Cambridge IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9386818547

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.

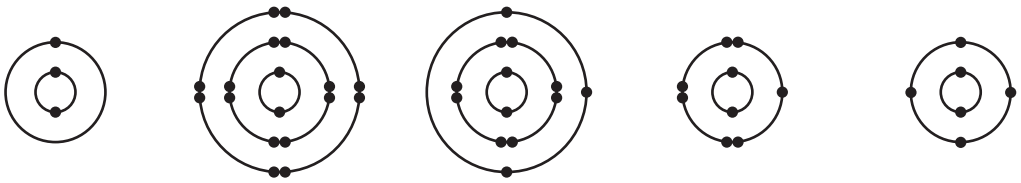
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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.



A **B** **C** **D** **E**

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.

$^{235}_{92}U$

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.

$2U + ... H_2 \square .... UH_3$

[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 × 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 cm^3 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 cm^3 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.

$$F + \text{.....} \rightarrow F^-$$

[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.

$$S + ... H_2SO_4 \rightarrow 2H_2O + ... SO_2$$ [2]

(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.

.....

.....

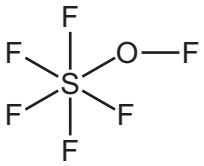
.....

.....

.....

..... [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]

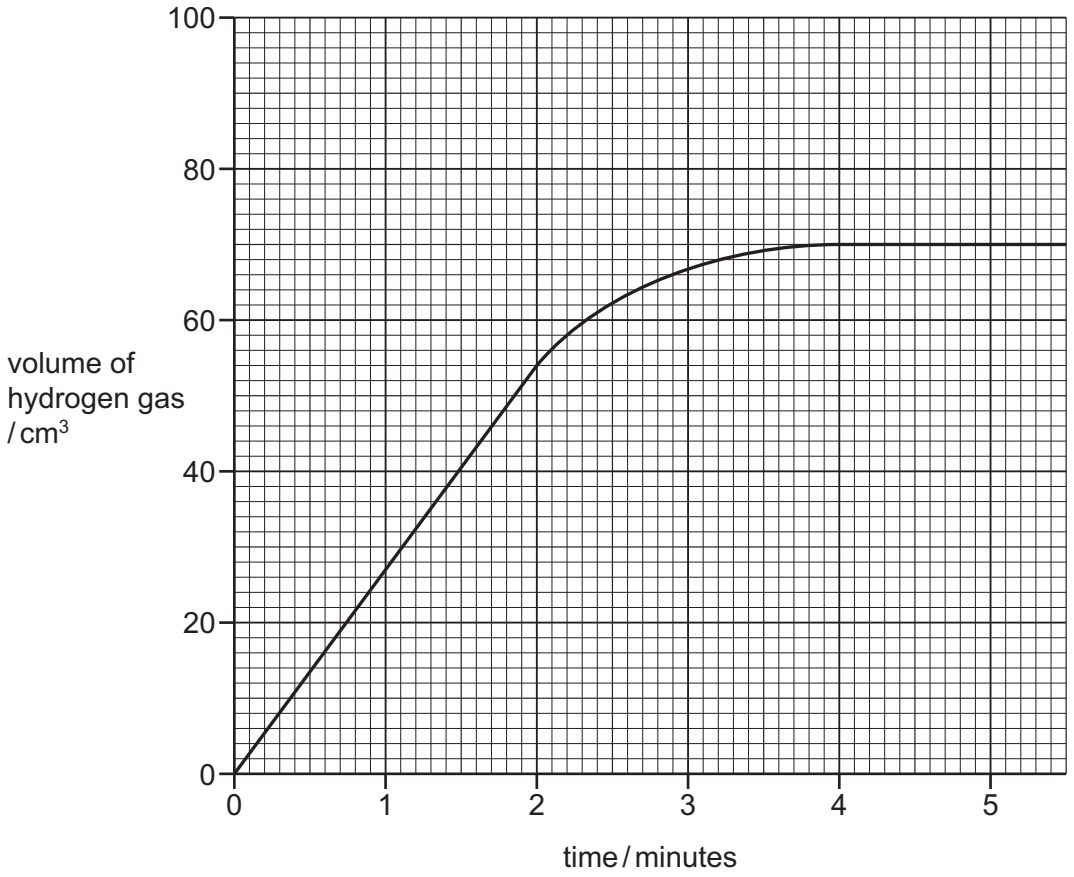
4 A student investigated the reaction between zinc and dilute hydrochloric acid by measuring the volume of hydrogen gas produced at one minute intervals.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

(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.

..... cm^3 [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 .....

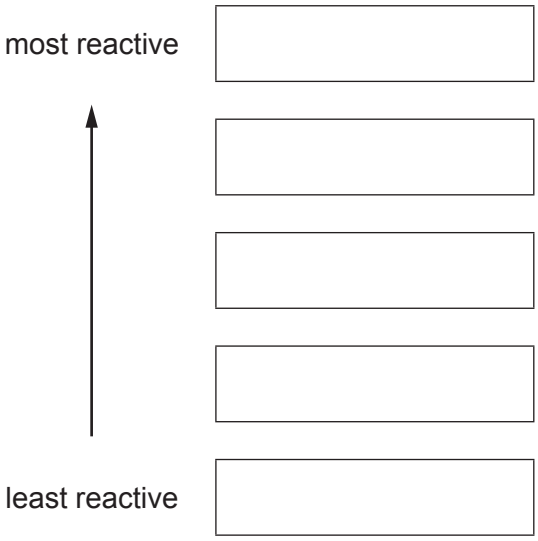
result .....

[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.



[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]

[Turn over

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.

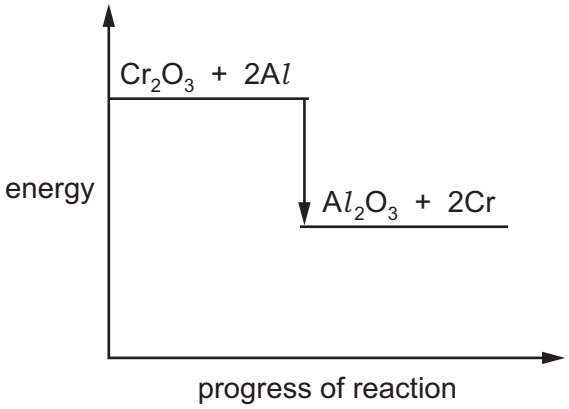
$$Cr_2O_3 + 2Al \rightarrow Al_2O_3 + 2Cr$$

(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.

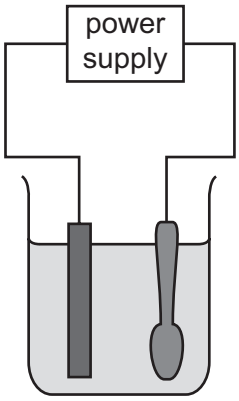
Describe **two** ways in which the properties of chromium are different from those of sodium.

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]

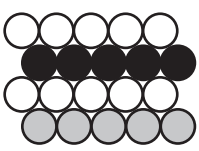
(iii) Suggest **one** reason why metal objects are electroplated.

..... [1]

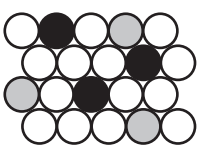
(e) Nichrome is an alloy of nickel, iron and chromium.

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

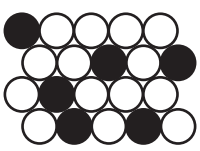
J



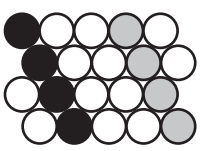
K



L



M



..... [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?

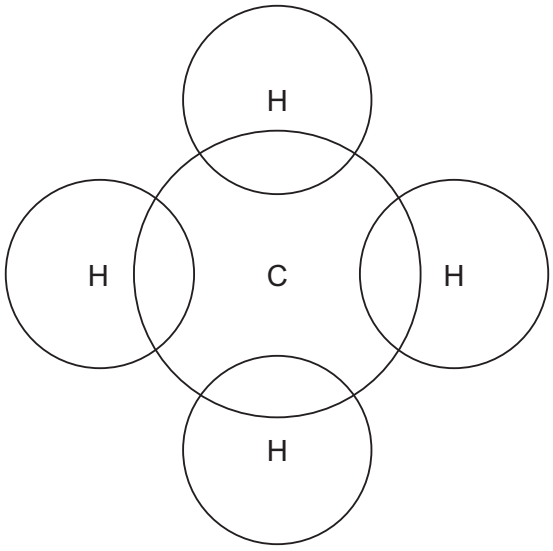
..... [1]

(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.

methane + oxygen → ..... + ...
.....

[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.

fraction	**use**
refinery gas	fuel for aircraft
bitumen	bottled gas for heating
kerosene fraction	making chemicals
naphtha fraction	making roads

[2]

[Total: 11]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											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											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
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 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
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 –		

Key

atomic number
atomic symbol
name
relative atomic mass

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
actinoids	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 dm^3 at room temperature and pressure (r.t.p.).