O Level Combined Chemistry Structured

Metals Test 3.0

Q1

Iron can be extracted from its ore in a blast furnace.

(a) Explain, including three chemical equations, how iron is extracted from the ore in a blast furnace.

....

....

....

....[3]

(b) Choose an equation from (a) that represents a redox reaction. Explain why this is a redox reaction.

equation: ....

reason: ....

....

....[2]

(c) Carbon dioxide is an acidic oxide. Classify the following oxides.

(i)   carbon monoxide ....

(ii)   iron(III) oxide   ....

(iii)   silicon dioxide   ....

(iv)   calcium oxide   ....

[2]

(d) Hence or otherwise, explain, including **two** chemical equations, how the impurities are removed from the ore in a blast furnace.

....

....

....

....[3]

Q2

Iron is a metallic element.

(a) State two properties of iron which are different from those of Group I metals.   [2]

_____

_____

(b) The symbols for two isotopes of iron are shown below

$$^{54}_{26}Fe \qquad ^{57}_{26}Fe$$

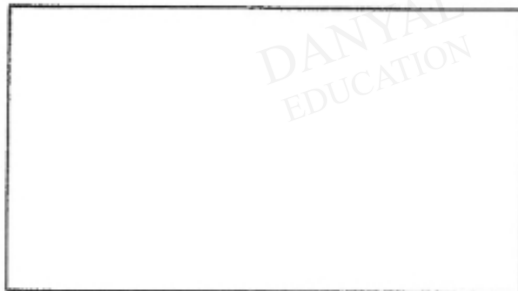(i) How do these two isotopes differ in their atomic structure?   [1]

_____

_____

(ii) How many electrons are there in a Fe^{3+} ion?   [1]

_____

(c) Pure iron is not strong enough to make structures such as bridges. An alloy of iron, such as steel is manufactured to increase the strength of materials for daily uses.
Explain, with the aid of a labelled diagram, why steel is stronger than pure iron.   [3]

structure of steel

_____

_____

_____

2

Q3

Some students found three unknown metals and decided to name them as **alpha**, **beta** and **gamma**. They carried out a series of experiments to determine the reactivity of the metals.

The three metals are dropped into water, **alpha** does not react, **but beta** and **gamma** do, liberating a gas which extinguishes a lighted splint with a 'pop' sound.

When **beta** is mixed with dilute sulfuric acid, a solution of **beta** sulfate is formed.

When **gamma** is dropped into a solution of **beta** sulfate, **beta** is **not** displaced.

(a) Place the three metals in order of reactivity, starting from the most reactive metal.

.... [1]

(b) Name the gas given off when beta and gamma reacted with water.

.... [1]

(c) If **beta** has been identified as calcium metal, suggest a metal which could be gamma.

.... [1]

(d) Write a balanced chemical equation for the reaction between calcium and water. State symbols are not required.

.... [1]

(e) Describe what you would observe when calcium reacts with water.

....

.... [1]

Q4

Lithium, sodium and potassium belongs to the same group in the Periodic Table.

(a) Which group are they placed in in the Periodic Table?   [2]
     Why are they placed in this group in the Periodic Table?

     ....

     ....

     ....

(b) These metals could react with water to form a gas.

(i) Write a balanced chemical equation for the reaction between sodium and   [2]
     water.

     ....

(ii) Determine the mass of sodium metal that is needed to react with water to [2]
     produce 200 cm^3 of gas.

(iii) What will be the observation made when a blue and red litmus paper is dipped [1]
      into the products formed after the reaction?

      ....

      ....

(iv) What is the ion present that caused this change observed in (b)(iii)?   [1]

     ....

Q5

Figure 6.1 shows metal X and metal Y are dipped into beakers containing copper (II) sulfate solution and their respective observations made.
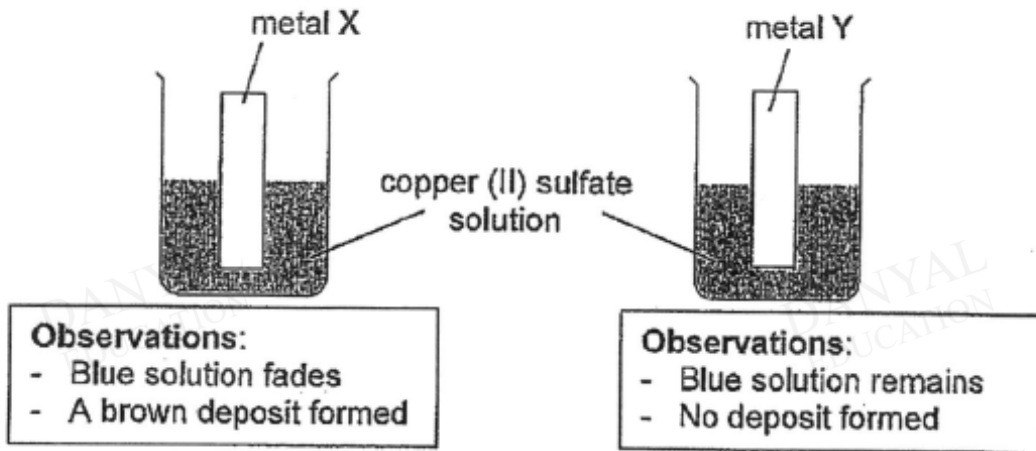
metal X

metal Y

copper (II) sulfate solution

Observations:
- Blue solution fades
- A brown deposit formed

Observations:
- Blue solution remains
- No deposit formed

Figure 6.1

(a)(i) Arrange the metal X, Y and copper in increasing order of their reactivity. [1]

....

(ii) Explain why a brown deposit is formed when metal X is dipped into copper (II) [3] sulfate solution.

....
....
....
....

(b) Describe the observation that would be made when metal X and Y are placed [2] in a beaker containing hydrochloric acid.

....
....
....

5

Answers

Metals Test 3.0

Q1

    (a)

3 equations [3]

    1. $C + O_2 \rightarrow CO_2$
    2. $CO_2 + C \rightarrow 2\,CO$
    3. $Fe_2O_3 + 3\,CO \rightarrow 2\,Fe + 3\,CO_2$

Coke combines with oxygen to form carbon dioxide, which reacts with more coke to form carbon monoxide.

Carbon monoxide reduces haematite to form iron and carbon dioxide gas.

    (b)

Choose any 1 of the 3 equations (all are redox)

For Equation 1:

Carbon is oxidised as its oxidation state increases from 0 in C to +4 in CO_2. [1]

Oxygen is reduced as its oxidation state decreases from 0 in O_2 to -2 in CO_2.[1]

OR

For Equation 2:

Carbon is oxidised as its oxidation state increases from 0 in C to +2 in CO. [1]

Carbon dioxide is reduced as its oxidation state decreases from +4 in CO_2 to +2 in CO.[1]

OR

For Equation 3:

Carbon monoxide is oxidised as its oxidation state increases from +2 in CO to +4 in CO_2. [1]

Carbon monoxide is oxidised as it gains oxygen.

Iron (III) oxide is reduced as its oxidation state decreases from +3 in Fe_2O_3 to 0 in Fe.[1]

Iron (III) oxide is reduced as it loses oxygen.

    (c)

    (i)   Carbon monoxide: neutral
    (ii)   Iron (III) oxide: basic
    (iii)   Silicon dioxide: acidic
    (iv)   Calcium oxide: basic

[All correct – 2 marks; 1-3 correct – 1 mark; 0 correct – 0 mark]

    (d)

[1 mark per equation]

    1. $CaCO_3 \rightarrow CaO + CO_2$
    2. $CaO + SiO_2 \rightarrow CaSiO_3$

Limestone undergoes thermal decomposition to form CaO and CO_2.

CaO, being a basic oxide, can react with SiO_2, an acidic oxide, to form slag. [1]

Q2

(a) high melting / boiling point; high density; form coloured compounds; form ions of more than one charge etc   [any 2 – 1 mark each]

(b) (i) The number of neutrons or nucleon number in Fe–54 is 3 less than in Fe–57. [1]
    (ii) 23   [1]

(c)

iron atom

carbon atom
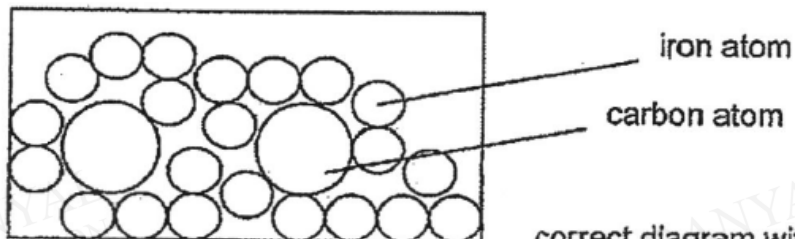
correct diagram with labeling [1]

When atoms of different atomic sizes are added to the metal, it disrupts the orderly arrangement of the metal atoms. [1] The layers of atoms cannot slide over one another easily, therefore this makes steel stronger than pure iron. [1]

Q3

(a)	Beta, gamma, alpha	
(b)	Hydrogen	
(c)	Magnesium	
(d)	Ca (s) + 2H₂O (l) $\longrightarrow$ Ca(OH)$_2$ (aq) + H$_2$ (g)	Correct formulae [1] Correct balancing [1]
(e)	Calcium reacts **quickly** with water producing a lot of bubbles of gas.	[1]

Or
Calcium reacts **quickly** with water and becomes **smaller in size.**

Q4

Lithium, sodium and potassium belongs to the same group in the Periodic Table.
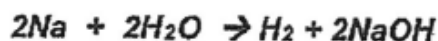
(a)   Which group are they placed in in the Periodic Table?   [2]
      Why are they placed in this group in the Periodic Table?

Group 1   [1]

They have one valence electrons. [1]

(b)   These metals could react with water to form a gas.

(i)   Write a balanced chemical equation for the reaction between sodium and   [2]
      water.

$2Na + 2H_2O \rightarrow H_2 + 2NaOH$

(ii) Determine the mass of sodium metal that is needed to react with water to   [2]
      produce 200 cm^3 of gas.

No. of moles of H_2 = 200/1000 ÷ 24 = 0.008333 mols

No. of moles of Na = 0.008333 x 2 = 0.016666 mols

Mass of Na = 0.016666 x 23 = 0.383318

= 0.383 g (3 s.f.)

(iii) What will be the observation made when a blue and red litmus paper is dipped   [1]
      into the products formed after the reaction?

The litmus paper will turn from red to blue

....

(iv) What is the ion present that caused this change observed in (b)(iii)?   [1]

OH⁻

Q5

(a)(i) Arrange the metal X, Y and copper in increasing order of their reactivity.   [1]

...Y, Copper, X...

(ii) Explain why a brown deposit is formed when metal X is dipped into copper (II)   [3]
sulfate solution.

Metal X is more reactive than copper metal. [1]

Hence it is able to displace copper from copper (II) sulfate [1]

To form copper metal which is the brown deposit. [1]

(b) Describe the observation that would be made when metal X and Y are placed   [2]
in a beaker containing hydrochloric acid.

With metal X, there will be bubbles formed. [1]

With metal Y, there will be no visible change. [1]