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CHEMISTRY

0620/32

Paper 3 Theory (Core)

October/November 2018

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

A copy of the Periodic Table is printed on page 16.

You may lose marks if you do not show your working or if you do not use appropriate units.

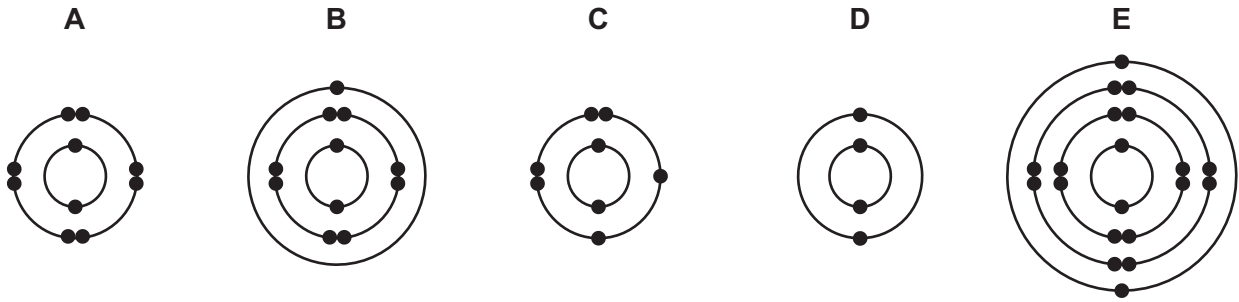
At the end of the examination, fasten all your work securely together.

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

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **16** printed pages.

1 (a) The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



Answer the following questions about these structures.

Each structure may be used once, more than once or not at all.

State which structure, **A**, **B**, **C**, **D** or **E**, represents:

- (i) an atom in Group VIII of the Periodic Table [1]
- (ii) an atom of a reactive non-metal [1]
- (iii) an atom with a proton number of 11 [1]
- (iv) an atom with only **three** shells of electrons [1]
- (v) an atom which forms a stable ion with a single positive charge. [1]

(b) Complete the table to show the number of electrons, neutrons and protons in the nitrogen atom and chromium ion shown.

| | number of electrons | number of neutrons | number of protons |
|----------------------------|---------------------|--------------------|-------------------|
| $^{15}_7\text{N}$ | 7 | | |
| $^{52}_{24}\text{Cr}^{2+}$ | | 28 | |

[3]

[Total: 8]

- 2 (a) The table shows the concentrations of the ions present in a solution obtained from cells in the body.

| ion present | formula of ion | concentration in mg/1000 cm ³ |
|-------------------|-------------------------------|--|
| sodium | Na ⁺ | 273 |
| potassium | K ⁺ | 540 |
| calcium | Ca ²⁺ | 3 |
| magnesium | Mg ²⁺ | 20 |
| chloride | Cl ⁻ | 140 |
| hydrogencarbonate | HCO ₃ ⁻ | 730 |
| phosphate | PO ₄ ³⁻ | 1 |

Answer these questions using only information from the table.

- (i) Which negative ion is present in the highest concentration?

..... [1]

- (ii) Calculate the mass of potassium ions present in 250 cm³ of this solution.

mass of potassium ions = mg [1]

- (iii) Calculate the **total** mass of positive ions present in 1000 cm³ of this solution.

total mass of positive ions = mg [1]

- (iv) Give the name of the compound formed from Na⁺ and HCO₃⁻ ions.

..... [1]

- (b) Describe what is observed in these **two** reactions.

- An excess of aqueous sodium hydroxide is added to a solution containing Ca²⁺ ions.

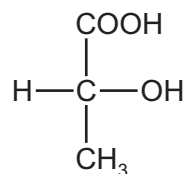
.....

- An excess of aqueous ammonia is added to a solution containing Ca²⁺ ions.

.....

[2]

- (c) Lactic acid can build up in muscle cells during exercise.
The structure of lactic acid is shown.



- (i) On the structure, draw a circle around the carboxylic acid functional group. [1]
- (ii) Deduce the molecular formula of lactic acid showing the number of carbon, hydrogen and oxygen atoms.

..... [1]

- (d) Lactic acid can form a polymer.

Complete the sentence about polymers using words from the list.

atomic large molecular monomers polymers small

During polymerisation molecules called join together to form long-chain molecules with a very high relative mass.

[3]

[Total: 11]

- 3 (a) The table gives information about the solubility of copper and selenium in an organic solvent and in water. The organic solvent boils at 30 °C.

| element | solubility in organic solvent | solubility in water |
|----------|-------------------------------|---------------------|
| copper | insoluble | insoluble |
| selenium | soluble | insoluble |

- (i) Use the information in the table to suggest how you could obtain pure, dry samples of copper and selenium from a mixture of copper powder and selenium powder.

.....

.....

.....

.....

.....

.....

..... [4]

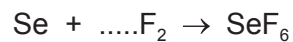
- (ii) Ethanol is an organic solvent.

Draw the structure of ethanol. Show all of the atoms and all of the bonds.

[2]

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

Balance the chemical equation for this reaction.

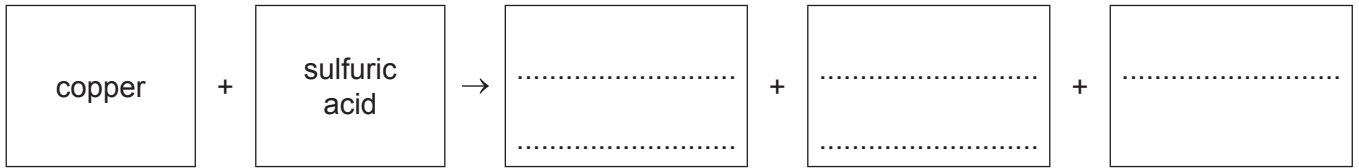


[1]

(b) The chemical equation for the reaction of copper with hot concentrated sulfuric acid is shown.



(i) Complete the word equation for this reaction.



[2]

(ii) One of the compounds in this equation is a pollutant gas which contributes to acid rain.

Identify the pollutant gas and state a common source of it.

pollutant gas

source

[2]

(c) Solid hydrated copper(II) sulfate decomposes to anhydrous copper(II) sulfate when it is continuously heated.

Is this an endothermic or an exothermic reaction?
Explain your answer.

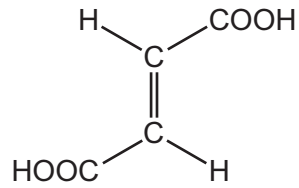
.....

..... [1]

[Total: 12]

4 This question is about acids.

(a) The structure of fumaric acid is shown.



Fumaric acid is an unsaturated compound.

(i) What feature of the structure of fumaric acid shows that it is unsaturated?

..... [1]

(ii) Describe a test for an unsaturated compound.

test

result

[2]

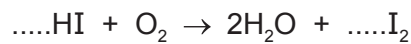
(b) Hydroiodic acid can be used for the reduction of some carboxylic acids.

(i) What is meant by the term *reduction*?

..... [1]

(ii) Hydroiodic acid is oxidised by oxygen.

Balance the chemical equation for this reaction.

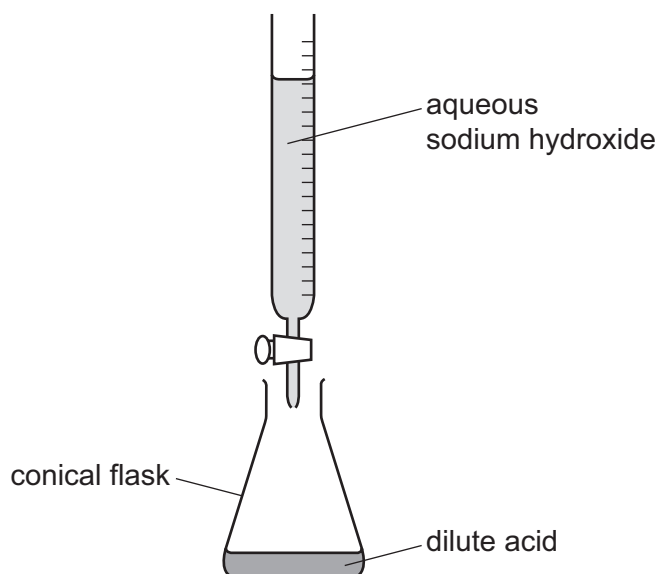


[2]

(iii) What percentage of clean, dry air is oxygen?

..... [1]

- (c) The concentration of a dilute acid can be found by reacting it with aqueous sodium hydroxide using the apparatus shown.



- (i) What piece of apparatus should be used to add exactly 25.0cm^3 of dilute acid to the conical flask?

..... [1]

- (ii) A few drops of litmus solution are added to the conical flask.

Explain why litmus solution is added to the conical flask.

.....
 [1]

- (iii) Aqueous sodium hydroxide is then added to the dilute acid until it is in excess.

Describe the change in the colour of the litmus solution in the conical flask.

from to [2]

[Total: 11]

5 Bromine is a volatile liquid. Potassium bromide is a compound made from bromine.

(a) Use the kinetic particle model to describe the arrangement **and** motion of the particles in bromine when it is:

- a liquid

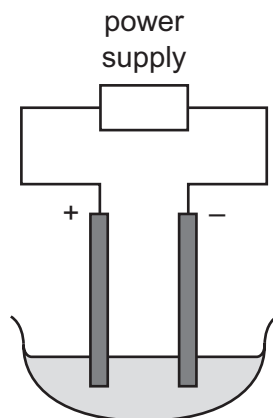
.....

- a gas

.....

[4]

(b) Molten potassium bromide can be electrolysed using the apparatus shown.



(i) On the diagram, label:

- the anode
- the electrolyte

[2]

(ii) Predict the products of this electrolysis at:

the positive electrode

the negative electrode.

[2]

(iii) Give **one** observation that is made at the positive electrode.

..... [1]

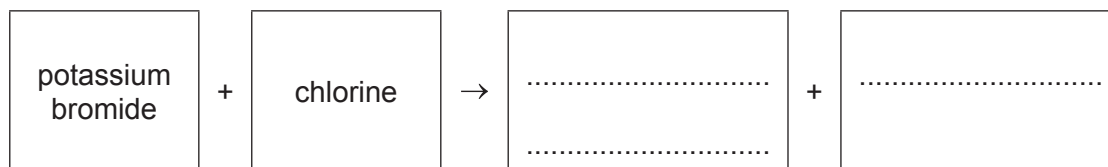
(iv) Suggest why the electrodes are made of graphite and **not** of magnesium.

.....

..... [1]

(c) Aqueous potassium bromide reacts with aqueous chlorine.

(i) Complete the word equation for this reaction.



[2]

(ii) Using ideas about the reactivity of the halogens, explain why aqueous potassium bromide does **not** react with aqueous iodine.

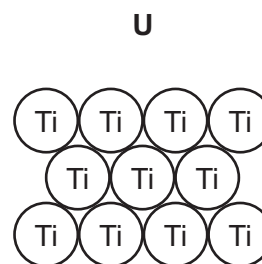
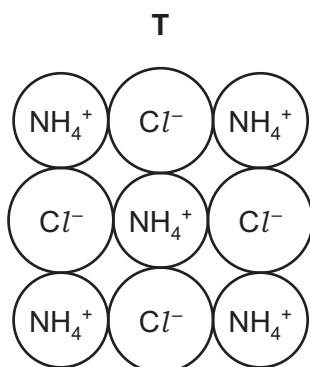
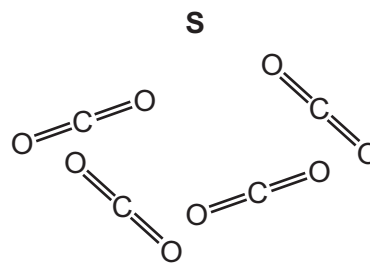
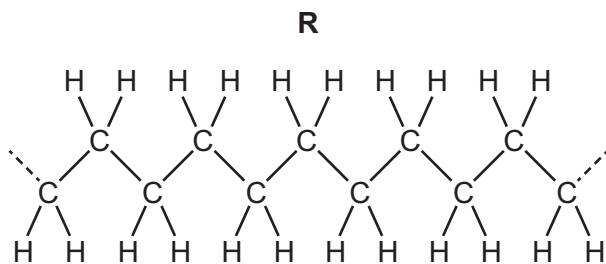
.....
..... [1]

(iii) Describe what you would observe when aqueous silver nitrate is added to aqueous potassium bromide.

..... [2]

[Total: 15]

6 (a) The diagrams show the structures of four substances, **R**, **S**, **T** and **U**.



State which **one** of these substances, **R**, **S**, **T** or **U**:

- (i) is an element [1]
- (ii) contains ionic bonds [1]
- (iii) is a gas at room temperature [1]
- (iv) is a polymer. [1]

(b) Ammonium chloride is present in some fertilisers.

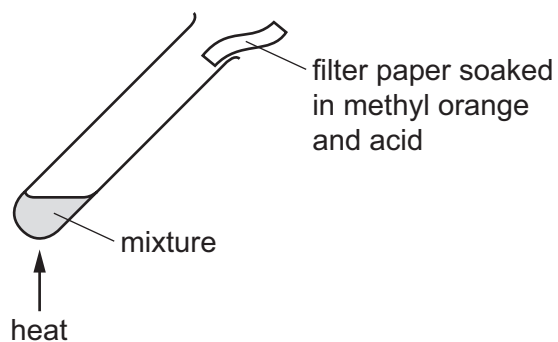
Which **two** of the following compounds are also present in many fertilisers?

Tick **two** boxes.

- | | |
|---------------------|--|
| hydrogen sulfide | |
| calcium phosphate | |
| copper(II) fluoride | |
| nickel(II) oxide | |
| potassium nitrate | |

[2]

(c) A mixture of ammonium chloride and aqueous sodium hydroxide is heated as shown.



The filter paper changes colour from red to yellow.

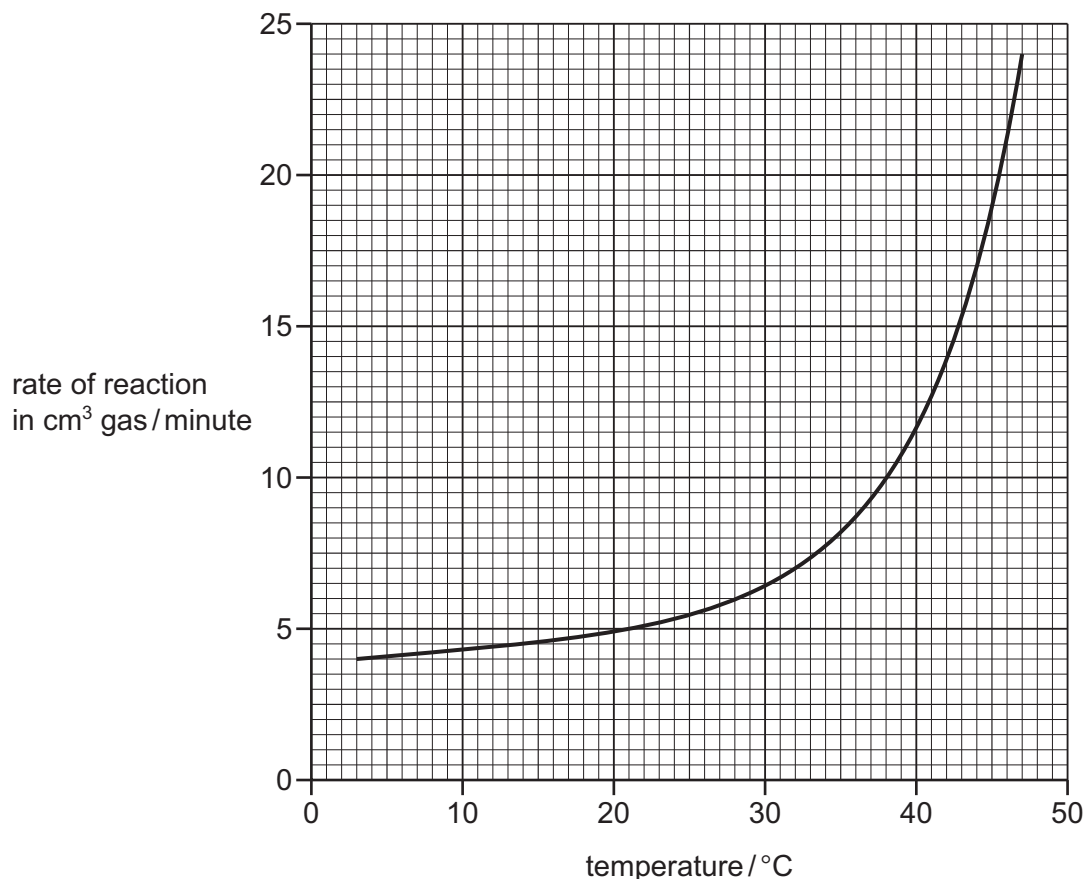
Explain why.

.....

..... [2]

[Total: 8]

- 7 (a) The graph shows the effect of temperature on the rate of reaction of dilute hydrochloric acid with zinc powder.



- (i) Determine the rate of reaction at 40 °C.

rate of reaction = cm³ gas/minute [1]

- (ii) The experiments were repeated using small lumps of zinc instead of zinc powder. All other conditions were kept the same.

On the grid, draw a graph to show how the rate of reaction changes with temperature when small lumps of zinc are used instead of zinc powder. [2]

- (b) What effects do these factors have on the rate of a chemical reaction?

- (i) decreasing the concentration of a reactant

..... [1]

- (ii) adding a catalyst

..... [1]

(c) Zinc and iron are both metals.

Give **two** physical properties which are characteristic of metals.

1

2 [2]

(d) Stainless steel is an alloy of iron.

(i) What is meant by the term *alloy*?

..... [1]

(ii) Give **one** common use of stainless steel.

..... [1]

[Total: 9]

8 The table shows the properties of some Group I elements.

| element | density in g/cm ³ | melting point in °C | relative hardness |
|-----------|---------------------------------|------------------------|----------------------|
| sodium | 0.97 | 98 | 4.9 |
| potassium | 0.86 | 63 | 2.6 |
| rubidium | 1.53 | | 1.6 |
| caesium | | 29 | 1.0 |

(a) (i) Describe the trend in the relative hardness of the Group I elements.

..... [1]

(ii) Predict the melting point of rubidium.

..... [1]

(iii) Explain why it is difficult to predict the density of caesium.

.....
 [1]

(b) When potassium reacts with water, it floats and melts into a ball. A flame is observed.

(i) What colour does potassium give to the flame?

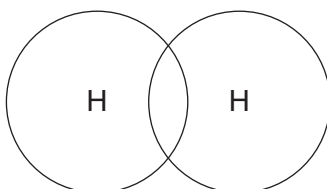
..... [1]

(ii) Use the information in the table to suggest why potassium floats on water.

..... [1]

(iii) Hydrogen is produced when potassium reacts with water.

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



[1]

[Total: 6]

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The Periodic Table of Elements

| | | Group | | | | | | | |
|-------------------------------------|------------------------------------|--|---------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|------------------------------------|--|
| I | II | III | IV | V | VI | VII | VIII | | |
| 3 Li lithium 7 | 4 Be beryllium 9 | 1 H hydrogen 1 | 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 | 2 |
| 11 Na sodium 23 | 12 Mg magnesium 24 | Key atomic number atomic symbol name relative atomic mass | | | | | | | |
| 19 K potassium 39 | 20 Ca calcium 40 | 13 Al aluminium 27 | 14 Si silicon 28 | 15 P phosphorus 31 | 16 S sulfur 32 | 17 Cl chlorine 35.5 | 18 Ar argon 40 | 36 Kr krypton 84 | |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 30 Zn zinc 65 | 31 Ga gallium 70 | 32 Ge germanium 73 | 33 As arsenic 75 | 34 Se selenium 79 | 35 Br bromine 80 | 54 Xe xenon 131 | |
| 55 Cs caesium 133 | 56 Ba barium 137 | 49 In indium 115 | 48 Cd cadmium 112 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 86 Rn radon — | |
| 87 Fr francium — | 88 Ra radium — | 81 Tl thallium 204 | 80 Hg mercury 201 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium — | 85 At astatine — | — | |
| 57 La lanthanum 139 | 58 Ce cerium 140 | 29 Cu copper 64 | 28 Ni nickel 59 | 27 Co cobalt 59 | 26 Fe iron 56 | 25 Mn manganese 55 | 24 Cr chromium 52 | 23 V vanadium 51 | 22 Ti titanium 48 |
| 89 Ac actinium — | 89–103 actinoids — | 47 Ag silver 108 | 46 Pd palladium 106 | 45 Rh rhodium 103 | 44 Ru ruthenium 101 | 43 Tc technetium — | 42 Mo molybdenum 96 | 41 Nb niobium 93 | 40 Zr zirconium 91 |
| | | 79 Au gold 197 | 78 Pt platinum 195 | 77 Ir iridium 192 | 76 Os osmium 190 | 75 Re rhenium 186 | 74 W tungsten 184 | 73 Ta tantalum 181 | 72 Hf hafnium 178 |
| | | 111 Rg roentgenium — | 110 Ds darmstadtium — | 109 Mt meitnerium — | 108 Hs hassium — | 107 Bh bohrium — | 106 Sg seaborgium — | 105 Db dubnium — | 104 Rf rutherfordium — |
| | | 112 Cn copernicium — | 112 Cn copernicium — | 114 Fl flerovium — | 116 Lv livermorium — | — | — | — | — |

lanthanoids

actinoids

| | | | | | | | | | | | | | | |
|-------------------------------------|-----------------------------------|--|-------------------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|----------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|
| 57 La lanthanum 139 | 58 Ce cerium 140 | 59 Pr praseodymium 141 | 60 Nd neodymium 144 | 61 Pm promethium — | 62 Sm samarium 150 | 63 Eu europium 152 | 64 Gd gadolinium 157 | 65 Tb terbium 159 | 66 Dy dysprosium 163 | 67 Ho holmium 165 | 68 Er erbium 167 | 69 Tm thulium 169 | 70 Yb ytterbium 173 | 71 Lu lutetium 175 |
| 89 Ac actinium — | 90 Th thorium 232 | 91 Pa protactinium 231 | 92 U uranium 238 | 93 Np neptunium — | 94 Pu plutonium — | 95 Am americium — | 96 Cm curium — | 97 Bk berkelium — | 98 Cf californium — | 99 Es einsteinium — | 100 Fm fermium — | 101 Md mendelevium — | 102 No nobelium — | 103 Lr lawrencium — |

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).