SECTION 3 Metals

Multiple-Choice Questions

CE90_07

The reaction between lead(II) nitrate solution and sodium hydrogencarbonate solution can be represented by the equation below:

$$Pb^{2+}(aq) + 2HCO_3^-(aq) \longrightarrow PbCO_3(x) + H_2O(y) + CO_2(z)$$

	x	y	z
A.	aq	aq	aq
B.	aq	l	g
C.	s	aq	g
D.	s	l	g

CE90_09

The molecular formula of a gas is X_3. If the Avogadro's Number is L mol^{-1}, how many molecules are there in 96g of X_3?

(Relative atomic mass of X = 16.0)

A. $\frac{1}{2}$L B. 2L

C. 3L D. 6L

CE90_10

If 2g of carbon dioxide gas contain x molecules, how many molecules are present in 2g of helium gas?

(Relative atomic masses: He = 4.0, C = 12.0, O = 16.0)

A. x B. 5.5x

C. 7x D. 11x

CE90_31

16.1g of a hydrated metal sulphate was heated to constant mass. After cooling to room temperature, the residual anhydrous metal sulphate weighed 7.1g.

How many moles of water of crystallization are there in one mole of the hydrated metal sulphate?

(Relative molecular masses: anhydrous metal sulphate = 142.0, water = 18.0)

A. 4 B. 5

C. 7 D. 10

CE90_45

1st statement	2nd statement
Magnesium chloride solution gives a white precipitate with lead(II) nitrate solution.	Magnesium is higher than lead in the metal reactivity series.

CE90_49

1st statement	2nd statement
Sea water can corrode ships more quickly than fresh water.	Sodium chloride in sea water speeds up the corrosion of iron.

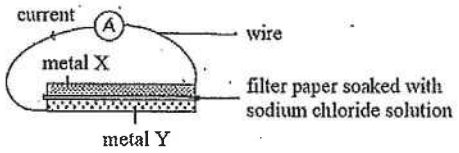
CE91_08

X, Y and Z are metals. Y can displace X from a solution of the nitrate of X. Oxides of X and Y can be reduced by hydrogen but not the oxide of Z. Which of the following arrangements represents the correct descending order of reactivity of the metals?

A. Z > Y > X B. X > Y > Z

C. Z > X > Y D. X > Z > Y

CE91_09



Which of the following combinations would produce the largest current flowing from metal X to metal Y in the external circuit?

	Metal X	Metal Y
A.	Fe	Cu
B.	Mg	Ag
C.	Ag	Zn
D.	Cu	Pb

CE91_11

2.60g of a metal X combine with 1.20g of oxygen to form an oxide in which the oxidation number of X is +3. What is the relative atomic mass of X?

(Relative atomic mass: O = 16.0)

A. 11.6 B. 34.7

C. 52.0 D. 104

CE91_31

Which of the following substances, when heated, can react with oxygen?

(1) sodium

(2) sulphur

(3) iron

A. (2) only B. (1) and (2) only

C. (1) and (3) only D. (1), (2) and (3)

CE92_01

Rubidium (Rb) is a group I element below potassium in the Periodic Table. Which of the following statements about rubidium is correct?

A. Rubidium forms an acidic oxide.
B. Rubidium is more reactive than potassium.
C. Rubidium can be obtained from its oxide by reaction with carbon.
D. The formula for rubidium chloride is $RbCl_2$.

CE92_06

0.01 mol of C_2H_5OH is burnt completely in oxygen. What are the numbers of moles of carbon dioxide and water formed respectively?

	carbon dioxide	water
A.	0.01	0.03
B.	0.02	0.03
C.	0.02	0.06
D.	0.04	0.06

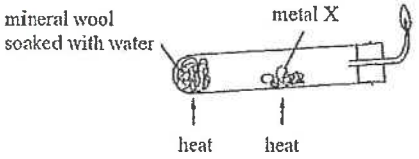
CE92_07

Which of the following gases, each having a mass of 10.0g, has the greatest number of molecules at room temperature and pressure?

(Relative atomic masses: C = 12.0; N = 14.0; O = 16.0; F = 19.0; Ne = 20.2)

A. nitrogen
B. fluorine
C. neon
D. carbon monoxide

CE92_31



In the above experiment, a gas is evolved and burns at the jet. Metal X is probably

A. zinc.
B. aluminium.
C. magnesium.
D. copper.

CE92_33

Which of the following ions is/are coloured?

(1) $Pb^{2+}(aq)$
(2) $Cr^{3+}(aq)$
(3) $MnO_4^-(aq)$

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

CE92_34

Which of the following metals can be obtained by reducing their oxides with carbon?

(1) iron
(2) calcium
(3) lead

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE93_08

The molecular formula of a gaseous element X is X_2. If the relative atomic mass of X is 19, what is the number of molecules in 114 g of the gas?

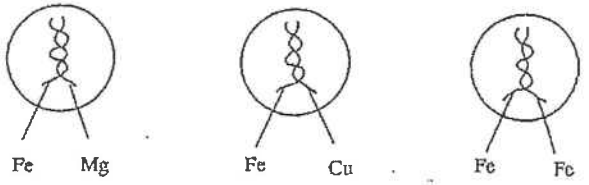
(Avogadro's number = 6.022×10^{23})

A. 3
B. 6
C. $3 \times 6.022 \times 10^{23}$
D. $6 \times 6.022 \times 10^{23}$

CE93_20

Direction: Q.20 and Q.21 refer to the following experiment:

Three different pairs of metal wires are placed separately in petri dishes (as shown in the diagram below) containing a mixture of gelatin, potassium hexacyanoferrate(III) solution and phenolphthalein solution.



Dish I Dish II Dish III

Which of the following statements are correct?

(1) The iron wire in Dish I does not corrode readily.
(2) The iron wire in Dish II corrodes readily.
(3) The iron wires in Dish III do not corrode.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE93_21

In Dish II, which of the following colours will develop around the iron wire and the copper wire?

	iron wire	copper wire
A.	pink	blue
B.	blue	pink
C.	pink	no colour
D.	blue	no colour

CE93_46

1st statement	2nd statement
Sodium carbonate is not decomposed by heat.	Sodium carbonate is an ionic compound.

CE94_08

Which of the following contains the same number of atoms as 2.20g of carbon dioxide?
(Relative atomic masses: H = 1.0, C = 12.0, N = 14.0, O = 16.0, S = 32.0, Cl = 35.5)

A. 1.70g of ammonia
B. 2.25g of nitrogen monoxide
C. 2.80g of sulphur dioxide
D. 3.55g of chlorine

CE94_18

The formula of hydrated magnesium sulphate crystals is $MgSO_4 \cdot xH_2O$. When 3.80g of the hydrated crystals are heated, 2.00g of anhydrous magnesium sulphate are produced. What is the value of x?
(Relative atomic mass: H = 1.0, O = 16.0, Mg = 24.0, S = 32.0)

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

CE94_44

Which of the following methods can be used to distinguish between solid sodium carbonate and calcium carbonate?

(1) Heating the solid and testing the gaseous product with lime water.
(2) Testing the solubility of the solid in water.
(3) Conducting a flame test on the solid.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE95_05

Which of the following methods can be used to extract lead from lead(II) oxide?

A. heating lead(II) oxide in the absence of air
B. heating lead(II) oxide in the presence of air
C. heating lead(II) oxide with copper at high temperature
D. heating lead(II) oxide with carbon at high temperature

CE95_18

Metal X reacts with dilute hydrochloric acid to liberate hydrogen, but metal Y and metal Z have no reaction with the dilute acid. The oxide of metal Y decomposes on heating but the oxide of metal Z does not.
Which of the following arrangements represents the order of increasing reactivity of the three metals?

A. X < Y < Z
B. Y < Z < X
C. X < Z < Y
D. Z < Y < X

CE95_45

1st statement	2nd statement
When a piece of iron wire coupled with a piece of tin wire is left in the air for a long period of time, the iron wire does not corrode.	Tin prevents iron from corrosion by sacrificial protection.

CE96_08

Zinc blocks are often attached to the steel legs of off-shore oil platforms because

A. zinc can protect steel from corrosion.
B. zinc is more resistant to corrosion than steel.
C. zinc is harder than steel.
D. zinc does not react with crude oil.

CE96_35

In which of the following processes will lead be produced?

(1) the electrolysis of molten lead(II) bromide
(2) heating lead(II) oxide strongly
(3) adding magnesium to lead(II) nitrate solution

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE96_47

1st statement	2nd statement
The resistance of aluminium to corrosion can be enhanced by anodization.	During anodization, aluminium oxide on the metal surface is reduced to aluminium.

CE97_28

What mass of copper is obtained when 0.40 mol of copper(II) oxide are completely reduced by carbon?
(Relative atomic masses: O = 16.0, Cu = 63.5)

A. 12.7 g
B. 15.9 g
C. 25.4 g
D. 31.8 g

CE97_32

Which of the following metal oxides can be reduced to the metal when heated with carbon?

(1) aluminium oxide
(2) lead(II) oxide
(3) iron(III) oxide

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE97_41

Aluminium is used to make window frames because

(1) it is strong

(2) it can resist corrosion

(3) it is the most abundant metallic element in the earth crust

Which of the above statements are correct?

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE97_47

1st statement	2nd statement
The reaction of sodium with water produce hydrogen.	The reaction of sodium with water is exothermic.

CE97_48

1st statement	2nd statement
The body of a motor car will corrode faster if common salts is sprinkled on roads after a heavy snow.	Common salt and water form a conducting solution.

CE98_02

The formula for ozone is O_3. If one mole of ozone contains x atoms, how many atoms will one mole of oxygen gas contain?

A. $\frac{x}{3}$
B. $\frac{2x}{3}$
C. $\frac{3x}{2}$
D. 3x

CE98_10

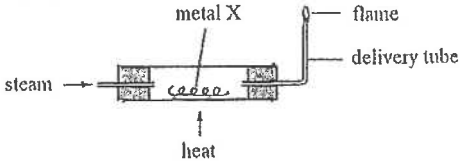
The formula for hydrated iron(II) sulphate is $FeSO_4 \cdot xH_2O$. On strong heating, 20.1g of the sulphate produces 9.1g of water. What is the value of x?

(Relative atomic masses: H = 1.0, O = 16.0, S = 32.1, Fe = 56.0)

A. 5
B. 6
C. 7
D. 8

CE98_11

Consider the following experiment.

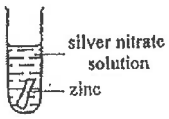


During the experiment, a gas is liberated. The gas can burn at the end of the delivery tube. X is probably

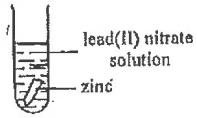
A. copper.
B. lead.
C. silver.
D. zinc.

CE98_19

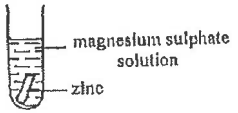
In each of the four solutions shown below, a strip of zinc is added.



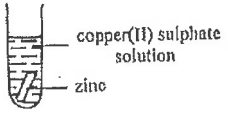
Tube I



Tube II



Tube III



Tube IV

Which of the following combinations is correct?

	Tube	Observation
A.	I	no change
B.	II	brown coating on zinc
C.	III	no change
D.	IV	grey coating on zinc

CE98_20

The following equation represents the reaction of an oxide of lead with hydrogen:

$$Pb_3O_4(s) + 4H_2(g) \longrightarrow 3Pb(s) + 4H_2O(l)$$

What mass of lead would be obtained if 68.5g of the oxide was consumed in the reaction?

(Relative atomic masses: O = 16.0, Pb = 207.0)

A. 20.7 g
B. 41.4 g
C. 62.1 g
D. 82.8 g

CE98_27

Consider the following chemical equation:

$$Zn + pMnO_2 + qNH_4^+ \longrightarrow Zn^{2+} + xMn_2O_3 + yNH_3 + zH_2O$$

Which of the following combinations is correct?

	x	y	z
A.	1	2	1
B.	1	3	2
C.	2	3	2
D.	2	2	3

CE98_44

Upon heating, a mixture of iron and sulphur gives a black substance. Which of the following statements concerning the black substance are correct?

(1) It is insoluble in water.
(2) It can be attracted by a bar magnet.
(3) It reacts with dilute hydrochloric acid to give a gas with a pungent smell.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE99_02

One mole of calcium bromide contains

A. 1 mole of molecules.
B. 2 moles of cations.
C. 2 moles of anions.
D. 3 moles of atoms.

CE99_08

Iron can be produced from iron(III) oxide by the following reaction:

$$Fe_2O_3(s) + 3CO(g) \longrightarrow 2Fe(s) + 3CO_2(g)$$

What mass of iron(III) oxide is required to produce 2.1g of iron?
(Relative atomic masses: O = 16.0, Fe = 56.0)

A. 3.0 g
B. 4.5 g
C. 6.0 g
D. 9.0 g

CE99_17

The compound X_2S contains 58.9% of X by mass. What is the relative atomic mass of X?
(Relative atomic mass: S = 32.0)

A. 11.5
B. 23.0
C. 39.0
D. 46.0

CE99_21

Consider the following chemical equation:

$$2HNO_3 + xFeSO_4 + yH_2SO_4 \longrightarrow zFe_2(SO_4)_3 + 4H_2O + 2NO$$

Which of the following combinations is correct?

	x	y	z
A.	2	1	1
B.	4	3	2
C.	6	2	3
D.	6	3	3

CE99_22

In which of the following situations is iron prevented from rusting by sacrificial protection?

A. Iron plates are jointed together with copper rivets.
B. Iron pipes are connected to lead blocks.
C. Iron sheets are plated with zinc.
D. Iron cans are coated with tin.

CE99_31

Which of the following metal oxides CANNOT be reduced by heating with carbon?

(1) magnesium oxide
(2) lead(II) bromide
(3) iron(III) oxide

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE99_46

1st statement	2nd statement
Metals have good thermal conductivity.	Metals are composed of giant lattices of positive ions surrounded by valence electrons which are free to move throughout the lattices.

CE00_03

Iron cans used for canning food are usually coated with tin instead of zinc. This is because

A. tin is more reactive than zinc.
B. tin ions are non-toxic but zinc ions are toxic.
C. tin forms an alloy with iron and this alloy is corrosion resistant.
D. tin prevents iron cans from rusting by sacrificial protection.

CE00_04

Metal X forms an oxide. 27.53g of this oxide contains 24.96g of X. What is the mole ratio of X to oxygen in the oxide?

(Relative atomic masses: O = 16.0, X = 207.0)

A. 1 : 1
B. 1 : 2
C. 2 : 3
D. 3 : 4

CE00_33

In an experiment, a piece of calcium metal was added to a beaker of water. Which of the following statements concerning the experiment is/are correct?

(1) The calcium metal sinks to the bottom of the beaker.
(2) The calcium metal burnt with brick red flame.
(3) At the end of the experiment, an alkaline solution was formed in the beaker.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE00_50

1st statement	2nd statement
Aluminium was used earlier than iron in the history of mankind.	Aluminium is more abundant than iron in the earth crust.

CE01_26

What is the percentage by mass of chromium in potassium dichromate?

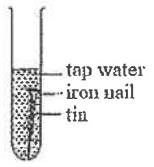
(Relative atomic mass: O = 16.0, K = 39.1, Cr = 52.0)

A. 17.7
B. 25.1
C. 35.4
D. 40.8

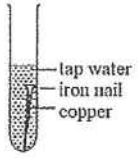
CE01_30

Which iron nail in the test tubes shown below would rust most slowly?

A.

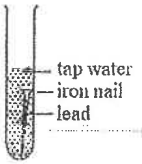


B.



C.

D.



CE01_38

In which of the following experiments would a metal be produced?

(1) heating silver oxide
(2) heating iron pyrite
(3) heating a mixture of lead(II) oxide and carbon powder

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE01_49

1st statement	2nd statement
Lithium is the most reactive element in Group I of the Periodic Table.	Among the Group I elements, lithium loses electrons most readily.

CE02_03

An oxide of element X has the formula X_2O_3. 10.2g of this oxide contains 5.4g of X. What is the relative atomic mass of X?

(Relative atomic mass: O = 16.0)

A. 12.0
B. 18.0
C. 27.0
D. 36.0

CE02_08

Which of the following statements concerning aluminium is correct?

A. Aluminium is used to make stainless steel.
B. The strength of aluminium can be enhanced by anodization.
C. Aluminium is the most abundant element in the earth's crust.
D. When aluminium is exposed to air, a layer of aluminium oxide is formed on its surface.

CE02_14

Ammonium dichromate, $(NH_4)_2Cr_2O_7$, decomposes on heating to give chromium(III) oxide, water and nitrogen. What mass of water is obtained when 126g of ammonium dichromate undergoes complete decomposition?

(Relative atomic masses: H = 1.0, N= 14.0, O = 16.0, Cr = 52.0)

A. 9 g
B. 18 g
C. 36 g
D. 72 g

CE02_23

Which of the following gases contains the greatest number of molecules at room temperature and pressure?

(Relative atomic masses: H = 1.0, N = 14.0, O = 16.0, Cl = 35.5)

A. 2.0 g of hydrogen
B. 16.0 g of oxygen
C. 18.0 g of ammonia
D. 60.0 g of chlorine

CE02_26

When a piece of copper is dropped into an aqueous solution of compound X, the copper gradually dissolve. X is probably

A. magnesium chloride
B. lead(II) nitrate
C. silver nitrate
D. ammonium chloride

CE02_27

Which of the following objects is *least* likely to contain titanium?

A. missile
B. water tap
C. bicycle frame
D. artificial hip joint

CE03_01

Which of the following pairs of elements in Group I and VII of the Periodic Table would react with each other most vigorously?

	Group I	Group VII
A.	lithium	fluorine
B.	lithium	iodine
C.	potassium	fluorine
D.	potassium	iodine

CE03_02

Which of the following substances, upon heating in a test tube, would undergo a chemical change?

A. Water
B. calcium oxide
C. sodium chloride
D. hydrated copper(II) sulphate

CE03_05

Which of the following methods can be used to obtain aluminium from aluminium oxide?

A. reducing the oxide with carbon
B. heating the oxide strongly
C. electrolysis of the molten oxide
D. heating the oxide with iron powder

CE03_11

A sample of $MgSO_4 \cdot xH_2O(s)$ of mass 123.2g contains 63.0g of water of crystallization. What is the value of x?

(Relative atomic masses: H = 1.0, O = 16.0, Mg = 24.3, S = 32.1)

A. 4
B. 5
C. 6
D. 7

CE03_28

Which of the following gases contains the greatest number of molecules?

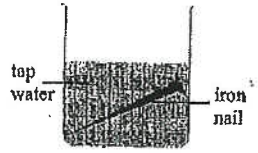
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0, Ne = 20.2, Cl = 35.5)

A. 50.0g of neon
B. 50.0g of oxygen
C. 50.0g of hydrogen chloride
D. 50.0g of carbon monoxide

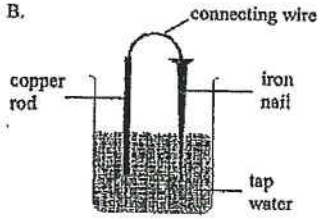
CE03_09

Which iron nail in the beakers shown below would undergo corrosion most readily?

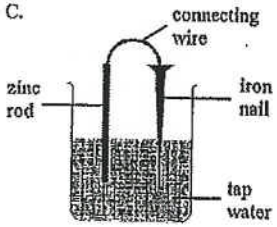
A.



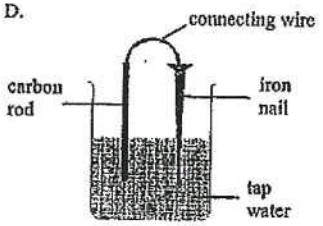
B.



C.



D.



CE03_42

Iron pyrite (FeS_2) looks like gold and its common name is "fool's gold". Which of the following methods can be used to distinguish iron pyrite from gold?

(1) comparing their densities
(2) comparing their electrical conductivity
(3) comparing the effect of heat on them

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE05SP_08

What is the formula mass of magnesium fluoride?

A. 43.3
B. 62.3
C. 67.6
D. 81.3

CE05SP_21

Both aluminium and iron can be extracted from their oxides. Which of the following combinations shows the commonly used extraction methods?

	Aluminium	Iron
A.	heating with carbon	heating with carbon
B.	heating with carbon	electrolysis
C.	electrolysis	heating with carbon
D.	electrolysis	electrolysis

CE05SP_29

1st statement	2nd statement
Iron was used earlier than copper in the history of mankind.	Iron is more reactive than copper in the earth crust.

CE05SP_32

Lead forms an oxide. 27.53g of this oxide of lead contains 24.96g of lead. What is the empirical formula of this oxide?

A. PbO
B. PbO_2
C. Pb_2O_3
D. Pb_3O_4

CE05SP_41

Which of the following statements concerning anodization of aluminium articles is/are correct?

(1) During the anodization process, aluminium articles are connected to the negative pole of the power supply.
(2) Anodization can increase the thickness of the oxide layer on aluminium articles.
(3) After anodization, aluminium articles will not easily be corroded.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE04_12

The relative atomic mass of element X is 74.9. It forms an oxide containing 24.3% of oxygen by mass. What is the mole ratio of X to oxygen in the oxide?

A. 1 : 2
B. 1 : 3
C. 2 : 3
D. 2 : 5

CE04_16

Magnesium can be obtained from magnesium oxide by

A. electrolysis of the molten oxide.
B. heating the oxide strongly.
C. heating the oxide with carbon.
D. heating the oxide with zinc powder.

CE04_26

What is the percentage by mass of nitrogen in the fertilizer $(NH_4)_2HPO_4$?

A. 10.6%
B. 12.3%
C. 21.2%
D. 24.6%

CE04_35

A piece of sodium is on fire in the laboratory. Which of the following methods can be used to put out the fire?

(1) Using sand to cover the burning sodium
(2) Spraying foam from a foam extinguisher onto the burning sodium
(3) Spraying powder from a powder extinguisher onto the burning sodium

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE04_48

1st statement	2nd statement
Lead can displace iron from iron(II) nitrate solution.	Lead occupies a higher position in the electrochemical series than iron.

CE05_10

Directions: Q.10 and Q.11 refer to the following experiment.

Rust indicator solution was poured into the following glass dishes to cover the iron nails, which were wrapped with different metal strips. The dishes were allowed to stand in air for some time.

silver strip dish 1 | zinc strip dish 2 | copper strip dish 3 | magnesium strip dish 4

If the iron nail rusts, what would the colour of the rust indicator be around the nail?

A. yellow
B. brown
C. red
D. blue

CE05_11

In which of the dishes would the iron nail rust?

A. dish 1 only
B. dish 2 only
C. dish 1 and dish 3 only
D. dish 2 and dish 4 only

CE05_23

Which of the following samples of gases contains the smallest number of molecules?
(Relative atomic masses: H = 1.0, C = 12.0, N = 14.0, O = 16.0, S = 32.1)

A. 10g of NO_2
B. 10g of CO_2
C. 10g of H_2S
D. 10g of C_2H_4

CE06_08

Consider the following equation:

$$x\ VO_2^+(aq) + y\ H^+(aq) + 2\ I^-(aq) \longrightarrow x\ VO^{2+}(aq) + z\ H_2O(l) + I_2(aq)$$

(V is the symbol for the element vanadium.)

Which of the following combinations is correct?

	x	y	z
A.	1	2	1
B.	1	4	2
C.	2	4	2
D.	3	6	3

CE06_09

Which of the following properties is considered the most important one when choosing an alloy for making fuse in electric plugs?

A. low melting point
B. high electrical conductivity
C. good ductility
D. high mechanical strength

CE06_13

X and Y are two different metals. Which of the following shows that Y is more reactive than X?

A. X forms an ion with a charge of +2 while Y forms an ion with a charge of +1.
B. X reacts with dilute hydrochloric acid but Y does not.
C. X can displace Y from an aqueous solution of a salt of Y.
D. The oxide of X undergoes decomposition upon strong heating but the oxide of Y does not.

CE06_18

Element X forms two oxides XO and XO_2. If 1 mole of XO contains n atoms, 2 moles of XO_2 would contain

A. 3/2n atoms
B. 2n atoms
C. 3n atoms
D. 6n atoms

CE06_34

Which of the following changes occur after an aluminium article has been anodized?

A. Its electrical conductivity increases.
B. Its tensile strength increases.
C. It becomes more easily dyed.
D. It becomes more easily oxidized.

CE06_37

The relative atomic mass of metal X is 55.8. 23.90 g of X is allowed to react with excess oxygen until X is completely oxidized. The mass of the metal oxides obtained is 34.18 g. What is the empirical formula of the oxide? (Relative atomic mass: O = 16.0)

A. XO
B. X_2O_3
C. X_3O_2
D. X_3O_4

CE07_05

Metal Y and calcium are both in the same group of the Periodic Table. When equal mass of Y and calcium respectively reacts with excess hydrochloric acid under the same condition, Y gives more hydrogen than calcium does. Which of the following deductions is correct?

A. The reactivity of Y is higher than that of calcium.
B. The metallic bond in Y is weaker than that in calcium.
C. The atomic number of Y is greater than that of calcium.
D. The relative atomic mass of Y is smaller than that of calcium.

CE07_07

X, Y and Z are metals. The table below shows the observations when each of them is put into copper(II) sulphate solution:

Metal	Observation
X	No observable change
Y	Brown solid formed and colourless gas evolved
Z	Brown solid formed

Which of the following arrangement correctly represents the ascending order of reactivity of the metals?

A. X < Z < Y
B. Y < Z < X
C. Z < X < Y
D. X < Y < Z

CE07_11

D, **J**, **R** and **Y** represent four different compounds. **D** and **J** react according to the following equation:

$$\mathbf{D} + 2\mathbf{J} \longrightarrow \mathbf{R} + 2\mathbf{Y}$$

d grams of **D** react with j grams of **J** to give r grams of **R** and y grams of **Y**. What is the value of y?

A. $d + j - r$
B. $d + 2j - r$
C. $2(d + j - r)$
D. $(d + 2j - r)/2$

CE07_34

What mass of iron can be obtained by complete reduction of 7.18g of iron(III) oxide?

(Relative atomic masses: Fe = 55.8, O = 16.0)

A. 2.51g
B. 3.86g
C. 5.02g
D. 5.58g

CE07_38

Which of the following methods is most suitable for preparing a sample of lead(II) sulphate?

A. Adding lead to dilute sulphuric acid
B. Adding lead to copper(II) sulphate solution
C. Adding lead(II) oxide to dilute sulphuric acid
D. Adding lead(II) nitrate solution to dilute sulphuric acid

CE07_48

1st statement	2nd statement
Galvanized iron is used for making food cans.	Zinc can prevent iron from rusting by sacrificial protection.

CE08_04

Consider the ionic equation below:

$$2MnO_4^- + x\,Sn^{2+} + y\,H^+ \longrightarrow 2Mn^{2+} + x\,Sn^{4+} + 8H_2O$$

What is the value of x?

A. 2
B. 4
C. 5
D. 7

CE08_10

Which of the following has the greatest number of ions?

A. 5 moles of iron(III) sulphate
B. 6 moles of aluminium fluoride
C. 7 moles of lead(II) nitrate
D. 8 moles of magnesium sulphate

CE08_12

Green patches appear on the surface of a metallic statue in a museum. It can be deduced that the statue may contain

A. tin.
B. iron.
C. silver.
D. copper.

CE08_15

X and Z are metals. X reacts with $Z(NO_3)_2$ solution according to the following equation:

$$X(s) + Z^{2+}(aq) \longrightarrow X^{2+}(aq) + Z(s)$$

Which of the following deductions is correct?

A. Both X and Z can react with water.
B. The reactivity of Z is higher than that of X.
C. X acts as a reducing agent in the reaction.
D. Z acts as the negative pole when X and Z are used as electrodes in a chemical cell with sodium chloride solution as electrolyte.

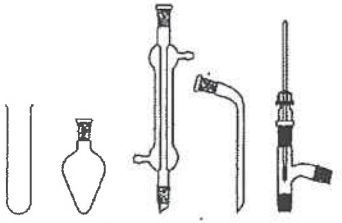
CE08_16

The oxidation number of metal M in its oxide is +2. Complete reduction of 11.9g of this oxide by hydrogen gas produces metal M and 2.7g of water. What is the relative atomic mass of M?
(Relative atomic masses: H = 1.0, O = 16.0)

A. 9.3
B. 24.3
C. 63.3
D. 137.3

CE08_26

Consider the following pieces of apparatus:



Which of the following processes can be performed by normal use of some or all of the above apparatus?

(1) refluxing a reacting mixture
(2) separating two immiscible liquids
(3) performing a simple distillation

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE08_31

Organic compound Q has the following composition by mass:

C: 37.5% H: 12.5% O: 50.0%

What is the possible chemical formula of Q?
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

A. CH_3OH
B. C_2H_5OH
C. HCOOH
D. CH_3COOH

CE08_34

From which of the following processes can lead be obtained in a school laboratory?

A. Lead(II) oxide is heated strongly.
B. Lead(II) oxide is mixed with carbon.
C. Dilute lead(II) nitrate solution is electrolyzed.
D. Zinc is added to dilute lead(II) nitrate solution.

CE08_50

1st statement	2nd statement
When equal mass of Mg and Zn granules is added separately to excess dilute H_2SO_4, a greater amount of gas will be produced by Mg than Zn.	Mg is more reactive than Zn.

CE09_05

What is the percentage by mass of oxygen in $Na_2CO_3 \cdot 10H_2O$?

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

A. 72.7
B. 55.9
C. 22.4
D. 16.8

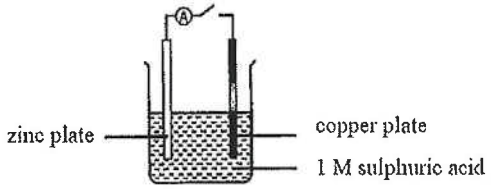
CE09_06

Which of the following rust prevention method does NOT match with the iron-made object?

	Rust prevention method	Iron-made object
A.	painting	gate
B.	greasing	machinery parts
C.	zinc plating	food can
D.	chromium plating	car bumper

CE09_08

Directions: Q.8 and Q.9 refer to the following diagram.



Which of the following observations can be made in the above set-up?

A. There is no observable change.
B. Gas bubbles appear on the zinc plate.
C. Gas bubbles appear on the copper plate.
D. The sulphuric acid gradually turns blue.

CE09_09

What will occur when the circuit is closed?

A. Both metal plates gradually dissolve.
B. The sulphuric acid gradually turns blue.
C. The hydrogen ions in the solution are reduced to hydrogen gas.
D. Electrons flow from the copper plate to the zinc plate in the external circuit.

CE09_20

Which of the following half equations are involved when iron rusts?

(1) $Fe \longrightarrow Fe^{3+} + 3e^-$
(2) $Fe \longrightarrow Fe^{2+} + 2e^-$
(3) $Fe^{2+} \longrightarrow Fe^{3+} + e^-$

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_33

An oxide of metal M reacts completely with carbon to give 12.6g of metal M and 2.38dm^3 of carbon dioxide measured at room temperature and pressure. What is the chemical formula of the oxide?

(Relative atomic masses: M = 63.5, O = 16.0;

Molar volume of gas at room temperature and pressure = 24dm^3)

A. MO
B. MO_2
C. M_2O
D. M_2O_3

CE09_41

Anodized aluminium is more commonly used than iron for making window frames.

This is because

(1) the cost for extracting aluminium is lower than the cost for extracting iron.
(2) anodized aluminium is more corrosion resistant than iron.
(3) anodized aluminium is harder than iron.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_46

Which of the following information is needed in order to deduce the molecular formula of a compound from its empirical formula?

(1) relative molecular mass of the compound
(2) percentage by mass of each constituent element
(3) relative atomic mass of each constituent element

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_47

Which of the following statements concerning the anodization of an aluminium object are correct?

(1) The electrolyte used can be dilute sulphuric acid.
(2) A layer of aluminium oxide is formed on the surface of the object.
(3) The aluminium object should be connected to the negative terminal of the power supply.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE10_03

X^{2+} ion has an electronic arrangement of 2, 8, 8. Which of the following statements concerning the carbonate of X is INCORRECT?

A. It is a white solid.
B. It is insoluble in water.
C. It decomposes on heating.
D. It produces a brick red flame in flame test.

CE10_04

Assuming that the total volume of 20 drops of water is 1.0 cm^3, what is the number of molecules in 1 drop of water?

(Avogadro's constant = 6.02×10^{23} mol^{-1}; density of water = 1.0 g cm^{-3};
Relative atomic masses: H = 1.0, O = 16.0)

A. 1.7×10^{21}
B. 3.3×10^{21}
C. 3.0×10^{22}
D. 3.3×10^{22}

CE10_06

Which of the following components of air is NOT obtained industrially from fractional distillation of liquid air?

A. Ar(g)
B. $CO_2(g)$
C. $N_2(g)$
D. $O_2(g)$

CE10_08

Naturally occurring magnesium has three isotopes: ^{24}Mg, ^{25}Mg and ^{26}Mg. The relative abundance of the ^{25}Mg isotope is 10%. What is the relative abundance of the ^{26}Mg isotope?

(Relative atomic mass: Mg = 24.3)

A. 10%
B. 15%
C. 23%
D. 85%

CE10_14

What mass of methane upon complete combustion gives 0.90g of water?

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

A. 0.40 g
B. 0.45 g
C. 0.75 g
D. 0.80 g

CE10_16

A boiling tube contains hot saturated copper(II) sulphate solution. Large crystals of the salt can be obtained by

A. placing the boiling tube in a test tube rack on a bench.
B. placing the boiling tube under running tap water.
C. placing the boiling tube in a ice-water bath.
D. heating the solution to dryness.

CE10_21

Which of the following substances contain(s) mainly calcium carbonate?

(1) rock salt
(2) limestone
(3) oyster shell

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE10_22

Which of the following statements concerning potassium and calcium is/are correct?

(1) The reducing power of potassium is stronger than that of calcium.
(2) The hardness of potassium is higher than that of calcium.
(3) The density of potassium is greater than that of calcium.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE10_26

Which of the following safety measures should be taken when investigating the reaction between sodium and water?

(1) Use forceps to pick sodium.
(2) Use a small piece of sodium.
(3) Use a small amount of water.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE10_23

A certain oxide of manganese contains 49.5% of manganese by mass. What is the empirical formula of this oxide?

(Relative atomic masses: O = 16.0, Mn = 54.9)

A. MnO
B. MnO_2
C. Mn_2O_2
D. Mn_2O_7

CE11_04

One mole of ethane and one mole of ethane have the same

A. mass.
B. number of atoms.
C. number of molecules.
D. number of bonded electrons.

CE11_08

An ore contains 80% of the zinc sulphate by mass. Assuming that the other components in this ore do not contain zinc, what mass of the ore is required to extract 0.70g of zinc?

(Relative atomic masses: S = 32.1, Zn = 65.4)

A. 0.88 g
B. 1.04 g
C. 1.30 g
D. 1.76 g

CE11_23

In an experiment, excess zinc granules are added to a solution containing copper(II) ions and magnesium ions. After complete reaction, the reaction mixture is filtered. Which of the following statements concerning the experiment is/are correct?

(1) The residue contains magnesium metal.
(2) The residue contains copper metal.
(3) The filtrate contains zinc ions.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE11_30

1st statement	2nd statement
When excess magnesium ribbons are added to iron(II) sulphate solution, the solution gradually changes from pale green to yellow.	When magnesium ribbons are added to iron(II) sulphate solution, a displacement reaction occurs.

CE11_36

In order to prevent rusting, zinc blocks can be attached to the surface of steel ships. This is because

A. zinc is stronger oxidizing agent than iron.
B. zinc prevents iron from losing electrons.
C. zinc separates iron from air and water.
D. zinc removes oxygen from rust.

CE11_38

Hydrocarbon X contains 80% of carbon by mass. What is the empirical formula of X?
(Relative atomic masses: H = 1.0, C = 12.0)

A. CH
B. CH_2
C. CH_3
D. CH_4

CE11_46

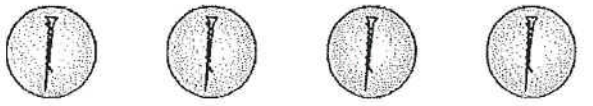
Which of the following are the advantages of using anodized aluminium to make drink cans?

(1) The drink cans can be dyed more easily.
(2) The hardness of the drink cans can be increased.
(3) The corrosion resistance of the drink cans can be enhance.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE11SP_05

Rust indicator containing potassium hexacyanoferrate(III) solution was poured into the following glass dishes to cover the iron nails, which were wrapped with different metal strips. The dishes were allowed to stand in air for some time.



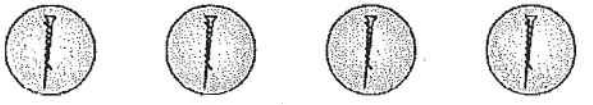
silver strip dish 1 | zinc strip dish 2 | copper strip dish 3 | magnesium strip dish 4

If the iron nail rusts, what would the color of the rust indicator be around the nail?

A. Yellow
B. Brown
C. Red
D. Blue

DSE11SP_06

Rust indicator containing potassium hexacyanoferrate(III) solution was poured into the following glass dishes to cover the iron nails, which were wrapped with different metal strips. The dishes were allowed to stand in air for some time.



silver strip dish 1 | zinc strip dish 2 | copper strip dish 3 | magnesium strip dish 4

In which pf the dishes would the iron nail rust?

A. Dish 1 only
B. Dish 2 only
C. Dish 1 and Dish 3 only
D. Dish 2 and Dish 4 only

DSE11SP_15

Which of the following samples of gases contains the smallest number of molecules?
(Relative atomic masses : H = 1.0, C = 12.0, N = 14.0, O = 16.0, S = 32.1)

A. 10 g of NO_2
B. 10 g of CO_2
C. 10 g of H_2S
D. 10 g of C_2H_4

DSE12PP_06

X, Y and Z are three different metals. When these metals are placed separately into an aqueous solution of tin(II) nitrate, a spongy layer of tin is formed only on X. When each of the oxides of these metals is heated strongly, only the oxide of Y gives a metallic lustre. Which of the following represents the arrangement of these metals in decreasing order of reactivity?

A. X > Y > Z
B. X > Z > Y
C. Y > X > Z
D. Z > X > Y

DSE12_03

In an oxide of metal M, the mass percentage of M is 55.0%. What is the chemical formula of this oxide? (Relative atomic masses : O = 16.0, M = 39.1)

A. MO_2 B. M_2O

C. M_2O_2 D. M_2O_3

DSE12_09

Which of the following statements concerning an aluminium ore consisting mainly of Al_2O_3 is correct?

(Relative atomic masses: O =16.0, Al = 27.0)

A. Carbon can be used to extract aluminium from this ore.

B. The abudance of this ore in the earth crust is very low.

C. This ore contains more than 55% of aluminium by mass.

D. Aluminium can be extracted from this ore due to the advancement of technology in apply electricity.

DSE12_16

Which of the following combinations is/are correct?

	Object	Corresponding corrosion prevention method / principle
(1)	Aluminium window frames	Cathodic protection
(2)	Galvanized iron buckets	Sacrificial protection
(3)	Tin-plated iron cans	Alloying

A. (1) only B. (2) only

C. (1) and (3) only D. (2) and (3) only

DSE13_23

1st statement	2nd statement
When iron and copper are separated immersed in hexane completely, iron corrodes faster than copper.	Iron can be oxidized more readily than copper.

DSE13_05

Which of the following methods can be used to obtain magnesium from magnesium compounds?

A. Electrolysis of a molten magnesium compound

B. Electrolysis of an aqueous solution of a magnesium compound

C. Heating magnesium oxide with carbon

D. Heating magnesium oxide strongly

DSE13_07

Both the frame and gear system of a bicycle are made of steel. Which of the following combinations can be used to prevent these parts of the bicycle from rusting?

	Frame	Gear system
A.	painting	greasing
B.	painting	galvanizing
C.	tin-plating	greasing
D.	tin-plating	galvanizing

DSE13_13

Titanium (Ti) is a metal. 2.66 g of a sample of titanium powder is heated in excess oxygen until the metal is completely oxidized. The mass of the oxide formed is 4.44 g. which of the following is the empirical formula of the oxide formed?

(Relative atomic masses : O = 16.0, Ti = 47.9)

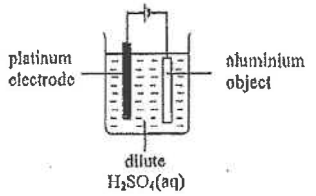
A. TiO B. Ti_2O_3

C. Ti_3O_4 D. TiO_2

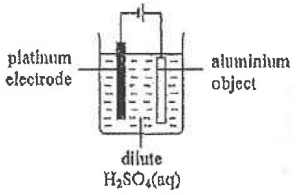
DSE13_06

Which of the set-ups shown below can best be used to anodize an aluminum object?

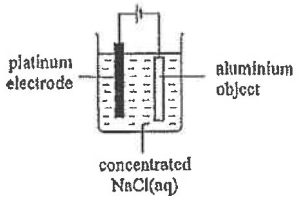
A.



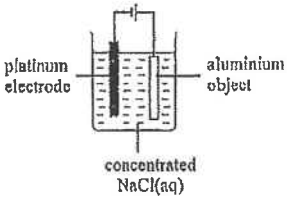
B.



C.



D.



DSE13_19

Which of the following statements about limestone is/are correct?

(4) It gives a golden yellow flame in a flame test.

(5) It gives a colorless gas when heated strongly.

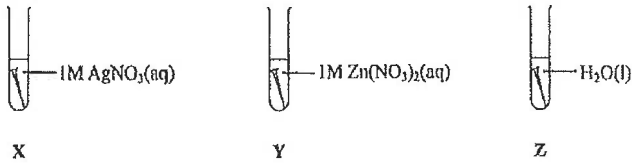
(6) It dissolves in dilute sulphuric acid to give a clear solution.

A. (1) only B. (2) only

C. (1) and (3) only D. (2) and (3) only

DSE14_03

The diagram below shows three iron nails of the same size and shape each immersed in a liquid.



Which of the following arrangements represents the ascending order of rate of corrosion of the iron nails?

A. Z < Y < X
B. Y < Z < X
C. Z < X < Y
D. X < Z < Y

DSE14_04

Refer to the following chemical equation:

$$Fe_2O_3(s) + 3CO(g) \longrightarrow 2Fe(s) + 3CO_2(g)$$

N moles of Fe_2O_3 are allowed to react with 2 N moles of CO under suitable conditions until the reaction stops. How many moles of Fe are formed?

A. N
B. 2 N
C. $\frac{2}{3}$ N
D. $\frac{4}{3}$ N

DSE14_05

Hydrated salt $X{\cdot}nH_2O$ contains 51.16% of water by mass. Given that the molar mass of X is 120.3 g, what is n?

(Relative atomic masses: H = 1.0, O = 16.0)

A. 2
B. 5
C. 7
D. 10

DSE14_18

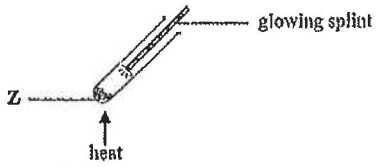
In an experiment, a small piece of potassium is added to a trough of water containing phenolphthalein. Which of the following statements concerning the experiment are correct?

(1) An exothermic reaction occurs
(2) A colorless solution is formed.
(3) The metal burns with a lilac flame.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE14_14

As shown in the diagram below, the glowing splint relights when solid Z is heated.



Which of the following chemicals may Z be?

A. HgO
B. Al_2O_3
C. $CaCO_3$
D. $MgCO_3$

DSE15_02

Which of the following processes would NOT give oxygen?

A. Heating mercury(II) oxide strongly
B. Electrolysis of dilute sulphuric acid
C. Fractional distillation of liquefied air
D. Passing steam over heated magnesium

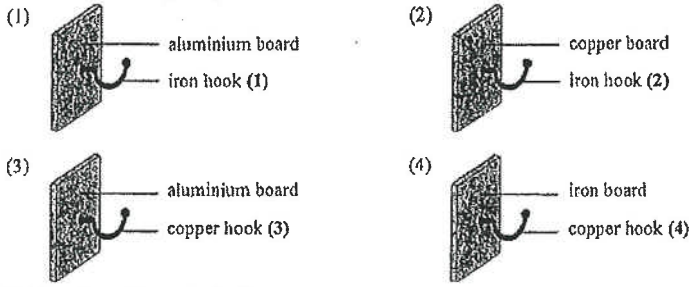
DSE15_05

A gel containing NaCl(aq), $K_3Fe(CN)_6$(aq) and phenolphthalein is yellow in color. An iron nail is put into the gel and corrodes after a period of time. Which of the following colors would NOT be observed in the gel after the iron nail corrodes?

A. Blue
B. Pink
C. Grey
D. Yellow

DSE15_07

Consider the following set-ups:



Which hook would corrode first?

A. Iron hook (1)
B. Iron hook (2)
C. Copper hook (3)
D. Copper hook (4)

DSE15_21

Which of the following observations would be expected when some calcium granules are put in cold water inside a test tube?

(1) A cloudy mixture is formed.
(2) The test tube becomes warm.
(3) Colourless gas bubbles are formed.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE16_03

Consider the following information concerning metal Y:

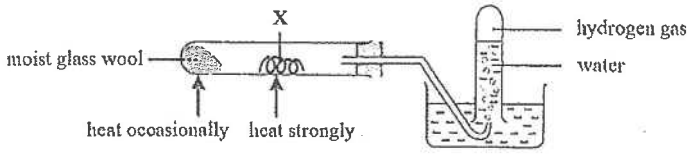
(1) Y reacts vigorously with water.
(2) Y forms an oxide with chemical formula Y_2O.
(3) An atom of Y has five occupied electron shells.

Y may be

A. silver (Ag).
B. caesium (Cs).
C. strontium (Sr).
D. rubidium (Rb).

DSE16_04

Consider the following experimental set-up:



Which of the following would NOT be X?

A. Iron
B. Zinc
C. Copper
D. Magnesium

DSE16_05

Tin plating is used to prevent iron cans from rusting because

A. tin provides sacrificial protection to iron.
B. tin layer prevent iron from exposure to air.
C. tin is higher than iron in the metal reactivity series.
D. tin and iron form an alloy which does not corrode.

DSE16_09

1 mol of a hydrocarbon requires 9 mol of oxygen for complete combustion. Which of the following may be this hydrocarbon?

A. C_6H_6
B. C_6H_{10}
C. C_6H_{12}
D. C_6H_{14}

DSE16_23

1st statement	2nd statement
During anodization, the aluminium oxide on the surface of aluminium is reduced to metal.	The corrosion resistance of aluminium can be enhanced by anodization.

DSE17_03

A hydrocarbon burns completely in oxygen to give 17.6 g of carbon dioxide and 3.6 g of water. Which of the following is the empirical formula of the hydrocarbon?

A. CH
B. CH_2
C. C_2H_2
D. C_2H_5

DSE17_09

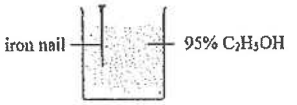
Which of the following processes would NOT produce metal?

A. Heating zinc oxide
B. Heating copper(II) oxide with carbon
C. Electrolysis of molten lithium chloride
D. Heating iron(III) oxide with carbon monoxide

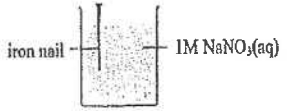
DSE17_13

In which of the following cases would the iron nail corrode fastest?

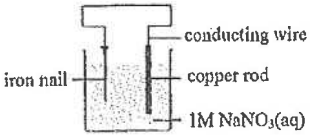
A.



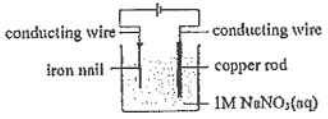
B.



C.



D.



DSE17_19

Which of the following statements concerning anhydrous copper(II) sulphate powder are correct?

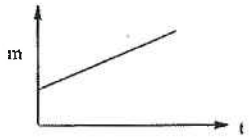
(1) It is white in color.
(2) It dissolves in water to give a blue solution.
(3) It can be obtained from heating hydrated copper(II) sulphate crystals

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

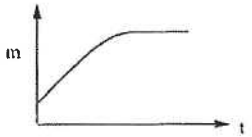
DSE18_03

A certain mass of a sample of $Ag_2O(s)$ is strongly heated in a test tube. Which of the following shows the relationships of the mass of the contents (m) in the test tube with time (t) from the start of heating?

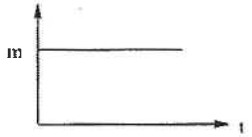
A.



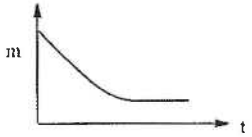
B.



C.



D.



DSE18_04

If 8.0 g of sulphur dioxide gas contains n molecules, how many molecules does 2.0 g of oxygen gas contain?

A. 2.0 n
B. 4.0 n
C. 0.25 n
D. 0.50 n

DSE18_06

Dilute sodium hydroxide solution is added to a 0.1 M solution until in excess. Which of the following combinations is correct?

	Solution	Observation
A.	Zinc sulphate	White precipitate formed
B.	Calcium nitrate	White precipitate formed
C.	Lead(II) nitrate	Yellow precipitate formed
D.	Iron(III) sulphate	Dirty green precipitate formed

DSE18_07

Which of the following statements concerning iron and magnesium is correct?

A. Iron is ductile but magnesium is not.
B. Iron corrodes less readily than magnesium.
C. The abundance of magnesium is higher than that of iron in the earth crust.
D. Both magnesium and iron can have more than one oxidation number in their oxides.

DSE18_09

X, Y and Z are different metals. When they are placed separately in NaCl(aq), only Y gives colorless gas bubbles. When each of their oxides is heated strongly, only the oxide of X gives a colorless gas. Which of the following shows the decreasing order of reactivity of these three metals?

A. Y > Z > X
B. X > Y > Z
C. Y > X > Z
D. Z > Y > X

DSE19_06

2.53 g of $NaHCO_3(s)$ was heated until no further changes and 1.59 g of a solid remained. Which of the following equations matches with the experimental result?
(Relative atomic masses : H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

A. $NaHCO_3(s) \longrightarrow NaOH(s) + CO_2(g)$
B. $2NaHCO_3(s) \longrightarrow Na_2O_2(s) + 2CO_2(g) + H_2(g)$
C. $2NaHCO_3(s) \longrightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$
D. $2NaHCO_3(s) \longrightarrow Na_2O(s) + H_2O(g) + 2CO_2(g)$

DSE19_08

39.2 g of an oxide of rubidium (Rb) contains 28.5 g of rubidium. What is the empirical formula of this oxide ?
(Relative atomic masses : O = 16.0, Rb = 85.5)

A. RbO
B. RbO_2
C. Rb_2O
D. Rb_2O_2

DSE19_15

Which of the following methods can slow down the corrosion of an iron-made object ?
(1) Connect it to a piece of lead.
(2) Plate a layer of copper coating completely onto its surface.
(3) Connect it to the cathode of a chemical cell.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE19_17

Which of the following metal oxides can be reduced to a metal when heated with carbon using a Bunsen burner?
(1) Lead(II) oxide
(2) Magnesium oxide
(3) Copper(II) oxide

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE2020:

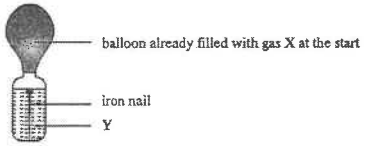
7. Refer to the information in the table below:

Material	Rank order of Hardness (1 = hardest)	Density / g cm^{-3}	Rank order of Price (1 = cheapest)
P	4	8.9	4
Q	3	7.8	1
R	2	10.5	3
S	1	2.7	2

Which is the best material to make aircraft body ?

A. P
B. Q
C. R
D. S

8. Consider the following experimental set-up :



In which of the following combinations would the iron nail rust the fastest ?

	X	Y
A.	hydrogen	petrol
B.	hydrogen	distilled water
C.	oxygen	petrol
D.	oxygen	distilled water

15. The observations of heating three metal carbonates are shown below :

Metal carbonate	Observation
X_2CO_3	A gas was given out and a shiny silvery solid was formed.
Y_2CO_3	There was no observable change.
ZCO_3	A gas was given out and a yellow solid was formed.

Which of the following shows the decreasing order of reactivity of the metals ?

A. Z > Y > X
B. Y > X > Z
C. Z > X > Y
D. Y > Z > X

17. Which of the following ways is / are acceptable in the storage of the chemical concerned ?

(1) Store concentrated $H_2SO_4(l)$ in a copper container.
(2) Store concentrated $AgNO_3(aq)$ in a brown glass container.
(3) Store concentrated $Pb(NO_3)_2(aq)$ in an iron container.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE21_04

4. M, Q and R are three different metals. When their oxides are separately heated, only the oxide of M gives a metallic lustre. When their carbonates are separately heated with a Bunsen burner, only the carbonate of R gives no observable changes. Which of the following shows the increasing order of reactivity of the metals ?

A. R < Q < M
B. R < M < Q
C. M < R < Q
D. M < Q < R

DSE21_18

18. Both aluminium and iron form oxides on their surfaces when they are exposed in air. The oxide of aluminium can prevent the aluminium from further corrosion, but the oxide of iron cannot prevent the iron from further corrosion. What is / are the reason(s) ?

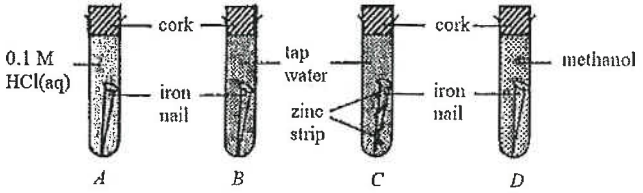
(1) The oxide of aluminium adheres firmly on the aluminium surface while the oxide of iron adheres loosely on the iron surface.
(2) The oxide of aluminium is insoluble in water while the oxide of iron is soluble in water.
(3) The oxide of aluminium has a giant ionic structure while the oxide of iron does not.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

Structural Questions

CE90_05a

The set-up below was used to investigate the corrosion of iron:



After some time, the solution from each tube was tested with potassium hexacyanoferrate(III) solution. It was found that corrosion of iron occurred only in tubes A and B.

(i) State the colour change when the solution from tube A was tested with potassium hexacyanoferrate(III)solution.

(ii) When the iron nail in the tube B corroded,

(1) indicate what cation and anion were produced, and

(2) write the half equation to show the formation of each ion.

(iii) In which of the tubes would bubbles of gas be observed?
Write an equation for the reaction involved.

(iv) Explain why corrosion of iron did not occur in

(1) tube C.

(2) tube D.

(9 marks)

CE91_02c

Iron sheets can be tin-plated by electrolysis of either tin(II) or tin(IV) compounds before they are used to make food cans.

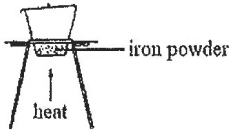
(iii) Give one reason to explain why iron is first tin-plated before food cans are made from it.

(iv) If the tin-plated iron sheet has been scratched to expose the iron, can it still be used to make a food can? Explain.

(3 marks)

CE91_04a

A student used the following set-up to determine the empirical formula of an oxide of iron.



Before the experiment, the student was instructed to see whether the iron powder was rusty and to remove any rust from it.

After weighing a sample of pure iron powder, the student then heated it strongly in a crucible, opening and closing the lid from time to time until the reaction was complete. He then reweighed the content after cooling.

The following results were obtained:

Mass of crucible + lid	25.27g
Mass of crucible + lid + iron powder before heating	26.16g
Mass of crucible + lid + content after cooling	26.50g

(i) If the iron powder were rusty, describe briefly how the rust could be removed chemically, Write an appropriate equation for the reaction.

(ii) Give TWO reasons why the crucible lid was opened and closed from time to time during heating.

(iii) Calculate the empirical formula of the oxide of iron from the above data.
(Relative atomic mass: O = 16.0, Fe = 56.0)

(9 marks)

CE92_01b

The table below gives some information about three metals A, B and C:

Metal	Rate of corrosion in moist air	Electrical conductivity	Strength of metal	Cost per tonne
A	Fast	Very good	Moderate	$13400
B	Fast	Good	Good	$13800
C	Slow	Very good	Moderate	$37000

(i) Based on the information given above, explain which metal is most suitable for making

(1) electrical cable.

(2) window frames.

(ii) Suggest one method to reduce the rate of corrosion of metal in moist air.

(iii) Why can metals conduct electricity?

(7 marks)

CE92_04b

Silvery metal **A** reacts vigorously with water to form colourless solution **B**. When **B** is subjected to the flame test, it gives a persistent yellow flame. When **B** is added to copper(II) nitrate solution, precipitate **C** is formed. **C** changes into black solid **D** upon strong heating.

(i) What is metal **A**? Write a balanced equation for the reaction between **A** and water.

(ii) Describe how the flame test on **B** can be carried out in the laboratory.

(iii) Write an ionic equation for the formation of **C**.

(iv) Give the name for **D**.

(6 marks)

CE93_01a

Aluminium and iron can be used in making window frames.

(i) Describe an experiment to show that aluminium is more reactive than iron.

(ii) Although aluminium is more reactive than iron, explain why most window frames are now made of anodized aluminium instead of painted iron.

(5 marks)

CE93_05a

The following table lists some reactions of iron(III) nitrate solution:

Reaction	Observation	Equation
(1) Zinc powder was added to iron(III) nitrate solution.	–	$Zn(s) + 2Fe^{3+}(aq) \longrightarrow Zn^{2+}(aq) + 2Fe^{2+}(aq)$

(i) What would be observed in reaction (1)? Explain your answer.

(2 marks)

CE94_01

The table below lists some information about three metals X, Y and Z.

Metal	X	Y	Z
Atomic number	12	20	–
Action of cold water	No apparent change	A colourless gas slowly evolves	No apparent change
Action of 0.1M hydrochloric acid	A colourless gas evolves	–	No apparent change

(a) To which group in the Periodic Table does Y belong?

(b) (i) Write an equation for the reaction between X and 0.1M hydrochloric acid. (An ionic equation will NOT be accepted for this question.)

(ii) Draw electronic structures for the TWO products formed in (i) above, showing electrons in the outermost shell ONLY.

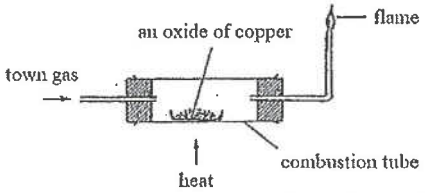
(c) What would be observed when Y is added to 0.1M hydrochloric acid?

(d) Based on the results of the reaction given in the above table, arrange the three metals in descending order of reactivity. Explain your answer.

(8 marks)

CE94_06a

The following experiment set-up was used to determine the empirical formula of an oxide of copper.



In the experiment, 8.58 g of an oxide of copper, after complete reaction, produced 7.62 g of copper.

(i) Deduce the empirical formula of the oxide of copper.

(ii) Write an equation for the reaction that occurred in the combustion tube.

(iii) State TWO potential hazards associated with this experiment, and suggest a safety precaution for each hazard.

(iv) At the end of the reaction, heating was stopped. However, it was necessary to continue pass the town gas through the combustion tube until the tube had cooled down. Explain why.

(Relative atomic masses: Cu = 63.5, O = 16.0)

(8 marks)

CE95_01

Rubidium (Rb) and potassium belong to the same group in the Periodic Table. The relative atomic mass of rubidium is larger than that of potassium.

(a) Explain whether rubidium is more reactive than potassium.

(b) Write a chemical equation for the reaction between rubidium and water. (State symbols should be given.)

(c) Suggest how rubidium can be stored safely in the laboratory.

(d) Suggest ONE safety precaution for handling rubidium in the laboratory.

(5 marks)

CE95_06b

The table below gives some information about five metals.

Metal	Abundance in the earth's crust (%)	Price per kg ($)	Relative resistance of corrosion (1 = least resistant 4 = most resistant)	Relative strength of metal (1= lowest 3= highest)
Al	8.1	170	3	1
Cu	0.0055	140	3	3
Au	0.0000004	1100000	4	2
Fe	5.0	20	1	3
Zn	0.007	160	2	2

(i) Although gold has a very low abundance in the earth's crust, gold was discovered by man a long time ago. Why?

(ii) Which of the metals in the above table is the most suitable to make pipes for hot water? Explain your answer.

(iii) (1) Aluminium does not corrode easily. Why?

(2) Aluminium is a principal material for making aircraft but its strength is relatively low. Suggest how the strength of aluminium can be improved to make it suitable for making aircraft.

(iv) (1) Based on the information given in the table, suggest ONE factor that affect the price of a metal.

(2) Suggest ONE other factor (not indicated in the table) that can also affect the price of a metal.

(9 marks)

CE96_04

Briefly describe an experiment, using the following apparatus and materials, to show that air is necessary for the rusting of iron.

2 test tubes, a test tube holder, a Bunsen burner

2 clean iron nails, paraffin oil and tap water

(8 marks)

CE97_01

For each of the tasks listed in the table below, decide which substance on the right is the best to use to **accomplish the task.** Explain your answer in each case.

Task	Substances
(a) To attach a substance to the iron hull of a tanker to prevent the full from rusting 	Calcium, Copper, Zinc

CE98_01

Lithium is a group I element in the Periodic Table. It occurs naturally in two isotopic forms. The relative abundance of each of these isotopes is shown in the table below:

Isotope	^{6}Li	^{7}Li
Relative abundance (%)	7.4	92.6

(c) A piece of freshly cut lithium metal is placed in air.

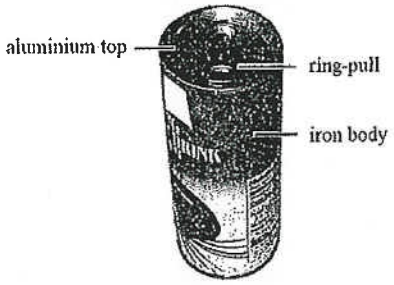
(i) What would be observed on the surface of the metal after some time? Write the relevant chemical equation.

(ii) Draw the electronic diagram of the product in (i), showing electrons in the *outermost shells* only.

(3 marks)

CE98_08b

The photograph below shows a can of fruit juice. The body of the can is made of iron coated with another metal. The top of the can and the right-pull are made of aluminium.



(i) (1) Suggest ONE reason why the iron body is coated with another metal.

(2) Name ONE metal commonly used for coating the iron body.

(ii) Suggest ONE reason why aluminium, rather than iron, is used for making the top of the can and the ring-pull.

(iii) Explain why it is not advisable to buy cans of fruit juice

(1) if the cans have scratches on the iron body;

(2) if the cans are swollen.

(iv) There is an increasing tendency for manufacturers to use cans made entirely of aluminium for the storage of fruit juice. Suggest ONE advantage and ONE disadvantage of using aluminium cans for the storage of fruit juice.

(9 marks)

CE99_02

For each of the following experiments, state ONE observable change and write a chemical equation for the reaction involved.

(b) A small piece of calcium is placed in a Bunsen flame.

(c) A mixture of copper(II) oxide and carbon powder is heated in a test tube.

(4 marks)

CE00_03

Consider the following materials:

Aluminium, bronze, copper, lead, mild steel and titanium

For each of the tasks listed below, choose the ONE material which is best to accomplish the task. Explain your choice in each case.

(a) making electrical wiring

(b) making overhead high voltage cables

(4 marks)

CE00_09a

X, Y and Z are three different metals. The table below shows the results of two experiments carried out using the metals or their oxides.

Experiment	X	Y	Z
Adding the metal to water	Effervescence	No observable change	No observable change
Heating the metal oxide	No observable change	Metal produced	No observable change

(i) Based on the above information, arrange the three metals in order of increasing reactivity. Explain your answer.

(3 marks)

CE01_05

Explain why anodization, sacrificial protection and tin-plating can protect metals from corrosion.

(9 marks)

CE01_07c

The photograph below shows a diamond ring:

(i) Explain why gold and diamond each has a high melting point.

(ii) 18-carat gold is an alloy of gold. Suggest ONE reason why 18-carat gold instead of pure gold is used in making the ring.
(You are NOT required to consider the price of the materials.)

(3 marks)

CE01_08a

(ii) A part of the Periodic Table is shown below:

		Group							
		I	II	III	IV	V	VI	VII	0
Period	2	Li	Be	B	C	N	O	F	Ne
	3	Na	Mg	Al	Si	P	S	Cl	Ar
	4	K	Ca					Br	Kr
	5								Xe

For each of the following pairs of elements, suggest ONE reaction in which both elements behave similarly. In each case, write a chemical equation for the reaction involving either one of the elements.

(1) magnesium and calcium

(2 marks)

CE02_01

Both ammonium dihydrogenphosphate and ammonium sulphate are nitrogenous fertilizers.

(b) List all the elements in ammonium dihydrogenphosphate.

(1 mark)

(c) (i) Calculate the percentage by mass of nitrogen in ammonium sulphate.

(2 marks)

CE02_02

For each of the following experiments, state an expected observation and write a chemical equation for the reaction involved.

(a) A magnesium ribbon is placed in a Bunsen flame.

(2 marks)

CE02_06a

Magnesium can be extracted from sea water which contains magnesium ions. The extraction of magnesium from sea water involves three stages.

Stage 1: Add slaked lime to sea water to precipitate magnesium ions as magnesium hydroxide.
Stage 2: Heat the magnesium hydroxide obtained in a stream of hydrogen chloride gas to give magnesium chloride.
Stage 3: Extract magnesium by electrolysis of the molten magnesium chloride.

(i) What substance is mainly present in slaked lime?
(ii) Write a chemical equation, with state symbols, for the reaction in *Stage 2*.
(iii) Explain why molten magnesium chloride can conduct electricity.

(3 marks)

CE02_07a

Calcite is a mineral which contains mainly calcium carbonate. An experiment, consisting of the following five stages, was conducted to determine the percentage by mass of calcium carbonate in a sample of calcite.

Stage 1: Weigh the sample. Add dilute nitric acid to it until the acid is in excess.
Stage 2: Filter the mixture obtained in Stage 1 to remove any undissolved solid.
Stage 3: Add excess sodium sulphate solution to the filtrate to precipitate out calcium sulphate.
Stage 4: Collect the calcium sulphate precipitate and wash it with distilled water.
Stage 5: Allow the calcium sulphate to dry and weigh it.

(i) Write a chemical equation for the reaction of calcium carbonate with dilute nitric acid. Suggest how one can know that excess acid has been added in *Stage 1*.
(ii) Draw a labelled diagram of the set-up used in the filtration process in *Stage 2*.
(iii) Write the ionic equation for the reaction in *Stage 3*.
(iv) Explain why it is necessary to wash the precipitate with distilled water in *Stage 4*.

(v) The results obtained in the experiment are listed below:

Mass of the calcite sample = 7.98g

Mass of the calcium sulphate obtained = 10.52g

(1) Calculate the percentage by mass of calcium carbonate in the sample of calcite.

(2) State ONE assumption in the calculation.

(Relative atomic masses: C = 12.0, O = 16.0, S = 32.0, Ca = 40.0)

(10 marks)

CE02_08b

Both carbon and silicon are Group IV elements in the Periodic Table.

(iv) Silicon can be obtained by heating silicon dioxide with carbon strongly.

(1) Write a chemical equation for the reaction involved.

(2) Suggest ONE use of silicon.

(2 marks)

CE03_02

X, **Y** and **Z** are three different metals. The table below lists the results of three experiments carried **out using** the metals or their oxides.

Experiment	X	Y	Z
Adding metal to cold water	Formation of a colourless gas	No observable change	No observable change
Adding metal to copper(II) sulphate solution	Formation of a colourless gas and a reddish brown solid	Formation of reddish brown solid	No observable change
Heating metal oxide with carbon powder	No observable change	Formation of a solid with metallic lustre	Formation of a solid with metallic lustre

(a) What is the colourless gas formed when **X** is added to cold water? Suggest a test for the gas.

(b) Name the type of reaction that occurs when the oxide of **Y** is heated with carbon powder.

(c) Arrange the three metals in order of increasing reactivity. Explain your answer.

(d) Why is a colourless gas formed when **X** is added to copper(II) sulphate solution?

(7 marks)

CE04_01

Calcium reacts with cold water to give a colourless gas.

(a) Write a chemical equation for the reaction.

(b) In a practical lesson, a student added a few pieces of calcium granules into a beaker of cold water.

(i) Draw a labelled diagram to show how the student could collect the gas produced.

(ii) The student recorded the following observation in his laboratory report:

'Evolution of the colourless gas was at first slow but became faster after some time.'

Suggest an explanation for the student's observation.

(c) Potassium also reacts with cold water. State TWO differences in observation when potassium and calcium are added separately to cold water.

(7 marks)

CE04_08b

Corrosion of iron often results in the formation of rust on its surface.

(i) What is the chemical nature of rust?

(ii) State the essential conditions for the rusting of iron.

(iii) For each of the following iron objects, suggest a suitable method to protect it from corrosion:

(1) bicycle gear wheel

(2) underground water pipe

(iv) Explain why connecting the body of a car to the negative terminal of the car battery can help protect the car body from corrosion.

(v) Although aluminium occupies a higher position than iron in the electrochemical series, it is more resistant to corrosion than iron.

(1) Provide an explanation for the phenomenon.

(2) Suggest a method to enhance the corrosion resistance of aluminium.

(7 marks)

CE05_02

(a) Upon strong heating, silver oxide (Ag_2O) undergoes decomposition as represented by the following word equation:

silver oxide $\longrightarrow$ silver + oxygen

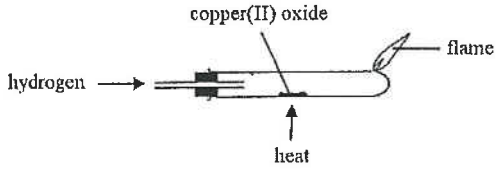
(i) Transcribe the word equation into a chemical equation.

(ii) Explain why the decomposition is a redox reaction.

(iii) Calculate the mass of silver that would be obtained when 3.50 g of silver oxide undergoes complete decomposition.

(5 marks)

(b) Copper(II) oxide can be reduced to copper using the set-up shown below:



(i) State an expected observation change in this experiment.

(ii) Suggest ONE way to show that a metal is formed in this experiment.

(iii) Write a chemical equation for the reaction of copper(II) oxide with hydrogen.

(iv) Suggest why it is necessary to burn the residual hydrogen in the set-up.

(4 marks)

(c) Is it possible to deduce from the results of the experiments in (a) and (b) that copper occupies a higher position in the metal reactivity series than silver does?
Explain your answer.

(1 mark)

CE05_08

Lead (Pb) is an element in Group IV of the Periodic Table.

(a) An oxide of lead, X, contains 90.6% of lead by mass. Calculate the empirical formula of X.

(2 marks)

(b) X is known to be a mixed oxide composed of PbO and PbO_2. Based on your answer in (a), deduce the mole ratio of PbO to PbO_2 in X.

(2 marks)

CE07_06

Read the paragraph below and answer the questions that follow.

> Magnesium is a useful metal. Scientists adopt different methods to extract magnesium from magnesium oxide. In 1828, a scientist obtained magnesium in two steps. In the first step, magnesium oxide reacts with chlorine and carbon to form magnesium chloride. In the second step, the magnesium chloride formed reacts with potassium to give magnesium. In 1951, some scientistis adopted another chemical process to obtain magnesium from magnesium chloride. Potassium is not used in this process, and there is even no need to use any other chemicals.

(a) Write a chemical equation for the reaction that occurred in the first step of the method used by the scientist in 1828.

(1 mark)

(b) Name the type of reaction between potassium and magnesium chloride. Why can potassium react with magnesium chloride to give magnesium?

(2 marks)

(c) (i) What would be the chemical process that can obtain magnesium from magnesium chloride, without using potassium or other chemicals, in 1951?

(ii) What property does magnesium chloride possess so as to make the chemical process possible?

(2 marks)

(d) Suggest one use of magnesium in daily life.

(1 mark)

CE08_03

Four iron-made objects are placed separately in gel with rust indicator solution containing potassium hexacyanoferrate(III), and allowed to stand in air for some time. Complete the following table by writing down the observation and giving the relevant explanation for each of the cases.

Case	Observation	Explanation
Iron-made object fully plated with zinc		
Iron-made object fully plated with tin		
Iron-made object fully plated with zinc, but part of the zinc scratched to expose the iron underneath		
Iron-made object fully plated with tin, but part of the tin scratched to expose the iron underneath		

(5 marks)

CE09_02

(a) Magnesium can burn in air under strong heating.

(i) State the expected observation when magnesium burns in air.

(ii) Magnesium nitride is also formed when magnesium burns in air.

(1) State the chemical formula of magnesium nitride.

(2) Draw the electronic diagram of magnesium nitride, showing electrons in the outermost shells only.

(3 marks)

(b) Carbon can be used to extract metals from certain metal oxides.

(i) Suggest how copper can be extracted from copper(II) oxide using carbon. State the expected observation.

(ii) Explain whether carbon can also be used to extract magnesium from magnesium oxide.

(3 marks)

CE09_03

Iron powder can be used to make 'warm packs' for keeping users warms. A kind of warm pack is made by putting iron powder in a package which allows air to pass through. The package also contains other substances for speeding up the production of heat.

(a) According to the given information, suggest why this kind of warm pack can produce heat.

(2 marks)

(b) Explain why iron powder, instead of a piece of iron with the same mass, is put in the warm pack.

(1 mark)

(c) The other substances in the package include moist sodium chloride. Suggest why it can speed up the production of heat.

(1 mark)

CE09_13

For question 13, candidates are required to give answers in paragraph form. For this question, 6 marks will be awarded for chemical knowledge and 3 marks for effective communication.

Electrolysis can be applied to enhance the corrosion resistance of iron. Describe the chemical principle involved in this application. Your description should include the chemical reactions involved, and the use of appropriate electrodes and electrolyte.

(Diagrams are NOT required.)

(9 marks)

CE10_01

Both bromine (Br) and chlorine (Cl) are Group VII elements in the Periodic Table.

(a) What is the name commonly given to this group of elements?

(1 mark)

(b) The electronic arrangement of bromine is 2, 8, p, q.
p is _____; q is _____.

(1 mark)

(c) Explain, in terms of bonding and structure, why the boiling point of bromine is higher than that of chlorine.

(2 marks)

(d) Rubidium (Rb) is a Group I element in the Periodic Table. It reacts with bromine to form an ionic compound.

(i) Write a chemical equation for the reaction involved.

(ii) Write the electronic arrangement of a rubidium ion.

(2 marks)

CE10_04

M_2O is an oxide of metal M. Upon heating, M_2O decomposes to give M and oxygen only.

(a) Suggest a method for testing oxygen, and state the expected observation.

(1 mark)

(b) In an experiment, 3.48g of M_2O completely decomposes to give 3.24g of M. Calculate the relative atomic mass of M.

(2 marks)

(c) Explain whether M can react with dilute hydrochloric acid.

(1 mark)

CE11_02

Under same experimental conditions, the same mass of 'expired' and 'fresh' calcium granules were separately put into water as shown in the diagrams below. The 'expired' calcium granules have been exposed in air for a long time, while the 'fresh' calcium granules are newly brought.

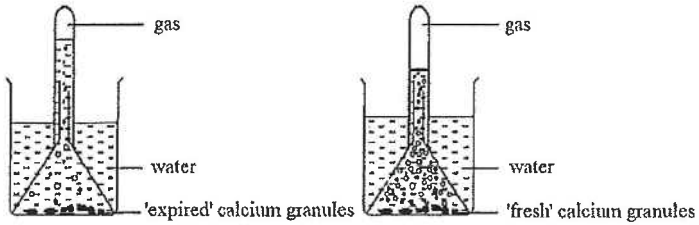


Diagram 1 Diagram 2

(a) Name the gas collected, and write a chemical equation for the reaction involved.

(2 marks)

(b) Suggest why less gas was collected in the set-up of Diagram 1 than in that of Diagram 2.

(1 mark)

(c) Would the pH of the content in the beaker increase, decrease or remain unchanged after the calcium granules were put into the water in Diagram 2? Explain your answer.

(2 marks)

(d) Suggest TWO potential hazards in performing the above experiment.

(2 marks)

AL02(II)_01

Devise an experiment, using chemicals and apparatus commonly available in a school laboratory, to determine the number of water of crystallization per formula unit of $CaSO_4$ in the sample of blackboard chalk.

(4 marks)

AL04(I)_08d

(i) Explain why carbon dioxide extinguishers must not be used to put out a piece of burning sodium.

(1 mark)

(ii) Suggest a proper way to put out a piece of burning sodium in the laboratory.

(1 mark)

AL04(II)_01 (Modifieid)

A gaseous compound **A** has the following composition by mass:

N 21.6%, O 49.2% and F 29.2%

(a) Deduce the empirical formula of **A**.

(2 marks)

(b) If the molecular mass of **A** is in the range of 60 to 70 and hence deduce its molecular formula.

(2 marks)

AL11(I)_07

(a) Copper(II) sulphate(VI) crystallizes from its aqueous solution as $CuSO_4 \cdot 5H_2O(s)$.

(i) The water of crystallization of the salt can be liberated upon heating. Suggest a chemical test to show that water is being liberated.

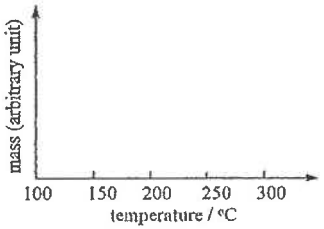
(1 mark)

(ii) Outline an experimental method to establish that the salt is pentahydrate.

(3 marks)

(iii) When $CuSO_4 \cdot 5H_2O(s)$ is heated slowly such that the temperature rises steadily, it will lose four water molecules at about 110 °C, and then the last water molecule at about 250 °C.

Using the axes below, sketch the change of mass when a sample of $CuSO_4 \cdot 5H_2O(s)$ is heated slowly.



(2 marks)

AL12(I)_01

The potassium salt of the iron(III) ethanedioate complex has the following composition by mass:

K, 26.8%; Fe, 12.8%; C, 16.5%; O, 43.9%

(ethanedioate: $C_2O_4^{2-}$)

Calculate the emipirical formula of this potassium salt.

(2 marks)

ASL12(II)_02

Metal **M** forms a water-soluble bromide MBr_2. The following gravimetric analysis experiment was conducted to determine the formula mass of MBr_2.

A solution of MBr_2 was prepared by dissolving 0.400 g of $MBr_2(s)$ completely in deionized water. The solution was acidified with $HNO_3(aq)$ and then treated with excess $AgNO_3(aq)$. The $AgBr(s)$ formed was separated from the mixture by filtration, washed and dried. Its mass was found to be 0.816 g.

(a) Given that the cation of **M** in MBr_2 does not react with $Ag^+(aq)$ ions, calculate the formula mass of MBr_2.

(3 marks)

(b) Calculate the relative atomic mass of **M**, and deduce what **M** is.

(2 marks)

AL13(II)_05

(b) Account for the difference in reactivity of Ca(s) and Ra(s) with water.

(2 marks)

DSE11SP_03

X, **Y** and **Z** are three different metals. The table below lists the results of three experiments carried out using the metals or their oxides.

Experiment	X	Y	Z
Adding metal to cold water	formation of a colorless gas	no observable change	no observable change
Adding metal to copper(II) sulphate solution	formation of a colorless gas and a reddish brown solid	formation of a reddish brown solid	no observable change
Heating metal oxide with carbon powder	no observable change	formation of a solid with metallic lustre	formation of a solid with metallic lustre

(a) What is the colourless gas formed when **X** is added to cold water? Suggest a test for the gas.

(2 marks)

(b) Name the type of reaction that occurs when the oxide of **Y** is heated with carbon powder.

(1 mark)

(c) Arrange the three metals in order of increasing reactivity. Explain your answer.

(3 marks)

(d) Why is a colorless gas formed when **X** is added to copper(II) sulphate solution?

(1 mark)

DSE11SP_08

For each of the following experiments, state an expected observation and write a chemical equation for the reaction involved.

(a) adding dilute hydrochloric acid to zinc granules

(2 marks)

DSE12PP_05

The fuel used in the torch for the Beijing 2008 Olympic Games was an alkane **X** with the following composition by mass:

C, 81.8% H, 18.2%

(a) Deduce what **X** could be.

(3 marks)

DSE12_05

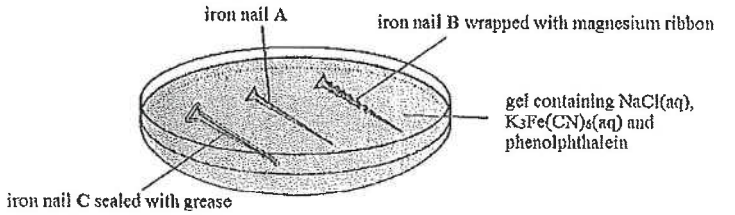
In order to prepare 50 dm^3 of 0.1 M $CuSO_4(aq)$, an inexperienced electroplating worker added the required exact amount of $CuSO_4 \cdot 5H_2O(s)$ to water in a plastic container. He then stirred the mixture with an iron rod until the $CuSO_4 \cdot 5H_2O(s)$ dissolved completely. Finally, he sent a sample of the solution to the Quality Control Laboratory for analysis, but found that the concentration of $CuSO_4(aq)$ was lower than 0.1 M.

(a) With the aid of a chemical equation, explain why the concentration of the $CuSO_4(aq)$ prepared was lower than 0.1 M.

(2 marks)

DSE12_09

The diagram below shows an experimental set-up for investigating the factors affecting rusting.



(a) What would be observed if an iron nail in the above set-up rusts?

(1 mark)

(b) Suggest which of the iron nails in the above set-up would NOT rust during the experiment. Explain your answer.

(3 marks)

DSE13_03

Compound **W** contains carbon, hydrogen and oxygen only. The relative molecular mass of **W** is 88.0. Complete combustion of 1.32 g of **W** gives 2.64 g of carbon dioxide and 1.08 g of water.

(a) Deduce the molecular formula of **W**.
(relative atomic masses : H = 1.0, C = 12.0, O = 16.0)

(3 marks)

DSE13_07

Thermite reactions broadly refer to exothermic oxidation-reduction reactions between a metal powder and a metal oxide. One example is the reaction of finely divided iron(III) oxide with aluminium powder. This reaction results in a very high temperature, and is commonly used in the welding of rail tracks for trains. At this very high temperature, the molten iron formed joins the rail tracks together.

(a) (i) Complete and balance the chemical equation for the following thermite reaction.

____$Fe_2O_3(s)$ + ____$Al(s)$ ⟶

(1 mark)

(ii) Sketch a labelled enthalpy level diagram for this reaction.

(1 mark)

(b) Copper powder CANNOT be used to replace aluminium powder in carrying out the thermite reaction with iron(III) oxide. Explain why.

(1 mark)

(c) The extraction of iron from its ores also involves the reduction of iron oxides.

(i) Suggest why aluminium is NOT used as the reducing agent in iron extraction.

(1 mark)

(ii) Suggest ONE reducing agent commonly used in iron extraction.

(1 mark)

DSE14_04

With reference to the methods of obtaining copper, magnesium and silver from their oxides, deduce the order of reactivity of these three metals.

(4 marks + 1 mark)

DSE15_03

Aluminium and iron are commonly used construction materials.

(a) Suggest why iron was used earlier than aluminium in history.

(1 mark)

(b) A compound contains iron and oxygen only. In an experiment for determining the empirical formula of this compound, 2.31 g of the compound was heated with carbon monoxide. Upon complete reaction, carbon dioxide and 1.67 g of iron were formed.

(i) Calculate the empirical formula of this compound.

(2 marks)

(ii) Write the chemical equation for the reaction involved in the experiment.

(1 mark)

(iii) As carbon monoxide is poisonous, suggest one necessary safety precaution in carrying out the experiment.

(1 mark)

(c) Explain why a galvanized iron object does not easily rust even if the zinc layer is broken.

(2 marks)

(d) Explain why anodization can prevent aluminum object from corrosion.

(2 marks)

DSE16_01

Refer to the **following information of phosphorus** (P) and chlorine (Cl).

	P	Cl
Atomic number	15	17
Relative atomic mass	31.0	35.5

(c) A compound of phosphorus and chlorine has a relative molecular mass smaller than 250. It contains 22.6% of phosphorus by mass.

(i) Deduce the molecular formula of the compound.

(2 marks)

(ii) Draw the electron diagram for the compound, *showing electrons in the outermost shells only*.

(1 mark)

DSE17_02

Water pipes used to carry drinking water are commonly made of copper instead of iron. Although lead-containing solder can be used to join these water pipes, such use is prohibited.

(a) Suggest one chemical property of copper that makes it more suitable than iron for making water pipes. Explain your answer.

(2 marks)

(b) (i) Suggest one reason of adding lead to soldering materials.

(1 mark)

(ii) Explain why lead-containing solder is prohibited in joining these water pipes.

(1 mark)

DSE18_01

(b) In an experiment, 1.25 g of lithium nitride is formed when a piece of lithium is burnt in air.

(i) Write a chemical equation for the reaction involved.

(1 mark)

(ii) Calculate the mass of lithium that reacted with nitrogen,
(Relative atomic masses: Li = 6.9, N = 14.0)

(2 marks)

(c) Name another compound which will also be formed when lithium is burnt in air.

(1 mark)

DSE18_05

Electroplating and rust prevention are common applications of electrochemistry.

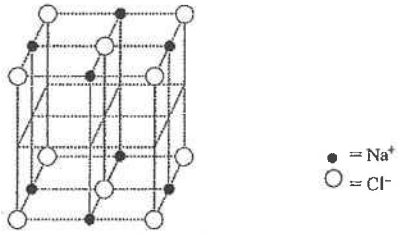
(b) Suggest a method, besides painting or electroplating, that can prevent underground iron-made pipelines from rusting. Explain your answer.

(2 marks)

DSE19_02

Sodium chloride crystal has a giant ionic structure.

(a) The diagram below shows a part of the structure of sodium chloride crystal with some ions missing.



Complete the diagram by using ● as Na^+ ion and ○ as Cl^- ion.

(b) From an experiment, it was found that there are 4 Na^+ ions and 4 Cl^- ions in a cube of sodium chloride crystal of volume 1.80×10^{-22} cm^3.

(i) Express the total mass of 4 Na^+ ions and 4 Cl^- ions in terms of the Avogadro's constant L. (Relative atomic masses : Na = 23.0, Cl = 35.5)

(ii) Hence, calculate the Avogadro's constant L, given that 1.00 cm^3 of sodium chloride crystal weighs 2.17 g.

(3 marks)

DSE19_09

Iron cans used to store food products are commonly coated with a thin layer of tin.

(a) The thin layer of tin prevents iron cans from corrosion.

(i) Briefly describe the principle for this kind of corrosion prevention.

(1 mark)

(ii) Explain whether these iron cans would corrode more readily once their surfaces are damaged by scratching.

(1 mark)

(iii) Suggest why galvanisation is not suitable to prevent corrosion in iron cans that are used to store food products.

(1 mark)

(b) There is an increasing trend for manufacturers to use cans made entirely of aluminium for storing food products.

(i) Explain why aluminium is more resistant to corrosion than iron, although it occupies a higher position than iron in the reactivity series.

(1 mark)

(ii) Name the process that increases the corrosion resistance of aluminium cans.

(1 mark)

(iii) Other than corrosion resistance, suggest one advantage of using aluminium to make cans.

(1 mark)

DSE21_03(c)(ii)

3. (c) (ii) Under certain conditions, 1.0 g of SiO_2 is allowed to react with 1.0 g of Mg. The equation for the reaction is shown below :

$$SiO_2 + 2Mg \rightarrow 2MgO + Si$$

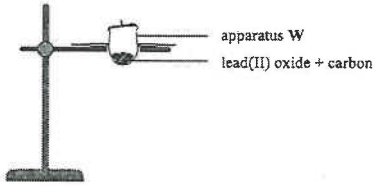
Calculate the theoretical mass of Si that can be formed.
(Relative atomic masses : O = 16.0, Mg = 24.3, Si = 28.1)

DSE21_06(d)(i),(ii)

(d) Lead can also be obtained from lead(II) oxide using carbon.

(i) Write a chemical equation for the reaction.

(ii) The diagram below shows an incomplete set-up for performing the reaction :



(1) Add suitable drawing (with label) to the diagram for completing the set-up.

(2) Name apparatus W.

(3 marks)

2022

11. In the electrolysis of 1.0 M $CuSO_4(aq)$, copper cathode and carbon anode are used. Which of the following combinations is correct ?

	Cathode	Anode
A.	Copper dissolves	Oxygen is formed
B.	Copper dissolves	Sulphur dioxide is formed
C.	Copper is deposited	Oxygen is formed
D.	Copper is deposited	Sulphur dioxide is formed

15. **P**, **Q** and **R** are three different metals. When dilute HCl(aq) is added to these metals separately, only **Q** and **R** give a colourless gas. When zinc is added to aqueous solutions of their chlorides separately, only the chloride of **R** shows no observable change. Which of the following shows the increasing order of the reducing power of the metals ?

A. **R < Q < P**
B. **Q < P < R**
C. **P < Q < R**
D. **P < R < Q**

2022

*8. Describe and explain the similarities and differences between the chemical principles involved in tin-plating and galvanising in the rusting prevention of iron-made objects.

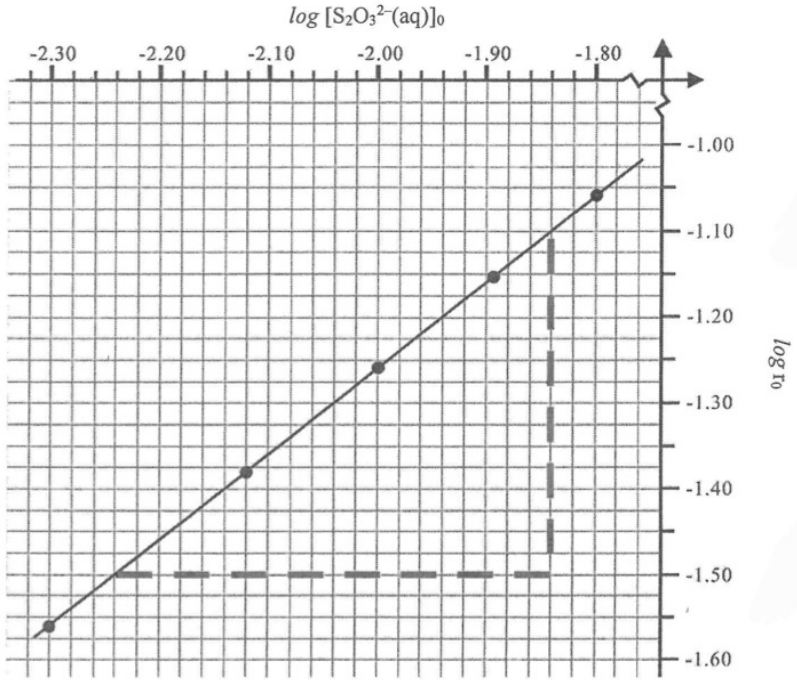
(6 marks)

2022

1. (c) The chemical kinetics of the following reaction at a certain temperature was studied :

$$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow SO_2(g) + S(s) + H_2O(l)$$

Several trials of an experiment were performed under the same experimental conditions, except varying the initial concentration of $S_2O_3^{2-}(aq)$ (represented by $[S_2O_3^{2-}(aq)]_0$), to measure the initial rate of formation of S(s) (represented by r_0). The following graph shows the experimental results obtained from these trials :



(i) What is meant by the term 'initial rate' ?

(1 mark)

(ii) The rate equation for the reaction is shown below :

$$\text{Rate} = k\,[S_2O_3^{2-}(aq)]^a\,[H^+(aq)]^b$$

where k is the rate constant,
a is the order of reaction with respect to $S_2O_3^{2-}(aq)$
and ***b*** is the order of reaction with respect to $H^+(aq)$.

Given that the concentration of $H^+(aq)$ used was much higher than that of $S_2O_3^{2-}(aq)$ in each trial, explain why the above rate equation can be modified as shown below :

$$\text{Rate} = k'\,[S_2O_3^{2-}(aq)]^a$$

where k′ is regarded as a constant.

(2 marks)

(iii) By using the dotted lines in the graph above, deduce the order of reaction with respect to $S_2O_3^{2-}(aq)$.

(3 marks)

(iv) The experiment was repeated at 25 °C and 35 °C separately, while other experimental conditions were the same. The rate constant of the reaction at 25 °C is k_1 and the rate constant of the reaction at 35 °C is k_2. The ratio of k_2 to k_1 is 1.9 : 1.0. Calculate the activation energy of the reaction, in kJ mol^{-1}.

(Gas constant $R = 8.31$ J K^{-1} mol^{-1}; Arrhenius equation : $\log k = constant - \frac{E_a}{2.3RT}$)

(2 marks)

Marking Scheme

MCQ

CE90_07	D	CE90_09	B	CE90_10	D	CE90_31	D
CE90_45	B	CE90_49	A	CE91_08	A	CE91_09	C
CE91_11	C	CE91_31	D	CE92_01	B	CE92_06	B
CE92_07	C	CE92_31	C	CE92_33	D	CE92_34	B
CE93_08	C	CE93_20	A	CE93_21	B	CE93_46	B
CE94_08	B	CE94_18	D	CE94_44	D	CE95_05	D
CE95_06	A	CE95_18	B	CE95_45	D	CE96_08	A
CE96_35	C	CE96_47	C	CE97_28	C	CE97_32	D
CE97_41	A	CE97_47	B	CE97_48	A	CE98_02	B
CE98_10	C	CE98_11	D	CE98_19	C	CE98_20	C
CE98_27	A	CE98_44	B	CE99_02	C	CE99_08	A
CE99_17	B	CE99_21	D	CE99_22	C	CE99_31	A
CE99_46	A	CE00_03	B	CE00_04	D	CE00_33	C
CE00_50	C	CE01_26	C	CE01_30	C	CE01_38	B
CE01_49	D	CE02_03	C	CE02_08	D	CE02_14	C
CE02_23	C	CE02_26	C	CE02_27	B	CE03_01	C (64%)
CE03_02	D (51%)	CE03_05	C (61%)	CE03_11	D (51%)	CE03_28	A (41%)
CE03_09	B (70%)	CE03_42	D (59%)	CE05SP_08	B (49%)	CE05SP_21	C
CE05SP_29	C	CE05SP_32	D	CE05SP_41	D	CE04_12	C (47%)
CE04_16	A (62%)	CE04_26	C (83%)	CE04_35	B (59%)	CE04_48	D (69%)
CE05_10	D (65%)	CE05_11	C (83%)	CE05_23	A (59%)	CE06_08	C (41%)
CE06_09	A (49%)	CE06_13	D (52%)	CE06_18	C (47%)	CE06_34	C (41%)
CE06_37	B (58%)	CE07_05	D (20%)	CE07_07	A (83%)	CE07_11	A (34%)
CE07_34	C (67%)	CE07_38	D (22%)	CE07_48	C (58%)	CE08_04	C (65%)
CE08_10	A (56%)	CE08_12	D (40%)	CE08_15	C (76%)	CE08_16	C (71%)
CE08_26	B (65%)	CE08_31	A (74%)	CE08_34	D (56%)	CE08_50	B (24%)
CE09_05	A (72%)	CE09_06	C (76%)	CE09_08	B	CE09_09	C (68%)
CE09_20	C (36%)	CE09_33	A (51%)	CE09_41	B (73%)	CE09_46	B (38%)
CE09_47	A (39%)	CE10_03	B (51%)	CE10_04	A (56%)	CE10_06	B (48%)
CE10_08	A (63%)	CE10_14	A (66%)	CE10_16	A (56%)	CE10_21	D (53%)
CE10_22	A (72%)	CE10_26	A (80%)	CE10_33	D (72%)	CE11_04	C (60%)
CE11_08	C (51%)	CE11_23	D (62%)	CE11_30	C (70%)	CE11_36	B (57%)
CE11_38	C (79%)	CE11_46	D (23%)	DSE11SP_05	D	DSE11SP_06	C
DSE11SP_15	A	DSE12PP_06	B	DSE12_03	A (78%)	DSE12_09	D (81%)
DSE12_16	B (64%)	DSE13_23	C (49%)	DSE13_05	A (71%)	DSE13_07	A (66%)
DSE13_13	D (74%)	DSE13_06	B (51%)	DSE13_19	B (65%)	DSE14_03	A (19%)
DSE14_04	D (62%)	DSE14_05	C (84%)	DSE14_18	B (66%)	DSE14_14	A (68%)
DSE15_02	D (77%)	DSE15_05	C (70%)	DSE15_07	B (87%)	DSE15_21	D (55%)
DSE16_03	D (59%)	DSE16_04	C (75%)	DSE16_05	B (86%)	DSE16_09	C (77%)
DSE16_23	C (77%)	DSE17_03	A (43%)	DSE17_09	A (72%)	DSE17_13	D (55%)
DSE17_19	D (60%)	DSE18_03	D (78%)	DSE18_04	D (60%)	DSE18_06	B (65%)

DSE18_07 B (68%) DSE18_09 A (59%) DSE19_06 C DSE19_08 B
DSE19_15 D DSE19_17 C

DSE2020:
7_D 8_D 15_D 17_B

Structural Questions

CE90_05a

(i) from colourless (or pale yellow) to blue. [1]

(ii) (1) Fe^{2+} (or iron(II) ions) [1]
OH^- (or hydroxide ions) [1]

(2) $Fe(s) \longrightarrow Fe^{2+}(aq) + 2e^-$ [1]
$2H_2O(l) + O_2(g) + 4e^- \longrightarrow 4OH^-(aq)$ [1]

(iii) tube A [1]
$Fe(s) + 2H^+(aq) \longrightarrow H_2(g) + Fe^{2+}(aq)$ [1]
OR, $Fe(s) + 2HCl(aq) \longrightarrow FeCl_2(aq) + H_2(g)$

(iv) (1) zinc is more reactive than iron [1]
OR, sacrificial protection by zinc

(2) absence of water and oxygen [1]

CE91_02c

(iii) Tin protects iron from rusting because tin prevents the contact of iron with water and air. [1]

(iv) No. Iron is more reactive than tin. [1]
Iron will lose electrons and corrode faster. [1]

CE91_04a

(i) Heat the rusty iron with carbon. [2]
$2Fe_2O_3 + 3C \longrightarrow 4Fe + 3CO_2$ [1]

(ii) The lid was opened to allow coming in of air. [1]
The lid was closed to prevent leaking out of iron powder. [1]

(iii)

	Fe	O
Mass	$26.16 - 25.27$ $= 0.89$ g	$26.50 - 26.16$ $= 0.34$ g
Number of mole	$\frac{0.89}{56.0} = 0.0159$	$\frac{0.34}{16} = 0.02125$
Mole ratio	$\frac{0.0159}{0.0159} = 1$ ≈ 3	$\frac{0.02125}{0.0159} = 1.336$ ≈ 4

[3]

Empirical formula = Fe_3O_4 [1]

CE92_01b

(i) (1) A is chosen because
A conducts electricity very well; [1]
The cost of A is low; [1]
A can be protected from corrosion by adding plastic coatings. [1]
OR, C is chosen because
C conducts electricity very well;
C has a high resistance to corrosion;
Although the cost of C is high, C can be used for a long time.

(2) B is chosen because (any two):
B is very hard; [1]
The cost of B is low; [1]
B corrodes very fast but this can be prevented by painting.
OR, C is chosen because
C corrodes very slow;
Although the cost of C is high, C can be used for a long time.

(ii) Any one: [1]
- Painting
- Connecting the metals with a more reactive metal (by sacrificial protection)
- By making alloy
- Adding plastic coating
- Electroplating

(iii) Metals have mobile electrons (or 'sea' of delocalized electrons) for conducting electricity. [1]

CE92_04b

(i) A is sodium metal. [1]
$2Na + 2H_2O \longrightarrow 2NaOH + H_2$ [1]

(ii) Step 1: Put a clean platinum wire into concentrated hydrochloric acid [1]
Step 2: Dip the platinum wire into solution B [1]
Step 3: Put it to the Bunsen flame

(iii) $Cu^{2+}(aq) + 2OH^-(aq) \longrightarrow Cu(OH)_2(s)$ [1]

(iv) Copper(II) oxide [1]
[Note: when copper(II) hydroxide is strongly heated, it turns to black copper(II) oxide
$Cu(OH)_2 \longrightarrow CuO + H_2O$]
Blue black

CE93_01a

(i) Adding Al and Fe metal in dilute hydrochloric acid, [1]
Al will react and give out colourless bubbles at a faster rate than that of Fe. [1]
[Note: $2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$ (faster)
$Fe + 2HCl \longrightarrow FeCl_2 + H_2$ (slower)]
OR, Al metal can displace iron from iron(II) sulphate solution,
the solution changes from pale green to colourless and a silvery solid is formed.
$2Al(s) + 3Fe^{2+}(aq) \longrightarrow 2Al^{3+}(aq) + 3Fe(s)$ (Displacement reaction)

(ii) Anodized aluminium contains a protective layer of Al_2O_3. [1]
But the painting on iron is easily scratched off. [1]
Therefore, iron corrodes much faster than aluminium. [1]

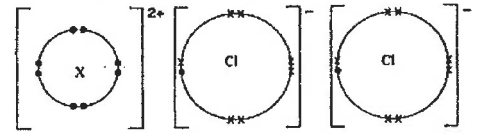
CE93_05a

(i) Fe^{3+} solution changes from yellow (or brown) to pale green. [1]
It is a redox (displacement) reaction that $Fe^{3+}(aq)$ is reduced by Zn to $Fe^{2+}(aq)$. [1]

CE94_01

(a) Group II [1]

(b) (i) $X + 2HCl \longrightarrow XCl_2 + H_2$ [1]
OR, $Mg + 2HCl \longrightarrow MgCl_2 + H_2$

(ii) 

[1]

(c) A colourless gas rapidly evolves. [1]
[Note: Y is Calcium
$Ca(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + H_2(g)$]

(d) Y > X > Z [1]
Y is most reactive because only Y can react with cold water but X and Z cannot. [1]
X is more reactive than Z because X can react with HCl but Z cannot. [1]

CE94_06a

(i) [1]

	Cu	O
Mass	7.62 g	8.58 – 7.62 = 0.96 g
Number of mole	$\frac{7.62}{63.5} = 0.12$	$\frac{0.96}{16} = 0.06$
Mole ratio	$\frac{0.12}{0.06} = 2$	$\frac{0.06}{0.06} = 1$

Empirical formula is Cu_2O [1]

(ii) $Cu_2O(s) + H_2(g) \longrightarrow 2Cu(s) + H_2O(l)$ [1]
OR, $Cu_2O(s) + CO(g) \longrightarrow 2Cu(s) + CO_2(g)$

(iii) Firstly, town gas is toxic, [1]
so the experiment should be done in fume cupboards. [1]
Secondly, burning of a mixture of town gas and air is explosive, [1]
so the combustion tube should be flush with town gas before heating. [1]

(iv) This is done to prevent the hot copper metal reacting with oxygen. [1]

CE95_01

(a) Rb is more reactive than K because Rb can release its (outermost) electron more readily. [1]

(b) $2Rb(s) + 2H_2O(l) \longrightarrow 2RbOH(aq) + H_2(g)$ [2]

(c) Store under paraffin oil [1]

(d) Any one: [1]

- Wear gloves
- Do not touch directly
- Use a pair of forceps
- Wear safety glasses
- Use a safety screen

CE95_06b

(i) Gold is very unreactive which can be found free in nature. [1]

(ii) Copper / Cu [1]
because: any two [2]

- it does not corrode easily
- has a high metallic strength
- is relatively cheap

(iii) (1) Al reacts with oxygen in air to form a layer of aluminium oxide [1]
which is not permeable to oxygen and water. So it prevents the metal from further [1]
corrosion.

(2) Alloying (with other metals e.g. Cu / Mn / Mg) [1]

(iv) (1) The price depends in its abundance in the earth's crust. [1]

(2) Any one: [1]

- cost of extraction
- cost in mining
- supply and demand of the metal

CE96_04

Chemical knowledge

Step 1: Place some tap water in a test tube to remove any undissolved oxygen (air) [1]

Step 2: Place one nail in a test tube containing some tap water (Tube 1) and the other nail [2]
in a test tube containing the boiled water (Tube 2)

Step 3: Add some paraffin oil on top of the boiled water in tube 2 to prevent air to dissolve [1]
into the water to get in contact with the nail.

After some time, reddish solid (rust) can be seen in tube 1 but no change in tube 2. [1]

Effective communication [3]

CE97_01

(a) Zinc [1]

Both zinc and calcium are more reactive than iron. They can prevent iron from rusting [2]
by sacrificial protection.

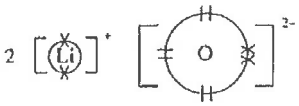
However, calcium reacts readily with water, so it cannot be used. [1]

CE98_01c

(i) The metal surface will turn dull [1]

$4Li(s) + O_2(g) \longrightarrow 2Li_2O(s)$ [1]

(ii) [1]



CE98_08b

(i) (1) To prevent iron from rusting. [1]

(2) Tin (Sn) [1]

(ii) Al is softer than iron. The ring pull can be pulled off more easily. [1]

(iii) (1) Tin (Sn) is less reactive than iron (Fe). [1]
Iron exposed to air will rust faster. [1]

(2) Fruit juice in swollen cans has already deteriorated (turn bad), [1]
gas generated by (anaerobic) respiration of bacteria causes the can to swell. [1]

(iv) Advantages: [1]

- Al is lighter
- is more resistant to corrosion than Fe
- can be recycled more easily
- can be dyed more easily

Disadvantages: [1]

- Al is more expensive
- is not so strong as Fe

CE99_02

(b) Calcium burns with a red (Brick red) flame and formation of white powder (solid) [1]

$2Ca + O_2 \longrightarrow 2CaO$ [1]

(b) Reddish brown powder (solid) [1]

$CuO + C \longrightarrow Cu + CO$ [1]

OR, $2CuO + C \longrightarrow 2Cu + CO_2$

CE00_03

(a) Copper [1]

Good electrical conductor [1]

(b) Aluminium [1]

Low density [1]

CE00_09a

(i) Reactivity: Y < Z < X [1]

Y is the least reactive because only the oxide of Y decomposes on heating. The oxides of [1]
X and Z are stable to heat.

X is the most reactive metal because only X can react with water. [1]

CE01_05

Chemical knowledge

Anodization is to thicken the layer of aluminium oxide on the surface of aluminium metal. [1]

The oxide layer is impervious (impermeable) to oxygen (water) / prevents the metal from reaction with air. [1]

Sacrificial protection is to attach a more reactive metal to a less reactive metal. [1]

The more reactive metal is more readily oxidized (forms cations) to gives out electrons. [1]

Corrosion of the less reactive metal is prevented.

Tin-plating is to coat the surface of an iron object with tin. [1]

Tin can protect the iron from rusting because tin layer prevents oxygen and water from contacting with iron for rusting to occur. [1]

Effective comunication [3]

CE01_07c

(i) Gold has strong metallic bond between atoms. [1]

Diamond has a covalent network structure and strong covalent bonds exist between carbon atoms. [1]

(ii) 18-carat gold is stronger and not easily deformed. [1]

CE01_08a

(ii) (1) Both Mg and Ca can burn in air. [1]

$2Mg + O_2 \longrightarrow 2MgO$ [1]

OR, $2Ca + O_2 \longrightarrow 2CaO$

Alternative answer:

Both Mg and Ca react with (hot) water.

$Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2$

OR, $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$

CE02_01

(b) Nitrogen (N), hydrogen (H), phosphorus (P) and oxygen (O) [1]

[Note: ammonium dihydrogenphosphate = $NH_4H_2PO_4$]

(c) (i) Formula mass of $(NH_4)_2SO_4 = (14+4)\times2 + 32 + 16\times4 = 132$ [1]

$$\%\text{ by mass of N} = \frac{14 \times 2}{132} = 21.2$$ [1]

(Accept 21, 21.2 and 21.21)

CE02_02

(a) Magnesium burns with a brilliant flame and a white solid (MgO) is formed. [1]

$2Mg + O_2 \longrightarrow 2MgO$ (white) [1]

CE02_06a

(i) Calcium hydroxide / $Ca(OH)_2$ [1]

(ii) $Mg(OH)_2(s) + 2HCl(g) \longrightarrow MgCl_2(s) + 2H_2O(l)$ [1]

(iii) Molten magnesium chloride contains mobile ions. [1]

CE02_07a

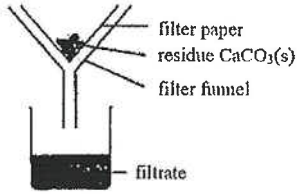
(i) $CaCO_3(s) + 2HNO_3(aq) \longrightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$ [1]

OR, $CaCO_3(s) + 2H^+(aq) \longrightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$

Evolution of CO_2 stops [1]

OR, Test the pH of the solution using pH paper, the pH should be less than 7.

(ii) Diagram [2]



(iii) $Ca^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow CaSO_4(s)$ [1]

(iv) To remove any soluble impurities (or appropriate example) [1]

(v) (1) $$\text{mole of } CaSO_4 = \frac{10.52}{(40 + 32 + 16 \times 4)} = 0.0774$$ [1]

Mass of $CaCO_3$ in the sample of calcite = mole × molar mass

$= 0.0774 \times (40 + 12 + 16\times3)$

$= 7.74$ g [1]

$$\%\text{ by mass of } CaSO_4 = \frac{7.74}{7.98} \times 100\% = 97.0$$ [1]

(Accept answers from 96.5 to 97.0)

(2) The sample does not contain ions which form insoluble sulphate, e.g. Ba^{2+}, Sr^{2+} [1]

OR, There is no loss of Ca^{2+} ions during the experiment

OR, $CaCO_3$ is the only calcium-containing compound present in the sample

CE02_08b

(iv) (1) $SiO_2 + C \longrightarrow Si + CO_2$ [1]

OR, $SiO_2 + 2C \longrightarrow Si + 2CO$

(2) Any one: [1]

- making computer chips
- electronic parts
- alloy
- semi-conductors
- silicone

CE03_02

(a) Hydrogen [1]

It burns with a 'pop' sound. [1]

(b) Redox. [1]

(c) Reactivity: Z < Y < X [1]

Y is more reactive than Z as Y can displace Cu from $CuSO_4(aq)$ but Z cannot. [1]

X is more reactive than Y as X can react with cold water but Y cannot. [1]

(d) X is a reactive metal. It reacts with water in the copper(II) sulphate solution and the colorless gas liberated is hydrogen. [1]

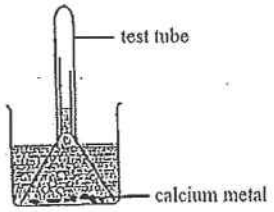
[Note: copper(II) sulphate solution contains water. And water reacts with X (Na, K or Ca) to give hydrogen.

e.g. $2Na + 2H_2O \longrightarrow 2NaOH + H_2$]

CE04_01

(a) $Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$ [1]

(b) (i) [2]



(1 mark for a correct set-up; 1 mark for the label of an appropriate gas collecting device)

(ii) The calcium metal is covered by a layer of calcium oxide. [1]

Reaction between Ca and water starts only when the oxide layer dissolves. [1]

OR, The reaction of calcium with water is exothermic.

The reaction becomes faster at elevated temperatures.

(Accept other reasonable answers.)

(c) Any TWO of the following: [2]

- Potassium floats / moves about on the surface of water while calcium sinks.
- Potassium melts (to form a silvery ball) while calcium does not.
- Potassium burns (with a lilac flame) while calcium does not catch fire.
- The reaction of potassium with water gives a hissing sound while that of calcium and water does not.
- The reaction of calcium with water gives bubbles while that of potassium with water does not.

(Accpet other reasonable answers)

CE04_08b

(i) Hydrated iron(III) oxide / $Fe_2O_3 .xH_2O$ [1]

(ii) Conditions: oxygen (air) and water [1]

(iii) (1) Greasing / oiling [1]

(2) Connect it to a more reactive metal (e.g. Zn / Mg) [1]

(Also accept sacrificial protection.)

(iv) The battery supplies electrons to the car body to prevent it from oxidized. [1]

(v) (1) The surface of aluminium is covered by a layer of oxide which is impermeable to air and water. [1]

(2) The thickness of the oxide layer can be increased by anodization. [1]

CE05_02

(a) (i) $2Ag_2O \longrightarrow 4Ag + O_2$ [1]

(ii) The oxidation no. of Ag decreases and the oxidation no. of O increases. [1]

(iii) $\text{mole of } Ag_2O = \dfrac{3.50}{[2(107.9) + 16]}$

No. of moles of Ag = 2 × no. of moles of Ag_2O

Mass of Ag that can be obtained = 107.9 × no. of moles of Ag

$= \dfrac{2(107.9)}{231.8} \times 3.5 = 3.26 \text{ g}$ [3]

(b) (i) The black oxide changes to reddish brown metal. [1]

(ii) The metal obtained can conduct electricity. [1]

(iii) $CuO + H_2 \longrightarrow Cu + H_2O$ [1]

(iv) Hydrogen is explosive / flammable. [1]

(c) No. The reactivity of Cu and Ag can only be compared using the same reaction. [1]

CE05_08

(a)

	Pb	O
Mole ratio	$\frac{90.6}{207.2}$	$\frac{9.4}{16}$
	0.4373	0.5875
Simplest ratio	3	4

Empirical formula of X is Pb_3O_4. [2]

(b) Let mole ratio of PbO to PbO_2 be x : y

$\dfrac{\text{mole of Pb}}{\text{mole of O}} = \dfrac{x+y}{x+2y} = \dfrac{3}{4}$ [1]

X is a mixture of PbO and PbO_2 in a mole ratio of 2 : 1. [1]

OR, X is not a mixture. In X, two-third of the lead exists in an oxidation number +2, while one-third in an oxidation number +4.

CE07_06

(a) $MgO + Cl_2 + C \longrightarrow MgCl_2 + CO$ [1]

OR, $2MgO + Cl_2 + C \longrightarrow 2MgCl_2 + CO_2$

(b) Redox (reaction) / displacement (reaction) [1]

Potassium is a more powerful reducing agent / more reactive than magnesium. [1]

(c) (i) Electrolysis [1]

(ii) Magnesium chloride is an ionic compound / electrolyte / conduct electricity in molten state / contains mobile ions. [1]

(d) Sacrificial protection / making alloy / firework / flash [1]

CE08_03

[5]

Case	Observation	Explanation
Iron-made object fully plated with zinc	No observable changes	Iron does not rust without contact with water and oxygen / air
Iron-made object fully plated with tin	No observable changes	Iron does not rust without contact with water and oxygen / air
Iron-made object fully plated with zinc, but part of the zinc scratched to expose the iron underneath	No observable changes	Zinc is more reactive / loses electrons more easily than iron *OR*, sacrificial protection
Iron-made object fully plated with tin, but part of the tin scratched to expose the iron underneath	Blue colour observed near the scratched area	The exposed iron rusts. Fe changes to Fe^{2+} which turns the indicator to blue / Fe is more reactive than Sn

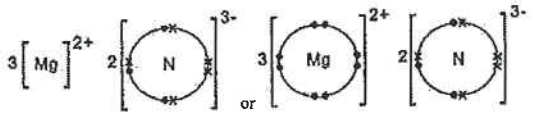
CE09_02

(a) (i) Brilliant light [1]

OR, white powder formed

(ii) (1) Mg_3N_2 [1]

(2) [1]



(b) (i) Mix carbon powder with copper(II) oxide, and heat the mixture strongly. [1]

Brown powder is formed. [1]

(ii) No. MgO is very stable. / Mg is high in the reactivity series of metal. / Mg is a strong reducing agent. / Mg loses electrons readily. [1]

CE09_03

(a) Iron powder reacts with oxygen. [1]

The reaction is exothermic. [1]

(b) Increase surface area / rate of reaction between iron and oxygen. / Speed up heat production. [1]

(c) Provide mobile ions. / Provide electrolyte. / Increase conductivity. / Increase rate of redox reaction. / Facilitate electron transfer. [1]

CE09_13

Chemical knowledge

A description of electroplating of iron:

a. The protective layer plated on iron can be a metal such as nickel / chromium / copper / silver. [1]

b. Electrolyte used is an aqueous salt solution of the metal. Example: nickel(II) sulphate (solution). [1]

c. The metal (e.g. Ni) should be made anode (positive electrode / connected to positive pole of power supply). [1]

d. The iron object should be made cathode (negative electrode / connected to negative pole of power supply). [1]

e. The metal (e.g. Ni) (anode) is oxidized / loses electrons to form ions. [1]

(Accept half equation: $Ni \longrightarrow Ni^{2+} + 2e^-$)

f. The metal ions (e.g. Ni^{2+}) are reduced / gain electrons on iron (cathode) surface to form metal (e.g. Ni) [1]

(Accept half equation: $Ni^{2+} + 2e^- \longrightarrow Ni$)

Effective communication [3]

CE10_01

(a) halogens [1]

(b) p: 18; q: 7 [1]

(c) Chlorine molecules attract each other by van der Waals' forces / weak intermolecular forces, so do bromine molecules. [1]

Bromine has a bigger molecular size than chlorine, and thus the van der Waals' forces / intermolecular forces between bromine molecules are stronger than that between chlorine molecules. [1]

(d) (i) $2Rb + Br_2 \longrightarrow 2RbBr$ [1]

(ii) 2, 8, 18, 8 [1]

CE10_04

(a) Relights a glowing splint [1]

(b) Let m be the relative atomic mass of M.

Mass ratio M : O = 2m : 16 = 3.24 : (3.48 – 3.24)

OR, Mass ratio M : M_2O = 2m : (2m+16) = 3.24 : 3.48

OR, Mole ratio $M : O = \frac{3.24}{m} : \frac{3.48 - 3.24}{16} = 2 : 1$

OR, Mole ratio $M : M_2O = \frac{3.24}{m} : \frac{3.48}{2m + 16} = 2 : 1$

m = 108 [2]

(c) No. The reactivity of M is very low. / M is lower than hydrogen in the electrochemical series. [1]

CE11_02

(a) Hydrogen [1]

$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$ [1]

(b) Most of the 'expired' calcium had been oxidized by air to form calcium oxide. [1]

(c) The pH would increase [1]

It is because calcium hydroxide formed is alkaline. [1]

(d) Any TWO points, 1 mark for each point [2]

- Hydrogen formed is explosive / flammable.
- Calcium / calcium hydroxide formed is corrosive.
- Heat is given off from the reaction.

AL02(II)_01

Heat a sample of the blackboard chalk (with a known mass) in a crucible until there is no [½]
further reduction in mass. Assuming that the initial mass and the final mass of the sample are [½]
m_1 and m_2 respectively.

No. of moles of $CaSO_4 = \frac{m_2}{40 + 32 + 16 \times 4} = \frac{m_2}{136}$ [½]

No. of moles of $H_2O = \frac{m_1 - m_2}{1 \times 2 + 16} = \frac{m_1 - m_2}{18}$ [½]

No. of moles of water of crystallization per formula unit of $CaSO_4 = \frac{m_1 - m_2}{18} \div \frac{m_2}{136}$ [1]

AL04(I)_08d

(i) The high temperature of the piece of burning sodium may cause decomposition of CO_2. [1]
The sodium will continue to burn.

(ii) Covering the piece of burning Na with sand / use dry powder extinguisher to put out the fire. [1]

AL04(II)_01 (Modifieid)

(a) Mole ratio of $N : O : F = \frac{21.6}{14} : \frac{49.2}{16} : \frac{29.2}{19} = 1.543 : 3.075 : 1.537 = 1 : 2 : 1$ [1]

∴ empirical formula : NO_2F [1]

(b) Molecular formula of A: $(NO_2F)_n$

$60 < (14.0 + 16.0 \times 2 + 19.0)n < 70$ [1]

$0.923 < n < 1.077$

n = 1 (n must be an integer)

Molecular formula: NO_2F [1]

AL11(I)_07

(a) (i) Treat the vapor with **anhydrous $CoCl_2$ / dry cobalt(II) chloride paper.** A change of color from **blue to pink** shows the presence of water. [½] [½]

OR, Treat the vapor with **anhydrous $CuSO_4$.** A change of color from **white to blue** shows the presence of water.

(ii) **Weigh** an empty crucible and its lid (m_1). [½]

Put a sample of the salt in the crucible and weigh the crucible, its content and the lid (m_2). [½]

Heat the crucible and its content, not completely covered by the lid, to allow water vapor to escape until the sample turns white. [½]

Allow the crucible and its content to cool in a desiccator and then weigh the crucible, its content and the lid.

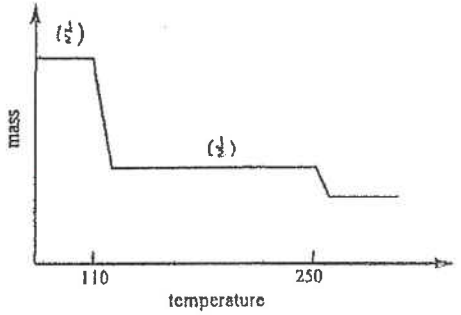
Repeat the heating and weighing processes until a constant mass (m_3) is reached. [½]

No. of molecules of water of crystallization

$= \frac{(m_2 - m_3)}{(m_3 - m_1)} \times \frac{(63.5 + 32.1 + 16 \times 4)}{(2 \times 1 + 16)}$ [1]

Should be equal to 5.

(iii) [2]



(1 mark for showing two 'steps' in the curve; 1 mark for showing that the heights of two 'steps' are in 4 : 1 ratio.)

AL12(I)_01

Mole ratio	K	Fe	C	O
	$\frac{26.8}{39.1}=0.685$	$\frac{12.8}{55.8}=0.229$	$\frac{16.5}{12.0}1.375$	$\frac{43.9}{16}2.744$
Simples ratio	3	1	6	12

[1]

Empirical formula of the salt is $K_3FeC_6O_{12}$ or $K_3Fe(C_2O_4)_3$ [1]

ASL12(II)_02

(a) No. of moles of AgBr(s) formed $= \frac{0.816}{(107.9+79.9)} = 0.004345$ [1]

No. of moles of MBr_2 used $= \frac{0.004345}{2} = 0.00217$ [1]

Formula mass of $MBr_2 = \frac{0.400}{0.00217} = 184.1$ [1]

(b) Relative atomic mass of M = 184.1 – 2(79.9) = 24.3 [1]

M is likely to be magnesium. [1]

AL13(II)_05

(b) Ra is more reactive than Ca towards water. ($H_2(g)$ is formed.) [1]

$M(s) + 2H_2O(l) \longrightarrow M(OH)_2(aq) + H_2(g)$

Ra has a larger size and is more ready to donate its outermost electrons. [1]

DSE11SP_03

(a) Hydrogen / H_2 [1]

It burns with a 'pop' sound. [1]

(b) Redox / reduction-oxidation reaction [1]

(c) Reactivity: $Z < Y < X$ [1]

Y is more reactive than *Z* as *Y* can displace Cu from $CuSO_4$(aq) but *Z* cannot. [1]

X is more reactive than *Y* as *X* can react with cold water but *Y* cannot / oxide of *X* cannot be reduced by carbon but oxide of *Y* can. [1]

(d) *X* is a reactive metal. It reacts with water in the copper(II) suphate solution and the colorless gas liberated is hydrogen [1]

DSE11SP_08

(a) zinc granules dissolve / a colorless gas is produced / solution gets warm [1]

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$ [1]

OR, $Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$

DSE12PP_05

(a) Atomic ratio of C : H $= \frac{81.8}{12} : \frac{18.2}{1} = 6.82 : 18.2 = 3 : 8$ [1]

Alkane has the general formula C_nH_{2n+2} [1]

∴ **X** is propane / C_3H_8 [1]

DSE12_05

(a) Displacement reaction occurred when the iron rod is dipped into the copper(II) sulphate solution. / Some copper(II) ions (Cu^{2+}) are reduced and deposited onto the surface of the iron rod as copper metal. [1]

$Cu^{2+}(aq) + Fe(s) \longrightarrow Cu(s) + Fe^{2+}(aq)$ [1]

$CuSO_4(aq) + Fe(s) \longrightarrow Cu(s) + FeSO_4(aq)$

DSE12_09

(a) Yellow to Blue / yellow to Blue and pink / blue and pink colouration would be observed near the iron nail which rusts. [1]

(b) Both iron nail B and iron nail C would not rust. [1]

For iron nail B, **as Mg is higher than iron in the metal reactivity series** (with further explanation such as: the magnesium ribbon loses electrons more readily and will become Mg^{2+} / Mg corrodes more readily). [1]

For iron nail B, the magnesium ribbon protects the iron nail from rusting by **sacrificial protection.** [1]

For iron nail C, as it is sealed with grease, the iron cannot contact with water and / or air (oxygen), so rusting cannot occur.

DSE13_03

(a) Atomic ratio of C : H : O $= \frac{2.64}{44} : \frac{1.08}{18}\times 2 : \frac{0.48}{16} = 2 : 4 : 1$ [1]

Empirical formula is C_2H_4O [1]

Molecular formula is $(C_2H_4O)_n$

$n\times(12\times2 + 1\times4 + 16\times1 = 88.0$

$n = 2$

molecular formula of W is $C_4H_8O_2$ [1]

Alternative method:

No. of C atoms in W $= \frac{2.64}{44}\times\frac{88}{1.32} = 4$

No. of H atoms in W $= \frac{1.08}{18}\times\frac{88}{1.32}\times 2 = 8$

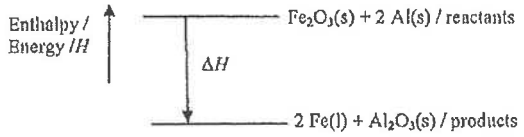
No. of O atoms in W $= \frac{88 - 12\times4 - 8\times1}{16} = 2$

molecular formula of W is $C_4H_8O_2$

DSE13_07

(a) (i) $Fe_2O_3(s) + 2Al(s) \longrightarrow 2Fe(s) + Al_2O_3(s)$ [1]

(ii)



[1]

(b) Copper is less reactive than iron. [*comparsive sense*] [1]

OR, Copper has a lower affinity for oxygen than iron.

OR, Copper is a weaker reducing agent than iron.

OR, Copper is lower than iron in the chemical reactivity series / electrochemical series.

∴ Cu(s) cannot reduce $Fe_2O_3(s)$.

(c) (i) Aluminium is more expensive than iron. / Using aluminium to extract iron is costly. [1]

(ii) Coke / carbon / charcoal / carbon monoxide / CO [1]

(Not accept coal or H_2)

DSE14_04

- By heating oxide of silver directly, silver can be obtained, while copper and magnesium cannot be obtained by similar method. [1]
- By heating with charcoal / carbon / hydrogen / carbon monoxide / town gas, oxide of copper can be reduced to copper, while magnesium cannot obtained by similar method. [1]
- Magnesium can only be obtained by electrolysis of its oxide in molten state. [1]
- As more stable is the metal oxide, the more reactive is the metal. So the order of reactivity is : magnesium > copper > silver
- Effective communication [1]

DSE15_03

(a) Iron is less reactive than aluminium [1]

OR, Compound/oxide/ore of iron is less stable

OR, Compound/oxide/ore of aluminum is more stable.

NOT accept answers like 'easy to extract", 'easier to extract"

(b) (i)

	Fe	O
Mass / g	1.67	0.64
Atom ratio	$\frac{1.67}{55.8} = 0.03$	$\frac{0.64}{16} = 0.04$

[1]

Empirical formula = Fe_3O_4 [1]

(ii) $Fe_3O_4(s) + 4CO(g) \longrightarrow 3Fe(s) + 4CO_2(g)$ [1]

(iii) Perform the experiment in a fume cupboard. [1]

(c) Zn is more reactive / a stronger reducing agent than iron. [1]

For galvanized objects with the surface layer of zinc broken, iron will be protected from corrosion as zinc will be preferentially oxidized (react with oxygen). [1]

OR, Zn is higher than Fe in the reactivity series or ECS.

OR, Zn is more electropositive than Fe.

NOT accept answers like "zinc sacrifices", "zinc corrodes".

OR, Zn releases / loses electrons

(d) The surface of the aluminium object is oxidized to $Al_2O_3(s)$ / aluminium oxide / oxide of aluminium. [1]

$Al_2O_3(s)$ is impermeable to water/oxygen/air, thus corrosion of aluminium is inhibited. [1]

DSE16_01

(a) (i) number of moles of P : number of moles of Cl

$= \frac{0.226}{31.0} : \frac{0.774}{35.5} = 1:3$

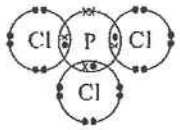
Molecular formula is $(PCl_3)_n$ [1]

$(31.0 + 35.5x3)\ n < 250$

$n = 1$

Molecular formula is PCl_3 [1]

(ii) [1]



DSE17_02

(a) Copper is not easily oxidized / corroded as iron [1]

(Accept: iron reacts with water / oxygen / air / acids but copper does not.)

(Not accept: iron rust but copper does not / Copper does not so easily rust as iron.)

Copper has a lower tendency to lose electrons than iron [1]

OR, Copper occupies at a lower position than iron in the e.c.s. / metal reactivity series / Copper is less reactive than iron.

(b) (i) To lower the melting point of soldering materials. [1]

(Not accept: The melting point of lead is low.)

(ii) Lead is / compounds of lead are toxic / poisonous. (not accept harmful) [1]

(Accept: Lead will damage / is harmful to the central nervous system (or other internal organs).)

DSE18_01

(b) (i) $6Li + N_2 \longrightarrow 2Li_3N$ [1]

(State symbols not required) (Ignore incorrect state symbols)

(ii) $\frac{y}{6.9} = 3 \times \frac{1.25}{34.7}$ [1]

$y = 0.746$ g

(Also accept 0.745, 0.75; NOT accept 0.750) (Correct unit is required) [1]

(Accept max. 4 decimal places)

(c) Lithium oxide / lithium peroxide [1]

DSE18_05

(b) Connect zinc / magnesium blocks (through connecting wires to the surface of the pipelines / scarification protection. [1]

Zinc / magnesium can release electrons more readily than iron. [1]

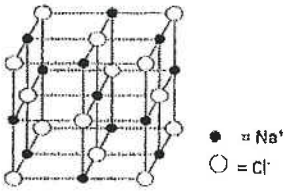
OR, Zinc and magnesium are more reactive than iron. / Zinc and magnesium has greater reducing power than iron. / Zinc and magnesium is higher than iron in the ECS.

OR, Connect the negative electrode of a D.C. source (through connecting wires) to the surface of the pipelines (and the positive electrode to a platinum electrode) / Cathodic protection

The electrons provided by the D.C. source prevent iron from releasing electrons.

(Do not accept wrapping with plastics / alloying / use stainless steel pipelines)

DSE19_02

(a) 

[1]

(b) (i) Total mass of 4 Na^+ ions and 4 Cl^- ions = (23.0 + 35.5) × 4 / L = 234 / L (g) [1]

(Accept answer without an unit, but NOT accept answer with an incorrect unit.)

(ii) $234/L = 2.17 \times 1.80 \times 10^{-22}$ [1]

$L = L = 5.99 \times 10^{23}$ (mol^{-1}) [1]

(Accept max. 3 decimal places)

(Accept answer without an unit, but NOT accept answer with an incorrect unit.)