

CANDIDATE  
NAME

CENTRE  
NUMBER

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NUMBER

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**CHEMISTRY**

**0620/31**

Paper 3 (Extended)

**October/November 2015**

**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) The symbols of six particles are shown below.



Select from the list of particles to answer the following questions. A particle may be selected once, more than once or not at all.

- (i) Which **two** ions have the same electronic structure? ..... [1]
- (ii) Which ion has the same electronic structure as an atom of argon? ..... [1]
- (iii) Which atom can form an ion of the type X<sup>3-</sup>? ..... [1]
- (iv) Which atom can form a hydride which has a formula of the type XH<sub>4</sub>? ..... [1]
- (b) (i) How many protons, neutrons and electrons are there in one copper(II) ion  ${}^{64}_{29}\text{Cu}^{2+}$ ?
- number of protons .....
- number of neutrons .....
- number of electrons .....
- [2]
- (ii)  ${}^{45}_{21}\text{Sc}$  represents an atom of scandium.
- How many nucleons and how many charged particles are there in one atom of scandium?
- number of nucleons .....
- number of charged particles .....
- [2]
- (c) Two different atoms of sodium are  ${}^{23}_{11}\text{Na}$  and  ${}^{24}_{11}\text{Na}$ .
- (i) Explain why these two atoms are isotopes.
- .....
- ..... [2]
- (ii)  ${}^{24}_{11}\text{Na}$  is radioactive. It changes into an atom of a different element which has one more proton.
- Identify this element.
- ..... [1]
- (iii) State **two** uses of radioactive isotopes.
- .....
- ..... [2]

[Total: 13]

2 Describe how to separate the following. In each example, give a description of the procedure used and explain why this method works.

(a) Copper powder from a mixture containing copper and zinc powders.

procedure .....

.....

explanation .....

.....

[3]

(b) Nitrogen from a mixture of nitrogen and oxygen.

procedure .....

.....

explanation .....

.....

[3]

(c) Glycine from a mixture of the two amino acids glycine and alanine. Glycine has the lower  $R_f$  value.

procedure .....

.....

explanation .....

.....

[2]

(d) Magnesium hydroxide from a mixture of magnesium hydroxide and zinc hydroxide.

procedure .....

.....

explanation .....

.....

[3]

[Total: 11]

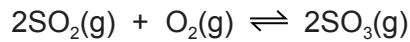
3 Sulfuric acid is made by the Contact process.

(a) Sulfur is burned by spraying droplets of molten sulfur into air.

Suggest and explain an advantage of using this method.

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

(b) The following equation represents the equilibrium in the Contact process.



Oxygen is supplied from the air.

The composition of the reaction mixture is 1 volume of sulfur dioxide to 1 volume of oxygen.

What volume of air contains 1 dm<sup>3</sup> of oxygen?

..... dm<sup>3</sup> [1]

(c) Sulfur dioxide is more expensive than air.

What is the advantage of using an excess of air?

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

(d) The forward reaction is exothermic. The reaction is usually carried out at a temperature between 400 and 450 °C.

(i) What is the effect on the position of equilibrium of using a temperature above 450 °C?  
 Explain your answer.

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

(ii) What is the effect on the rate of using a temperature below 400 °C?  
 Explain your answer.

.....  
 .....  
 ..... [3]

(e) A low pressure, 2 atmospheres, is used. At equilibrium, about 98% SO<sub>3</sub> is present.

(i) What is the effect on the position of equilibrium of using a higher pressure?

..... [1]

(ii) Explain why a higher pressure is **not** used.

..... [1]

(f) Name the catalyst used in the Contact process.

..... [1]

(g) Describe how concentrated sulfuric acid is made from sulfur trioxide.

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

[Total: 15]

4 (a) Synthetic polymers are disposed of in landfill sites and by burning.

(i) Describe **two** problems caused by the disposal of synthetic polymers in landfill sites.

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

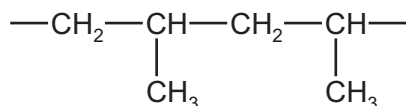
(ii) Describe **one** problem caused by burning synthetic polymers.

..... [1]

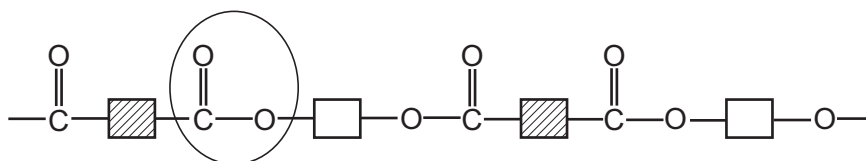
(b) State **two** uses of synthetic polymers.

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

(c) The structural formulae of two synthetic polymers are given below.



polymer A



polymer B

(i) Draw the structural formula of the monomer of polymer A.

[2]

(ii) Identify the functional group circled in polymer B.

..... [1]

(iii) Deduce the **two** types of organic compound which have reacted to form polymer B.

..... [2]

(d) Explain the difference between addition and condensation polymers. Classify **A** and **B** as either addition or condensation polymers.

.....

.....

.....

..... [3]

[Total: 12]

5 (a) A compound, **X**, contains 55.85% carbon, 6.97% hydrogen and 37.18% oxygen.

(i) How does this prove that compound **X** contains only carbon, hydrogen and oxygen?

..... [1]

(ii) Use the above percentages to calculate the empirical formula of compound **X**.

..... [2]

(iii) The  $M_r$  of **X** is 86.

What is its molecular formula?

..... [2]

(b) (i) Bromine water changes from brown to colourless when added to **X**.

What does this tell you about the structure of **X**?

..... [1]

(ii) Magnesium powder reacts with an aqueous solution of **X**. Hydrogen is evolved.

What does this tell you about the structure of **X**?

..... [1]

(iii) **X** contains two different functional groups.

Draw a structural formula of **X**.

[1]

[Total: 8]



6 Carbon and silicon are elements in Group IV. They both form oxides of the type  $XO_2$ .

(a) Silicon(IV) oxide,  $SiO_2$ , has a macromolecular structure.

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

.....  
.....  
.....  
.....  
..... [3]

(ii) State **three** properties which silicon(IV) oxide and diamond have in common.

.....  
.....  
..... [3]

(iii) How could you show that silicon(IV) oxide is acidic and not basic or amphoteric?

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

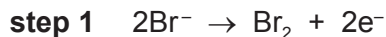
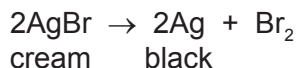
(b) Explain why the physical properties of carbon dioxide are different from those of diamond and silicon(IV) oxide.

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

[Total: 9]

7 The rate of a photochemical reaction is affected by light.

(a) The decomposition of silver bromide is the basis of film photography. This is a redox reaction.



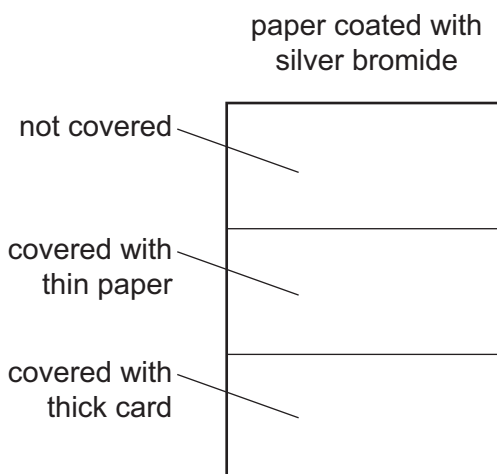
(i) Which step is reduction? Explain your answer.

..... [1]

(ii) Which ion is the oxidising agent? Explain your answer.

..... [1]

(b) A piece of white paper was coated with silver bromide and exposed to the light. Sections of the paper were covered as shown in the diagram.



Predict the appearance of the different sections of the paper after exposure to the light and the removal of the card. Explain your predictions.

.....

.....

.....

.....

.....

.....

..... [4]

(c) Photosynthesis is another example of a photochemical reaction. Green plants can make simple carbohydrates, such as glucose. These can polymerise to make more complex carbohydrates, such as starch.

(i) Write a word equation for photosynthesis.

..... [2]

(ii) Name the substance which is responsible for the colour in green plants and is essential for photosynthesis.

..... [1]

(iii) The structural formula of glucose can be represented by  $\text{H}-\text{O}-\square-\text{O}-\text{H}$ .

Draw part of the structural formula of starch which contains two glucose units.

[2]

(iv) Living organisms need carbohydrates for respiration.

What is meant by *respiration*?

..... [1]

[Total: 12]

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

		Group																							
I	II	III	IV	V	VI	VII	0																		
1 <b>H</b> Hydrogen 1											2 <b>He</b> Helium 2														
3 <b>Li</b> Lithium 3	4 <b>Be</b> Beryllium 4	5 <b>B</b> Boron 5	6 <b>C</b> Carbon 6	7 <b>N</b> Nitrogen 7	8 <b>O</b> Oxygen 8	9 <b>F</b> Fluorine 9	10 <b>Ne</b> Neon 10	11 <b>B</b> Boron 11	12 <b>C</b> Carbon 12	13 <b>Al</b> Aluminium 13	14 <b>N</b> Nitrogen 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>K</b> Potassium 19	20 <b>Ca</b> Calcium 20	21 <b>Sc</b> Scandium 21	22 <b>Ti</b> Titanium 22	23 <b>V</b> Vanadium 23	24 <b>Cr</b> Chromium 24	25 <b>Mn</b> Manganese 25	26 <b>Fe</b> Iron 26	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	29 <b>Cu</b> Copper 29	30 <b>Zn</b> Zinc 30	31 <b>Ga</b> Gallium 31	32 <b>Ge</b> Germanium 32	33 <b>As</b> Arsenic 33	34 <b>Se</b> Selenium 34	35 <b>Br</b> Bromine 35	36 <b>Kr</b> Krypton 36								
37 <b>Rb</b> Rubidium 37	38 <b>Sr</b> Strontium 38	39 <b>Y</b> Yttrium 39	40 <b>Zr</b> Zirconium 40	41 <b>Nb</b> Niobium 41	42 <b>Mo</b> Molybdenum 42	43 <b>Tc</b> Technetium 43	44 <b>Ru</b> Ruthenium 44	45 <b>Rh</b> Rhodium 45	46 <b>Pd</b> Palladium 46	47 <b>Ag</b> Silver 47	48 <b>Cd</b> Cadmium 48	49 <b>In</b> Indium 49	50 <b>Sn</b> Tin 50	51 <b>Sb</b> Antimony 51	52 <b>Te</b> Tellurium 52	53 <b>I</b> Iodine 53	54 <b>Xe</b> Xenon 54								
55 <b>Cs</b> Caesium 55	56 <b>Ba</b> Barium 56	57 <b>La</b> Lanthanum 57	72 <b>Hf</b> Hafnium 72	73 <b>Ta</b> Tantalum 73	74 <b>W</b> Tungsten 74	75 <b>Re</b> Rhenium 75	76 <b>Os</b> Osmium 76	77 <b>Ir</b> Iridium 77	78 <b>Pt</b> Platinum 78	79 <b>Au</b> Gold 79	80 <b>Hg</b> Mercury 80	81 <b>Tl</b> Thallium 81	82 <b>Pb</b> Lead 82	83 <b>Bi</b> Bismuth 83	84 <b>Po</b> Polonium 84	85 <b>At</b> Astatine 85	86 <b>Rn</b> Radon 86								
87 <b>Fr</b> Francium 87	88 <b>Ra</b> Radium 88	89 <b>Ac</b> Actinium 89											103 <b>Lr</b> Lawrencium 103												
*58-71 Lanthanoid series																									
†90-103 Actinoid series																									
<table border="1"> <tr> <td>a</td> <td>X</td> <td>b</td> </tr> </table> <p>Key a = relative atomic mass X = atomic symbol b = proton (atomic) number</p>																	a	X	b						
a	X	b																							
140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	162 <b>Dy</b> Dysprosium 66	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	232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	238 <b>Pa</b> Protactinium 91	238 <b>Np</b> Neptunium 93	238 <b>Pu</b> Plutonium 94	238 <b>Am</b> Americium 95	238 <b>Cm</b> Curium 96	238 <b>Bk</b> Berkelium 97	238 <b>Cf</b> Californium 98	238 <b>Es</b> Einsteinium 99	238 <b>Fm</b> Fermium 100	238 <b>Md</b> Mendelevium 101	238 <b>No</b> Nobelium 102	238 <b>Lr</b> Lawrencium 103

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