



Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

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CHEMISTRY

0620/32

Paper 3 Theory (Core)

February/March 2019

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.

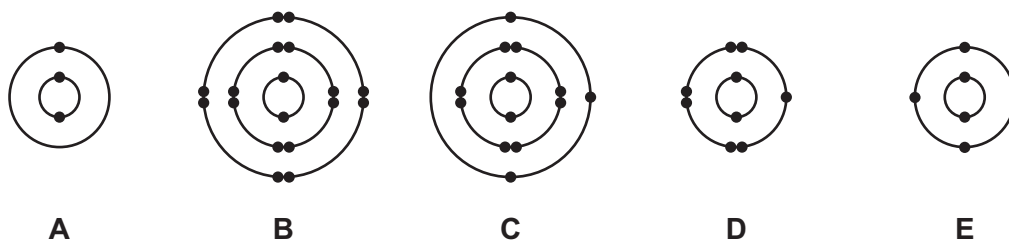
The number of marks is given in brackets [] at the end of each question or part question.

This syllabus is regulated 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 This question is about electronic structures.

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



Answer the following questions about these electronic structures.
Each electronic structure may be used once, more than once or not at all.

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

- (i) of an element in Group III of the Periodic Table [1]
- (ii) of a monatomic gas [1]
- (iii) of carbon [1]
- (iv) which has 18 protons [1]
- (v) which forms a stable ion with a single negative charge. [1]

(b) Draw the electronic structure of a silicon atom.

[2]

[Total: 7]

2 This question is about uranium and its compounds.

(a) (i) An isotope of uranium is represented by the symbol shown.



Deduce the number of electrons and neutrons in one atom of this isotope of uranium.

number of electrons

number of neutrons

[2]

(ii) State the main use of this isotope of uranium.

..... [1]

(b) Complete the sentence about isotopes using words from the list.

atoms compound electrons element ions
mixture molecules neutrons substance

Isotopes are of the same which have the same
 proton number but a different number of

[3]

(c) Uranium is a metal.

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

1

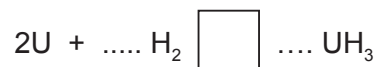
2

[2]

(d) 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.



[3]

(e) A compound of uranium has the formula UO_2F_2 .

Complete the table to calculate the relative formula mass of UO_2F_2 .
Use your Periodic Table to help you.

| | number of atoms | relative atomic mass | |
|----------|-----------------|----------------------|----------------------|
| uranium | 1 | 238 | $1 \times 238 = 238$ |
| oxygen | | | |
| fluorine | | | |

relative formula mass =
[2]

[Total: 13]

3 This question is about sulfur, sulfur compounds and the water from a sulfur spring. A sulfur spring is a natural source of water containing sulfur.

(a) The table shows the mass of ions present in a 1000 cm³ sample of water from a sulfur spring.

| ion present | formula of ion | mass present in the 1000 cm ³ sample / mg |
|-------------|-------------------------------|--|
| | Br ⁻ | 4 |
| calcium | Ca ²⁺ | 44 |
| chloride | Cl ⁻ | 14 |
| fluoride | F ⁻ | 6 |
| iron(III) | Fe ³⁺ | 2 |
| magnesium | Mg ²⁺ | 10 |
| | K ⁺ | 8 |
| sodium | Na ⁺ | 88 |
| sulfate | SO ₄ ²⁻ | 92 |

Answer these questions using only information from the table.

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

..... [1]

(ii) Give the name of the compound formed from only K⁺ and Br⁻ ions.

..... [1]

(iii) Calculate the mass of calcium ions present in a 250 cm³ sample of this water.

mass of calcium ions = mg [1]

(iv) Complete the equation to show the formation of a fluoride ion from a fluorine atom.

F + → F⁻ [1]

(b) Describe a test for sulfate ions.

test

observations

[2]

(c) Solid sulfur is found around the edge of sulfur springs.

(i) When heated, sulfur undergoes sublimation.

What is meant by the term *sublimation*?

.....
 [1]

(ii) Sulfur reacts with hot concentrated sulfuric acid.

Complete the chemical equation for this reaction.



(iii) The table shows the solubility of sulfur and zinc in an organic solvent and in water. The organic solvent boils at 46 °C.

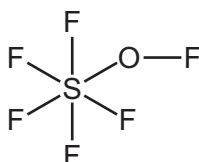
| element | solubility in organic solvent | solubility in water |
|---------|-------------------------------|---------------------|
| sulfur | soluble | insoluble |
| zinc | insoluble | insoluble |

Use the information in the table to suggest how to obtain pure, dry samples of both sulfur and zinc from a mixture of sulfur powder and zinc powder.

.....

 [4]

(d) The structure of a sulfur compound is shown.

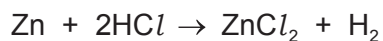


Deduce the molecular formula of this compound showing the number of sulfur, fluorine and oxygen atoms.

..... [1]

[Total: 14]

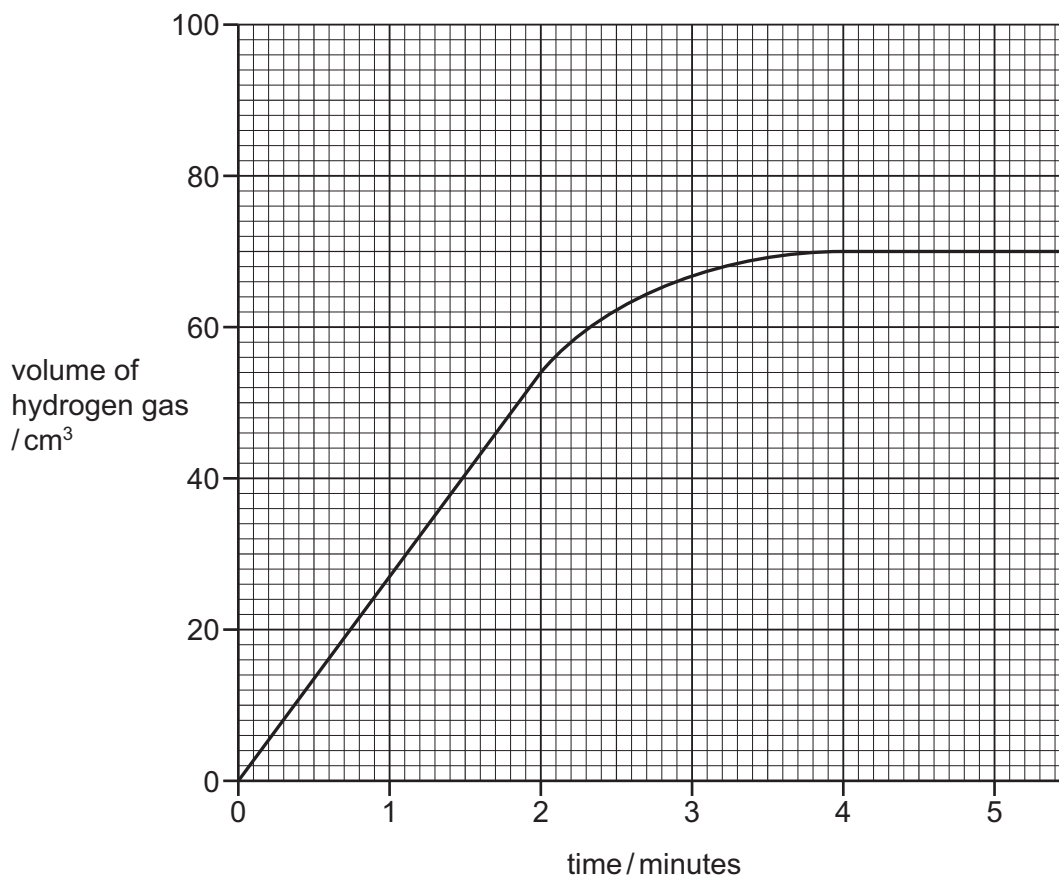
- 4 A student investigated the reaction between zinc and dilute hydrochloric acid by measuring the volume of hydrogen gas produced at one minute intervals.



- (a) Give the name of the salt formed in this reaction.

..... [1]

- (b) The graph shows the results using small pieces of zinc and dilute hydrochloric acid.



- (i) Deduce the volume of hydrogen gas produced in the first **two** minutes of the reaction.
..... cm³ [1]
- (ii) Draw a letter **S** on the graph to show where the reaction is slowing down but has **not** stopped completely. [1]
- (iii) Draw a line **on the grid** to show how the volume of hydrogen gas changes with time when the reaction is repeated with a catalyst. All other conditions are kept the same. [2]

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

- Decreasing the temperature at which the reaction is done.
All other conditions are kept the same.
-

- Using zinc powder instead of small pieces of zinc.
All other conditions are kept the same.
-

[2]

(c) Describe a test for hydrogen.

test

result

[2]

(d) The table gives some information about the rate of reaction of zinc and some other metals with cold water and with steam.

| metal | rate of reaction | |
|-----------|--------------------|------------------------------|
| | with cold water | with steam |
| iron | no reaction | hot iron reacts very slowly |
| magnesium | reacts very slowly | hot magnesium reacts rapidly |
| mercury | no reaction | no reaction |
| strontium | reacts rapidly | reacts rapidly |
| zinc | no reaction | hot zinc reacts slowly |

Put the **five** metals in order of their reactivity.
Put the most reactive metal at the top.

most reactive

↑

least reactive

[2]

(e) When 13.0 g of zinc reacts completely with sulfur, 19.4 g of zinc sulfide is formed.

Calculate the maximum mass of zinc sulfide formed when 3.25 g of zinc reacts completely with sulfur.

mass of zinc sulfide formed = g [1]

[Total: 12]

5 Aqueous sodium hydroxide is a base.

(a) Describe the reaction of aqueous sodium hydroxide with:

- a named acid

.....

.....

.....

- ammonium salts

.....

.....

.....

- a named indicator.

.....

.....

.....

[5]

(b) Ammonia is a soluble base.

Which **one** of the following pH values could be the pH of aqueous ammonia?
Draw a circle around the correct answer.

pH 1

pH 5

pH 7

pH 10

[1]

(c) Ammonia is used in the manufacture of some fertilisers.

Which **two** of these compounds are present in fertilisers?
Tick **two** boxes.

copper(II) oxide

potassium chloride

sodium phosphate

strontium fluoride

sulfur dioxide

[2]

(d) Bacteria in the soil are able to convert ammonium compounds into oxides of nitrogen. The oxides of nitrogen can escape into the atmosphere.

(i) State **one** other source of oxides of nitrogen in the atmosphere.

..... [1]

(ii) State **one** effect of oxides of nitrogen on health.

..... [1]

(iii) Oxides of nitrogen are greenhouse gases which contribute to climate change.

Give the name of **one** other greenhouse gas which makes a major contribution to climate change.

..... [1]

[Total: 11]

6 This question is about chromium and chromium compounds.

(a) (i) Suggest why chromium is manufactured by electrolysis and **not** by the reduction of chromium(VI) oxide, CrO_3 , with carbon.

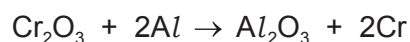
..... [1]

(ii) Suggest the products of electrolysis of molten chromium(VI) oxide at:

- the positive electrode
- the negative electrode.

[2]

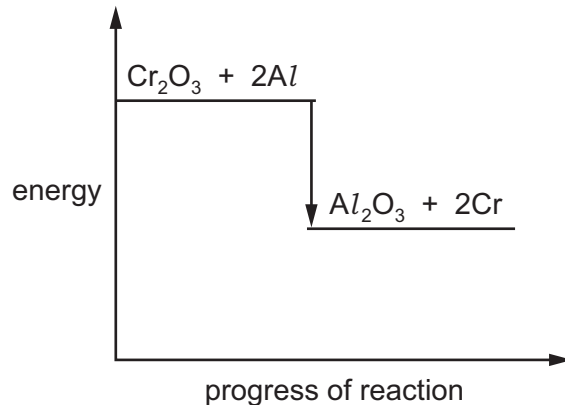
(b) Chromium can also be manufactured by the reduction of chromium(III) oxide, Cr_2O_3 , with aluminium.



(i) How does this equation show that chromium(III) oxide is reduced?

.....
 [1]

(ii) The energy level diagram for this reaction is shown.



Explain how this diagram shows that the reaction is exothermic.

.....
 [1]

(c) Chromium is a transition element. Sodium is an element in Group I of the Periodic Table.

Describe **two** ways in which the properties of chromium are different from those of sodium.

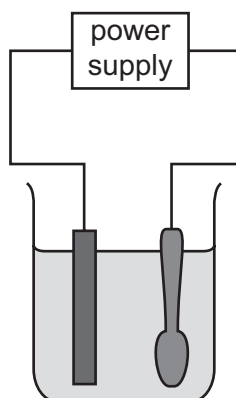
1

2

[2]

(d) Chromium is a silver-coloured metal.

The diagram shows how a copper spoon can be electroplated with chromium.



(i) On the diagram, label:

- the cathode
- the electrolyte.

[2]

(ii) Give **one** observation that is made during the electroplating process.

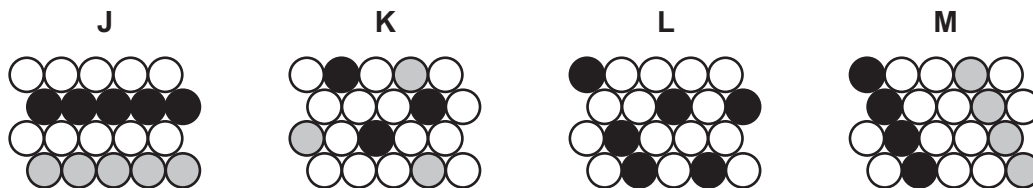
..... [1]

(iii) Suggest **one** reason why metal objects are electroplated.

..... [1]

(e) Nichrome is an alloy of nickel, iron and chromium.

Which **one** of these diagrams, **J**, **K**, **L** or **M**, best represents nichrome?



..... [1]

[Total: 12]

7 This question is about alkanes and petroleum fractions.

(a) The table gives some information about alkanes.

| alkane | number of carbon atoms in each molecule | melting point in °C | boiling point in °C |
|---------|---|---------------------|---------------------|
| methane | 1 | -182 | -164 |
| ethane | 2 | -183 | -88 |
| propane | 3 | -190 | -42 |
| butane | 4 | -135 | 0 |

Answer these questions using only information from the table.

(i) Describe how the boiling points of the alkanes vary with the number of carbon atoms in each molecule.

.....
 [1]

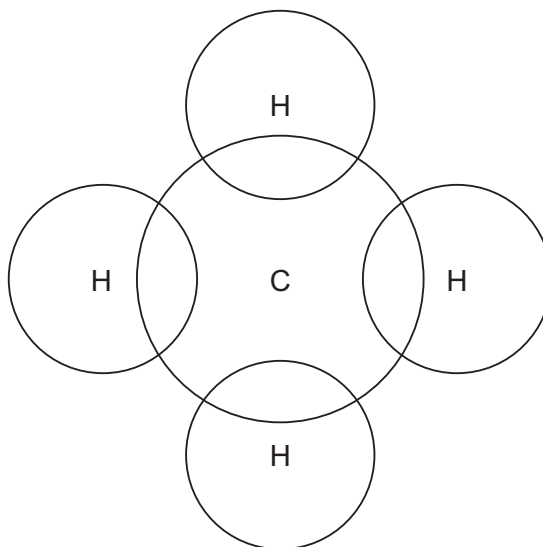
(ii) Which alkane has the lowest melting point?

..... [1]

(iii) Deduce the physical state of butane at -50°C .
 Explain your answer.

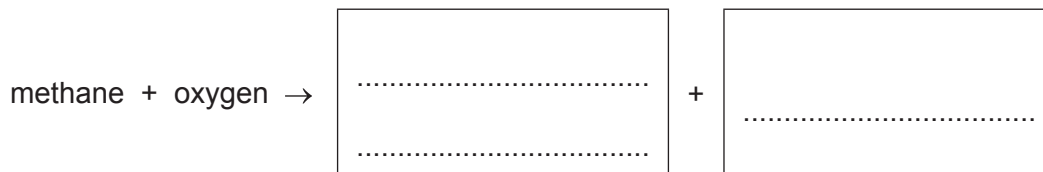
.....
 [1]

(b) (i) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of methane. Show outer shell electrons only.



[1]

(ii) Complete the word equation for the complete combustion of methane.



[2]

(c) Complete the sentences about homologous series using words from the list.

acidic alkenes alcohol carbohydrates
chemical functional hydrocarbons physical

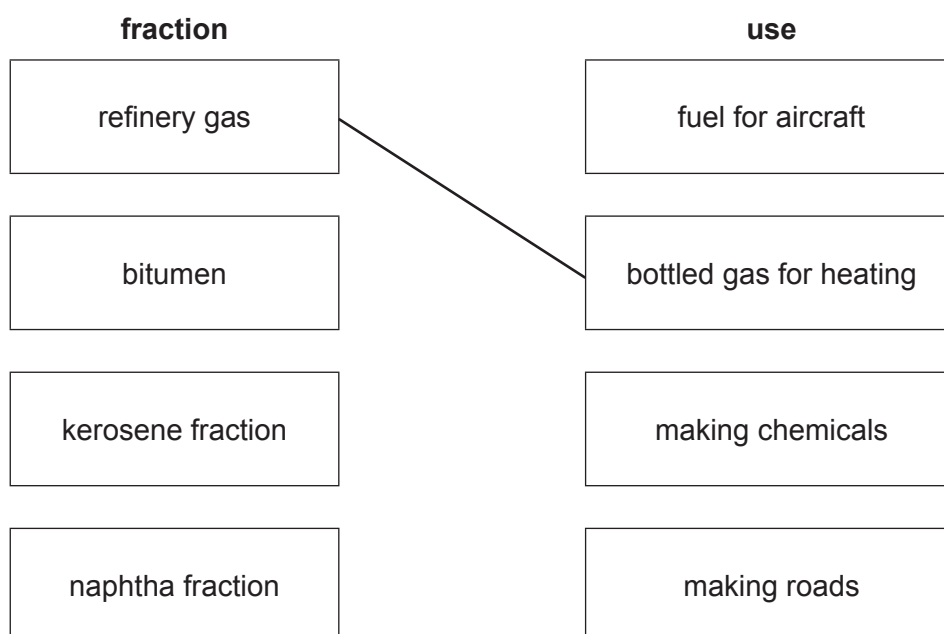
Methane and ethane are which belong to the same homologous series.

Members of the alkane homologous series have similar properties due to the presence of the same group.

[3]

(d) Petroleum is separated into useful fractions by fractional distillation.

Match the fractions on the left with the uses on the right.
The first one has been done for you.



[2]

[Total: 11]

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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 | | | | | | | | | |
| 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 | 21 Sc scandium 45 | 22 Ti titanium 48 | 23 V vanadium 51 | 24 Cr chromium 52 | 25 Mn manganese 55 | 26 Fe iron 56 | 27 Co cobalt 59 | 28 Ni nickel 59 | 29 Cu copper 64 | 30 Zn zinc 65 | 31 Al aluminium 27 | 32 Si silicon 28 | 33 P phosphorus 31 | 34 S sulfur 32 | 35 Cl chlorine 35.5 | 36 Ar argon 40 |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 39 Y yttrium 89 | 40 Zr zirconium 91 | 41 Nb niobium 93 | 42 Mo molybdenum 96 | 43 Tc technetium — | 44 Ru ruthenium 101 | 45 Rh rhodium 103 | 46 Pd palladium 106 | 47 Ag silver 108 | 48 Cd cadmium 112 | 49 In indium 115 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 54 Xe xenon 131 |
| 55 Cs caesium 133 | 56 Ba barium 137 | 57–71 lanthanoids | 72 Hf hafnium 178 | 73 Ta tantalum 181 | 74 W tungsten 184 | 75 Re rhenium 186 | 76 Os osmium 190 | 77 Ir iridium 192 | 78 Pt platinum 195 | 79 Au gold 197 | 80 Hg mercury 201 | 81 Tl thallium 204 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium — | 85 At astatine — | 86 Rn radon — |
| 87 Fr francium — | 88 Ra radium — | 89–103 actinoids | 104 Rf rutherfordium — | 105 Db dubnium — | 106 Sg seaborgium — | 107 Bh bohrium — | 108 Hs hassium — | 109 Mt meitnerium — | 110 Ds darmstadtium — | 111 Rg roentgenium — | 112 Cn copernicium — | 114 Fl flerovium — | 116 Lv livermorium — | — | — | — | — |

lanthanoids

| | | | | | | | | | | | | | | |
|-------------------------------------|-----------------------------------|--|-------------------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|----------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|
| 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 — |

actinoids

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