



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.

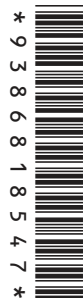
You may lose marks if you do not show your working or if you do not use appropriate units.

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.

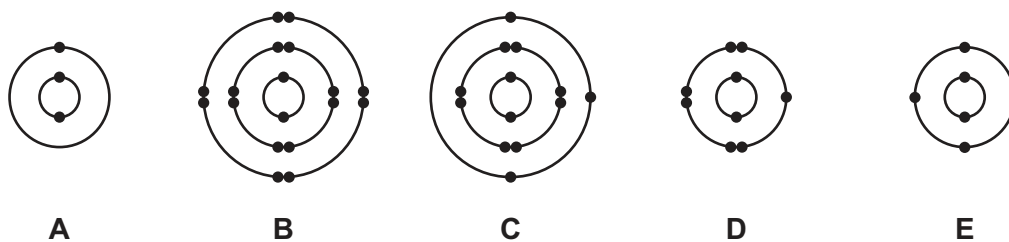
This document consists of **16** printed pages.



2

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]

3

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

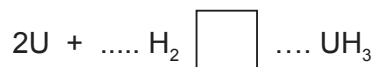
2

[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]

4

(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]

5

- 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.

$\text{F} + \text{.....} \rightarrow \text{F}^-$ [1]

- (b)** Describe a test for sulfate ions.

test

observations [2]

6

(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.

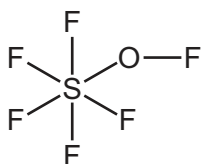
element	solubility in organic solvent	solubility in water
sulfur	soluble	insoluble
zinc	insoluble	insoluble

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.



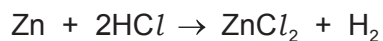
Deduce the molecular formula of this compound showing the number of sulfur, fluorine and oxygen atoms.

..... [1]

[Total: 14]

7

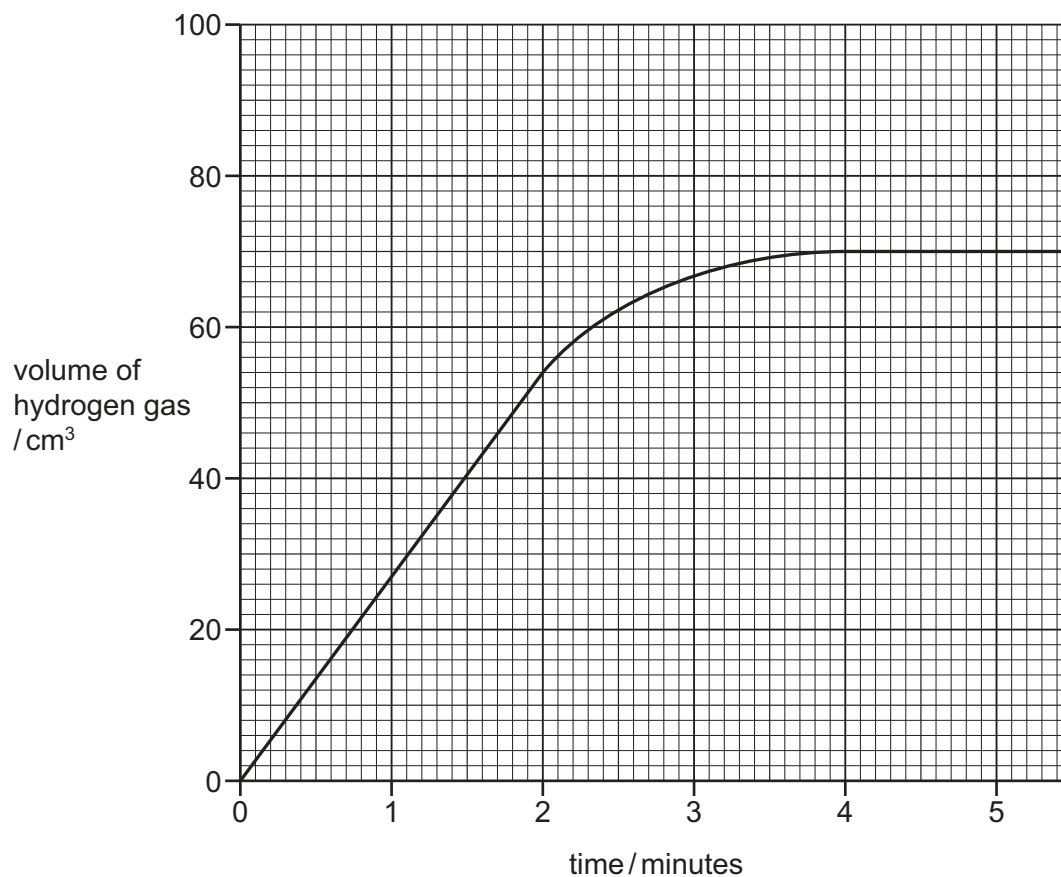
- 4 A student investigated the reaction between zinc and dilute hydrochloric acid by measuring the volume of hydrogen gas produced at one minute intervals.



- (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]

9

- (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]

10

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]

11

- (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]

12

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.

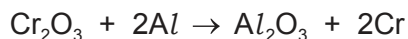
..... [1]

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

- the positive electrode
- the negative electrode.

[2]

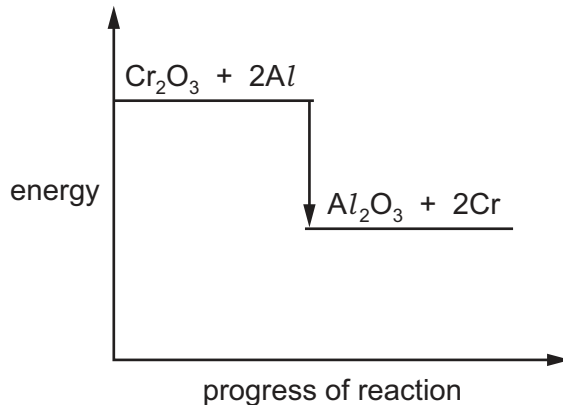
- (b) Chromium can also be manufactured by the reduction of chromium(III) oxide, Cr_2O_3 , with aluminium.



- (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.

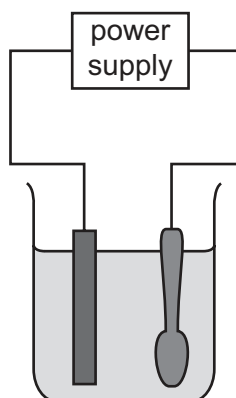
Describe **two** ways in which the properties of chromium are different from those of sodium.

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.

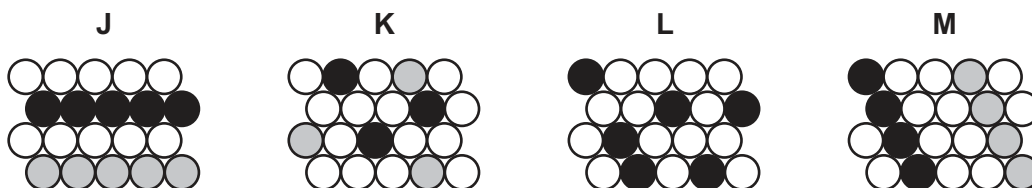
..... [1]

(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]

14

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]

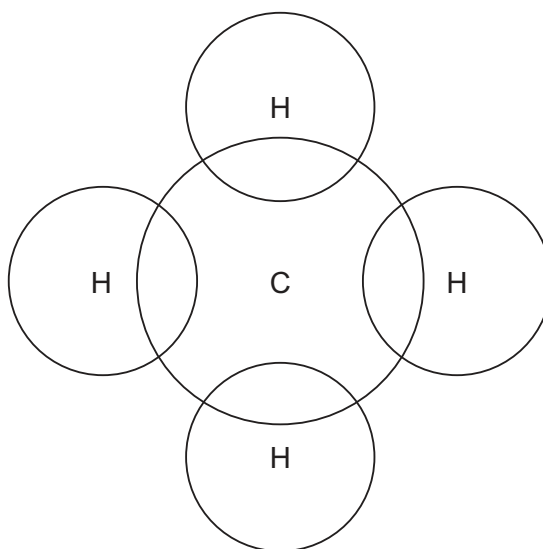
(ii) Which alkane has the lowest melting point?

..... [1]

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

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

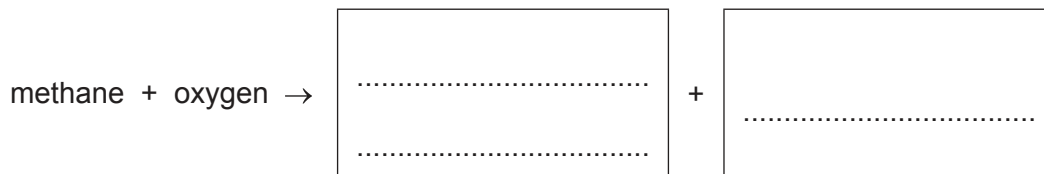
(b) (i) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of methane. Show outer shell electrons only.



[1]

15

(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.

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

[2]

[Total: 11]

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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	atomic number atomic symbol name relative atomic mass										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	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	117	Uu ununoctium	118	Ts tennessine	119	Og oganeson	120	Ubn unbinilium	

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	—

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