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CHEMISTRY

0620/42

Paper 4 Theory (Extended)

May/June 2016

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 12.

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.

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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 **12** printed pages.

- 1 (a) For each of the following, give the name of an element from Period 2 (lithium to neon), which matches the description.

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

- (i) an element which is gaseous at room temperature and pressure
 [1]
- (ii) an element which forms an oxide that is a reactant in photosynthesis
 [1]
- (iii) an element that is a product of photosynthesis
 [1]
- (iv) an element that makes up approximately 78% by volume of the air
 [1]
- (v) an element which has atoms with a full outer shell of electrons
 [1]
- (vi) an element which exists as both diamond and graphite
 [1]
- (vii) an element that reacts vigorously with cold water
 [1]
- (viii) a soft metallic element which is stored in oil
 [1]
- (b) Give the formula of a compound that contains
- (i) only boron and oxygen, [1]
- (ii) only lithium and nitrogen. [1]

[Total: 10]

2 (a) (i) Define the term *atomic number*.

..... [1]

(ii) Define the term *nucleon number*.

.....

..... [2]

(b) The table shows the number of protons, neutrons and electrons in some atoms or ions.

Complete the table. The first line is given as an example.

particle	number of protons	number of electrons	number of neutrons	symbol or formula
A	6	6	6	$^{12}_6\text{C}$
B	12	12	12	
C	8			$^{16}_8\text{O}^{2-}$
D	11	10	13	

[6]

[Total: 9]

3 Gallium is a metallic element in Group III. It has similar properties to aluminium.

- (a) (i) Describe the structure and bonding in a metallic element.
You should include a labelled diagram in your answer.

.....
..... [3]

- (ii) Explain why metallic elements such as gallium are good conductors of electricity.

..... [1]

- (b) Give the formula of

gallium(III) chloride,

gallium(III) sulfate. [2]

- (c) Gallium(III) oxide, Ga_2O_3 , is amphoteric.

- (i) Write the chemical equation for the reaction between gallium(III) oxide and dilute nitric acid to form a salt and water only.

..... [2]

- (ii) The reaction between gallium(III) oxide and sodium hydroxide solution forms only water and a salt containing the negative ion $\text{Ga}_2\text{O}_4^{2-}$.

Write the chemical equation for this reaction.

..... [2]

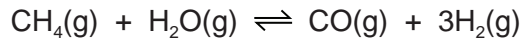
- (d) Alloys of gallium and other elements are often more useful than the metallic element itself.

Suggest **two** reasons why alloys of gallium are more useful than the metallic element.

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

[Total: 12]

- 4 Hydrogen can be manufactured from methane by steam reforming.



The reaction is carried out using a nickel catalyst at temperatures between 700°C and 1100°C and using a pressure of one atmosphere.

The forward reaction is endothermic.

- (a) What is meant by the term *catalyst*?

.....
 [2]

- (b) Suggest **two** reasons why a temperature lower than 700°C is not used.

.....
 [2]

- (c) Suggest **one** advantage of using a pressure greater than one atmosphere.

..... [1]

- (d) Suggest **one** disadvantage of using a pressure greater than one atmosphere.

..... [1]

- (e) Hydrogen can also be manufactured by electrolysis. The electrolyte is concentrated aqueous sodium chloride. The electrodes are inert.

The products of electrolysis are hydrogen, chlorine and sodium hydroxide.

- (i) Define the term *electrolysis*.

.....
 [2]

- (ii) Name a substance that can be used as the inert electrodes.

..... [1]

- (iii) Write an ionic half-equation for the reaction in which hydrogen is produced.

..... [1]

- (iv) Where is hydrogen produced in the electrolytic cell?

..... [1]

(v) Describe a test for chlorine.

test

result

[2]

(f) The electrolysis of concentrated aqueous sodium chloride can be represented by the following word equation.

sodium chloride + water → sodium hydroxide + hydrogen + chlorine

Construct a chemical equation to represent this reaction. Do not include state symbols.

..... [2]

(g) State one use of

chlorine,

sodium hydroxide,

hydrogen.

[3]

[Total: 18]

5 (a) Hydrocarbons are compounds which contain hydrogen and carbon only.

- 10 cm³ of a gaseous hydrocarbon, C_xH_y, are burned in 100 cm³ of oxygen, which is an excess of oxygen.
- After cooling to room temperature and pressure, there is 25 cm³ of unreacted oxygen, 50 cm³ of carbon dioxide and some liquid water.

All volumes are measured under the same conditions of temperature and pressure.

(i) What is meant by an excess of oxygen?

..... [1]

(ii) What was the volume of oxygen that reacted with the hydrocarbon?

..... [1]

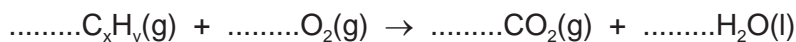
(iii) Complete the table below to express the smallest whole number ratio of

volume of hydrocarbon reacted : volume of oxygen reacted : volume of carbon dioxide produced

	volume of hydrocarbon reacted	volume of oxygen reacted	volume of carbon dioxide produced
smallest whole number ratio of volumes			

[1]

(iv) Use your answer to (a)(iii) to find the mole ratio in the equation below. Complete the equation and deduce the formula of the hydrocarbon.



formula of hydrocarbon = [2]

- (b) Cracking is used to convert long chain alkanes into shorter chain alkanes and alkenes. Alkenes are unsaturated compounds.

Decane, $C_{10}H_{22}$, can be cracked to give propene and one other product.

- (i) Complete the chemical equation.



- (ii) What is meant by the term *unsaturated*?

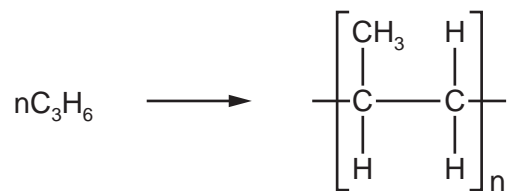
..... [1]

- (iii) Describe a test to show that propene is an unsaturated compound.

test

result [2]

- (c) Propene can be polymerised. The only product is polypropene. The equation for the polymerisation is:



- (i) Name the type of polymerisation that occurs.

..... [1]

- (ii) Deduce the maximum mass of polypropene that could be produced from 1 kg of propene.

..... kg [1]

- (iii) Give the empirical formula of

propene,

polypropene.

[2]

[Total: 13]

6 Zinc is extracted from an ore called zinc blende, which consists mainly of zinc sulfide, ZnS.

(a) (i) The zinc sulfide in the ore is first converted into zinc oxide.

Describe how zinc oxide is made from zinc sulfide.

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

(ii) Write a chemical equation for the reaction in (a)(i).

..... [2]

(b) Zinc oxide is converted into zinc. Zinc oxide and coke are fed into a furnace. Hot air is blown into the bottom of the furnace.

Zinc has a melting point of 420 °C and a boiling point of 907 °C. The temperature inside the furnace is over 1000 °C.

(i) Explain how zinc oxide is converted into zinc. Your answer should include details of how the heat is produced and equations for all the reactions you describe.

.....
.....
.....
.....
..... [3]

(ii) Explain why the zinc produced inside the furnace is a gas.

..... [1]

(iii) State the name of the physical change for conversion of gaseous zinc into molten zinc.

..... [1]

- (c) Rusting of steel can be prevented by coating the steel with a layer of zinc.

Explain, in terms of electron transfer, why steel does **not** rust even if the layer of zinc is scratched so that the steel is exposed to air and water.

.....

.....

.....

.....

..... [4]

- (d) When a sample of steel is added to dilute hydrochloric acid, an aqueous solution of iron(II) chloride, FeCl_2 , is formed.

When a sample of rust is added to dilute hydrochloric acid, an aqueous solution of iron(III) chloride, FeCl_3 , is formed.

- (i) Aqueous sodium hydroxide is added to the solutions of iron(II) chloride and iron(III) chloride.

Complete the table below, showing the observations you would expect to make.

	iron(II) chloride solution	iron(III) chloride solution
aqueous sodium hydroxide		

[2]

Solutions of iron(II) chloride and iron(III) chloride were added to solutions of potassium iodide and acidified potassium manganate(VII). The results are shown in the table.

	iron(II) chloride solution	iron(III) chloride solution
potassium iodide solution	no change	solution turns from colourless to brown
acidified potassium manganate(VII) solution	solution turns from purple to colourless	no change

(ii) What **types** of substance cause potassium iodide solution to turn from colourless to brown?

..... [1]

(iii) What **types** of substance cause acidified potassium manganate(VII) solution to turn from purple to colourless?

..... [1]

(iv) Which **ion** in iron(III) chloride solution causes potassium iodide solution to turn from colourless to brown?

..... [1]

(v) Which **ion** in iron(II) chloride solution causes acidified potassium manganate(VII) solution to turn from purple to colourless?

..... [1]

[Total: 18]

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The Periodic Table of Elements

		Group							
I	II	III	IV	V	VI	VII	VIII		
1	2	3	4	5	6	7	8	9	10
H hydrogen 1	He helium 4	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20		
<p>Key</p> <p>atomic number atomic symbol name relative atomic mass</p>									
3	4	5	6	7	8	9	10	11	12
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20	Ar argon 40	
11	12	13	14	15	16	17	18	19	20
Na sodium 23	Mg magnesium 24	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40		
19	20	21	22	23	24	25	26	27	28
K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59
37	38	39	40	41	42	43	44	45	46
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium —	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106
55	56	57–71	72	73	74	75	76	77	78
Cs caesium 133	Ba barium 137	lanthanoids	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195
87	88	89–103	104	105	106	107	108	109	110
Fr francium —	Ra radium —	actinoids	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —
81	82	83	84	85	86	87	88	89	90
Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium —	At astatine —	Rn radon —	Cn copernicium —	Fl flerovium —	Og oganeson —	Uu unununium —
91	92	93	94	95	96	97	98	99	100
La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144	Pm promethium —	Sm samarium 150	Eu europium 152	Gd gadolinium 157	Tb terbium 159	Dy dysprosium 163
89	90	91	92	93	94	95	96	97	98
Ac actinium —	Th thorium 232	Pa protactinium 231	U uranium 238	Np neptunium —	Pu plutonium —	Am americium —	Cm curium —	Bk berkelium —	Cf californium —
71	72	73	74	75	76	77	78	79	80
Lu lutetium 175	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201
103	104	105	106	107	108	109	110	111	112
Lr lawrencium —	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —
107	108	109	110	111	112	113	114	115	116
Yb ytterbium 173	Lu lutetium 175	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197
103	104	105	106	107	108	109	110	111	112
No nobelium —	Lr lawrencium —	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —
117	118	119	120	121	122	123	124	125	126
Uu unununium —	Uu unununium —	Uu unununium —	Uu unununium —	Uu unununium —	Uu unununium —	Uu unununium —	Uu unununium —	Uu unununium —	Uu unununium —

lanthanoids

actinoids

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