UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4887396987

CHEMISTRY **0620/21**

Paper 2 **May/June 2011**

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 in the spaces at the top of this page.
Write in dark blue or black pen.
You may need to use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
A copy of the Periodic Table is printed on page 16.

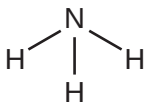
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
Total	

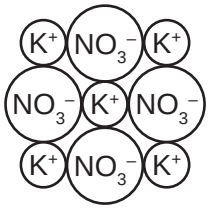
This document consists of **15** printed pages and **1** blank page.

1 The structures of some substances containing nitrogen are shown below.

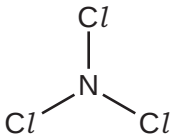
A



B

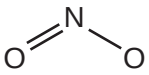


C



D

E



Answer the following questions by choosing from the structures **A**, **B**, **C**, **D** or **E**. You can use each structure once, more than once or not at all.

Which structure represents

(a) an acidic oxide, ☐

(b) an ionic giant structure, ☐

(c) a gas which turns moist litmus paper blue, ☐

(d) a compound which is formed under conditions of high temperature and pressure in car engines, ☐

(e) a molecule containing halogen atoms, ☐

(f) a salt? ☐

[Total: 6]

2 Vanadium has two isotopes.

$^{50}_{23}V$ $^{51}_{23}V$

(a) Define the term *isotope*.

.....

..... [1]

(b) An atom contains protons, electrons and neutrons.
Complete the table to show the number of protons, electrons and neutrons in these two isotopes of vanadium.

isotope	number of protons	number of electrons	number of neutrons
$^{50}_{23}V$	23	23	
$^{51}_{23}V$			28

[3]

(c) Complete these sentences using words from the list.

cancer **extra** **industry** **influenza** **medicine** **non**

Two types of isotopes are radioactive and .....-radioactive. Radioactive isotopes are used in ..... for treating patients with ..... . [3]

(d) Vanadium is a transition element.
Which two of these statements about vanadium are correct?
Tick **two** boxes.

- vanadium is a non-metal ☐
- vanadium conducts electricity ☐
- vanadium has a low melting point ☐
- vanadium is less dense than sodium ☐
- compounds of vanadium are coloured ☐

[2]

[Total: 9]

For Examiner's Use

3 Water is present in the atmosphere, the seas and in ice and snow.

(a) Describe a chemical test for water.

test .....

result ..... [2]

(b) State **one** use of water in industry.

..... [1]

(c) Water is a good solvent.
What do you understand by the term *solvent*?

..... [1]

(d) Water vapour in the atmosphere reacts with sulfur dioxide, SO_2, to produce acid rain.

(i) State **one** source of sulfur dioxide.

..... [1]

(ii) State **two** adverse effects of acid rain.

1. .....

2. ..... [2]

(iii) Calculate the relative molecular mass of sulfur dioxide.

[1]

(e) Water from lakes and rivers can be treated to make the water safer to drink.

Describe **two** of the steps in water purification.
For each of these steps, give an explanation of its purpose.

step 1 .....

.....

step 2 .....

..... [4]

For Examiner's Use

(f) Water is formed when hydrogen burns in air.

(i) State the percentage of oxygen present in the air.

..... [1]

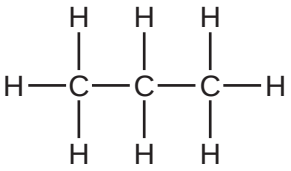
(ii) When 8 g of hydrogen is burned in excess air, 72 g of water is formed.
What mass of hydrogen needs to be burnt to produce 252 g of water?

[1]

[Total: 14]

4 The structures of some organic compounds are shown below.

A



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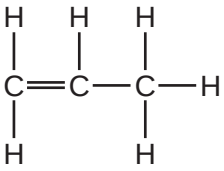
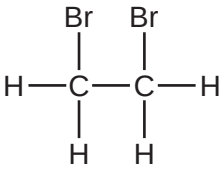
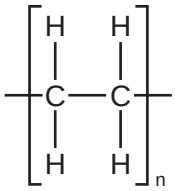


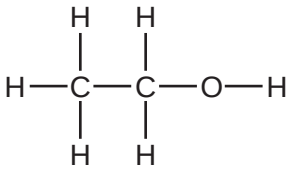
C



D



E



(a) Which one of these structures represents

(i) a polymer, ☐

(ii) an unsaturated hydrocarbon, ☐

(iii) the product of the catalytic addition of steam to ethene, ☐

(iv) a product of the addition of aqueous bromine to ethene? ☐

[4]

(b) **(i)** Balance the equation for the complete combustion of compound **A**, C_3H_8.

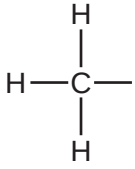
$$C_3H_8 + ...O_2 \rightarrow 3CO_2 + ...H_2O$$

[2]

(ii) State the name of **two** substances formed when compound **A** undergoes incomplete combustion.

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

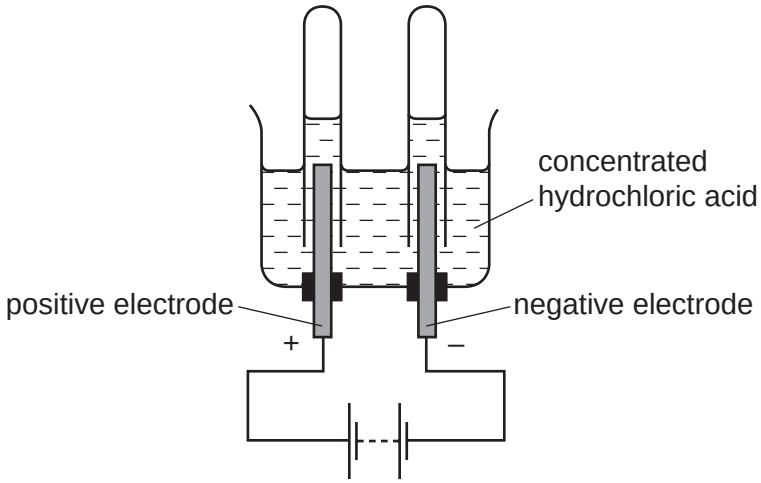
(c) Complete the structure of ethanoic acid to show all atoms and bonds.



[1]

[Total: 9]

5 Concentrated hydrochloric acid can be electrolysed using the apparatus shown.



(a) What do you understand by the term *electrolysis*?

.....

..... [1]

(b) What is the name given to the positive electrode?
Put a ring around the correct answer.

anion **anode** **cathode** **cation** **electrolyte**

[1]

(c) State the name of the gas given off at the negative electrode.

..... [1]

(d) Complete the following sentence about electrolysis using words from the list.

inert **magnesium** **platinum** **reactive** **solid**

Electrodes made of graphite or ..... are generally used in electrolysis because they are ..... . [2]

[Turn over

(e) When concentrated hydrochloric acid is electrolysed, chlorine is released at the positive electrode.

(i) Draw the arrangement of the electrons in an atom of chlorine.

[1]

(ii) Draw the electronic structure of a chlorine molecule.
Show only the outer electron shells.

[2]

(iii) Describe a test for chlorine.

test .....

result ..... [2]

(f) Hydrochloric acid reacts with the base calcium hydroxide.

(i) Complete the word equation for this reaction.

hydrochloric acid + calcium hydroxide → ..... + ...

.....

[2]

(ii) Hydrochloric acid also reacts with zinc.
Complete the symbol equation for this reaction.

$$Zn + ...HCl \rightarrow ZnCl_2 + ...$$

[2]

[Total: 14]

6 A student observed the reaction of various metals with both cold water and steam. Her results are shown below.

metal	reaction with cold water	reaction with steam
calcium	reacts rapidly	reacts very rapidly
copper	no reaction	no reaction
magnesium	reacts very slowly	reacts rapidly
zinc	no reaction	reacts

(a) (i) Put these metals in order of their reactivity.

least reactive ⟶ most reactive

[1]

(ii) Iron is a metal between zinc and copper in the reactivity series.
Predict the reactivity of iron with

cold water, ...

steam. ..... [2]

(b) The equation for the reaction of zinc with steam is:

$$Zn + H_2O \rightarrow ZnO + H_2$$

Write a word equation for this reaction.

[1]

(c) State **three** physical properties which are characteristic of **most** metals.

1. .....

2. .....

3. ..... [3]

(d) Some properties of the Group I metals are shown in the table.

metal	melting point / °C	hardness	density / g per cm^3
lithium		fairly hard	0.53
sodium	98	fairly soft	
potassium	63	soft	
rubidium	39	very soft	1.53
caesium	29	extremely soft	1.88

(i) Estimate the melting point of lithium.

..... [1]

(ii) How does the hardness of these metals change down the group?

..... [1]

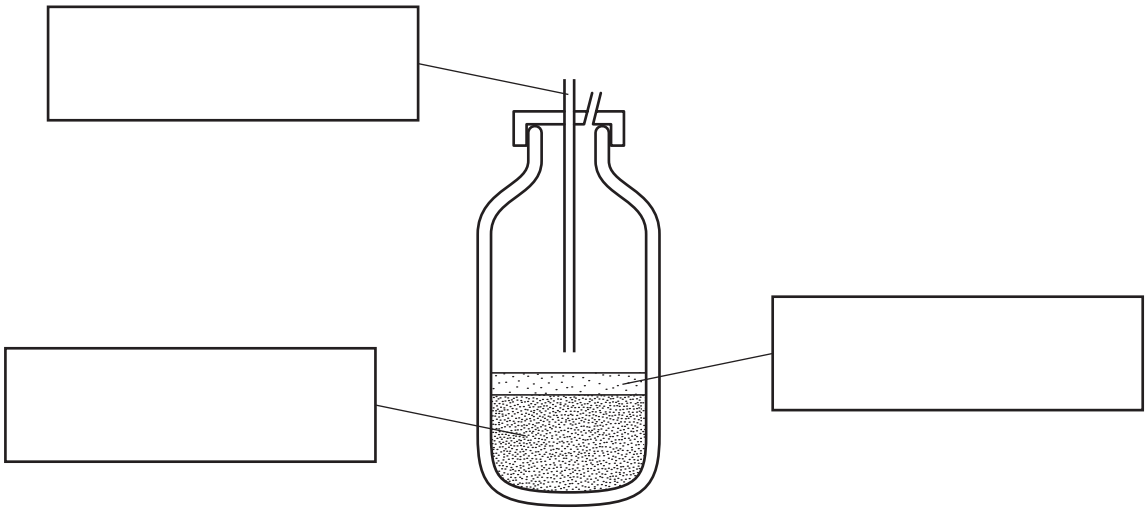
(iii) Estimate the density of potassium.

..... [1]

[Total: 10]

For Examiner's Use

7 The diagram shows a basic oxygen converter. This is used to convert impure iron from the blast furnace into steel. During this process, some of the impurities in the iron are converted into a slag.



(a) Label the diagram to show each of the following:

- where the oxygen enters;
- the slag;
- the molten steel. [3]

(b) In the converter, the oxygen oxidises sulfur, carbon and phosphorus to their oxides.

(i) Explain why sulfur dioxide and carbon dioxide are easily removed from the converter.

..... [1]

(ii) Explain how calcium oxide is used to remove phosphorus(V) oxide from the converter.

.....

.....

.....

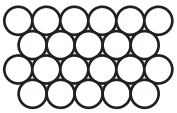
..... [3]

For Examiner's Use

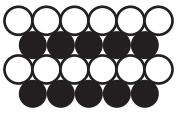
(c) Stainless steel is an alloy.

(i) Which **one** of the diagrams, **A**, **B**, **C** or **D**, best represents an alloy?
Put a ring around the correct answer.

A



B



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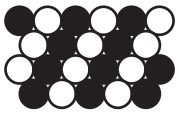
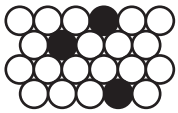


D



[1]

(ii) State **one** use of stainless steel.

..... [1]

[Total: 9]

8 Bromine is a red-brown liquid. When warmed, it forms an orange vapour.

(a) Describe what happens to the arrangement and motion of the particles when bromine changes state from a liquid to a vapour.

.....

.....

.....

..... [3]

(b) Bromine can be obtained from bromide ions in seawater.

(i) The symbol equation for this reaction is:

$$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$$

Complete the word equation for this reaction.

..... + bromide ions → ..... + ...

[1]

(ii) Bromine is very volatile, so it can be removed from solution by bubbling air through the solution.
What do you understand by the term *volatile*?

..... [1]

(c) Hydrogen reacts with bromine in the presence of a hot platinum catalyst to form hydrogen bromide.

(i) Define the term *catalyst*.

..... [1]

(ii) Hydrogen bromide reduces hydrogen peroxide, H_2O_2.

$$2HBr + H_2O_2 \rightarrow Br_2 + 2H_2O$$

Explain how this equation shows that hydrogen peroxide is reduced.

.....

..... [1]

(iii) A solution of hydrogen bromide in water is called hydrobromic acid. Hydrobromic acid has similar reactions to hydrochloric acid.

State the names of **three** products formed when hydrobromic acid reacts with sodium carbonate.

..... [2]

[Total: 9]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	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	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															
				140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**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	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

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

Key

a
X
b

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

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