CHEMISTRY MULTIPLE CHOICE QUESTIONS

F. Electrochemistry

2002 -2014

1.

During electrolysis of brine in a diaphragm cell, chlorine, hydrogen and sodium hydroxide are produced.

What is the molar ratio of these products?

	chlorine	*hydrogen*	*sodium hydroxide*
A	1	1	1
B	1	1	2
C	2	1	1
D	2	2	1

[2002 M/J (16)]

2.

In the industrial electrolysis of brine to manufacture chlorine, the diaphragm used is a porous screen which allows the flow of electrolytes but keeps other chemicals separate.

Which substance needs to be kept separate from the chlorine by the diaphragm?

A hydrogen

B sodium hydroxide

C sodium chloride

D water

[2002 O/N (18)]

3.

Use of the Data Booklet is relevant to this question.

In the commercial electrolysis of brine, the products are chlorine, hydrogen and sodium hydroxide.

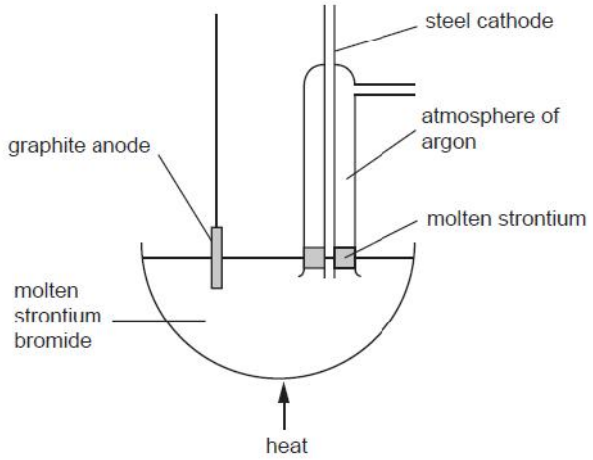
What is the maximum yield of each of these products when 58.5 kg of sodium chloride are electrolysed as brine?

	yield of chlorine / kg	yield of hydrogen / kg	yield of sodium hydroxide / kg
A	35.5	1	40
B	35.5	2	40
C	71	1	40
D	71	2	80

[2004 M/J (18)]

4.

Strontium metal can be obtained by the electrolysis of molten strontium bromide, $SrBr_2$, using the apparatus shown in the diagram.



Why is an atmosphere of argon used around the cathode?

A The argon keeps the strontium molten.

B The argon stops the molten strontium rising too high in the tube.

C A thin film of a compound of strontium and argon forms on the surface protecting the freshly formed metal.

D Without the argon strontium oxide would form in the air.

[2004 O/N (15)]

5.

A weedkiller can be prepared by heating a bleach solution.

$$\underset{\text{bleach}}{3NaClO} \xrightarrow{\text{heat}} \underset{\text{weedkiller}}{2NaCl + NaClO_3}$$

What are the oxidation states of chlorine in these three compounds?

A –1 –1 +5

B +1 –1 +5

C +1 –1 +7

D +2 +1 +7

[2004 O/N (16)]

6.

In the extraction of aluminium by electrolysis, why is it necessary to dissolve aluminium oxide in molten cryolite?

A to reduce the very high melting point of the electrolyte

B cryolite provides the ions needed to carry the current

C cryolite reacts with the aluminium oxide to form ions

D molten aluminium oxide alone would not conduct electricity

[2005 M/J (8)]

7.

A cheap carbon monoxide detector for a gas heater consists of a patch containing palladium chloride crystals. When carbon monoxide is present, the crystals turn from orange to black as the following reaction takes place.

$$\underset{\text{orange}}{CO(g) + PdCl_2(s)} + H_2O(l) \rightarrow CO_2(g) + \underset{\text{black}}{Pd(s)} + 2HCl(aq)$$

Which is the element whose oxidation number **decreases** in this reaction?

A carbon

B chlorine

C hydrogen

D palladium

[2005 M/J (9)]

8.

During the electrolysis of brine using a diaphragm cell, which reaction occurs at the cathode?

A $2Cl^-(aq) \rightarrow Cl_2(g) + 2e$

B $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e$

C $2H_2O(l) + 2e \rightarrow H_2(g) + 2OH^-(aq)$

D $Na^+(aq) + e \rightarrow Na(s)$

[2005 O/N (8)]

9.

The nickel-cadmium rechargeable battery is based upon the following overall reaction.

$$Cd + 2NiOOH + 4H_2O \rightarrow Cd(OH)_2 + 2Ni(OH)_2.H_2O$$

What is the oxidation number of nickel at the beginning and at the end of the reaction?

	beginning	end
A	+1.5	+2
B	+2	+3
C	+3	+2
D	+3	+4

[2006 M/J (9)]

10.

When copper is extracted from its ores, the metal is not pure enough for electrical uses. The impure copper, which contains small amounts of silver and gold, is purified by electrolysis. During this process a 'sludge' forms beneath the anode which is found to contain silver and traces of gold.

Why is silver found in this sludge?

A Silver is less electropositive than copper.

B Silver is more dense than copper and falls off the cathode.

C Silver reacts with the electrolyte to form an insoluble chloride salt.

D Silver reacts with the electrolyte to form an insoluble sulfate salt.

[2009 M/J (9)]

11.

Which conversion involves a reduction of chromium?

A $CrO_4^{2-} \rightarrow CrO_3$

B $CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$

C $CrO_2Cl_2 \rightarrow CrO_4^{2-}$

D $CrO_2Cl_2 \rightarrow Cr_2O_3$

[2009 O/N-11 (7)]

12.

Photochromic glass, used for sunglasses, darkens when exposed to bright light and becomes more transparent again when the light is less bright. The depth of colour 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 2 is the one in which light is absorbed.

D Ag^+ ions are oxidised in reaction 1.

[2009 O/N-11 (11)]

13.

How does concentrated sulfuric acid behave when it reacts with sodium chloride?

A as an acid only

B as an acid and oxidising agent

C as an oxidising agent only

D as a reducing agent only

[2010 M/J-11 (13)]

14.

What happens when chlorine is bubbled through aqueous potassium iodide?

A Chlorine is oxidised to chlorate(V) ions.

B Chlorine is oxidised to chloride ions.

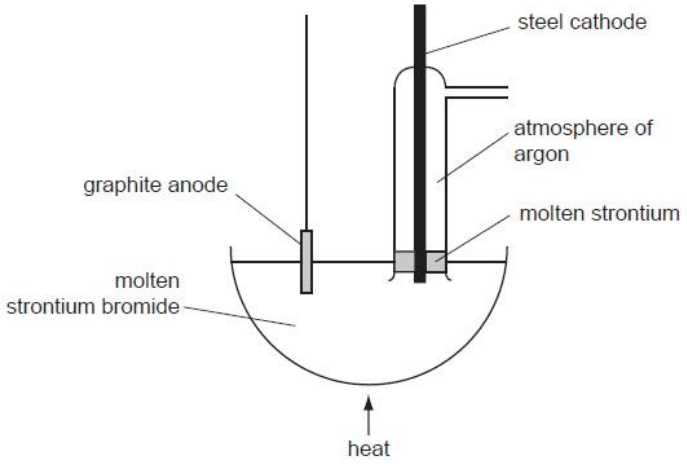
C Iodide ions are oxidised to iodine.

D There is no observable reaction.

[2010 O/N-12 (16)]

15.

Strontium metal can be obtained by the electrolysis of molten strontium bromide, $SrBr_2$, using the apparatus shown in the diagram.



Why is an atmosphere of argon used around the cathode?

A A thin film of a compound of strontium and argon forms on the surface protecting the freshly formed metal.

B The argon keeps the strontium molten.

C The argon stops the molten strontium rising too high in the tube.

D Without the argon, strontium oxide would form in the air.

[2010 O/N-12 (17)]

16.

In the extraction of aluminium by the electrolysis of molten aluminium oxide, why is cryolite added to the aluminium oxide?

A to ensure the aluminium is not oxidised

B to ensure the anode is not oxidised

C to lower the melting point of the aluminium oxide

D to prevent corrosion of the cathode

[2011 M/J-11 (3)]

17.

Aluminium is the most abundant metal in the Earth's crust. The extraction of aluminium is carried out by the electrolysis of aluminium oxide dissolved in molten cryolite.

Which material is used for each of the electrodes in this electrolysis?

	anode	cathode
A	aluminium	carbon
B	carbon	carbon
C	carbon	steel
D	steel	aluminium

[2011 M/J-12 (3)]

18.

When chlorine and aqueous sodium hydroxide are heated together the following overall reaction occurs.

$$3Cl_2(aq) + 6NaOH(aq) \rightarrow 5NaCl(aq) + NaClO_3(aq) + 3H_2O(l)$$

What are the oxidation numbers for chlorine in each of the following species?

	Cl_2	$NaCl$	$NaClO_3$
A	0	+1	–5
B	+2	–1	+3
C	0	–1	+5
D	–2	+1	–3

[2011 O/N-11 (7)]

19.

The amount of titanium dioxide in an ore can be determined by using the following reaction.

$$3TiO_2 + 4BrF_3 \rightarrow 3TiF_4 + 2Br_2 + 3O_2$$

Which element increases in oxidation number in this reaction?

A bromine

B fluorine

C oxygen

D titanium

[2011 O/N-12 (11)]

20.

Chlorine can be manufactured from brine in a diaphragm cell.

Which row represents the correct electrodes?

	nature of anode	nature of cathode
A	graphite	titanium
B	steel	titanium
C	titanium	graphite
D	titanium	steel

[2011 O/N-12 (15)]

21.

Sodium iodide reacts with concentrated sulfuric acid. The equation which represents one of the reactions that takes place is shown.

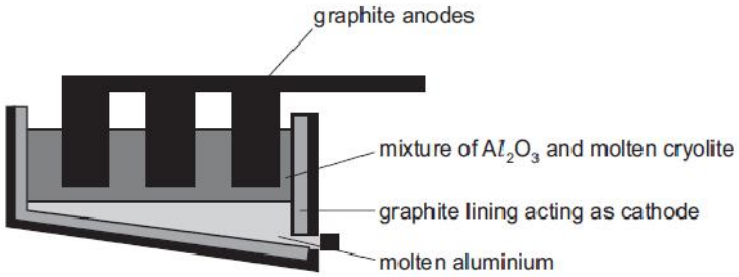
$$8NaI + 9H_2SO_4 \rightarrow 8NaHSO_4 + 4I_2 + H_2S + 4H_2O$$

Which species has been oxidised in this reaction?

A H^+ **B** I^- **C** Na^+ **D** SO_4^{2-}

[2011 O/N-12 (16)]

22.
The diagram shows a cell for the manufacture of aluminium.



Which statement is **incorrect**?

A Aluminium ions are oxidised in this process.

B Aluminium is liberated at the cathode by the reaction $Al^{3+} + 3e^- \rightarrow Al$.

C The cryolite acts as a solvent.

D The graphite anode burns away.

[2012 M/J-11 (11)]

23.
Aluminium is extracted by the electrolysis of a molten mixture containing aluminium oxide. By a similar method, magnesium is extracted by the electrolysis of a molten mixture containing magnesium chloride.

Which statement about the extraction of magnesium is correct?

A Magnesium ions travel to the anode and are oxidised to magnesium metal.

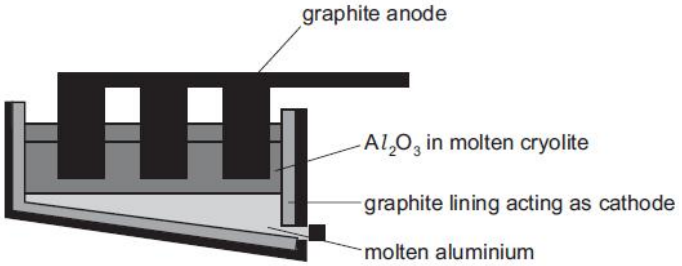
B Magnesium ions travel to the anode and are reduced to magnesium metal.

C Magnesium ions travel to the cathode and are oxidised to magnesium metal.

D Magnesium ions travel to the cathode and are reduced to magnesium metal.

[2012 O/N-11 (7)]

24.
The diagram shows an electrolytic cell for the extraction of aluminium.



Which statement is correct?

A Aluminium ions are oxidised in this process.

B Aluminium is liberated at the anode by the reaction $Al^{3+} + 3e^- \rightarrow Al$

C Cryolite is purified aluminium oxide.

D The graphite anode burns away.

[2013 M/J-11 (3)]

25.
During the electrolysis of molten aluminium oxide to produce aluminium, using carbon electrodes, two consecutive reactions occur at the anode, each producing a different gas.

How does the oxidation number of oxygen change in these reactions?

A decreases by 2, then increases by 2

B increases by 2, then decreases by 2

C increases by 2, then decreases by 4

D no change, then decreases by 2

[2013 M/J-12 (1)]

26.

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

[2013 M/J-13 (1)]

27.

A space shuttle's upward thrust came from the following reaction between aluminium and ammonium perchlorate.

$$10Al + 6NH_4ClO_4 \rightarrow 4Al_2O_3 + 2AlCl_3 + 12H_2O + 3N_2$$

Which statements about this reaction are correct?

1 Aluminium is oxidised.

2 Chlorine is reduced.

3 Nitrogen is oxidised.

[2013 M/J-13 (31)]

28.

At the age of 17, in a woodshed in Ohio, Charles Martin Hall discovered the commercial process for the production of aluminium metal by the electrolysis of a mixture of bauxite, Al_2O_3, and cryolite, Na_3AlF_6.

What is the main purpose of the cryolite?

A Al_2O_3 is covalent, and AlF_6^{3-} ions interact with it to produce Al^{3+} ions which can be discharged at the cathode.

B Cryolite is a base, forming $NaAlO_2$ with bauxite, enabling aluminium to be discharged at the anode.

C Cryolite minimises the release of O^{2-} ions at the graphite anodes, which are otherwise burnt away to CO.

D Cryolite reduces the melting point of the bauxite.

[2013 O/N-11 (1)]

29.

In which reaction does a single nitrogen atom have the greatest change in oxidation number?

A $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

B $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$

C $2NO + O_2 \rightarrow 2NO_2$

D $4NH_3 + 6NO \rightarrow 5N_2 + 6H_2O$

[2013 O/N-11 (2)]

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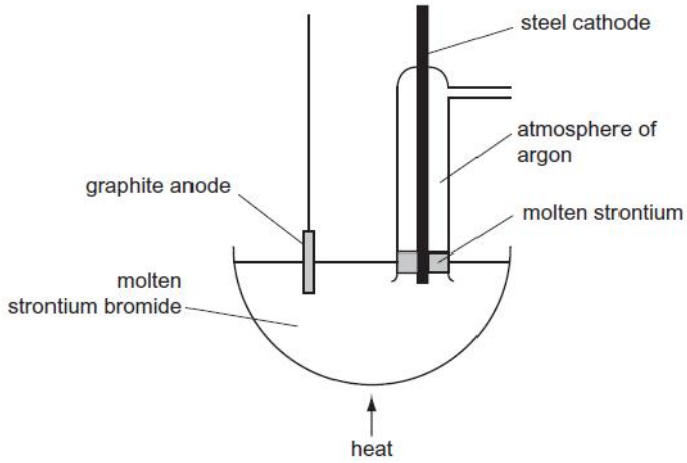

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D Without the argon, strontium oxide would form in the air.

[2013 O/N-11 (12)]

31.

Ammonium nitrate, NH_4NO_3, can decompose explosively when heated.

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

What are the changes in the oxidation numbers of the two nitrogen atoms in NH_4NO_3 when this reaction proceeds?

A –2, –4 **B** +2, +6 **C** +4, –6 **D** +4, –4

[2013 O/N-13 (1)]

32.

In the extraction of aluminium by electrolysis, why is it necessary to dissolve aluminium oxide in molten cryolite?

A to reduce the very high melting point of the electrolyte

B cryolite is a base; aluminium oxide is amphoteric

C cryolite reacts with the aluminium oxide to form ions

D molten aluminium oxide alone would not conduct electricity

[2013 O/N-13 (2)]

33.

The electrolysis of brine using the diaphragm cell is an important industrial process.

What happens at the anode?

A Chloride ions are oxidised.

B Hydrogen gas is produced.

C Hydroxide ions are formed.

D The electrode reaction is $2Cl^-(aq) + 2e^- \rightarrow Cl_2(g)$.

[2014 M/J-13 (5)]

34.

Many crude oils contain H_2S. During refining, by the Claus process, the H_2S is converted into solid sulfur, which is then removed.

reaction I $2H_2S(g) + 3O_2(g) \rightarrow 2H_2O(l) + 2SO_2(g)$

reaction II $2H_2S(g) + SO_2(g) \rightarrow 2H_2O(l) + 3S(s)$

Which statements about the Claus process are correct?

1 H_2S is oxidised in reaction I.

2 SO_2 oxidises H_2S in reaction II.

3 Hydrogen is oxidised in reaction II.

[2014 M/J-13 (33)]

35.

In which reaction does hydrogen behave as an oxidising agent?

A $H_2 + Cl_2 \rightarrow 2HCl$

B $C_2H_4 + H_2 \rightarrow C_2H_6$

C $N_2 + 3H_2 \rightarrow 2NH_3$

D $2Na + H_2 \rightarrow 2NaH$

[2014 O/N-12 (2)]

36.

Impure copper is purified by electrolysis. The electrolyte used in this process is aqueous copper(II) sulfate.

Which reaction takes place at the anode?

A $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

B $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

C $2OH^-(aq) \rightarrow \frac{1}{2}O_2(g) + H_2O(l) + 2e^-$

D $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$

[2014 O/N-13 (4)]

37.

In a solution that contains both Br_2 and Cl_2, a process takes place that produces BrO_3^- ions.

The process is represented by the following equations.

equation 1 $Br_2 + H_2O \rightarrow HBr + HBrO$

equation 2 $3HBrO + Cl_2 \rightarrow 2Cl^- + BrO_3^- + Br_2 + 3H^+$

Which statements about these reactions are correct?

1 Chlorine is reduced in equation 2.

2 Bromine is oxidised in both equation 1 and equation 2.

3 Bromine is reduced in both equation 1 and equation 2.

[2014 O/N-13 (31)]