Cambridge IGCSE

**Cambridge International Examinations**
Cambridge International General Certificate of Secondary Education

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | | | | | | CANDIDATE NUMBER | | | | |

**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.



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CAMBRIDGE International Examinations

**1** **(a)** The symbols of six particles are shown below.

View solution

$Na^+$ $Ca^{2+}$ Kr P Si $O^{2-}$

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 $X^{3-}$? ..... [1]

**(iv)** Which atom can form a hydride which has a formula of the type $XH_4$? ..... [1]

**(b)** **(i)** How many protons, neutrons and electrons are there in one copper(II) ion $^{64}_{29}Cu^{2+}$?

View solution

number of protons .....

number of neutrons .....

number of electrons .....

[2]

**(ii)** $^{45}_{21}Sc$ represents an atom of scandium.

How many nucleons and how many charged particles are there in one atom of scandium?

View solution

number of nucleons .....

number of charged particles .....

[2]

**(c)** Two different atoms of sodium are $^{23}_{11}Na$ and $^{24}_{11}Na$.

View solution

**(i)** Explain why these two atoms are isotopes.

.....

..... [2]

**(ii)** $^{24}_{11}Na$ is radioactive. It changes into an atom of a different element which has one more proton.

Identify this element.

View solution

..... [1]

**(iii)** State **two** uses of radioactive isotopes.

View solution

.....

..... [2]

[Total: 13]

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**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.

View solution

procedure .....

.....

explanation .....

.....

[3]

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

View solution

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 .....

.....

View solution [2]

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

procedure .....

.....

explanation .....

.....

[3]

[Total: 11]

View solution

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**3** Sulfuric acid is made by the Contact process.

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

View solution

Suggest and explain an advantage of using this method.

.....

..... [2]

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

View solution

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

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 $dm^3$ of oxygen?

..... $dm^3$ [1]

**(c)** Sulfur dioxide is more expensive than air.

View solution

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.

View solution

.....

.....

..... [2]

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

View solution

.....

.....

..... [3]

**(e)** A low pressure, 2 atmospheres, is used. At equilibrium, about 98% $SO_3$ is present.

View solution

**(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.

View solution

..... [1]

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

View solution

..... [1]

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

View solution

.....

.....

.....

..... [2]

[Total: 15]

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

View solution

**(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.

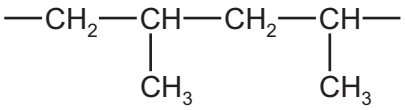
View solution

.....

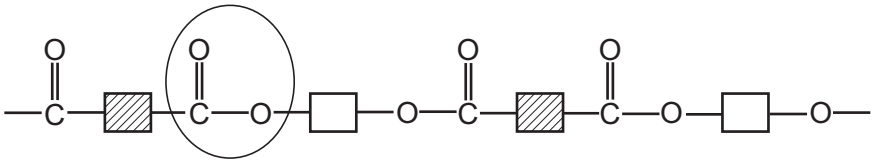
..... [1]

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

View solution



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]

View solution

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

View solution

**(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**.

View solution

..... [2]

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

View solution

What is its molecular formula?

..... [2]

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

View solution

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

..... [1]

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

View solution

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

..... [1]

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

View solution

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.

View solution

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

.....

.....

.....

.....

..... [3]

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

View solution

.....

.....

..... [3]

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

View solution

.....

.....

..... [2]

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

.....

..... [1]

[Total: 9]

View solution

**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.

View solution

$$\underset{\text{cream}}{2AgBr} \rightarrow \underset{\text{black}}{2Ag} + Br_2$$

**step 1** $2Br^- \rightarrow Br_2 + 2e^-$

**step 2** $Ag^+ + e^- \rightarrow Ag$

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

..... [1]

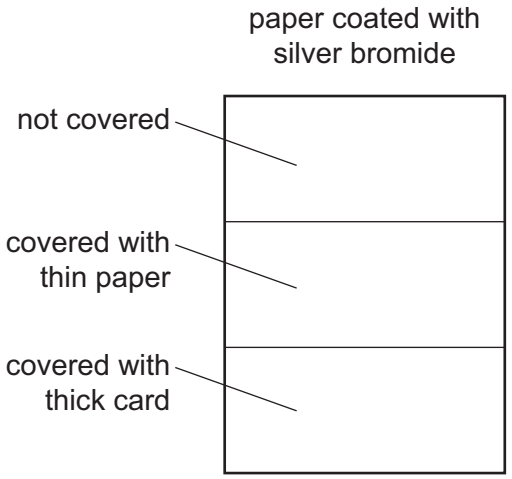
**(ii)** Which ion is the oxidising agent? Explain your answer.

View solution

..... [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.

View solution




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.

View solution

**(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 H—O—□—O—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 |
| | | | | | | | | | | | | | | | | 4 **He** Helium 2 |
| | | | | | 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 |
| 7 **Li** Lithium 3 | 9 **Be** Beryllium 4 | | | | | | | | | | 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 |
| 23 **Na** Sodium 11 | 24 **Mg** Magnesium 12 | | | | | | | | | | 70 **Ga** Gallium 31 | 73 **Ge** Germanium 32 | 75 **As** Arsenic 33 | 79 **Se** Selenium 34 | 80 **Br** Bromine 35 | 84 **Kr** Krypton 36 |
| 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 | 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 |
| 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 | 222 **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 = 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.).

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