Chemistry · Chemical Analysis

Detection of Anions

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Multiple choice questions — 112 questions

1 Chemical analysis has played a major role in all of the following, except .....

(A) diagnosing and treating diseases.

(B) determining the suitability of iron ores.

(C) improving soil and crop properties.

(D) the suitable conditions for the reaction of iron oxides with acids.

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2 When a solution of compound (A) is added to a solution of compound (Y), a reddish-brown precipitate of compound (W) forms.

Which of the following is correct?

(A) (W) : FeCl , qualitative chemical analysis.

(B) (W) : FeCl , quantitative chemical analysis.

(C) (W) : $Fe(OH)_3$, qualitative chemical analysis.

(D) (W) : $Fe(OH)_3$, quantitative chemical analysis.

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3 All of the following describe analytical chemistry, except .....

(A) Analytical chemistry is closely linked to industry.

(B) One of the tasks of analytical chemistry is determining the chemical formula of an unknown compound.

(C) Quantitative analysis is carried out before qualitative analysis.

(D) One of the tasks of quantitative analysis is determining the percentages of elements in alloys.

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4 Analytical chemistry is linked to many other branches of science, such as .....

(A) physics and biology only.

(B) geology and mineralogy only.

(C) physics and mineralogy only.

(D) physics, biology, geology and mineralogy.

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5 A pure sample of Na_2CO_3 can be identified through .....

(A) its solubility in water.
(B) its physical state.
(C) its melting and boiling points.
(D) its reaction with HCl(aq)

6 Qualitative analysis aims at all of the following, except .....

(A) proving whether the unknown sample is organic or inorganic.
(B) identifying the elements or ions present in the unknown sample.
(C) determining the concentration of the compound that makes up the unknown sample.
(D) identifying the functional groups present in the unknown sample.

7 All carbonate and bicarbonate salts agree in all of the following, except .....

(A) the acid they are derived from.
(B) their solubility in water.
(C) their reaction with acids.
(D) their reaction with $MgSO_4$(aq)

8 Turbidity forms when mixing solutions of .....

(A) ammonia and sodium chloride.
(B) copper(II) sulphate and magnesium chloride.
(C) zinc nitrate and ammonium carbonate.
(D) sodium hydroxide and potassium iodide.

9 The solution of the substance that must be added to a solution containing Mg^{2+} ions to separate them as a precipitate in the cold is .....

(A) $NaHCO_3$ (B) K_2SO_4 (C) Na_2CO_3 (D) KNO_3

10 A precipitate forms when mixing solutions of .....

(A) H_2SO_4 , $CuCl_2$ (B) $CuCl_2$, Na_2CO_3 (C) KCl , H_2SO_4 (D) NaCl , HNO_3

11 The anion of the salt formed by passing carbon dioxide gas through clear limewater for a long time can be detected using .....

(A) magnesium sulphate solution in the cold.
(B) sodium hydroxide solution.
(C) magnesium sulphate solution, then heating.
(D) potassium dichromate.

12 HCl(aq) is used to distinguish between the following pairs of salts, except .....

(A) Na_2S , $NaNO_3$
(B) Na_2SO_3 , NaBr
(C) $NaNO_2$, Na_2SO_4
(D) NaI , Na_3PO_4

13 A beaker contains $MgCO_3$ and $Mg(HCO_3)_2$; an amount of water was added to them with stirring.

Which of the following is needed to increase the mass of the precipitated substance?

(A) Adding $HNO_3(aq)$
(B) Adding more water.
(C) Heating.
(D) Adding $H_2SO_4(aq)$

14 When a solution of salt (X) reacts with a solution of salt (Y), a white precipitate forms only after heating.

What is the anion of salt (X) and the cation of salt (Y)?

(A) (X) : CO_3^{2-} , (Y) : Na^+
(B) (X) : S^{2-} , (Y) : Ag^+
(C) (X) : HCO_3^- , (Y) : Mg^{2+}
(D) (X) : SO_4^{2-} , (Y) : Ca^{2+}

15 A solid mixture of the salts sodium bicarbonate, sodium sulphate and sodium nitrate.

What gas (gases) is formed when dilute HI acid is added to it?

(A) CO_2 only.
(B) NO_2 only.
(C) CO_2 , NO_2 only.
(D) CO_2 , NO_2 , SO_2

16 $MgCO_3(s)$ and $Mg(HCO_3)_2(s)$ can be distinguished in the laboratory using .....

(A) HCl(aq)
(B) $H_2O(l)$
(C) $HNO_3(aq)$
(D) $Na_2SO_4(aq)$

17 A mixture contains the two anions $CO_3^{2-}(aq)$ and $SO_4^{2-}(aq)$.

Which of the following, when added to the mixture, precipitates one of the two anions?

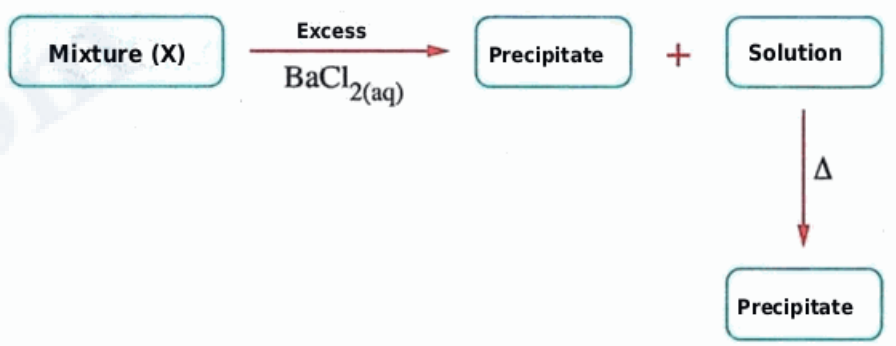
(A) $NaNO_3(aq)$
(B) $NH_4NO_2(s)$
(C) $FeCl_3(aq)$
(D) $K_2SO_3(s)$

18 For which pair of the following anions is $HNO_3(aq)$ not used to distinguish between them?

(A) CO_3^{2-} , NO_2^-
(B) SO_3^{2-} , $S_2O_3^{2-}$
(C) CO_3^{2-} , HCO_3^-
(D) S^{2-} , NO_2^-

19 From the opposite chart:

Mixture (X) is made of the two anions .....



(A) NO_3^- , CO_3^{2-} (B) HCO_3^- , CO_3^{2-} (C) NO_3^- , SO_3^{2-} (D) Cl^- , SO_3^{2-}

---

20 When lead(II) nitrate solution is added to solution (X), a white precipitate forms, and when drops of dilute nitric acid

are added to the white precipitate, effervescence is observed and the precipitate disappears.

Solution (X) is .....

(A) zinc chloride.
(B) ammonium iodide.
(C) aluminium sulphate.
(D) sodium carbonate.

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21 Compound (X) has the following properties:

• 1 mol of it dissolves in water forming 3 mol of ions.

• It reacts with ammonium carbonate forming an acidic gas.

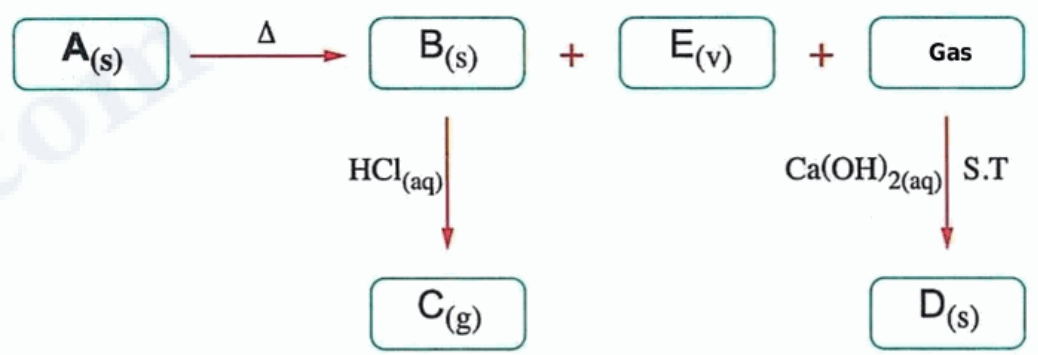
Compound (X) is .....

(A) calcium hydroxide.
(B) nitric acid.
(C) sodium hydroxide.
(D) sulphuric acid.

---

22 From the opposite chart:

Which of the following is correct?



(A) (A) : Na_2CO_3 , (B) : $NaHCO_3$, (C) : H_2O , (D) : $CaCO_3$

(B) (A) : $NaHCO_3$, (B) : Na_2O , (C) : H_2O , (D) : $Ca(HCO_3)_2$

(C) (A) : $NaHCO_3$, (B) : Na_2CO_3 , (C) : CO_2 , (D) : $CaCO_3$

(D) (A) : $KHCO_3$, (B) : K_2CO_3 , (C) : CO_2 , (D) : $Ca(HCO_3)_2$

---

23 When gas (A) is passed through clear limewater for a short time a white precipitate forms, and when the same gas is passed over heated charcoal

gas (B) forms. Gases (A) and (B) are .....

(A) (A) : CO_2 , (B) : CO

(B) (A) : CO , (B) : CO_2

(C) (A) : CO_2 , (B) : CO_2

(D) (A) : CO , (B) : CO

---

24 Sodium carbonate and sodium chloride can be distinguished using .....

(A) dilute nitric acid.

(B) potassium sulphite.

(C) ammonium hydroxide solution.

(D) potassium nitrate solution.

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25 The oxidation numbers of chromium in the compound used in making dyes and in the compound formed by the reaction of sulphur dioxide gas

with potassium dichromate solution acidified with conc. sulphuric acid are .....

(A) +3 , +6

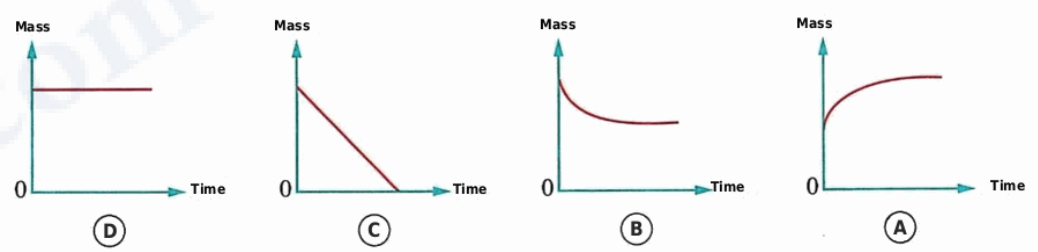
(B) +3 , +3

(C) +4 , +4

(D) +4 , +6

---

26 Which of the following graphs represents the mass of a mixture of sodium carbonate and excess dilute hydrochloric acid
in an open beaker over time?



(A) Graph (A) (B) Graph (B) (C) Graph (C) (D) Graph (D)

---

27 Strongly heating a sample of substance (A) gives a red solid (B) and a colourless gas (C) that turns a paper moistened
with acidified potassium dichromate solution green.
Which of the following is correct?

(A) (A) : $Fe_2(SO_4)_3$, (B) : FeO , (C) : SO_2

(B) (A) : $FeSO_4$, (B) : Fe_2O_3 , (C) : SO_2

(C) (A) : $Fe_2(SO_4)_3$, (B) : Fe_2O_3 , (C) : SO_3

(D) (A) : $FeSO_4$, (B) : FeO , (C) : SO_3

---

28 When salt (X) is strongly heated, two sulphur compounds form, and when potassium permanganate solution acidified
with conc. sulphuric acid is added to a solution of salt (Y), two sulphate salts form.
Which of the following is correct?

(A) (X) : $FeSO_4$, (Y) : $NaNO_3$ (B) (X) : $CuSO_4$, (Y) : $NaNO_2$

(C) (X) : $CuSO_4$, (Y) : $NaNO_3$ (D) (X) : $FeSO_4$, (Y) : $NaNO_2$

---

29 When compound (A) is dissolved in:

• dilute hydrochloric acid, colourless gas (B) is given off.

• water, and then silver nitrate solution is added, a white precipitate (C) forms.

Which of the following gives compound (A), gas (B) and the effect of heating precipitate (C)?

(A) (A) : Na_2SO_4 , (B) : SO_3 , (C) : turns black.

(B) (A) : Na_2SO_3 , (B) : SO_2 , (C) : the precipitate disappears.

(C) (A) : Na_2S , (B) : H_2S , (C) : the precipitate disappears.

(D) (A) : Na_2SO_3 , (B) : SO_2 , (C) : turns black.

---

30 Which of the following is used to distinguish between sulphur dioxide gas and carbon dioxide gas?

(A) Acidified potassium dichromate solution.

(B) Sodium hydroxide solution.

(C) Sodium carbonate solution.

(D) A blue litmus paper moistened with water.

---

31 From the following equation:

$2KMnO_4(aq) + 5SO_2(g) + 2H_2O(l) \longrightarrow 2H_2SO_4(aq) + K_2SO_4(aq) + 2MnSO_4(aq)$

All of the following are correct, except .....

(A) The mixture of reaction products contains a paramagnetic substance.

(B) Acidified potassium permanganate solution is used as a reagent for SO_2 gas.

(C) SO_2 gas acts as the reducing agent.

(D) Oxidation of the manganese ion takes place.

---

32 From the following ionic equation:

$3SO_3^{2-}(aq) + Cr_2O_7^{2-}(aq) + 8H^+(aq) \longrightarrow 3SO_4^{2-}(aq) + 2Cr^{3+}(aq) + 4H_2O(l)$

All of the following are correct, except .....

(A) The colour of the solution changes from orange to green.

(B) The SO_3^{2-} anion acts as the reducing agent.

(C) The H^+ ions come from conc. sulphuric acid.

(D) The oxidation state of chromium changes from +3 to +6

---

33 The following table shows the properties of the two gases (X) and (Y):

• Properties of gas (X): can be oxidised, has a pungent smell, decolourises acidified $KMnO_4$ solution.

• Properties of gas (Y): can be reduced, odourless, forms a white precipitate when passed through $Ca(OH)_2$ solution.

Which of the following is correct?

(A) (X) : SO_2 , (Y) : CO_2

(B) (X) : SO_3 , (Y) : CO

(C) (X) : SO_2 , (Y) : CO

(D) (X) : SO_3 , (Y) : CO_2

---

34 Which of the following anions forms a black water-insoluble substance with the cation (X^+) whose electron configuration ends with the sublevel ($4d^{10}$)?

(A) SO_3^{2-} (B) S^{2-} (C) NO_3^- (D) HCO_3^-

---

35 According to the products of the two opposite reactions:

• anion (X) + HCl(aq) ⟶ colourless gas (Y) with a bad smell

• gas (Y) + $(CH_3COO)_2Pb(aq)$ ⟶ a black solid

Which of the following is correct?

(A) (X) : S^{2-} , (Y) : SO_2

(B) (X) : Cl^- , (Y) : HCl

(C) (X) : S^{2-} , (Y) : H_2S

(D) (X) : SO_3^{2-} , (Y) : H_2S

---

36 When gas (1) is passed through solution (2), no colour change occurs.

Which of the following gives gas (1) and solution (2)?

(A) (1) : CO_2 , (2) : $Ca(OH)_2$

(B) (1) : SO_2 , (2) : $K_2Cr_2O_7$ / H^+

(C) (1) : H_2S , (2) : $(CH_3COO)_2Pb$

(D) (1) : NH_3 , (2) : NaOH

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37 For which pairs of the following anions does each one alone form the same gas when treated with a suitable acid?

(A) The pair (CO_3^{2-} , HCO_3^-) : correct , the pair (SO_3^{2-} , $S_2O_3^{2-}$) : correct

(B) The pair (CO_3^{2-} , HCO_3^-) : wrong , the pair (SO_3^{2-} , $S_2O_3^{2-}$) : correct

(C) The pair (CO_3^{2-} , HCO_3^-) : correct , the pair (SO_3^{2-} , $S_2O_3^{2-}$) : wrong

(D) The pair (CO_3^{2-} , HCO_3^-) : wrong , the pair (SO_3^{2-} , $S_2O_3^{2-}$) : wrong

---

38 A solid compound reacts with $H_2SO_4(aq)$ and the gaseous compound (X) forms, whose anion is oxidised forming one of the impurities of iron ores.

All of the following are correct, except .....

(A) Compound (X) forms a precipitate with (Pb^{2+}).

(B) The anion of compound (X) forms a black precipitate with (Ag^{+}).

(C) The oxidation number of the anion of gas (X) equals $(+4)$.

(D) The aqueous solution of gas (X) is more volatile than $HNO_3(aq)$

---

39 Dilute sulphuric acid was added to a salt, and a gas was given off that turns a paper moistened with acidified $K_2Cr_2O_7$ solution green,

in addition to the formation of a yellow suspension. The anion of this salt is .....

(A) sulphide. (B) sulphite. (C) thiosulphate. (D) sulphate.

---

40 When dilute hydrochloric acid is added to sodium thiosulphate salt, ... takes place.

(A) oxidation of sulphur and reduction of oxygen

(B) reduction of sulphur and oxidation of oxygen

(C) oxidation and reduction of oxygen

(D) oxidation and reduction of sulphur

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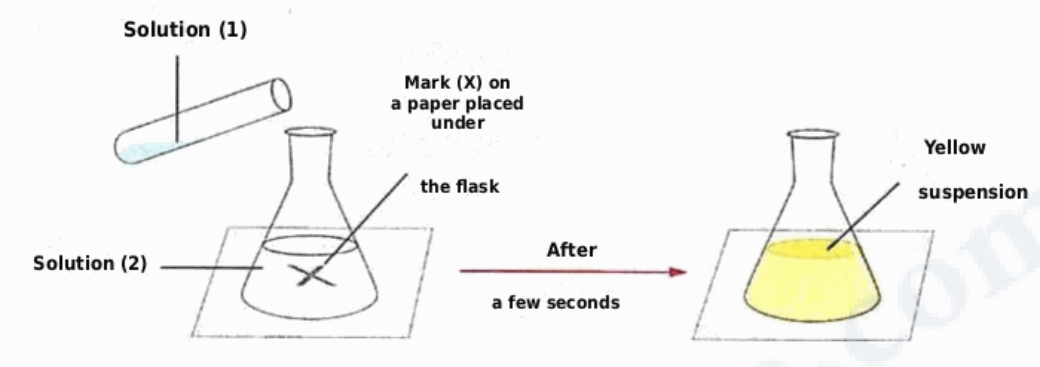
41 Solutions of two different sodium salts form when $Na_2X(aq)$ reacts with .....

(A) $MgCO_3$ (B) $AgNO_3$ (C) I_2 (D) S

---

42 The following figure shows a chemical experiment:

What is solution (1) and the anion of solution (2)?



(A) (1) : $HCl(aq)$, (2) : $SO_4^{2-}(aq)$

(B) (1) : $HCl(aq)$, (2) : $S_2O_3^{2-}(aq)$

(C) (1) : $I_2(aq)$, (2) : $S_4O_6^{2-}(aq)$

(D) (1) : $I_2(aq)$, (2) : $S_2O_3^{2-}(aq)$

43 The substance whose two parts are both oxidised by $KMnO_4$ solution in an acidic medium is .....

(A) $Fe(NO_3)_2$ (B) $MgSO_3$ (C) $Ti(NO_2)_3$ (D) K_2CO_3

44 The anion that changes the colour of acidified $K_2Cr_2O_7$ solution is .....

(A) NO_3^- (B) NO_2^- (C) HCO_3^- (D) CO_3^{2-}

45 What happens when potassium permanganate solution acidified with conc. sulphuric acid is added to sodium nitrite?

(A) Only sodium nitrite is oxidised.

(B) Only potassium permanganate is reduced.

(C) The sodium ion is oxidised and the potassium ion is reduced.

(D) The nitrite ion is oxidised and the manganese ion is reduced.

46 When carbon monoxide gas is used to reduce the solid compound formed by strongly heating iron(II) sulphate .....

(A) a gas forms that turns clear limewater milky.

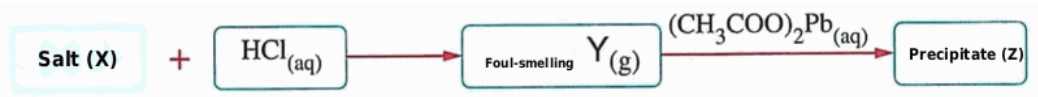
(B) a group of gases forms, all of which turn clear limewater milky.

(C) a group of gases forms, one of which blackens a paper moistened with lead(II) acetate solution.

(D) a group of gases forms, one of which turns acidified potassium permanganate solution green.

47 From the following chart:

Which of the following is correct?



(A) (X) : Na_2SO_3 , (Y) : SO_2 , (Z) : black.

(B) (X) : $NaNO_2$, (Y) : NO , (Z) : white.

(C) (X) : Na_2S , (Y) : H_2S , (Z) : black.

(D) (X) : Na_2CO_3 , (Y) : CO_2 , (Z) : white.

48 When each of the substances (W) and (X) reacts with dilute hydrochloric acid, the gases (Y) and (Z) are given off respectively.

• Gas (Y): turns acidified potassium dichromate solution green.

• Gas (Z): is oxidised in air forming a reddish-brown gas.

What are the two anions present in substances (W) and (X)?

(A) (W) : sulphite , (X) : sulphide.
(B) (W) : bicarbonate , (X) : nitrite.
(C) (W) : sulphite , (X) : nitrite.
(D) (W) : sulphide , (X) : bicarbonate.

49 When dilute hydrochloric acid is added to the salts (X) and (Y) - each alone - a gas is given off that does not affect potassium permanganate solution acidified with sulphuric acid.

Salts (X) and (Y) are .....

(A) (X) : KNO_2 , (Y) : K_2CO_3
(B) (X) : K_2SO_3 , (Y) : $K_2S_2O_3$
(C) (X) : KNO_3 , (Y) : K_2SO_3
(D) (X) : $KHCO_3$, (Y) : K_2CO_3

50 The number of moles of $KMnO_4$ needed to react completely with 0.05 mol of sodium nitrite in an acidic medium is .....

(A) 0.125 mol
(B) 0.02 mol
(C) 0.2 mol
(D) 2 mol

51 Dilute sulphuric acid can be used to detect the anions .....

(A) $S_2O_3^{2-}$, NO_3^- , SO_3^{2-} , CO_3^{2-}
(B) NO_2^- , S^{2-} , $S_2O_3^{2-}$, SO_3^{2-}
(C) NO_3^- , I^- , $S_2O_3^{2-}$, SO_3^{2-}
(D) NO_2^- , NO_3^- , SO_3^{2-} , CO_3^{2-}

52 KCl(s) and KBr(s) can be distinguished using .....

(A) $H_2SO_3(aq)$
(B) $HNO_3(l)$
(C) $H_2SO_4(l)$
(D) $HNO_2(aq)$

53 Sodium chloride solution and sodium nitrate solution can be distinguished using .....

(A) dilute hydrochloric acid.
(B) potassium carbonate solution.
(C) silver nitrate solution.
(D) dilute sulphuric acid.

54 Which of the following salt solutions gives a white precipitate when added to $AgNO_3$?

(A) $Cu(NO_3)_2$
(B) Na_2S
(C) $BaCl_2$
(D) KI

55 The ions present in the solution formed by adding excess silver nitrate to sodium chloride solution are .....

(A) Cl^- , Na^+ (B) Na^+ , NO_3^- , Cl^- (C) Ag^+ , Na^+ , Cl^- (D) Na^+ , NO_3^- , Ag^+

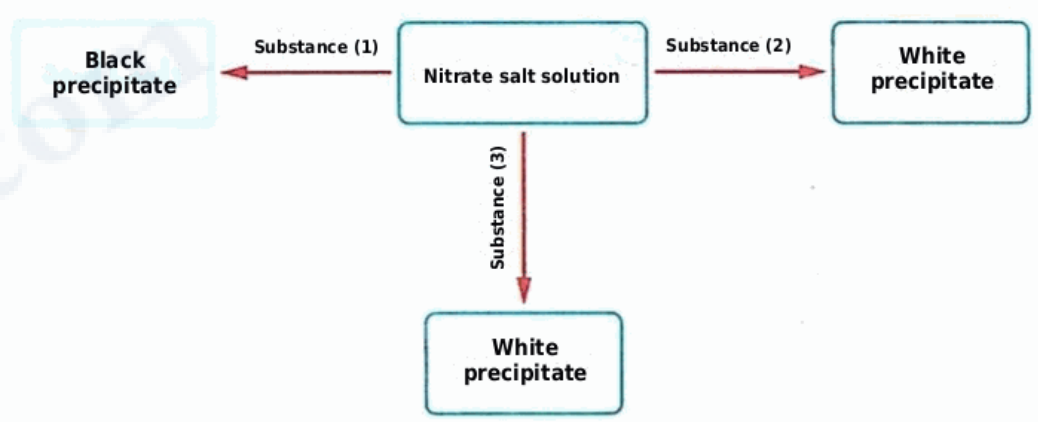
56 Acid (X) is used as the basic reagent for the chloride and bromide anions; when it reacts with excess iron filings
and heating, the ions ..... form.

(A) SO_4^{2-} , Fe^{2+} (B) Cl^- , Fe^{2+}
(C) SO_4^{2-} , Fe^{3+} , Fe^{2+} (D) Cl^- , Fe^{3+} , Fe^{2+}

57 In the chemical reaction shown by the following equation:
$2AgNO_3 + BaCl_2 \longrightarrow 2AgCl + Ba(NO_3)_2$
Which of the following shows the solubility in water of the reacting salts and the products?

(A) Soluble in water: silver nitrate ; insoluble in water: barium chloride , barium nitrate , silver chloride
(B) Soluble in water: silver nitrate , barium chloride ; insoluble in water: barium nitrate , silver chloride
(C) Soluble in water: silver nitrate , barium chloride , barium nitrate ; insoluble in water: silver chloride
(D) Soluble in water: silver nitrate , barium chloride , silver chloride ; insoluble in water: barium nitrate

58 The reactions shown in the following chart take place under suitable conditions:
Which of the following is correct?



(A) $(1) : Na_2S$, $(2) : NaI$, $(3) : Na_2SO_3$

(B) $(1) : Pb(NO_3)_2$, $(2) : Na_2SO_3$, $(3) : Na_2CO_3$

(C) $(1) : Na_2S$, $(2) : NaCl$, $(3) : Na_2SO_3$

(D) $(1) : Pb(NO_3)_2$, $(2) : Na_2SO_3$, $(3) : Na_2CO_3$

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59 Which of the following equations represents the final reaction between conc. sulphuric acid and sodium bromide salt?

(A) $2NaBr(s) + H_2SO_4(aq) \longrightarrow^{(\Delta)} Na_2SO_4(aq) + 2HBr(g)$

(B) $2NaBr(s) + H_2SO_4(l) \longrightarrow^{(\Delta)} Na_2SO_4(aq) + 2HBr(g)$

(C) $2NaBr(s) + 2H_2SO_4(l) \longrightarrow^{(\Delta)} Na_2SO_4(aq) + 2H_2O(l) + SO_2(g) + Br_2(v)$

(D) $2NaBr(s) + 2H_2SO_4(aq) \longrightarrow^{(\Delta)} Na_2SO_4(aq) + 2H_2O(l) + SO_2(g) + Br_2(v)$

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60 The reaction of a solid sodium salt with the hot concentrated acid prepared by the contact process gives all of the following,
except .....

(A) a gas that is partly oxidised.

(B) a salt solution whose anion is detected by HCl(aq)

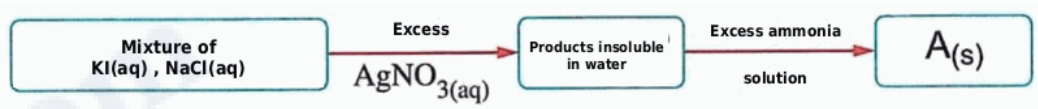
(C) a vapour that turns starch solution yellow.

(D) a gas that is affected by acidified $K_2Cr_2O_7$ solution.

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61 From the following chart:

Which of the following describes substance (A)?



(A) A yellowish-white precipitate.
(B) A white precipitate.
(C) A yellow precipitate.
(D) A black precipitate.

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62 A colourless solution forms when sodium metal is added to acid (X), and when silver nitrate solution is added

to this solution a precipitate forms that darkens when exposed to light.

What is the chemical formula of acid (X), and what is the effect of concentrated ammonia solution on the precipitate?

(A) $H_2S(aq)$ / does not dissolve.
(B) HBr(aq) / dissolves.
(C) $HNO_2(aq)$ / does not dissolve.
(D) HCl(aq) / dissolves.

---

63 What role does hot conc. sulphuric acid play when it is added in excess to sodium bromide salt?

(A) Oxidising agent.
(B) Reducing agent.
(C) Dehydrating agent.
(D) Catalyst.

---

64 A sufficient amount of silver nitrate solution was added to a mixture of sodium chloride and potassium iodide solutions.

What is the effect of adding excess concentrated ammonia solution to the products of the two previous reactions?

(A) A yellowish-white precipitate forms.
(B) A white precipitate forms.
(C) A yellow precipitate forms.
(D) No precipitate forms.

---

65 A white salt whose solution reacts with concentrated silver nitrate solution forming a precipitate that does not dissolve in ammonia solution,

and when the same salt reacts with hot conc. sulphuric acid, a mixture of ..... is given off.

(A) NO , NO_2
(B) SO_2 , I_2
(C) SO_2 , Br_2
(D) H_2S , Cl_2

---

66 One of the gases dissolves in water forming compound (X), which reacts with gas (Y) under suitable conditions forming a coloured vapour, whose solution is used to detect the $S_2O_3^{2-}$ anion.
Which of the following is correct?

(A) (X) : HCl , (Y) : NH_3
(B) (X) : H_2SO_4 , (Y) : HCl
(C) (X) : H_2SO_4 , (Y) : HI
(D) (X) : HCl , (Y) : HBr

---

67 The following table shows the results of two experiments carried out on compound (X):
• Experiment: adding silver nitrate solution to a solution of compound (X), then adding ammonia solution to the product ; Observation: a precipitate forms that does not dissolve in ammonia solution.
• Experiment: heating solid compound (X) with conc. sulphuric acid ; Observation: violet fumes are given off.
Compound (X) is .....

(A) iron(II) chloride
(B) lithium bromide.
(C) potassium sulphate.
(D) sodium iodide.

---

68 When pale yellow $FeCl_3$ solution is added to colourless KI solution, a brown solution forms as a result of
.....

(A) oxidation of Fe^{3+} ions
(B) oxidation of I^- ions
(C) reduction of I^- ions
(D) reduction of Cl^- ions

---

69 What colour change takes place when potassium iodide solution is oxidised by acidified $KMnO_4$ solution,
and when acidified potassium dichromate solution is reduced by SO_2 gas?

(A) Colour change in the oxidation: from violet to brown ; colour change in the reduction: from green to orange
(B) Colour change in the oxidation: from violet to brown ; colour change in the reduction: from orange to green
(C) Colour change in the oxidation: from colourless to violet ; colour change in the reduction: from green to orange
(D) Colour change in the oxidation: from colourless to violet ; colour change in the reduction: from orange to green

70 From the opposite reaction:

$2KI(aq) + Fe_2(SO_4)_3(aq) \longrightarrow K_2SO_4(aq) + I_2(aq) + 2FeSO_4(aq)$

All of the following are correct, except .....

(A) The magnetic moment of the iron cation decreases.

(B) Reduction of the iodide anion takes place.

(C) One of the products is affected by acidified $KMnO_4(aq)$.

(D) One of the products is used to detect $S_2O_3^{2-}(aq)$

---

71 From the reaction:

$2KI(aq) + Fe_2(SO_4)_3(aq) \longrightarrow K_2SO_4(aq) + I_2(aq) + 2FeSO_4(aq)$

Which of the following is correct after the reaction ends?

(A) The number of unpaired electrons in the cation of the transition element increases.

(B) The number of unpaired electrons in the cation of the transition element decreases.

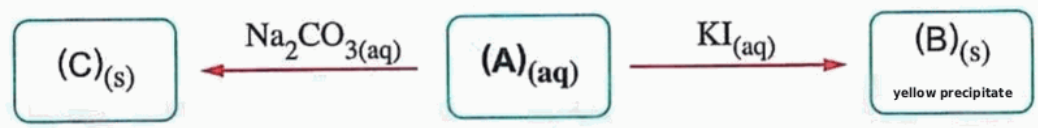
(C) The brown colour of iodine disappears.

(D) The solution turns violet.

---

72 From the following chart:

Which of the following is correct?



(A) (A) : $CuSO_4$, (B) : CuI_2 , (C) : $CuCO_3$

(B) (A) : $AgNO_3$, (B) : AgI , (C) : Ag_2CO_3

(C) (A) : $AgNO_3$, (B) : KNO_3 , (C) : Ag_2CO_3

(D) (A) : $Ca(NO_3)_2$, (B) : KNO_3 , (C) : $CaCO_3$

---

73 A solid mixture (X):

- reacts with dilute HCl acid forming a gas that turns clear limewater milky.
- its solution reacts with silver nitrate solution forming a yellow precipitate.

The anions present in mixture (X) are .....

(A) I^- , CO_3^{2-} (B) CO_3^{2-} , Cl^- (C) SO_4^{2-} , Cl^- (D) SO_4^{2-} , I^-

---

74 Which of the following silver salts dissolves neither in water nor in ammonia solution?

(A) $AgHCO_3$ (B) AgBr (C) AgCl (D) AgI

75 What are the similarities between the compounds AgCl, AgBr and AgI?

(A) Colour : wrong , solubility in NH_4OH : correct , sparingly soluble in H_2O : correct

(B) Colour : correct , solubility in NH_4OH : correct , sparingly soluble in H_2O : correct

(C) Colour : wrong , solubility in NH_4OH : correct , sparingly soluble in H_2O : wrong

(D) Colour : wrong , solubility in NH_4OH : wrong , sparingly soluble in H_2O : correct

76 When a small amount of colourless potassium iodide solution is added to colourless solution (X), the resulting
solution turns brown, and when the same amount of acidified potassium permanganate solution is added to solution (X),
the violet colour of the permanganate disappears. Which of the following describes solution (X)?

(A) It acts as an oxidising agent and as a reducing agent.

(B) It acts as an oxidising agent only.

(C) It acts neither as an oxidising agent nor as a reducing agent.

(D) It acts as a reducing agent only.

77 Fumes of colour (1) are given off when hot conc. sulphuric acid is added to the solid salt of anions (2).
All of the following may describe the colour of fumes (1) and anions (2), except .....

(A) (1) : reddish orange , (2) : bromide. (B) (1) : violet , (2) : iodide.

(C) (1) : reddish brown , (2) : nitrate. (D) (1) : white , (2) : chloride.

78 A sodium salt reacts with hot H_2SO_4(l) forming acid (X), which reacts with metal (Y) under suitable conditions
and a coloured gas (Z) is given off.
Which of the following is correct?

(A) (X) : HNO_2 , (Y) : Fe , (Z) : NO_2 (B) (X) : HNO_3 , (Y) : Fe , (Z) : NO

(C) (X) : HNO_2 , (Y) : Cu , (Z) : NO (D) (X) : HNO_3 , (Y) : Cu , (Z) : NO_2

79 When each of the following two experiments is carried out:

• Experiment (1): adding hot conc. nitric acid to copper turnings.

• Experiment (2): adding dilute hydrochloric acid to scandium carbonate powder.

then .....

(A) a colourless gas is given off in experiment (1).

(B) a coloured gas is given off in experiment (2).

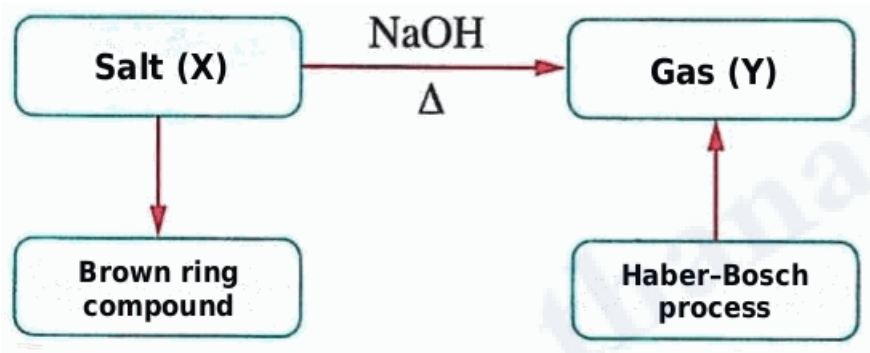
(C) a coloured gas forms in experiment (1).

(D) a coloured gas forms in both experiments (1) and (2).

---

80 From the opposite chart:

The chemical formula of salt (X) is .....



(A) NH_4NO_3 (B) NH_4Cl (C) KNO_3 (D) $Ba(NO_3)_2$

---

81 Iron reacts with dilute sulphuric acid forming solution (X), which forms a brown compound when it combines with .....

(A) N_2O (B) NO (C) N_2O_3 (D) N_2O_5

---

82 The brown ring test for the nitrate anion depends on .....

(A) reduction of the nitrogen of the nitrate ion.

(B) reduction of iron(II) sulphate

(C) oxidation of the nitrogen of the nitrate ion.

(D) oxidation of sulphuric acid.

---

83 Which of the following processes takes place under suitable conditions and is accompanied by the release of only one gaseous substance?

(A) Thermal decomposition of HNO_3 acid

(B) The reaction of hydrogen iodide with H_2SO_4

(C) Strongly heating the compound $FeCO_3$

(D) Strongly heating the compound $FeSO_4$

---

84 When hot conc. sulphuric acid is added to:

• salt (X): a gas that can be oxidised is given off.

• salt (Y): a gas that is hard to oxidise is given off.

Which of the following is correct?

(A) (X) : NaCl , (Y) : NaBr

(B) (X) : $NaNO_3$, (Y) : NaI

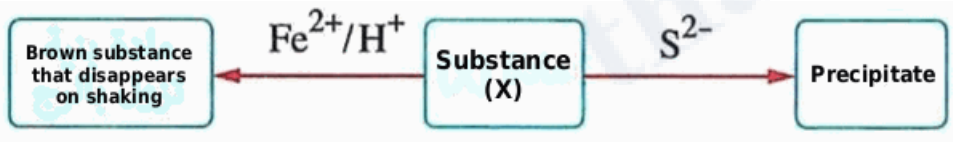
(C) (X) : $NaNO_2$, (Y) : Na_2SO_3

(D) (X) : NaI , (Y) : $NaNO_3$

---

85 From the opposite chart:

The chemical formula of substance (X) is .....



(A) NH_4NO_3 (B) $Pb(NO_3)_2$ (C) Ag_2SO_3 (D) NaCl

---

86 When conc. sulphuric acid is added to salt (X) with heating, gas (Y) is given off and precipitate (Z) forms.

Which of the following is correct?

(A) (X) : Na_2CO_3 , (Y) : CO_2 , (Z) : Na_2SO_4

(B) (X) : $CaCl_2$, (Y) : Cl_2 , (Z) : $CaSO_4$

(C) (X) : $Mg(NO_3)_2$, (Y) : NO_2 , (Z) : $MgSO_4$

(D) (X) : $Pb(NO_3)_2$, (Y) : NO_2 , (Z) : $PbSO_4$

---

87 Among the compounds that dissolve in water are .....

(A) barium chloride , calcium carbonate , magnesium hydroxide.

(B) barium sulphate , calcium hydroxide , ammonium carbonate.

(C) barium chloride , ammonium hydroxide , magnesium sulphate.

(D) barium sulphate , calcium sulphate , magnesium hydroxide.

---

88 A white precipitate forms when either conc. sulphuric acid or silver nitrate solution is added to a solution of .....

(A) magnesium chloride.

(B) magnesium sulphate.

(C) barium chloride.

(D) barium nitrate.

---

89 The two salts formed by the combination of the Ba^{2+} cation with anion (1) and with anion (2) share property (3).

Which of the following is correct?

(A) (1) : CO_3^{2-} , (2) : PO_4^{3-} , (3) : solubility in HCl

(B) (1) : HCO_3^{-} , (2) : SO_4^{2-} , (3) : solubility in H_2O

(C) (1) : SO_4^{2-} , (2) : CO_3^{2-} , (3) : solubility in HCl

(D) (1) : CO_3^{2-} , (2) : PO_4^{3-} , (3) : solubility in H_2O

---

90 The following anions can form salts that do not dissolve in water, except .....

(A) SO_4^{2-} (B) Cl^{-} (C) NO_3^{-} (D) SO_3^{2-}

---

91 A solution of a salt was divided into two parts: dilute nitric acid was added to the first and conc. sulphuric acid to the second,

and no reaction took place.

Which anion is probably present in the solution of this salt?

(A) Nitrate. (B) Sulphide. (C) Sulphite. (D) Phosphate.

---

92 In each of the following pairs of anions one of them can be separated as a precipitate, except .....

(A) NO_3^{-} , CO_3^{2-} (B) NO_3^{-} , NH_4^{+} (C) NH_4^{+} , PO_4^{3-} (D) SO_4^{2-} , SO_3^{2-}

---

93 Silver and barium cations form a precipitate with both of the anions .....

(A) phosphate and sulphate.
(B) nitrate and sulphite.
(C) bicarbonate and sulphate.
(D) chloride and sulphite.

94 An anhydrous white salt (Z) was strongly heated, forming a solid (X) and a gaseous mixture; then the solid (X) was dissolved in
dilute hydrochloric acid, and when drops of dilute sulphuric acid were added to the resulting solution a white precipitate formed.
Salt (Z) is .....

(A) copper carbonate.
(B) magnesium nitrate.
(C) magnesium carbonate.
(D) barium nitrate.

95 The white salt that dissolves in concentrated NH_4OH solution and does not dissolve in H_2O is .....

(A) $CuSO_4$ (B) AgI (C) AgCl (D) Ag_3PO_4

96 Sodium chloride solution and lead(II) nitrate solution can be distinguished by each of the following, except .....

(A) dilute sulphuric acid.
(B) silver nitrate solution.
(C) potassium bicarbonate solution.
(D) hydrogen sulphide gas.

97 The cation of metal (M) combines with the sulphate anion forming a white precipitate (Y). Which of the following gives metal (M) and how soluble precipitate (Y) is in different acids?

(A) (M) : Ba , (Y) : dissolves in dilute HCl acid.
(B) (M) : Mg , (Y) : does not dissolve in conc. H_2SO_4 acid.
(C) (M) : Mg , (Y) : dissolves in conc. H_2SO_4 acid.
(D) (M) : Ba , (Y) : does not dissolve in dilute HCl acid.

98 Silver nitrate solution forms each of the following precipitates, except .....

(A) a yellow precipitate with the phosphate ion.
(B) a white precipitate with the iodide ion.
(C) a white precipitate with the sulphite ion.
(D) a yellowish-white precipitate with the bromide ion.

99 Pollution of drinking water by lead compounds is one of the main causes of disease, so water treatment plants
remove lead ions.
Which substance can be used for this purpose?

(A) Sodium bicarbonate.
(B) Magnesium sulphate.
(C) Acetic acid.
(D) Nitric acid.

100 A solution is made of a mixture of Cl^- and SO_4^{2-} ions.
Which cation, when added to the solution, precipitates one of the two anions but not the other?

(A) Mg^{2+}
(B) Ba^{2+}
(C) Fe^{3+}
(D) Fe^{2+}

101 When a mixture of solutions of barium nitrate, iron(II) sulphate and magnesium chloride is shaken,
the number of precipitates formed is .....

(A) 1
(B) 2
(C) 3
(D) 4

102 Which of the following gives the anions that form coloured fumes when hot conc. sulphuric acid is added to their solid salt?

(A) Br^- : correct , NO_3^- : wrong , PO_4^{3-} : correct
(B) Br^- : wrong , NO_3^- : correct , PO_4^{3-} : wrong
(C) Br^- : correct , NO_3^- : correct , PO_4^{3-} : wrong
(D) Br^- : wrong , NO_3^- : wrong , PO_4^{3-} : correct

103 Dilute hydrochloric acid was added to a solution containing Ag^+, Ba^{2+}, Mn^{2+} and Cu^{2+} ions, and precipitate (X) formed; after separating precipitate (X), sulphuric acid was added to the remaining solution and precipitate (Y) formed.
Which of the following is correct?

(A) (X) : AgCl , (Y) : $BaSO_4$
(B) (X) : $BaCl_2$, (Y) : Ag_2SO_4
(C) (X) : AgCl , (Y) : $MnSO_4$
(D) (X) : $MnCl_2$, (Y) : $CuSO_4$

104 Mixture (X) contains equal amounts of the nitrate and sulphate of a group 2A metal; when water was added to
mixture (X) one of the two compounds dissolved, while the other precipitated, and after separating the mixture by filtration the resulting solution was found
to react with sulphuric acid forming a precipitate. Which of the following describes mixture (X)?

(A) $Ba(NO_3)_2 + BaSO_4$
(B) $Ba(NO_3)_2 + MgSO_4$
(C) $Mg(NO_3)_2 + BaSO_4$
(D) $Mg(NO_3)_2 + MgSO_4$

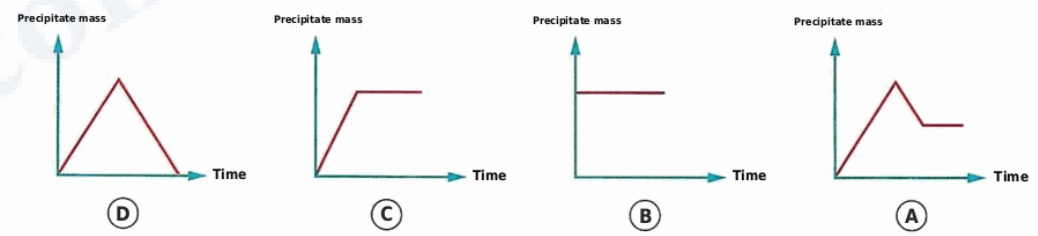
105 The phosphate anion in sodium phosphate solution can be detected using calcium nitrate solution.
What is the sum of the coefficients in the balanced equation of the reaction, and the coefficient of the precipitate formed, respectively?

(A) 11 / 1
(B) 12 / 1
(C) 11 / 2
(D) 12 / 2

106 Cations (A) combine with carbonate anions forming a white precipitate that dissolves in dilute hydrochloric acid,
and the same cations combine with phosphate anions forming precipitate (B); cations (C) combine with chloride anions
forming a white precipitate that dissolves in ammonia solution, and the same cations combine with phosphate anions forming precipitate (D).
Which of the following is correct?

(A) Precipitate (B): a white precipitate that does not dissolve in HCl acid ; precipitate (D): a reddish-brown precipitate that dissolves in ammonia solution
(B) Precipitate (B): a white precipitate that dissolves in HCl acid ; precipitate (D): a yellow precipitate that dissolves in nitric acid
(C) Precipitate (B): a reddish-brown precipitate that dissolves in HCl acid ; precipitate (D): a reddish-brown precipitate that dissolves in ammonia solution
(D) Precipitate (B): a reddish-brown precipitate that does not dissolve in HCl acid ; precipitate (D): a white precipitate that dissolves in nitric acid

107 Which of the following graphs represents adding excess silver nitrate solution to a mixture of potassium phosphate
and potassium chloride solutions, then adding excess concentrated ammonia solution to the products?

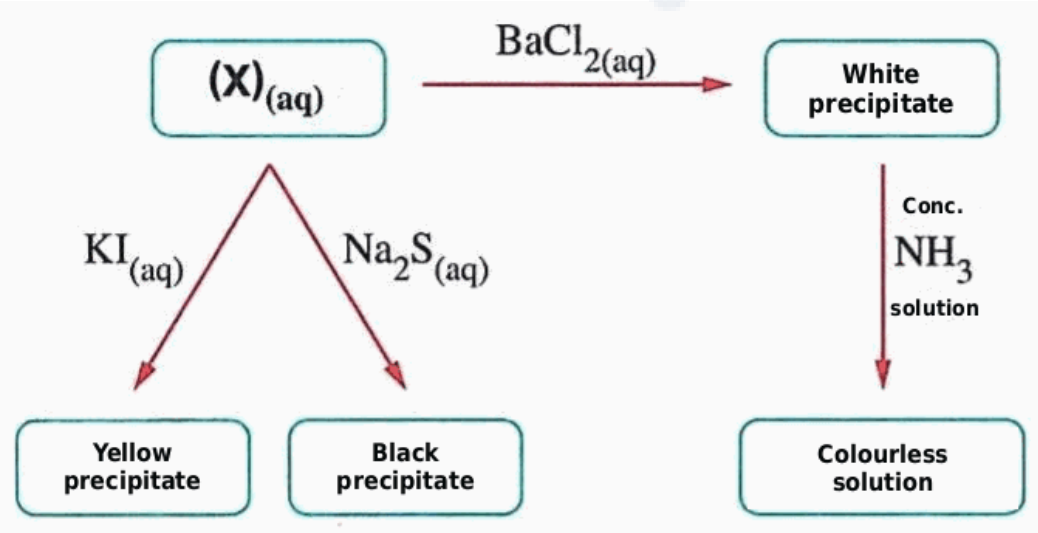


(A) Graph (A) (B) Graph (B) (C) Graph (C) (D) Graph (D)

108 What are the steps followed to separate a mixture of the salts barium phosphate and barium nitrate?

(A) Dissolving → evaporating → filtering.
(B) Dissolving → filtering → evaporating.
(C) Filtering → evaporating → dissolving.
(D) Filtering → dissolving → evaporating.

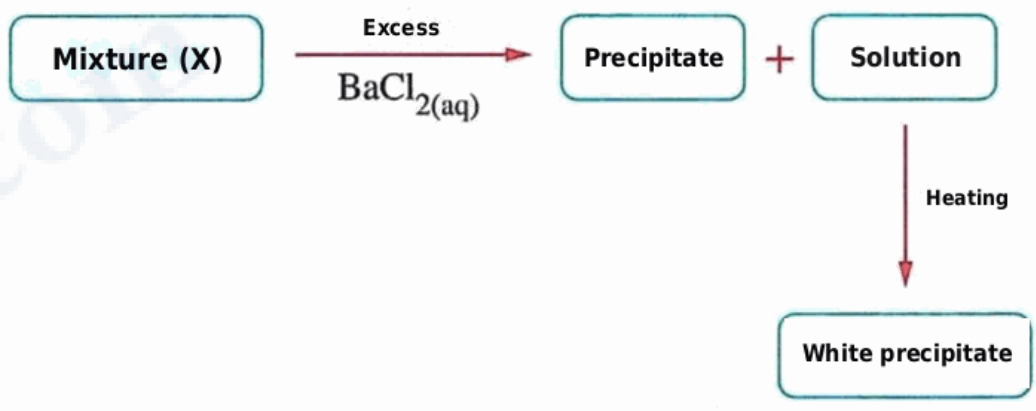
109 The opposite chart shows some reactions of compound (X).
Which of the following describes compound (X)?



(A) $Mg(NO_3)_2$ (B) $CuSO_4$ (C) H_2SO_4 (D) $AgNO_3$

110 From the opposite chart:

Mixture (X) contains the two anions .....

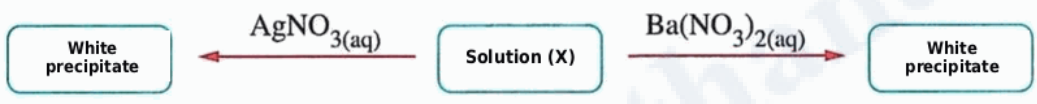


(A) HCO_3^- , SO_4^{2-} (B) PO_4^{3-} , SO_4^{2-} (C) CO_3^{2-} , PO_4^{3-} (D) Cl^- , NO_3^-

---

111 Solution (X) contains a mixture of two salts, and the following chart shows the results of some reactions of this solution:

All of the following describe the two salts of solution (X), except .....



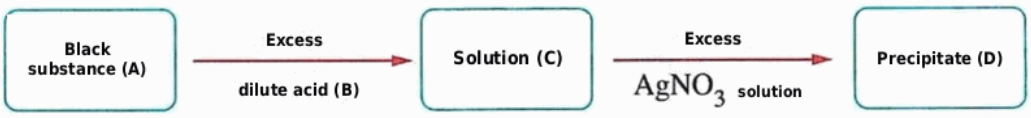
(A) $CuSO_4$, KI (B) $ZnCl_2$, $Sc_2(SO_4)_3$

(C) $TiCl_4$, K_3PO_4 (D) $ZnSO_4$, NaCl

---

112 The following chart shows a series of chemical reactions:

Which of the following is correct?



(A) Substance (A) is iron(II) oxide and precipitate (D) is black.

(B) Acid (B) is HCl and precipitate (D) turns violet when exposed to light.

(C) Substance (A) is iron filings and solution (C) is iron(III) chloride

(D) Acid (B) is H_2SO_4 and solution (C) does not form a precipitate with $BaCl_2$ solution

---

Essay questions — 12 questions

1 When iron(II) sulphate is strongly heated, compound (X) forms, and when compound (X) is reduced by carbon monoxide gas,
gas (Y) forms:
(1) Write the balanced symbolic equation for the reduction of compound (X) to form gas (Y) at a temperature above 700°C
(2) Explain how gas (Y) is detected.

2 A sample of an iron ore with a yellowish-grey colour was divided into two equal parts (X) and (Y):
• Part (X): heated in the absence of air until its mass was constant, then dilute HCl acid was added to it.
• Part (Y): dilute HCl acid was added to it without heating.
(1) Write the equations of the two reactions that take place for part (X).
(2) Write the equation for detecting the gas formed for part (Y).

3 What do you observe when dilute sulphuric acid is added to each of:
(1) sodium carbonate salt.
(2) barium chloride salt.

4 What is the effect of passing the gas formed from:
(1) roasting siderite through calcium hydroxide solution.
(2) the oxidation of one of the impurities in siderite ore during roasting through acidified potassium dichromate solution.

5 Salt (X) reacts with dilute hydrochloric acid forming a gas that turns acidified potassium dichromate solution green:
(1) What is the anion of salt (X)?
(2) If all the salts formed by the cation of salt (X) dissolve in water, what are the possible cations of salt (X)?

6 The metals (X) and (Y) belong to the first transition series, and their compounds KXO_4 and $K_2Y_2O_7$ are used as oxidising agents.

(1) What is the highest oxidation state of:

(a) element (X).

(b) element (Y).

(2) What is the colour of the aqueous solution of:

(a) KXO_4

(b) $K_2Y_2O_7$

---

7 What gases are formed from the reaction of:

(1) dilute hydrochloric acid with a solid mixture of the salts sodium carbonate, nitrate, sulphide and sulphate.

(2) conc. sulphuric acid with a solid mixture of the salts sodium bicarbonate, phosphate and chloride.

---

8 (A) and (B) are two solutions of potassium salts; silver nitrate solution was added to each of them and a yellow precipitate formed in each,

and when dilute nitric acid was added to each of the two precipitates, the precipitate from solution (A) was found to dissolve in the acid,

while the precipitate from solution (B) did not dissolve in the acid.

Write the symbolic equation for the basic detection test of the anion of:

(1) salt (A).

(2) salt (B).

---

9 Adding dilute hydrochloric acid to:

• the two anions (1) and (2) forms the odourless gas (X).

• the two anions (3) and (4) forms gas (Y), which has a pungent smell.

Write the chemical formulas of the anions (1) to (4).

---

10 When barium chloride solution is added to two different solutions of sodium salts, a white precipitate forms in the first solution that dissolves

in dilute hydrochloric acid, and a white precipitate forms in the second solution that does not dissolve in dilute hydrochloric acid.

Write the chemical formula of each of the two precipitates formed.

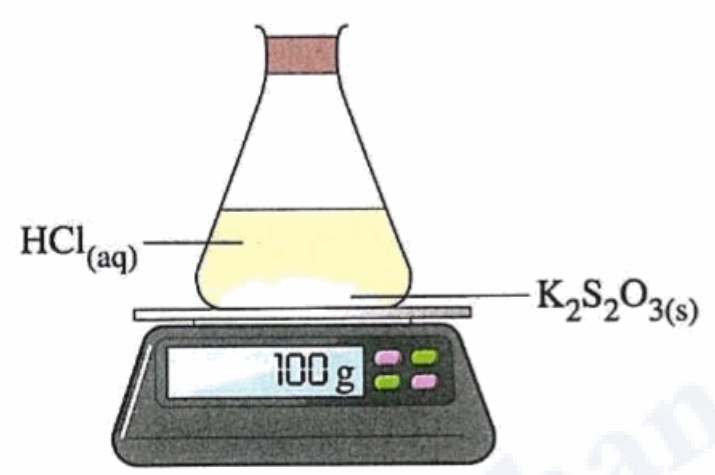
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11 Bottle (A) contains conc. hydrochloric acid, and bottle (B) contains concentrated ammonia solution.

What is the effect of bringing the mouths of the two bottles close to each other? Write the symbolic equation for the reaction.

12 The opposite figure shows a chemical reaction at its start.

Record two observations that can be seen with the naked eye showing that a chemical reaction has taken place.



Past exam questions — 63 questions

1 Two salts (X) and (Y) both contain the same cation:

• (X): dissolves in water and dissolves in dilute acids.

• (Y): does not dissolve in water and dissolves in dilute acids.

When dilute hydrochloric acid is added to each of the two salts separately, gas (Z) is given off.

Which of the following describes gas (Z)?

(Sample exam 2026)

(A) It forms a white precipitate when passed through potassium hydroxide solution for a short time.

(B) It is given off when salt (X) is heated and salt (Y) forms.

(C) When passed through water containing salt (Y), the salt dissolves as sodium bicarbonate.

(D) When passed through clear limewater for a long time, it turns milky.

---

2 Dilute hydrochloric acid was added to each of three salts (X), (Y) and (Z) separately, and the results were as follows:

• For salt (X): a colourless gas that is easily oxidised was given off.

• For salt (Y): a white precipitate formed.

• For salt (Z): a gas was given off that blackens a paper moistened with lead(II) acetate.

Which of the following describes the salts (X), (Y) and (Z)?

(Sample exam 2026)

(A) (X) : $NaNO_2$, (Y) : $AgNO_3$, (Z) : Na_2S

(B) (X) : KNO_2 , (Y) : $Pb(NO_3)_2$, (Z) : Na_2SO_3

(C) (X) : NH_4Cl , (Y) : Ag_2SO_4 , (Z) : Na_2SO_3

(D) (X) : $NaNO_3$, (Y) : $Ba(NO_3)_2$, (Z) : Na_2S

---

3 Conc. sulphuric acid was added to three solid salts (A), (B) and (C):

• For salt (A): a colourless gas that is hard to oxidise was given off.

• For salt (B): coloured fumes were given off, whose solution can be used to detect one of the anions of the first group.

• For salt (C): no gas was given off.

Which of the following describes the salts (A), (B) and (C)?

(Sample exam 2026)

(A) (A) : $CaCl_2$, (B) : $MgBr_2$, (C) : $PbSO_4$

(B) (A) : $CaCl_2$, (B) : MgI_2 , (C) : Ag_3PO_4

(C) (A) : $MgBr_2$, (B) : $NaNO_3$, (C) : Ag_3PO_4

(D) (A) : CaI_2 , (B) : $MgBr_2$, (C) : $PbSO_4$

---

4 When hot conc. sulphuric acid is added to salt (X), fumes are given off that turn a paper moistened with starch blue.

When barium chloride solution is added to a solution of salt (Y), a white precipitate forms that dissolves in dilute HCl acid.

Which of the following gives the result of adding silver nitrate solution to solutions of (X) and (Y)?

(Sample exam 2026)

(A) For the solution of salt (X): a yellow precipitate forms that dissolves in ammonia solution ; for the solution of salt (Y): a yellow precipitate forms that does not dissolve in ammonia solution

(B) For the solution of salt (X): a yellow precipitate forms that does not dissolve in ammonia solution ; for the solution of salt (Y): a yellow precipitate forms that dissolves in ammonia solution

(C) For the solution of salt (X): a yellowish-white precipitate forms ; for the solution of salt (Y): a yellow precipitate forms that does not dissolve in ammonia solution

(D) For the solution of salt (X): a white precipitate forms that dissolves in ammonia solution ; for the solution of salt (Y): a yellow precipitate forms that dissolves in ammonia solution

---

5 Two salts (Na_2X) and (NaY) were used in the experiments whose observations are shown in the following table:

• Experiment (solid salt + HCl(aq)): salt (Na_2X): a gas is given off ; salt (NaY): no gas is given off

• Experiment (salt solution + $AgNO_3(aq)$): salt (Na_2X): $Ag_2X(s)$ forms ; salt (NaY): AgY(s) forms

Which of the following describes anion (X) or anion (Y) and their silver salts?

(Sample exam 2026)

(A) Anion (Y) is probably iodide and AgY(s) is a black precipitate.

(B) Anion (X) is probably sulphite and $Ag_2X(s)$ is a white precipitate.

(C) Anion (X) is probably sulphide and $Ag_2X(s)$ is a white precipitate.

(D) Anion (Y) is probably bromide and AgY(s) is a black precipitate.

---

6 When conc. sulphuric acid is added to salt (X), fumes (Y) are given off;
when a solution of these fumes is added to a solution of salt (Z), their colour disappears.

Which of the following describes (X), (Y) and (Z)?

(Sample exam 2026)

(A) (X) : NaI(s) , (Y) : $I_2(v)$, (Z) : $Na_2S_2O_3(aq)$

(B) (X) : NaBr(s) , (Y) : $Br_2(v)$, (Z) : $Na_2S(aq)$

(C) (X) : $NaNO_3(s)$, (Y) : $NO_2(v)$, (Z) : $Na_2S(aq)$

(D) (X) : NaI(s) , (Y) : $I_2(v)$, (Z) : $Na_2SO_3(aq)$

---

7 All of the following solutions can be used to distinguish between magnesium sulphate and magnesium chloride,
except .....

(Sample exam 2026)

(A) barium chloride.

(B) hot conc. sulphuric acid.

(C) calcium bicarbonate.

(D) dilute hydrochloric acid.

---

8 When hot conc. sulphuric acid reacts with salt (X), a colourless gas is given off, while the same acid reacts with
salt (Y) and fumes are given off that turn a paper moistened with starch blue. Salts (X) and (Y) are .....
(Sample exam 2026)

(A) (X) : sodium chloride , (Y) : sodium iodide
(B) (X) : sodium bromide , (Y) : sodium iodide
(C) (X) : sodium nitrate , (Y) : sodium sulphate
(D) (X) : sodium chloride , (Y) : sodium bromide

---

9 When a confirmatory reagent (X) is added to a solution of salt (Y), the colour of reagent (X) disappeared and salt (Y) was oxidised.
Which of the following describes reagent (X) and salt (Y)?
(Sample exam 2026)

(A) Reagent (X): acidified potassium permanganate , salt (Y): sodium nitrite
(B) Reagent (X): magnesium sulphate , salt (Y): sodium nitrate
(C) Reagent (X): lead(II) acetate , salt (Y): sodium sulphide
(D) Reagent (X): brown iodine solution , salt (Y): sodium sulphate

---

10 Hydrochloric acid solution was added to three solid salts (X), (Y) and (Z) separately, and the results were as follows:
• (X): a gas is given off that does not change the colour of acidified potassium permanganate solution.
• (Y): a suspension forms in the solution and a gas that affects acidified potassium permanganate solution.
• (Z): the colour of the solution does not change and no gas is given off.
Which of the following is correct for the salts (X), (Y) and (Z)?
(Sample exam 2026)

(A) Salt (X): silver bicarbonate , salt (Y): sodium thiosulphate , salt (Z): sodium nitrate
(B) Salt (X): sodium sulphite , salt (Y): sodium nitrate , salt (Z): sodium nitrite
(C) Salt (X): sodium carbonate , salt (Y): sodium thiosulphate , salt (Z): sodium sulphide
(D) Salt (X): sodium nitrate , salt (Y): sodium nitrite , salt (Z): sodium chloride

---

11 The following experiments were carried out on four salt solutions (X), (Y), (Z) and (W):

- Solution (X): a precipitate formed when calcium hydroxide solution was added.
- Solution (Y): no precipitate formed when calcium hydroxide solution was added.
- Solution (Z): decolourised iodine solution.
- Solution (W): a black precipitate formed when lead(II) nitrate was added.

Which of the following is correct for the salts (X), (Y), (Z) and (W)?
(Sample exam 2026)

(A) Salt (X): potassium bicarbonate , salt (Y): ammonium carbonate , salt (Z): sodium sulphide , salt (W): sodium thiosulphate

(B) Salt (X): ammonium carbonate , salt (Y): potassium bicarbonate , salt (Z): sodium thiosulphate , salt (W): sodium sulphide

(C) Salt (X): sodium thiosulphate , salt (Y): sodium sulphide , salt (Z): ammonium bicarbonate , salt (W): sodium sulphide

(D) Salt (X): sodium sulphide , salt (Y): sodium thiosulphate , salt (Z): ammonium carbonate , salt (W): sodium bicarbonate

---

12 Which of the following is not used to distinguish between nitric oxide gas and hydrogen chloride gas?
(Sample exam 2026)

(A) Sodium chloride solution.

(B) Exposing each of them separately to air.

(C) A rod moistened with ammonia.

(D) Acidified potassium permanganate.

---

13 The experiments shown in the following table were carried out to identify three acids:

• Experiment (1): hydrogen bromide gas was passed through hot concentrated acid (1) ; observation: orange fumes were given off

• Experiment (2): exposing a rod moistened with ammonia to the fumes of acid (2) ; observation: white clouds formed

• Experiment (3): adding barium nitrate solution to a solution of dilute acid (3) ; observation: a white precipitate formed

Which of the following describes the acids (1), (2) and (3)?

(Sample exam 2026)

(A) Acid (1): sulphuric acid , acid (2): hydrochloric acid , acid (3): phosphoric acid

(B) Acid (1): hydrochloric acid , acid (2): phosphoric acid , acid (3): nitric acid

(C) Acid (1): nitric acid , acid (2): sulphuric acid , acid (3): phosphoric acid

(D) Acid (1): sulphuric acid , acid (2): hydrochloric acid , acid (3): nitric acid

---

14 Each of the following is a reaction that produces substances sparingly soluble in water, except .....

(Sample exam 2026)

(A) Magnesium sulphate solution with potassium bicarbonate solution.

(B) Dilute hydrochloric acid with potassium thiosulphate salt.

(C) Silver nitrate solution with potassium sulphite solution.

(D) Carbon dioxide with calcium hydroxide solution for a short time.

---

15 When dilute hydrochloric acid is added to a salt whose anion is (X^{2-}), gas (Y) is given off, which is oxidised by common oxidising agents.

Which of the following applies to anion (X^{2-}) and gas (Y)?

(Sample exam 2026)

(A) Anion (X^{2-}): nitrite , gas (Y): colourless, turns reddish brown in air

(B) Anion (X^{2-}): sulphite , gas (Y): has a pungent smell and turns acidified potassium dichromate solution green

(C) Anion (X^{2-}): sulphide , gas (Y): odourless and gives a black precipitate with lead(II) acetate solution

(D) Anion (X^{2-}): carbonate , gas (Y): colourless and odourless and turns clear limewater milky

---

16 Which of the following is not preferred for distinguishing between the nitrate and nitrite anions in their salts?
(Sample exam 2026)

(A) Dilute hydrochloric acid.

(B) Hot conc. sulphuric acid.

(C) Potassium permanganate solution acidified with sulphuric acid.

(D) Iron(II) sulphate with drops of conc. sulphuric acid.

---

17 Acid (X) was added to three salts (A), (B) and (C):

- For (A): a colourless gas was given off that is partly oxidised to violet fumes.
- For (B): a colourless gas was given off that is partly oxidised to orange fumes.
- For (C): a reddish-brown gas was given off.

Which of the following describes acid (X) and the salts (A), (B) and (C)?
(Sample exam 2026)

(A) Acid (X): dilute hydrochloric , salt (A): CaI_2 , salt (B): $MgBr_2$, salt (C): $Pb(NO_3)_2$

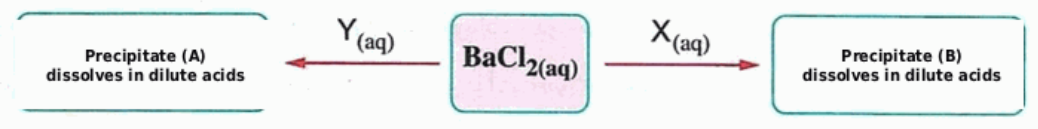
(B) Acid (X): concentrated nitric , salt (A): $NaNO_3$, salt (B): NaI , salt (C): NaBr

(C) Acid (X): concentrated sulphuric , salt (A): NaBr , salt (B): $NaNO_3$, salt (C): NaI

(D) Acid (X): concentrated sulphuric , salt (A): CaI_2 , salt (B): $MgBr_2$, salt (C): $Pb(NO_3)_2$

---

18 From the following chart:
Which of the following is correct?
(Sample exam 2026)



(A) Solution (X): Na_2SO_4 , precipitate (A): $Ba_3(PO_4)_2$

(B) Solution (X): Na_2CO_3 , precipitate (A): $BaSO_4$

(C) Solution (X): Na_2SO_4 , precipitate (A): $BaCO_3$

(D) Solution (X): Na_2CO_3 , precipitate (A): $Ba_3(PO_4)_2$

---

19 Which of the following describes the effect of the gas formed from (the reaction of dilute hydrochloric acid with sodium sulphite)?
(Sample exam 2026)

(A) It turns a paper moistened with acidified potassium dichromate solution green.

(B) It does not decolourise potassium permanganate solution acidified with conc. sulphuric acid.

(C) It blackens a paper moistened with lead(II) acetate solution.

(D) It turns a paper moistened with starch yellow.

---

20 Which of the following reactions produces a precipitate?
(Sample exam 2026)

(A) Hydrogen sulphide gas with lead(II) acetate solution.

(B) Sodium thiosulphate solution with brown iodine solution.

(C) Sulphur dioxide gas with potassium dichromate solution acidified with conc. sulphuric acid.

(D) Sodium nitrite solution with potassium permanganate solution acidified with conc. sulphuric acid.

---

21 When hot conc. sulphuric acid reacts with salt (X), a gas is given off that the acid hardly oxidises, and when the same acid reacts with salt (Y), a gas is given off that is partly oxidised. Salts (X) and (Y) are .....
(Sample exam 2026)

(A) Salt (X): sodium chloride , salt (Y): sodium iodide

(B) Salt (X): sodium bromide , salt (Y): sodium iodide

(C) Salt (X): sodium nitrate , salt (Y): sodium carbonate

(D) Salt (X): sodium chloride , salt (Y): sodium sulphate

---

22 When barium chloride solution is added to a solution of salt (X), a white precipitate forms that dissolves in dilute acids, and when lead(II) acetate solution is added to a solution of salt (Y), a white precipitate forms.

Which of the following describes the anions of salts (X) and (Y)?

(Sample exam 2026)

(A) Anion of salt (X): phosphate , anion of salt (Y): sulphate

(B) Anion of salt (X): phosphate , anion of salt (Y): sulphide

(C) Anion of salt (X): sulphate , anion of salt (Y): phosphate

(D) Anion of salt (X): chloride , anion of salt (Y): sulphate

---

23 Which pair of the following salts can be distinguished using hydrochloric acid?

(Sample exam 2026)

(A) Na_2SO_3 , Na_3PO_4

(B) NaCl , NaBr

(C) NaI , $NaNO_3$

(D) $NaHCO_3$, Na_2CO_3

---

24 Which of the following cannot be used to distinguish between a calcium carbonate precipitate and a silver phosphate precipitate?

(Sample exam 2026)

(A) The different colour of the two precipitates.

(B) Adding water in which carbon dioxide is dissolved.

(C) Adding ammonium hydroxide (NH_4OH) solution.

(D) Adding acidified $KMnO_4$ solution to each of them.

---

25 A mixture of hydrogen sulphide and sulphur dioxide gases is given off from a factory.

Which of the following solutions can be used to get rid of these gases, each separately?

(Sample exam 2026)

(A) Sodium chloride solution, then lead(II) acetate.

(B) Hydrochloric acid, then acidified potassium permanganate.

(C) Lead(II) nitrate solution, then copper sulphate solution.

(D) Lead(II) acetate, then acidified potassium dichromate.

---

26 A solution of salt (X) reacted with each of:

• silver nitrate solution, and a white precipitate formed.

• ammonium carbonate solution, and a white precipitate formed.

Which of the following describes salt (X)?

(Sample exam 2026)

(A) Calcium chloride.
(B) Calcium phosphate.
(C) Sodium chloride.
(D) Lead(II) nitrate.

---

27 Dilute hydrochloric acid was added to three solid salts (A), (B) and (C), each separately:

• For (A): a colourless gas was given off.

• For (B): a gas was given off that is oxidised in air.

• For (C): no reaction took place.

Which describes the anions of these salts?

(1st session 2025)

(A) Anion of salt (A): NO_2^- , anion of salt (B): $S_2O_3^{2-}$, anion of salt (C): SO_3^{2-}
(B) Anion of salt (A): CO_3^{2-} , anion of salt (B): NO_2^- , anion of salt (C): PO_4^{3-}
(C) Anion of salt (A): SO_4^{2-} , anion of salt (B): NO_2^- , anion of salt (C): CO_3^{2-}
(D) Anion of salt (A): CO_3^{2-} , anion of salt (B): SO_3^{2-} , anion of salt (C): PO_4^{3-}

---

28 Dilute nitric acid was added to solid salt (X) and a gas was given off that is oxidised in air, and when sodium sulphate solution was added to a solution of salt (X), a white precipitate formed.

Which of the following choices gives the chemical formula of salt (X)?

(1st session 2025)

(A) $Ca(NO_2)_2$ (B) $Cu(NO_2)_2$ (C) $Pb(HCO_3)_2$ (D) $Fe(SO_3)_3$

---

29 Which of the following does not distinguish between the main reagent of the nitrite ion and the main reagent of the nitrate ion?

(Sample exam 2025)

(A) Sodium chloride.
(B) Sodium iodide.
(C) Sodium thiosulphate.
(D) Barium chloride.

---

30 (X) and (Y) are two magnesium salts of the same acid.

• Salt (X): does not dissolve in water and dissolves in dilute acids.

• Salt (Y): dissolves in water and in dilute acids.

Each of them is placed in a separate test tube containing some water, then carbon dioxide gas is passed through each of them.

Which of the following choices is correct?

(2nd session 2024)

(A) Salt (Y) changes into salt (X).

(B) Salt (X) changes into salt (Y).

(C) The two salts change into the acid they are formed from.

(D) The two salts remain unchanged.

---

31 Which of the following salts gives a gas and a substance sparingly soluble in water when hot conc. sulphuric acid is added to it?

(2nd session 2024)

(A) $BaCl_2$ (B) NaCl (C) $(CH_3COO)_2Mg$ (D) $Cu(NO_3)_2$

---

32 The anion of the salt that is oxidised by oxidising agents and does not form a precipitate with magnesium chloride solution is .....

(2nd session 2024)

(A) nitrate. (B) carbonate. (C) bicarbonate. (D) nitrite.

---

33 When silver nitrate solution is added to solutions of two salts (A) and (B) - each separately - a yellow precipitate forms in each of them.

Which of the following is used to distinguish between the two precipitates formed?

(2nd session 2024)

(A) Barium chloride solution. (B) Sodium hydroxide solution.

(C) Ammonium hydroxide solution. (D) Magnesium sulphate solution.

---

34 Ammonium carbonate solution may be used to identify all of the following cations, except .....

(2nd session 2022)

(A) Ca^{2+} (B) Mg^{2+} (C) Na^{+} (D) Ag^{2+}

---

35 Two chemical compounds (A) and (B): heating compound (A) gives a gas used in reducing iron oxides, and heating compound (B) gives a gas that changes the colour of a paper moistened with potassium dichromate solution acidified with conc. sulphuric acid from orange to green.
Which of the following correctly describes compounds (A) and (B)?
(Trial exam / May 2021)

(A) Compound (A): iron(II) sulphate , compound (B): iron(III) hydroxide

(B) Compound (A): iron(II) carbonate , compound (B): iron(III) chloride

(C) Compound (A): iron(II) oxalate , compound (B): iron(II) sulphate

(D) Compound (A): iron(III) sulphate , compound (B): iron(III) oxide

---

36 In the chemical equation:
$Salt + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + X(g)$
Which of the following statements describes the gas formed (X)?
(2nd session 2022)

(A) It turns a paper moistened with acidified potassium dichromate solution green.

(B) It blackens a paper moistened with lead(II) acetate solution.

(C) It turns a paper moistened with starch solution yellow.

(D) It turns a paper moistened with starch solution blue.

---

37 When solution (X) is added to a solution containing anion (Y), a black precipitate forms, and when solution (X) is added to a solution containing anion (Z), a white precipitate forms that turns black on heating.
Solution (X) and the anions (Y) and (Z) are .....
(1st session 2024)

(A) Solution (X): I_2 , anion (Y): I^- , anion (Z): SO_3^{2-}

(B) Solution (X): $AgNO_3$, anion (Y): SO_3^{2-} , anion (Z): S^{2-}

(C) Solution (X): $AgNO_3$, anion (Y): S^{2-} , anion (Z): SO_3^{2-}

(D) Solution (X): $KMnO_4$, anion (Y): NO_3^- , anion (Z): SO_4^{2-}

---

38 Dilute HCl was added to a solid salt with the chemical formula (A_2X), and a gas was given off that forms a black precipitate with a paper moistened with $B(Y)_2$ solution.

Anion (Y) is .....

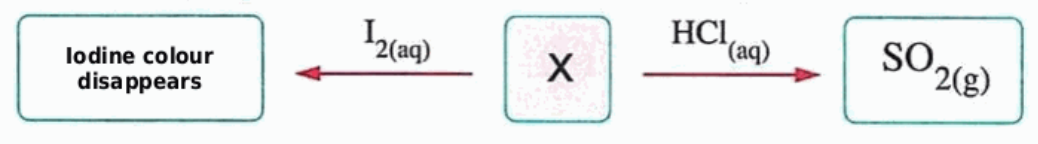
(Trial exam / June 2021)

(A) CH_3COO^- (B) S^{2-} (C) SO_3^{2-} (D) HCO_3^-

39 In the following chart:

Salt (X) is .....

(2nd session 2023)



(A) Na_2SO_4 (B) Na_2SO_3 (C) Na_2S (D) $Na_2S_2O_3$

40 Given that $KMnO_4$ is a strong oxidising agent,

the colour of acidified $KMnO_4$ disappears when it is added to the two solutions .....

(Trial exam / June 2021)

(A) $FeSO_4$, $NaNO_2$ (B) $FeSO_4$, $NaNO_3$

(C) $Fe_2(SO_4)_3$, KNO_2 (D) $Fe_2(SO_4)_3$, $NaNO_3$

41 When silver nitrate solution is added to solutions of salts (A) and (B), a precipitate formed with the solution of salt (A) and no precipitate formed with the solution of salt (B).

The anions of the two salts, respectively, are .....

(1st session 2021)

(A) (A) : sulphide , (B) : nitrite. (B) (A) : nitrite , (B) : sulphide.

(C) (A) : bicarbonate , (B) : nitrite. (D) (A) : nitrite , (B) : bicarbonate.

42 (X) and (Y) are two acids:
acid (X) can be used to detect the anion of acid (Y) in its salts.
The anions of acids (X) and (Y) are .....
(1st session 2024)

(A) Anion of acid (X): chloride , anion of acid (Y): nitrite.
(B) Anion of acid (X): chloride , anion of acid (Y): sulphate.
(C) Anion of acid (X): nitrite , anion of acid (Y): nitrate.
(D) Anion of acid (X): nitrate , anion of acid (Y): sulphate.

---

43 The reagent that can be used to distinguish between HBr gas and HCl gas is .....
(1st session 2024)

(A) hot conc. sulphuric acid.
(B) dilute hydrochloric acid.
(C) a paper moistened with starch.
(D) a moistened litmus paper.

---

44 Which of the following salts gives only one gas when hot conc. sulphuric acid is added to it in its solid state?
(1st session 2024)

(A) $NaNO_3$ (B) NaCl (C) NaBr (D) NaI

---

45 When silver nitrate solution is added to solutions of the two salts (A) and (B), a precipitate (X) forms with the solution of salt (A) that dissolves quickly in conc. ammonia solution, and a precipitate (Y) forms with the solution of salt (B) that dissolves slowly in conc. ammonia solution.
Precipitates (X) and (Y), respectively, are .....
(Trial exam / June 2021)

(A) Precipitate (X): AgCl , precipitate (Y): AgBr
(B) Precipitate (X): AgCl , precipitate (Y): AgI
(C) Precipitate (X): AgBr , precipitate (Y): AgI
(D) Precipitate (X): AgI , precipitate (Y): $BaSO_4$

---

46 When a strong conc. mineral acid is added to the solid salts (X) and (Y) - each separately - a gas is given off with salt (X) whose colour differs from that of the gas given off with salt (Y). Which of the following does not represent these observations?
(2nd session 2021)

(A) (X) : potassium bromide , (Y) : potassium iodide.

(B) (X) : potassium bromide , (Y) : potassium nitrate.

(C) (X) : potassium chloride , (Y) : potassium carbonate.

(D) (X) : potassium iodide , (Y) : potassium nitrate.

---

47 When conc. sulphuric acid is added to two salts, gas (X), which turns a paper moistened with starch solution yellow, is given off with one of them, and gas (Y), which turns a paper moistened with starch solution blue, is given off with the other.
The two gases are .....
(1st session 2021)

(A) Gas (X): $NO_2(g)$, gas (Y): $I_2(v)$

(B) Gas (X): $HBr(g)$, gas (Y): $HI(g)$

(C) Gas (X): $HCl(g)$, gas (Y): $Br_2(v)$

(D) Gas (X): $Br_2(g)$, gas (Y): $I_2(v)$

---

48 When hot conc. H_2SO_4 is added to each of the solid salts (A), (B), (C) and (D) separately, the observations shown in the following table occur:

- Salt (A): a colourless gas that forms white clouds with a rod moistened with NH_4OH
- Salt (B): reddish-orange fumes that turn a paper moistened with starch yellow
- Salt (C): violet fumes that turn a paper moistened with starch blue
- Salt (D): reddish-brown fumes that increase when copper turnings are added

Which is correct?
(2nd session 2022)

(A) (B) : a bromide salt , (C) : a nitrate salt.

(B) (A) : a chloride salt , (D) : an iodide salt.

(C) (D) : a nitrate salt , (C) : a bromide salt.

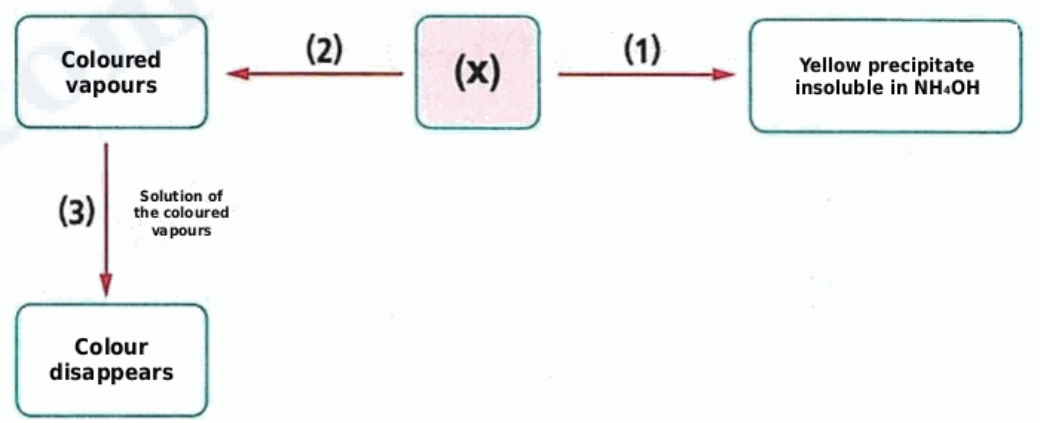
(D) (A) : a chloride salt , (D) : a nitrate salt.

---

49 The following reactions take place under suitable conditions:

Compounds (1), (2) and (3) are .....

(1st session 2023)



(A) Compound (1): $AgNO_3$, compound (2): HCl , compound (3): Na_2SO_3

(B) Compound (1): K_3PO_4 , compound (2): HBr , compound (3): $Na_2S_2O_3$

(C) Compound (1): $AgNO_3$, compound (2): H_2SO_4 , compound (3): $Na_2S_2O_3$

(D) Compound (1): Na_3PO_4 , compound (2): HI , compound (3): Na_2SO_3

---

50 The anion that forms precipitates with both the cations (Ag^+) and (Ba^{2+}) is .....

(2nd session 2021)

(A) Cl^- (B) HCO_3^- (C) NO_3^- (D) PO_4^{3-}

---

51 You have solutions of two salts (A) and (B). When silver nitrate solution was added to each of them separately, it was observed that:

• a white precipitate that turns black on heating formed with the solution of salt (A).

• a white precipitate that dissolves in ammonia solution formed with the solution of salt (B).

The anions of salts (A) and (B) are .....

(2nd session 2022)

(A) Anion of salt (A): Br^- , anion of salt (B): $S_2O_3^{2-}$

(B) Anion of salt (A): SO_3^{2-} , anion of salt (B): Cl^-

(C) Anion of salt (A): SO_3^{2-} , anion of salt (B): Br^-

(D) Anion of salt (A): Cl^- , anion of salt (B): $S_2O_3^{2-}$

---

52 If you have a mixture of $BaSO_4$ and $Ba_3(PO_4)_2$, which of the following is correct?
(Trial exam / June 2021)

(A) They can be separated from each other by adding dilute HCl and filtering.

(B) They can be separated from each other by adding water and filtering.

(C) $BaSO_4$ does not dissolve in water and dissolves in dilute HCl.

(D) $Ba_3(PO_4)_2$ dissolves in water and dissolves in dilute HCl.

---

53 You have the following pairs of salts:
(1) : sodium nitrite and sodium carbonate.
(2) : sodium sulphite and sodium sulphate.
(3) : potassium sulphate and potassium phosphate.
(4) : potassium iodide and copper sulphate.
For which of the previous pairs can dilute hydrochloric acid be used to distinguish between the two salts?
(Trial exam / May 2021)

(A) Pairs (1) , (3) (B) Pairs (1) , (2) (C) Pairs (3) , (4) (D) Pairs (2) , (4)

---

54 Which of the following is used to distinguish between solid sodium sulphide and sodium sulphate?
(1st session 2021)

(A) $AgNO_3(s)$ (B) $Ca(OH)_2(s)$ (C) HCl(aq) (D) NaOH(aq)

---

55 When dilute hydrochloric acid is added to three solid salts (A), (B) and (C) each separately, a gas is given off with (A), a gas is given off and a precipitate forms with (B), and no reaction takes place with (C).
The anions of (A), (B) and (C) are .....
(2nd session 2021)

(A) Anion of salt (A): NO_2^- , anion of salt (B): $S_2O_3^{2-}$, anion of salt (C): SO_4^{2-}

(B) Anion of salt (A): NO_3^- , anion of salt (B): S^{2-} , anion of salt (C): PO_4^{3-}

(C) Anion of salt (A): Cl^- , anion of salt (B): $S_2O_3^{2-}$, anion of salt (C): SO_4^{2-}

(D) Anion of salt (A): CO_3^{2-} , anion of salt (B): NO_3^- , anion of salt (C): PO_4^{3-}

---

56 When $AgNO_3$ solution is added to solutions of the two salts (X) and (Y), a yellow precipitate forms in each of them, and when ammonia solution is added to the precipitates formed, the precipitate disappears with the solution of salt (Y) and stays as it is with the solution of salt (X).

Salts (X) and (Y) are .....

(1st session 2021)

(A) Salt (X): NaI , salt (Y): Na_3PO_4

(B) Salt (X): NaCl , salt (Y): NaBr

(C) Salt (X): $NaNO_3$, salt (Y): Na_2SO_4

(D) Salt (X): $NaNO_2$, salt (Y): $NaNO_3$

---

57 Solution of salt (X) was added to each of three salt solutions (A), (B) and (C) separately, and the following formed:

• a white precipitate that turns black on heating with (A).

• a yellow precipitate that does not dissolve in ammonia solution with (B).

• a yellow precipitate that dissolves in ammonia solution with (C).

The anions of salts (A), (B) and (C) and reagent (X) are .....

(1st session 2022)

(A) Reagent (X): $AgNO_3$, anion (A): SO_3^{2-} , anion (B): PO_4^{3-} , anion (C): I^-

(B) Reagent (X): $KMnO_4$, anion (A): I^- , anion (B): SO_3^{2-} , anion (C): PO_4^{3-}

(C) Reagent (X): $Na_2S_4O_6$, anion (A): PO_4^{3-} , anion (B): Cl^- , anion (C): NO_3^-

(D) Reagent (X): $AgNO_3$, anion (A): SO_3^{2-} , anion (B): I^- , anion (C): PO_4^{3-}

---

58 (A) and (B) are two solutions of potassium salts. Silver nitrate solution was added to each of them, and a yellow precipitate formed in each.

When dilute nitric acid was added to the two precipitates, the precipitate from solution (A) was found to dissolve in the acid, while the precipitate from solution (B) did not dissolve in the acid.

The anions of salts (A) and (B), respectively, are .....

(Trial exam / May 2021)

(A) Anion of salt (A): phosphate , anion of salt (B): iodide

(B) Anion of salt (A): bromide , anion of salt (B): chloride

(C) Anion of salt (A): iodide , anion of salt (B): phosphate

(D) Anion of salt (A): chloride , anion of salt (B): iodide

---

59 When calcium chloride solution is added to solutions of the two salts (X) and (Y) in the cold, the solution of salt (X) forms a white precipitate, while no precipitate forms with the solution of salt (Y).

Salts (X) and (Y) are .....

(1st session 2022)

(A) Salt (X): sodium carbonate , salt (Y): sodium bicarbonate.

(B) Salt (X): sodium nitrite , salt (Y): sodium thiosulphate.

(C) Salt (X): sodium chloride , salt (Y): sodium sulphite.

(D) Salt (X): sodium nitrite , salt (Y): sodium bicarbonate.

---

60 When dilute HCl is added to two salts (A) and (B) - each separately - a colourless, odourless gas is given off with salt (A), and a colourless gas that turns reddish-brown at the mouth of the tube is given off with salt (B).

The anions of salts (A) and (B) are .....

(1st session 2022)

(A) Anion of salt (A): HCO_3^- , anion of salt (B): NO_3^-

(B) Anion of salt (A): SO_3^{2-} , anion of salt (B): NO_3^-

(C) Anion of salt (A): CO_3^{2-} , anion of salt (B): NO_2^-

(D) Anion of salt (A): S^{2-} , anion of salt (B): NO_2^-

---

61 When hot conc. sulphuric acid was added to salts (X), (Y) and (Z), the results were as follows:

- With salt (X): a colourless gas was given off.
- With salt (Y): fumes were given off that turn a paper moistened with starch yellow.
- With salt (Z): no observations appeared.

The anions of salts (X), (Y) and (Z) are .....

(1st session 2022)

(A) Anion of salt (X): CO_3^{2-} , anion of salt (Y): Br^- , anion of salt (Z): I^-

(B) Anion of salt (X): Br^- , anion of salt (Y): Cl^- , anion of salt (Z): PO_4^{3-}

(C) Anion of salt (X): I^- , anion of salt (Y): Br^- , anion of salt (Z): Cl^-

(D) Anion of salt (X): Cl^- , anion of salt (Y): Br^- , anion of salt (Z): SO_4^{2-}

---

62 When dilute hydrochloric acid solution is added to two different salts - each separately - a gas is given off from each of them, and both gases can be oxidised.

The two salts are .....

(Trial exam / March 2023)

(A) $KHCO_3$, $K_2S_2O_3$ (B) KNO_2 , K_2S (C) KNO_2 , K_2CO_3 (D) KNO_2 , K_2SO_3

---

63 Which of the following salts gives a mixture of gases with conc. sulphuric acid?

(1st session 2023)

(A) potassium carbonate.

(B) potassium phosphate.

(C) sodium chloride.

(D) sodium bromide.

Answer key and solutions

Multiple choice questions

1 D	2 C	3 C	4 D	5 C	6 C	7 B	8 C	9 C	10 B
11 C	12 D	13 C	14 C	15 A	16 B	17 C	18 C	19 B	20 D
21 D	22 C	23 A	24 A	25 B	26 B	27 B	28 D	29 D	30 A
31 D	32 D	33 A	34 B	35 C	36 D	37 A	38 C	39 C	40 D
41 C	42 B	43 C	44 B	45 D	46 A	47 C	48 C	49 D	50 B
51 B	52 C	53 C	54 C	55 D	56 C	57 C	58 C	59 C	60 B
61 C	62 B	63 A	64 C	65 B	66 C	67 D	68 B	69 B	70 B
71 B	72 B	73 A	74 D	75 D	76 A	77 D	78 D	79 C	80 A
81 B	82 A	83 C	84 D	85 B	86 D	87 C	88 C	89 A	90 C
91 D	92 B	93 A	94 D	95 C	96 C	97 D	98 B	99 B	100 B
101 A	102 C	103 A	104 A	105 B	106 B	107 D	108 B	109 D	110 A
111 A	112 B								

1 **Answer (D)**

Chemical analysis helps in diagnosing diseases, in judging the suitability of ores and in improving soil.

Determining the suitable conditions for the reaction of iron oxides with acids is not a field of analysis.

2 **Answer (C)**

The reddish-brown precipitate is $Fe(OH)_3$, not FeCl.

Identifying the type of the product is qualitative analysis.

3 **Answer (C)**

Qualitative analysis comes before quantitative analysis: we first identify the components, then determine their amounts.

So statement (C) is the wrong one.

4 **Answer (D)**

Analytical chemistry is linked to physics, biology, geology and mineralogy, all of them.

5 **Answer (C)**

A pure sample has constant melting and boiling points.

So pure Na_2CO_3 can be identified by comparing them with the known values.

6 **Answer (C)**

Qualitative analysis identifies the type of the sample (organic or inorganic), its elements, ions and functional groups.

Determining the concentration is a task of quantitative analysis.

7 **Answer (B)**

Carbonates and bicarbonates agree in their reaction with acids giving off CO_2, and in their reaction with $MgSO_4$.

But they differ in solubility in water: bicarbonates dissolve, while carbonates (other than those of alkali metals) do not.

8 **Answer (C)**

Zinc nitrate with ammonium carbonate gives a white precipitate of zinc carbonate $ZnCO_3$, so turbidity forms.

9 **Answer (C)**

Carbonate gives a precipitate of $MgCO_3$ with Mg^{2+} in the cold, while bicarbonate only precipitates it on heating.

10 **Answer (B)**

$CuCl_2$ with Na_2CO_3 gives a precipitate of $CuCO_3$.

The other pairs give soluble solutions.

11 **Answer (C)**

CO_2 with limewater gives $CaCO_3$, which with excess CO_2 changes into calcium bicarbonate $Ca(HCO_3)_2$.

The HCO_3^- anion is detected with $MgSO_4$ solution: no precipitate forms in the cold, then a precipitate forms on heating.

12 **Answer (D)**

Dilute HCl distinguishes between Na_2S and $NaNO_3$, between Na_2SO_3 and NaBr, and between $NaNO_2$ and Na_2SO_4.

But neither NaI nor Na_3PO_4 reacts with dilute HCl.

13 **Answer (C)**

When the solution is heated, the dissolved $Mg(HCO_3)_2$ changes into insoluble $MgCO_3$.

So the mass of the precipitated substance increases.

14 **Answer (C)**

Magnesium bicarbonate dissolves in water, so no precipitate forms in the cold.

On heating, the HCO_3^- anion with Mg^{2+} changes into a white precipitate of $MgCO_3$.

15 **Answer (A)**

Dilute HI reacts with $NaHCO_3$ only, giving CO_2.

Sulphate and nitrate do not react with the dilute acid.

16 **Answer (B)**

$Mg(HCO_3)_2$ dissolves in water, while $MgCO_3$ does not.

So we distinguish between them by adding water.

17 **Answer (C)**

Fe^{3+} precipitates the carbonate CO_3^{2-} as iron(III) hydroxide or carbonate, giving off CO_2.

The sulphate stays dissolved, so only one of the two anions precipitates.

18 **Answer (C)**

HNO_3 distinguishes between CO_3^{2-} and NO_2^- (CO_2 is colourless and NO_2 is reddish brown), between SO_3^{2-} and $S_2O_3^{2-}$ (yellow sulphur forms with the second), and between S^{2-} and NO_2^-.

But CO_3^{2-} and HCO_3^- both give CO_2, so it does not distinguish between them.

19 **Answer (B)**

CO_3^{2-} gives a precipitate of $BaCO_3$ directly with $BaCl_2$.

HCO_3^- stays dissolved as $Ba(HCO_3)_2$, then gives a precipitate on heating.

20 **Answer (D)**

The white precipitate that dissolves in HNO_3 with effervescence is $PbCO_3$ (CO_2 is given off).

So solution (X) is sodium carbonate.

21 **Answer (D)**

The compound that gives 3 mol of ions per mole: H_2SO_4 ($2H^+ + SO_4^{2-}$) or $Ca(OH)_2$.

It reacts with $(NH_4)_2CO_3$ giving an acidic gas (CO_2), so it is the acid H_2SO_4.

22 **Answer (C)**

On heating: $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

So substance (A) is $NaHCO_3$, (B) is Na_2CO_3, (C) is CO_2 and the precipitate (D) with limewater is $CaCO_3$.

23 **Answer (A)**

Gas (A), which turns limewater milky, is CO_2.

Passing it over hot charcoal reduces it, giving carbon monoxide CO.

24 **Answer (A)**

Dilute HNO_3 with Na_2CO_3 gives effervescence as CO_2 is given off.

It does not react with NaCl.

25 **Answer (B)**

The compound used in making dyes is Cr_2O_3, and the oxidation number of chromium in it is +3.

SO_2 with acidified $K_2Cr_2O_7$ gives $Cr_2(SO_4)_3$, and the oxidation number of chromium in it is +3.

26 **Answer (B)**

In an open beaker CO_2 is given off and leaves the beaker, so the mass decreases.

The mass becomes constant after the reaction ends, at a value lower than the start but not zero.

27 **Answer (B)**

Strongly heated $FeSO_4$ gives red iron(III) oxide Fe_2O_3 (B).

Colourless SO_2 gas is given off, which turns a paper moistened with acidified potassium dichromate green.

28 **Answer (D)**

Strongly heating $FeSO_4$ gives the two sulphur compounds SO_2 and SO_3.

$NaNO_2$ reduces acidified $KMnO_4$, forming K_2SO_4 and $MnSO_4$ (two sulphate salts).

29 **Answer (D)**

The colourless gas given off from the salt with dilute HCl is SO_2 (from sulphite).

White Ag_2SO_3 turns into black silver on heating.

30 **Answer (A)**

SO_2 turns a paper moistened with acidified potassium dichromate green.

CO_2 does not change its colour, so we distinguish between them.

31 **Answer (D)**

The oxidation number of Mn in $KMnO_4$ changes from +7 to +2, so it is reduced, not oxidised.

So statement (D) is wrong, and SO_2 is the reducing agent.

32 **Answer (D)**

The oxidation number of chromium changes from +6 in $Cr_2O_7^{2-}$ to +3 in Cr^{3+} (reduction).

So statement (D) is wrong because it states the opposite.

33 **Answer (A)**

Gas (X) is oxidised, decolourises $KMnO_4$ and has a pungent smell, so it is SO_2.

Gas (Y) is odourless and turns limewater milky, so it is CO_2.

34 **Answer (B)**

The cation X^+ whose configuration ends with $4d^{10}$ is Ag^+.

With S^{2-} it gives black silver sulphide Ag_2S, which is insoluble in water.

35 **Answer (C)**

The bad-smelling gas that gives a black substance with lead acetate is H_2S.

So anion (X) is sulphide S^{2-}.

36 **Answer (D)**

NH_3 with NaOH gives no colour change.

CO_2 turns limewater milky, SO_2 turns dichromate green, and H_2S turns lead acetate black.

37 **Answer (A)**

CO_3^{2-} and HCO_3^- each give CO_2 with the acid.

SO_3^{2-} and $S_2O_3^{2-}$ each give SO_2 (and thiosulphate also gives sulphur).

So both pairs are correct.

38 **Answer (C)**

(X) is H_2S, whose anion S^{2-} is oxidised to sulphur, one of the impurities of iron ores.

H_2S gives a black precipitate of PbS with Pb^{2+}, and S^{2-} gives black Ag_2S.

The oxidation number of S in H_2S equals -2, not $+4$, so statement (C) is wrong.

39 **Answer (C)**

The gas that turns the paper green is SO_2, and the yellow suspension is sulphur.

This is what happens with thiosulphate $S_2O_3^{2-}$.

40 **Answer (D)**

$S_2O_3^{2-} + 2H^+ \rightarrow S + SO_2 + H_2O$

The oxidation number of sulphur changes: it is reduced to sulphur (0) and oxidised to SO_2 $(+4)$.

So oxidation and reduction of sulphur take place.

41 **Answer (C)**

$Na_2S_2O_3$ with iodine: $2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$

Solutions of two different sodium salts form, sodium tetrathionate and sodium iodide, so the reagent is I_2.

42 **Answer (B)**

The yellow suspension (sulphur) appearing after seconds and hiding the mark X shows the thiosulphate anion.

$S_2O_3^{2-} + 2H^+ \rightarrow S + SO_2 + H_2O$, so solution (1) is HCl and solution (2) contains $S_2O_3^{2-}$.

43 **Answer (C)**

In $Ti(NO_2)_3$ the cation Ti^{3+} is oxidised to Ti^{4+} and the nitrite is oxidised to nitrate.

In the other salts only one part is oxidised.

44 **Answer (B)**

NO_2^- is a reducing agent, so it changes the colour of acidified $K_2Cr_2O_7$ from orange to green.

Nitrate, bicarbonate and carbonate do not change its colour.

45 **Answer (D)**

NO_2^- is oxidised to NO_3^-.

The manganese ion in MnO_4^- is reduced from +7 to +2.

46 **Answer (A)**

Strongly heated $FeSO_4$ gives solid Fe_2O_3 and the gases SO_2 and SO_3.

CO reduces Fe_2O_3 to iron and is oxidised to CO_2, which turns limewater milky.

47 **Answer (C)**

(X) is the sulphide Na_2S: with HCl, bad-smelling H_2S is given off.

H_2S with lead acetate gives a black precipitate of PbS (Z).

48 **Answer (C)**

(Y) turns dichromate green, so it is SO_2 and the anion of (W) is sulphite.

(Z) is oxidised in air to reddish-brown NO_2, so it is NO and the anion of (X) is nitrite.

49 **Answer (D)**

The gas that does not affect acidified $KMnO_4$ is not a reducing gas; it is CO_2.

The salts that give CO_2 with dilute HCl are bicarbonate and carbonate.

50 **Answer (B)**

$5NaNO_2 + 2KMnO_4 + 3H_2SO_4 \rightarrow 5NaNO_3 + K_2SO_4 + 2MnSO_4 + 3H_2O$

Every 5 mol of nitrite need 2 mol of $KMnO_4$.

Number of moles = $0.05 \times 2 \div 5 = 0.02$ mol

51 **Answer (B)**

Dilute H_2SO_4 detects: NO_2^- (brown NO_2 fumes), S^{2-} (H_2S), $S_2O_3^{2-}$ (sulphur and SO_2), SO_3^{2-} (SO_2).

Nitrate and iodide are detected with the concentrated acid.

52 **Answer (C)**

Hot conc. H_2SO_4 with KCl gives colourless HCl gas.

With KBr it gives reddish-orange Br_2 vapour.

53 **Answer (C)**

Silver nitrate gives a white precipitate of AgCl with NaCl.

It gives no precipitate with $NaNO_3$.

54 **Answer (C)**

$BaCl_2$ with $AgNO_3$ gives white AgCl.

Na_2S gives black Ag_2S, KI gives yellow AgI, and $Cu(NO_3)_2$ gives no precipitate.

55 **Answer (D)**

$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$, and the AgCl precipitate is not counted among the ions.

Na^+, NO_3^- and the excess Ag^+ remain (because silver nitrate is in excess).

56 **Answer (C)**

Acid (X) is conc. H_2SO_4, the basic reagent for chloride and bromide.

With excess iron filings and heating, $Fe_2(SO_4)_3$ forms, then the excess iron partly reduces it to Fe^{2+}.

So the ions SO_4^{2-}, Fe^{3+} and Fe^{2+} form.

57 **Answer (C)**

$AgNO_3$, $BaCl_2$ and $Ba(NO_3)_2$ dissolve in water.

AgCl is the only salt that does not dissolve.

58 **Answer (C)**

Lead nitrate with Na_2S gives black PbS.

With NaCl it gives white $PbCl_2$, and with Na_2SO_3 it gives white $PbSO_3$.

59 **Answer (C)**

Hot conc. H_2SO_4 oxidises the HBr formed to Br_2 and is reduced to SO_2.

$2NaBr + 2H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + SO_2 + Br_2$

We write the concentrated acid as (l), not (aq).

60 **Answer (B)**

Conc. H_2SO_4 with the salt gives SO_2 gas, which is partly oxidised, and Br_2 vapour (with bromide), which turns starch yellow; SO_2 is affected by dichromate.

The salt formed, Na_2SO_4, does not have its anion detected by HCl, so statement (B) is wrong.

61 **Answer (C)**

AgI stays solid because it does not dissolve in excess concentrated ammonia, while AgCl dissolves in it.

So substance (A) is a yellow precipitate.

62 **Answer (B)**

63 **Answer (A)**

Hot conc. H_2SO_4 oxidises the HBr formed to Br_2 and is itself reduced to SO_2.

So it acts as an oxidising agent.

64 **Answer (C)**

NaCl + KI with $AgNO_3$ give white AgCl and yellow AgI.

Excess concentrated ammonia dissolves AgCl only, so yellow AgI remains.

65 **Answer (B)**

The precipitate that does not dissolve in ammonia is AgI, so the salt is an iodide.

With hot conc. H_2SO_4, SO_2 and iodine vapour I_2 are given off.

66 **Answer (C)**

SO_3 gas with water gives H_2SO_4 (X).

Conc. H_2SO_4 with HI gas (Y) gives violet iodine vapour I_2, and its solution detects thiosulphate.

67 **Answer (D)**

The precipitate with silver nitrate that does not dissolve in ammonia shows iodide (AgI).

The violet fumes with conc. H_2SO_4 show iodine I_2, so the compound is sodium iodide.

68 **Answer (B)**

Fe^{3+} is reduced to Fe^{2+}, and I^- is oxidised to brown I_2.

So oxidation of I^- ions takes place.

69 **Answer (B)**

When KI is oxidised by acidified $KMnO_4$, the violet colour changes to brown (iodine).

When dichromate is reduced by SO_2, its colour changes from orange to green (Cr^{3+}).

70 **Answer (B)**

Fe^{3+} ($3d^5$) is reduced to Fe^{2+} ($3d^6$), so the magnetic moment decreases.

Iodide is oxidised to iodine, not reduced, so statement (B) is wrong.

$FeSO_4$ is affected by $KMnO_4$, and iodine is used to detect thiosulphate.

71 **Answer (B)**

Fe^{3+} has five unpaired electrons ($3d^5$).

Fe^{2+} has four unpaired electrons ($3d^6$).

So the number of unpaired electrons decreases, and the brown colour of iodine remains.

72 **Answer (B)**

(A) silver nitrate gives a yellow precipitate of AgI (B) with KI.

With Na_2CO_3 it gives Ag_2CO_3 (C).

73 **Answer (A)**

The gas that turns limewater milky is CO_2, so the mixture contains CO_3^{2-}.

The yellow precipitate with silver nitrate is AgI, so the mixture contains I^-.

74 **Answer (D)**

AgI dissolves neither in water nor in ammonia.

AgCl dissolves in ammonia, and AgBr dissolves in concentrated ammonia.

75 **Answer (D)**

AgCl is white, AgBr is yellowish white and AgI is yellow, so the colour differs.

AgI does not dissolve in ammonia, so solubility in it is not shared.

And all of them are sparingly soluble in water.

76 **Answer (A)**

Solution (X) oxidises I^- to brown I_2, so it is an oxidising agent.

It decolourises $KMnO_4$, reducing it, so it is also a reducing agent (like H_2O_2 or nitrite).

77 **Answer (D)**

With hot conc. H_2SO_4, reddish-orange Br_2 is given off from bromide, violet I_2 from iodide, and reddish-brown NO_2 from nitrate.

Chloride gives colourless HCl gas, not white.

78 **Answer (D)**

The sodium salt with hot conc. H_2SO_4 gives HNO_3 (X) from the nitrate.

Conc. HNO_3 with copper gives reddish-brown NO_2 gas.

Iron becomes passive with conc. HNO_3.

79 **Answer (C)**

Experiment (1): copper with hot conc. HNO_3 gives reddish-brown NO_2 (a coloured gas).

Experiment (2): scandium carbonate with HCl gives colourless CO_2.

80 **Answer (A)**

Salt (X) with NaOH and heating gives gas (Y), which is ammonia (Haber–Bosch method), so it is an ammonium salt.

It gives the brown ring compound, so the anion is nitrate: the salt is NH_4NO_3.

81 **Answer (B)**

Fe + dilute $H_2SO_4 \rightarrow FeSO_4$ (X)

$FeSO_4$ with NO gas forms a brown compound, $[Fe(NO)]SO_4$ (the brown ring compound).

82 **Answer (A)**

In the brown ring test, Fe^{2+} reduces the nitrogen of nitrate $(+5)$ to NO $(+2)$.

Then NO combines with Fe^{2+} forming the brown ring.

83 **Answer (C)**

Strongly heated $FeCO_3$ gives FeO and CO_2 gas only.

HNO_3 decomposes to NO_2 and O_2, $FeSO_4$ gives SO_2 and SO_3, and HI with H_2SO_4 gives several products.

84 **Answer (D)**

Hot conc. H_2SO_4 with NaI gives HI, which can be oxidised to I_2.

With $NaNO_3$ it gives HNO_3, an oxidising agent that is hard to oxidise.

85 **Answer (B)**

(X) contains nitrate because it gives a brown ring (brown substance) with Fe^{2+}/H^+.

It gives a precipitate with S^{2-}, so it is a metal nitrate such as $Pb(NO_3)_2$.

86 **Answer (D)**

$Pb(NO_3)_2$ with hot conc. H_2SO_4 gives off NO_2, and insoluble white $PbSO_4$ forms.

$MgSO_4$, Na_2SO_4 and $CaSO_4$ do not give a precipitate in the same way, and Na_2CO_3 gives CO_2, not NO_2.

87 **Answer (C)**

$BaCl_2$, NH_4OH and $MgSO_4$ dissolve in water.

$CaCO_3$, $BaSO_4$ and $Mg(OH)_2$ do not dissolve.

88 **Answer (C)**

$BaCl_2$ with conc. H_2SO_4 gives a white precipitate of $BaSO_4$.

With $AgNO_3$ it gives a white precipitate of AgCl.

89 **Answer (A)**

$BaCO_3$ and $Ba_3(PO_4)_2$ both do not dissolve in water and dissolve in HCl.

90 **Answer (C)**

Nitrate always forms soluble salts.

SO_4^{2-}, Cl^- and SO_3^{2-} form some insoluble salts such as $BaSO_4$, AgCl and $BaSO_3$.

91 **Answer (D)**

Sulphide and sulphite react with acids, and nitrate reacts with conc. H_2SO_4.

Phosphate reacts neither with dilute HNO_3 nor with conc. H_2SO_4.

92 **Answer (B)**

NO_3^- and NH_4^+ both form soluble salts, so neither can be separated as a precipitate.

CO_3^{2-}, PO_4^{3-}, SO_4^{2-} and SO_3^{2-} are precipitated by suitable cations.

93 **Answer (A)**

Ag^+ and Ba^{2+} give a white or yellow precipitate with phosphate and sulphate.

Bicarbonate and nitrate form soluble salts, and $BaCl_2$ dissolves.

94 **Answer (D)**

Heating barium nitrate gives BaO and the gases NO_2 and O_2.

BaO dissolves in HCl forming $BaCl_2$, which gives a white precipitate of $BaSO_4$ with dilute H_2SO_4.

95 **Answer (C)**

AgCl is white, does not dissolve in water and dissolves in concentrated ammonia.

AgI is yellow and does not dissolve in ammonia, Ag_3PO_4 is yellow, and $CuSO_4$ dissolves in water.

96 **Answer (C)**

H_2SO_4 gives $PbSO_4$ with lead nitrate, $AgNO_3$ gives AgCl with chloride, and H_2S gives black PbS.

$KHCO_3$ gives no precipitate with either solution in the cold, so it does not distinguish between them.

97 **Answer (D)**

Ba^{2+} with SO_4^{2-} gives white $BaSO_4$, which does not dissolve in acids (even dilute HCl).

98 **Answer (B)**

$AgNO_3$ gives a yellow precipitate with phosphate, a white precipitate with sulphite and a yellowish-white one with bromide.

With iodide it gives a yellow precipitate, not a white one.

99 **Answer (B)**

$MgSO_4$ gives an insoluble precipitate of $PbSO_4$ with Pb^{2+}, so it is removed from the water.

100 **Answer (B)**

Ba^{2+} precipitates SO_4^{2-} as $BaSO_4$ and does not precipitate Cl^- because $BaCl_2$ is soluble.

101 **Answer (A)**

$Ba(NO_3)_2$ with $FeSO_4$ gives white $BaSO_4$.

The other reactions give soluble salts ($Fe(NO_3)_2$, $BaCl_2$, $Mg(NO_3)_2$ and $MgSO_4$).

So only one precipitate forms.

102 **Answer (C)**

Br^- gives reddish-orange Br_2 and NO_3^- gives reddish-brown NO_2 with hot conc. H_2SO_4.

Phosphate does not react.

103 **Answer (A)**

Dilute HCl precipitates Ag^+ as AgCl (X).

After filtering, H_2SO_4 precipitates the Ba^{2+} ions as $BaSO_4$ (Y).

104 **Answer (A)**

The compound that gives a precipitate with H_2SO_4 after dissolving is $Ba(NO_3)_2$ (the soluble one).

$BaSO_4$ stays as a precipitate because it does not dissolve in water.

105 **Answer (B)**

$2Na_3PO_4 + 3Ca(NO_3)_2 \rightarrow Ca_3(PO_4)_2 + 6NaNO_3$

Sum of the coefficients = 2 + 3 + 1 + 6 = 12 , and the coefficient of the precipitate = 1

106 **Answer (B)**

(A) are cations such as Ca^{2+} or Ba^{2+}: their precipitate with phosphate is white and dissolves in HCl (B).

(C) is Ag^+: its chloride is white and dissolves in ammonia, and its precipitate with phosphate, Ag_3PO_4, is yellow and dissolves in HNO_3 (D).

107 **Answer (D)**

$AgNO_3$ with phosphate and chloride gives yellow Ag_3PO_4 and white AgCl, so the mass of the precipitate increases.

Excess concentrated ammonia dissolves both Ag_3PO_4 and AgCl, so the mass falls to zero.

108 **Answer (B)**

Barium phosphate does not dissolve and barium nitrate dissolves.

We dissolve the mixture in water, then filter to separate the precipitate, then evaporate the filtrate to get barium nitrate.

109 **Answer (D)**

(X) with $BaCl_2$ gives a white precipitate that dissolves in concentrated ammonia (AgCl), so it contains Ag^+.

With KI it gives a yellow precipitate (AgI) and with Na_2S a black precipitate (Ag_2S), so it is $AgNO_3$.

110 **Answer (A)**

With excess $BaCl_2$: SO_4^{2-} gives $BaSO_4$ at once, while HCO_3^- stays dissolved.

On heating, the dissolved $Ba(HCO_3)_2$ changes into white $BaCO_3$.

111 **Answer (A)**

Solution (X) gives a white precipitate with $AgNO_3$ (chloride) and a white precipitate with $Ba(NO_3)_2$ (sulphate).

KI gives a yellow precipitate with $AgNO_3$, so the salts $CuSO_4$ and KI do not agree with the chart.

112 **Answer (B)**

Substance (A) is a black solid that dissolves in acid (B) forming solution (C).

Solution (C) with $AgNO_3$ gives precipitate (D), so the acid is HCl and the precipitate is white AgCl, which turns violet in light.

Essay questions

1 **Model answer**

Compound (X): iron(III) oxide , gas (Y): CO_2

(1) • $Fe_2O_3 + 3CO \longrightarrow (> 700°C)\ 2Fe + 3CO_2$

(2) CO_2 gas is detected by passing it for a short time through clear limewater (calcium hydroxide); it turns milky because calcium carbonate forms, which does not dissolve in water.

2 **Model answer**

The yellowish-grey iron ore is siderite ore $FeCO_3$.

(1) • $FeCO_3 \longrightarrow (\Delta, \text{absence of air}) FeO + CO_2$

• $FeO + 2HCl \longrightarrow (\text{dil}) FeCl_2 + H_2O$

(2) When HCl acid is added to iron(II) carbonate, CO_2 gas is given off, which turns clear limewater milky.

$CO_2 + Ca(OH)_2 \longrightarrow (S.T) CaCO_3 + H_2O$

3 **Model answer**

(1) Gas bubbles of CO_2 are given off.

(2) A white precipitate of $BaSO_4$ forms.

4 **Model answer**

(1) CO_2 gas forms, which turns calcium hydroxide solution milky.

(2) SO_2 gas forms, which turns acidified potassium dichromate solution green.

5 **Model answer**

(1) The sulphite anion.

(2) Na^+ , K^+ , NH_4^+

6 **Model answer**

(1) (a) +7

(b) +6

(2) (a) Violet.

(b) Orange.

7 **Model answer**

(1) CO_2 , H_2S only.

(2) CO_2 , HCl only.

8 **Model answer**

Silver nitrate solution forms a yellow precipitate with the phosphate PO_4^{3-} and iodide I^- anions; Ag_3PO_4 dissolves in dilute HNO_3 acid while AgI does not.

(1) $K_3PO_4 + 3AgNO_3 \longrightarrow 3KNO_3 + Ag_3PO_4$

(2) • $2KI + H_2SO_4 \longrightarrow (\text{conc}, \Delta) K_2SO_4 + 2HI$

• $2HI + H_2SO_4 \longrightarrow (\text{conc}) 2H_2O + SO_2 + I_2$

9 **Model answer**

- Gas (X): CO_2 , gas (Y): SO_2
- The anions (1) and (2): CO_3^{2-} , HCO_3^-
- The anions (3) and (4): SO_3^{2-} , $S_2O_3^{2-}$

10 **Model answer**

Barium chloride is used to detect the SO_4^{2-} and PO_4^{3-} anions; it forms with:

- sodium phosphate a white precipitate of barium phosphate, which dissolves in dilute hydrochloric acid.
- sodium sulphate a white precipitate of barium sulphate $BaSO_4$, which does not dissolve in dilute hydrochloric acid.
- The first precipitate: $Ba_3(PO_4)_2$
- The second precipitate: $BaSO_4$

11 **Model answer**

When the mouth of bottle (A) (conc. hydrochloric acid) is brought close to the mouth of bottle (B) (concentrated ammonia solution), the hydrogen chloride gas given off from (A) combines with the ammonia gas given off from (B) forming white clouds of ammonium chloride.

$NH_3 + HCl \longrightarrow NH_4Cl$

12 **Model answer**

- First observation: gas bubbles are given off.
- Second observation: a yellow precipitate appears as sulphur is suspended in the solution.

Past exam questions

1	2	3	4	5	6	7	8	9	10
B	A	B	B	B	A	D	A	A	A
11	12	13	14	15	16	17	18	19	20
B	A	A	A	B	B	D	D	A	A
21	22	23	24	25	26	27	28	29	30
A	A	A	D	D	A	B	A	C	B
31	32	33	34	35	36	37	38	39	40
A	D	C	C	C	A	C	A	D	A
41	42	43	44	45	46	47	48	49	50
A	A	A	B	A	C	D	D	C	D
51	52	53	54	55	56	57	58	59	60
B	A	B	C	A	A	D	A	A	C

61	62	63
D	D	D

1 **Answer (B)**

(X) dissolves in water and in acid; it is the bicarbonate $Ca(HCO_3)_2$. (Y) does not dissolve in water but dissolves in acid; it is the carbonate $CaCO_3$.

Gas (Z) is CO_2, and when salt (X) is heated, CO_2 is given off and salt (Y) forms.

2 **Answer (A)**

(X) gives a colourless gas that is easily oxidised; it is NO from nitrite.

(Y) gives a white precipitate with HCl; it is AgCl from $AgNO_3$.

(Z) gives a gas that blackens lead acetate paper; it is H_2S from Na_2S.

3 **Answer (B)**

(A) a colourless gas that is hard to oxidise is HCl, so the salt is the chloride $CaCl_2$.

(B) coloured fumes (iodine I_2) whose solution detects thiosulphate, so the salt is the iodide MgI_2.

(C) no gas is given off with the phosphate Ag_3PO_4.

4 **Answer (B)**

(X) the fumes that turn starch blue are I_2, so the salt is an iodide, and with $AgNO_3$ it gives yellow AgI that does not dissolve in ammonia.

(Y) the white precipitate with $BaCl_2$ that dissolves in dilute HCl is the phosphate, and with $AgNO_3$ it gives yellow Ag_3PO_4 that dissolves in ammonia.

5 **Answer (B)**

Na_2X gives off a gas with HCl and gives Ag_2X; this fits sulphite SO_3^{2-}, which gives off SO_2 and forms white Ag_2SO_3.

Iodide and bromide give off no gas with dilute HCl, and AgI is yellow, not black.

6 **Answer (A)**

7 **Answer (D)**

$BaCl_2$ gives a precipitate of $BaSO_4$ with magnesium sulphate.

Hot conc. H_2SO_4 gives HCl with magnesium chloride only.

Calcium bicarbonate gives a precipitate with the sulphate ($CaSO_4$) but not with the chloride.

Dilute HCl reacts with neither of them, so it does not distinguish between them.

8 **Answer (A)**

(X) gives a colourless gas, HCl, so it is sodium chloride.

(Y) gives iodine vapour I_2, which turns starch blue, so it is sodium iodide.

9 **Answer (A)**

The confirmatory reagent acidified $KMnO_4$ is violet and its colour disappears when it is reduced. Nitrite NO_2^- is oxidised to NO_3^- and the colour of the reagent disappears.

10 **Answer (A)**

(X) a gas that does not affect acidified $KMnO_4$ is CO_2, from silver bicarbonate.

(Y) a suspension (sulphur) and SO_2 gas that affects $KMnO_4$, so it is the thiosulphate.

(Z) does not react with HCl; it is sodium nitrate.

11 **Answer (B)**

(X) gives a precipitate with $Ca(OH)_2$; it is the carbonate $(NH_4)_2CO_3$.

(Y) gives no precipitate; it is the bicarbonate $KHCO_3$.

(Z) decolourises iodine; it is the thiosulphate $Na_2S_2O_3$.

(W) gives a black precipitate with lead; it is the sulphide Na_2S.

12 **Answer (A)**

NO changes in air into brown NO_2, while HCl does not change.

HCl gives white clouds with a rod moistened with ammonia, and NO decolourises acidified $KMnO_4$.

Sodium chloride solution does not distinguish between the two gases.

13 **Answer (A)**

(1) Orange Br_2 is given off when HBr reacts with hot conc. H_2SO_4.

(2) White clouds with ammonia are HCl.

(3) The acid that gives a precipitate with $Ba(NO_3)_2$ is neither nitric nor hydrochloric, so it is phosphoric.

14 **Answer (A)**

$MgSO_4$ with $KHCO_3$ does not give a sparingly soluble product.

HCl with thiosulphate gives sulphur, silver nitrate with sulphite gives Ag_2SO_3, and CO_2 with limewater for a short time gives $CaCO_3$.

15 **Answer (B)**

SO_3^{2-} with HCl gives pungent SO_2, which is oxidised and turns acidified potassium dichromate green.

H_2S has a bad smell, and CO_2 is not oxidised.

16 **Answer (B)**

Nitrate and nitrite both give reddish-brown NO_2 with hot conc. H_2SO_4, so it does not distinguish between them.

Dilute HCl, acidified $KMnO_4$ and $FeSO_4$ do distinguish between them.

17 **Answer (D)**

Hot conc. H_2SO_4 with HI gives violet I_2, with HBr gives orange Br_2, and with nitrate gives reddish-brown NO_2.

So the salts CaI_2, $MgBr_2$ and $Pb(NO_3)_2$ are (A), (B) and (C).

18 **Answer (D)**

$BaCl_2$ with carbonate and phosphate gives two white precipitates that dissolve in dilute acids.

Sulphate gives $BaSO_4$, which does not dissolve in acids, so solution (X) is Na_2CO_3 and precipitate (A) is $Ba_3(PO_4)_2$.

19 **Answer (A)**

The SO_2 formed from the reaction of HCl with sulphite turns a paper moistened with acidified potassium dichromate green.

It is a reducing agent, so it decolourises acidified $KMnO_4$, and it does not blacken lead acetate.

20 **Answer (A)**

H_2S with lead(II) acetate gives a black precipitate of PbS.

The other reactions only change the colour of the solution, and no precipitate forms.

21 **Answer (A)**

(X) a gas that the acid hardly oxidises is HCl, from sodium chloride.

(Y) a gas that is partly oxidised is HI, from sodium iodide (it gives I_2).

22 **Answer (A)**

(X) a white precipitate with $BaCl_2$ that dissolves in dilute acids, so it is phosphate or carbonate.

(Y) a white precipitate with lead(II) acetate is $PbSO_4$, so the anion is sulphate.

23 **Answer (A)**

Dilute HCl with Na_2SO_3 gives SO_2, and it does not react with Na_3PO_4, so it distinguishes between them.

The other pairs do not react with dilute HCl or give the same gas (CO_2).

24 **Answer (D)**

The two precipitates have different colours (white and yellow), water containing dissolved CO_2 dissolves $CaCO_3$, and ammonia dissolves Ag_3PO_4.

Acidified $KMnO_4$ reacts with neither of them, so it does not distinguish between them.

25 **Answer (D)**

H_2S is removed by lead(II) acetate, as black PbS precipitates.

SO_2 is removed by acidified potassium dichromate, which it reduces to Cr^{3+}, so this order is correct.

26 **Answer (A)**

A white precipitate with $AgNO_3$ shows chloride.

A white precipitate with $(NH_4)_2CO_3$ shows Ca^{2+}, so the salt is calcium chloride.

27 **Answer (B)**

(A) a colourless gas, CO_2, from carbonate.

(B) a gas that is oxidised in air, NO, from nitrite.

(C) no reaction takes place with phosphate.

28 **Answer (A)**

The gas that is oxidised in air is NO, so the anion is nitrite.

The white precipitate with Na_2SO_4 is $CaSO_4$, so the cation is Ca^{2+} and the salt is $Ca(NO_2)_2$.

29 **Answer (C)**

30 **Answer (B)**

(X) is $MgCO_3$, which does not dissolve in water, and (Y) is the soluble $Mg(HCO_3)_2$.

CO_2 in water changes $MgCO_3$ into $Mg(HCO_3)_2$, so (X) changes into (Y).

31 **Answer (A)**

$BaCl_2$ with hot conc. H_2SO_4 gives HCl gas and a precipitate of sparingly soluble $BaSO_4$.

NaCl gives the gas only, and copper nitrate gives NO_2 but no precipitate.

32 **Answer (D)**

Nitrite is oxidised by oxidising agents, and NO_2^- gives no precipitate with magnesium chloride.
Carbonate gives a precipitate, and nitrate and bicarbonate are not oxidised.

33 **Answer (C)**

$AgNO_3$ gives two yellow precipitates, AgI and Ag_3PO_4.
Concentrated ammonia dissolves Ag_3PO_4 and does not dissolve AgI, so it distinguishes between them.

34 **Answer (C)**

$(NH_4)_2CO_3$ gives a white carbonate precipitate with Ca^{2+}, Mg^{2+} and Ag^+.
The carbonate of Na^+ is soluble, so it cannot be identified with this reagent.

35 **Answer (C)**

(A) gives CO gas on heating, which reduces iron oxides; it is iron(II) oxalate.
(B) gives SO_2 on heating, which turns dichromate green; it is $FeSO_4$.

36 **Answer (A)**

$Na_2SO_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2$
SO_2 gas turns a paper moistened with acidified potassium dichromate green.

37 **Answer (C)**

$AgNO_3$ with S^{2-} gives black Ag_2S.
$AgNO_3$ with SO_3^{2-} gives white Ag_2SO_3, which turns black on heating.

38 **Answer (A)**

The black precipitate is PbS from H_2S with a lead salt, so the test paper is moistened with lead(II) acetate $(CH_3COO)_2Pb$.
So anion (Y) is acetate CH_3COO^-.

39 **Answer (D)**

40 **Answer (A)**

The colour of acidified $KMnO_4$ disappears with reducing substances such as Fe^{2+} and NO_2^-.
Fe^{3+} and nitrate are oxidising agents, so they do not remove the colour.

41 **Answer (A)**

(A) sulphide gives black Ag_2S with $AgNO_3$.

(B) nitrite gives soluble $AgNO_2$, so no precipitate forms.

42 **Answer (A)**

Dilute HCl detects nitrite as reddish-brown NO_2 is given off.

So acid (X) is hydrochloric acid and acid (Y) contains the nitrite anion.

43 **Answer (A)**

Hot conc. H_2SO_4 oxidises HBr to orange Br_2 and does not oxidise HCl,

so it distinguishes between the two gases.

44 **Answer (B)**

NaCl with conc. H_2SO_4 gives HCl gas only.

The other salts give several gases, such as Br_2 and SO_2, or I_2 and H_2S, or NO_2.

45 **Answer (A)**

AgCl dissolves quickly in conc. ammonia.

AgBr dissolves slowly, and AgI does not dissolve.

46 **Answer (C)**

KCl and K_2CO_3 give HCl and CO_2, which are both colourless, so the gases do not differ in colour.

The other pairs give different coloured gases (Br_2, I_2 and NO_2).

47 **Answer (D)**

Br_2 turns starch yellow, while I_2 turns it blue,

so gas (X) is Br_2 and gas (Y) is I_2.

48 **Answer (D)**

(A) a colourless gas that gives white clouds with ammonia is HCl, so the salt is a chloride.

(B) Br_2 is reddish-orange, (C) I_2 is violet, (D) NO_2 is reddish-brown and increases with copper, so the salt is a nitrate.

49 **Answer (C)**

(1) $AgNO_3$ gives with (X) a yellow precipitate that does not dissolve in ammonia, AgI, so the salt is an iodide.

(2) Conc. H_2SO_4 gives coloured iodine vapour.

(3) The colour of iodine solution disappears with thiosulphate $Na_2S_2O_3$.

50 **Answer (D)**

Ag^+ and Ba^{2+} give a precipitate with phosphate PO_4^{3-} (Ag_3PO_4 and $Ba_3(PO_4)_2$).
Cl^-, HCO_3^- and NO_3^- form soluble salts with Ba^{2+}.

51 **Answer (B)**

(A) a white precipitate that turns black on heating is Ag_2SO_3, from sulphite.
(B) a white precipitate that dissolves in ammonia is AgCl, from chloride.

52 **Answer (A)**

Dilute HCl dissolves $Ba_3(PO_4)_2$ and does not dissolve $BaSO_4$,
so we separate them by adding the acid and filtering.

53 **Answer (B)**

(1) Nitrite gives brown NO_2 and carbonate gives colourless CO_2.
(2) Sulphite gives SO_2 and sulphate does not react.
In (3) and (4), none of the salts reacts with dilute HCl.

54 **Answer (C)**

Dilute HCl with Na_2S gives foul-smelling H_2S,
and it does not react with Na_2SO_4.

55 **Answer (A)**

(A) a gas: nitrite gives NO.
(B) a gas and a precipitate: thiosulphate gives SO_2 and sulphur.
(C) no reaction: sulphate.

56 **Answer (A)**

$AgNO_3$ gives a yellow precipitate with iodide (AgI) and with phosphate (Ag_3PO_4).
Ammonia dissolves only Ag_3PO_4, so the iodide is (X) and the phosphate is (Y).

57 **Answer (D)**

Reagent (X) is $AgNO_3$.
(A) a white precipitate that turns black on heating is Ag_2SO_3, from SO_3^{2-}.
(B) a yellow precipitate that does not dissolve in ammonia is AgI, from I^-.
(C) a yellow precipitate that dissolves in ammonia is Ag_3PO_4, from PO_4^{3-}.

58 **Answer (A)**

Yellow Ag_3PO_4 dissolves in dilute HNO_3, and yellow AgI does not dissolve in it, so the anion in (A) is phosphate and in (B) is iodide.

59 **Answer (A)**

$CaCl_2$ with sodium carbonate gives a white precipitate of $CaCO_3$.
Sodium bicarbonate gives soluble $Ca(HCO_3)_2$, so no precipitate forms in the cold.

60 **Answer (C)**

(A) a colourless, odourless gas is CO_2, from carbonate.
(B) a colourless gas that turns reddish-brown at the mouth is NO, from nitrite.

61 **Answer (D)**

(X) a colourless gas, HCl, from chloride.
(Y) Br_2 fumes turn starch yellow, from bromide.
(Z) no observations with sulphate.

62 **Answer (D)**

63 **Answer (D)**

Bromide with hot conc. H_2SO_4 gives a mixture of Br_2, SO_2 and HBr.
Potassium carbonate gives only CO_2, chloride only HCl, and phosphate does not react.