Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

1792185691

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **February/March 2020**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- 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.

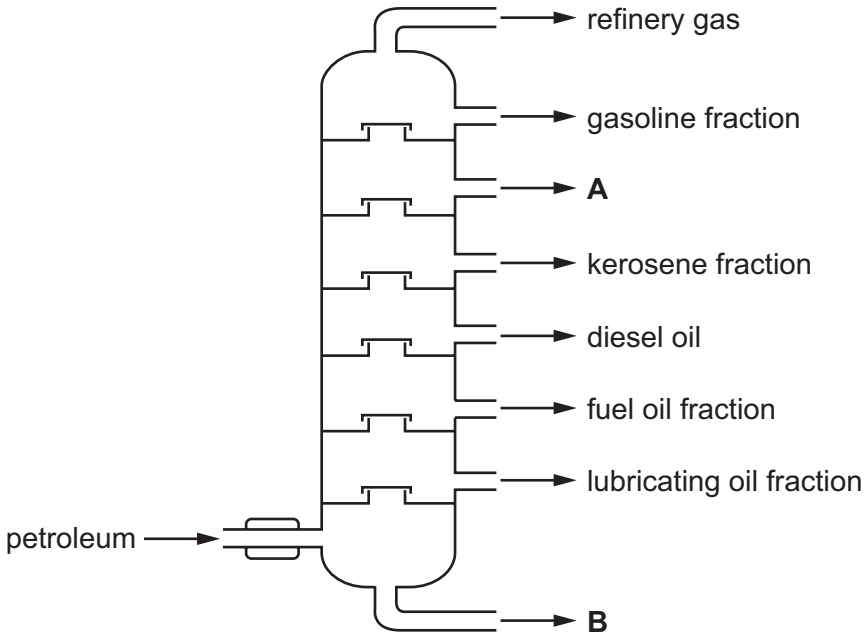
INFORMATION

- 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 **12** pages. Blank pages are indicated.

1 Petroleum is a useful natural resource.

The diagram shows how petroleum can be separated into useful substances.



(a) What is the name of the separation process shown in the diagram?

..... [2]

(b) Name the fraction leaving at:

A .....

B .....
[2]

(c) Refinery gas is a mixture of hydrocarbons.

One refinery gas is butane, C_4H_{10}.

(i) Suggest the names of **two** other refinery gases.

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

(ii) Write the chemical equation for the complete combustion of butane.

..... [2]

(iii) Name the toxic gas produced by the incomplete combustion of butane.

..... [1]

(d) Gasoline and kerosene are both fuels. They have different properties.

(i) Describe the differences in the properties given.

viscosity of the fuel .....

.....

flammability of the fuel .....

.....

[2]

(ii) What difference in the molecules of gasoline and kerosene causes these differences in properties?

..... [1]

(e) Hydrogen fuel cells can be used to power vehicles.

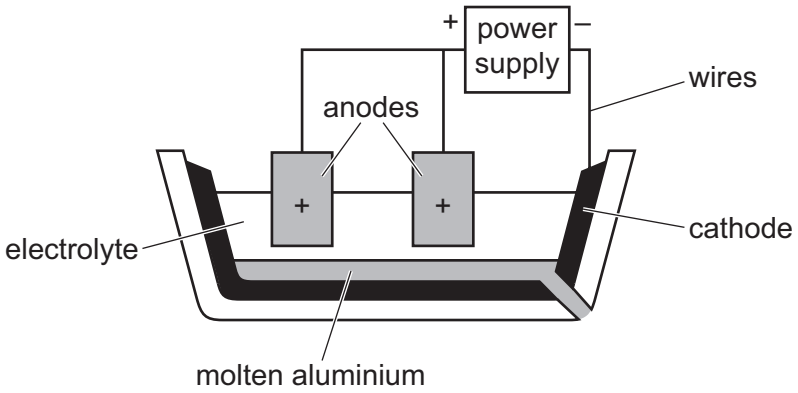
Write the word equation for the overall reaction that takes place in a hydrogen fuel cell.

..... [1]

[Total: 13]

[Turn over

2 Aluminium is extracted from its ore. The ore is converted into pure aluminium oxide, which then undergoes electrolysis as shown.



(a) (i) Name an ore of aluminium.

..... [1]

(ii) What is meant by the term *electrolysis*?

.....

..... [2]

(b) Aluminium oxide has a melting point of about 2000 °C, but the electrolysis process operates at about 900 °C.

(i) Name the compound added to aluminium oxide to reduce the operating temperature.

..... [1]

(ii) Suggest **one** benefit to the environment of reducing the operating temperature.

.....

..... [1]

(iii) Write the ionic half-equation for the reaction taking place at:

the negative electrode (cathode) .....

the positive electrode (anode) .....
[4]

(iv) Explain why the anodes need frequent replacement.

.....

..... [2]

(c) Aluminium oxide reacts with acids and with alkalis.

(i) What term is used to describe an oxide that reacts with acids and with alkalis?

..... [1]

(ii) Aluminium oxide reacts with dilute sulfuric acid to form a salt.

State the name and write the formula of the salt formed.

name .....

formula .....
[2]

(iii) Aluminium oxide reacts with dilute sodium hydroxide to form a salt and one other product.

Name the other product.

..... [1]

(iv) Aluminium hydroxide, $Al(OH)_3$, decomposes when heated to form aluminium oxide and water.

Write the chemical equation for this reaction.

..... [2]

(v) Suggest the names of **two** other aluminium compounds that decompose when heated to form aluminium oxide.

.....

..... [2]

[Total: 19]

[Turn over

3 The Periodic Table is a method of classifying elements.

(a) Identify the element which is in Group VI and Period 4.

..... [1]

(b) Calcium is in Group II and chlorine is in Group VII of the Periodic Table.

Explain, in terms of number of outer shell electrons and electron transfer, how calcium atoms and chlorine atoms form ions. Give the formulae of the ions formed.

.....

.....

.....

.....

.....

.....

..... [5]

(c) Group V chlorides are covalent molecules. The boiling points of some Group V chlorides are shown.

chloride	boiling point / °C
NCl_3	71
PCl_3	
$AsCl_3$	130
$SbCl_3$	283

(i) Suggest the approximate boiling point of PCl_3.

..... [1]

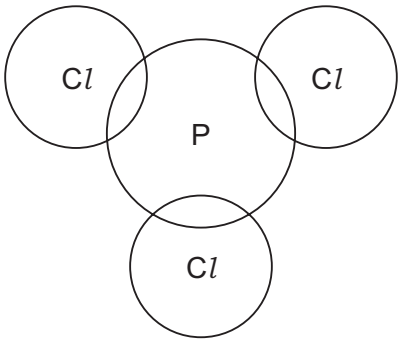
(ii) Explain the trend in boiling points in terms of attractive forces between particles.

.....

..... [2]

(iii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of PCl_3.

Show outer electrons only.



[3]

(d) PCl_3 reacts with chlorine, Cl_2, to form PCl_5. This reaction is exothermic and reaches an equilibrium.

$$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$$

(i) Describe **two** features of an equilibrium.

.....

.....

..... [2]

(ii) State the effect, if any, on the position of this equilibrium when the following changes are made.
Explain your answers.

temperature is increased .....

.....

pressure is increased .....

.....
[4]

(iii) Explain, in terms of particles, what happens to the rate of the forward reaction when the reaction mixture is heated.

.....

.....

.....

.....

..... [3]

[Turn over

(e) PCl_5 reacts with lithium fluoride, LiF, to form $LiPF_6$.

$$PCl_5 + 6LiF \rightarrow LiPF_6 + 5LiCl$$

Calculate the mass of LiF needed to form 3.04 g of $LiPF_6$ using the following steps.

- Calculate the number of moles of $LiPF_6$ formed.
  [M_r: $LiPF_6$, 152]

number of moles = ...

- Deduce the number of moles of LiF needed.

number of moles = ...

- Calculate the mass of LiF needed.

mass = ... g
[3]

(f) Lithium fluoride has ionic bonding.

(i) What is an ionic bond?

.....

..... [2]

(ii) Give **two** physical properties of ionic compounds.

.....

..... [2]

[Total: 28]

4 Iron is a typical transition element.

Iron:
- acts as a catalyst
- forms coloured compounds
- has more than one oxidation state.

(a) Name **one** major industrial process that uses iron as a catalyst and name the product made in this process.

process .....

product made .....
[2]

(b) When aqueous sodium hydroxide is added to aqueous iron(II) sulfate, a precipitate forms.

(i) What colour is this precipitate?

..... [1]

(ii) Write the ionic equation for this reaction. Include state symbols.

..... [3]

(c) Iron(II) sulfate can be converted to iron(III) sulfate by potassium manganate(VII) at room temperature.

(i) What is the role of potassium manganate(VII) in this reaction?

..... [1]

(ii) What condition must be used for this reaction to occur?

..... [1]

(iii) In terms of electron transfer, what happens to the iron(II) ions in this reaction?

..... [1]

(iv) State the colour change seen during this reaction.

from purple to ..... [1]

(d) Deduce the charge on the iron ion in each of these compounds.

FeF_3 .....

$Fe(NO_3)_3$ .....
[2]

[Total: 12]

[Turn over

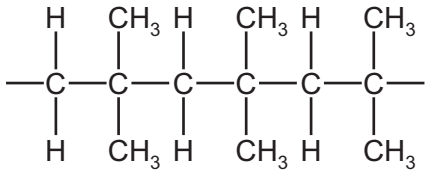
5 There are two types of polymers.

(a) Addition polymers are made from many identical small units.

(i) What is the term used to describe these small units?

..... [1]

(ii) A section of an addition polymer is shown.



Draw the structure of the small unit used to make this addition polymer.

Show all of the atoms and all of the bonds.

[2]

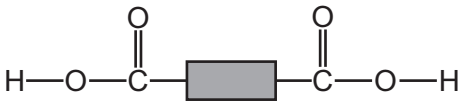
(b) Polyamides are condensation polymers.

What does the term *condensation* mean when used to describe this type of polymer?

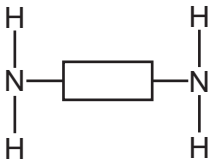
..... [1]

(c) A polyamide can be made from two different molecules.

A simplified structure of octanedioic acid is shown.



A simplified structure of 1,6-diaminohexane is shown.



(i) Complete the diagram to show a section of polyamide manufactured from octanedioic acid and 1,6-diaminohexane. Include all of the atoms and all of the bonds in the linkages.

[3]

(ii) State the name of a synthetic polyamide.

..... [1]

[Total: 8]

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.).