Section A

Q1 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

Q2 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.
$CO(g) + PdCl_2(s) + H_2O(l) \rightarrow CO_2(g) + Pd(s) + 2HCl(aq)$
orange black
Which is the element whose oxidation number decreases in this reaction?
A carbon B chlorine
C hydrogen D palladium

Q3 Concentrated sulphuric acid is added to separate solid samples of sodium chloride, sodium bromide or sodium iodide.
With which sample(s) does sulphuric acid act as an oxidising agent?
A sodium chloride only
B sodium chloride and sodium bromide
C sodium bromide and sodium iodide
D sodium iodide only

Q4 The nickel-cadmium rechargeable battery is based upon the following overall reaction.
$Cd + 2NiOOH + 4H2O \rightarrow Cd(OH)2 + 2Ni(OH)2.H2O$
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

Q5 In the treatment of domestic water supplies, chlorine is added to the water to form chloric(I) acid, HClO.
$Cl_2(aq) + H_2O(l) \rightarrow H^+(aq) + Cl^-(aq) + HClO(aq)$
This reacts further to give the chlorate(I) ion.
$HClO(aq) + H_2O(l) \rightarrow H_3O^+(aq) + ClO^-(aq)$
Both HClO and ClO^- kill bacteria by oxidation.
What is the change in oxidation number of chlorine in forming the chlorate(I) ion from the aqueous chlorine?
A –1 B 0 C +1 D +2

Q6 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

Q7 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

Q8 In which substance does nitrogen exhibit the highest oxidation state?
A NO B N_2O C N_2O_4 D $NaNO_2$

Q9 Chlorine shows oxidation states ranging from –1 to +7 in its compounds.
What are the reagent(s) and conditions necessary for the oxidation of elemental chlorine into a compound containing chlorine in the +5 oxidation state?
A $AgNO_3$(aq) followed by NH_3(aq) at room temperature
B concentrated H_2SO_4 at room temperature
C cold dilute NaOH(aq)
D hot concentrated NaOH(aq)

Q10 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 $Na^+(aq) + e^- \rightarrow Na(s)$

Q11 Chlorine dioxide is produced on a large scale as it is used for bleaching paper pulp. It is made by the following reaction.

$$2Cl\,O_3(aq) + SO_2(g) \rightarrow 2Cl\,O_2(g) + SO_4(aq)$$

How do the oxidation numbers of chlorine and sulphur change in this reaction?

	chlorine	sulphur
A	decreases by 1	increases by 1
B	decreases by 1	increases by 2
C	decreases by 3	increases by 1
D	decreases by 3	increases by 2

Q12 In some early paintings, lead(II) carbonate was used as a white pigment. In the 19th century hydrogen sulphide from burning coal reacted with this pigment to form black lead(II) sulphide, PbS. The original colour of the painting may be restored by carefully treating the area with dilute hydrogen peroxide, producing lead(II) sulphate which is also white.
What is the role of the hydrogen peroxide?
A catalyst
B oxidising agent
C reducing agent
D solvent

Q13 In an experiment, 50.0 cm^3 of a 0.10 mol dm^{-3} solution of a metallic salt reacted exactly with 25.0 cm^3 of 0.10 mol dm^{-3} aqueous sodium sulphite.
The half-equation for oxidation of sulphite ion is shown below.

$$SO_3\ (aq) + H_2O(I) \rightarrow SO_4\ (aq) + 2H\ (aq) + 2e$$

If the original oxidation number of the metal in the salt was +3, what would be the new oxidation number of the metal?

A+1 B+2 C+4 D+5

Q14 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

Q15 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

Q16 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?

AH^+ BI^- CNa^+ DSO_4^{2-}

Q17 In which reaction does an element undergo the largest change in oxidation state?

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

Q18 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.

Q19 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 $CrO_2Cl_2 \rightarrow Cr_2O_3$

Section B

A	B	C	D
1, 2 and 3 are correct	**1 and 2 only are correct**	**2 and 3 only are correct**	**1 only is correc t**

Q20 Many crude oils contain sulphur as H_2S. During refining, by the Claus process, the H_2S is converted into solid sulphur, 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 SO_2 behaves as a catalyst.

Q21 Which reactions are redox reactions?

1 $CaBr_2 + 2H_2SO_4 \rightarrow CaSO_4 + Br_2 + SO_2 + 2H_2O$

2 $CaBr_2 + 2H_3PO_4 \rightarrow Ca(H_2PO_4)_2 + 2HBr$

3 $CaBr_2 + 2AgNO_3 \rightarrow Ca(NO_3)_2 + 2AgBr$

Q22 Zirconium, Zr, proton number 40, is a metal which is used in corrosion-resistant alloys. Zirconium metal is extracted from the oxide ZrO_2 by the following sequence of reactions.

reaction 1 $ZrO_2 + 2Cl_2 + 2C \rightarrow ZrCl_4 + 2CO$

reaction 2 $ZrCl_4 + 2Mg \rightarrow Zr + 2MgCl_2$

Which statements about this extraction process are correct?

1 Carbon in reaction 1 behaves as a reducing agent.
2 Magnesium in reaction 2 behaves as a reducing agent.
3 Chlorine in reaction 1 behaves as a reducing agent.

1. A
2. D
3. C
4. C
5. C
6. D
7. B
8. C
9. D
10. C
11. B
12. B
13. B
14. C
15. D
16. B
17. B
18. D
19. D
20. B
21. D
22. B

Q1 During their electrolysis of aqueous radium bromide, a scientist obtained radium at the cathode and bromine at the anode. Write half-equations for the two electrode reactions that take place during this electrolysis.

anode .....

cathode .....

(NOV 2009 P21)

Q2 Magnesium burns in nitrogen to give magnesium nitride, a yellow solid which has the formula Mg_3N_2.

Magnesium nitride reacts with water to give ammonia and magnesium hydroxide.

(i) Construct an equation for the reaction of magnesium nitride with water.

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(ii) Does a redox reaction occur when magnesium nitride reacts with water?
Use the oxidation numbers of nitrogen to explain your answer.

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(June 2009)

Q3 Chlorine gas is manufactured by the electrolysis of brine using a diaphragm cell.

(a) Write half-equations, including state symbols, for the reactions occurring at each of the electrodes of a diaphragm cell.

anode.....

cathode .....

(b) In the diaphragm cell, Suggest why steel is never used for the anode.

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(c) One important product made in the diaphragm cell is formed in aqueous solution.

(i) What substance is produced in aqueous solution in the diaphragm cell?

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(ii) Explain, with the aid of appropriate half-equation(s), how this compound is formed by electrolysis.

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(NOV 2008)

Q4 Chlorine is manufactured by electrolysis from brine, concentrated aqueous sodium chloride.

(a)(i) Describe, with the aid of a fully labelled diagram, the industrial electrolysis of brine in a diaphragm cell. State what each electrode is made of and show clearly the inlet for the brine and the outlets for the products.

(ii) Write a half-equation, with state symbols, for the reaction at **each** electrode.

anode .....

cathode .....

(iii) Name the chemical that is produced in solution in this electrolytic process.

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(June 2011 P22)