

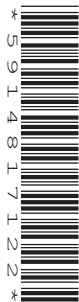
CANDIDATE  
NAME

CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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**CHEMISTRY**

Paper 2 Theory

**5070/22**

**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.

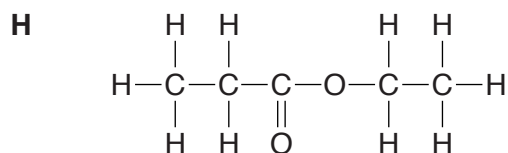
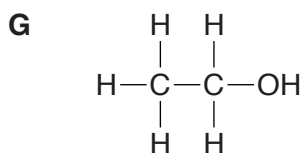
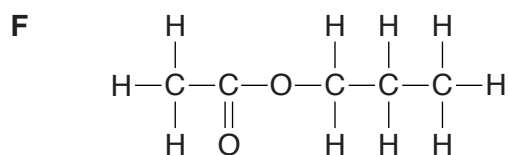
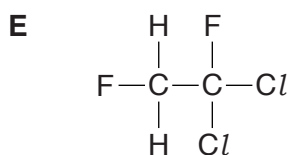
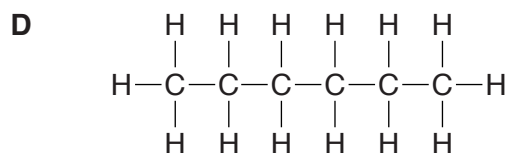
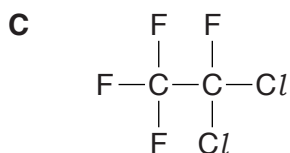
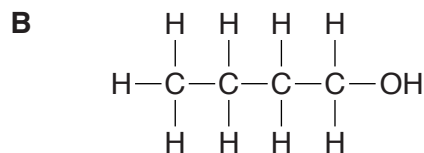
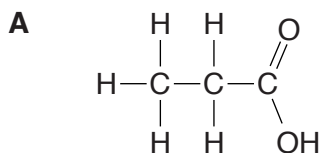
This document consists of **20** printed pages.

## 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.



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]

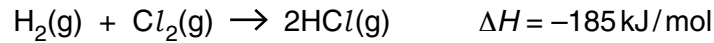
[Total: 5]

**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.



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

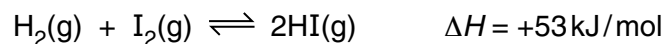
.....  
 .....  
 .....  
 .....[2]

**(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.



**(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]

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

**(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  $^{31}_{15}\text{P}^{3-}$ .

number of neutrons	.....
number of protons	.....
electronic configuration	.....

[3]

- (e) Phosphorus forms a compound called phosphine,  $\text{PH}_3$ .

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

Only draw the outer shell electrons.

[2]

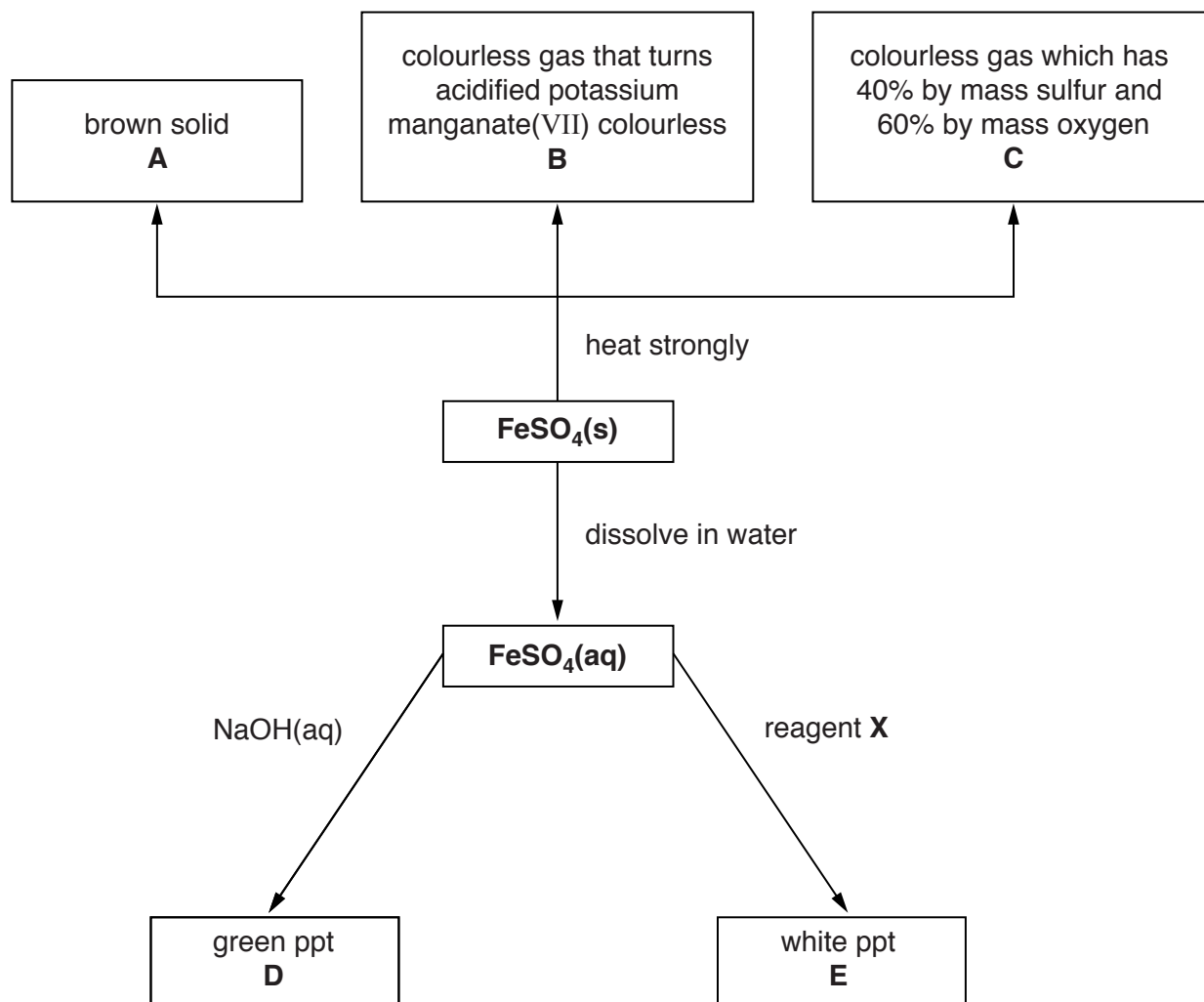
- (f) Phosphine ignites in air to make water and phosphorus(V) oxide.

Construct the equation for this reaction.

.....[2]

[Total: 12]

**A4** The flow chart shows some reactions of iron(II) sulfate,  $\text{FeSO}_4$ .



**(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)?

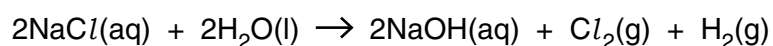
..... [1]

**(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.



55 dm<sup>3</sup> of 3.5 mol/dm<sup>3</sup> 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<sup>3</sup> [3]

[Total: 7]

**Question B6 begins on page 12.**

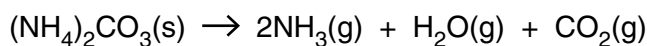
## Section B

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

The total mark for this section is 30.

**B6** Ammonium carbonate,  $(\text{NH}_4)_2\text{CO}_3$ , is a white solid that is a component of ‘smelling salts’.

It decomposes when it is heated.



**(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,  $\text{TiCl}_4$ , 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.

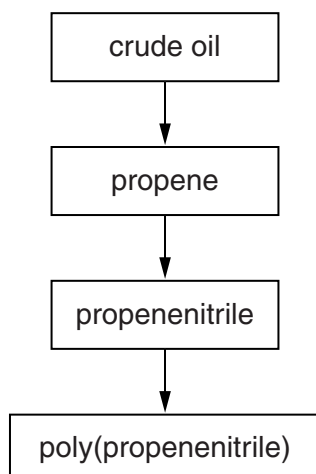
.....  
.....[2]

(f) Explain how titanium metal conducts electricity.

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

[Total: 10]

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

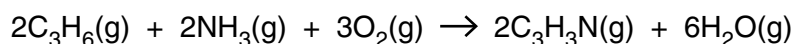


**(a)** Long chain alkanes such as  $C_{17}H_{36}$  can be cracked to form propene,  $C_3H_6$ .

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.

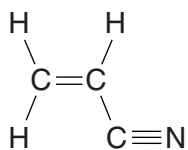


Describe and explain what happens to the rate of this reaction if the temperature is increased.

.....  
 .....  
 .....  
 .....[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 <sub>2</sub> H <sub>4</sub>	-169	-105
butene	C <sub>4</sub> H <sub>8</sub>	-185	-6
hexene	C <sub>6</sub> H <sub>12</sub>	-140	63
decene	C <sub>10</sub> H <sub>20</sub>	-66	171
dodecene	C <sub>12</sub> H <sub>24</sub>	-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.

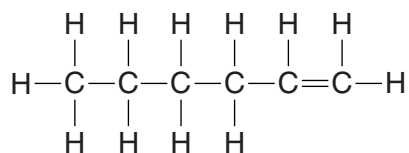
Explain why.

.....  
 ..... [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]

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**DATA SHEET**  
**The Periodic Table of the Elements**

		Group																				
		I	II	III	IV	V	VI	VII	0													
		<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;"></td> <td style="width: 10%; text-align: center;">1 <b>H</b> Hydrogen 1</td> <td colspan="8"></td> <td style="width: 10%;"></td> </tr> </table>											1 <b>H</b> Hydrogen 1									
	1 <b>H</b> Hydrogen 1																					
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4											4 <b>He</b> Helium 2										
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	13 <b>Al</b> Aluminium 13	14 <b>Si</b> Silicon 14	15 <b>P</b> Phosphorus 15	16 <b>S</b> Sulfur 16	17 <b>Cl</b> Chlorine 17	18 <b>Ar</b> Argon 18	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10											
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	55 <b>Mn</b> Manganese 25	52 <b>Cr</b> Chromium 24	51 <b>V</b> Vanadium 23	59 <b>Co</b> Cobalt 27	58 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36									
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	91 <b>Ti</b> Titanium 22	96 <b>Mo</b> Molybdenum 42	93 <b>Nb</b> Niobium 41	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	128 <b>Te</b> Tellurium 52	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54									
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	144 <b>Nd</b> Neodymium 60	141 <b>Pr</b> Praseodymium 59	140 <b>Ce</b> Cerium 58	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	209 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	222 <b>Rn</b> Radon 86									
223 <b>Fr</b> Francium 87	226 <b>Ra</b> Radium 88	147 <b>Pm</b> Promethium 61	141 <b>Pr</b> Praseodymium 59	140 <b>Ce</b> Cerium 58	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	159 <b>Tb</b> Terbium 65	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71									
		237 <b>Np</b> Neptunium 93	231 <b>Pa</b> Protactinium 91	232 <b>Th</b> Thorium 90	244 <b>Pu</b> Plutonium 94	243 <b>Am</b> Americium 95	247 <b>Cm</b> Curium 96	247 <b>Bk</b> Berkelium 97	252 <b>Es</b> Einsteinium 99	257 <b>Fm</b> Fermium 100	258 <b>Md</b> Mendelevium 101	259 <b>No</b> Nobelium 102	260 <b>Lr</b> Lawrencium 103									

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

**Key**

a	<b>X</b>
b	b

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

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