GCSE

3410U20-1

THURSDAY, 16 MAY 2019 – MORNING

CHEMISTRY – UNIT 2:

Chemical Bonding, Application of Chemical Reactions and Organic Chemistry

FOUNDATION TIER

1 hour 45 minutes plus your additional time allowance

Surname

_____

Other Names

_____

Centre Number

_____

Candidate Number

0 _____

ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

Write your name, centre number and candidate number in the spaces on the previous page.

Answer ALL questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question 6(a) is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table and the formulae for some common ions are printed as a separate insert.

Answer ALL questions.

1 (a) **The diagrams opposite show some uses of smart materials which rely on their unusual properties.**

continued on the following page

4

The box contains the names of four types of smart material.

THERMOCHROMIC PIGMENT
SHAPE MEMORY POLYMER
HYDROGEL
PHOTOCHROMIC PIGMENT

Use the information given to complete the table.

[2]

Unusual property	Use	Type of smart material
it regains its original shape on heating	car bumpers	shape memory polymer
it changes colour with changing temperature	_____	_____
it can absorb up to 1000 times its volume of water	_____	_____

1 (b) Draw a line to link the use of each nano-material to its property. [2]

USE	PROPERTY
nano-silver in dressings for cuts and burns	antibacterial
	blocks harmful UV light
nano-titanium dioxide in sunscreen creams	breaks down dirt
	strong and light

4

2 **The diagram opposite shows an electrolysis cell used in the extraction of aluminium from alumina.**

BAUXITE	**ELECTRICAL**
MOLTEN ALUMINA	**POSITIVE**
NEGATIVE	**CRYOLITE**
MOLTEN ALUMINIUM	**OXYGEN**
LIGHT	

(a) Choose words from the box to complete the following sentences. [5]

The molten electrolyte is a mixture of alumina

and _____ .

Product A is _____ .

Oxygen is formed at the anode which is

the _____ electrode.

Alumina is obtained from an ore called

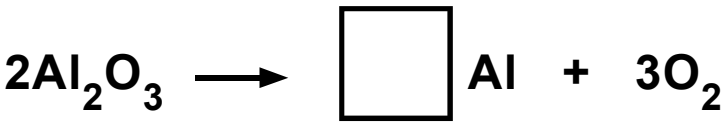
_____ .

The process of extracting aluminium is expensive

because it uses a lot of _____

energy.

2 (b) **Balance the symbol equation that shows the overall reaction. [1]**



2 (c) **250 tonnes of an aluminium ore can produce 195 tonnes of alumina.**

Calculate the percentage of alumina in the ore.

[2]

Percentage = _____ %

2 (d) **The chart opposite compares the amount of energy used to extract and to recycle three metals.**

Use the information in the chart to answer the following question.

Put a tick (✓) in the box next to the statement that describes why it is more cost effective to recycle aluminium than steel and copper. [1]

The energy used to extract metals is greater than that used in recycling them ☐

The difference between the energy used to extract and the energy used to recycle is the greatest ☐

The energy used in recycling is less than for copper but greater than for steel ☐

☐

9

3 (a) The flow diagram opposite shows steps in the manufacture of sulfuric acid using the Contact Process.

(i) Name the ELEMENT in the air which reacts with sulfur in step 1. [1]

_____

(ii) State the purpose of the catalyst in step 2. [1]

_____

_____

(iii) Name liquid A used to dilute the concentrated sulfuric acid in step 3. [1]

_____

(iv) Complete and balance the symbol equation for the reaction in step 2. [2]

$2SO_2 + O_2 \rightleftharpoons$ ☐ _____

3 (b) **The pie chart opposite shows the main uses of sulfuric acid.**

Calculate the percentage of sulfuric acid used for making plastics. [2]

Percentage = _____ %

(c) **One important use of sulfuric acid is in the production of the fertiliser ammonium sulfate, $(NH_4)_2SO_4$.**

Complete the following word equation for the production of ammonium sulfate. [1]

sulfuric acid + _____ → ammonium sulfate

8

4 (a) The table shows the electronic structure of the elements present in water.

Element	Electronic structure
hydrogen	1
oxygen	2,6

The top diagrams opposite show the outer shell electrons in an atom of hydrogen and an atom of oxygen.

(i) Complete the bottom diagram opposite to show the outer shell electrons in a molecule of water. [2]

4 (a)(ii)

The diagram opposite shows some water molecules and the weak forces between them.

Put a tick (✓) in the box next to the property of water which can be explained by the weak forces between water molecules. [1]

poor conductor of electricity	
colourless	
good conductor of heat	
low melting point and boiling point	

4 (b) The diagram opposite shows the apparatus used by a group of students to investigate the volume of hydrogen and oxygen gas formed during the electrolysis of water.

The overall equation for the electrolysis of water is as follows.

$$2H_2O \longrightarrow 2H_2 + O_2$$

(i) The table shows the total volume of hydrogen formed over 10 minutes.

Time (minutes)	0	2	4	6	8	10
Volume of hydrogen (cm^3)	0	10	20	30	40	50

I. Plot the values from the table on the grid opposite page 15.

Draw a suitable line. Label this line 'HYDROGEN'.

(0,0) has been plotted for you. [2]

II. Using a ruler, draw a second line ON THE GRID to show the volume of oxygen that would be collected during the same 10 minutes. Label this line 'OXYGEN'. [1]

4 (b)

III. Describe the relationship between the volume of hydrogen and the volume of oxygen formed during electrolysis. [2]

4 (b)(ii)

Electrolysis of water can be represented by the following equation.

$$2H_2O \longrightarrow 2H_2 + O_2$$

Give the letter, A, B, C or D, of the diagram opposite which also represents this reaction. [1]

_____

4 (c) **One use of electrolysis is in electroplating. The diagram opposite shows the silver plating of a metal spoon.**

(i) **State why this process does not work for a plastic spoon. [1]**

(ii) **Explain why the silver ions move towards the spoon. [2]**

4 (c)(iii)

Put a tick (✓) in the box next to the electrode equation for the reaction at electrode B. [1]

$2Ag^+ + 2e^- \rightarrow Ag$ ☐

$Ag^+ + e^- \rightarrow Ag$ ☐

$Ag^+ - e^- \rightarrow Ag$ ☐

$Ag^+ + 2e^- \rightarrow Ag$ ☐

☐

13

5 (a) **Study the diagram opposite.**

Dafydd was asked to make some silver chloride. He formed a white precipitate of silver chloride by mixing solutions of sodium chloride and silver nitrate.

(i) **Complete the symbol equation for this reaction. [1]**

$NaCl + AgNO_3 \rightarrow$ _____ + _____

(ii) **Put a tick (✓) in the box next to the statement which describes why this method works. [1]**

silver is more dense than sodium ☐

silver chloride is soluble ☐

silver chloride is insoluble ☐

silver is below sodium in the reactivity series ☐

5 (a)(iii)

Give the name of the process that you would use to separate the precipitate of silver chloride from the reaction mixture. [1]

_____

5 (b) **Calculate the relative formula mass (M_r) of silver nitrate, $AgNO_3$. [2]**

A_r(O) = 16 **A_r(N) = 14** **A_r(Ag) = 108**

M_r = _____

5 (c) **The relative formula mass (M_r) of sodium chloride, NaCl, is 58.5.**

Calculate the percentage of sodium in sodium chloride.

Give your answer to 1 DECIMAL PLACE. [2]

A_r(Na) = 23

Percentage = _____ %

7

6 (a) **Plastics have replaced many traditional materials. The diagrams opposite show plastics being used for three different types of food and drink packaging and containers.**

Describe the advantages and disadvantages of using plastics in these examples. [6 QER]

6 (b) **Read the following information and look at the diagram opposite.**

MICROPLASTICS IN THE OCEAN

Plastics are used in many areas of modern life. FIGURE 1 opposite shows the amount of plastic production between 1950 and 2013.

One of plastic's greatest properties, its durability, is also one of the main reasons that plastics present a threat to the marine environment.

The term 'microplastic' is used to describe plastic particles that are less than 5 millimetres in diameter, which includes particles as small as 10 nanometres. Microplastics can be found in some cosmetic products, toothpastes and soaps.

Microplastics are spread throughout the oceans and are found on shorelines from the Arctic to Antarctica. FIGURE 2 opposite page 26 shows the number of microplastic pieces found in sea ice at four Arctic sites during a survey in 2014.

Microplastics have been found inside the bodies of marine animals. Microplastics often contain chemicals that can absorb poisons such as pesticides from the surrounding seawater. There is strong evidence of transfer of poisons from eaten microplastics into animal tissues.

continued on the following page

Nano-size microplastics have been shown to cross cell membranes, under laboratory conditions, causing tissue damage.

Public awareness of the potential for microplastics to damage marine animals is low compared with that of the impact of plastic litter in our seas and oceans. Effective education of society is essential to raise awareness of the damaging effects of microplastics.

6 (b)(i)

Put a tick (✓) in the box next to the size of microplastics. [1]

less than 10 mm ☐

between 5 mm and 10 nm ☐

greater than 5 mm and less than 10 nm ☐

between 5 mm and 10 mm ☐

6 (b)(ii)

Put a tick (✓) in the box next to the statement that best describes the amount of plastic produced in Europe since 2002. [1]

plastic production has remained constant ☐

plastic production has increased ☐

plastic production has decreased ☐

(iii) Name the type of plastic most often found in the Arctic microplastic survey. [1]

_____

6 (b)(iv)

Put a tick (✓) in the box next to a hypothesis which needs further testing by scientists. [1]

the quantity of microplastics found in the Earth's oceans is increasing	☐
microplastics carry contaminants from sea water into animals	☐
microplastics cause tissue damage in marine animals	☐
microplastics are a greater problem near land than in deep water	☐

6 (b)(v)

Suggest a method of educating people of the hazards of microplastics. [1]

11

7 (a) **The table opposite shows the names, molecular formulae and structural formulae of some alcohols.**

Complete the table. [3]

7 (b) **The diagram opposite shows apparatus that can be used to make ethanol by fermentation.**

(i) **Complete and balance the symbol equation for the reaction. [2]**

$$C_6H_{12}O_6 \xrightarrow{\text{yeast}} 2C_2H_5OH + \square \text{ ——————}$$

glucose solution **ethanol** **gas X**

(ii) **Yeast acts as a catalyst in the process. Give the reason why catalysts are written above the arrow in equations. [1]**

———————————————————

7 (c) In Brazil sugar cane is used to make ethanol which can be used instead of petrol in cars. Many people see ethanol as the fuel of the future but others are concerned with environmental and social issues.

The table opposite shows information relating to the burning of 1 dm^3 of ethanol and petrol.

Use the information in the table and your knowledge to answer the following question.

Explain ONE advantage and ONE disadvantage of using ethanol instead of petrol in cars. [2]

Advantage

continued on the following page

Disadvantage

8

8 Study the diagram opposite.

A student investigated the temperature rise during a neutralisation reaction.

continued on the following page

8 The student put 25.0 cm^3 of sodium hydroxide solution and 5 drops of universal indicator into a polystyrene cup and recorded the temperature of the alkali. After 10 seconds the student added 25.0 cm^3 of dilute hydrochloric acid to the alkali and recorded the temperature every 5 seconds for another 30 seconds. Graph **A** opposite shows the results obtained.

(a)(i) Use the graph to find the maximum temperature rise during the reaction. [1]

Temperature rise = _____ °C

8 (a)(ii)

The energy given out can be calculated using the formula shown opposite.

Calculate the energy given out during the reaction.

[2]

Energy given out = _____ J

8 (a)(iii)

The temperature of the contents in the cup was recorded after 2 hours.

Give the final temperature reading you would expect. Give the reason for your answer. [1]

Final temperature _____ °C

Reason

_____

_____

_____

_____

8 (b) **The student repeated the experiment using 25.0 cm^3 of ethanoic acid of the same concentration as the hydrochloric acid.**

The table opposite shows the results obtained.

Plot the results on the grid opposite page 35.

Draw a suitable line. Label your graph B. [2]

(c) **Use the graphs to state which of the two acids is the stronger – hydrochloric acid or ethanoic acid.**

Give the reason for your choice. [1]

Acid _____

Reason

_____

_____

_____

_____

8 (d) **The temperature rises in both experiments were much LOWER than expected. The student suggested that using a temperature sensor instead of a thermometer would give temperature rises closer to the expected values.**

(i) **State why using a temperature sensor would still give a lower than expected temperature rise. [1]**

8 (d)(ii)

What improvement to the apparatus would you suggest to the student to obtain temperature rises closer to the expected values? [1]

9	

9 The diagram opposite shows three reactions which are used to prepare soluble salts.

(a)(i) Name compound A. [1]

_____

(ii) Give the names of blue solution B and gas C formed in reaction 3. [2]

blue solution B _____

gas C _____

(b) Write the balanced symbol equation for reaction 1. [2]

_____

9 (c) **Reaction 1 was repeated using magnesium instead of zinc.**

Explain the difference, if any, that you would expect to see. [2]

7	

10 The tables opposite show the molecular formulae of some alkanes and alkenes.

(a) The general formula for the alkene family is C_nH_{2n}.

Give the general formula for the alkane family. [1]

_____

(b) When alkanes and alkenes completely burn in air they form the same two products.

Give the chemical formulae for both products. [1]

_____ **and** _____

10 (c) Draw the structural formula for propene. [1]

10 (d) **Bromine water is used to distinguish alkenes from alkanes. Describe the colour CHANGE seen when bromine water is added to an alkene. [1]**

4

END OF PAPER

QUESTION NUMBER	ADDITIONAL PAGE, IF REQUIRED. WRITE THE QUESTION NUMBER(S) IN THE LEFT-HAND MARGIN.

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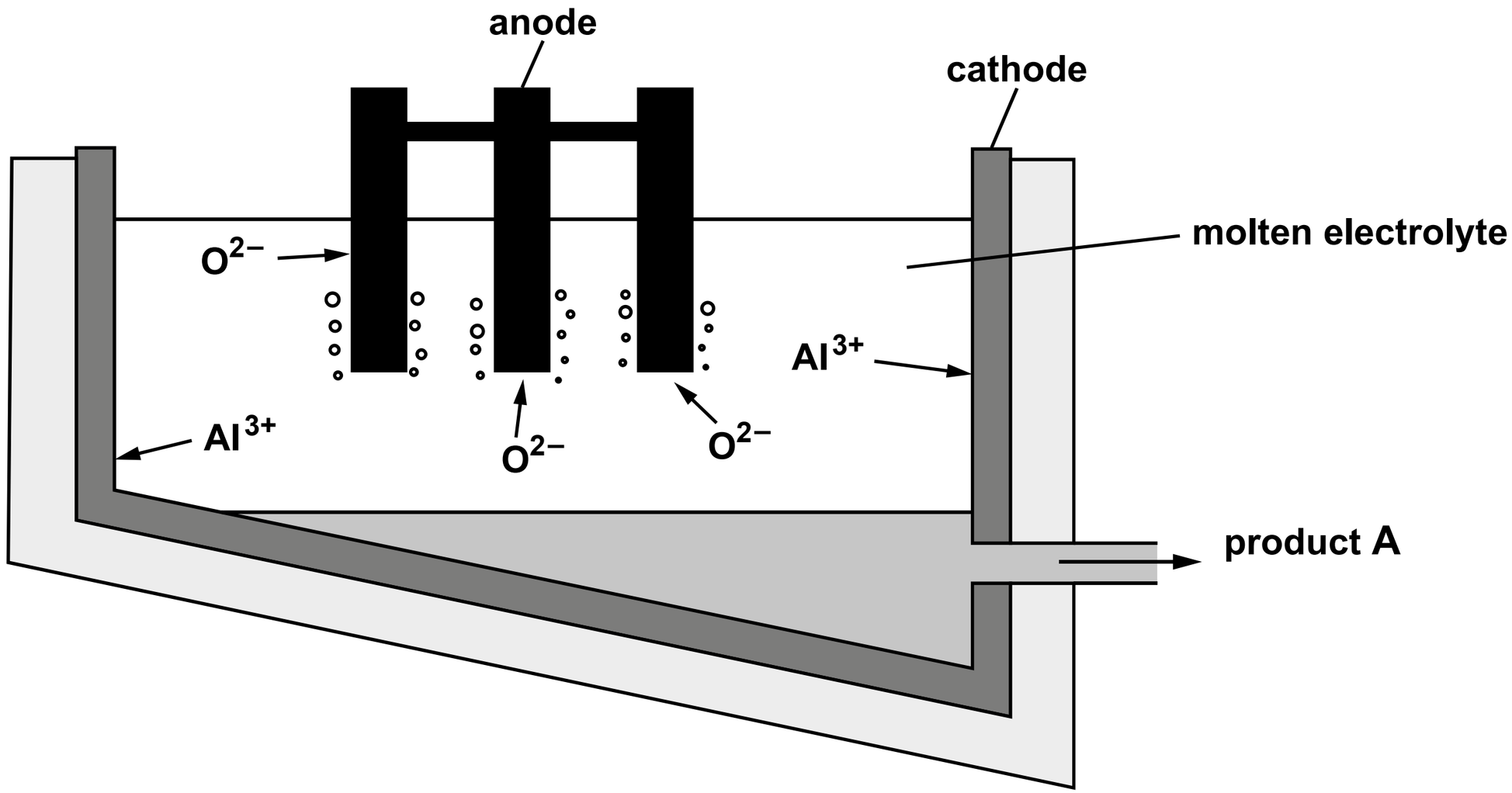
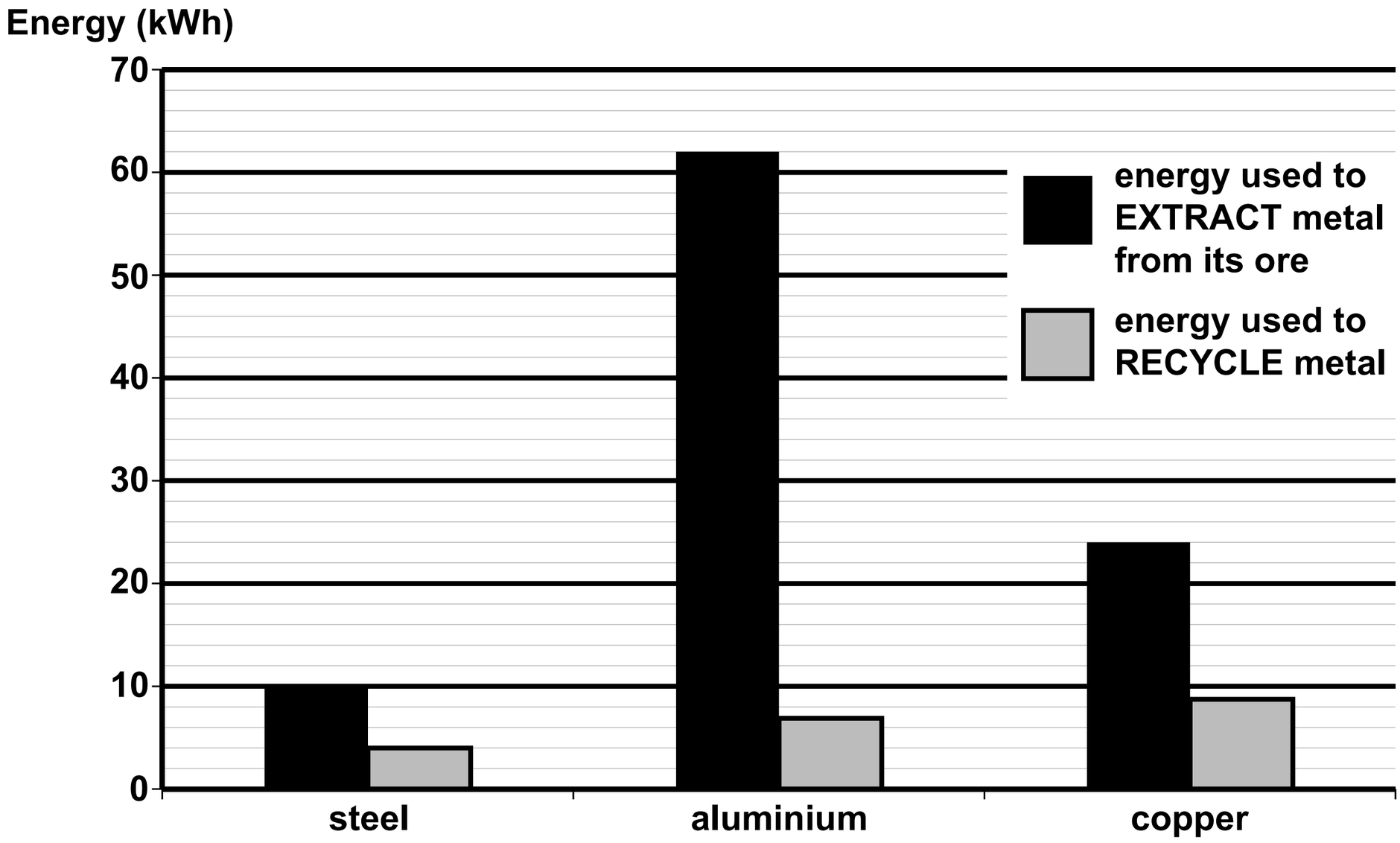
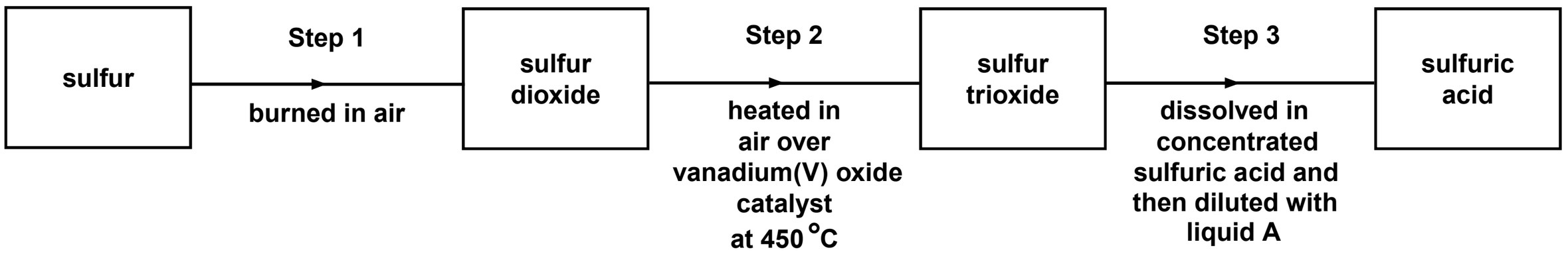
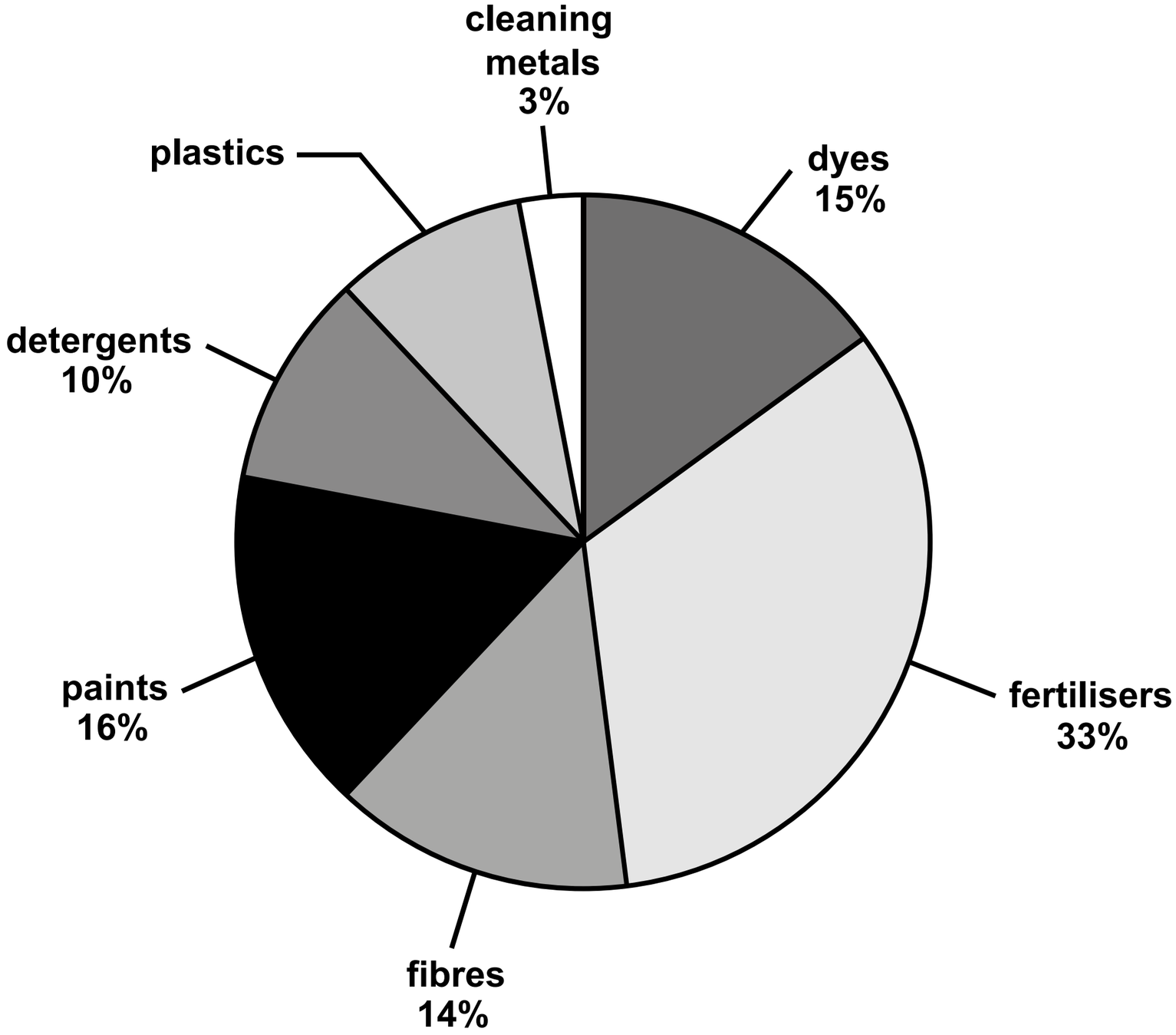
For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1	4	
2	9	
3	8	
4	13	
5	7	
6	11	
7	8	
8	9	
9	7	
10	4	
Total	80	

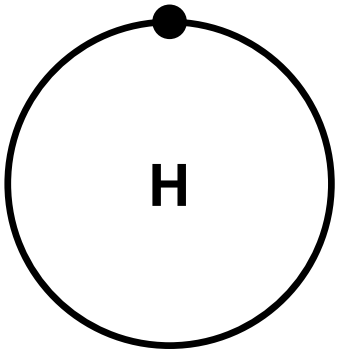

anode
cathode
molten electrolyte
O^{2-}
Al^{3+}
Al^{3+}
O^{2-}
O^{2-}
product A


Energy (kWh)
70
60
50
40
30
20
10
0
steel
aluminium
copper
energy used to EXTRACT metal from its ore
energy used to RECYCLE metal

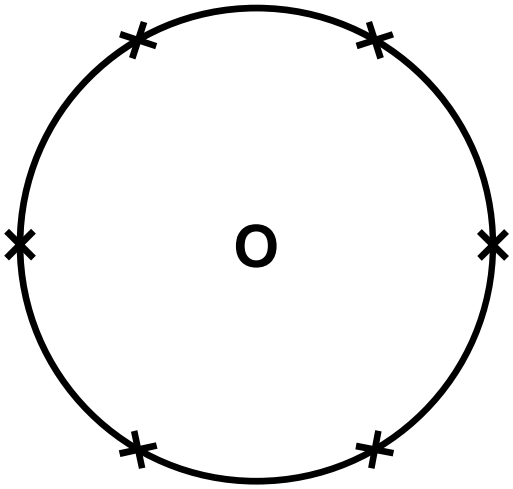

sulfur
Step 1
burned in air
sulfur dioxide
Step 2
heated in air over vanadium(V) oxide catalyst at 450 °C
sulfur trioxide
Step 3
dissolved in concentrated sulfuric acid and then diluted with liquid A
sulfuric acid


cleaning
metals
3%
plastics
dyes
15%
detergents
10%
paints
16%
fertilisers
33%
fibres
14%

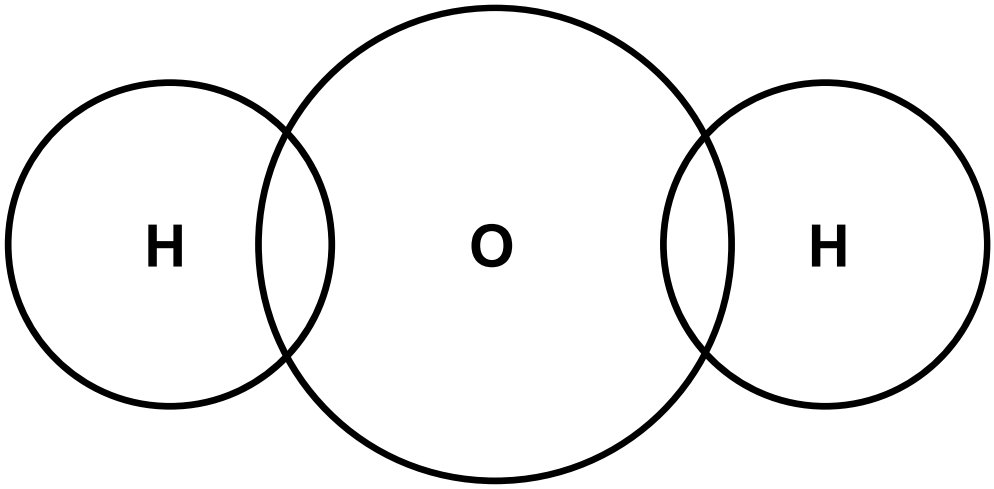
hydrogen atom

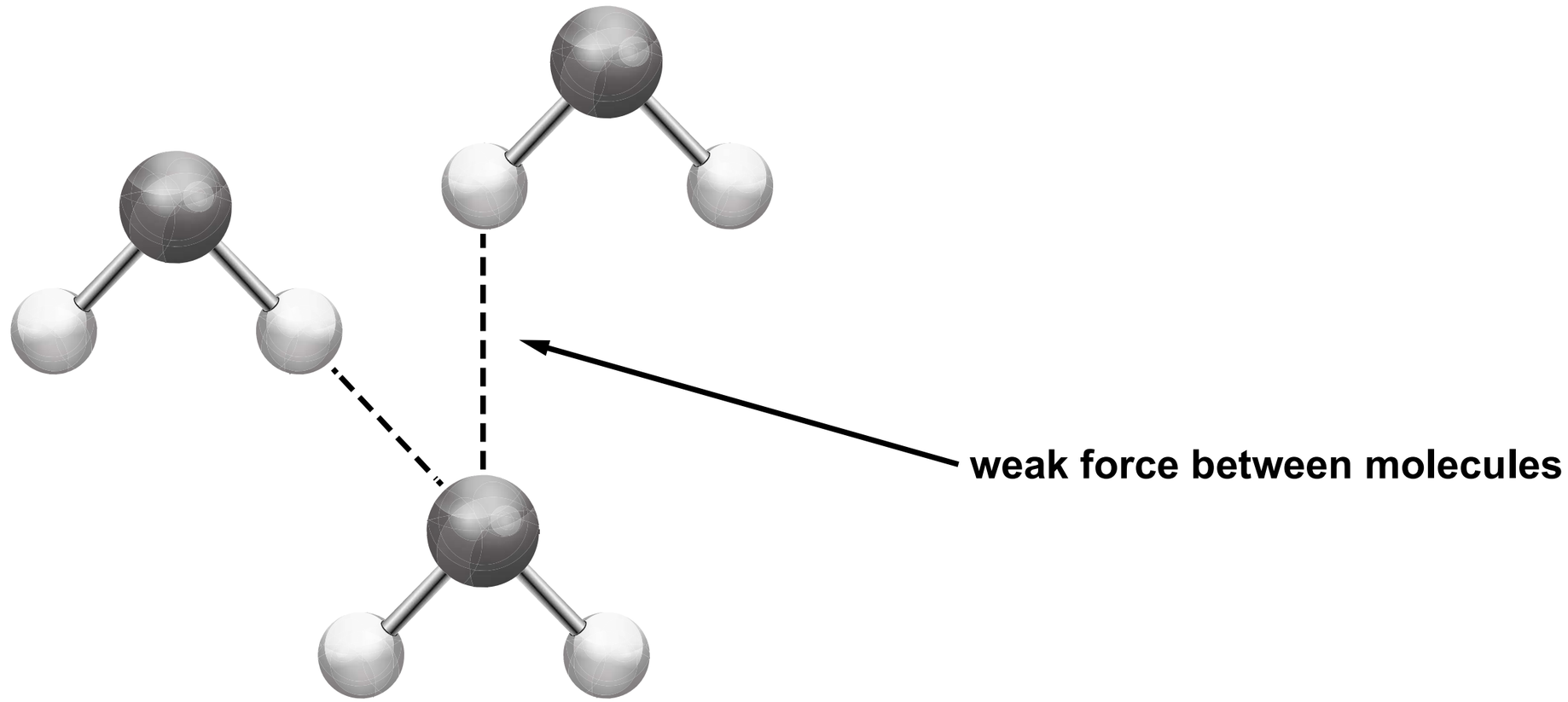


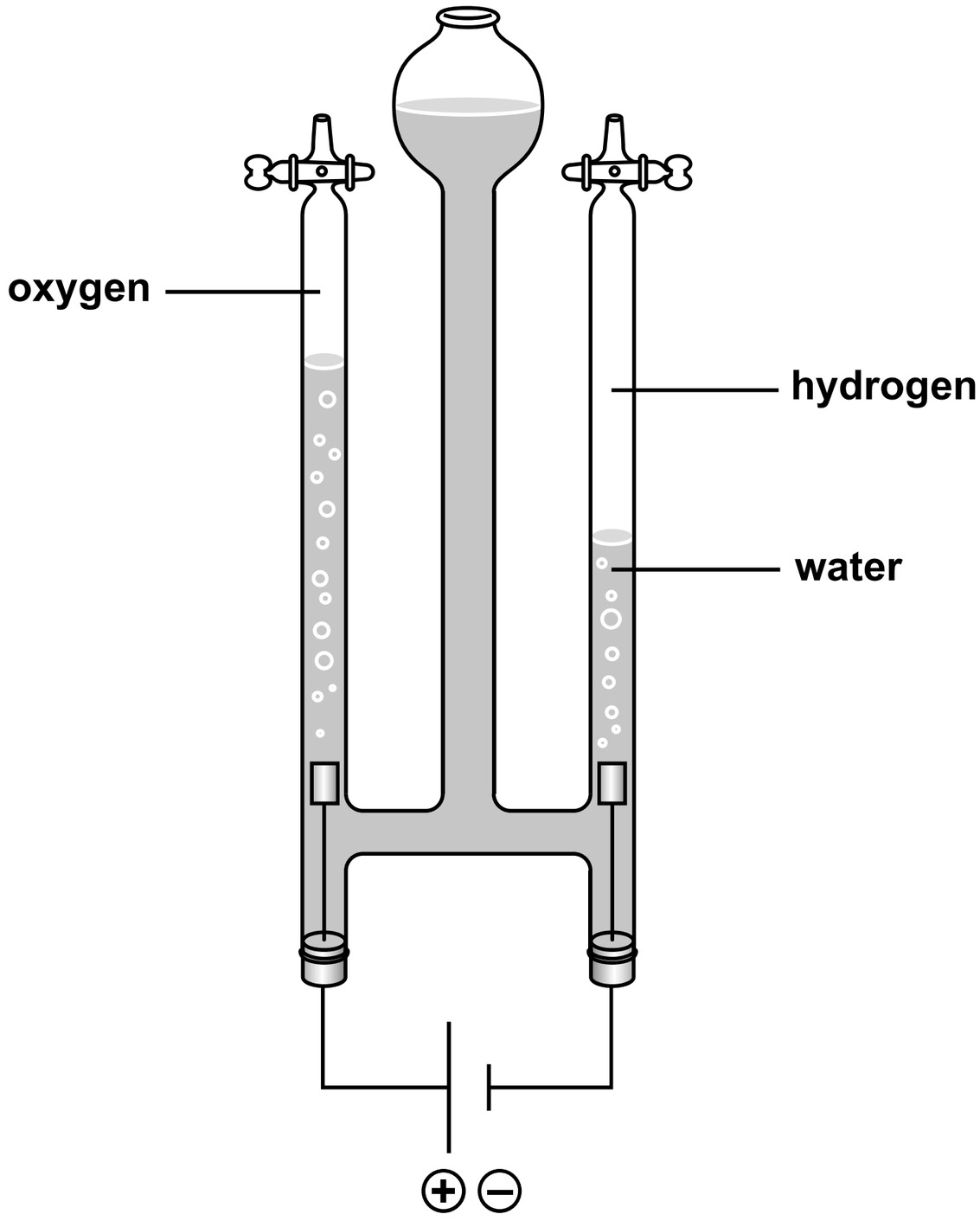
oxygen atom

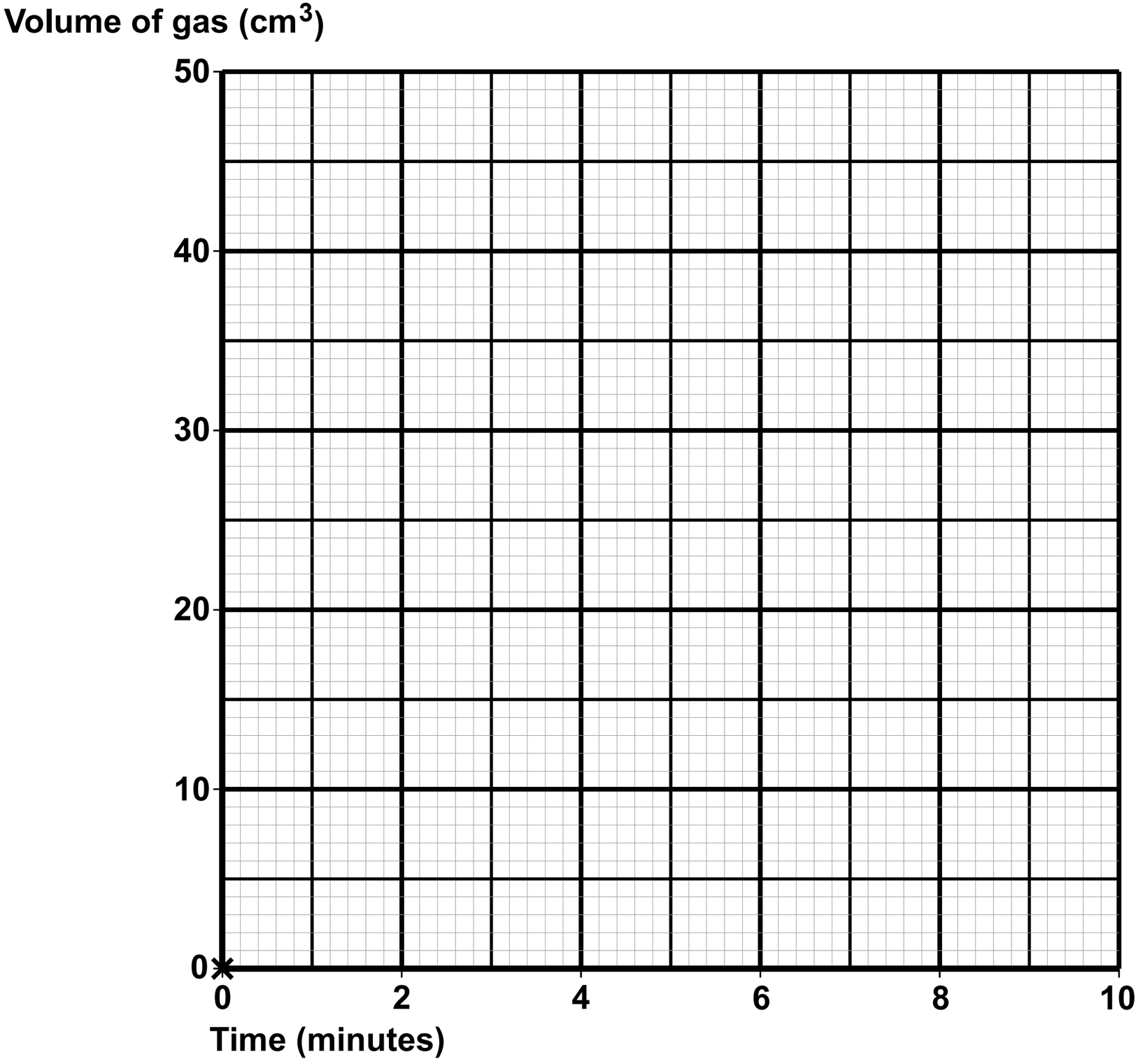


water molecule

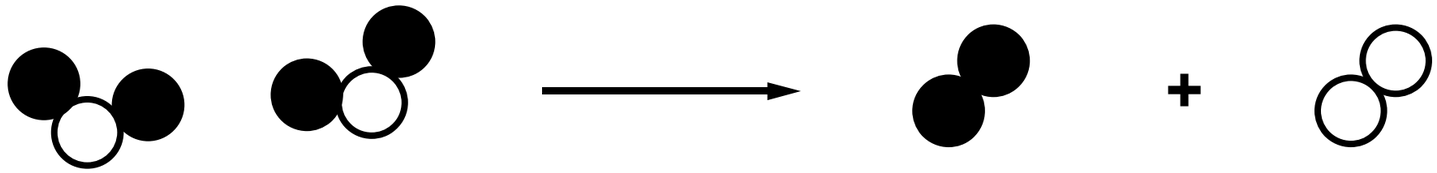



weak force between molecules

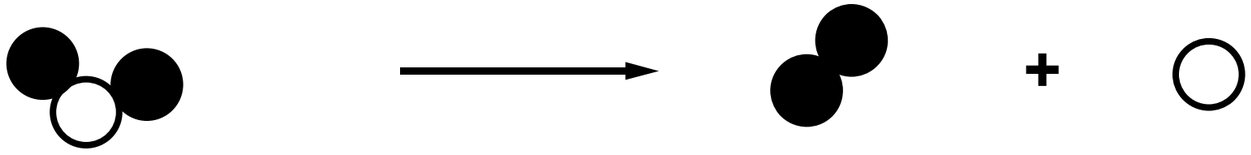

oxygen
hydrogen
water


Volume of gas (cm3)
50
40
30
20
10
0
0
2
4
6
8
10
Time (minutes)

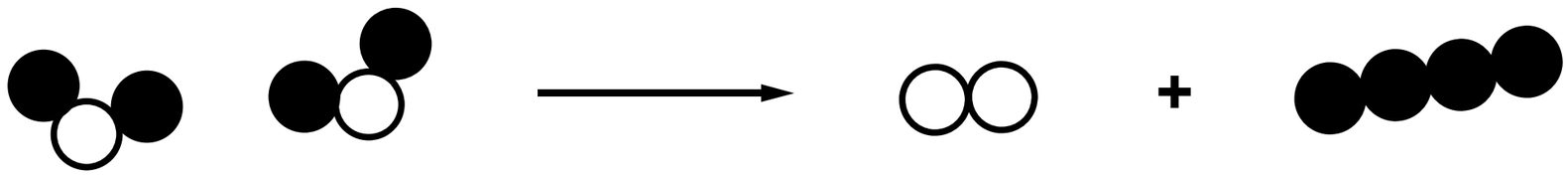
A



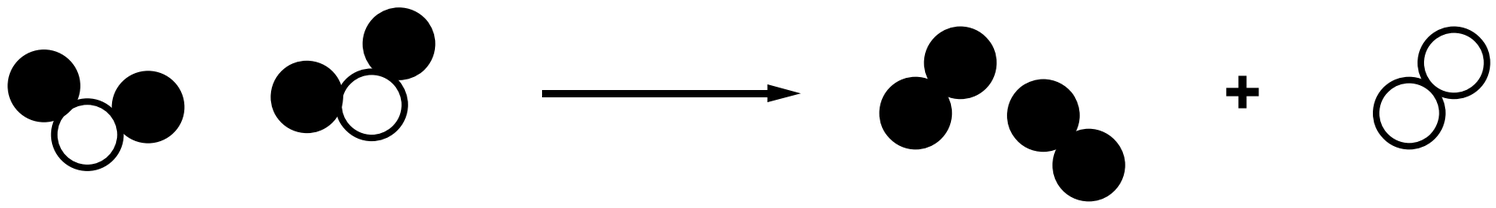
B



C

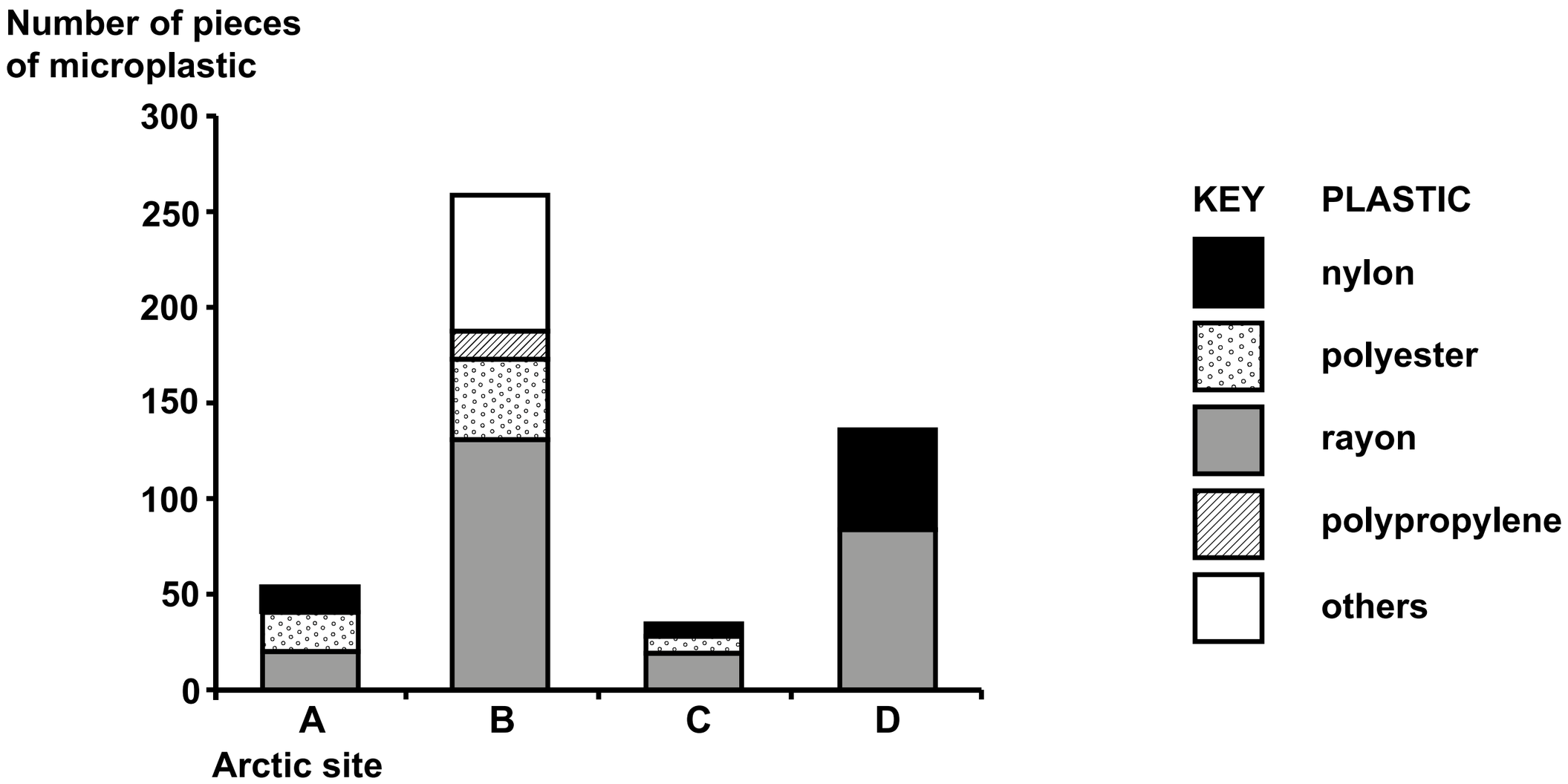


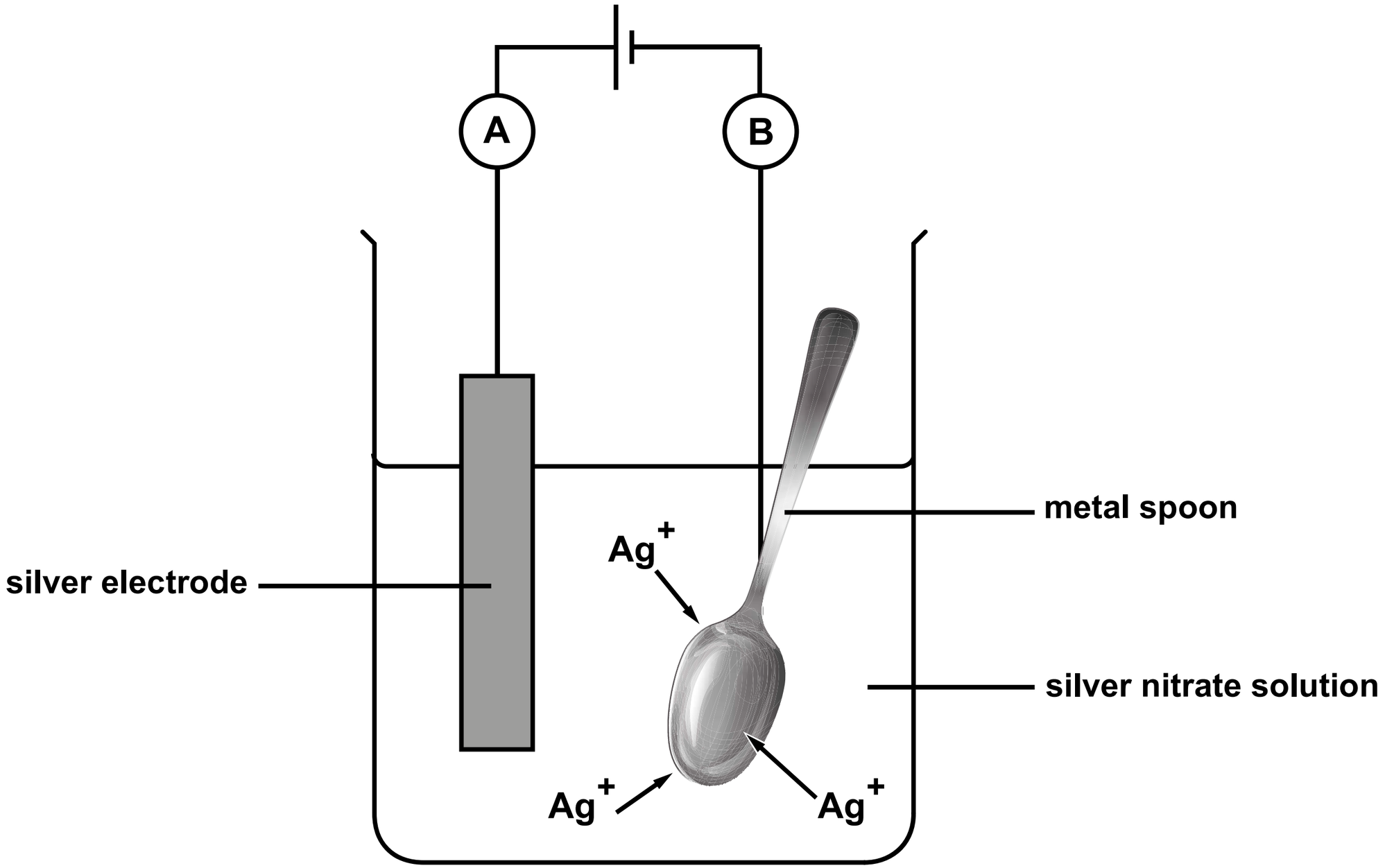
D

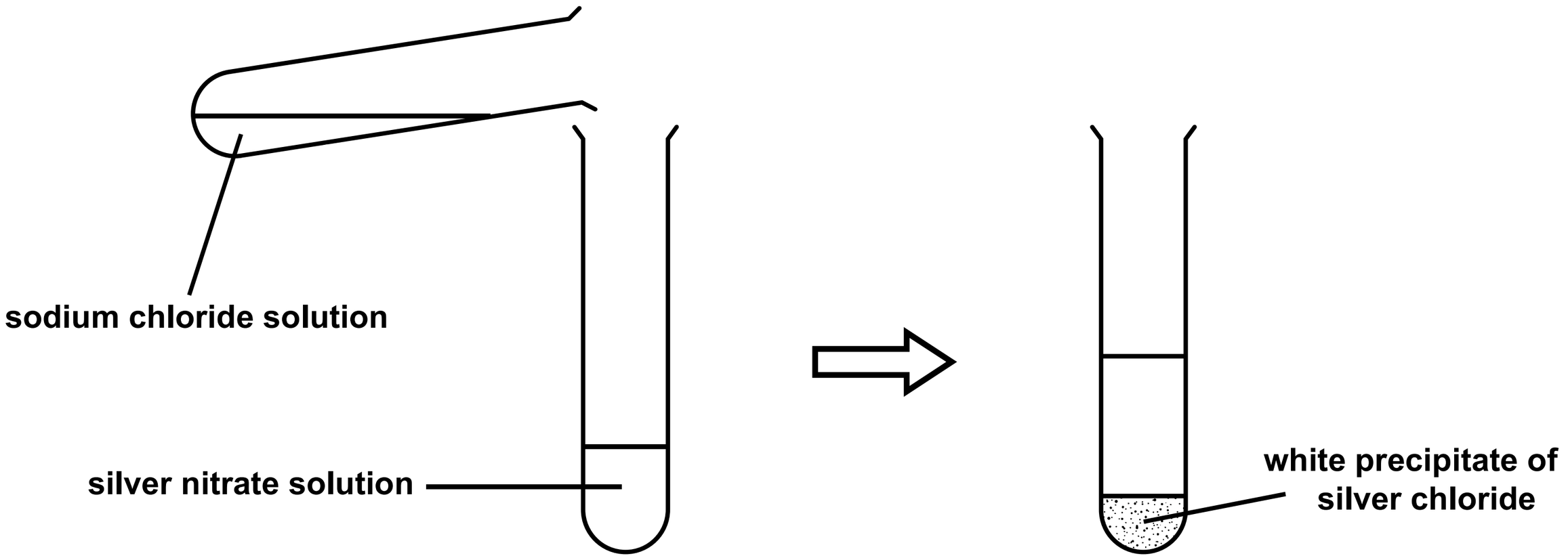


Letter _____

FIGURE 2


Number of pieces of microplastic
300
250
200
150
100
50
0
A
B
C
D
Arctic site
KEY
PLASTIC
nylon
polyester
rayon
polypropylene
others


A
B
metal spoon
silver electrode
Ag+
silver nitrate solution
Ag+
Ag+


sodium chloride solution
silver nitrate solution
white precipitate of
silver chloride

Fruit packaging

Drinks containers

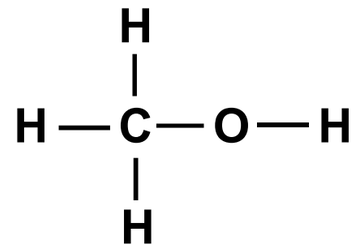
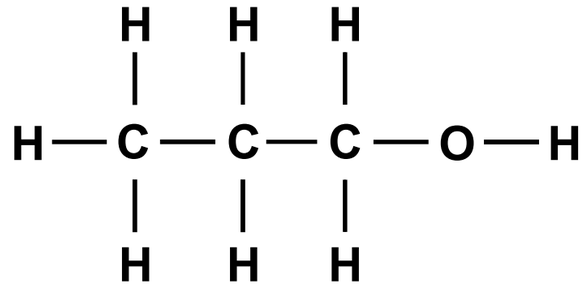
Take-away meal containers

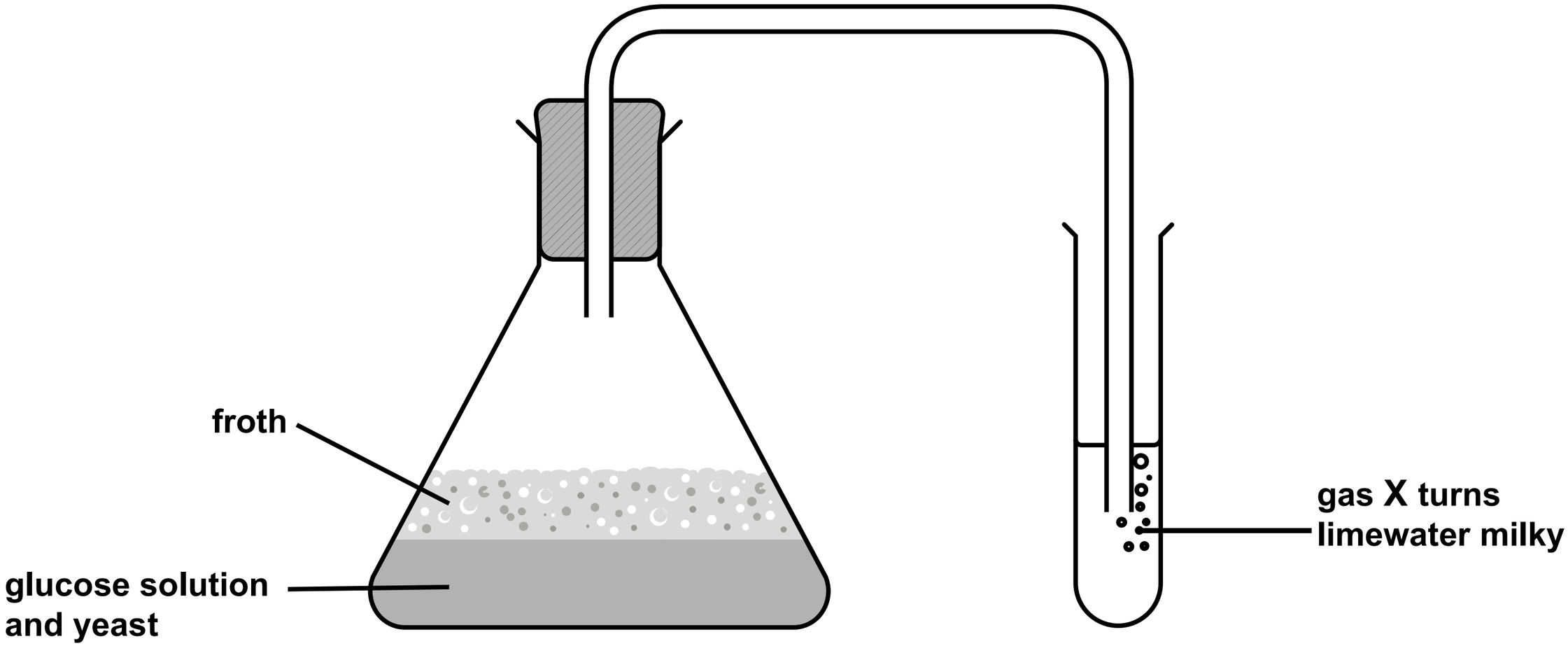
10 Mt European plastic production

1950 1967 1989 2002 2009 2010 2011 2012 2013

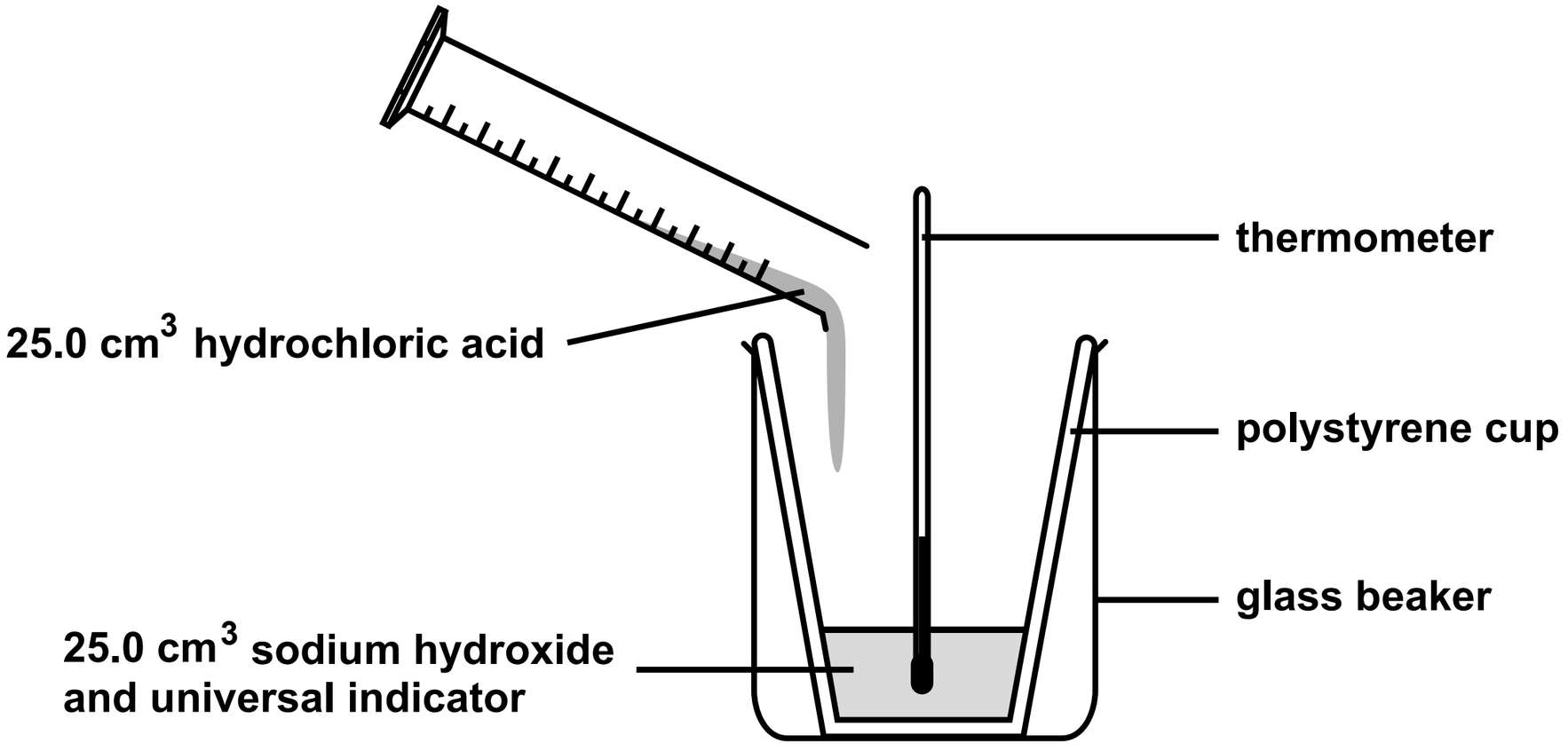
Year

MICROPLASTICS

Name	Molecular formula	Structural formula
methanol	_____	
ethanol	C_2H_5OH	_____
_____	C_3H_7OH	

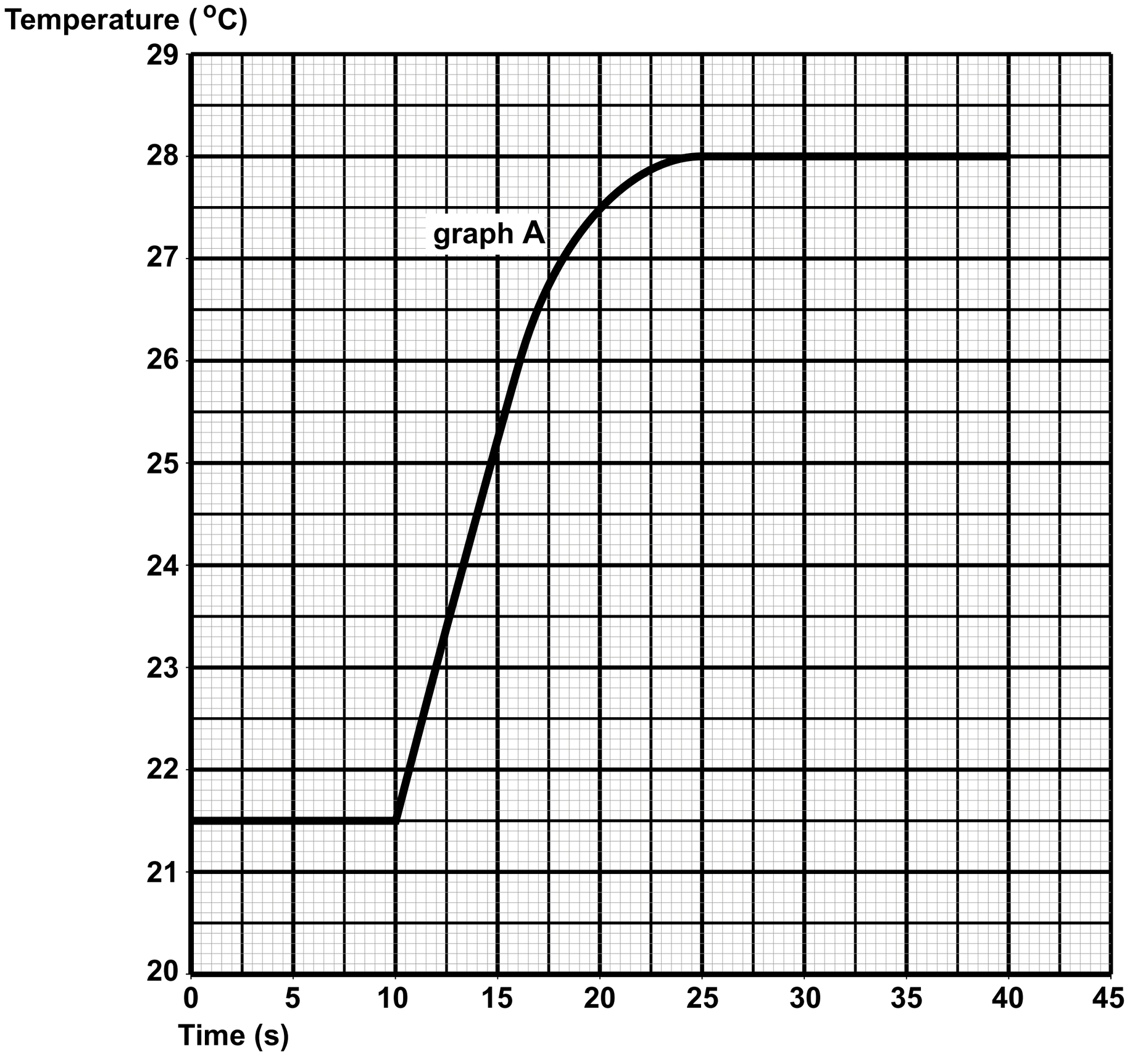

froth
glucose solution
and yeast
gas X turns
limewater milky

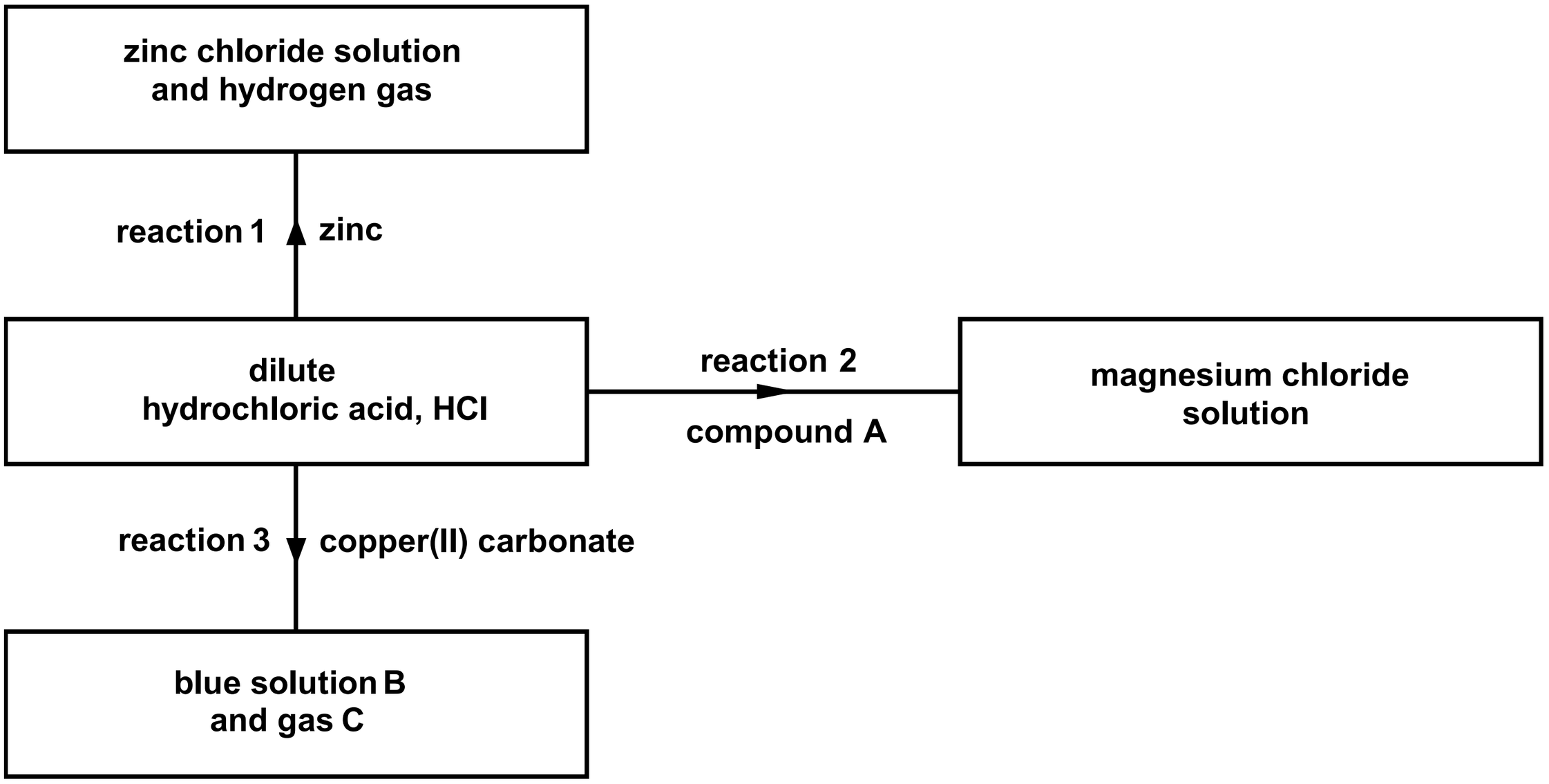
	Ethanol	Petrol
Source	sugar cane	crude oil
Energy released (MJ)	23.5	33.0
CO_2 released (kg)	1.5	2.2


thermometer
25.0 cm3 hydrochloric acid
polystyrene cup
glass beaker
25.0 cm3 sodium hydroxide
and universal indicator

energy given out = TOTAL volume of reaction mixture × 4.2 × temperature rise

Time (s)	0	5	10	15	20	25	30	35	40
Temperature (°C)	21.5	21.5	21.5	24.0	26.0	26.9	27.0	27.0	27.0


Temperature (°C)
29
28
27
26
25
24
23
22
21
20
graph A
0
5
10
15
20
25
30
35
40
45
Time (s)


zinc chloride solution
and hydrogen gas
reaction 1
zinc
dilute
hydrochloric acid, HCl
reaction 2
compound A
magnesium chloride
solution
reaction 3
copper(II) carbonate
blue solution B
and gas C

Alkanes
CH_4
C_2H_6
C_3H_8
C_4H_{10}

Alkenes
C_2H_4
C_3H_6

GCSE

3410U20-1

THURSDAY, 16 MAY 2019 – MORNING

CHEMISTRY – UNIT 2:

Chemical Bonding, Application of Chemical Reactions and Organic Chemistry

FOUNDATION TIER

INSERT

THE PERIODIC TABLE

1	2	Group										3	4	5	6	7	0
																	4 He
7 Li	9 Be											11 B	12 C	14 N	16 O	19 F	20 Ne
23 Na	24 Mg											27 Al	28 Si	31 P	32 S	35.5 Cl	40 Ar
39 K	40 Ca	45 Sc	48 Ti	51 V	52 Cr	55 Mn	56 Fe	59 Co	59 Ni	63.5 Cu	65 Zn	70 Ga	73 Ge	75 As	79 Se	80 Br	84 Kr
86 Rb	88 Sr	89 Y	91 Zr	93 Nb	96 Mo	99 Tc	101 Ru	103 Rh	106 Pd	108 Ag	112 Cd	115 In	119 Sn	122 Sb	128 Te	127 I	131 Xe
133 Cs	137 Ba	139 La	179 Hf	181 Ta	184 W	186 Re	190 Os	192 Ir	195 Pt	197 Au	201 Hg	204 Tl	207 Pb	209 Bi	210 Po	210 At	222 Rn
223 Fr	226 Ra	227 Ac															

1
H

Key:

PERIODIC TABLE - KEY
ATOMIC NUMBER - SYMBOL - NAME

1 H - Hydrogen
2 He - Helium
3 Li - Lithium
4 Be - Beryllium
5 B - Boron
6 C - Carbon
7 N - Nitrogen
8 O - Oxygen
9 F - Fluorine
10 Ne - Neon
11 Na - Sodium
12 Mg - Magnesium
13 Al - Aluminium
14 Si - Silicon
15 P - Phosphorus
16 S - Sulfur
17 Cl - Chlorine
18 Ar - Argon
19 K - Potassium
20 Ca - Calcium
21 Sc - Scandium
22 Ti - Titanium
23 V - Vanadium
24 Cr - Chromium
25 Mn - Manganese
26 Fe - Iron
27 Co - Cobalt
28 Ni - Nickel
29 Cu - Copper
30 Zn - Zinc
31 Ga - Gallium
32 Ge - Germanium
33 As - Arsenic
34 Se - Selenium
35 Br - Bromine
36 Kr - Krypton
37 Rb - Rubidium
38 Sr - Strontium
39 Y - Yttrium
40 Zr - Zirconium
41 Nb - Niobium
42 Mo - Molybdenum
43 Tc - Technetium
44 Ru - Ruthenium
45 Rh - Rhodium
46 Pd - Palladium
47 Ag - Silver
48 Cd - Cadmium
49 In - Indium
50 Sn - Tin
51 Sb - Antimony
52 Te - Tellurium
53 I - Iodine
54 Xe - Xenon
55 Cs - Caesium
56 Ba - Barium
57 La - Lanthanum
72 Hf - Hafnium
73 Ta - Tantalum
74 W - Tungsten
75 Re - Rhenium
76 Os - Osmium
77 Ir - Iridium
78 Pt - Platinum
79 Au - Gold
80 Hg - Mercury
81 Tl - Thallium
82 Pb - Lead
83 Bi - Bismuth
84 Po - Polonium
85 At - Astatine
86 Rn - Radon
87 Fr - Francium
88 Ra - Radium
89 Ac - Actinium