1 The equation for the burning of butane is shown below.

$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

How many molecules of water are formed when one molecule of butane burns completely?

A 4 **B** 5 **C** 8 **D** 10

[1]

[Total: 1]

2 Sodium hydroxide and ammonia are both bases. They both turn red litmus blue.

(a) The chemical equation shows a reaction that produces sodium hydroxide.

$$Na_2CO_3 + Ca(OH) \rightarrow 2NaOH + CaCO_3$$

Complete the word equation for this reaction

....	+	....	→	sodium hydroxide	+	....

[2]

[Total: 2]

3 Complete the word equation for the reaction of dilute sulfuric acid with magnesium.

sulfuric acid	+	magnesium	→	....	+	.....

[2]

[Total: 2]

4 Balance the chemical equation for the oxidation of methane to form hydrogen.

$$.....CH_4 + O_2 \rightarrow 2CO + ...H_2$$ [2]

[Total: 2]

5 A compound of chlorine has the formula $C_6H_4Cl_2$.

Complete the table to calculate the relative molecular mass of $C_6H_4Cl_2$.
Use your Periodic Table to help you.

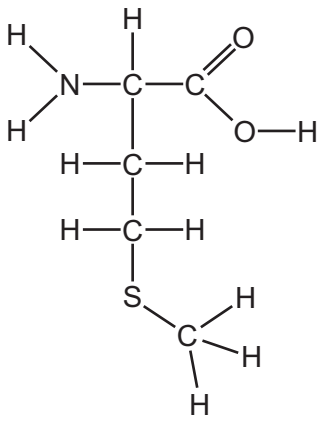
type of atom	number of atoms	relative atomic mass	
carbon	6	12	6 x 12 = 72
hydrogen			
chlorine			

relative molecular mass = ... [2]

[Total: 2]

6 A biogas fermentation mixture contains a small amount of compound **M**.

The structure of compound **M** is shown.



(a) On the structure shown, draw a circle around the carboxylic acid functional group.

[1]

(b) How many different types of atoms are present in compound **M**?

..... [1]

[Total: 2]

7 Chlorine reacts with an aqueous potassium salt to form iodine and a different potassium salt.

Complete the word equation for this reaction.

chlorine	+	....	→	iodine	+	....

[2]

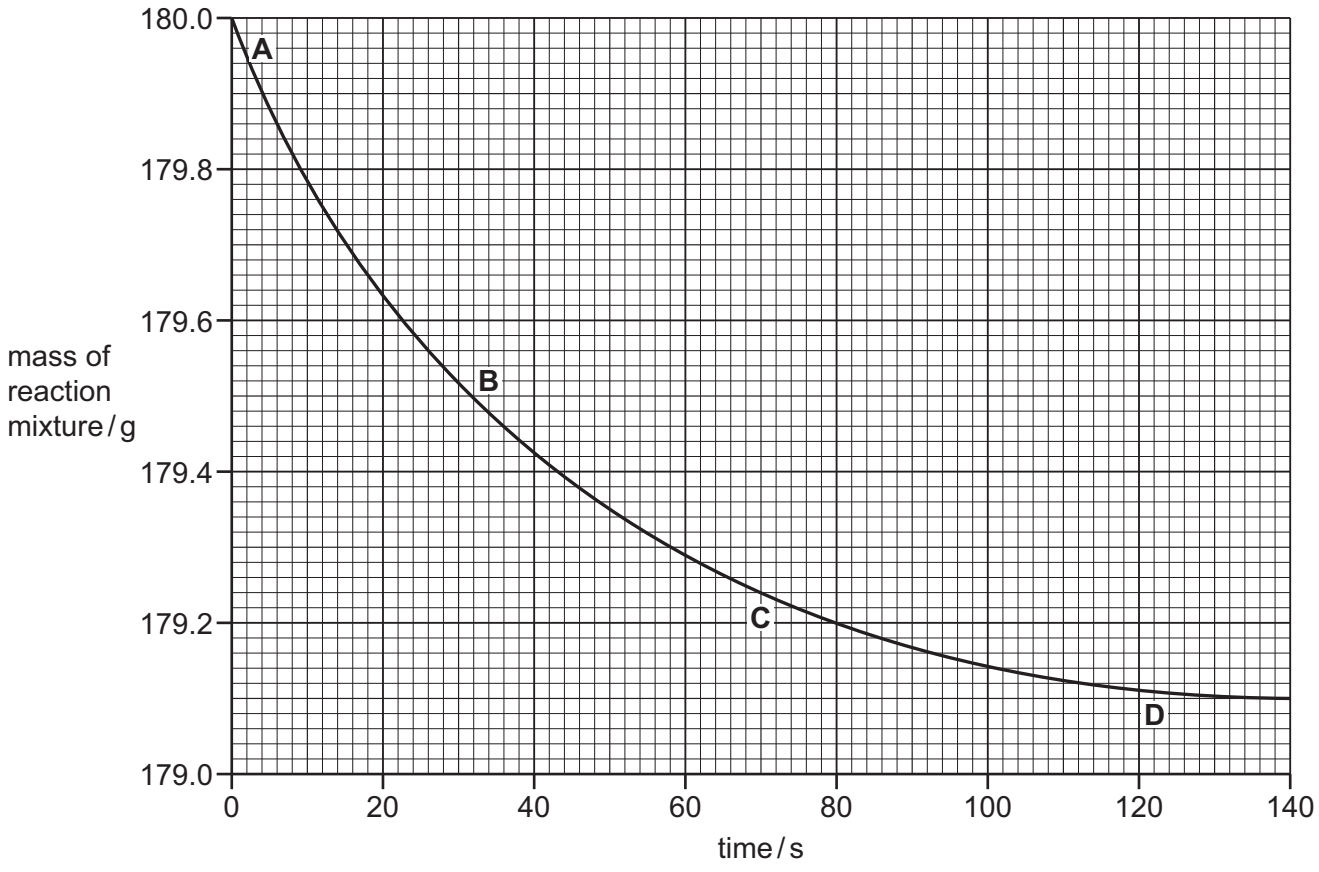
[Total: 2]

8 A student investigated the reaction of magnesium carbonate with an excess of dilute hydrochloric acid.

$$MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$$

The rate of reaction can be found by measuring the decrease in the mass of the reaction mixture over time.

The results are shown on the graph.



(a) Determine the mass of the reaction mixture after 58 seconds.

..... [1]

(b) At which point on the graph, **A**, **B**, **C**, or **D**, was the rate of reaction the fastest?
Use the graph to explain your answer.

.....

..... [2]

(c) When 0.42 g of magnesium carbonate is used, 120 cm^3 of carbon dioxide is formed.

Determine the volume of carbon dioxide produced when 1.26 g of magnesium carbonate reacts completely.

volume of carbon dioxide = ... cm^3 [1]

(d) What effect do the following have on the rate of this reaction?

(i) • Decreasing the concentration of the acid.
All other conditions are kept the same.

..... [1]

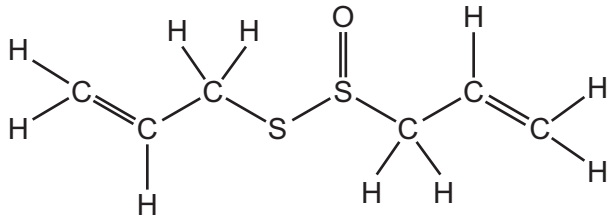
(ii) • Using smaller pieces of magnesium carbonate.
All other conditions are kept the same.

..... [1]

[Total: 6]

9 A biogas fermentation mixture contains a small amount of compound **C**.

The structure of compound **C** is shown.



(a) On the structure shown, draw a circle around a functional group which reacts with aqueous bromine.

[1]

(b) How many different types of atoms are present in compound **C**?

..... [1]

[Total: 2]

10 Dilute hydrochloric acid reacts with zinc.

Complete the word equation for this reaction.

zinc	+	hydrochloric acid	→	....	+	.....

[2]

[Total: 2]

11 A student investigated the reaction between zinc carbonate and an excess of dilute hydrochloric acid.

$$ZnCO_3 + 2HCl \rightarrow ZnCl_2 + CO_2 + H_2O$$

The rate of reaction can be found by measuring the decrease in the mass of the reaction mixture over time.

(a) Describe **one** other practical method for measuring the rate of this reaction.

.....

.....

.....

.....

..... [3]

(b) When 6.25 g of zinc carbonate is used, 2.20 g of carbon dioxide is formed.

Calculate the mass of zinc carbonate that forms 11.00 g of carbon dioxide.

mass of zinc carbonate = ... g [1]

(c) What effect do the following have on the rate of this reaction?

(i) Decreasing the temperature of the reaction mixture.
All other conditions are kept the same.

..... [1]

(ii) Increasing the concentration of hydrochloric acid.
All other conditions are kept the same.

..... [1]

[Total: 6]

12 Sodium reacts with water to form:

- an alkaline solution
- a gas which 'pops' with a lighted splint.

Complete the word equation for the reaction of sodium with water.

sodium + water → .... + ...

[2]

[Total: 2]

13 A compound of lithium has the formula C_2H_5Li.

Complete the table to calculate the relative molecular mass of C_2H_5Li.
Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
carbon			
hydrogen	5	1	5 × 1 = 5
lithium			

relative molecular mass = ... [2]

[Total: 2]

14 Balance the chemical equation for the complete combustion of methane.

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

[2]

[Total: 2]

15 Ammonia is used in the manufacture of nitric acid.

(a) Balance the chemical equation for the first step in the process.

$$4NH_3 + 5O_2 \rightarrow .....NO + 6H_2O$$

[1]

(b) The reaction is exothermic.

What is meant by the term *exothermic*?

.....

..... [1]

(c) The NO produced in the first step then reacts with oxygen to produce nitrogen dioxide, NO_2.

$$2NO + O_2 \rightarrow 2NO_2$$

How does this equation show that NO is oxidised?

.....

..... [1]

(d) Is nitrogen dioxide an acidic oxide or a basic oxide?
Give a reason for your answer.

.....

..... [1]

[Total: 4]

16 Lithium reacts with oxygen to form lithium oxide.

Balance the chemical equation for this reaction.

$$.....Li + O_2 \rightarrow .....Li_2O$$ [2]

[Total: 2]

17 During the fermentation of animal and vegetable waste, carbon dioxide reacts with hydrogen to produce methane and water.

Complete the chemical equation for this reaction.

$$CO_2 + ...H_2 \rightarrow CH_4 + ...H_2O$$ [2]

[Total: 2]

18 The table shows the percentage by mass of the elements on Earth and in the Universe.

element	percentage by mass on Earth	percentage by mass in the Universe
helium	0.1	21.0
hydrogen	0.1	76.0
iron	35.0	1.0
magnesium	14.0	0.1
oxygen	29.0	0.8
silicon	14.0	0.1
sulfur	2.9	0.1
other elements		0.9
total	100.0	100.0

Answer these questions using only the information in the table.

(a) Deduce the percentage by mass of other elements present on Earth.

..... % [1]

(b) Which non-metallic element is present on Earth in the greatest percentage by mass?

..... [1]

(c) Give **two** major differences in the percentage by mass of the elements on Earth and in the Universe.

1 .....

.....

2 .....

..... [2]

[Total: 4]

19 In a blast furnace used for the extraction of iron, carbon reacts with oxygen from the air to form carbon monoxide.

Complete the chemical equation for this reaction.

.....C + ... → 2CO [2]

[Total: 2]

20 A compound of fluorine has the formula XeO_3F_2.

Complete the table to calculate the relative molecular mass of XeO_3F_2.
Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
xenon			
oxygen	3	16	3 × 16 = 48
fluorine			

relative molecular mass = ... [2]

[Total: 2]

21 Bromine reacts with an aqueous potassium salt to form iodine and a different potassium salt.

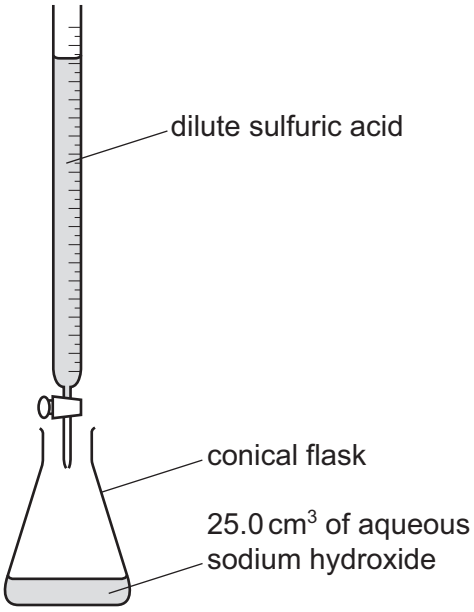
Complete the word equation for this reaction.

bromine	+	....	→	iodine	+	....

[2]

[Total: 2]

22 Dilute sulfuric acid and aqueous sodium hydroxide are used to make aqueous sodium sulfate, $Na_2SO_4(aq)$, or aqueous sodium hydrogen sulfate, $NaHSO_4(aq)$. The method includes use of the following apparatus.



$25.0\,cm^3$ of aqueous sodium hydroxide of concentration $0.100\,mol/dm^3$ was neutralised by $25.0\,cm^3$ of dilute sulfuric acid of concentration $0.0500\,mol/dm^3$.
The equation for the reaction is shown. This is **reaction 1**.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l) \qquad \textbf{reaction 1}$$

The same technique and the same solutions are used to make aqueous sodium hydrogen sulfate.
The equation for the reaction is shown. This is **reaction 2**.

$$NaOH(aq) + H_2SO_4(aq) \rightarrow NaHSO_4(aq) + H_2O(l) \qquad \textbf{reaction 2}$$

Complete the table to calculate the volume of dilute sulfuric acid that reacts with $25.0\,cm^3$ of aqueous sodium hydroxide in **reaction 2**.

	volume of $0.0500\,mol/dm^3$ dilute sulfuric acid in cm^3	volume of $0.100\,mol/dm^3$ aqueous sodium hydroxide in cm^3
reaction 1	25.0	25.0
reaction 2		25.0

[1]

[Total: 1]

23 The phosphonium ion, PH_4^+, is similar to the ammonium ion.

(a) State the formula of the ammonium ion.

..... [1]

(b) Suggest the formula of phosphonium iodide.

..... [1]

[Total: 2]

24 Phosphorus forms a compound with hydrogen with the following composition by mass:

P, 93.94%; H, 6.06%.

(a) Calculate the empirical formula of the compound.

empirical formula = ... [2]

(b) The compound has a relative molecular mass of 66.

Deduce the molecular formula of the compound.

molecular formula = ... [1]

[Total: 3]

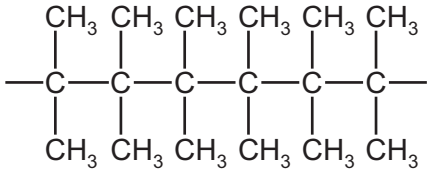
25 Magnesium phosphate contains magnesium ions, Mg^{2+}, and phosphate ions, PO_4^{3-}.

Deduce the formula of magnesium phosphate.

..... [1]

[Total: 1]

26 Part of the structure of synthetic polymer **A** is shown.



(a) What type of synthetic polymer is **A**?

..... [1]

(b) Deduce the empirical formula of polymer **A**.

..... [1]

(c) Draw the structure of the monomer from which polymer **A** is made.

[2]

[Total: 4]

27 Insoluble salts can be made by precipitation reactions.

A student mixed solutions of some soluble salts.

The results the student obtained are shown in the table.

		second salt solution		
		$Co(NO_3)_2(aq)$	$AgNO_3(aq)$	$Pb(NO_3)_2(aq)$
first salt solution	NaI(aq)	no change	yellow precipitate	yellow precipitate
	$Na_2CO_3(aq)$	purple precipitate	yellow precipitate	white precipitate
	$Na_2SO_4(aq)$	no change	white precipitate	white precipitate

All sodium salts are soluble in water.
Use only results from the table to answer the following questions.

(a) Name:

(i) an insoluble cobalt salt

..... [1]

(ii) an insoluble yellow lead salt

..... [1]

(b) Write the chemical equation for the reaction in which silver carbonate is formed.

..... [2]

(c) Write the ionic equation for the reaction in which lead(II) iodide is formed.

..... [2]

[Total: 6]

28 Calcium phosphate contains the phosphate ion, PO_4^{3-}.

What is the formula of calcium phosphate?

..... [1]

[Total: 1]

29 Nitrates such as ammonium nitrate are used as fertilisers.

The final stage in the production of ammonium nitrate is shown in the equation.

$$Ca(NO_3)_2 + 2NH_3 + CO_2 + H_2O \rightarrow 2NH_4NO_3 + CaCO_3$$

Calculate the maximum mass of ammonium nitrate that can be produced from 820 g of calcium nitrate, $Ca(NO_3)_2$, using the following steps.

The relative formula mass, *M*r, of calcium nitrate, $Ca(NO_3)_2$, = 164.

(a) Calculate the number of moles of $Ca(NO_3)_2$ in 820 g.

..... mol [1]

(b) Deduce the number of moles of NH_4NO_3 produced.

..... mol [1]

(c) Calculate the M_r of NH_4NO_3.

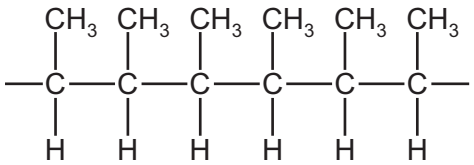
M_r of NH_4NO_3 = ... [1]

(d) Calculate the maximum mass of ammonium nitrate produced.

..... g [1]

[Total: 4]

30 Part of an addition polymer is shown.



(a) How many monomer units are needed to make the part of the addition polymer shown?

..... [1]

(b) Draw the structure of the monomer that is used to make this addition polymer. Show all of the atoms and all of the bonds.

Name the monomer.

name ..... [2]

(c) State the empirical formula of:

the monomer .....

the polymer ..... [2]

[Total: 5]

31 The gases Ar, CO_2, N_2 and O_2 are in clean, dry air.

CO, NO, NO_2 and SO_2 are gases commonly found in polluted air.

(a) What percentage of clean, dry air is N_2?

Give your answer to the nearest whole number.

..... % [1]

(b) Name the process used to separate O_2 from clean, dry air.

..... [2]

(c) State **one** major adverse effect of the pollutant SO_2.

..... [1]

(d) NO and NO_2 are produced in car engines.

Describe how oxides of nitrogen form in a car engine.

.....

.....

..... [2]

(e) Many cars have catalytic converters in their exhaust systems. In a catalytic converter, most of the CO and NO formed in a car engine is changed into less harmful products.

Identify these products and state the metal catalyst used.

products .....

catalyst ..... [3]

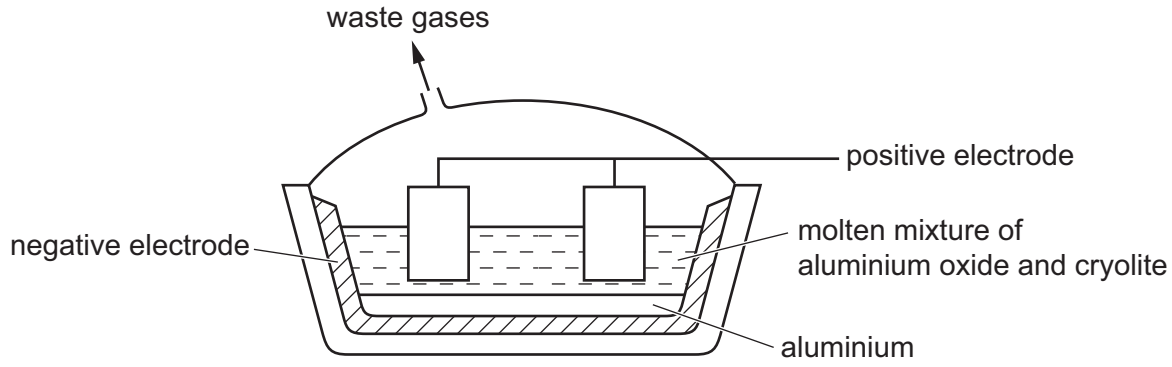
(f) CO is formed from the incomplete combustion of fossil fuels such as methane.

Write a chemical equation to show the incomplete combustion of methane.

..... [2]

[Total: 11]

32 Aluminium is produced by the electrolysis of aluminium oxide dissolved in molten cryolite.



(a) Give **two** reasons why the electrolysis is done using a molten mixture of aluminium oxide and cryolite instead of molten aluminium oxide only.

1 .....

2 ..... [2]

(b) Write ionic half-equations for the reactions occurring at the electrodes.

positive electrode .....

negative electrode ..... [2]

(c) The anodes are made of carbon and have to be replaced regularly.

Explain why the carbon anodes have to be replaced regularly.

.....

..... [2]

[Total: 6]

33 Write a chemical equation for the **incomplete** combustion of C_4H_{10}.

..... [2]

[Total: 2]

34 The table shows the percentage by mass of the elements in the oceans and in the biosphere. The biosphere is all living organisms.

element	percentage by mass in the oceans	percentage by mass in the biosphere
calcium	0.05	0.40
carbon	0.01	39.00
chlorine	1.80	0.05
hydrogen	11.00	6.60
magnesium	0.12	0.10
oxygen	85.80	53.00
silicon	0.00	0.10
sodium	1.15	0.05
other elements	0.07	
total	100.00	100.00

Answer these questions using only the information in the table.

(a) Deduce the percentage by mass of other elements present in the biosphere.

..... % [1]

(b) Which metallic element is present in the oceans in the greatest percentage by mass?

..... [1]

(c) Give **two** major differences in the percentage by mass of the elements in the oceans and in the biosphere.

1 .....

.....

2 .....

..... [2]

[Total: 4]

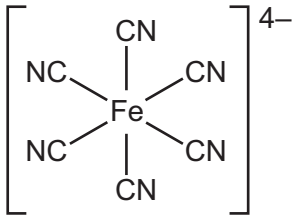
35 Chlorine reacts with warm turpentine, $C_{10}H_{16}$.

Balance the chemical equation for this reaction.

$$C_{10}H_{16} + 8Cl_2 \rightarrow \text{.....}C + \text{.....}HCl$$ [2]

[Total: 2]

36 The structure of an ion is shown.



Deduce the molecular formula of this ion to show the number of iron, carbon and nitrogen atoms.

..... [1]

[Total: 1]

37 Uranium reacts with hydrogen to form uranium hydride, UH_3.
The reaction is reversible.

Complete the chemical equation for this reaction by:

- balancing the equation
- drawing the symbol for a reversible reaction in the box.

$$2U + \text{.....}H_2 \quad \square \quad \text{.....}UH_3$$

[3]

[Total: 3]

38 A student investigated the reaction between zinc and dilute hydrochloric acid by measuring the volume of hydrogen gas produced at one minute intervals.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Give the name of the salt formed in this reaction.

..... [1]

[Total: 1]

39 Phosphorus burns in oxygen to form phosphorus(V) oxide.

Balance the chemical equation for this reaction.

$$P_4 + 5O_2 \rightarrow .....P_2O_5$$ [1]

[Total: 1]

40 Selenium reacts with fluorine to form selenium(VI) fluoride.

Balance the chemical equation for this reaction.

$$Se + ...F_2 \rightarrow SeF_6$$ [1]

[Total: 1]