

CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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CHEMISTRY

0620/31

Paper 3 (Extended)

October/November 2014

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.

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) Match the following pH values to the solutions given below.

1 3 7 10 13

The solutions all have the same concentration.

solution	pH
aqueous ammonia, a weak base
dilute hydrochloric acid, a strong acid
aqueous sodium hydroxide, a strong base
aqueous sodium chloride, a salt
dilute ethanoic acid, a weak acid

[5]

- (b) Explain why solutions of hydrochloric acid and ethanoic acid with the same concentration, in mol/dm³, have a different pH.

.....

 [2]

- (c) Measuring pH is one way of distinguishing between a strong acid and a weak acid. Describe another method.

method

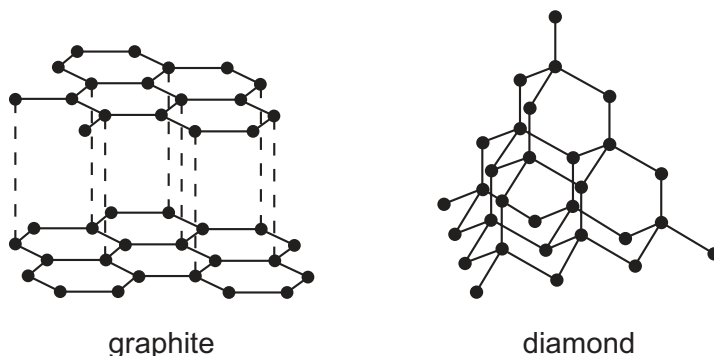
.....

results

..... [2]

[Total: 9]

2 Two macromolecular forms of carbon are graphite and diamond. The structures of graphite and diamond are given below.



(a) Explain in terms of its structure why graphite is soft and is a good conductor of electricity.

.....

.....

.....

.....

..... [3]

(b) State **two** uses of graphite which depend on the above properties.

It is soft

.....

It is a good conductor of electricity

..... [2]

(c) Silicon(IV) oxide also has a macromolecular structure.

(i) Describe the macromolecular structure of silicon(IV) oxide.

.....

..... [1]

(ii) Predict **two** physical properties which diamond and silicon(IV) oxide have in common.

.....

..... [2]

[Total: 8]

3 The main use of sulfur dioxide is the manufacture of sulfuric acid.

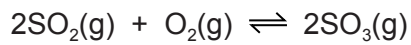
(a) State **two** other uses of sulfur dioxide.

.....
 [2]

(b) One source of sulfur dioxide is burning sulfur in air.
 Describe how sulfur dioxide can be made from the ore zinc sulfide.

.....
 [2]

(c) The Contact process changes sulfur dioxide into sulfur trioxide.



the forward reaction is exothermic

temperature 400 to 450 °C

low pressure 1 to 10 atmospheres

catalyst vanadium(V) oxide

(i) What is the formula of vanadium(V) oxide?

..... [1]

(ii) Vanadium(V) oxide is an efficient catalyst at any temperature in the range 400 to 450 °C.
 Scientists are looking for an alternative catalyst which is efficient at 300 °C.
 What would be the advantage of using a lower temperature?

.....

 [2]

(iii) The process does not use a high pressure because of the extra expense.
 Suggest **two** advantages of using a high pressure?
 Explain your suggestions.

.....

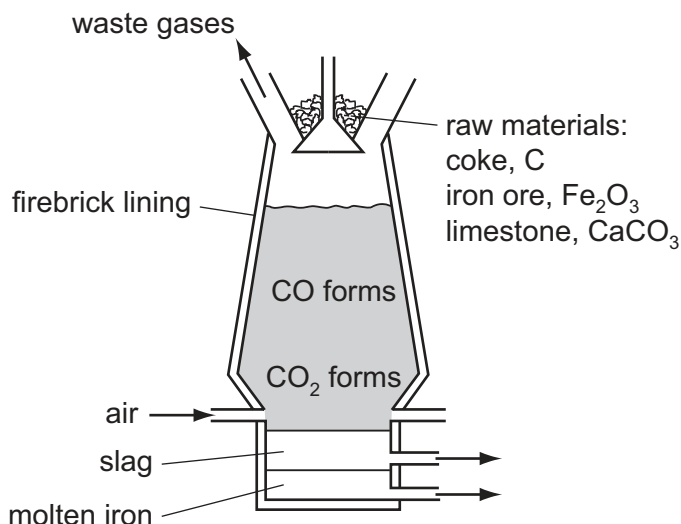
 [4]

- (d) Sulfuric acid is made by dissolving sulfur trioxide in concentrated sulfuric acid to form oleum. Water is reacted with oleum to form more sulfuric acid. Why is sulfur trioxide not reacted directly with water?

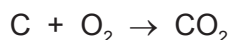
..... [1]

[Total: 12]

- 4 Iron is extracted from the ore hematite in the Blast Furnace.



- (a) The coke reacts with the oxygen in the air to form carbon dioxide.



- (i) Explain why carbon monoxide is formed higher in the Blast Furnace.

.....
 [2]

- (ii) Write an equation for the reduction of hematite, Fe₂O₃, by carbon monoxide.

..... [2]

- (b) (i) Limestone decomposes to form two products, one of which is calcium oxide. Name the other product.

..... [1]

- (ii) Calcium oxide reacts with silicon(IV) oxide, an acidic impurity in the iron ore, to form slag. Write an equation for this reaction.

..... [2]

- (iii) Explain why the molten iron and the molten slag form two layers and why molten iron is the lower layer.

.....
 [2]

- (iv) Suggest why the molten iron does **not** react with the air.

..... [1]

(c) Iron and steel rust. Iron is oxidised to hydrated iron(III) oxide, $\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$, which is rust.

(i) Name the **two** substances which cause iron to rust.

..... [1]

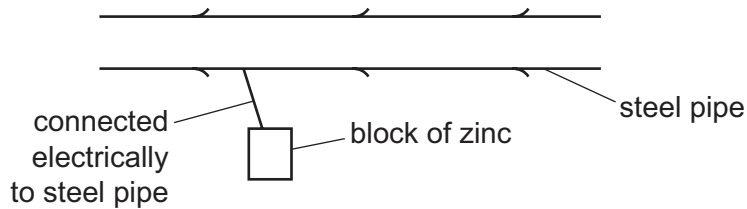
(ii) Explain why an aluminium article coated with aluminium oxide is protected from further corrosion but a steel article coated with rust continues to corrode.

.....
 [1]

(d) There are two electrochemical methods of rust prevention.

(i) The first method is sacrificial protection.

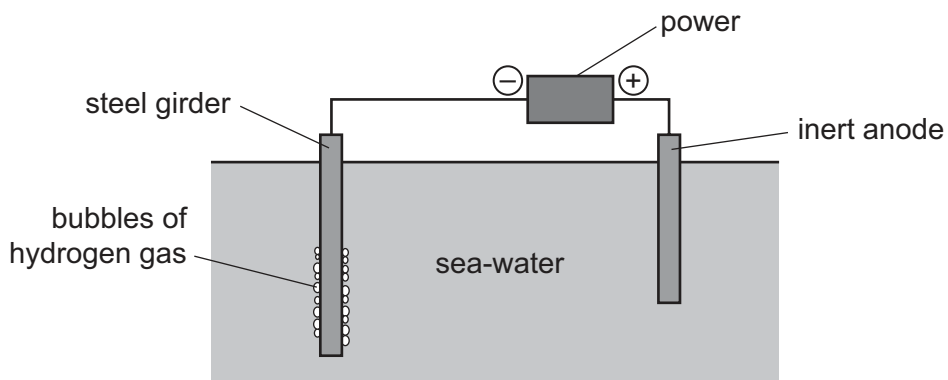
Explain why the steel article does not rust.



.....

 [4]

The second method is to make the steel article the cathode in a circuit for electrolysis.



(ii) Mark on the diagram the direction of the electron flow. [1]

(iii) The steel girder does not rust because it is the cathode. Reduction takes place at the cathode. Give the equation for the reduction of hydrogen ions.

..... [2]

[Total: 19]

5 Three common pollutants in the air are carbon monoxide, the oxides of nitrogen, NO and NO₂, and unburnt hydrocarbons. They are all emitted by motor vehicles.

(a) Describe how the oxides of nitrogen are formed.

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

(b) Describe how a catalytic converter reduces the emission of these three pollutants.

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

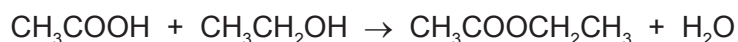
(c) Other atmospheric pollutants are lead compounds from leaded petrol. Explain why lead compounds are harmful.

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

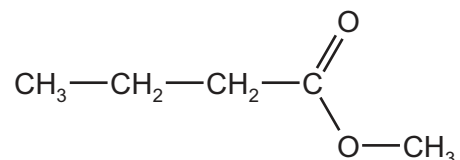
[Total: 7]

6 Esters, polyesters and fats all contain the ester linkage.

- (a) Esters can be made from alcohols and carboxylic acids. For example, the ester ethyl ethanoate can be made by the following reaction.



- (i) Name the carboxylic acid and the alcohol from which the following ester could be made.



name of carboxylic acid

name of alcohol

[2]

- (ii) 6.0 g of ethanoic acid, $M_r = 60$, was reacted with 5.5 g of ethanol, $M_r = 46$. Determine which is the limiting reagent and the maximum yield of ethyl ethanoate, $M_r = 88$.

number of moles of ethanoic acid = [1]

number of moles of ethanol = [1]

the limiting reagent is [1]

number of moles of ethyl ethanoate formed = [1]

maximum yield of ethyl ethanoate = [1]

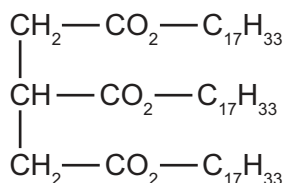
- (b) The following two monomers can form a polyester.



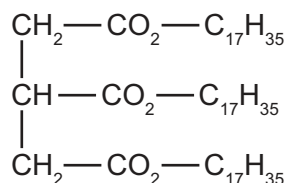
Draw the structural formula of this polyester. Include two ester linkages.

[3]

- (c) Fats and vegetable oils are esters. The formulae of two examples of natural esters are given below.



ester 1



ester 2

- (i) One ester is saturated, the other is unsaturated. Describe a test to distinguish between them.

test

result with unsaturated ester

.....

result with saturated ester

.....

[3]

- (ii) Deduce which one of the above esters is unsaturated. Give a reason for your choice.

.....

.....

..... [2]

- (iii) Both esters are hydrolysed by boiling with aqueous sodium hydroxide. What types of compound are formed?

..... and [2]

[Total: 17]

7 Nitrogen can form ionic compounds with reactive metals and covalent compounds with non-metals.

(a) Nitrogen reacts with lithium to form the ionic compound lithium nitride, Li_3N .

(i) Write the equation for the reaction between lithium and nitrogen.

..... [2]

(ii) Lithium nitride is an ionic compound. Draw a diagram which shows its formula, the charges on the ions and the arrangement of the valency electrons around the negative ion.

Use x for an electron from a lithium atom.
Use o for an electron from a nitrogen atom.

[2]

(b) Nitrogen fluoride is a covalent compound.

(i) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound nitrogen trifluoride, NF_3 .

Use x for an electron from a nitrogen atom.
Use o for an electron from a fluorine atom.

[2]

(ii) Lithium nitride has a high melting point, 813°C . Nitrogen trifluoride has a low melting point, -207°C .
Explain why the melting points are different.

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

[Total: 8]

DATA SHEET
The Periodic Table of the Elements

		Group																														
I	II	III	IV	V	VI	VII	0																									
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18																		
39 K Potassium 19	40 Ca Calcium 20	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36																			
85 Rb Rubidium 37	88 Sr Strontium 38	93 Nb Niobium 41	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54																			
133 Cs Caesium 55	137 Ba Barium 56	181 Ta Tantalum 73	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	210 Rn Radon 86																			
87 Fr Francium	88 Ra Radium	226 Ra Radium	227 Ac Actinium	89 †	†	†	†	†	†	†	†	†	†																			
*58-71 Lanthanoid series																																
†90-103 Actinoid series																																
<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td style="width: 5%;"></td> <td style="width: 5%;">a</td> <td style="width: 5%;"></td> <td style="width: 5%;">X</td> <td style="width: 5%;"></td> <td style="width: 5%;">b</td> </tr> <tr> <td>Key</td> <td></td> <td>a = relative atomic mass</td> <td></td> <td>x = atomic symbol</td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>b = proton (atomic) number</td> <td></td> </tr> </table>																a		X		b	Key		a = relative atomic mass		x = atomic symbol						b = proton (atomic) number	
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				b = proton (atomic) number																												
140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	152 Eu Europium 63	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71	232 Th Thorium 90	238 U Uranium 92	238 Np Neptunium 93	238 Pu Plutonium 94	238 Am Americium 95	238 Cm Curium 96	238 Bk Berkelium 97	238 Cf Californium 98	238 Es Einsteinium 99	238 Fm Fermium 100	238 Md Mendelevium 101	238 No Nobelium 102	238 Lr Lawrencium 103									

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

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