Cambridge AS & A Level

CHEMISTRY

Paper 1

Topical Past Paper Questions

+ Answer Scheme

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PapaCambridge

Chapter 6

Electrochemistry

6.1 Redox processes: electron transfer and changes in oxidation number (oxidation state)

281. 9701_m22_qp_12 Q: 10

Two half-equations are shown.

$$MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2 + 4OH^-$$

$$2OH^- + SO_3^{2-} \rightarrow SO_4^{2-} + H_2O + 2e^-$$

The equation for the reaction between manganate(VII) ions and sulfite ions is shown.

$$uMnO_4^- + vH_2O + wSO_3^{2-} \rightarrow xMnO_2 + ySO_4^{2-} + zOH^-$$

Which statements are correct?

1 $u = x = z$

2 Manganese is reduced to oxidation state +4.

3 Sulfur is oxidised from oxidation state +4 to +6.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

282. 9701_m21_qp_12 Q: 8

VO_2Cl reacts with NaI under acidic conditions.

$$2VO_2Cl + 2H_2SO_4 + 2NaI \rightarrow VOCl_2 + VOSO_4 + I_2 + Na_2SO_4 + 2H_2O$$

The oxidation state of Cl is –1 in VO_2Cl and in $VOCl_2$.

Which row about this reaction is correct?

	vanadium	iodine
A	is oxidised	is oxidised
B	is oxidised	is reduced
C	is reduced	is oxidised
D	is reduced	is reduced

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283. 9701_s21_qp_11 Q: 9

When hydrogen iodide is reacted with concentrated sulfuric acid, several reactions occur, including:

$$8HI + H_2SO_4 \rightarrow H_2S + 4H_2O + 4I_2$$

Which row gives the change in oxidation number of iodine and of sulfur in this reaction?

	change in oxidation number of iodine	change in oxidation number of sulfur
A	–1	+6
B	–1	+8
C	+1	–6
D	+1	–8

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284. 9701_s21_qp_12 Q: 9

The equation for a redox reaction is shown.

$$SnCl_2(aq) + 2HgCl_2(aq) \rightarrow SnCl_4(aq) + Hg_2Cl_2(s)$$

Which species is being oxidised in this reaction?

A Sn^{2+} **B** Cl^- **C** Hg^+ **D** Hg^{2+}

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285. 9701_w21_qp_11 Q: 9

Zinc atoms can be oxidised to Zn^{2+} ions by dichromate(VI) ions in acid solution. Chromium is reduced to Cr^{3+} in this reaction.

Which equation is correct?

A $Cr_2O_7^{2-} + Zn + 14H^+ \rightarrow 2Cr^{3+} + Zn^{2+} + 7H_2O$

B $Cr_2O_7^{2-} + Zn + 14H^+ \rightarrow 2Cr^{3+} + 3Zn^{2+} + 7H_2O$

C $Cr_2O_7^{2-} + 3Zn + 14H^+ \rightarrow 2Cr^{3+} + 3Zn^{2+} + 7H_2O$

D $2Cr_2O_7^{2-} + 3Zn + 14H^+ \rightarrow 2Cr^{3+} + 3Zn^{2+} + 7H_2O$

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286. 9701_w21_qp_12 Q: 10

In a catalytic converter in the exhaust system of a car, carbon monoxide is oxidised to carbon dioxide, and nitrogen monoxide is reduced to nitrogen.

What are the changes in oxidation number of carbon and nitrogen in these two processes?

	carbon	nitrogen
A	–2	+2
B	–1	+1
C	+1	–1
D	+2	–2

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287. 9701_m20_qp_12 Q: 5

In the redox reaction shown, how do the oxidation states of vanadium and sulfur change?

$$VO_2^+ + SO_2 \rightarrow V^{3+} + SO_4^{2-}$$

	vanadium		sulfur	
	from	to	from	to
A	+1	+3	0	–2
B	+1	+3	+4	+6
C	+5	+3	0	–2
D	+5	+3	+4	+6

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288. 9701_m20_qp_12 Q: 10

When the equation is correctly balanced, what is the value of *c*?

$$aC_2H_4 + bH_2O + cH^+ + 2MnO_4^- \rightarrow dC_2H_6O_2 + eMn^{2+}$$

A 3 **B** 4 **C** 5 **D** 6

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289. 9701_s20_qp_11 Q: 2

Cobalt can form the positive ion $Co(NH_3)_4Cl_2^+$.

What is the oxidation number of cobalt in this ion?

A +1 **B** +2 **C** +3 **D** +6

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290. 9701_s20_qp_11 Q: 8

In this question you should use changes in oxidation numbers to balance a chemical equation.

Acidified potassium dichromate(VI) solution can oxidise a solution of V^{2+} ions. The equation for this reaction is shown.

$$a\,Cr_2O_7^{2-} + b\,V^{2+} + c\,H^+ \rightarrow d\,Cr^{3+} + e\,VO_3^- + f\,H_2O$$

What is the ratio $a : b$ in the correctly balanced equation?

A 1 : 1 **B** 1 : 2 **C** 2 : 1 **D** 4 : 1

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291. 9701_s20_qp_12 Q: 5

In this question you should use changes in oxidation numbers to balance a chemical equation.

The following reaction occurs when MnO_2 is warmed with dilute H_2SO_4.

$$a\,MnO_2 + b\,H^+ \rightarrow c\,Mn^{2+} + d\,MnO_4^- + e\,H_2O$$

What is the ratio of c : d in the correctly balanced equation?

A 1 : 1 **B** 1 : 2 **C** 2 : 3 **D** 3 : 2

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292. 9701_s20_qp_12 Q: 10

In which reaction does an element undergo the largest change in oxidation number?

A $Cl_2 + 2OH^- \rightarrow OCl^- + Cl^- + H_2O$

B $3Cl_2 + 6OH^- \rightarrow ClO_3^- + 5Cl^- + 3H_2O$

C $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

D $3MnO_4^{2-} + 4H^+ \rightarrow MnO_2 + 2MnO_4^- + 2H_2O$

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293. 9701_s20_qp_13 Q: 10

When solid $KClO_3$ is heated in the absence of air, a mixture of two chlorine compounds in the mole ratio of 3 : 1 is formed. Chlorine is the only element whose oxidation number changes in this reaction.

What could be the oxidation numbers of chlorine in the two compounds that are formed?

A +3 and –1 **B** +6 and +4 **C** +7 and –1 **D** +7 and +1

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294. 9701_w20_qp_11 Q: 8

In which reaction does the greatest change in the oxidation number of sulfur occur?

A $S(s) + O_2(g) \rightarrow SO_2(g)$

B $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$

C $SO_3(g) + H_2SO_4(l) \rightarrow H_2S_2O_7(l)$

D $H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4(l)$

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295. 9701_w20_qp_11 Q: 9

The first stage in the chloride process for the manufacture of titanium consists of the following reaction.

$$2TiO_2 + 4Cl_2 + 3C \rightarrow 2TiCl_4 + 2CO + CO_2$$

What is reduced in this reaction?

A carbon

B chlorine

C oxygen

D titanium

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296. 9701_w20_qp_12 Q: 1

What is the average oxidation number of sulfur in each compound?

	$Ca(HSO_3)_2$	$Na_2S_2O_3$
A	4	2
B	4	4
C	6	2
D	6	4

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297. 9701_w20_qp_12 Q: 9

Chlorine dioxide, ClO_2, reacts with sodium hydroxide in the reaction shown.

$$2ClO_2 + 2OH^- \rightarrow ClO_2^- + ClO_3^- + H_2O$$

Which statement correctly describes this redox reaction?

A Chlorine atoms are oxidised and oxygen atoms are reduced.

B Chlorine atoms are reduced and oxygen atoms are oxidised.

C Some chlorine atoms are oxidised and some chlorine atoms are reduced.

D Some oxygen atoms are oxidised and some oxygen atoms are reduced.

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298. 9701_m19_qp_12 Q: 10

Acidified potassium manganate(VII) reacts with iron(II) ethanedioate, FeC_2O_4.

The reactions taking place are shown.

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

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

$$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$$

How many moles of iron(II) ethanedioate react with **one** mole of potassium manganate(VII)?

A 0.60 **B** 1.67 **C** 2.50 **D** 5.00

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299. 9701_s19_qp_11 Q: 9

Ethanedioic acid, HO_2CCO_2H, can be oxidised by $KMnO_4$ in dilute sulfuric acid. The products of this reaction are carbon dioxide, water, potassium sulfate and manganese(II) sulfate.

In this reaction each ethanedioic acid molecule loses two electrons as it is oxidised. A half-equation for this process is shown.

$$HO_2CCO_2H \rightarrow 2CO_2 + 2H^+ + 2e^-$$

How many water molecules are produced when five ethanedioic acid molecules are oxidised by $KMnO_4$ in dilute sulfuric acid?

A 5 **B** 8 **C** 10 **D** 16

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300. 9701_s19_qp_12 Q: 9

X is either chlorine or an oxide of chlorine.

X reacts with water, under suitable conditions, to form the two acids HCl and $HClO_3$ in the mole ratio of 1 (HCl) : 5 ($HClO_3$).

What could be X?

A Cl_2 **B** Cl_2O **C** ClO_2 **D** Cl_2O_7

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301. 9701_s19_qp_13 Q: 1

Manganese and nitrogen can show a range of different oxidation states.

Calculate the sum of the oxidation states of Mn and N in each row of the table.

In which row is this sum the smallest?

	manganese-containing species	nitrogen-containing species
A	$MnCl_4$	N_2
B	$MnCO_3$	NO_2^-
C	K_2MnO_4	NH_4^+
D	$Mn(OH)_3$	NH_2OH

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302. 9701_s19_qp_13 Q: 8

Ethanol can be oxidised to ethanal by dilute acidified dichromate(VI) ions.

The oxidation reaction equation is $C_2H_5OH \rightarrow C_2H_4O + 2H^+ + 2e^-$.

The reduction reaction equation is $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$.

Which equation is correct?

A $Cr_2O_7^{2-} + 8H^+ + 3C_2H_5OH \rightarrow 2Cr^{3+} + 7H_2O + 3C_2H_4O$

B $Cr_2O_7^{2-} + 12H^+ + C_2H_5OH \rightarrow 2Cr^{3+} + 7H_2O + C_2H_4O$

C $Cr_2O_7^{2-} + 12H^+ + 3C_2H_5OH \rightarrow 2Cr^{3+} + 6H_2O + 3C_2H_4O$

D $Cr_2O_7^{2-} + 14H^+ + 3C_2H_5OH \rightarrow 2Cr^{3+} + 6H_2O + 3C_2H_4O$

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303. 9701_w19_qp_11 Q: 6

What is the oxidation number of sulfur in each species?

	H_2S	SO_2	H_2SO_3
A	–2	+4	+4
B	–2	+4	+6
C	+2	–4	+4
D	+2	–4	+6

---

304. 9701_w19_qp_11 Q: 9

In the chemical equation, w, x, y and z are all whole numbers.

$$wClO_3^- + xMnO_4^- + yH^+ \rightarrow wClO_4^- + xMnO_2 + zH_2O$$

When the equation is balanced, what are w, x and y?

	w	x	y
A	1	1	2
B	2	2	2
C	2	3	8
D	3	2	2

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305. 9701_w19_qp_12 Q: 8

$(NH_4)_2Cr_2O_7$ decomposes when heated.

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

Which element is oxidised and which element is reduced?

	oxidised	reduced
A	chromium	nitrogen
B	hydrogen	chromium
C	nitrogen	chromium
D	nitrogen	hydrogen

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306. 9701_w19_qp_12 Q: 15

Chlorate(V) ions, ClO_3^-, are produced in the redox reaction between chlorine and hot aqueous sodium hydroxide. Oxidation numbers can be used to help balance the equation for this reaction.

$$vCl_2(g) + wOH^-(aq) \rightarrow xCl^-(aq) + yClO_3^-(aq) + zH_2O(l)$$

What are the values of v, x and y in the balanced equation?

	v	x	y
A	2	3	1
B	3	4	2
C	3	5	1
D	7	12	2

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307. 9701_m18_qp_12 Q: 10

Which reaction is **not** a redox reaction?

A $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$

B $2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$

C $SO_2 + NO_2 \rightarrow SO_3 + NO$

D $SO_3 + H_2O \rightarrow H_2SO_4$

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308. 9701_m18_qp_12 Q: 11

The reaction between sulfur dioxide and oxygen is reversible.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3 \qquad \Delta H^\ominus = -196\,kJ\,mol^{-1}$$

Which conditions of pressure and temperature favour the **reverse** reaction?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

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309. 9701_m18_qp_12 Q: 12

Which statement about the effect of a catalyst on a reversible reaction is correct?

A The activation energy of the forward reaction stays the same.

B The composition of the equilibrium mixture stays the same.

C The rate of the backward reaction stays the same.

D The value of the equilibrium constant changes.

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310. 9701_s18_qp_11 Q: 8

Ethanedioate ions, $C_2O_4^{2-}$, react with a suitable reagent to form CO_2. A half-equation for this reaction is shown.

$$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$$

Which row is correct?

	oxidation state of carbon in $C_2O_4^{2-}$	type of reaction
A	+3	oxidation
B	+3	reduction
C	+5	oxidation
D	+5	reduction

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311. 9701_s18_qp_11 Q: 9

Oxidation numbers should be used to answer this question.

A redox reaction takes place between hydroxylammonium ions, $[NH_3OH]^+$, and acidified iron(III) ions, Fe^{3+}. The products are iron(II) ions, Fe^{2+}, H^+ ions, water and a compound of nitrogen.

The mole ratio of reacting hydroxylammonium ions to reacting iron(III) ions is 1 : 2.

Which nitrogen-containing compound could be formed in the reaction?

A NH_3 **B** N_2O **C** NO **D** NO_2

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312. 9701_s18_qp_12 Q: 8

Sulfur reacts with concentrated nitric acid in a redox reaction.

$$S + 4HNO_3 \rightarrow SO_2 + 4NO_2 + 2H_2O$$

What are the changes in oxidation number of sulfur and of nitrogen in this reaction?

	sulfur	nitrogen
A	+2	–3
B	+2	–1
C	+4	–3
D	+4	–1

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313. 9701_s18_qp_13 Q: 8

Xenon hexafluoride, XeF_6, reacts with water.

$$XeF_6 + 3H_2O \rightarrow XeO_3 + 6HF$$

Which statement is correct?

A Hydrogen is reduced in this reaction.

B Hydrogen is the only element oxidised in this reaction.

C The only element oxidised in this reaction is xenon.

D This is not a redox reaction.

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314. 9701_w18_qp_11 Q: 7

Nitric acid is known to take part in the oxidation of atmospheric sulfur dioxide. One possible reaction is shown.

$$SO_2 + HNO_3 \rightarrow NO^+ + HSO_4^-$$

Which row shows the correct changes in oxidation numbers of nitrogen and sulfur?

	nitrogen	sulfur
A	–3	+3
B	–2	+2
C	–2	+3
D	–1	+2

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315. 9701_w18_qp_11 Q: 8

A transition metal ion, M^{2+}, reacts with acidified dichromate(VI) ions to form M^{4+} ions, Cr^{3+} ions, and H_2O.

Which equation correctly represents this reaction?

A $Cr_2O_7^{2-} + 14H^+ + M^{2+} \rightarrow 2Cr^{3+} + 7H_2O + M^{4+}$

B $Cr_2O_7^{2-} + 14H^+ + 2M^{2+} \rightarrow 2Cr^{3+} + 7H_2O + 2M^{4+}$

C $Cr_2O_7^{2-} + 14H^+ + 3M^{2+} \rightarrow 2Cr^{3+} + 7H_2O + 3M^{4+}$

D $Cr_2O_7^{2-} + 14H^+ + 6M^{2+} \rightarrow 2Cr^{3+} + 7H_2O + 6M^{4+}$

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316. 9701_w18_qp_12 Q: 8

Ammonium metavanadate, NH_4VO_3, can be used to make a solution containing VO_2Cl, which contains chloride ions.

What is the **change** in the oxidation number of vanadium in this reaction?

A –1 **B** 0 **C** +1 **D** +2

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317. 9701_m17_qp_12 Q: 8

HOCl(aq) is the molecule that kills bacteria when chlorine is added to water.

The following reaction produces this molecule.

$$Cl_2(g) + H_2O(l) \rightleftharpoons HOCl(aq) + H^+(aq) + Cl^-(aq)$$

Which statement about this reaction is correct?

A Chlorine is both oxidised and reduced.

B Chlorine is oxidised but not reduced.

C Hydrogen is both oxidised and reduced.

D Hydrogen is oxidised but not reduced.

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318. 9701_s17_qp_11 Q: 8

Solutions containing chlorate(I) ions are used as household bleaches and disinfectants. These solutions decompose on heating as shown.

$$3ClO^- \rightarrow ClO_3^- + 2Cl^-$$

Which oxidation state is shown by chlorine in each of these three ions?

	ClO^-	ClO_3^-	Cl^-
A	+1	+3	–1
B	–1	+3	+1
C	+1	+5	–1
D	–1	+5	+1

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319. 9701_s17_qp_11 Q: 9

When K_2MnO_4 is dissolved in water, the following reaction occurs.

$$a\,MnO_4^{2-}(aq) + b\,H_2O(l) \rightarrow c\,MnO_4^-(aq) + d\,MnO_2(s) + e\,OH^-(aq)$$

What are the values of *a* and *c* in the balanced chemical equation?

	a	*c*
A	2	1
B	3	2
C	4	3
D	5	4

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320. 9701_s17_qp_12 Q: 8

A reaction sequence is shown.

$$SO_2 \xrightarrow{1} SO_3 \xrightarrow{2} H_2SO_4 \xrightarrow{3} H_2S \xrightarrow{4} SO_2$$

In each stage of this sequence the sulfur is oxidised, reduced or neither oxidised nor reduced.

Which row is correct?

	1	2	3	4
A	neither	oxidised	reduced	reduced
B	oxidised	neither	reduced	reduced
C	oxidised	neither	reduced	oxidised
D	oxidised	oxidised	reduced	oxidised

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321. 9701_s17_qp_13 Q: 4

Two conversions are shown.

$$NH_4^+ \rightarrow NH_3$$

$$C_2H_4 \rightarrow C_2H_6$$

Which similar feature do these two conversions have?

A change in oxidation state of an element

B decrease in bond angle

C formation of a lone pair of electrons

D loss of a π bond

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322. 9701_s17_qp_13 Q: 7

Vanadium reacts with dilute sulfuric acid to form $V_2(SO_4)_3$ and hydrogen gas.

What happens to vanadium atoms in this reaction?

A They lose three electrons and are oxidised.

B They lose three electrons and are reduced.

C They lose two electrons and are oxidised.

D They lose two electrons and are reduced.

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323. 9701_s17_qp_13 Q: 8

$Na_2S_2O_3$ reacts with HCl as shown.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$$

When calculating the oxidation number of sulfur in $Na_2S_2O_3$, the **average** oxidation number of the two sulfur atoms should be found.

What is the oxidation number of sulfur in each of $Na_2S_2O_3$, SO_2, and S?

	$Na_2S_2O_3$	SO_2	S
A	+2	+2	+1
B	+2	+4	0
C	+4	+4	0
D	+5	+4	0

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324. 9701_w17_qp_11 Q: 6

One of the reactions in a lead / acid cell is shown.

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

Which statement about this reaction is correct?

A Lead is both oxidised and reduced.

B Lead is neither oxidised nor reduced.

C Lead is oxidised only.

D Lead is reduced only.

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325. 9701_w17_qp_12 Q: 8

Which statement is **always** correct for an oxidation reaction?

A It involves the gain of oxygen by an element.

B For one reactant to be oxidised a different reactant must be reduced.

C The element or ion being oxidised will gain electrons.

D The oxidation number of the element being oxidised will increase.

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326. 9701_m16_qp_12 Q: 1

Which compound contains two different elements with identical oxidation states?

A HClO **B** $Mg(OH)_2$ **C** Na_2SO_4 **D** NH_4Cl

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327. 9701_s16_qp_12 Q: 9

In the treatment of domestic water supplies, chlorine is added to the water to form HClO.

$$Cl_2(aq) + H_2O(l) \rightarrow H^+(aq) + Cl^-(aq) + HClO(aq)$$

The HClO reacts further to give ClO^- ions.

$$HClO(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + ClO^-(aq)$$

Both HClO and ClO^- kill bacteria by oxidation.

What is the change in oxidation number of chlorine when forming the ClO^- ion from aqueous chlorine?

A –1 **B** 0 **C** +1 **D** +2

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328. 9701_s16_qp_12 Q: 17

Nitrogen(II) oxide, NO, nitrogen(IV) oxide, NO_2, carbon monoxide, CO, and unburnt hydrocarbons are present in the exhaust gases of internal combustion engines. When catalytic converters are used to remove these compounds from the exhaust gases, redox reactions occur.

What happens to each compound in the catalytic converter?

	NO	NO_2	CO	hydrocarbons
A	oxidised	oxidised	reduced	oxidised
B	oxidised	oxidised	oxidised	oxidised
C	reduced	reduced	oxidised	oxidised
D	reduced	reduced	reduced	reduced

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329. 9701_w16_qp_11 Q: 3

The reaction between acidified dichromate(VI) ions, $Cr_2O_7^{2-}$, and aqueous Fe^{2+} ions results in the dichromate(VI) ions being reduced to Cr^{3+} ions.

What is the correct equation for this reaction?

A $Cr_2O_7^{2-} + Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + Fe^{3+} + 7H_2O$

B $Cr_2O_7^{2-} + 2Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 2Fe^{3+} + 7H_2O$

C $Cr_2O_7^{2-} + 3Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 3Fe^{3+} + 7H_2O$

D $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

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330. 9701_w16_qp_11 Q: 9

Sodium chromate(VI), Na_2CrO_4, is manufactured by heating chromite, $FeCr_2O_4$, with sodium carbonate in an oxidising atmosphere. Chromite contains $Cr_2O_4^{2-}$ ions.

$$2FeCr_2O_4 + 4Na_2CO_3 + 3\tfrac{1}{2}O_2 \rightarrow 4Na_2CrO_4 + Fe_2O_3 + 4CO_2$$

What happens in this reaction?

A Chromium and iron are the only elements oxidised.

B Chromium, iron and carbon are oxidised.

C Only chromium is oxidised.

D Only iron is oxidised.

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331. 9701_s15_qp_11 Q: 4

In oxygen difluoride, OF_2, fluorine has an oxidation number of –1. OF_2 will react with sulfur dioxide according to the following equation.

$$OF_2 + SO_2 \rightarrow SO_3 + F_2$$

What is oxidised and what is reduced in this reaction?

	fluorine	oxygen in OF_2	sulfur
A	oxidised	oxidised	reduced
B	oxidised	reduced	oxidised
C	reduced	oxidised	reduced
D	reduced	reduced	oxidised

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332. 9701_s15_qp_12 Q: 10

Photochromic glass, used for sunglasses, darkens when exposed to bright light and becomes more transparent again when the light is less bright. The darkness of the glass is related to the concentration of silver atoms.

The following reactions are involved.

reaction 1 $Ag^+ + Cl^- \rightleftharpoons Ag + Cl$

reaction 2 $Cu^+ + Cl \rightarrow Cu^{2+} + Cl^-$

reaction 3 $Cu^{2+} + Ag \rightarrow Cu^+ + Ag^+$

Which statement about these reactions is correct?

A Cu^+ and Cu^{2+} ions act as catalysts.

B Cu^+ ions act as an oxidising agent in reaction 2.

C Reaction 3 increases the darkness of the glass.

D Silver atoms are reduced in reaction 3.

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333. 9701_s15_qp_13 Q: 5

In which reaction does an element have the largest change in oxidation number?

A $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

B $3OCl^- \rightarrow ClO_3^- + 2Cl^-$

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

D $PbO_2 + Sn^{2+} + 4H^+ \rightarrow Sn^{4+} + Pb^{2+} + 2H_2O$

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334. 9701_s15_qp_13 Q: 16

Transition elements and their compounds are widely used as catalysts.

What is the identity and what is the oxidation number of the element present in the catalyst used in the Contact process?

	element	oxidation number
A	iron	0
B	iron	+3
C	vanadium	0
D	vanadium	+5

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335. 9701_w15_qp_11 Q: 19

Element X forms a pollutant oxide Y. Y can be further oxidised to Z. Two students made the following statements.

Student P 'The molecule of Y contains lone pairs of electrons.'

Student Q 'The oxidation number of X increases by 1 from Y to Z.'

X could be carbon or nitrogen or sulfur.

Which student(s) made a correct statement?

A P only

B Q only

C both P and Q

D neither P nor Q

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336. 9701_w15_qp_12 Q: 5

Calcium forms an ionic compound with carbon, called calcium carbide. The oxidation number of carbon in calcium carbide is –1.

Calcium carbide is readily hydrolysed by water giving two products only.

What could be the formulae of calcium carbide and the two products of hydrolysis?

	calcium carbide	products
A	Ca_2C	CaO and C_2H_4
B	Ca_2C	$Ca(OH)_2$ and C_2H_2
C	CaC_2	CaO and C_2H_4
D	CaC_2	$Ca(OH)_2$ and C_2H_2
