

Surname	Centre Number	Candidate Number
Other Names		0



GCSE

3410U20-1



S19-3410U20-1

THURSDAY, 16 MAY 2019 – MORNING

CHEMISTRY – Unit 2:
Chemical Bonding, Application of Chemical Reactions
and Organic Chemistry

FOUNDATION TIER

1 hour 45 minutes

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page 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 is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

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	

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01

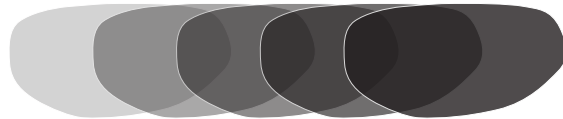


MAY193410U20101

Answer all questions.

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

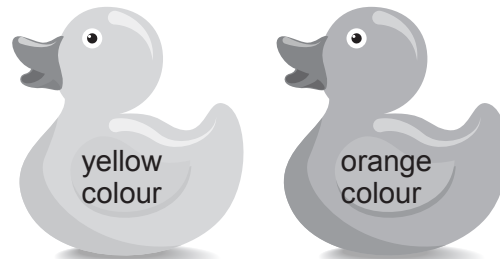
sunglasses



cloudy

sunny

baby bath thermometer



cold

hot

car bumpers



nappies



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		



(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

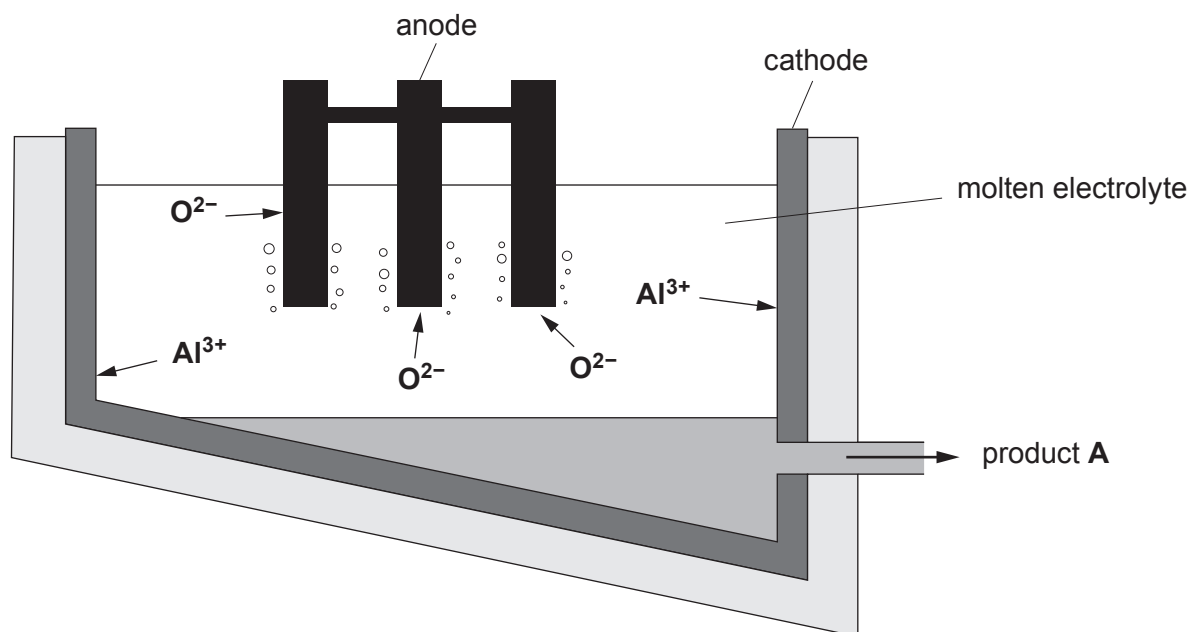


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2. The diagram shows an electrolysis cell used in the extraction of aluminium from alumina.



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

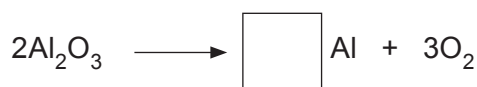
Product **A** is

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.

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

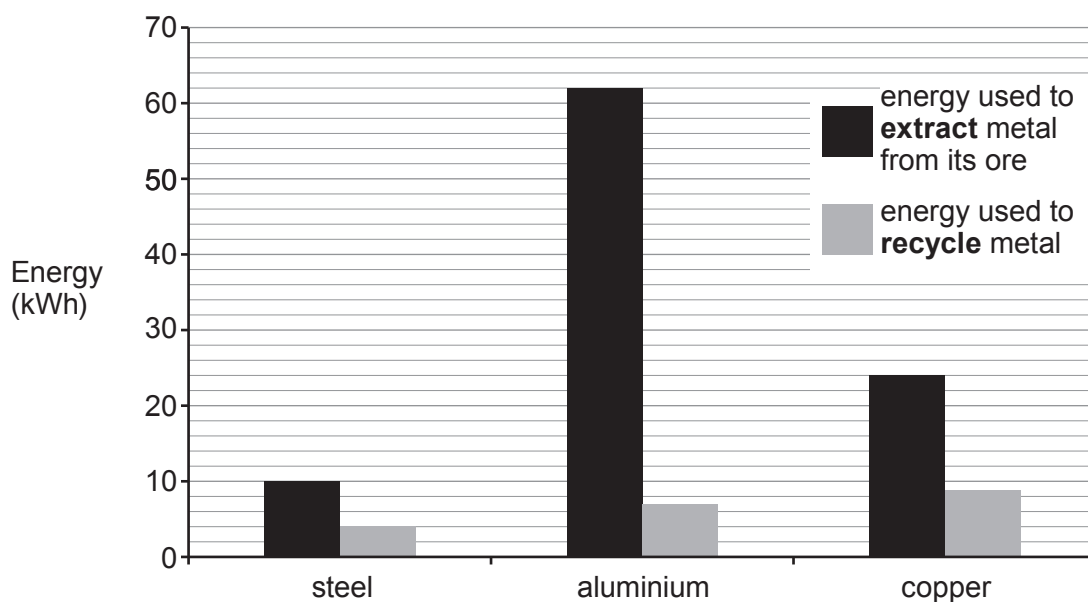


- (c) 250 tonnes of an aluminium ore can produce 195 tonnes of alumina.
Calculate the percentage of alumina in the ore.

[2]

Percentage = %

- (d) The chart 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

☐

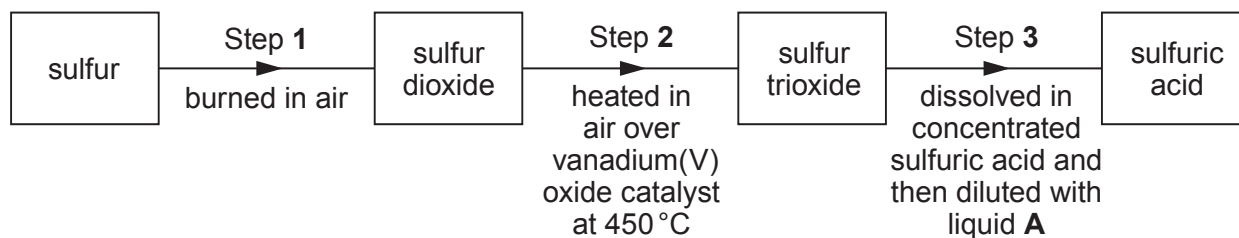
The difference between the energy used to extract and the energy used to recycle is the greatest

☐

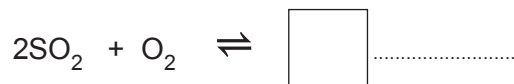
The energy used in recycling is less than for copper but greater than for steel

☐

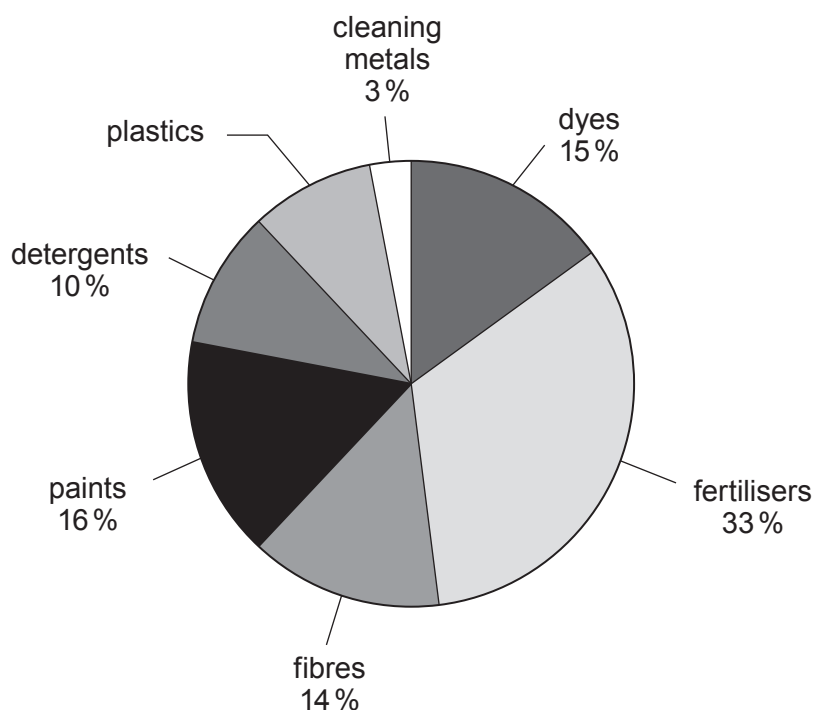

3. (a) The flow diagram shows steps in the manufacture of sulfuric acid using the Contact Process.



- (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]



(b) The pie chart 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, $(\text{NH}_4)_2\text{SO}_4$.

Complete the following word equation for the production of ammonium sulfate.

[1]

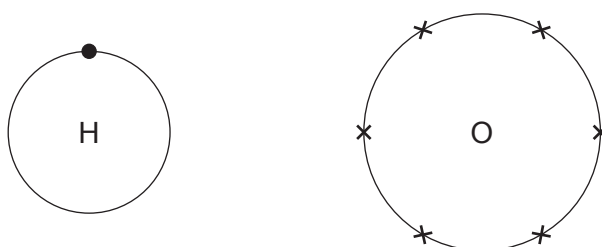
sulfuric acid + $\longrightarrow$ ammonium sulfate



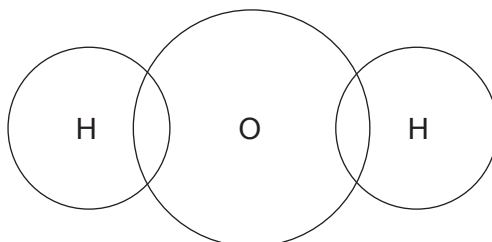
4. (a) The table shows the electronic structure of the elements present in water.

Element	Electronic structure
hydrogen	1
oxygen	2,6

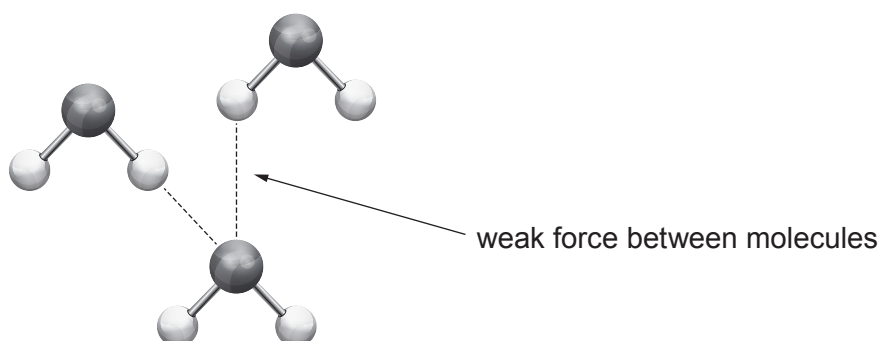
The diagrams show the outer shell electrons in an atom of hydrogen and an atom of oxygen.



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



- (ii) The diagram shows some water molecules and the weak forces between them.

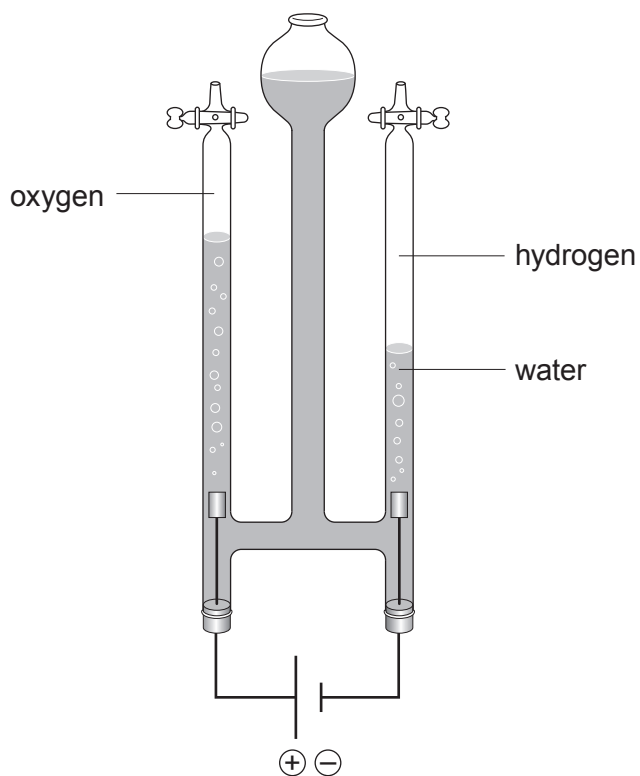


Put a tick (✓) in the box next to the property of water which can be explained by the weak forces between water molecules. [1]

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



- (b) The diagram 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.



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

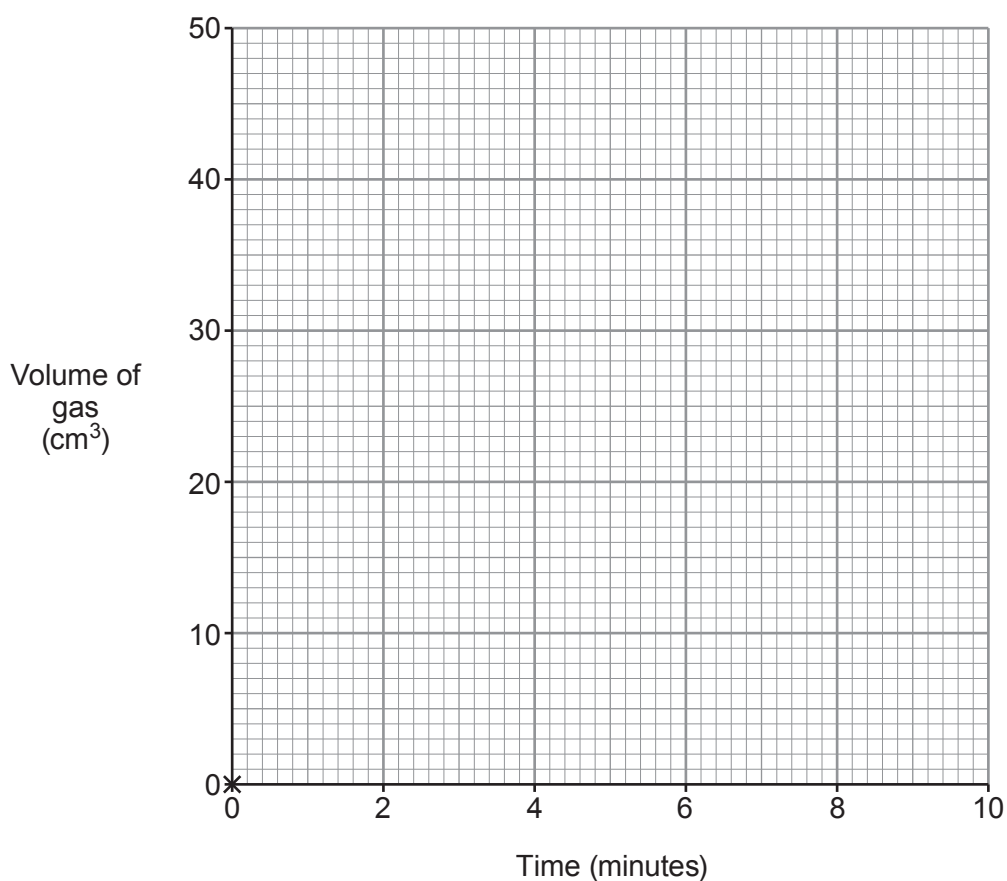
Time (minutes)	0	2	4	6	8	10
Volume of hydrogen (cm ³)	0	10	20	30	40	50



- I. Plot the values from the table on the grid. 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]

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

.....

.....

.....

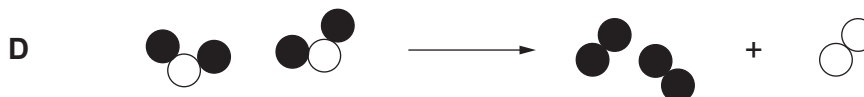


(ii) Electrolysis of water can be represented by the following equation.



Give the **letter, A, B, C or D**, of the diagram which also represents this reaction.

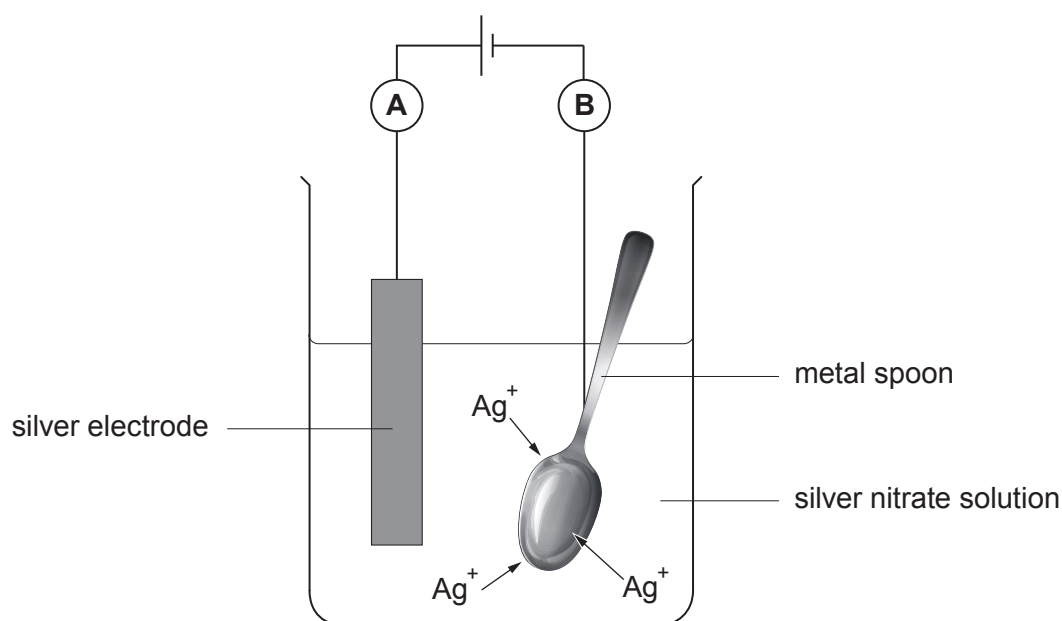
[1]



Letter



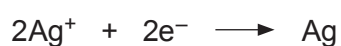
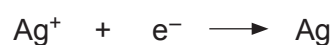
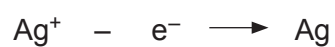
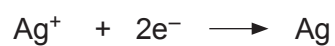
- (c) One use of electrolysis is in electroplating. The diagram shows the silver plating of a metal spoon.



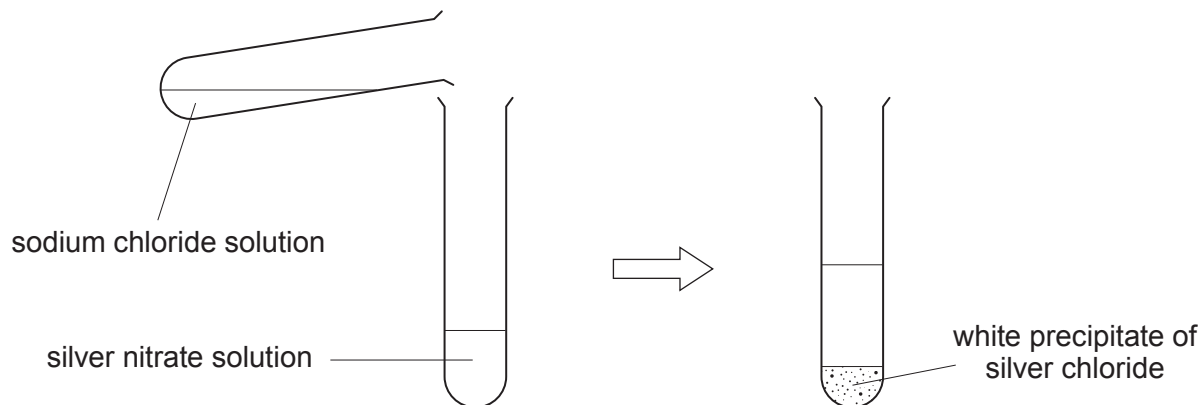
- (i) State why this process does not work for a plastic spoon. [1]

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

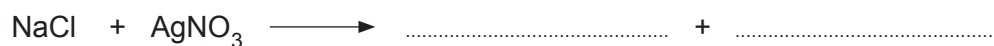
- (iii) Put a tick (✓) in the box next to the electrode equation for the reaction at electrode **B**. [1]


☐

☐

☐

☐


5. (a) 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]



- (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

☐

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

.....



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

$$A_r(\text{O}) = 16$$

$$A_r(\text{N}) = 14$$

$$A_r(\text{Ag}) = 108$$

$$M_r = \dots\dots\dots$$

- (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]

$$A_r(\text{Na}) = 23$$

$$\text{Percentage} = \dots\dots\dots \%$$



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- ## Take-away meal containers



[6 QER]

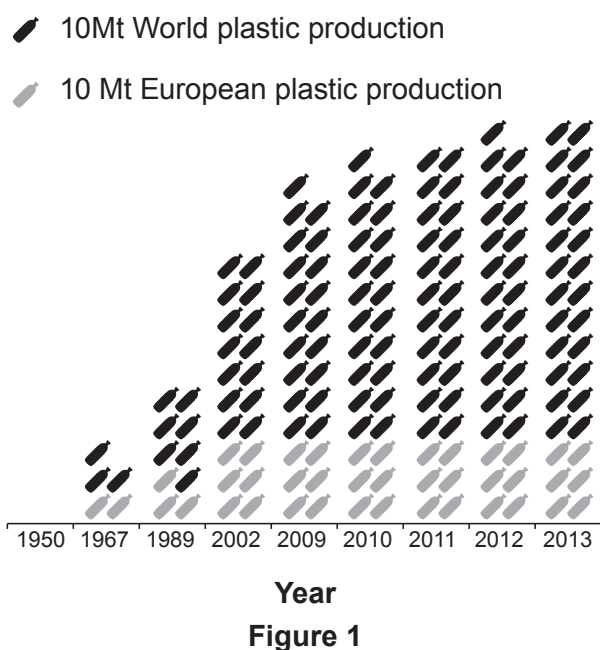


(b)

Microplastics in the Ocean

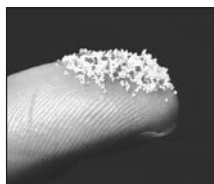
Plastics are used in many areas of modern life.

Figure 1 shows the amount of plastic production between 1950 and 2013.

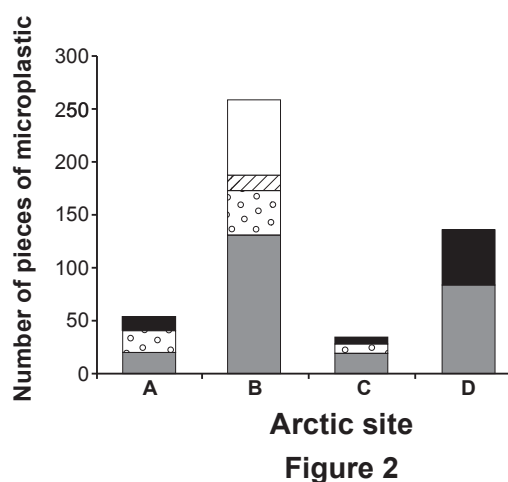
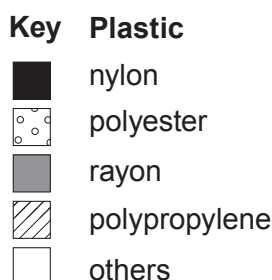


One of plastic's greatest properties, its durability, is also one of the main reasons that plastics present a threat to the marine environment.

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** 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. 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.



- (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

☐

- (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]

.....

- (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

☐

- (v) Suggest a method of educating people of the hazards of microplastics. [1]

.....

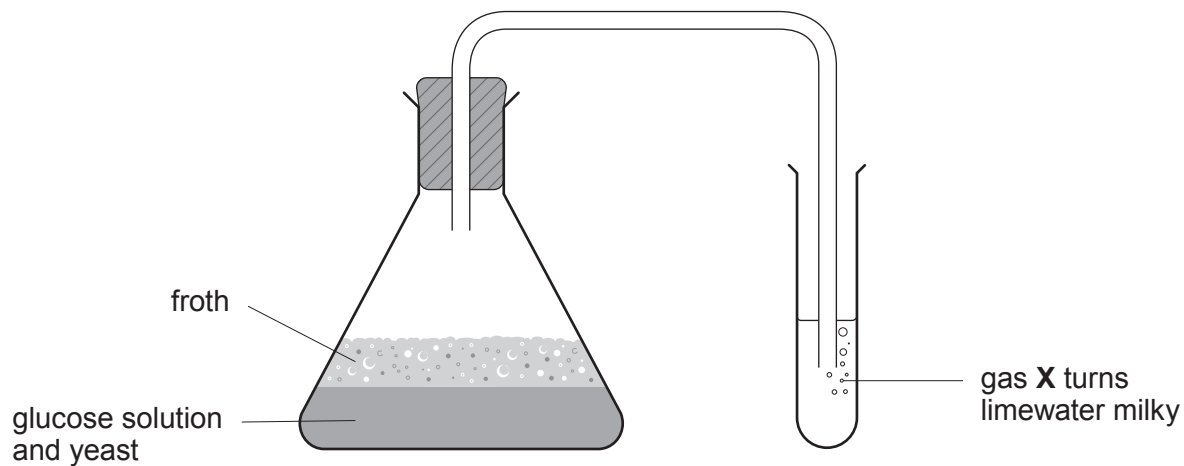


7. (a) The table shows the names, molecular formulae and structural formulae of some alcohols. Complete the table. [3]

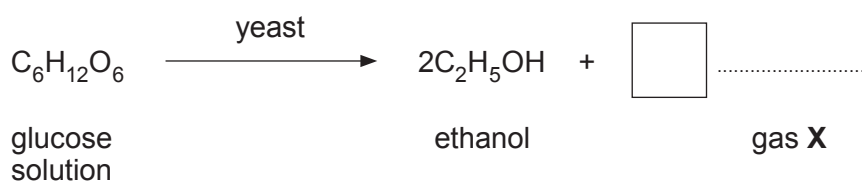
Name	Molecular formula	Structural formula
methanol		$ \begin{array}{c} \text{H} \\ \\ \text{H} - \text{C} - \text{O} - \text{H} \\ \\ \text{H} \end{array} $
ethanol	$\text{C}_2\text{H}_5\text{OH}$	
.....	$\text{C}_3\text{H}_7\text{OH}$	$ \begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{H} & \\ & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - \text{O} - \text{H} \\ & & & & & & \\ & \text{H} & & \text{H} & & \text{H} & \end{array} $



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



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



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

.....



- (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 shows information relating to the burning of 1 dm³ of ethanol and petrol.

	Ethanol	Petrol
Source	sugar cane	crude oil
Energy released (MJ)	23.5	33.0
CO ₂ released (kg)	1.5	2.2

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

.....

Disadvantage

.....

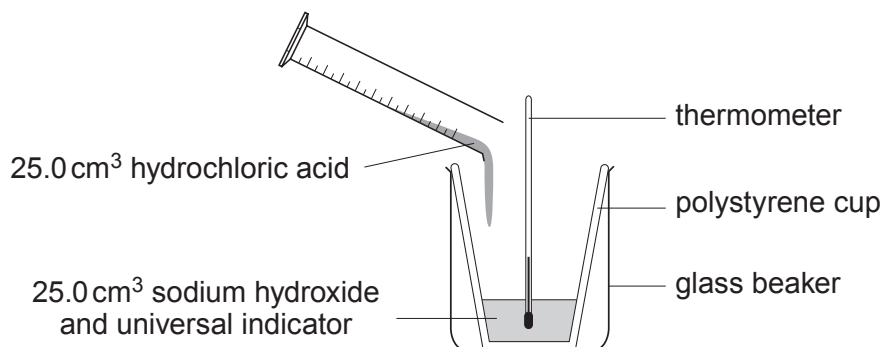


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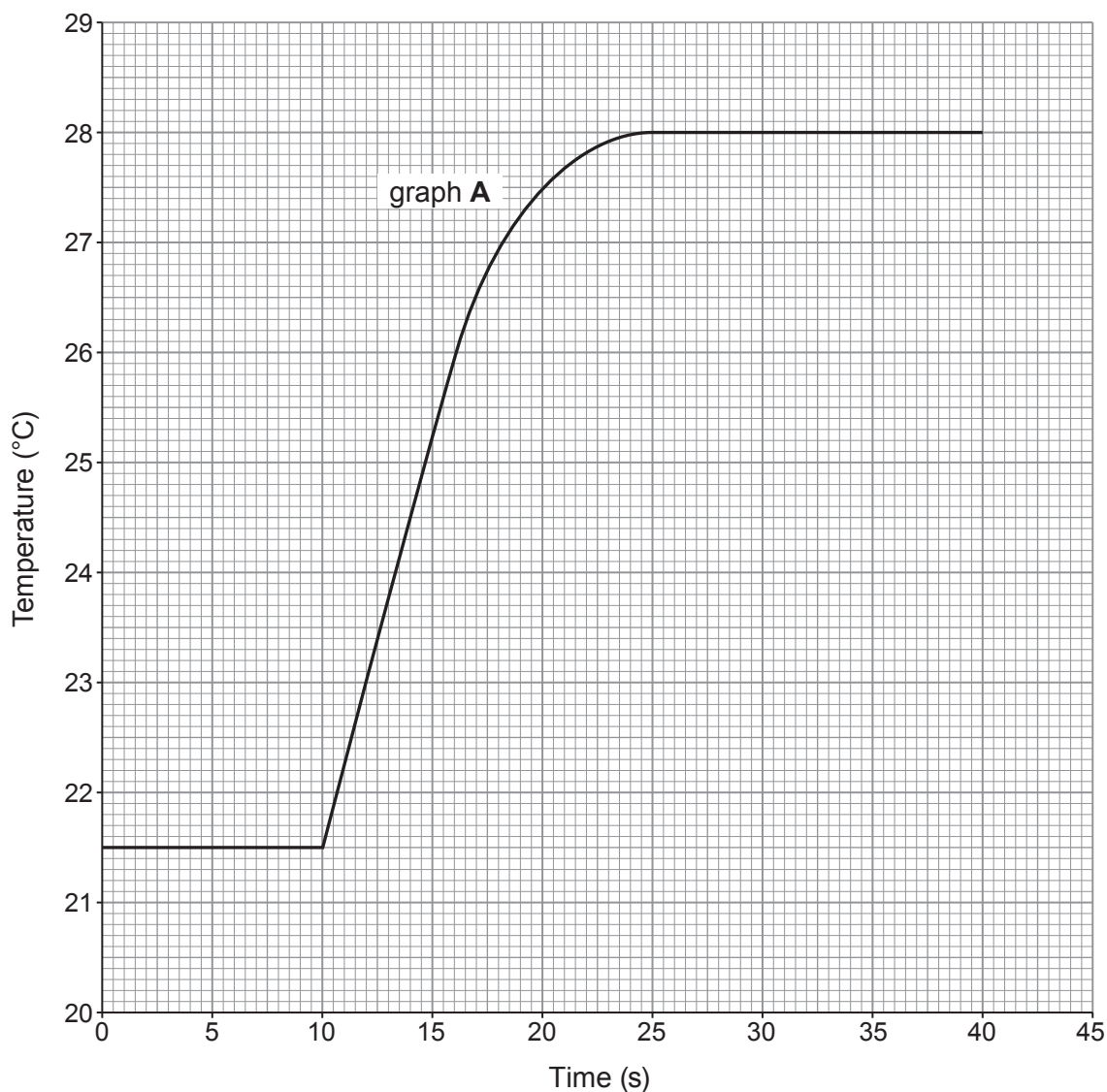
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8. A student investigated the temperature rise during a neutralisation reaction.



The student put 25.0 cm³ 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 cm³ of dilute hydrochloric acid to the alkali and recorded the temperature every 5 seconds for another 30 seconds. Graph **A** shows the results obtained.



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

Temperature rise = °C

- (ii) The energy given out can be calculated using the following formula.

energy given out = **total** volume of reaction mixture $\times$ 4.2 $\times$ temperature rise

Calculate the energy given out during the reaction. [2]

Energy given out = J

- (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

.....

- (b) The student repeated the experiment using 25.0 cm³ of ethanoic acid of the same concentration as the hydrochloric acid. The table shows the results obtained.

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

Plot the results on the grid on page 26. 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

.....



(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]

.....

.....

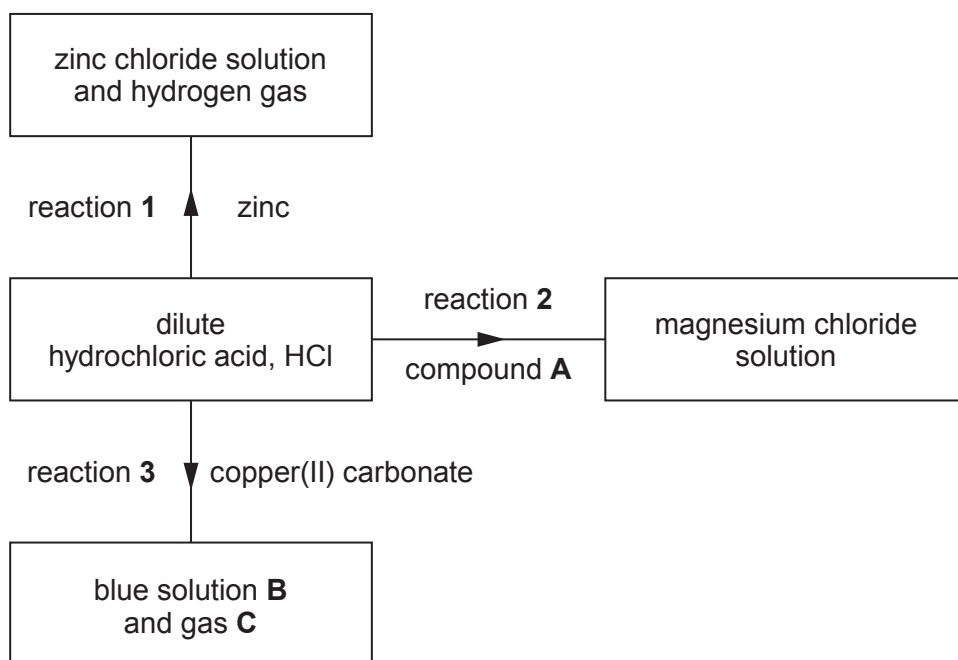
(ii) What improvement to the apparatus would you suggest to the student to obtain temperature rises closer to the expected values? [1]

.....

.....



9. The diagram 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]

.....

- (c) Reaction 1 was repeated using magnesium instead of zinc. Explain the difference, if any, that you would expect to see. [2]

.....

.....

.....



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

Alkanes	Alkenes
CH_4	C_2H_4
C_2H_6	C_3H_6
C_3H_8	
C_4H_{10}	

- (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

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

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

.....

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[illegible]

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FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	Formula	Name	Formula
aluminium	Al^{3+}	bromide	Br^-
ammonium	NH_4^+	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^-
calcium	Ca^{2+}	fluoride	F^-
copper(II)	Cu^{2+}	hydroxide	OH^-
hydrogen	H^+	iodide	I^-
iron(II)	Fe^{2+}	nitrate	NO_3^-
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^+	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^+		
silver	Ag^+		
sodium	Na^+		
zinc	Zn^{2+}		





THE PERIODIC TABLE

Group

1

2

3

4

5

6

7

0

<div><div>1</div><div>H</div><div>Hydrogen</div><div>1</div></div>																				<div><div>4</div><div>He</div><div>Helium</div><div>2</div></div>							
<div><div>7</div><div>Li</div><div>Lithium</div><div>3</div></div>	<div><div>9</div><div>Be</div><div>Beryllium</div><div>4</div></div>											<div><div>11</div><div>B</div><div>Boron</div><div>5</div></div>	<div><div>12</div><div>C</div><div>Carbon</div><div>6</div></div>	<div><div>14</div><div>N</div><div>Nitrogen</div><div>7</div></div>	<div><div>16</div><div>O</div><div>Oxygen</div><div>8</div></div>	<div><div>19</div><div>F</div><div>Fluorine</div><div>9</div></div>											<div><div>20</div><div>Ne</div><div>Neon</div><div>10</div></div>
<div><div>23</div><div>Na</div><div>Sodium</div><div>11</div></div>	<div><div>24</div><div>Mg</div><div>Magnesium</div><div>12</div></div>											<div><div>27</div><div>Al</div><div>Aluminium</div><div>13</div></div>	<div><div>28</div><div>Si</div><div>Silicon</div><div>14</div></div>	<div><div>31</div><div>P</div><div>Phosphorus</div><div>15</div></div>	<div><div>32</div><div>S</div><div>Sulfur</div><div>16</div></div>	<div><div>35.5</div><div>Cl</div><div>Chlorine</div><div>17</div></div>											<div><div>40</div><div>Ar</div><div>Argon</div><div>18</div></div>
<div><div>39</div><div>K</div><div>Potassium</div><div>19</div></div>	<div><div>40</div><div>Ca</div><div>Calcium</div><div>20</div></div>	<div><div>45</div><div>Sc</div><div>Scandium</div><div>21</div></div>	<div><div>48</div><div>Ti</div><div>Titanium</div><div>22</div></div>	<div><div>51</div><div>V</div><div>Vanadium</div><div>23</div></div>	<div><div>52</div><div>Cr</div><div>Chromium</div><div>24</div></div>	<div><div>55</div><div>Mn</div><div>Manganese</div><div>25</div></div>	<div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div>	<div><div>59</div><div>Co</div><div>Cobalt</div><div>27</div></div>	<div><div>59</div><div>Ni</div><div>Nickel</div><div>28</div></div>	<div><div>63.5</div><div>Cu</div><div>Copper</div><div>29</div></div>	<div><div>65</div><div>Zn</div><div>Zinc</div><div>30</div></div>	<div><div>70</div><div>Ga</div><div>Gallium</div><div>31</div></div>	<div><div>73</div><div>Ge</div><div>Germanium</div><div>32</div></div>	<div><div>75</div><div>As</div><div>Arsenic</div><div>33</div></div>	<div><div>79</div><div>Se</div><div>Selenium</div><div>34</div></div>	<div><div>80</div><div>Br</div><div>Bromine</div><div>35</div></div>											<div><div>84</div><div>Kr</div><div>Krypton</div><div>36</div></div>
<div><div>86</div><div>Rb</div><div>Rubidium</div><div>37</div></div>	<div><div>88</div><div>Sr</div><div>Strontium</div><div>38</div></div>	<div><div>89</div><div>Y</div><div>Yttrium</div><div>39</div></div>	<div><div>91</div><div>Zr</div><div>Zirconium</div><div>40</div></div>	<div><div>93</div><div>Nb</div><div>Niobium</div><div>41</div></div>	<div><div>96</div><div>Mo</div><div>Molybdenum</div><div>42</div></div>	<div><div>99</div><div>Tc</div><div>Technetium</div><div>43</div></div>	<div><div>101</div><div>Ru</div><div>Ruthenium</div><div>44</div></div>	<div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div>	<div><div>106</div><div>Pd</div><div>Palladium</div><div>46</div></div>	<div><div>108</div><div>Ag</div><div>Silver</div><div>47</div></div>	<div><div>112</div><div>Cd</div><div>Cadmium</div><div>48</div></div>	<div><div>115</div><div>In</div><div>Indium</div><div>49</div></div>	<div><div>119</div><div>Sn</div><div>Tin</div><div>50</div></div>	<div><div>122</div><div>Sb</div><div>Antimony</div><div>51</div></div>	<div><div>127</div><div>Te</div><div>Tellurium</div><div>52</div></div>	<div><div>127</div><div>I</div><div>Iodine</div><div>53</div></div>											<div><div>131</div><div>Xe</div><div>Xenon</div><div>54</div></div>
<div><div>133</div><div>Cs</div><div>Caesium</div><div>55</div></div>	<div><div>137</div><div>Ba</div><div>Barium</div><div>56</div></div>	<div><div>139</div><div>La</div><div>Lanthanum</div><div>57</div></div>	<div><div>179</div><div>Hf</div><div>Hafnium</div><div>72</div></div>	<div><div>181</div><div>Ta</div><div>Tantalum</div><div>73</div></div>	<div><div>184</div><div>W</div><div>Tungsten</div><div>74</div></div>	<div><div>186</div><div>Re</div><div>Rhenium</div><div>75</div></div>	<div><div>190</div><div>Os</div><div>Osmium</div><div>76</div></div>	<div><div>192</div><div>Ir</div><div>Iridium</div><div>77</div></div>	<div><div>195</div><div>Pt</div><div>Platinum</div><div>78</div></div>	<div><div>197</div><div>Au</div><div>Gold</div><div>79</div></div>	<div><div>201</div><div>Hg</div><div>Mercury</div><div>80</div></div>	<div><div>204</div><div>Tl</div><div>Thallium</div><div>81</div></div>	<div><div>207</div><div>Pb</div><div>Lead</div><div>82</div></div>	<div><div>209</div><div>Bi</div><div>Bismuth</div><div>83</div></div>	<div><div>210</div><div>Po</div><div>Polonium</div><div>84</div></div>	<div><div>210</div><div>At</div><div>Astatine</div><div>85</div></div>											<div><div>222</div><div>Rn</div><div>Radon</div><div>86</div></div>
<div><div>223</div><div>Fr</div><div>Francium</div><div>87</div></div>	<div><div>226</div><div>Ra</div><div>Radium</div><div>88</div></div>	<div><div>227</div><div>Ac</div><div>Actinium</div><div>89</div></div>																									

Key

Key

Ar

Symbol

Name

Z

relative atomic mass

atomic number