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NAME

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**CHEMISTRY**

**0620/43**

Paper 4 Theory (Extended)

**May/June 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.

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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 **14** printed pages and **2** blank pages.

1 Atoms contain particles called electrons, neutrons and protons.

(a) Complete the table.

particle	where the particle is found in an atom	relative mass	relative charge
	orbiting the nucleus	$\frac{1}{1840}$	
			+1
	in the nucleus		

[3]

(b) How many electrons, neutrons and protons are there in the ion shown?



number of electrons .....

number of neutrons .....

number of protons .....

[3]

[Total: 6]

2 Magnesium exists as three isotopes,  ${}^{24}_{12}\text{Mg}$ ,  ${}^{25}_{12}\text{Mg}$  and  ${}^{26}_{12}\text{Mg}$ .

(a) State, in terms of the total numbers of electrons, neutrons and protons, **one** difference and **two** similarities between these magnesium isotopes.

difference .....

similarity 1 .....

similarity 2 .....

[3]

(b) All isotopes of magnesium react with dilute hydrochloric acid to make hydrogen and a salt.

(i) Why do all isotopes of magnesium react in the same way?

.....

.....

..... [2]

(ii) Write a chemical equation for the reaction between magnesium and dilute hydrochloric acid.

..... [2]

(iii) Describe a test for hydrogen.

test .....

result .....

[2]

(c) Magnesium is a metal.

Describe the structure and bonding of metals. Include a labelled diagram in your answer.

.....

.....

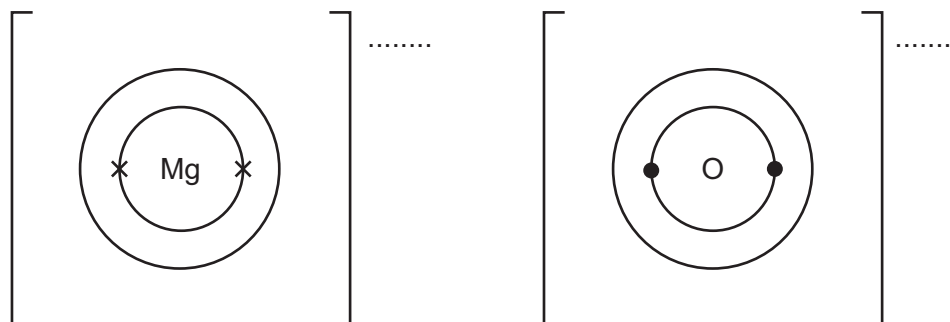
.....

.....

[3]

(d) Magnesium reacts with oxygen to form the ionic compound magnesium oxide.

- (i) Complete the dot-and-cross diagrams to show the electronic structures of the ions in magnesium oxide. Show the charges on the ions.



[3]

- (ii) Magnesium oxide melts at 2853 °C.

Why does magnesium oxide have a high melting point?

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

- (iii) Explain why molten magnesium oxide can conduct electricity.

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

[Total: 17]

3 (a) (i) Sodium is in Group I of the Periodic Table.

Describe **two** physical properties of sodium which are different from the physical properties of transition elements such as copper.

1 .....

.....

2 .....

.....

[2]

(ii) Sodium reacts rapidly with water.

Give **one** observation made when sodium is added to water.

..... [1]

(b) Some car airbags contain sodium azide.

When a car airbag is used the sodium azide,  $\text{NaN}_3$ , decomposes.

The products are nitrogen and sodium.

The equation for the decomposition of sodium azide is shown.



Calculate the mass, in g, of sodium azide needed to produce  $144\text{ dm}^3$  of nitrogen using the following steps.

- Calculate the number of moles in  $144\text{ dm}^3$  of  $\text{N}_2$  measured at room temperature and pressure.

moles of  $\text{N}_2$  = ..... mol

- Determine the number of moles of  $\text{NaN}_3$  needed to produce this number of moles of  $\text{N}_2$ .

moles of  $\text{NaN}_3$  = ..... mol

- Calculate the relative formula mass,  $M_r$ , of  $\text{NaN}_3$ .

$M_r$  = .....

- Calculate the mass of  $\text{NaN}_3$  needed to produce  $144\text{ dm}^3$  of  $\text{N}_2$ .

..... g

[4]

- (c) Some airbags contain silicon(IV) oxide.  
When the airbag is used sodium oxide is formed.

Oxides can be classified as acidic, amphoteric, basic or neutral.

Classify each of these oxides:

sodium oxide .....

silicon(IV) oxide. ....

[2]

- (d) Lead(II) azide is insoluble in water. Solid lead(II) azide can be made in a precipitation reaction between aqueous lead(II) nitrate and aqueous sodium azide.  
Lead(II) azide has the formula  $\text{Pb}(\text{N}_3)_2$ .

- (i) Deduce the formula of the azide ion.

..... [1]

- (ii) Complete the chemical equation for the reaction between aqueous lead(II) nitrate and aqueous sodium azide to form solid lead(II) azide and aqueous sodium nitrate. Include state symbols.



[2]

- (iii) Describe how you could obtain a sample of lead(II) azide that is **not** contaminated with any soluble salts from the reaction mixture.

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

- (e) An organic compound made from sodium azide has the composition by mass: 49.5% carbon, 7.2% hydrogen and 43.3% nitrogen.

Calculate the empirical formula of the organic compound.

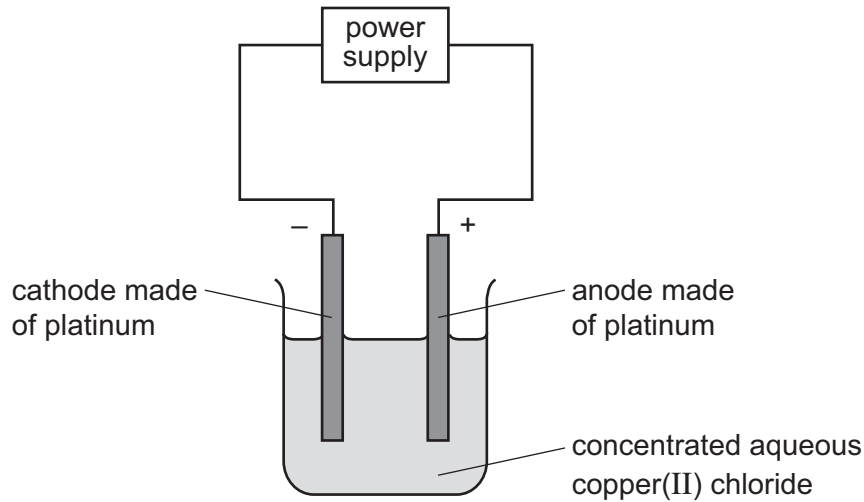
[3]

[Total: 17]

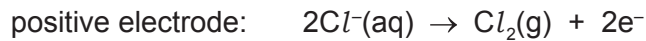
**Question 4 starts on the next page.**

4 Solutions of ionic compounds can be broken down by electrolysis.

(a) Concentrated aqueous copper(II) chloride was electrolysed using the apparatus shown.



The ionic half-equations for the reactions at the electrodes are shown.



(i) Platinum is a solid which is a good conductor of electricity.

State **one** other property of platinum which makes it suitable for use as electrodes.

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

(ii) State what would be **seen** at the positive electrode during this electrolysis.

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

(iii) State and explain what would happen to the mass of the negative electrode during this electrolysis.

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



(iv) The concentrated aqueous copper(II) chloride electrolyte is green.

Suggest what would happen to the colour of the electrolyte during this electrolysis.  
Explain your answer.

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

(v) Identify the species that is oxidised during this electrolysis.  
Explain your answer.

species that is oxidised .....

explanation .....

..... [2]

(b) Metal objects can be electroplated with silver.

(i) Describe how a metal spoon can be electroplated with silver.  
Include:

- what to use as the positive electrode and as the negative electrode
- what to use as the electrolyte
- an ionic half-equation to show the formation of silver.

You may include a diagram in your answer.

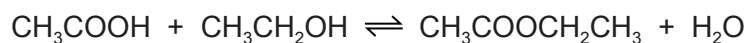
.....  
.....  
.....  
ionic half-equation ..... [4]

(ii) Give **one** reason why metal spoons are electroplated with silver.

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

[Total: 13]

- 5 Carboxylic acids react with alcohols to form esters. The reaction is reversible. The equation for the reaction between ethanoic acid and ethanol is shown.



- (a) (i) What is the name of the ester formed in this reaction?

..... [1]

- (ii) Draw the structure of the ester formed. Show all of the atoms and all of the bonds.

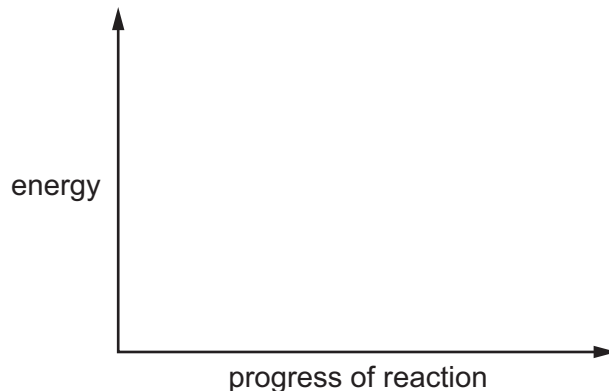
[1]

- (b) The reaction between ethanoic acid and ethanol is exothermic.

Draw an energy level diagram for this reaction.

On your diagram label:

- the reactants and products
- the energy change of the reaction,  $\Delta H$ .



[3]

- (c) Concentrated sulfuric acid is a catalyst for this reaction.

What is meant by the term *catalyst*?

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

(d) The rate of reaction can be increased by increasing the temperature.

Explain why increasing the temperature increases the rate of reaction.

.....  
.....  
.....  
.....  
.....  
..... [4]

(e) The reaction between ethanoic acid and ethanol reaches equilibrium.

(i) The reaction between ethanoic acid and ethanol is exothermic.

State and explain the effect, if any, of increasing the temperature on the amount of ester at equilibrium.

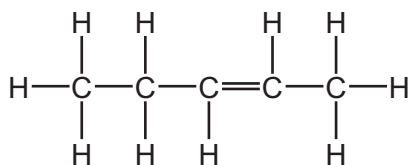
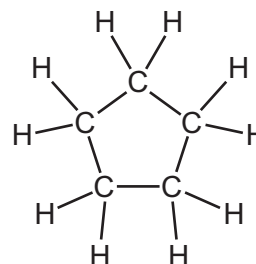
.....  
.....  
..... [2]

(ii) State and explain the effect, if any, of removing water from the mixture on the amount of ester at equilibrium.

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

[Total: 15]

- 6 (a) Two hydrocarbons have the structures shown.

hydrocarbon **A**hydrocarbon **B**

- (i) Why are these **two** compounds *hydrocarbons*?

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

- (ii) Hydrocarbon **B** reacts in the same way as a typical alkane.

Describe a chemical test to tell the difference between hydrocarbon **A** and hydrocarbon **B**.

State the name of the reagent you would use and the result you would obtain with hydrocarbon **A** and hydrocarbon **B**.

reagent .....

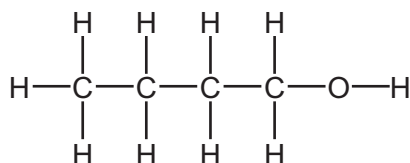
result with hydrocarbon **A** .....

result with hydrocarbon **B** .....

[3]

- (b) Alkenes react with steam to form alcohols.

Compound **C** is an alcohol.

compound **C**

Draw the structure of the alkene which could be reacted with steam to make compound **C**. Show all of the atoms and all of the bonds.

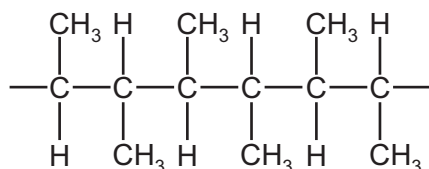
[1]

(c) Alkenes can form polymers.

(i) What type of polymerisation occurs when alkenes form polymers?

..... [1]

(ii) Part of the structure of a polymer is shown.

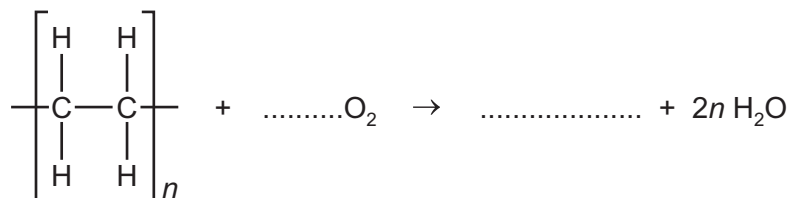


Draw the structure of the alkene from which this polymer can be made. Show all of the atoms and all of the bonds.

[1]

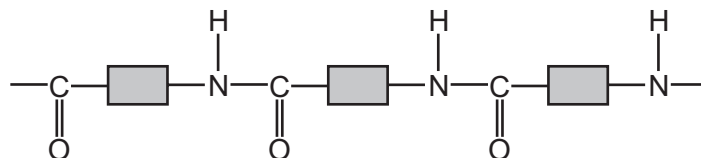
(iii) Polymers can undergo incomplete combustion to form carbon monoxide.

Complete the chemical equation for the incomplete combustion of poly(ethene). The only carbon-containing product is carbon monoxide.



[2]

(d) Part of the structure of a polyamide is shown.



This polyamide is formed from identical monomers. Complete the diagram to show the structure of **one** monomer. Show all of the atoms and all of the bonds.



[2]

[Total: 12]



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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	11	12	13	14	15	16	17	18																					
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	Al aluminium 13	Si silicon 14	P phosphorus 15	S sulfur 16	Cl chlorine 17	Ar argon 18	K potassium 19	Ca calcium 20	Sc scandium 21	Ti titanium 22	V vanadium 23	Cr chromium 24	Mn manganese 25	Fe iron 26	Co cobalt 27	Ni nickel 28	Cu copper 29	Zn zinc 30	Ga gallium 31	Ge germanium 32	As arsenic 33	Se selenium 34	Br bromine 35	Kr krypton 36											
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57-71 lanthanoids	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86			
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 90	Nb niobium 91	Mo molybdenum 92	Tc technetium 93	Ru ruthenium 94	Rh rhodium 95	Pd palladium 96	Ag silver 97	Cd cadmium 98	In indium 99	Sn tin 100	Sb antimony 101	Te tellurium 102	I iodine 103	Xe xenon 104	Cs caesium 133	Ba barium 137	La lanthanum 139	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	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium 210	At astatine 210	Rn radon 222			
87	88	89-103 actinoids	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137		
Fr francium	Ra radium	Ac actinium	Rf rutherfordium	Db dubnium	Sg seaborgium	Bh bohrium	Hs hassium	Mt meitnerium	Ds darmstadtium	Rg roentgenium	Cn copernicium	Fl flerovium	Lv livermorium	Uu ununoctium	Uub unubium	Uuc ununcium	Uud unundecium	Uue ununeptium	Uuq ununquadium	Uur ununhexium	Uus ununseptium	Uuo ununoctium	Uuq ununquadium	Uur ununhexium	Uus ununseptium	Uuo ununoctium	Uuq ununquadium	Uur ununhexium	Uus ununseptium	Uuo ununoctium	Uuq ununquadium	Uur ununhexium	Uus ununseptium	Uuo ununoctium	Uuq ununquadium	Uur ununhexium	Uus ununseptium	Uuo ununoctium

## Key

atomic number  
atomic symbol  
name  
relative atomic mass

1  
H  
hydrogen  
1

lanthanoids

actinoids

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
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	Ho holmium 165	Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Ac actinium	Th thorium 232	Pa protactinium 231	U uranium 238	Np neptunium	Pu plutonium	Am americium	Cm curium	Bk berkelium	Cf californium	Es einsteinium	Fm fermium	Md mendelevium	No nobelium	Lr lawrencium

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).