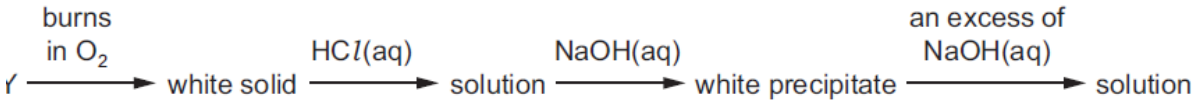
Group 2 – 2021 AS

1. Nov/2021/Paper_11/No.13

An element, Y, reacts according to the following sequence.



What could be element Y?

A Na **B** Mg **C** Al **D** P

2. Nov/2021/Paper_11/No.15

Anhydrous magnesium nitrate, $Mg(NO_3)_2$, decomposes when heated, giving a white solid and a mixture of two gases, X and Y.

Y is oxygen.

What is the ratio $\frac{\text{mass of X released}}{\text{mass of Y released}}$?

A $\frac{1}{0.174}$ **B** $\frac{1}{0.267}$ **C** $\frac{1}{0.348}$ **D** $\frac{1}{3.43}$

3. Nov/2021/Paper_11/No.36

Which statements about calcium oxide are correct?

1 It can be reduced by heating with magnesium.

2 It is produced when calcium nitrate is heated.

3 It reacts with cold water.

4. Nov/2021/Paper_12/No.12

A mixture of two Period 3 oxides are added to water. A solution forms with a pH of just below 7.

What could be the constituents of the mixture?

A Al_2O_3 and MgO

B Na_2O and MgO

C Na_2O and P_4O_{10}

D SO_3 and P_4O_{10}

5. Nov/2021/Paper_12/No.13

Which statement about the compounds of the Group 2 metals is correct?

A Barium carbonate is less thermally stable than strontium carbonate.

B Barium sulfate is less soluble than magnesium sulfate.

C Calcium hydroxide is less soluble than magnesium hydroxide.

D Calcium nitrate is more thermally stable than strontium nitrate.

6. Nov/2021/Paper_12/No.14

A 0.005 mol sample of anhydrous calcium carbonate is completely thermally decomposed to give 100 cm^3 of gas.

In a separate experiment carried out under the same conditions, a 0.005 mol sample of anhydrous calcium nitrate is completely thermally decomposed. The volume of gaseous products is measured.

What total volume of gaseous products is produced from the calcium nitrate?

A 50 cm^3 **B** 100 cm^3 **C** 200 cm^3 **D** 250 cm^3

7. Nov/2021/Paper_12/No.16

Silver chloride and silver iodide form equilibria when added to water.

$$AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq) \qquad K_c = K_1$$

$$AgI(s) \rightleftharpoons Ag^+(aq) + I^-(aq) \qquad K_c = K_2$$

Each equilibrium position lies well to the **left**.

Silver iodide will not dissolve in aqueous ammonia. Silver chloride will dissolve in aqueous ammonia. Another equilibrium is formed.

$$Ag^+(aq) + 2NH_3(aq) \rightleftharpoons Ag(NH_3)_2^+(aq) \qquad K_c = K_3$$

The position of this equilibrium lies to the **right**.

What is the order of magnitude for these three equilibrium constants?

	smallest ⟶		largest
A	K_3	K_2	K_1
B	K_3	K_1	K_2
C	K_2	K_1	K_3
D	K_1	K_2	K_3

8. Nov/2021/Paper_12/No.17

X is the ion of a metal which burns with a red flame.

Y is an ion that reacts with concentrated H_2SO_4 to produce H_2S.

What could be the formula of a compound containing X and Y?

A $BaBr_2$ **B** BaI_2 **C** $SrBr_2$ **D** SrI_2

9. Nov/2021/Paper_12/No.19

Magnesium hydroxide dissolves in aqueous ammonium chloride, but not in aqueous sodium chloride.

Which statement explains this observation?

A The ionic radius of the NH_4^+ ion is similar to that of Mg^{2+} but not that of Na^+.

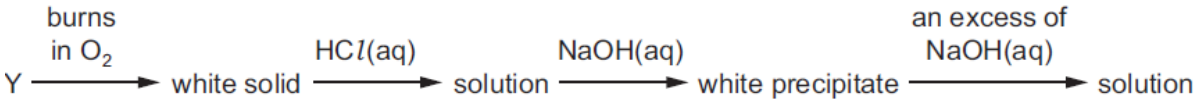
B NH_4Cl dissociates less fully than $NaCl$.

C The Na^+ and Mg^{2+} ions have the same number of electrons.

D The NH_4^+ ion can donate a proton.

10. Nov/2021/Paper_13/No.13

An element, Y, reacts according to the following sequence.



What could be element Y?

A Na **B** Mg **C** Al **D** P

11. Nov/2021/Paper_13/No.14

In which list are all three compounds soluble in water?

A barium chloride, calcium carbonate, magnesium hydroxide

B barium hydroxide, calcium hydroxide, strontium carbonate

C barium chloride, barium hydroxide, magnesium sulfate

D barium sulfate, calcium sulfate, magnesium hydroxide

12. Nov/2021/Paper_13/No.15

Anhydrous magnesium nitrate, $Mg(NO_3)_2$, decomposes when heated, giving a white solid and a mixture of two gases, X and Y.

Y is oxygen.

What is the ratio $\frac{\text{mass of X released}}{\text{mass of Y released}}$?

A $\frac{1}{0.174}$ **B** $\frac{1}{0.267}$ **C** $\frac{1}{0.348}$ **D** $\frac{1}{3.43}$

13. Nov/2021/Paper_13/No.19

The table describes two possible environmental consequences of adding too much ammonium nitrate fertiliser to the soil.

Which row is correct?

	increased plant growth in rivers	photochemical smog
A	✗	✗
B	✓	✗
C	✗	✓
D	✓	✓

14. Nov/2021/Paper_13/No.36

Which statements about calcium oxide are correct?

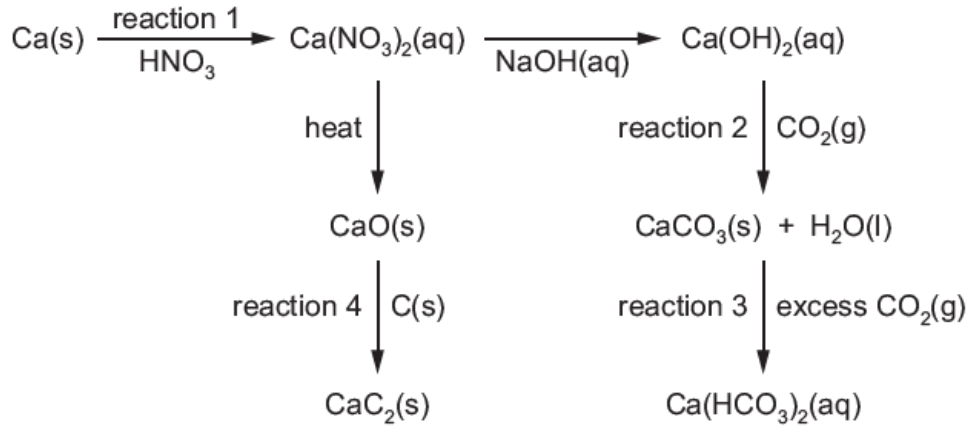
1 It can be reduced by heating with magnesium.

2 It is produced when calcium nitrate is heated.

3 It reacts with cold water.

15. Nov/2021/Paper_21/No.2

The reaction scheme shows some reactions of calcium.



(a) (i) Reaction 1 produces $Ca(NO_3)_2$ and one other product.

Identify the other product.

..... [1]

(ii) Construct an equation for the thermal decomposition of $Ca(NO_3)_2(s)$.

..... [1]

(iii) State the trend in the thermal stability of the Group 2 nitrates down the group.

..... [1]

(iv) In reaction 3, excess CO_2 is bubbled through water containing $CaCO_3$. A solution of $Ca(HCO_3)_2(aq)$ forms.

Construct an equation for reaction 3.

..... [1]

(b) Describe how $Ca(OH)_2$ is used in agriculture.

.....

..... [1]

(c) In reaction 4, calcium carbide, CaC_2, is formed from CaO.

CaC_2 contains the C_2^{2-} anion. Each carbon in C_2^{2-} is sp hybridised.

(i) Describe how sp hybridised orbitals are formed.

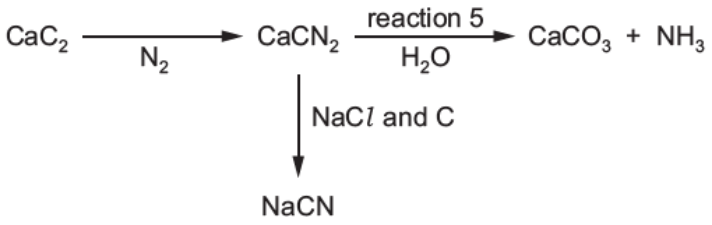
.....

..... [1]

(ii) Sketch a diagram to show how two sp hybrid orbitals can form a sigma (σ) bond.

[2]

(d) The flowchart shows some reactions of CaC_2.



(i) Reaction 5 can be used to prepare NH_3.

$$CaCN_2 + 3H_2O \rightarrow CaCO_3 + 2NH_3$$

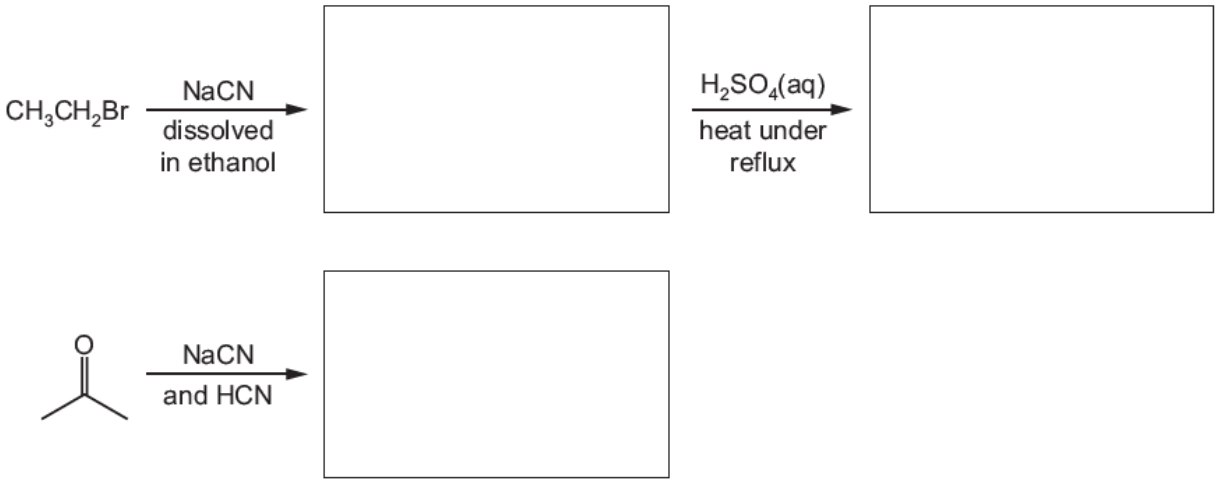
Calculate the minimum mass, in tonnes, of calcium cyanamide, $CaCN_2$, that is required to produce 1.50×10^6 tonnes of NH_3.

Show your working.

1 tonne = 1.00×10^6 g

minimum mass of $CaCN_2$ = ... tonnes
[2]

(ii) Draw the structure of the organic products formed in the following reactions.

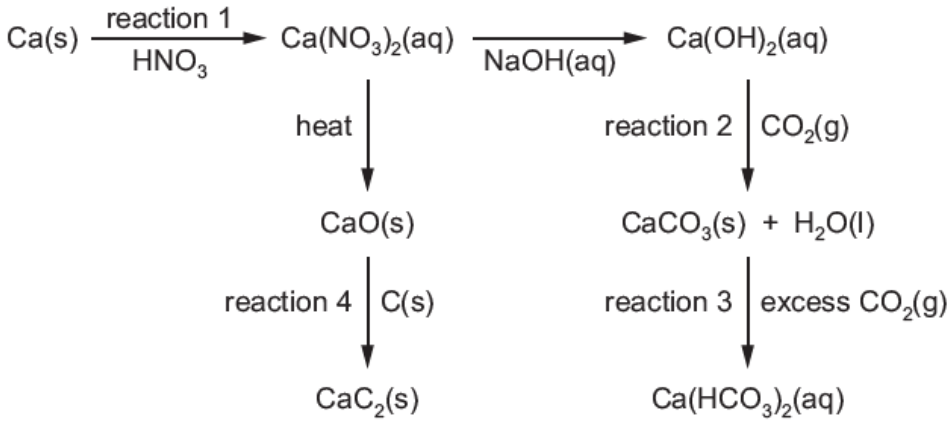


[3]

[Total: 13]

16. Nov/2021/Paper_23/No.2

The reaction scheme shows some reactions of calcium.



(a) (i) Reaction 1 produces $Ca(NO_3)_2$ and one other product.

Identify the other product.

..... [1]

(ii) Construct an equation for the thermal decomposition of $Ca(NO_3)_2(s)$.

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[2]

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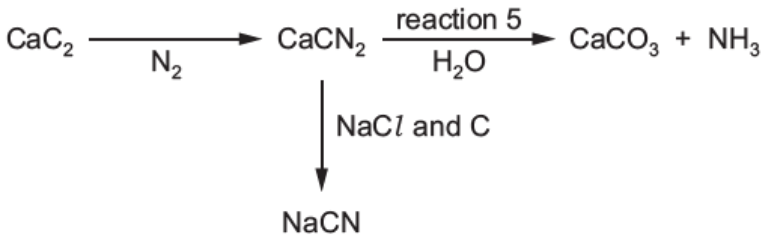

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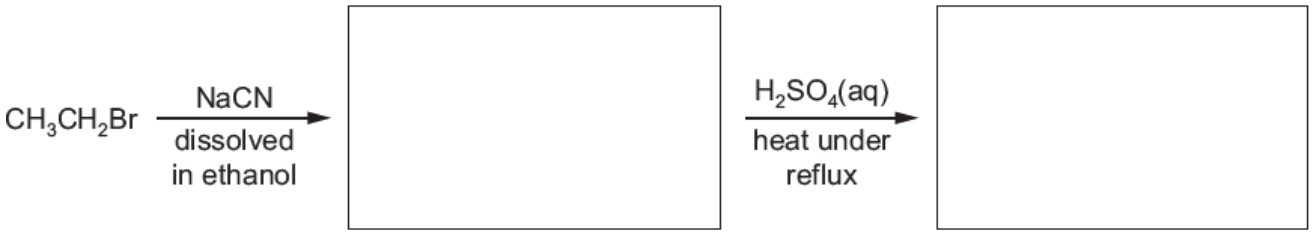

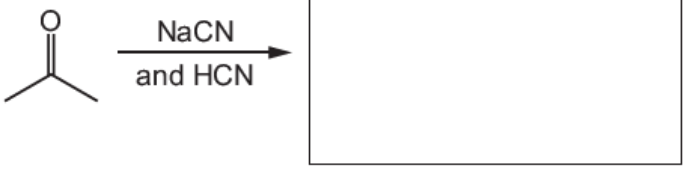

[3]

[Total: 13]

17. March/2021/Paper_12/No.14

Which row correctly describes one property of barium and one property of barium oxide?

	observation when barium metal is added to water	pH of solution obtained when a spatula measure of BaO is added to 100 cm^3 of water
A	a few gas bubbles form on the metal surface	8
B	a few gas bubbles form on the metal surface	13
C	rapid effervescence is seen	8
D	rapid effervescence is seen	13

18. March/2021/Paper_12/No.15

An anhydrous white salt, Z, is heated strongly for 30 minutes. A mixture of gases is given off. The solid remaining in the test-tube is then dissolved in a small volume of dilute hydrochloric acid. The addition of a few drops of dilute sulfuric acid to the test-tube causes a white precipitate to form.

Which substance could be Z?

A barium carbonate

B barium nitrate

C magnesium carbonate

D magnesium nitrate

19. June/2021/Paper_11/No.14

Q is a mixture of a Group 2 oxide and a Group 2 sulfate. Q contains equal amounts of the two compounds.

Q is shaken with water and the resulting mixture filtered; a solid residue is obtained. There is no reaction when the solid residue is shaken with $HCl(aq)$. Shaking the filtrate with $H_2SO_4(aq)$ produces a white precipitate.

What could be Q?

A $BaO + BaSO_4$

B $BaO + MgSO_4$

C $MgO + BaSO_4$

D $MgO + MgSO_4$

20. June/2021/Paper_11/No.15

Which substance will **not** be a product of the thermal decomposition of hydrated magnesium nitrate?

A dinitrogen monoxide

B magnesium oxide

C oxygen

D steam

21. June/2021/Paper_11/No.16

A 5 cm^3 sample of 0.05 mol dm^{-3} sodium chloride is mixed with a 5 cm^3 sample of 0.05 mol dm^{-3} potassium iodide. 10 cm^3 of acidified 0.05 mol dm^{-3} silver nitrate is then added, followed by concentrated ammonia solution.

What is seen after the addition of an excess of concentrated ammonia solution?

A a cream precipitate

B a white precipitate

C a yellow precipitate

D no precipitate

22. June/2021/Paper_11/No.19

R is an oxide of Period 3 element T. 5.00 g of R contains 2.50 g of T.

What is T?

A magnesium

B aluminium

C silicon

D sulfur

23. June/2021/Paper_11/No.36

Which statements are correct?

1 Magnesium carbonate decomposes at a lower temperature than calcium carbonate.

2 Calcium hydroxide is more soluble in water than magnesium hydroxide.

3 Calcium is a stronger reducing agent than magnesium.

24. June/2021/Paper_12/No.15

Z is an anhydrous compound of a Group 2 element. When it is heated, Z undergoes thermal decomposition to produce two different gases. Z has relatively low thermal stability compared to other Group 2 compounds containing the same anion as Z.

What is compound Z?

A barium carbonate

B barium nitrate

C magnesium carbonate

D magnesium nitrate

25. June/2021/Paper_12/No.36

Which reaction routes can be used to make a pure sample of barium sulfate?

1 $Ba \xrightarrow[\text{in } O_2]{\text{heat}} \text{product} \xrightarrow[HCl]{\text{dilute}} \text{product} \xrightarrow[H_2SO_4]{\text{dilute}} \text{product} \xrightarrow[\text{and dry}]{\text{filter, wash}}$

2 $Ba(NO_3)_2 \xrightarrow[\text{heat in air}]{\text{strong}} \text{solid product} \xrightarrow[\text{of water}]{\text{an excess}} \text{product} \xrightarrow[H_2SO_4]{\text{dilute}} \text{product} \xrightarrow[\text{and dry}]{\text{filter, wash}}$

3 $Ba(OH)_2 \xrightarrow[HNO_3]{\text{dilute}} \text{product} \xrightarrow[H_2SO_4]{\text{dilute}} \text{product} \xrightarrow[\text{and dry}]{\text{filter, wash}}$

26. June/2021/Paper_13/No.17

Which statement is correct?

A Doctors can use the very insoluble $MgSO_4$ to investigate the digestive system.

B Farmers can lower the pH of soil by spreading $CaCO_3$ on it.

C Students can test a solution for SO_4^{2-} ions by using $Ba(NO_3)_2(aq)$ followed by $HNO_3(aq)$.

D The insoluble hydroxide, $Ba(OH)_2$, can be safely used to lower the acidity of the stomach.

27. June/2021/Paper_13/No.18

A solid, X, was placed in an excess of the liquid Y.

A colourless gas was given off and a white precipitate was seen. The precipitate was not X.

What could be the identities of X and Y?

	X	Y
A	$BaCO_3$	H_2O
B	Ca	dilute H_2SO_4
C	Mg	dilute H_2SO_4
D	$SrCO_3$	dilute HCl

28. June/2021/Paper_21/No.3

Sodium halide salts react with concentrated sulfuric acid at room temperature.

(a) (i) Write an equation to represent the reaction of NaCl(s) with concentrated sulfuric acid.

..... [1]

(ii) Name this type of reaction.

..... [1]

(b) NaI(s) reacts with concentrated sulfuric acid, at room temperature, to form steamy fumes.

(i) Identify the chemical responsible for the steamy fumes.

..... [1]

(ii) The reaction of NaI(s) with concentrated sulfuric acid continues, forming several other products, including a dark grey solid.

Identify the chemical responsible for the dark grey solid and **one** other product of this further reaction.

dark grey solid .....

other product .....

[2]

(c) Explain the differences in observations, at room temperature, when NaI(s) reacts with concentrated sulfuric acid compared to those for NaCl(s).

.....

.....

..... [2]

(d) Complete the equation for the reaction of Br^- with excess concentrated H_2SO_4 at room temperature.

.....Br^- + ...H^+ + ...H_2SO_4 → .....

[1]

[Total: 8]

29. June/2021/Paper_22/No.1

A Group 2 metal combines with bromine to form a crystalline solid, **M**Br_2.

Excess aqueous $AgNO_3$ is added to a solution of **M**Br_2 and a precipitate forms. The mixture is filtered. The precipitate is dried and the mass of the precipitate is recorded.

(a) State the formula and colour of the precipitate.

..... [2]

(b) Complete the equation to represent the reaction between **M**Br_2 and $AgNO_3$.

.....**M**Br_2 + ...$AgNO_3$ → ..... [1]

(c) A 0.250 g sample of pure **M**Br_2 contains 8.415×10^{-4} mol **M**Br_2.

Calculate the relative formula mass, M_r, of **M**Br_2. Use this to identify **M**.

Show your working.

M_r = ...

M = ...
[3]

(d) A sample of **M**Br_2 is dissolved in water. Chlorine gas is then bubbled into the solution.

(i) Describe the observations for this reaction.

.....

..... [1]

(ii) Name the type of reaction that occurs when **M**Br_2 reacts with chlorine gas.

..... [1]

(e) Compound **Y** is a pure **insoluble** solid which contains halide ions.

A single reagent is added directly to compound **Y** to determine the halide ion present.

Identify the reagent added. State the observation which would confirm that **Y** contains bromide ions.

reagent .....

observation .....

[2]

(f) Separate 1.0 g samples of three different magnesium salts are tested in order to identify the anion present in each sample.

(i) Explain how the action of heat is used to identify which sample is:

- $MgCO_3$
- $Mg(NO_3)_2$
- MgO.

.....

.....

.....

.....

..... [3]

(ii) Complete the electron configuration of the magnesium cation present in these salts.

$1s^2$ ..... [1]

(g) A sample of $MgCO_3(s)$ is distinguished from a sample of $Mg(OH)_2(s)$ by adding a small amount of each solid to $HCl(aq)$.

State **one** similarity and **one** difference in these two reactions.

similarity .....

.....

difference .....

.....

[2]

[Total: 16]