Introducing Chemical Reactions (H)

1. Phosphoric acid contains phosphate ions, PO_4^{3-}.

Phosphoric acid is completely neutralised by sodium hydroxide.

What is the formula of the salt that is made?

A Na_2PO_4
B Na_3PO_4
C $Na(PO_4)_3$
D $Na_2(PO_4)_3$

Your answer ☐ **[1]**

2. Avogadro's constant has a value of 6.02×10^{23}.

What is the number of atoms in 0.5 mol of water?

A 2.00×10^{23}
B 3.01×10^{23}
C 6.02×10^{23}
D 9.03×10^{23}

Your answer ☐ **[1]**

3. Sodium hydroxide reacts with hydrochloric acid. Sodium chloride and water are made.

$NaOH + HCl \rightarrow NaCl + H_2O$

What mass of sodium hydroxide would be needed to make 46.8 g of sodium chloride?

A 16 g
B 32 g
C 50 g
D 64 g

Your answer ☐ **[1]**

4. Which equation shows the formation of a Group 2 metal ion?

M represents a Group 2 metal and e^- represents an electron.

A $M + e^- \rightarrow M^+$
B $M + 2e^- \rightarrow M^{2+}$
C $M \rightarrow M^+ + e^-$
D $M \rightarrow M^{2+} + 2e^-$

Your answer ☐ **[1]**

5. Magnesium reacts with chlorine. Magnesium chloride is made.

What is the balanced symbol equation for this reaction?

A $Mg + Cl \rightarrow MgCl$
B $Mg + Cl_2 \rightarrow MgCl_2$
C $2Mg + Cl_2 \rightarrow 2MgCl$
D $2Mg + Cl_2 \rightarrow Mg_2Cl_2$

Your answer ☐ **[1]**

6. Methane burns in oxygen to form carbon dioxide and water.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Calculate the amount of carbon dioxide made when 6.4 g of methane is burnt.

A 2.8 g
B 4.4 g
C 14.4 g
D 17.6 g

Your answer ☐ **[1]**

7. Avogadro's constant has a value of 6.02×10^{23}.

How many **oxygen atoms** are in 0.25 moles of oxygen molecules?

A 1.204×10^{24}
B 1.505×10^{23}
C 3.010×10^{23}
D 6.020×10^{23}

Your answer ☐ **[1]**

8 (a). A student investigates the reactivity of four metals, **A**, **B**, **C** and **D**.

He adds a small piece of each metal to cold water.

He then adds a small piece of each metal to dilute hydrochloric acid.

Look at his results.

"

Metal	Observations in water	Observations in dilute hydrochloric acid
A	slow bubbling	very fast bubbling
B	no reaction	no reaction
C	fast bubbling	very fast bubbling
D	no change	slow bubbling

The piece of metal **C** used by the student produces 30 cm^3 of hydrogen gas when it reacts with the dilute hydrochloric acid at room temperature and pressure.

i. Calculate the number of **moles** of hydrogen gas produced.

One mole of any gas occupies 24 dm^3 at room temperature and pressure.

Moles of hydrogen gas = ... **[2]**

ii. Use your answer from **(i)** to calculate the **mass** of hydrogen gas produced.

Mass of hydrogen gas = ... g **[1]**

(b). Chromium metal, Cr, reacts with nickel sulfate solution, $NiSO_4$. Solid nickel is made.

Two possible equations for this reaction are:

Equation 1 $Cr + NiSO_4 \rightarrow CrSO_4 + Ni$

Equation 2 $2Cr + 3NiSO_4 \rightarrow Cr_2(SO_4)_3 + 3Ni$

10.40 g of chromium metal reacts with excess nickel sulfate solution to make 17.61 g of nickel.

Deduce which equation, **1** or **2**, represents the reaction which takes place.

A_r: Cr = 52.0, Ni = 58.7

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[3]

9. Sodium is in Group 1 of the Periodic Table.

Sodium reacts with water to make sodium hydroxide, NaOH, and hydrogen.

Write the **balanced symbol** equation for the reaction between sodium and water.

_____ **[2]**

10.

i. Sodium oxide reacts with water.

An aqueous solution of sodium hydroxide is made.

Write the **balanced symbol equation** for this reaction, including **state symbols**.

_____ **[3]**

ii. Sodium hydroxide neutralises acids. It is an alkali.

Which ion do solutions of alkalis contain?

_____ **[1]**

iii. A salt is made when sodium hydroxide neutralises sulfuric acid.

Name this salt.

_____ **[1]**

iv. A sample of hydrochloric acid has a pH of 1.04.

A student adds water to the hydrochloric acid until the pH is 3.04.

The concentration of hydrogen ions decreases.

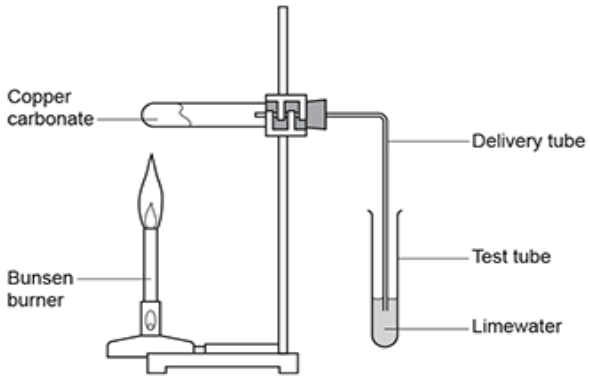
Calculate the factor by which the hydrogen ion concentration has decreased.

Decrease in hydrogen ion concentration = ... **[2]**

11 (a). A student investigates the thermal decomposition of copper carbonate.

copper carbonate → copper oxide + carbon dioxide

Here is the set-up of the apparatus she uses.



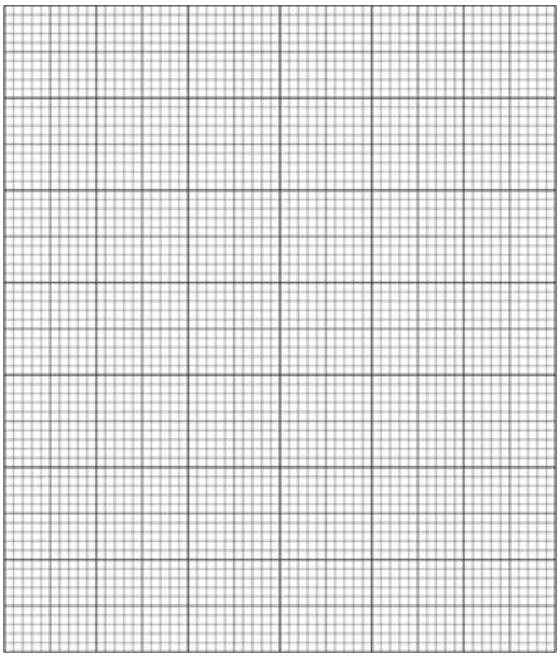
The student measures the mass of copper carbonate at the start of the experiment. She then measures the mass of copper oxide made.

She does the experiment five times using a different mass of copper carbonate each time.

Look at her results.

Mass of copper carbonate (g)	Mass of copper oxide (g)
1.00	0.70
2.00	1.35
3.00	1.95
4.00	2.65
5.00	3.30

i. Plot a graph of the student's results and draw a line of best fit.



[4]

ii. What is the mass of copper carbonate that needs to be heated to produce 2.50 g of copper oxide?

Use your graph in your answer.

Mass of copper carbonate = ... g **[1]**

iii. The mass of copper oxide made in the reaction is less than the mass of the copper carbonate heated.

Suggest why.

---**[1]**

(b). Calcium carbonate thermally decomposes to make calcium oxide and carbon dioxide.

$CaCO_3 \rightarrow CaO + CO_2$

Calculate the mass of calcium carbonate needed to make 209g of calcium oxide.

(A_r: Ca = 40.1, C = 12.0, O = 16.0)

Give your answer to **3** significant figures.

Mass of calcium carbonate = ... g **[4]**

12. After testing some soil samples, a farmer finds that the soil in one of his fields is acidic.

Acidic soil can be neutralised by spreading magnesium carbonate, $MgCO_3$, onto the soil.

The farmer uses 25.0 kg of magnesium carbonate.

Calculate the number of moles of magnesium carbonate the farmer uses.
(A_r: C = 12.0; Mg = 24.3; O = 16.0)

Give your answer to **3** significant figures.

Number of moles of magnesium carbonate = ... **[3]**

13 (a). A student is investigating chemical reactions that produce heat.

She adds zinc to hydrochloric acid, HCl .

Zinc chloride, $ZnCl_2$, and hydrogen gas are made.

i. Write the **balanced symbol** equation for this reaction.

_____ **[2]**

ii. What term is used to describe a reaction that produces heat?

_____ **[1]**

(b). The student draws the reaction profile for this reaction, as shown in **Fig. 18.1**.

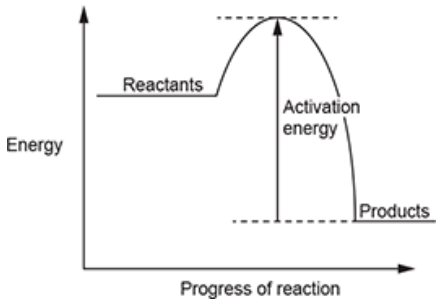


Fig. 18.1

Explain what is meant by the term **activation energy**.

_____

_____ **[1]**

14. In the Haber process nitrogen gas, N_2, reacts with hydrogen gas.

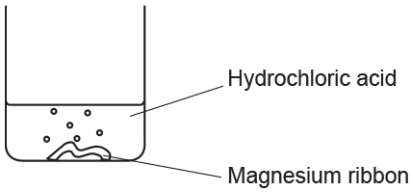
Ammonia, NH_3, is made. The reaction is a reversible reaction.

Write the **balanced symbol** equation for the reaction.

_____ **[2]**

15. A student investigates the reaction between magnesium and dilute hydrochloric acid, HC*l*.

The student adds magnesium ribbon to hydrochloric acid in a beaker, as shown in the diagram.



Write the **balanced symbol** equation for this reaction.

[2]

16.

i. Solid lead reacts with nitric acid, HNO_3.

Lead nitrate, $Pb(NO_3)_2$, nitrogen oxide, NO, and water are made.

Write a **balanced symbol** equation for this reaction.

[2]

ii. How many moles of lead nitrate would be produced if 20.7 g of lead reacts with nitric acid?

Give your answer to **2** significant figures.

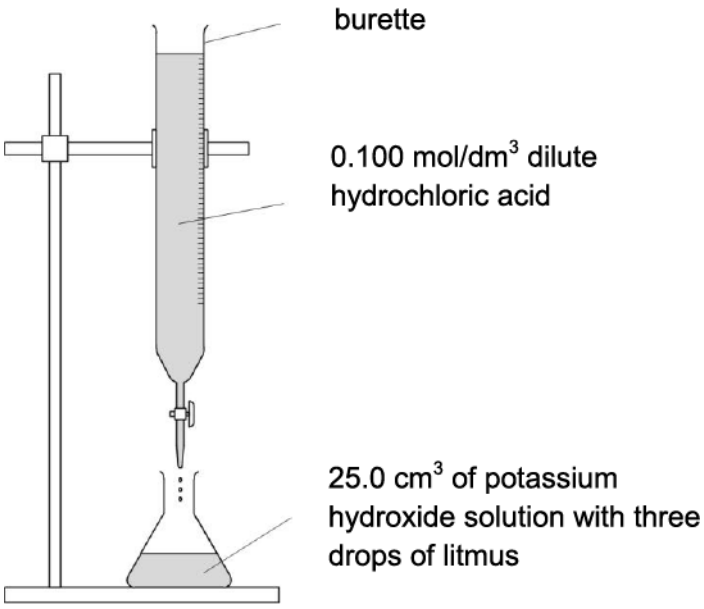
Moles of lead nitrate = ... **[4]**

17 (a). Sarah does three titrations with dilute hydrochloric acid and potassium hydroxide solution.

Hydrochloric acid neutralises the alkali potassium hydroxide.

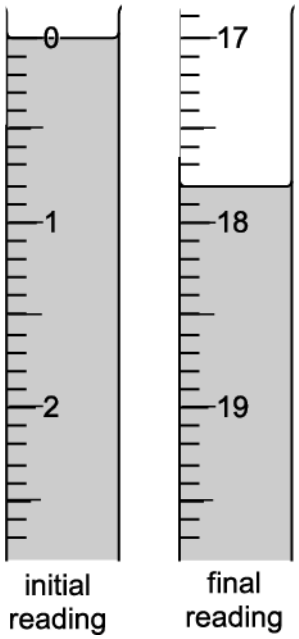
$$HCl(aq) + KOH(aq) \rightarrow KCl(aq) + H_2O(l)$$

Look at the apparatus she uses.



Look at the diagrams. They show parts of the burette during the first titration.

First titration



Here is Sarah's results table:

Titration number	1	2	3
final reading (cm^3)		37.5	32.1
initial reading (cm^3)		20.4	15.0

titre (volume of acid added) (cm_3)		17.1	17.1

Use the diagrams and table to help you calculate the mean titre.

Explain your answer.

Mean titre = ... cm^3 **[2]**

(b). Sarah uses 25.0 cm^3 of potassium hydroxide solution, KOH.

She also uses hydrochloric acid with a concentration of 0.100 mol/dm^3.

Calculate the concentration, in mol/dm^3, of the KOH(aq).

Concentration of KOH(aq) = ... mol/dm^3 **[2]**

(c). Use your answer to **(b)** to calculate the concentration of the KOH(aq) in g/dm^3.

Concentration of KOH(aq) = ... g/dm^3 **[2]**

18. The Group 7 elements are known as the halogens.

The halogens have similar chemical properties.

Their physical properties vary with increasing atomic number.

All halogens react with alkali metals to make a salt.

i. All halogens have similar chemical reactions.

Explain why in terms of electronic structure.

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[1]

ii. Sodium reacts with bromine to make sodium bromide, NaBr.

Construct the **balanced symbol** equation for this reaction.

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[2]

iii. What is the formula of the product of the reaction between astatine and potassium?

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[1]

19. A student adds calcium to dilute hydrochloric acid. The mixture begins to fizz.

Write a balanced symbol equation for this reaction.

_____ **[2]**

20. Magnesium has an atomic number of 12.

Calculate the mean mass of an atom of magnesium. Quote your answer to **three** significant figures.

(Avogadro constant = 6.022×10^{23} atoms per mole)

Mean mass ..... g **[2]**

21. Zinc nitrate can be made by reacting zinc oxide with nitric acid, HNO_3.

Write a **balanced symbol** equation for this reaction.

_____ **[2]**

22 (a). Irenka reacts an element, **X**, with oxygen, O_2.

There is one product. It is the oxide of **X** i.e. **X** oxide.

4.86 g of **X** reacts with 3.20 g of oxygen to make 8.06 g of **X** oxide.

i. Calculate the number of moles of **X**, oxygen and **X** oxide involved in the reaction.

(The relative atomic mass of **X** is 24.3 and the relative formula mass of oxygen, O_2, is 32.0 and of **X** oxide is 40.3.)

Number of moles of **X** = ...

Number of moles of O_2 = ...

Number of moles of **X** oxide = ... **[3]**

ii. Use your answers to write the **balanced symbol** equation for the reaction between **X** and oxygen to make **X** oxide.

_____ **[2]**

(b). Look at the equation.

It shows the reaction between sodium hydroxide and dilute sulfuric acid.

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

sodium hydroxide + sulfuric acid → sodium sulfate + water

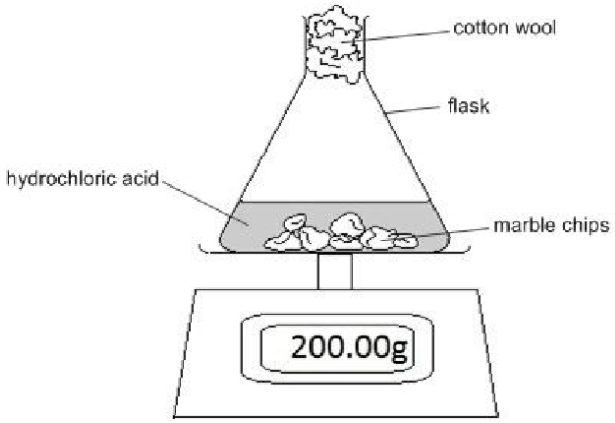
Calculate the mass of sodium hydroxide needed to make 30.0 g of sodium sulfate.

Give your answer to three significant figures.

Mass of sodium hydroxide = ... g **[3]**

23. Look at the diagram.

It shows how the reaction between hydrochloric acid and marble chips (calcium carbonate) can be monitored.



The reading on the balance **decreases** during the reaction.

Which of these statements is the **best** explanation?

A. Acid escapes from the flask.
B. A gas called hydrogen is made which leaves the flask.
C. A gas called carbon dioxide is made which leaves the flask.
D. The temperature in the laboratory changes.

Your answer ☐

[1]

24. Which of these shows the balanced symbol equation for the reaction between potassium and chlorine to make potassium chloride?

A. $K + Cl_2 \rightarrow KCl_2$
B. $P + Cl_2 \rightarrow PCl_2$
C. $2K + Cl_2 \rightarrow 2KCl$
D. $2P + Cl_2 \rightarrow 2PCl$

Your answer ☐

[1]

END OF QUESTION PAPER