P BLOCK ELEMENTS – GROUP 16

TUTORIAL 01

1.

i.

a) Name the two allotropes of Oxygen.

b) Draw the Lewis structures of the species mentioned in (a) above.

ii. $O_2(g)$ can be formed in the laboratory by the thermal decomposition of "saltpeter".

a) What is the chemical formula of the compound commonly known as "saltpeter" ?

b) Write the balanced chemical formula for the reaction mentioned in (ii).

2.

i.

a) Out of all the allotropic forms of crystalline Sulphur, what is the most commonly occurring form?

b) Mention another name for this allotropic form.

c) Sketch the 3D structure of the allotrope in (a) above.

d) Briefly explain how you would synthesize the above allotrope using powdered Sulphur and Carbon disulphide.

ii. At temperatures greater than 95 °C, the above allotropic form in part (i) converts to another allotropic form.

a) Write two names for this allotropic form.

b) Briefly explain how you would synthesize the allotrope mentioned in (a) above, using powdered Sulphur.

c) Mention the solubility of the allotrope in (a) above in Water and Carbon disulphide.

iii. What is the molecule that forms both of the allotropes mentioned in parts (i) and (ii) ?
Sketch the structure of this molecule.

P BLOCK ELEMENTS – GROUP 16

TUTORIAL 02

1. Compound **A** is allowed to completely react with a solution of $FeSO_4$ in the acidic medium, to give water and a yellow coloured aqueous solution **B** (Reaction 01). When $NH_4OH(aq)$ is added to the solution **B**, a reddish brown precipitate **D** is observed (Reaction 02). Upon the addition of excess $NH_4OH(aq)$, precipitate **D** did not dissolve.

   Compound **A** also reacts with gas **E** to form pale white solid **G** and water (Reaction 03). Gas **E** is colourless and has the odour of rotten eggs. Compound **A** is pale blue in colour when in the liquid state but exists as white crystals in the solid state.

   i. Identify the compounds **A, B , D, E** and **G**.

   ii. Write balanced chemical equations for reactions 01 - 03.

   iii. Does compound **A** act as an oxidizing agent or a reducing agent in Reactions 01 and 03?

   iv. What are the species that undergoes a change in the oxidation state in reactions mentioned in (iii) above? Mention the change in the oxidation state.

   v. Write one use of compound **A**.

2. Compound **P** is reacted with acidic $KMnO_4(aq)$ to give a colourless solution **Q** and a colourless, odourless gas **R** (Reaction 01). When solution **Q** was made basic by the addition of NH_4OH, and gas **S** which has the odour of rotten eggs was passed through it, a pale pink precipitate **T** was formed (Reaction 02).

   i. Identify the compounds **P, Q , R, S** and **T**.

   ii. Write balanced chemical equations for reactions 01 and 02.

   iii. Does compound **P** act as an oxidizing agent or a reducing agent in Reaction 01?

   iv. Name one test to identify the gas **R**.

   v. Compound **P** reacts with MnO_2 in the acidic medium to give the same products **Q** and **R**. Write a balanced chemical equation for this reaction.

   vi. Why should compound **P** be stored in dark brown coloured bottles?

3. Gas **M** is formed by the addition of dil HCl to Na_2SO_3.
   i. Identify Gas **M**.

   ii. Write the balanced chemical equation for the above reaction.

   iii. Gas **M** dissolves in water to form a di basic weak acid.
   Write balanced chemical equations for the dissociation of this weak acid.

   iv. Gas **M** also has bleaching properties.
   By giving relevant balanced chemical equations, explain this statement.
   (Hint – consider the coloured species as **X**)

4. A gas **X** with bleaching properties was reacted with an acidified solution of $K_2Cr_2O_7$ to give a green coloured aqueous solution **Y** (Reaction 01). Upon the dropwise addition of NH_4OH, a green coloured gelatinous precipitate **Z** was observed (Reaction 02).

   When gas **X** reacted with excess NaOH, water and a colourless aqueous solution **P** was formed (Reaction 03). When dil HCl is added to solution **P**, NaCl, water and gas **X** is formed (Reaction 04).

   i. Identify the compounds **X, Y , Z,** and **P**.

   ii. Write balanced chemical equations for reactions 01 – 04.

   iii. Does gas **X** act as an oxidizing agent or a reducing agent in Reaction 01?

5. When gas **K** and gas **L** are reacted with each other a pale white solid **M** and water are formed (Reaction 01). When H_2SO_4(aq) is added to the above solution gas **K** is evolved (Reaction 02). When gas **K** is passed through a solution of $FeCl_3$, a yellowish green clear solution **N** was observed (Reaction 03). Gas **L** has a rotten egg smell.

   i. Identify the compounds **X, Y , Z,** and **P**.

   ii. Write balanced chemical equations for reactions 01 – 03.

   iii. Mention the changes in oxidation states (if any) of all the species in the above question.

   iv. What is the allotropic form of solid **M** ?

6.

a) There are two unlabelled clear solutions in separate beakers in the laboratory. One of these solutions is $Na_2SO_3(aq)$ and the other is $Na_2S_2O_3(aq)$.

   i. How would you identify each solution by using only one reagent?

   ii. Write down balanced chemical equations for the reactions taking place in part (i) above.

b) Compound **G** is dissolved in distilled water, and a colourless clear solution was obtained. When a solution of $BaCl_2$ is added to this solution, a white precipitate **J** was observed. When dil HCl was added to this solution, the white precipitate formed did not dissolve. When the flame test was carried out on compound **G**, a violet colour was observed.

   i. Identify the cation and anion present in compound **G**.

   ii. Identify compound **J**.

   iii. Write balanced chemical equations for all the reactions taking place in part (b).

7. An anion **R** exists as its sodium salt, Na**R.** When a solution of Lead acetate was added to an aqueous solution of Na**R**, a white coloured precipitate **S** was formed (Reaction 01). Upon heating this precipitate, it turned into a black precipitate **T** (Reaction 02).

   An anion **Q** exists as its sodium salt Na**Q**. When a solution of Lead acetate was added to an aqueous solution of Na**Q**, a white coloured precipitate **U** was formed (Reaction 03). However, upon heating, a white precipitate was still observed.

   i. By giving the relevant balanced chemical equations, identify the anions **R** and **Q**.

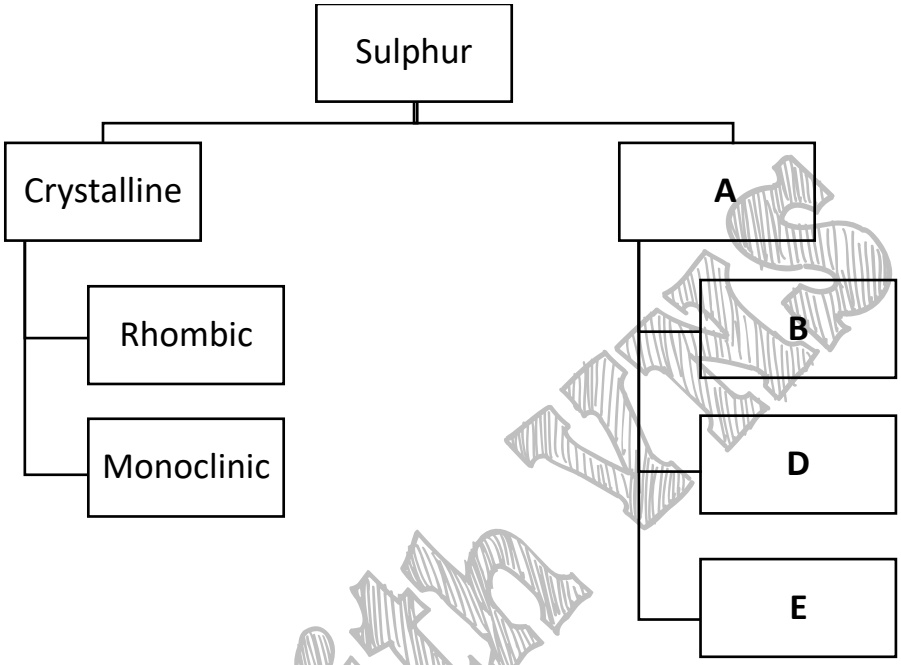
   ii. Identify the compounds **S, T** and **U**.

   iii. Mention another method by which compound **T** can be formed.

iv. Write three uses of Sulphur.

3.

i. Complete the following chart which illustrates the classification of Sulphur.



ii.

a) Briefly explain how you would synthesize Plastic Sulphur, using powdered Sulphur.

b) Mention three properties of Plastic Sulphur.

iii. With the use of a balanced chemical equation, explain how colloidal Sulphur is formed.

4.

i.

a) Write balanced chemical equations for four reactions by which $O_2(g)$ can be prepared in the laboratory.

b) "Although Na and Li both belong to the same group in the periodic table, out of $NaNO_3(s)$ and $LiNO_3(s)$, only $NaNO_3(s)$ can be decomposed to collect $O_2(g)$ in the laboratory."

Using relevant balanced chemical equations, explain the above statement.

c) Write five uses of $O_2(g)$.

ii.

a) Where is the Ozone layer located?

b) What is the importance of the Ozone layer?

c) Mention three uses of Ozone.

5.

i. Sketch the variation of the Boiling points of the Hydrides in Group 16.

ii. Explain the reason for the variation observed in (i) above.

iii. What happens to the bond length and the covalent bond angle of the hydrides when going down the group? Explain.

iv. Write the balanced chemical equation for the self-ionization of water.

6. Gas **A** reacts with a limited amount of Na metal to form NaHS and gas **B** (Reaction 01). When gas **A** is reacted with excess Na metal, it forms the strongly alkaline compound **D** and gas **B** (Reaction 02). Gas **A** also reacts with a limited amount of NaOH(aq) to form NaHS and liquid **E** (Reaction 03). When gas **A** is reacted with excess NaOH(aq), it forms the strongly alkaline compound **D** and liquid **E** (Reaction 04). Gas **A** is colourless, toxic and has an odour of rotten eggs.

i. Identify the compounds **A**, **B, D** and **E**.

ii. Write balanced chemical equations for the reactions 01 – 04.

iii. "Gas **A** exhibits weakly acidic properties."
By giving relevant chemical equations, explain the given statement.

7. When gas **P** reacts with conc. HNO_3, reddish brown coloured gas **Q**, pale white solid **R** and water are formed (Reaction 01). When gas **P** is reacted with hot conc. H_2SO_4, colourless gas **T** and water are formed (Reaction 02). When gas **P** is reacted with gas **T**, pale white solid **R** and water are formed (Reaction 03).

i. Identify the compounds **P, Q, R** and **T**.

ii. Write balanced equations for the reactions 01 – 03.

iii. Write the balanced chemical equations for the reaction of gas **P** with,

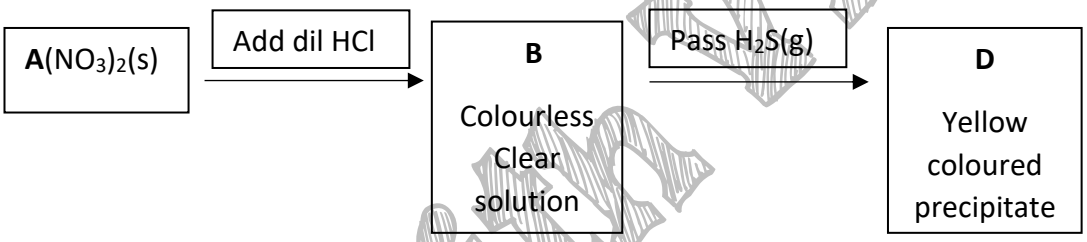
a) Acidic $KMnO_4(aq)$
b) Acidic $K_2Cr_2O_7(aq)$
c) $K(s)$
d) $FeCl_3(aq)$

iv. What is the change in the oxidation number of Sulphur in the reactions mentioned in (iii) above?

v. Has gas **P** acted as an oxidizing agent or a reducing agent in the reactions mentioned in (iii) above?

8.

i.



a) Identify the cation **A**, compound **B** and **D**.

b) Write the balanced chemical equation for the reaction in the second step.

ii.

P_1 and **P_2** are compounds which contain the same metal cation with different oxidation states, and the same anion.
When dilute HCl is added to **P_1**, a colourless gas **Q** with bleaching properties and a clear solution **R** was formed. When a gas **T** with a rotten egg odour was passed through the clear solution **R**, a yellow coloured precipitate **U** was observed.
When dilute HCl is added to **P_2**, gas **Q** and a clear solution **X** was obtained. When gas **T** was passed through the clear solution **X**, a brown coloured precipitate **Y** was obtained.

a) Identify the compounds **P_1, P_2, Q, R, T, U, X** and **Y**.

b) Write balanced chemical reactions for each of the reactions given above.

P BLOCK ELEMENTS – GROUP 16

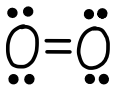
TUTORIAL 01 – ANSWERS

1.

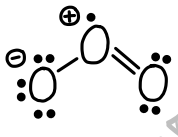
i.

a) Oxygen (O_2) and Ozone (O_3)

b) Oxygen



Ozone



ii.

a) KNO_3

b) $2\ KNO_3 \longrightarrow 2\ KNO_2 + O_2$

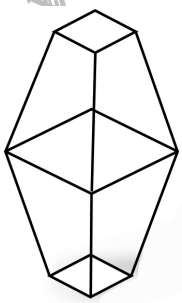
2.

i.

a) Rhombic Sulphur

b) α – Sulphur / $\alpha - S_8$

c)



d)

- Place some powdered Sulphur in an evaporating dish and add CS_2 till the solid sulphur dissolves.
- Leave the evaporating dish aside for CS_2 to evaporate.
- Then you can see the crystals of rhombic Sulphur formed inside the evaporating dish.

ii.

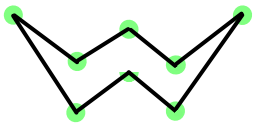
a) Monoclinic Sulphur, β – Sulphur / $\beta - S_8$

b)

- Add powdered Sulphur into an evaporating dish and heat until it becomes a liquid.
- Let the resulting liquid cool down gently.
- A crust would form on top of the liquid layer as it cools down.
- The crust is pierced in several places to remove the remaining liquid.
- Then, needle like crystals of Monoclinic sulphur can be seen under the crust and inside the evaporating dish.

c) Water – insoluble
CS_2 – Soluble

iii. S_8 molecules



iv.

I. As a fungicide in agriculture
II. As an anti-fungal treatment for skin conditions due to fungi
III. For the industrial manufacturing of H_2SO_4

3.

i. **A** – Amorphous
B – Plastic Sulphur
D – Colloidal Sulphur
E – Milk of Sulphur
} Can be interchanged

ii.

a)

- Add powdered Sulphur into an evaporating dish and heat until it becomes a liquid.
- When this liquid Sulphur is about to boil, add it into a beaker of cold water.
- You can see the formation of plastic Sulphur.

b)

I. Can be stretched into fibres
II. Insoluble in CS_2

III. When left undisturbed for a few hours, the Sulphur chains break to form rhombic Sulphur

iii. If a chemical reaction results in both S and H_2O as products, the S which is insoluble in water, forms colloids.

$$Na_2S_2O_3 + 2\,HCl \longrightarrow 2\,NaCl + SO_2 + \underbrace{S + H_2O}_{\text{Colloidal Sulphur}}$$

4.

i.

a) $2\,KClO_3 \longrightarrow 2\,KCl + 3\,O_2$

$H_2O_2 \longrightarrow H_2O + O_2$

$2\,KMnO_4 \longrightarrow MnO_2 + K_2MnO_4 + O_2$

$2PbO_2 \longrightarrow 2\,PbO + O_2$

b)

- Li and Na both belong to group 1 of the periodic table.
- $NaNO_3(s)$ decomposes into $NaNO_2(s)$ and $O_2(g)$ when heated.
- Here, O_2 is the only gaseous product formed.
- Therefore, $NaNO_3$ can be used to collect O_2.

$$2\,NaNO_3(s) \longrightarrow 2\,NaNO_2(s) + O_2(g)$$

- $LiNO_3(s)$ decomposes into $Li_2O(s)$, $NO_2(g)$ and $O_2(g)$ when heated.
- Here, O_2 and NO_2 are both gases.
- Therefore, O_2 cannot be collected separately.
- Hence, $LiNO_3$ cannot be used to collect O_2.

$$4\,LiNO_3(s) \longrightarrow 2\,Li_2O(s) + 4\,NO_2(g) + O_2(g)$$

c)

I. For the respiration of living beings
II. During the burning of fuel to obtain energy
III. Metal industries (Oxy-acetylene flame)
IV. To manufacture HNO_3 and H_2SO_4 industrially
V. Inside submarines and rockets

ii.

a) In the lower part of the Earth's stratosphere (15 – 35 km above Earth)

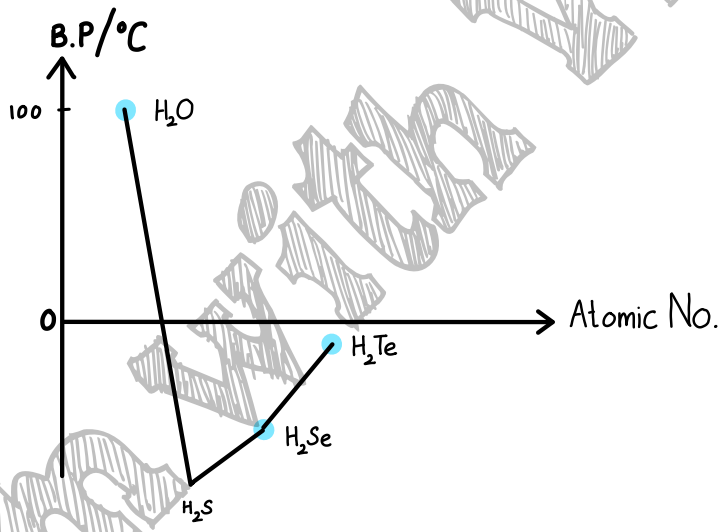
b) Ozone layer absorbs harmful UV rays that are emitted from the sun. This reduces the risk of cataracts and skin cancers among humans.

c)

I. To disinfect water
II. To disinfect air
III. In organic synthesis

5.

i.



ii.

- When considering the boiling points of hydrides from H_2O to H_2Te, H_2O has a higher boiling point than the expected value according to the relative molecular mass.

- The reason for this is the strong H bonding intermolecular interactions between H_2O molecules.

- From H_2S to H_2Te, as no H bonding is present, the boiling point increases with the increases relative molecular mass. (This is due to increases London Dispersion Forces among the molecules)

iii. Bond length :

- When going down the group, the size of the central atom increases.
- Therefore, the bond length increases.
-

Covalent bond angle :

- When going down the group, electronegativity of the central atom decreases.
- Therefore, the bonding electrons experience a lower repulsion between each other.
- Hence, the bond angle decreases down the group.

iv. $2\ H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$

6.

i. **A** – H_2S
B – H_2
D – Na_2S
E – H_2O

ii.

$$\text{Limited Na(s)} + H_2S(g) \longrightarrow 2\ NaHS(s) + H_2(g) \quad \text{Reaction 01}$$

$$\text{Excess Na(s)} + H_2S(g) \longrightarrow Na_2S(s) + H_2(g) \quad \text{Reaction 02}$$

$$\text{Limited NaOH(aq)} + H_2S(g) \longrightarrow 2\ NaHS(s) + H_2O(l) \quad \text{Reaction 03}$$

$$\text{Excess NaOH(aq)} + H_2S(g) \longrightarrow Na_2S(s) + H_2O(l) \quad \text{Reaction 04}$$

iii.

When dissolved in water, H_2S (Gas **A**) partially dissociates to give a small amount of H_3O^+ ions.

$$H_2S(g) + H_2O(l) \rightleftharpoons HS^-(aq) + H_3O^+(aq)$$

$$HS^-(aq) + H_2O(l) \rightleftharpoons S^{2-}(aq) + H_3O^+(aq)$$

7.

i. **P** – H_2S
Q – NO_2
R – S
T – SO_2

ii. $H_2S(g) + 2\,HNO_3(aq) \longrightarrow 2\,NO_2(g) + S(s) + 2\,H_2O(l)$ Reaction 01

$H_2S(g) + H_2SO_4(aq) \longrightarrow 4\,SO_2(g) + 4\,H_2O(l)$ Reaction 02

$2\,H_2S(g) + SO_2(g) \longrightarrow 3\,S(s) + 2\,H_2O(l)$ Reaction 03

iii.

a) $5\,H_2S + 6\,H^+ + 2\,KMnO_4 \longrightarrow 5\,S + 2\,Mn^{2+} + 8\,H_2O + 2\,K^+$

b) $3\,H_2S + 8\,H^+ + K_2Cr_2O_7 \longrightarrow 3\,S + 2\,Cr^{3+} + 7\,H_2O + 2\,K^+$

c) $2\,K + H_2S \longrightarrow K_2S + H_2$

d) $2\,Fe^{3+} + H_2S \longrightarrow 2\,Fe^{2+} + S + 2\,H^+$

iv. -2 to 0 in parts a, b and d
-2 in part c (Oxidation state of S does not change here.)

v. Parts a, b and d – H_2S acts as a reducing agent
Part c – H_2S acts as an oxidizing agent

8.

i.

a) **A** – Cd^{2+}
B – $CdCl_2(aq)$
D – CdS

b) $CdCl_2(aq) + H_2S(g) \longrightarrow CdS(s) + 2\,HCl(aq)$

ii.

a) **P_1** – $SnSO_3$
P_2 – $Sn(SO_3)_2$
Q – SO_2
R – $SnCl_2(aq)$
T – H_2S
U – SnS
X – $SnCl_4$
Y – SnS_2

b) $SnSO_3(s) + 2\,HCl(aq) \longrightarrow SnCl_2(aq) + SO_2(g) + H_2O(l)$

$H_2S(g) + SnCl_2(aq) \longrightarrow SnS(s) + 2\,HCl(aq)$

$Sn(SO_3)_2(s) + 4\,HCl(aq) \longrightarrow SnCl_4(aq) + 2\,SO_2(g) + 2\,H_2O(l)$

$2\,H_2S(g) + SnCl_4(aq) \longrightarrow SnS_2(s) + 4\,HCl(aq)$

P BLOCK ELEMENTS – GROUP 16

TUTORIAL 02 – ANSWERS

1.

i. **A** – H_2O_2
B – $Fe_2(SO_4)_3$
D – $Fe(OH)_3$
E – H_2S
G – S

ii. Reaction 01

$$H_2SO_4(aq) + H_2O_2(aq) + 2\ FeSO_4(aq) \longrightarrow Fe_2(SO_4)_3(aq) + 2\ H_2O(l)$$

Reaction 02

$$Fe_2(SO_4)_3(aq) + 6\ NH_4OH(aq) \longrightarrow 2\ Fe(OH)_3(s) + 3\ (NH_4)_2SO_4(aq)$$

Reaction 03

$$H_2O_2(aq) + H_2S(g) \longrightarrow 2\ H_2O(l) + S(s)$$

iii. As an oxidizing agent in both reactions

iv. Reaction 01 : O in H_2O_2 (-1) to H_2O (-2)
Fe (+2) to (+3)

Reaction 03 : S in H_2S (-2) to S (0)
O in H_2O_2 (-1) to H_2O (-2)

v. As a disinfectant
As a bleaching agent

2.

i. **P** – H_2O_2
Q – $MnSO_4(aq)$
R – O_2
S – H_2S
T – MnS

ii. Reaction 01

$$3\ H_2SO_4(aq) + 2\ KMnO_4(aq) + 5\ H_2O_2(aq) \longrightarrow 2\ MnSO_4(aq) + 8\ H_2O(l) + 5\ O_2(g) + K_2SO_4(aq)$$

Reaction 02

$$Mn(OH)_2(s) + H_2S(g) \longrightarrow MnS(s) + 2\ H_2O(l)$$

iii. Reducing agent

iv. When a glowing splint is introduced to a chamber with O_2 (Gas **R**) it reignites to produce a flame.

v. $H_2SO_4(aq) + MnO_2(s) + H_2O_2(aq) \longrightarrow MnSO_4(aq) + 2\,H_2O(l) + O_2(g)$

vi. H_2O_2 can decompose into water and oxygen when exposed to light. In order to prevent this, H_2O_2 is stored is dark brown coloured bottles which prevents the interaction with light.

$$2\,H_2O_2 \xrightarrow{h\nu} 2\,H_2O + O_2$$

3.

i. **M** – SO_2

ii. $Na_2SO_3(aq) + 2\,HCl(aq) \longrightarrow 2\,NaCl(aq) + H_2O(l) + SO_2(g)$

iii. $SO_2(g) + H_2O(l) \longrightarrow H_2SO_4(aq)$

$H_2SO_3(aq) + H_2O(l) \rightleftharpoons HSO_3^-(aq) + H_3O^+(aq)$

$HSO_3^-(aq) + H_2O(l) \rightleftharpoons SO_3^{2-}(aq) + H_3O^+(aq)$

iv. In the presence of moisture, $SO_2(g)$ bleaches coloured species. The coloured species is reduced to its hydride by $SO_2(g)$.

$$2\,H_2O(l) + SO_2(g) + X \longrightarrow SO_4^{2-}(aq) + 2\,H^+(aq) + XH_2$$

(Coloured) (Colourless)

4.

i. **X** – SO_2
Y – $Cr_2(SO_4)_3(aq)$
Z – $Cr(OH)_3$
P – $Na_2SO_3(aq)$

ii. Reaction 01

$2\,H_2SO_4(aq) + K_2Cr_2O_7(aq) + 3\,SO_2(g) \longrightarrow Cr_2(SO_4)_3(aq) + H_2O(l) + K_2SO_4(aq)$

Reaction 02

$Cr_2(SO_4)_3(aq) + 6\,NH_4OH(aq) \longrightarrow 2\,Cr(OH)_3(s) + 3\,(NH_4)_2SO_4(aq)$

Reaction 03

$$2\ NaOH(aq) + SO_2(g) \longrightarrow Na_2SO_3(aq) + H_2O(l)$$

Reaction 04

$$Na_2SO_3(aq) + 2\ HCl(aq) \longrightarrow 2\ NaCl(aq) + H_2O(l) + SO_2(g)$$

iii. Reducing agent

5.

Please note that Part (i) should be changed to "Identify the compounds **K, L, M** and **N**."

i. **K** – SO_2
L – H_2S
M – S
N – $FeCl_2$ (aq)

ii. Reaction 01

$$2\ H_2S(g) + SO_2(g) \longrightarrow 3S(s) + 2\ H_2O(l)$$

Reaction 02

$$S(s) + 2\ H_2SO_4(aq) \longrightarrow 3\ SO_2(g) + 2\ H_2O(l)$$

Reaction 03

$$2\ FeCl_3(aq) + 2\ H_2O(l) + SO_2(g) \longrightarrow 2\ FeCl_2(aq) + H_2SO_4(aq) + 2\ HCl(aq)$$

iii. Reaction 01 : S in H_2S (-2) to S (0)
S in SO_2 (+4) to S (0)

Reaction 02 : S in S(0) to SO_2 (+4)
S in SO_4^{2-} (+6) to SO_2 (+4)

Reaction 03 : Fe (+3) to (+2)
S in SO_2 (+4) to SO_4^{2-} (+6)

iv. Colloidal Sulphur

6.

a)

i. Add dil HCl(aq) to each of the solutions. The solution where effervescence can be observed is $Na_2SO_3(aq)$. The solution where effervescence is observed along with a milky white precipitate (due to colloidal Sulphur) is $Na_2S_2O_3(aq)$.

Effervescence observed is due to evolution of $SO_2(g)$. This can be identified using a filter paper dipped in acidified $K_2Cr_2O_7(aq)$ solution. When the above filter paper is exposed to $SO_2(g)$, the orange colour on the filter paper would change to green.

ii. $Na_2SO_3(aq) + 2\ HCl(aq) \longrightarrow 2\ NaCl(aq) + H_2O(l) + SO_2(g)$

$Na_2S_2O_3(aq) + 2\ HCl(aq) \longrightarrow 2\ NaCl(aq) + SO_2(g) + S(s) + H_2O(l)$

$2\ H_2SO_4(aq) + K_2Cr_2O_7(aq) + 3\ SO_2(g) \longrightarrow Cr_2(SO_4)_3(aq) + H_2O(l) + K_2SO_4(aq)$

b)

i. Cation : K^+ and Anion : $SO_4^{2-}(aq)$

ii. **J** – $BaSO_4(s)$

iii. $K_2SO_4(s) + H_2O(l) \longrightarrow 2K^+(aq) + SO_4^{2-}(aq)$

$BaCl_2(aq) + K_2SO_4(aq) \longrightarrow BaSO_4(aq) + 2\ KCl(aq)$

7.

(Please note that the compounds should be Na_2**R** and Na_2**Q**.)

i. **R** : $S_2O_3^{2-}(aq)$

$Na_2S_2O_3(aq) + Pb(CH_3COO)_2(aq) \longrightarrow PbS_2O_3(s) + 2Na(CH_3COO)_2(aq)$
(white)

$2\ PbS_2O_3(s) \xrightarrow{\Delta} 2\ PbS(s) + 2\ SO_2(g) + O_2(g)$
(white) (black)

Q : $SO_3^{2-}(aq)$

$Na_2SO_3(aq) + Pb(CH_3COO)_2(aq) \longrightarrow PbSO_3(s) + 2Na(CH_3COO)_2(aq)$
(white)

$2\ PbSO_3(s) + O_2(g) \longrightarrow 2\ PbSO_4(s)$
(white) (white)

ii. **S** – PbS_2O_3
T – PbS
U – $PbSO_3$

iii. Pass $H_2S(g)$ through a solution of $Pb(CH_3COO)_2(aq)$.

$H_2S(g) + Pb(CH_3COO)_2(aq) \longrightarrow PbS(s) + 2\ CH_3COOH(aq)$