EXTRACTION OF METALS

MARKING SCHEME

1. a) Iron is extracted from Iron pyrite / FeS_2 siderite /$FeCO_3$, magnetite / Fe_3O_4 and haematite / Fe_2O_3
Aluminium is extracted from Bauxite / $Al_2O_3 . 2H_2O$
Feldspar / $K_2O. Al_2O_3 . 6Si O_3$ and
Ruby (aluminum oxide) / Al_2O_3 (1)

b) Electrolysis

2. (i) $Al_2 O_3 \quad 2H_2O$ ✔ ½

(ii) A- Aluminium Oxide ✔ ½
B- Aluminium Chloride ✔ ½
C- Hydrogen ✔ ½

(iii) Cryolite is added to aluminium oxide to reduce its melting ✔ ½ point from 2000^0c to 800^0c ✔ ½

3. (a) U ✔ 1

(b) T ✔ 1

(c) U> S>T> ✔ 1

4. a) Haematite / Magnetite / Iron pyrites / Siderite *(Any 1 x 1mk)*

b) R✓½

c) Carbon (IV) oxide / Carbon (II) oxide / Nitrogen *(Any 1 x ½mk)*

d) To provide oxygen to react with coke to form carbon (IV) oxide✓1

5. (a) - Cryolite ✔ 1 / sodiumhexafluoroaluminate (III)/ Na_3AlF_6
- Felsper, $KALSi_3O_8$ ✔ 1
- Kaolin, $Al_2Si_2O_7.2H_2O$
- Rubies/ Emeralds.

(b) Electrolysis ✔ 1

(c) (i) - Silicon (IV) oxide / silica ✔ 1
- Iron (III) oxide ✔ 1

(ii) – grind the ore and mixture with Na_2CO_3 and heat the mixture ✔ ½
- aluminium oxide reacts with Na_2CO_3 to give soluble aluminate
- impurities are filtered off and aluminium hydroxide is added to the filtrate to precipitate out $Al(OH)_{3(s)}$

(d) To lower the temperature of aluminium oxide for best conduction of electricity ✔ 1

(e) this is due to the formation of unreactive oxide (Al_2O_3) ✔ 1 which coats the surface and prevents further reaction ✔ 1

(f) - High energy demand is reduced ✔ 1

- Less pollutant in form of gases are emitted into the atmosphere ✔ 1

6. a) i) Sulphur (iv) oxide (SO_2) ✓1

ii) Copper (iv) Oxide (CO_2) ✓1

b) i) $2CUFeS_{2(s)} + 4O_{2(g)} \longrightarrow Cu_2S_{(s)} + 3SO_{2(g)} + 2FeO_{(s)}$ ✓1

ii) $SO_{3(g)} + H_2SO_{4(l)} \longrightarrow H_2S_2O_{7(s)}$ ✓1

c) i) Fe^{2+} ✓1

ii) Redox reaction✓1

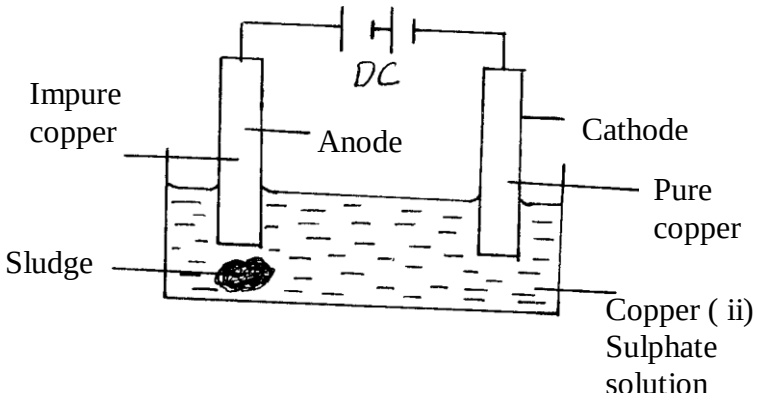
Reason : Copper (I) oxide is reduced to copper whereas coke is oxidized to carbon (IV) oxide✓1

d) i) Vanadium (V) Oxide ✓1 (Reject formula)

ii) - Manufacture of fertilizers ✓ ½

- Conc. Sulphuric is used as drying agent✓ ½

f) i)



3 mks

iii) RFM of $CuFeS_2$ = 63.5 + 56 + 64

= 183.5 ✓

63.5 kg of Cu = 183.5kg of Cu

∴ 210kg " = y ✓

$$Y = \frac{210 \times 183.5}{63.5} \checkmark$$

= 606.85 kg✓

$$\therefore \% \text{ purity} = \frac{606.85}{810} \times 100 \checkmark$$

= 74.9 %✓

7.a) – Bauxite ✓ 1 *2 mks -letters in formula should not be joined*

- $Al_2O_3 . 2H_2O$✓ 1
Nrk

b) Anode : $2O^{2-} \longrightarrow O_{2(g)} + 4e^-$ ✓ 1

Cathode : $Al^{3+} + 3e- \longrightarrow Al_{(s)}$ ✓ 1

c) Al_2O_3✓ 1

d) Lowers the melting point ✓ 1of aluminum from *1 mk acc.*
Lowers
2050 to 900°C *melting point of alumina alone*

e) Extraction is not cost effective ✓ 1

f) Reacts with O_2✓ 1 to form carbon (IV) oxide due to high temperature 1mk

g) Does not corrode / Resistant to attack by cooking solutions✓ 1 1 mk*

h) Forms an oxide ✓ ½ layer which prevents ✓ ½ attack by acids and air 1 mk*

i) Q = It
3 x 270 ✓ ½ x 60
= 48600c
96500c deposits 27g ✓ ½ of aluminium 2 mks*Nrk*
48600c deposits $\frac{27 \times 48600}{96500}$
= 13.598g✓
½ *

8. a) Extraction of copper 1mk

b) Provide large surface area 1mk

c) Froath flotation 1mk

d) I Sinks earthly impurities and float the ore
II Covers the ore and enable the ore to float on water
III Aerates the ore and sinks earthly impurities 3mks

e) $FeO_{(s)} + SiO_{2(s)} \longrightarrow FeSiO_{3(s)}$ 1mk

f) Cu^{2+} , H^+
1mk

g) I Good electric conductivity
1mk

II Good thermal conductivity
1mk

9.

(a) Bauxite (1mk)

(b) $Al_2O_{3(s)} + NaOH_{(aq)} + 3H_2O_{(l)} \rightarrow 2Al(OH)^-_{4(aq)}$ (1mk)

(c) Iron (III) oxide (1mk)

(d) Filtration (1mk)

(e) Strong heating (1mk)

(f) Anode $2O^{2-}_{(l)} - 4e^- \rightarrow O_{2(g)}$ // $2O^{2-}_{(l)} \rightarrow O_{2(g)} + 4e^-$ (1mk)

$Al^{3+}_{(l)} + 3e^- \rightarrow Al_{(l)}$ (1mk)

(g) Heating the electrolyte to keep it molten. (1mk)

(h) The melting point of aluminium oxide in cryolite is much higher than the melting point of aluminium metal
(2mks)

(i) $2Al_{(s)} + 6HCl_{(g)} \rightarrow 2AlCl_3 + 3H_{2(g)}$ (1mk) with the conditions)

(j) Uses of aluminium

- manufacture of: - utensils
- overhead mains electricity supply cables
- Aluminium foil for wrapping chocolates
- For painting of roofs and water storage tanks
- Extraction of small amounts of metals like chromium

(1mk for any one correct use)

(k) Effervescence occurs because aluminium Sulphate hydrolyses in aqueous solution forming $H^+_{(aq)}$ which liberates $CO_{2(g)}$ from Na_2CO_3 (2mks)

10.

(a) Copper pyrites (½ mark) $CuFeS_2$ (½ mark)
Copper glance (½ mark) Cu_2S (½ mark)

(b) – Crushing the Ore (1mark)

- Froth floatation (1mark)

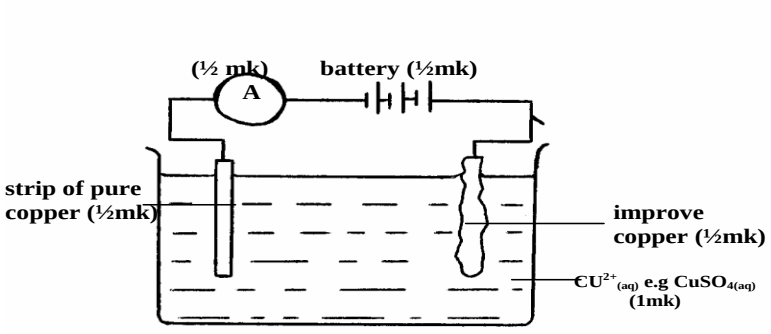
(c) $2CuFeS_{2(s)} + 4O_{2(g)} \longrightarrow Cu_2S_{(s)} + 3SO_{2(g)} + 2FeO_{(s)}$ (1mark)

$FeO_{(s)} + SiO_{2(s)} \longrightarrow FeSiO_{3(l)}$ (1mark)

(d) By heating the copper (i) sulphade obtained in a controlled amount of air (1mark)

- Silver and gold are the common impurities in blister copper. (1mark)

(e)



(f) (i) Anode: $Cu_{(s)} \longrightarrow Cu^{2+}_{(aq)} + 2e^-$

(ii) Cathode: $Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$

(g) Uses of copper

- Manufacture dynamo windings for conveyance of electrical power
- Construction of condensers for chemical plants and car radiators
- Brass an alloy of copper and Zinc used for making headlamp reflectors and working parts of clocks & watches
- Bronze (alloy of copper & tin) is used for watch springs and galvanometer suspensions.(any 2, one mark each)

11. a) i) Copper pyrites✓ ½

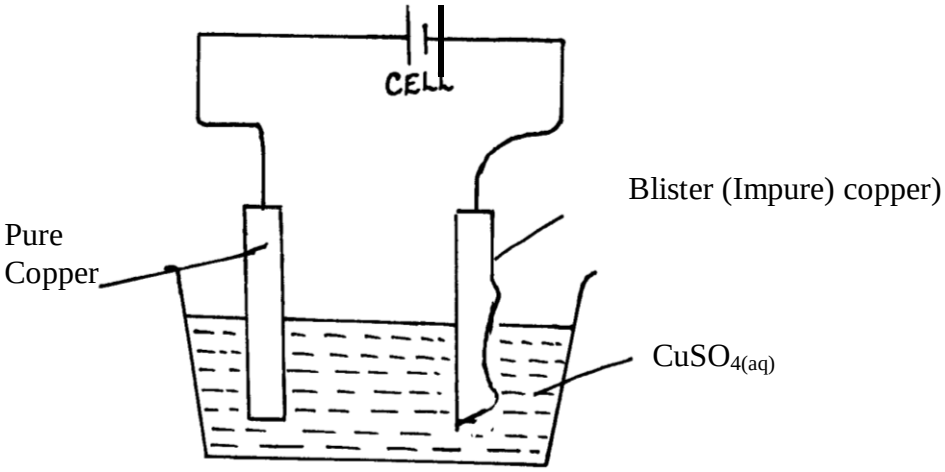
ii) Froth floatation ✓ ½

Y - Electrolysis✓ ½

iii) $FeSiO_3$✓ 1

iv) $2Cu_2S_{(g)} + 3O_{2(g)} \longrightarrow 2\,CuO_{(s)} + 2SO_{2(g)}$

v)



vi) - Making electrical wires ***Any***
- Making electrical application✓ ½
- Making alloys

b) - Causes acidic rain that corrodes building✓ ½
- Causes gullys leading to soil erosion. ***Any***