Cambridge O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/22**

Paper 2 Theory **May/June 2015**

1 hour 30 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.

Section A
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.

Section B
Answer any **three** questions.
Write your answers in the spaces provided in the Question Paper.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 20.

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 document consists of **20** printed pages.

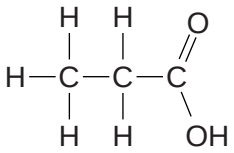
Section A

Answer **all** the questions in this section in the spaces provided.

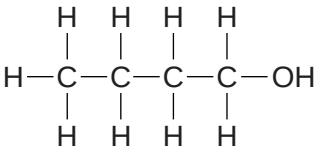
The total mark for this section is 45.

A1 Choose from the following compounds to answer the questions opposite.

A



B



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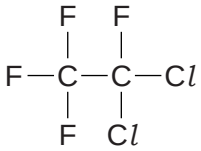

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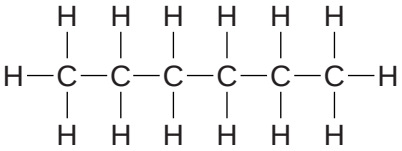

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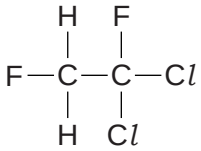

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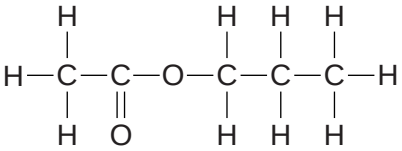

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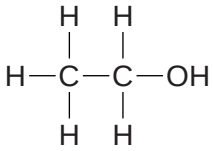
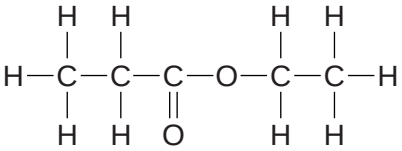


H



Each compound can be used once, more than once or not at all.

(a) Give the letter of the compound which

(i) is a CFC,

..... [1]

(ii) is propanoic acid,

..... [1]

(iii) is propyl ethanoate,

..... [1]

(iv) can be oxidised to ethanoic acid.

..... [1]

(b) Give the letters of **two** compounds that react together to make an ester.

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

[Total: 5]

A2 Hydrogen reacts with halogens to form hydrogen halides.

(a) Predict which halogen reacts most violently with hydrogen.

.....[1]

(b) The reaction between hydrogen and chlorine is exothermic.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g) \qquad \Delta H = -185\,kJ/mol$$

(i) Explain, in terms of bond breaking and bond forming, why this reaction is exothermic.

.....

.....

.....

.....[2]

(ii) When one mole of chlorine molecules reacts, 185 kJ of energy is released.

Calculate the amount of energy released when 106.5 g of chlorine reacts.

energy released = ... kJ [2]

(c) Hydrogen reacts with iodine in a reversible reaction.

This reaction reaches an equilibrium if carried out in a closed system.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = +53\,kJ/mol$$

(i) The reaction is studied at a temperature of 400 °C.

Describe and explain what happens to the position of equilibrium if the pressure is increased.

.....

.....

.....

.....[2]

(ii) The reaction is studied at 25 atmospheres pressure.

Describe and explain what happens to the position of equilibrium if the temperature is decreased.

.....

.....

.....

.....[2]

(d) Hydrogen iodide dissolves in water to form hydroiodic acid, HI(aq).

Hydroiodic acid is a strong acid.

(i) Write an equation to show the dissociation of hydroiodic acid.

.....[1]

(ii) Hydroiodic acid reacts with calcium.

Write the equation for this reaction.

.....[1]

(iii) Hydroiodic acid reacts with sodium carbonate.

Write the ionic equation for this reaction.

.....[1]

[Total: 12]

[Turn over

A3 Two isotopes of phosphorus are $^{31}_{15}P$ and $^{32}_{15}P$.

(a) State one difference and one similarity between these two isotopes.

difference

.....

.....

similarity

.....

.....
[2]

(b) Phosphorus forms simple molecules which have a relative molecular mass of 124.

Suggest the formula of a phosphorus molecule.

.....[1]

(c) Phosphorus has a low melting point and does not conduct electricity.

(i) Explain why phosphorus has a low melting point.

.....

.....[1]

(ii) Explain why phosphorus does not conduct electricity.

.....

.....[1]

(d) Complete the table for $^{31}_{15}P^{3-}$.

number of neutrons	……
number of protons	……
electronic configuration	……

[3]

(e) Phosphorus forms a compound called phosphine, PH_3.

Draw the 'dot-and-cross' diagram to show the bonding in a molecule of phosphine.

Only draw the outer shell electrons.

[2]

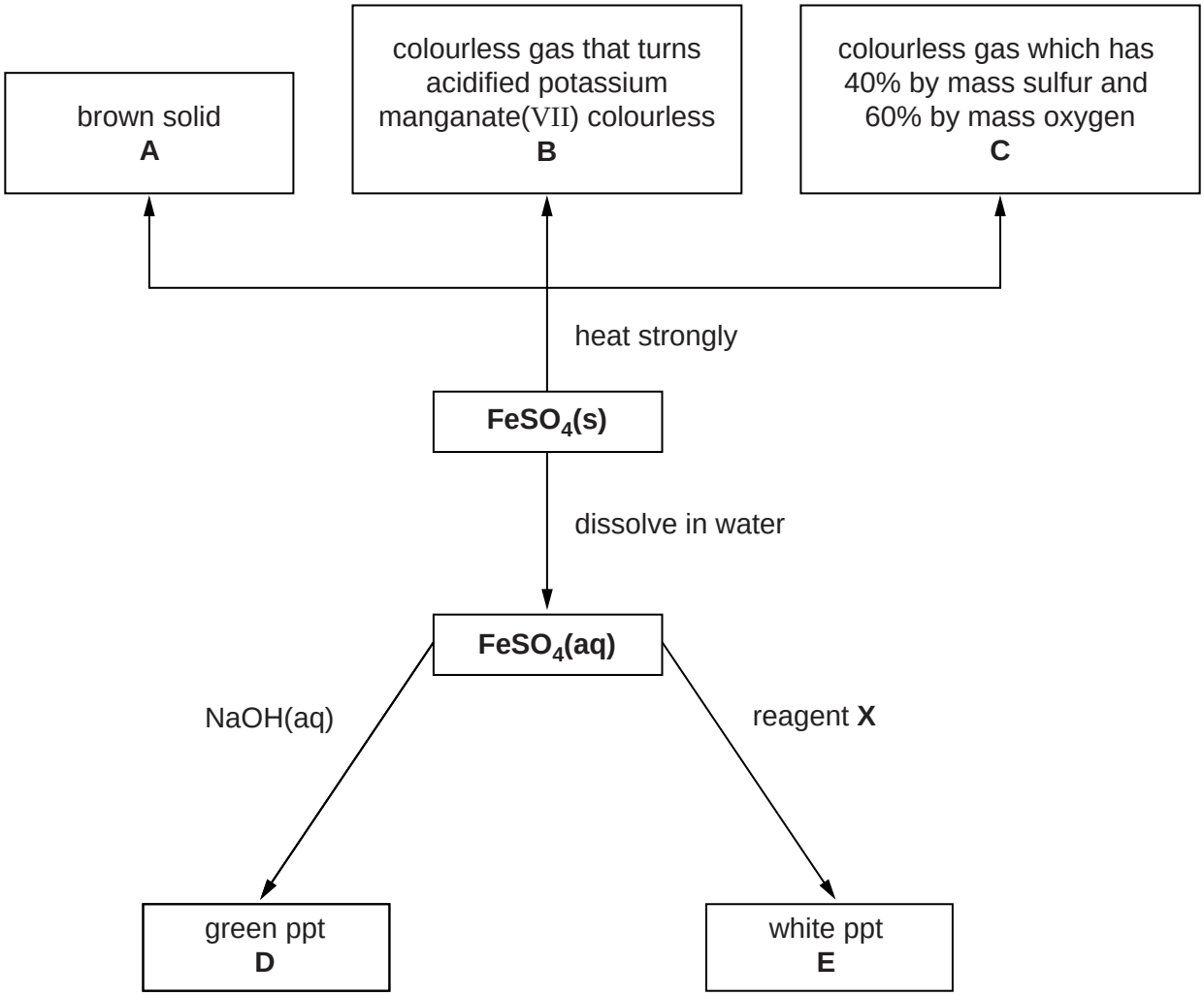
(f) Phosphine ignites in air to make water and phosphorus(V) oxide.

Construct the equation for this reaction.

.....[2]

[Total: 12]

A4 The flow chart shows some reactions of iron(II) sulfate, $FeSO_4$.



(a) Iron(II) sulfate is heated strongly.

(i) Write the formula of gas **B**.

.....[1]

(ii) Calculate the empirical formula of gas **C**.

Name gas **C**.

empirical formula is .....

name .....[3]

(iii) Two moles of iron(II) sulfate decompose to form one mole of solid **A**, one mole of gas **B** and one mole of gas **C**.

Deduce the formula of solid **A**.

formula of **A** .....[1]

(b) Write an ionic equation, including state symbols, for the formation of the green precipitate **D**.

.....[2]

(c) Suggest the name of reagent **X** and give the formula for the white precipitate **E**.

name of reagent **X** .....

formula of precipitate **E** .....[2]

[Total: 9]

A5 Electrolysis is often used in the extraction and purification of elements.

(a) Magnesium is manufactured by the electrolysis of molten magnesium chloride.

Write equations for the two electrode reactions that occur during this electrolysis.

.....

.....[2]

(b) Copper can be purified using the electrolysis of aqueous copper(II) sulfate.

(i) What is used as the anode (positive electrode)?

.....[1]

(ii) What is used as the cathode (negative electrode)?

.....[1]

(c) Chlorine can be made by the electrolysis of concentrated aqueous sodium chloride.

The overall process can be represented by the following equation.

$$2NaCl(aq) + 2H_2O(l) \longrightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$$

55 dm^3 of 3.5 mol/dm^3 aqueous sodium chloride is electrolysed.

What is the maximum volume of chlorine that can be formed, measured at room temperature and pressure?

volume of chlorine = ... dm^3 [3]

[Total: 7]

Question B6 begins on page 12.

Section B

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

B6 Ammonium carbonate, $(NH_4)_2CO_3$, is a white solid that is a component of 'smelling salts'.

It decomposes when it is heated.

$$(NH_4)_2CO_3(s) \rightarrow 2NH_3(g) + H_2O(g) + CO_2(g)$$

(a) A sample of ammonium carbonate is heated strongly until it all decomposes.

Suggest what you would observe during the experiment.

.....

.....[1]

(b) Describe how you would show that both ammonia and carbon dioxide are formed in this decomposition.

.....

.....

.....

.....

.....

.....

.....[4]

(c) Ammonium carbonate is soluble in water but zinc carbonate is insoluble in water.

Describe how you would prepare a sample of pure, dry zinc carbonate using a solution of ammonium carbonate.

.....

.....

.....

.....

.....

.....

.....

.....[3]

(d) Excess ammonium carbonate reacts with phosphoric acid, H_3PO_4.

Construct an equation for this reaction.

.....[2]

[Total: 10]

B7 Titanium can be manufactured by heating titanium(IV) chloride, $TiCl_4$, with magnesium.

(a) Construct the equation for this reaction.

.....[1]

(b) Explain why this reaction involves both oxidation **and** reduction.

.....

.....

.....

.....

.....[2]

(c) What mass of titanium can be made from 125 g of titanium(IV) chloride?

mass of titanium = ... g [3]

(d) Which metal is the less reactive, magnesium or titanium?

Explain your answer.

.....

.....

.....[1]

(e) Titanium(IV) chloride is a liquid with a low boiling point of 126 °C.

Suggest the structure and bonding of titanium(IV) chloride.

.....

.....[2]

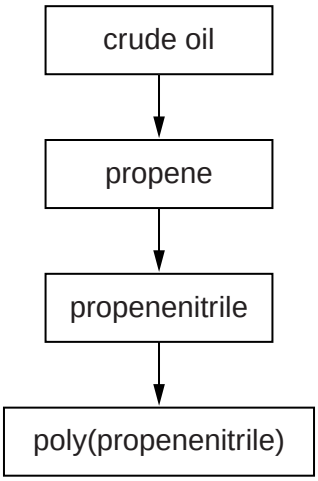
(f) Explain how titanium metal conducts electricity.

.....

.....[1]

[Total: 10]

B8 The flow chart shows the steps involved in the manufacture of poly(propenenitrile).



(a) Long chain alkanes such as $C_{17}H_{36}$ can be cracked to form propene, C_3H_6.

Construct an equation to show the cracking of $C_{17}H_{36}$ to form propene.

.....[1]

(b) The equation shows the reaction to make propenenitrile.

$$2C_3H_6(g) + 2NH_3(g) + 3O_2(g) \rightarrow 2C_3H_3N(g) + 6H_2O(g)$$

Describe and explain what happens to the rate of this reaction if the temperature is increased.

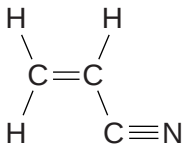
.....

.....

.....

.....[2]

(c) The structure of propenenitrile is shown.



(i) Explain why propenenitrile is unsaturated.

.....

.....[1]

(ii) Describe a chemical test to show that propenenitrile is unsaturated.

.....

.....

.....

.....[2]

(d) Draw part of the structure of poly(propenenitrile).

[2]

(e) A factory uses 1750 tonnes of propenenitrile to produce poly(propenenitrile).

The percentage yield is 95%.

Calculate the mass of poly(propenenitrile) produced.

mass of poly(propenenitrile) = ... tonnes [2]

[Total: 10]

B9 Alkenes are a homologous series of unsaturated hydrocarbons.

The table shows information about some alkenes.

alkene	molecular formula	melting point /°C	boiling point /°C
ethene	C_2H_4	–169	–105
butene	C_4H_8	–185	–6
hexene	C_6H_{12}	–140	63
decene	$C_{10}H_{20}$	–66	171
dodecene	$C_{12}H_{24}$	–35	214

(a) Decene is a liquid at 25 °C.

How can you make this deduction from the data in the table?

.....

.....

.....[2]

(b) Butene boils at –6 °C.

Use the kinetic particle theory to explain what happens when butene boils.

.....

.....

.....

.....[2]

(c) A sample of ethene gas in a gas syringe is heated from 20 °C to 100 °C.

The pressure remains constant.

Describe and explain, in terms of the kinetic particle theory, what happens to the volume of the gas.

.....

.....

.....[2]

(d) At room temperature ethene diffuses faster than butene.

Explain why.

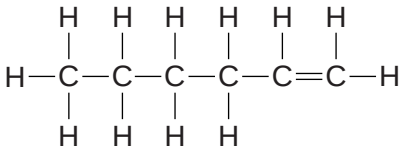
.....

.....[1]

(e) Draw the structure, showing all the atoms and all the bonds, for two isomers with the molecular formula C_4H_8.

[2]

(f) The structure of hexene is shown.



Draw the structure, showing all the atoms and all the bonds, for the product of the reaction of hexene with steam.

[1]

[Total: 10]

DATA SHEET
The Periodic Table of the Elements

Group I	Group II						Group III	Group IV	Group V	Group VI	Group VII	Group 0
					1 H Hydrogen 1							4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4						11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12						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	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	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	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	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	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	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	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	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	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103

* 58–71 Lanthanoid series
† 90–103 Actinoid series

Key

a	a = relative atomic mass
X	X = atomic symbol
b	b = atomic (proton) number

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