Sulphur and its compounds

1. *(a) Frasch process*
   (b) Hot compressed air
   (c) Monoclinic / prismatic sulphur /beta sulphur
   Rhombic/octahedral sulphur /alpha sulphur

2. *(a) RFM of H_2SO_3 = 98 (no units)*
   Number of moles of H_2SO_4 = $\frac{1.8}{98}$
   = 0.01837moles
   Molarity of H_2SO_4 = $\frac{0.01837 \times 1000}{1}$
   = 18.37M ½

   (b) Apply formular; M conc. X Vol conc. = Mdil. x Vdil.
   18.37 x V conc: = 0.2 x 500 ⟶ Vconc. = $\frac{0.2 \times 500}{18.37}$
   = 5.44cm^3 of conc. H_2SO_4

3. *(a) By dissolving in water*
   (b) – Manufacture of fertilizers
   - Manufacture of detergents
   - Cleaning of metal surfaces
   - As an electrolyte in car batteries
   - In refining of petroleum
   - Manufacture of synthetic fibre (e.g. rayon)
   - Manufactures of paints, dyes and explosives (award 1mk any one)

4. *Chlorine bleaches permanently by oxidation 1 while sulphur (IV) oxide bleaches temporary by eduction. 1*

5. *(i) Weak acid 1*
   (ii) Has few free H^+ (Hydrogen) ions

6. *a) Vanadium (v) oxide* V_2O_5 √ ½

   b) $2SO_{2\,(g)} + O_{2\,(g)} _____ 2SO_{3\,(g)}$ √ ½

   c) $SO_{3\,(g)} + H_2SO_{4\,(l)} _____ H_2S_2O_{7\,(l)}$

   $H_2S_2O_{7(L)} + H_2O_{(L)} _____ H_2SO_{4(l)}$
   Student must explain *Explanation 1 mark*

7. *– Concentrated sulphuric acid <u>oxidizes copper turnings</u> to <u>copper(II) oxide black</u> solid,SO_2 gas and water.* ½ mk
   - Then copper (II) <u>oxide reacts excess conc. sulphuric acid</u> to produce copper (II) sulphate mk
   - Which is <u>dehydrated by conc.</u> Sulphuric acid to an <u>hydrous copper (II) sulphate</u> white solid 1½
   Which dissolves in water to produce blue solution

8. *a) Method of collection is wrong. √½ Should be collected by downward delivery/upward displacement of air √½ since the gas is denser than air.*
   b) $Na_2SO_3(s) + H_2SO_4(aq) _____ Na_2SO_4(aq) + SO_2(g) + H_2O(l)$ √1

c) By passing it through calcium hydroxide in which the gas dissolves. √1

9. a) Dirty grey solids are formed. √1

b) $FeS_{(s)} + 2HCl_{(aq)} \longrightarrow FeCl_{2(aq)}$ √1 $+ H_2S_{(g)}$

c) Iron powder has high surface area hence the reaction is none vigorous than iron fillings with low surface area.

10. a) a sulphate e.g. sodium sulphate √1

b) moist blue litmus paper turns to red √ ½ then after some minutes to white √ ½ .it is bleached by sulphur(iv)oxide

$SO_{2(g)} + H_2O_{(l)} + Dye \longrightarrow H_2SO_{4(aq)} + (Dye\text{-}o)$ √1

(litmus) (white)

11. (a) – Flexible /elastic ½

- Strong and tough ½
- Non-sticky (any two)

(b) Molten sulphur would have lost heat to the surrounding hence solidify/ in the middle pipe sulphur cannot solidify since hot air in the inner pipe and hot water in the outer pipe mountains high temperature.

12. (a) It dissolves in water releasing √1 a lot of heat which boils the acid which can easily be spilt to the body. √1 (2 mks)

(b) - It is used in manufacture √1 of batteries/acid accumulators
- Manufacture of soap, plastics, detergents. 3

13. (a) Deposits of a yellow solid; and droplets of colourless liquid;

(b) $2H_2S_{(aq)} + SO_{(g)} \longrightarrow 2H_2O_{(l)} + 3S_{(s)}$

(c) Oxidizing agent

14. (a) A – takes in hot compressed air to force out molten sulphur to the surface.
B - takes out molten sulphur.
C – takes in super heated water to melt the sulphur.

(b) Rhombic, Monoclinic

(c) $S(s) + O_2(g) \longrightarrow SO_2(g)$

(d) Iron (II) sulphide.

(e) – Vulcanization of rubber.
- Making chemicals
- Manufacture of matches and fire works.

(f) (i) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

(ii) 24 dm^3 of SO_2 = 1 mole

6.0 dm^3 ( ) ½ = 0.25 mole ½

From the equation :-

Moles of O_2 used = $\underline{0.25}$ ½ = 0.125 moles ½

(iii) 1 mole of O_2 = 0.125

0.25 mole = ( ) ✓1

= 3. dm^3 ✓1

15. i) X – Rhombic ✓½
Y – Monoclinic ✓½
ii) I) Mg has a higher ✓1 ✓1 affinity for combined oxygen than S.
II) Add ✓1 dilute nitric acid to the mixture. It reacts with MgO✓1 to form $Mg(NO_3)_2$
Filter ✓1 to obtain S as residue.

16. (a) (i) – Rhombic sulphur (½ mk)
(ii) Sulphur is heated until it boils. The boiling liquid sulphur is then poured into a beaker containing water to form plastic sulphur (½ mk)
(a)
() – sulphur (½ mk)
- Iron (II) Sulphide (Iron pyrites)
- Zinc sulphide (Zinc blend)
- Dust or Arsenic compounds (½ mk)

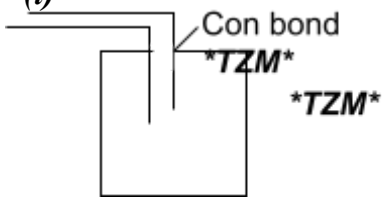
(c) – Avoid poisoning of the catalyst (Avoid destruction of catalytic properties by impurities)
(d) $2SO_{2(g)} + O_{2(g)} \longrightarrow 2SO_{3(g)}$

(e) (I) – Vanadinim (V) Oxide (½ mk)
(II) - Heat incoming air (SO_2 & Air)
- Cools the SO_3
(III) - The reaction between SO_2 and water is highly exothermic which makes the solution boil to form a mist of dilute sulphuric (VI) acid which pollutes the environment

(g) I. – SO_2
II- Un reacted SO_2 is recycled
- Absorbed by $Ca(OH)_2$ in tall chimneys
- Passed over hot carbon (IV) Oxide and sulphur which is recycled and Carbon (IV) Oxide released to the environment

(h) Manufacture of fertilizers

17. a) (i)



(ii) I ion II sulphide or copper II Sulphur
II anhydrous Calcium Chloride (zero of Calcium chloride)
III $Fe\ s_{(l)} + Hcl_{(aq)} \longrightarrow Fecl_{2(aq)} + H_2s$

b) Fe^{3+} is reduced or Fe^{2+} or $Fe^{2+}_{(aq)}$ ions and formed

H_2S is oxidized to sulphur on sulphur is formed.

c) (i) Vanadium V oxide or platinised asbestos

(ii) I. The yield of SO_3 increase because increase in pressure favour the forward reaction since less number of SO_3

II. The yield of SO_3 is the same because catalyst only speeds the rate at which equibrium.

(iii) Exothermic reaction occurs. When dissolved in water produce acid spray (fumes) cause pollution.

18 (a) (i) Red-brown fumes

(ii) It is not an oxidizing agent

(iii) $S_{(s)} + 6HNO_{3(l)} \longrightarrow 2H_2O_{(l)} + 6NO_{2(g)} + H_2SO_{4(l)}$

(iv) Neutralization

(v) Sulphuric acid

(vi) Forms acid rain / plant + yellowing corrodes metallic and stone works

19. a) i) They are different physical/ structural forms of an element

ii) Trausition temperature

b) i) X - Diluter

Y- Heat exchanger

Z- Roaster/ Burner

ii) Catalyst- Vanadium (v) Oxide, V_2O_5

Temperature – 450C

Pressure – 1 atmosphere

iii) I - They are purified not to poison the catalyst

II - The reaction in the convertor/ production of sulphur (vi) Oxide is exothermic/ heat is produced. Chamber Y is used to ensure temperature does not rise above 450°C

iv) Step 2: $250_{2(g)} + O_{2(g)} _____ 250_{3(g)}$ √ 1 mark

Step 3: $50_{3(g)} + H_2SO_{4(L)}) _____ H_25_2O_{7(l}$ √ 1 mark

Step 4: $H_2S_2O_{7(L)} + H_2O_{(L)} _____ 2H_2SO_{4(L)}$ √ 1 mark

20. - Test tube L- Acidified $KMnO_4$ changed from purple to colourless (it is decolourized) – SO_2 is a reducing agent.

- Test tube K $Hal^+/KMnO4$ was not decoloured – SO_2 was absorbed by ash solution hence did not reach the $H^+/KMnO_4$.

21. a) Metal sulphide

b) Hydrogen sulphide is less soluble in warm water compared to cold water

22. SO_2 form acidic when it dissolves in atmospheric moisture. The acidic rain lowers soil PH/ corrodes stone building

No – disrupts the Ozone cycle hence causing depletion of Ozone layer which react with oxygen in the atmosphere to form NO_2 gas

23. a) The solution changed from brown/yellow ½ to light/pale green ½

b) $2FeCl(aq) + H_2S(g) \longrightarrow 2FeCl_2(aq) + 2HCl(aq) + S(s)$ 1 mk

c) Oxidation. 1 mk

24. ***Barium carbonate reacts with dilute sulphuric (VI) acid to form the insoluble Barium sulphate ($BaSO_4$) which covers the reactant. Barium Carbonate preventing any contact between the acid and the Carbonate salt.***

Hence, the reaction is slow and stops after a very short time.

$$BaCO_{3(s)} = H_2SO_{4(aq)} \quad BaSO_{4(s)} + CO_{2(g)} + H_2O_{(l)}$$