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_S √ ½

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

c) $SO_{3\,(g)} + H_2\,SO_{4\,(l)}$ _____ $H_2S_2O_{7\,(l)}$

$H_2S_2O_{7(L)} + H_2\,O_{\,(L)}$ _________ $H_2SO_{4(l)}$
Student must explain Explanation 1 mark

7. – Concentrated sulphuric acid oxidizes copper turnings to copper(II) oxide black solid,SO_2 gas and water. ½ mk
- Then copper (II) oxide reacts excess conc. sulphuric acid to produce copper (II) sulphate mk
- Which is dehydrated by conc. Sulphuric acid to an hydrous copper (II) sulphate 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) $FeS_{(s)}$ + $2HCl_{(aq)}$ $FeCl_{2(aq)}$ √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 $H_2SO_{4(aq)}$ + (Dye-o)√1

(litmus)   (white)

11. *(a) – Flexible ✓ elastic*

- Strong and tough ✓ 1

- Non-sticky ✓ 1 (any two)

✓ ½ ✓ ½

(b) Molten sulphur would have lost heat to the surrounding hence solidify/ in the middle pipe sulphur ✓ ½ 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. Any 3

- Manufacture of soap, plastics, detergents. one

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

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

(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) 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) $2SO_3$(g)

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

$$6.0\ dm^3 \quad \frac{1\ mol \times 6\ dm^3}{24\ dm^3} \ \checkmark ½ \quad = 0.25\ mole\ \checkmark ½$$

From the equation :-

Moles of O_2 used = $\frac{0.25}{2}$ ✓½ = 0.125 moles ✓½

(iii) 1 mole of O_2 = 0.125

0.25 mole = $\frac{24\ dm^3 \times 0.125\ mol}{1\ mol}$ ✓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) $25O_{2(g)} + O_{2(g)}$ $2SO_{3(g)}$

(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 $s_{(l)}$ + $Hcl_{(aq)}$ $Fecl_{2(aq)}$ + 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) $S_{(s)} + 6HNO_{3(l)} \qquad 2H_2O_{(l)} + 6NO_{2(g)} + H_2SO_{4(l)}$
(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^oC

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. ✓1
✓1 ✓1
- 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) $2FeCl(aq) + H_2S(g) \qquad 2FeCl_2(aq) + 2HCl(aq) + S(s)$ ✓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.

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