Oxidation Number 1

A Level

Essential Pre-Uni Chemistry K1.1

Give the oxidation number of nitrogen in the following compounds:

Part A NH_3

NH_3

Part B NO

NO

Part C N_2

N_2

Part D NO_2

NO_2

Part E HNO_3

HNO_3

Part F $Ca(NO_3)_2$

$Ca(NO_3)_2$

Part G N_2H_4

N_2H_4

Part H Mg_3N_2

Mg_3N_2

Part I NCl_3

NCl_3

Part J NO^+

NO^+

Oxidation Number 2

A Level

Essential Pre-Uni Chemistry K1.2

Write down the oxidation number of:

Part A H_2O

Oxygen in H_2O

Part B H_2SO_4

Sulfur in H_2SO_4

Part C H_3PO_4

Phosphorus in H_3PO_4

Part D H_3PO_3

Phosphorus in H_3PO_3

Part E $\mathrm{ClO_2}$

Chlorine in $\mathrm{ClO_2}$

Part F $\mathrm{OF_2}$

Oxygen in $\mathrm{OF_2}$

Part G **Sodium nitrite**

Nitrogen in sodium nitrite $\mathrm{NaNO_2}$

Part H **Ammonium sulfate**

Nitrogen in ammonium sulfate $\mathrm{(NH_4)_2(SO_4)}$

Part I **Hydrogen peroxide**

Oxygen in hydrogen peroxide $\mathrm{H_2O_2}$

Part J VO_2^+

V in VO_2^+

Part K VO^{2+}

V in VO^{2+}

Part L Hg_2^{2+}

Hg in Hg_2^{2+}

Part M $Cr_2O_7^{2-}$

Cr in $Cr_2O_7^{2-}$

Part N MnO_4^-

Mn in MnO_4^-

Part O I_3^-

I in I_3^-

Gameboard:

STEM SMART Chemistry Week 10

Oxidation Number 3

A Level

P P P

Essential Pre-Uni Chemistry K1.3

Select the element or species that is being reduced in the following reactions

Part A **(a)**

$$CuO + H_2 \longrightarrow Cu + H_2O$$

- O in H_2O
- H in H_2
- Cu in CuO
- O in CuO

Part B **(b)**

$$C_3H_6 + H_2 \longrightarrow C_3H_8$$

- C_3H_6
- C_3H_8
- H in H_2
- H in C_3H_6

Part C (c)

$2\,\mathrm{Na} + \mathrm{Br_2} \longrightarrow 2\,\mathrm{NaBr}$

- Na
- $\mathrm{Br_2}$
- Br in NaBr
- Na in NaBr

Part D (d)

$\mathrm{H_2O_2} + 2\,\mathrm{FeSO_4} + \mathrm{H_2SO_4} \longrightarrow 2\,\mathrm{H_2O} + \mathrm{Fe_2(SO_4)_3}$

- S in $\mathrm{H_2SO_4}$
- Fe in $\mathrm{FeSO_4}$
- S in $\mathrm{FeSO_4}$
- $\mathrm{H_2O_2}$

Part E (e)

$\mathrm{ZnCl_2} \longrightarrow \mathrm{Zn} + \mathrm{Cl_2}$

- Cl in $\mathrm{ZnCl_2}$
- Zn in $\mathrm{ZnCl_2}$
- Cl in $\mathrm{Cl_2}$

Part F (f)

$$Fe_2(SO_4)_3 + Zn \longrightarrow 2\,FeSO_4 + ZnSO_4$$

- Fe in $Fe_2(SO_4)_3$
- Zn in $ZnSO_4$
- S in $Fe_2(SO_4)_3$
- Zn

Part G (g)

$$NiSO_4 + Fe \longrightarrow FeSO_4 + Ni$$

- S in $NiSO_4$
- O in $NiSO_4$
- Fe
- Ni in $NiSO_4$

Part H (h)

$$4\,C_3H_6O + NaBH_4 + 4\,H_2O \longrightarrow 4\,C_3H_8O + NaB(OH)_4$$

- C_3H_6O
- H in $NaBH_4$
- H in C_3H_6O
- B in $NaBH_4$

Oxidation Number 4

A Level

Essential Pre-Uni Chemistry K1.4

Select the element or species that is being oxidised in the following reactions.

Part A **(a)**

$$2\,\mathrm{Al} + \mathrm{Cr_2O_3} \longrightarrow \mathrm{Al_2O_3} + 2\,\mathrm{Cr}$$

- Al
- O in $\mathrm{Cr_2O_3}$
- Cr in $\mathrm{Cr_2O_4}$
- Al in $\mathrm{Al_2O_3}$

Part B **(b)**

$$2\,\mathrm{NH_3} + 3\,\mathrm{CuO} \longrightarrow \mathrm{N_2} + 3\,\mathrm{Cu} + 3\,\mathrm{H_2O}$$

- $\mathrm{NH_3}$
- O in CuO
- N in $\mathrm{N_2}$
- Cu in CuO

Part C (c)

$2\,Cu^{2+} + 4\,I^- \longrightarrow 2\,CuI + I_2$

- I^-
- Cu in CuI
- I in CuI
- Cu^{2+}

Part D (d)

$6\,PbO + O_2 \longrightarrow 2\,Pb_3O_4$

- Pb in PbO
- O in PbO
- Pb in Pb_3O_4
- O in O_2

Part E (e)

$H_2O_2 + SO_2 \longrightarrow H_2SO_4$

- H in H_2SO_4
- H_2O_2
- SO_2
- S in H_2SO_4

Part F (f)

$$3\,H_2SO_4 + 2\,NaBr \longrightarrow 2\,NaHSO_4 + Br_2 + SO_2 + 2\,H_2O$$

- Br in NaBr
- H in H_2SO_4
- S in H_2SO_4
- Na in NaBr

Part G (g)

$$Mg + 2\,CH_3COOH \longrightarrow Mg(CH_3COO)_2 + H_2$$

- Mg
- H_2
- C in CH_3COOH
- Mg in $Mg(CH_3COO)_2$

Part H (h)

$$2\,Fe^{3+} + 6\,ClO^- + 4\,OH^- \longrightarrow 2\,FeO_4{}^{2-} + 3\,Cl_2 + 2\,H_2O$$

- Fe^{3+}
- OH^-
- O in ClO^-
- Cl in ClO^-

Oxidation States of S and N

A Level

P P P

Part A Oxidation states of sulfur

In which of the following pairs of species is the sulfur in the same oxidation state in both members of the pair?

1. SF_6 and SO_4^{2-}
2. SO_2 and HSO_3^-
3. $S_2O_3^{2-}$ and $S_4O_6^{2-}$

- **1, 2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct
- **3** only is correct

Part B Oxidation states of nitrogen

In which of the following conversions does the oxidation number of the nitrogen change by two?

1. $NH_2OH \longrightarrow NH_3$
2. $N_2 \longrightarrow NO$
3. $NO_2 \longrightarrow HNO_3$

- **1, 2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct
- **3** only is correct

Part A adapted with permission from UCLES, A-Level Chemistry, June 1990, Paper 1, Question 35;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1994, Paper 4, Question 34

Gameboard:
STEM SMART Chemistry Week 10

Rocket and Metal Reduction

A Level

P P P

Part A Solid rocket booster

The propellant used in the solid rocket booster of a space shuttle is a mixture of aluminium and compound **X**. Compound **X** contains chlorine in an oxidation state of $+7$.

Which of the following could be compound **X**?

- N_2H_5Cl
- NCl_3
- NH_4ClO_3
- NH_4ClO_4
- NH_4Cl

Part B Metals and reduction

In which of the following changes has the metal undergone reduction?

- $[Al(H_2O)_6]^{3+} \longrightarrow [Al(OH)_2(H_2O)_4]^{+}$
- $[Co(NH_3)_6]^{2+} \longrightarrow [CoCl_4]^{2-}$
- $[CuCl_4]^{2-} \longrightarrow [CuCl_2]^{-}$
- $MnO_4{}^{2-} \longrightarrow MnO_4{}^{-}$
- $[Cr(OH)_6]^{3-} \longrightarrow CrO_4{}^{2-}$

Oxidation Numbers of Halides

A Level

Part A Oxidation of bromine

What changes can be regarded as oxidation of bromine?

1. $Br_2 \longrightarrow BrO^-$
2. $Br_2 \longrightarrow BrF$
3. $Br_2 \longrightarrow BrI$

- **1, 2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct

Part B Oxidation numbers of halides

Which of the statements about the reaction below are correct?

$$\mathrm{IO_3}^-\,(\mathrm{aq}) + 2\,\mathrm{I}^-\,(\mathrm{aq}) + 6\,\mathrm{H}^+\,(\mathrm{aq}) + 6\,\mathrm{Cl}^-\,(\mathrm{aq}) \longrightarrow 3\,\mathrm{ICl_2}^-\,(\mathrm{aq}) + 3\,\mathrm{H_2O}\,(\mathrm{l})$$

1. The oxidation number of chlorine changes from -1 to -2.
2. The oxidation number of the iodine in the iodide ion $\mathrm{I}^-\,(\mathrm{aq})$ changes from -1 to $+1$.
3. The oxidation number of the iodine in the iodate ion $\mathrm{IO_3}^-\,(\mathrm{aq})$ changes from $+5$ to $+1$.

- **1, 2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct

Part A adapted with permission from UCLES, A-Level Chemistry, June 1996, Paper 3, Question 37;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1989, Paper 3, Question 37

Gameboard:

STEM SMART Chemistry Week 10

Platinum, Hydroquinone and Silver

A Level

Part A Oxidation numbers of platinum

The anti-cancer drug *cis-platin* has the formula $\mathrm{Pt(NH_3)_2Cl_2}$.

In the human body, one of the chloride ions of *cis-platin* is replaced by one water molecule.

$$\mathrm{Pt(NH_3)_2Cl_2 + H_2O \longrightarrow [Pt(NH_3)_2(H_2O)Cl]^+ + Cl^-}$$

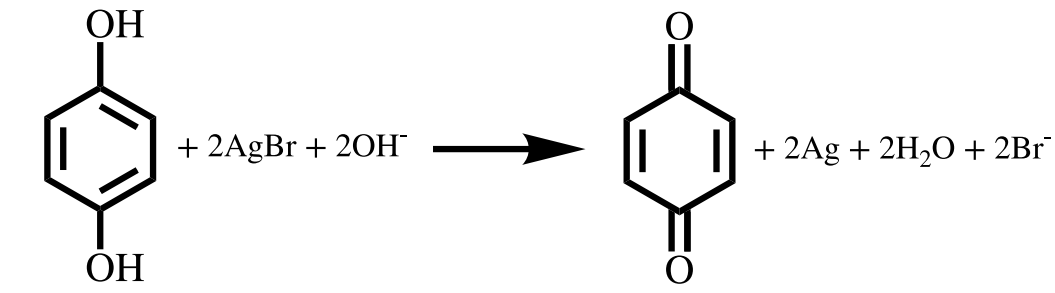
What is the oxidation number of platinum in each of these complexes?

	cis-platin	*in the aquo complex*
A	$+2$	$+1$
B	$+2$	$+2$
C	$+4$	$+3$
D	$+4$	$+4$

- **A**
- **B**
- **C**
- **D**

Part B Hydroquinone and silver bromide

When exposed film from a camera is developed, one step involves reacting the light-activated silver bromide crystals with hydroquinone in alkali according to the following equation:



Hydroquinone

Figure 1: Hydroquinone and silver bromide in presence of base.

Which of the following describes the role of hydroquinone?

- It acts only as a reducing agent
- It acts as both a base and a reducing agent
- It acts only as an oxidising agent
- It acts only as an acid
- It acts as both an acid and a reducing agent

Part A adapted with permission from UCLES, A-Level Chemistry, June 1996, Paper 3, Question 9;
Part B adapted with permission from OCSEB, A-Level Chemistry, June 1994, Paper 1, Question 3

Gameboard:

STEM SMART Chemistry Week 10

Ferrite

A Level

C C C

Aerials in portable radios are made of a mixed oxide of calcium and iron known as 'Ferrite'. It contains 18.5 % calcium and 51.9 % iron by mass. Calculate the empirical formula of 'Ferrite' and hence deduce the oxidation number of the iron it contains.

Part A Empirical formula

Empirical Formula:

Part B Oxidation number

Oxidation number:

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

Gameboard:

STEM SMART Chemistry Week 10

Oxides of Nitrogen

A Level

C C C

Part A Oxides of nitrogen

In an attempt to establish the formula of an oxide of nitrogen, a known volume of the pure gas was mixed with hydrogen and passed over a catalyst at a suitable temperature. 100% conversion of the oxide to ammonia and water was shown to have taken place.

$$\mathrm{N}_x\,\mathrm{O}_y \xrightarrow[\text{catalyst}]{\mathrm{H_2}} x\,\mathrm{NH_3} + y\,\mathrm{H_2O}$$

$2400\,\mathrm{cm^3}$ of the nitrogen oxide, measured at room temperature and pressure (RTP) produced $7.200\,\mathrm{g}$ of water. The ammonia produced was neutralised by $200\,\mathrm{cm^3}$ of $1.0\,\mathrm{mol\ dm^{-3}\ HCl}$.

[Molar volume of gas at RTP = $24000\,\mathrm{cm^3\ mol^{-1}}$]

What was the oxidation number of nitrogen in the solid oxide?

- +1
- +2
- +3
- +4
- +5

Part B Oxidation numbers of nitrogen

The key stage in the manufacture of nitric acid is the reaction of ammonia with air in the presence of a platinum-rhodium gauze:

$$4\,\mathrm{NH_3\,(g)} + 5\,\mathrm{O_2\,(g)} \longrightarrow 4\,\mathrm{NO\,(g)} + 6\,\mathrm{H_2O\,(g)}$$

What is the oxidation number of nitrogen in

$\mathrm{NH_3}$

NO

Part A adapted with permission from UCLES, A-Level Chemistry, November 1989, Paper 3, Question 2;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1995, Paper 3, Question 1