. The oxidation state of Pb metal changes from 0 to +2
III. PbO_2 is the oxidising agent

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Markscheme

C

Examiners report

[N/A]

Which statement is correct for a voltaic but **not** for an electrolytic cell?

A. An electrolyte is required.
B. The anode is where oxidation occurs.
C. Ions move in the electrolyte.
D. Electrons flow from the negative electrode to the positive electrode.

Markscheme

D

Examiners report

[N/A]

Which element is reduced in the following decomposition?

$(NH_4)_2Cr_2O_7(s) \rightarrow N_2(g) + Cr_2O_3(s) + 4H_2O(g)$

A. N

B. H

C. Cr

D. O

Markscheme

C

Examiners report

[N/A]

Which change represents oxidation?

A. $HClO_4$ to $HClO_3$

B. N_2 to NH_3

C. N_2O to NO

D. SO_4^{2-} to SO_3^{2-}

Markscheme

C

Examiners report

[N/A]

What is the correct order of reaction types in the following sequence?

$$C_3H_7Br \xrightarrow{\mathbf{I}} C_3H_7OH \xrightarrow{\mathbf{II}} C_2H_5COOH \xrightarrow{\mathbf{III}} C_2H_5COOC_2H_5$$

	I	II	III
A.	substitution	oxidation	condensation
B.	addition	substitution	condensation
C.	oxidation	substitution	condensation
D.	substitution	oxidation	substitution

Markscheme

A

Examiners report

[N/A]

What is the name of $\mathrm{MnO_2}$?

A. Manganese(II) oxide

B. Magnesium(II) oxide

C. Manganese(IV) oxide

D. Magnesium(IV) oxide

Markscheme

C

Examiners report

[N/A]

The following equations indicate reactions that occur spontaneously.

$$\mathrm{Fe(s) + NiCl_2(aq) \rightarrow FeCl_2(aq) + Ni(s)}$$
$$\mathrm{Zn(s) + FeCl_2(aq) \rightarrow ZnCl_2(aq) + Fe(s)}$$
$$\mathrm{Ni(s) + PbCl_2(aq) \rightarrow NiCl_2(aq) + Pb(s)}$$

Which is the **increasing** order of the reactivity of the metals?

A. $\mathrm{Fe < Ni < Zn < Pb}$

B. $\mathrm{Pb < Ni < Fe < Zn}$

C. $\mathrm{Ni < Zn < Pb < Fe}$

D. $\mathrm{Zn < Fe < Ni < Pb}$

Markscheme

B

Examiners report

[N/A]

Consider the following half-equations:

I_2 (s) + $2e^-$ $\rightleftharpoons$ $2I^-$ (aq) E^θ = +0.54 V
(brown) (colourless)

MnO_4^- (aq) + $8H^+$ (aq) + $5e^-$ $\rightleftharpoons$ Mn^{2+} (aq) + $4H_2O$ (l) E^θ = +1.51 V
(purple) (colourless)

Which statement is correct for the reaction between $KMnO_4$ (aq) and KI (aq) in acidic conditions?

A. MnO_4^- reduces I^- to I_2.

B. I^- reduces MnO_4^- to Mn^{2+}.

C. The colour changes from brown to purple.

D. MnO_4^- is oxidized to Mn^{2+}.

Markscheme

B

Examiners report

[N/A]

Which is a redox reaction?

A. $[Cu(H_2O)_4]^{2+}(aq) + 4Cl^-(aq) \rightarrow [CuCl_4]^{2-}(aq) + 4H_2O(l)$

B. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

C. $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

D. $2K_2CrO_4(aq) + 2HCl(aq) \rightarrow K_2Cr_2O_7(aq) + H_2O(l) + 2KCl(aq)$

Markscheme

C

Examiners report

[N/A]

Applying IUPAC rules, what is the name of MnO_2?

A. Magnesium(II) oxide
B. Manganese(II) oxide

C. Magnesium(IV) oxide
D. Manganese(IV) oxide

Markscheme

D

Examiners report

[N/A]

Consider the following reaction.

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

Which statement is correct?

A. $\mathrm{MnO_4^-}$ is the oxidizing agent and it loses electrons.

B. $\mathrm{MnO_4^-}$ is the reducing agent and it loses electrons.

C. $\mathrm{MnO_4^-}$ is the oxidizing agent and it gains electrons.

D. $\mathrm{MnO_4^-}$ is the reducing agent and it gains electrons.

Markscheme

C

Examiners report

[N/A]

Which species are the oxidizing and reducing agents in the following reaction?

$$\mathrm{SO_3^{2-}(aq) + PbO_2(s) + H_2O(l) \rightarrow SO_4^{2-}(aq) + Pb(OH)_2(s)}$$

	Oxidizing agent	Reducing agent
A.	$\mathrm{PbO_2}$	$\mathrm{H_2O}$
B.	$\mathrm{SO_3^{2-}}$	$\mathrm{PbO_2}$
C.	$\mathrm{H_2O}$	$\mathrm{SO_3^{2-}}$
D.	$\mathrm{PbO_2}$	$\mathrm{SO_3^{2-}}$

Markscheme

D

Examiners report

[N/A]

Which compounds can be reduced?

I. C_2H_4
II. CH_3COOH
III. CH_3CHO

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Markscheme

D

Examiners report

[N/A]

Which species are produced at each electrode during the electrolysis of molten lead(II) bromide, $\mathrm{PbBr_2(l)}$?

	Negative electrode (cathode)	Positive electrode (anode)
A.	$Br^-(l)$	$Pb^{2+}(l)$
B.	$Pb^{2+}(l)$	$Br^-(l)$
C.	$Br_2(g)$	$Pb(l)$
D.	$Pb(l)$	$Br_2(g)$

Markscheme

D

Examiners report

Candidates needed to notice that it is the “species produced” that is required. Many gave B, the *ions* attracted to the electrodes or A, the wrong ions attracted to the electrodes.

Which are correct statements about a voltaic cell?

I. A spontaneous redox reaction occurs which converts chemical energy to electrical energy.

II. Oxidation occurs at the negative electrode (anode).

III. Electricity is conducted by the movement of electrons through the salt bridge.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Markscheme

A

Examiners report

[N/A]

Consider the following reaction.

$$2\mathrm{Cr(OH)_3(s)} + 6\mathrm{ClO^-(aq)} \rightarrow 2\mathrm{CrO_4^{2-}(aq)} + 3\mathrm{Cl_2(g)} + 2\mathrm{OH^-(aq)} + 2\mathrm{H_2O(l)}$$

Which statement is correct?

A. $\mathrm{Cr(OH)_3}$ is the oxidizing agent and the oxidation number of chromium changes from +3 to +6.

B. $\mathrm{Cr(OH)_3}$ is the reducing agent and undergoes reduction.

C. $\mathrm{ClO^-}$ is the oxidizing agent and the oxidation number of chlorine changes from +1 to 0.

D. $\mathrm{ClO^-}$ is the reducing agent and the oxidation number of chlorine changes from –1 to 0.

Markscheme

C

Examiners report

[N/A]

Which represents a redox reaction?

A. $\mathrm{NaH(s) + H_2O(l) \rightarrow NaOH(aq) + H_2(g)}$

B. $\mathrm{CaCO_3(s) \rightarrow CaO(s) + CO_2(g)}$

C. $\mathrm{CuCl_2(aq) + K_2S(aq) \rightarrow CuS(s) + 2KCl(aq)}$

D. $\mathrm{HCl(aq) + NH_3(aq) \rightarrow NH_4^+Cl^-(aq)}$

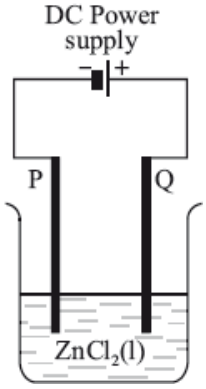
Markscheme

A

Examiners report

[N/A]

In the electrolytic cell shown, at which electrode will chlorine form, and what is the process taking place there?



	Electrode	Process
A.	P	reduction
B.	Q	reduction
C.	P	oxidation
D.	Q	oxidation

Markscheme

D

Examiners report

[N/A]

Which compound contains nitrogen with an oxidation number of +3?

A. NH_4Cl

B. HNO_3

C. N_2O_4

D. KNO_2

Markscheme

D

Examiners report

[N/A]