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## 0620/32

February/March 2021

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

[illegible]

0620/32/F/M/21

- 2 The table shows the mass of some of the ions in a  $1000\text{ cm}^3$  sample of sea water.

| name of ion       | formula of ion              | mass of ion in $1000\text{ cm}^3$ of sea water / mg |
|-------------------|-----------------------------|-----------------------------------------------------|
| bromide           | $\text{Br}^-$               | 65                                                  |
| calcium           | $\text{Ca}^{2+}$            | 400                                                 |
| chloride          | $\text{Cl}^-$               | 18 980                                              |
| hydrogencarbonate | $\text{HCO}_3^-$            | 140                                                 |
| magnesium         | $\text{Mg}^{2+}$            | 1262                                                |
| metaborate        | $\text{B}_3\text{O}_6^{3-}$ | 26                                                  |
|                   | $\text{K}^+$                | 380                                                 |
| sodium            | $\text{Na}^+$               | 10 556                                              |
| strontium         | $\text{Sr}^{2+}$            | 13                                                  |
|                   | $\text{SO}_4^{2-}$          | 2649                                                |

- (a) Answer these questions using only the information in the table.

- (i) State which negative ion has the lowest mass in  $1000\text{ cm}^3$  of sea water.

..... [1]

- (ii) Give the formulae of the ions in potassium sulfate.

..... and ..... [1]

- (iii) Calculate the mass of calcium ions in  $200\text{ cm}^3$  of this sample of sea water.

mass = ..... mg [1]

- (iv) A sample of this sea water is evaporated.

State the name of the compound which is present in the greatest quantity when this sample is evaporated.

..... [1]

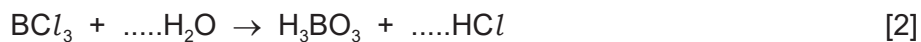
- (v) Give the name of the ion which reacts with aqueous silver nitrate to give a cream precipitate.

..... [1]

- (b) The  $\text{B}_3\text{O}_6^{3-}$  ion can be converted to boric acid,  $\text{H}_3\text{BO}_3$ .

Boric acid is also produced when boron trichloride,  $\text{BCl}_3$ , reacts with water.

Complete the equation for this reaction.



- (c) The symbol of a strontium ion is shown.



Deduce the number of electrons, protons and neutrons in one atom of this strontium ion.

number of electrons .....

number of protons .....

number of neutrons ..... [3]

- (d) Some isotopes of strontium are radioactive.

- (i) Give **one** medical use of radioactive isotopes.

..... [1]

- (ii) The isotope  ${}^{235}\text{U}$  is also radioactive.

State the major use of this isotope of uranium.

..... [1]

[Total: 12]

3 The table shows some properties of four halogens.

| element  | melting point<br>in °C | boiling point<br>in °C | density of liquid<br>at melting point<br>in g/cm <sup>3</sup> |
|----------|------------------------|------------------------|---------------------------------------------------------------|
| fluorine | –220                   | –188                   |                                                               |
| chlorine | –101                   |                        | 1.56                                                          |
| bromine  | –7                     | 59                     | 3.12                                                          |
| iodine   | 114                    | 184                    | 4.93                                                          |

(a) (i) Complete the table by predicting:

- the boiling point of chlorine
- the density of fluorine at its melting point.

[2]

(ii) Describe the trend in the melting points of the halogens down the group.

..... [1]

(iii) Deduce the physical state of iodine at 130 °C.  
Explain your answer.

.....  
 .....  
 ..... [2]

(b) (i) Give the electronic structure of a fluorine atom.

..... [1]

(ii) Explain why a fluoride ion has a single negative charge.

.....  
 ..... [1]

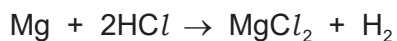
(c) Magnesium reacts with excess fluorine to produce magnesium fluoride.  
When 2.40 g of magnesium is reacted, 6.20 g of magnesium fluoride is produced.

Calculate the mass of magnesium needed to produce 1.24 g of magnesium fluoride.

mass of magnesium = ..... g [1]

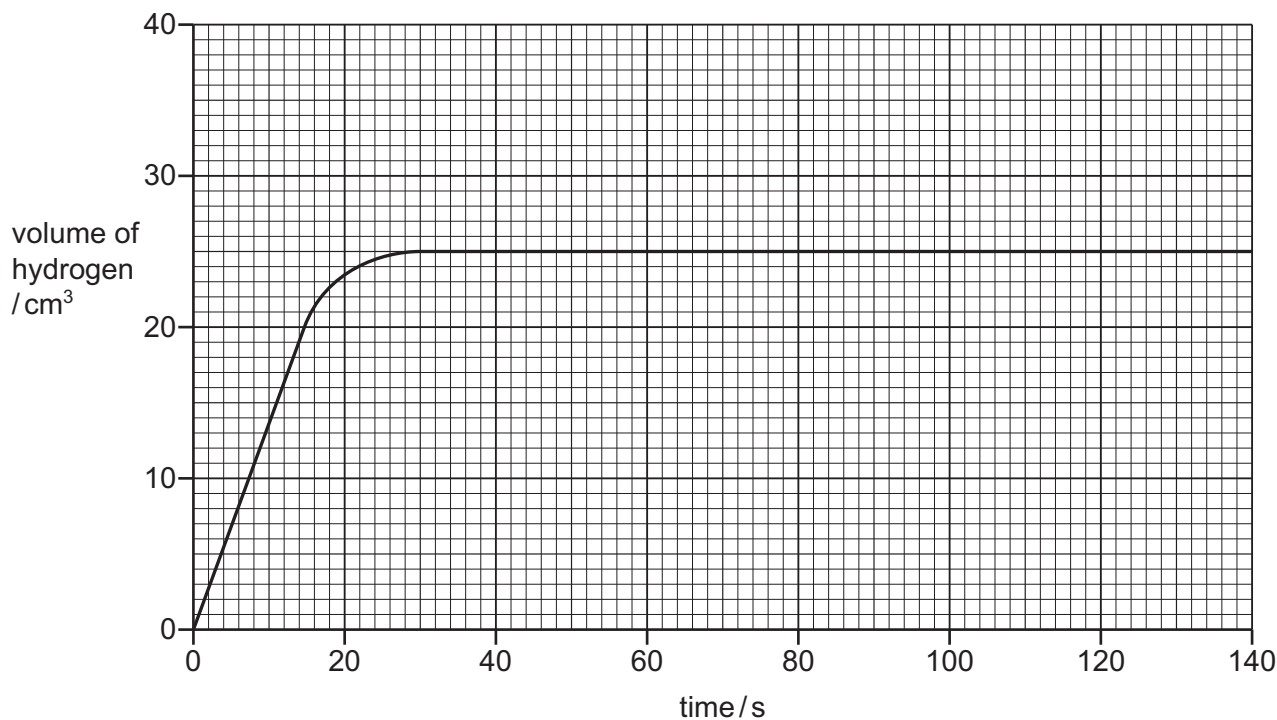
[Total: 8]

- 4 A student investigates the reaction of magnesium powder with dilute hydrochloric acid. The magnesium is in excess.



The rate of reaction can be found by measuring the increase in volume of hydrogen with time.

The results are shown on the graph.



- (a) Deduce the time taken for the reaction to finish.

time taken = ..... s [1]

- (b) The experiment is repeated using dilute hydrochloric acid of a lower concentration.

Draw a line **on the grid** to show how the volume of hydrogen changes with time using dilute hydrochloric acid of a lower concentration.

All other conditions stay the same.

[2]

(c) Describe the effect each of the following has on the rate of reaction of magnesium with hydrochloric acid.

- The temperature is increased.

All other conditions stay the same.

.....

- Magnesium ribbon is used instead of magnesium powder.

All other conditions stay the same.

.....

[2]

(d) Hydrochloric acid reacts with calcium carbonate.

Name the products of this reaction and give the observations.

products .....

.....

observations .....

.....

[4]

[Total: 9]

5 This question is about sulfur and compounds of sulfur.

(a) Sulfur is a non-metal.

Describe **three** physical properties which are typical of non-metals.

1 .....

2 .....

3 .....

[3]

(b) Name **one** source of sulfur.

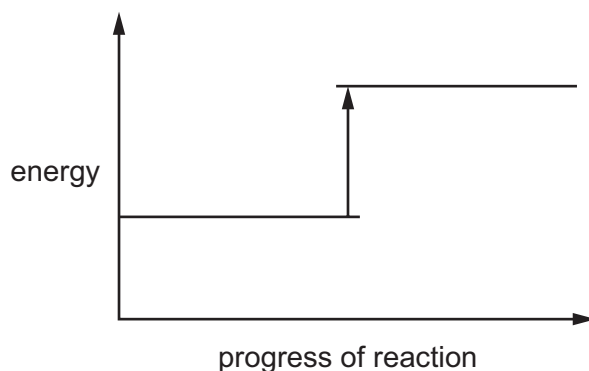
..... [1]

(c) When carbon is heated with sulfur, carbon disulfide, CS<sub>2</sub>, is produced.



(i) Complete the energy level diagram for the production of carbon disulfide by writing these formulae on the diagram:

- C + 2S
- CS<sub>2</sub>.



[1]

(ii) Explain, using information on the energy level diagram, how you know that this reaction is endothermic.

..... [1]

- (d) Carbon disulfide is a liquid at room temperature.

Describe the separation and motion of the particles in carbon disulfide liquid.

separation .....

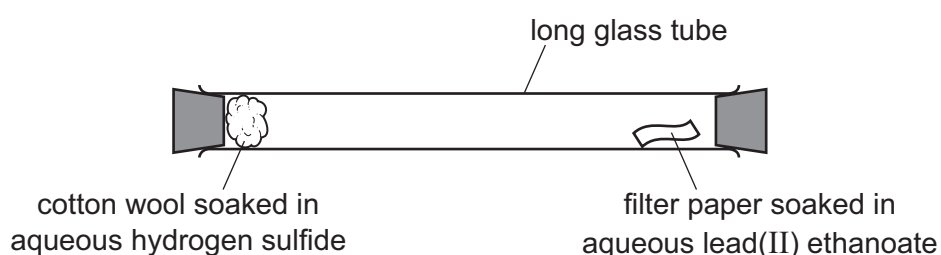
motion .....

[2]

- (e) Hydrogen sulfide is a gas which turns filter paper soaked in aqueous lead(II) ethanoate from white to black.

Hydrogen sulfide is slightly soluble in water.

A long glass tube is set up as shown.



At first, the filter paper soaked in aqueous lead(II) ethanoate does not turn black.  
After a short time, the filter paper soaked in aqueous lead(II) ethanoate turns black.

Explain these observations using the kinetic particle model.

.....  
 .....  
 .....  
 .....  
 ..... [3]

- (f) Sulfur dioxide is a pollutant in the air.

- (i) Give **one** adverse effect of sulfur dioxide on buildings.

..... [1]

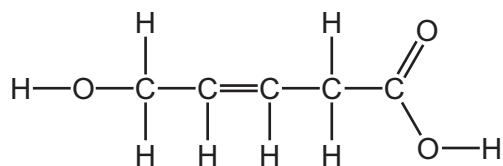
- (ii) Sulfur dioxide is used to bleach paper.

Give one **other** use of sulfur dioxide.

..... [1]

[Total: 13]

6 The structure of compound **A** is shown.



(a) (i) On the structure of compound **A**, draw a circle around the carboxylic acid functional group. [1]

(ii) State the name of the carboxylic acid that has only two carbon atoms.

..... [1]

(iii) Deduce the molecular formula of compound **A** to show the number of carbon, hydrogen and oxygen atoms.

..... [1]

(iv) Explain, by referring to its structure, why compound **A** is described as unsaturated.

..... [1]

(b) Ethene is an unsaturated hydrocarbon.

Draw the structure of ethene to show all of the atoms and all of the bonds.

[2]

(c) Ethene can be produced by cracking hydrocarbons.

(i) State the meaning of the term *cracking*.

..... [1]

(ii) Give the conditions required for cracking.

1 .....

2 .....

[2]

(d) Ethene can be polymerised.

Complete these sentences about the polymerisation of ethene using words from the list.

**addition    decomposition    neutralisation    poly(ethene)**

**poly(ethane)    reduction    Terylene**

When ethene polymerises, it produces a molecule called .....

The type of reaction which occurs is .....

[2]

(e) Describe **one** pollution problem caused by non-biodegradable plastics.

..... [1]

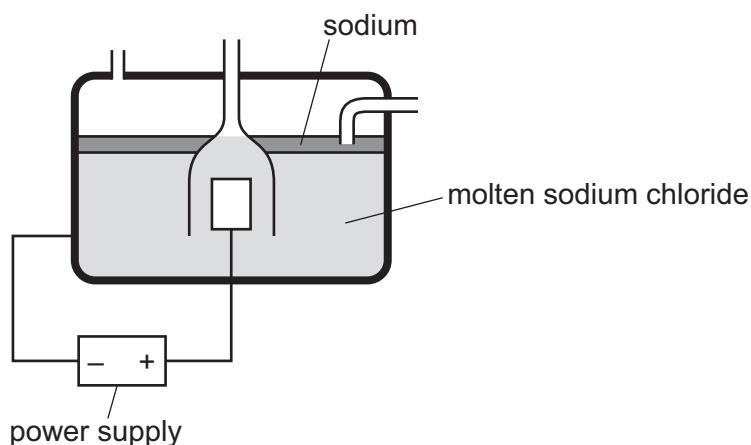
[Total: 12]

7 Sodium is manufactured by electrolysis.

(a) Explain why sodium is manufactured by electrolysis and **not** by reduction with carbon.

..... [1]

(b) The diagram shows the equipment for the production of sodium.



(i) The anode is inert.

Suggest a suitable substance that can be used for the anode.

..... [1]

(ii) Label the anode **on the diagram**. [1]

(iii) Describe, by reference to the diagram, how you know that sodium is less dense than molten sodium chloride.

..... [1]

(c) When concentrated aqueous sodium chloride is electrolysed, gases are produced at each electrode.

State the names of the products and give the observations at each electrode.

product at the negative electrode .....

observations at the negative electrode .....

.....

product at the positive electrode .....

observations at the positive electrode .....

.....

[4]

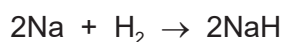
- (d) Give **two** ways in which the physical properties of sodium are different from the physical properties of transition elements.

1 .....

2 .....

[2]

- (e) The symbol equation for the production of sodium hydride is shown.



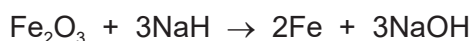
- (i) Write a word equation for this reaction.

..... [1]

- (ii) Suggest why the hydrogen must be dry.

..... [1]

- (iii) Sodium hydride reduces iron(III) oxide to iron.



Explain how this equation shows that iron(III) oxide is reduced.

..... [1]

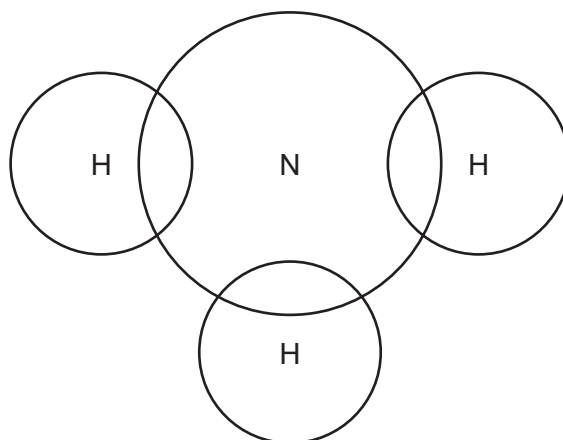
- (f) State the colour observed in the flame test for sodium.

..... [1]

[Total: 14]

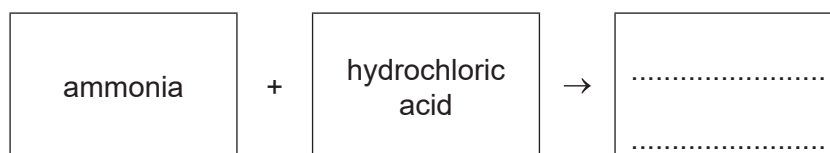
8 Aqueous ammonia is an alkali.

- (a) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ammonia.



[2]

- (b) Complete the word equation for the reaction of aqueous ammonia with dilute hydrochloric acid.



[1]

- (c) Describe the colour change when excess aqueous ammonia is added to an acidified solution of methyl orange.

from ..... to ..... [1]

(d) Aqueous ammonia reacts with aqueous copper(II) ions to produce compound **B**.

The formula of compound **B** is  $\text{CuN}_4\text{H}_{16}\text{O}_2$ .

Complete the table to calculate the relative molecular mass of compound **B**.

| type of atom | number of atoms | relative atomic mass |                    |
|--------------|-----------------|----------------------|--------------------|
| copper       | 1               | 64                   | $1 \times 64 = 64$ |
| nitrogen     | 4               | 14                   | $4 \times 14 = 56$ |
| hydrogen     |                 | 1                    |                    |
| oxygen       |                 | 16                   |                    |

relative molecular mass = .....

[2]

(e) Ammonia is used in the production of fertilisers.

State why farmers put fertilisers on the soil where crops are to be grown.

..... [1]

[Total: 7]

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## Group

| Group                      |                             |                                                                              |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                             |                             |                               |                              |                           |
|----------------------------|-----------------------------|------------------------------------------------------------------------------|---------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|--------------------------------|-------------------------------|-------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|------------------------------|---------------------------|
| I                          | II                          | Key                                                                          |                                 |                             |                              |                             |                              |                              |                                |                               |                               | III                         | IV                          | V                           | VI                            | VII                          | VIII                      |
|                            |                             | <div>1Hhydrogen1</div>                                                       |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                             |                             |                               |                              |                           |
|                            |                             | <div>atomic number<br/>atomic symbol<br/>name<br/>relative atomic mass</div> |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                             |                             |                               |                              |                           |
| 3<br>Li<br>lithium<br>7    | 4<br>Be<br>beryllium<br>9   |                                                                              |                                 |                             |                              |                             |                              |                              |                                |                               |                               | 5<br>B<br>boron<br>11       | 6<br>C<br>carbon<br>12      | 7<br>N<br>nitrogen<br>14    | 8<br>O<br>oxygen<br>16        | 9<br>F<br>fluorine<br>19     | 10<br>Ne<br>neon<br>20    |
| 11<br>Na<br>sodium<br>23   | 12<br>Mg<br>magnesium<br>24 |                                                                              |                                 |                             |                              |                             |                              |                              |                                |                               |                               | 13<br>Al<br>aluminium<br>27 | 14<br>Si<br>silicon<br>28   | 15<br>P<br>phosphorus<br>31 | 16<br>S<br>sulfur<br>32       | 17<br>Cl<br>chlorine<br>35.5 | 18<br>Ar<br>argon<br>40   |
| 19<br>K<br>potassium<br>39 | 20<br>Ca<br>calcium<br>40   | 21<br>Sc<br>scandium<br>45                                                   | 22<br>Ti<br>titanium<br>48      | 23<br>V<br>vanadium<br>51   | 24<br>Cr<br>chromium<br>52   | 25<br>Mn<br>manganese<br>55 | 26<br>Fe<br>iron<br>56       | 27<br>Co<br>cobalt<br>59     | 28<br>Ni<br>nickel<br>59       | 29<br>Cu<br>copper<br>64      | 30<br>Zn<br>zinc<br>65        | 31<br>Ga<br>gallium<br>70   | 32<br>Ge<br>germanium<br>73 | 33<br>As<br>arsenic<br>75   | 34<br>Se<br>selenium<br>79    | 35<br>Br<br>bromine<br>80    | 36<br>Kr<br>krypton<br>84 |
| 37<br>Rb<br>rubidium<br>85 | 38<br>Sr<br>strontium<br>88 | 39<br>Y<br>yttrium<br>89                                                     | 40<br>Zr<br>zirconium<br>91     | 41<br>Nb<br>niobium<br>93   | 42<br>Mo<br>molybdenum<br>96 | 43<br>Tc<br>technetium<br>— | 44<br>Ru<br>ruthenium<br>101 | 45<br>Rh<br>rhodium<br>103   | 46<br>Pd<br>palladium<br>106   | 47<br>Ag<br>silver<br>108     | 48<br>Cd<br>cadmium<br>112    | 49<br>In<br>indium<br>115   | 50<br>Sn<br>tin<br>119      | 51<br>Sb<br>antimony<br>122 | 52<br>Te<br>tellurium<br>128  | 53<br>I<br>iodine<br>127     | 54<br>Xe<br>xenon<br>131  |
| 55<br>Cs<br>caesium<br>133 | 56<br>Ba<br>barium<br>137   | 57–71<br>lanthanoids                                                         | 72<br>Hf<br>hafnium<br>178      | 73<br>Ta<br>tantalum<br>181 | 74<br>W<br>tungsten<br>184   | 75<br>Re<br>rhenium<br>186  | 76<br>Os<br>osmium<br>190    | 77<br>Ir<br>iridium<br>192   | 78<br>Pt<br>platinum<br>195    | 79<br>Au<br>gold<br>197       | 80<br>Hg<br>mercury<br>201    | 81<br>Tl<br>thallium<br>204 | 82<br>Pb<br>lead<br>207     | 83<br>Bi<br>bismuth<br>209  | 84<br>Po<br>polonium<br>—     | 85<br>At<br>astatine<br>—    | 86<br>Rn<br>radon<br>—    |
| 87<br>Fr<br>francium<br>—  | 88<br>Ra<br>radium<br>—     | 89–103<br>actinoids                                                          | 104<br>Rf<br>rutherfordium<br>— | 105<br>Db<br>dubnium<br>—   | 106<br>Sg<br>seaborgium<br>— | 107<br>Bh<br>bohrium<br>—   | 108<br>Hs<br>hassium<br>—    | 109<br>Mt<br>meitnerium<br>— | 110<br>Ds<br>darmstadtium<br>— | 111<br>Rg<br>roentgenium<br>— | 112<br>Cn<br>copernicium<br>— |                             | 114<br>Fl<br>flerovium<br>— |                             | 116<br>Lv<br>livermorium<br>— |                              |                           |

lanthanoids

actinoids

The volume of one mole of any gas is  $24\text{ dm}^3$  at room temperature and pressure (r.t.p.).