

CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
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 X³⁻? [1]
- (iv) Which atom can form a hydride which has a formula of the type XH₄? [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]

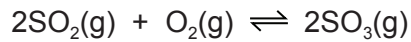
3 Sulfuric acid is made by the Contact process.

(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 dm³ of oxygen?

..... dm³ [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% SO₃ 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]

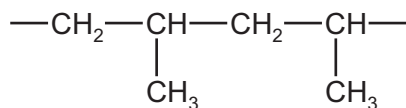
(ii) Describe **one** problem caused by burning synthetic polymers.

..... [1]

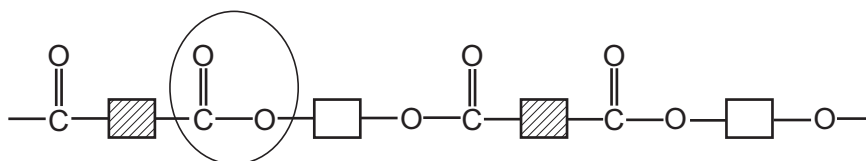
(b) State **two** uses of synthetic polymers.

.....
 [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]

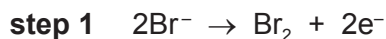
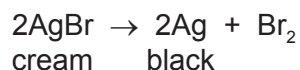
(b) Explain why the physical properties of carbon dioxide are different from those of diamond and silicon(IV) oxide.

.....
..... [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.



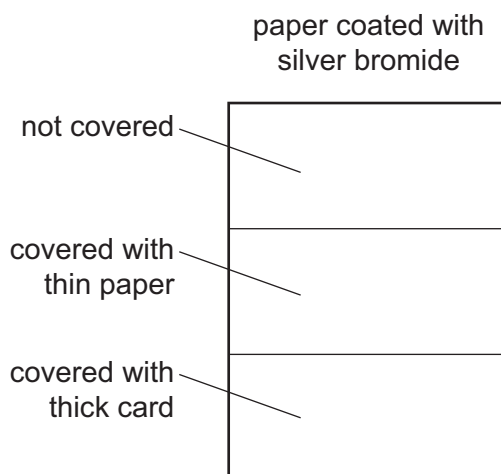
(i) Which step is reduction? Explain your answer.

..... [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 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		65 Zn Zinc 30	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		112 Cd Cadmium 48	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		204 Pb Lead 82	207 Pb Lead 82	209 Bi Bismuth 83	209 Bi Bismuth 83	209 Bi Bismuth 83	209 Bi Bismuth 83			
87 Fr Francium	226 Ra Radium		80 Hg Mercury	81 Tl Thallium	81 Tl Thallium	81 Tl Thallium	81 Tl Thallium	81 Tl Thallium			
			201 Hg Mercury	201 Hg Mercury	201 Hg Mercury	201 Hg Mercury	201 Hg Mercury	201 Hg Mercury			
			64 Cu Copper	64 Cu Copper	64 Cu Copper	64 Cu Copper	64 Cu Copper	64 Cu Copper			
			59 Ni Nickel	59 Ni Nickel	59 Ni Nickel	59 Ni Nickel	59 Ni Nickel	59 Ni Nickel			
			56 Fe Iron	56 Fe Iron	56 Fe Iron	56 Fe Iron	56 Fe Iron	56 Fe Iron			
			55 Mn Manganese	55 Mn Manganese	55 Mn Manganese	55 Mn Manganese	55 Mn Manganese	55 Mn Manganese			
			52 Cr Chromium	52 Cr Chromium	52 Cr Chromium	52 Cr Chromium	52 Cr Chromium	52 Cr Chromium			
			51 V Vanadium	51 V Vanadium	51 V Vanadium	51 V Vanadium	51 V Vanadium	51 V Vanadium			
			48 Ti Titanium	48 Ti Titanium	48 Ti Titanium	48 Ti Titanium	48 Ti Titanium	48 Ti Titanium			
			45 Sc Scandium	45 Sc Scandium	45 Sc Scandium	45 Sc Scandium	45 Sc Scandium	45 Sc Scandium			
			91 Zr Zirconium	91 Zr Zirconium	91 Zr Zirconium	91 Zr Zirconium	91 Zr Zirconium	91 Zr Zirconium			
			89 Y Yttrium	89 Y Yttrium	89 Y Yttrium	89 Y Yttrium	89 Y Yttrium	89 Y Yttrium			
			178 Hf Hafnium	178 Hf Hafnium	178 Hf Hafnium	178 Hf Hafnium	178 Hf Hafnium	178 Hf Hafnium			
			139 La Lanthanum	139 La Lanthanum	139 La Lanthanum	139 La Lanthanum	139 La Lanthanum	139 La Lanthanum			
			57 La Lanthanum	57 La Lanthanum	57 La Lanthanum	57 La Lanthanum	57 La Lanthanum	57 La Lanthanum			
			72 Hf Hafnium	72 Hf Hafnium	72 Hf Hafnium	72 Hf Hafnium	72 Hf Hafnium	72 Hf Hafnium			
			181 Ta Tantalum	181 Ta Tantalum	181 Ta Tantalum	181 Ta Tantalum	181 Ta Tantalum	181 Ta Tantalum			
			184 W Tungsten	184 W Tungsten	184 W Tungsten	184 W Tungsten	184 W Tungsten	184 W Tungsten			
			75 Re Rhenium	75 Re Rhenium	75 Re Rhenium	75 Re Rhenium	75 Re Rhenium	75 Re Rhenium			
			101 Ru Ruthenium	101 Ru Ruthenium	101 Ru Ruthenium	101 Ru Ruthenium	101 Ru Ruthenium	101 Ru Ruthenium			
			103 Rh Rhodium	103 Rh Rhodium	103 Rh Rhodium	103 Rh Rhodium	103 Rh Rhodium	103 Rh Rhodium			
			106 Pd Palladium	106 Pd Palladium	106 Pd Palladium	106 Pd Palladium	106 Pd Palladium	106 Pd Palladium			
			108 Ag Silver	108 Ag Silver	108 Ag Silver	108 Ag Silver	108 Ag Silver	108 Ag Silver			
			197 Au Gold	197 Au Gold	197 Au Gold	197 Au Gold	197 Au Gold	197 Au Gold			
			79 Au Gold	79 Au Gold	79 Au Gold	79 Au Gold	79 Au Gold	79 Au Gold			
			159 Tb Terbium	159 Tb Terbium	159 Tb Terbium	159 Tb Terbium	159 Tb Terbium	159 Tb Terbium			
			65 Gd Gadolinium	65 Gd Gadolinium	65 Gd Gadolinium	65 Gd Gadolinium	65 Gd Gadolinium	65 Gd Gadolinium			
			64 Gd Gadolinium	64 Gd Gadolinium	64 Gd Gadolinium	64 Gd Gadolinium	64 Gd Gadolinium	64 Gd Gadolinium			
			152 Eu Europium	152 Eu Europium	152 Eu Europium	152 Eu Europium	152 Eu Europium	152 Eu Europium			
			63 Eu Europium	63 Eu Europium	63 Eu Europium	63 Eu Europium	63 Eu Europium	63 Eu Europium			
			150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium			
			62 Sm Samarium	62 Sm Samarium	62 Sm Samarium	62 Sm Samarium	62 Sm Samarium	62 Sm Samarium			
			150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium			
			61 Pm Promethium	61 Pm Promethium	61 Pm Promethium	61 Pm Promethium	61 Pm Promethium	61 Pm Promethium			
			61 Pm Promethium	61 Pm Promethium	61 Pm Promethium	61 Pm Promethium	61 Pm Promethium	61 Pm Promethium			
			144 Nd Neodymium	144 Nd Neodymium	144 Nd Neodymium	144 Nd Neodymium	144 Nd Neodymium	144 Nd Neodymium			
			60 Nd Neodymium	60 Nd Neodymium	60 Nd Neodymium	60 Nd Neodymium	60 Nd Neodymium	60 Nd Neodymium			
			141 Pr Praseodymium	141 Pr Praseodymium	141 Pr Praseodymium	141 Pr Praseodymium	141 Pr Praseodymium	141 Pr Praseodymium			
			59 Pr Praseodymium	59 Pr Praseodymium	59 Pr Praseodymium	59 Pr Praseodymium	59 Pr Praseodymium	59 Pr Praseodymium			
			140 Ce Cerium	140 Ce Cerium	140 Ce Cerium	140 Ce Cerium	140 Ce Cerium	140 Ce Cerium			
			58 Ce Cerium	58 Ce Cerium	58 Ce Cerium	58 Ce Cerium	58 Ce Cerium	58 Ce Cerium			
			232 Th Thorium	232 Th Thorium	232 Th Thorium	232 Th Thorium	232 Th Thorium	232 Th Thorium			
			90 Th Thorium	90 Th Thorium	90 Th Thorium	90 Th Thorium	90 Th Thorium	90 Th Thorium			
			238 U Uranium	238 U Uranium	238 U Uranium	238 U Uranium	238 U Uranium	238 U Uranium			
			92 U Uranium	92 U Uranium	92 U Uranium	92 U Uranium	92 U Uranium	92 U Uranium			
			141 Pa Protactinium	141 Pa Protactinium	141 Pa Protactinium	141 Pa Protactinium	141 Pa Protactinium	141 Pa Protactinium			
			91 Pa Protactinium	91 Pa Protactinium	91 Pa Protactinium	91 Pa Protactinium	91 Pa Protactinium	91 Pa Protactinium			
			150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium			
			62 Sm Samarium	62 Sm Samarium	62 Sm Samarium	62 Sm Samarium	62 Sm Samarium	62 Sm Samarium			
			150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium	150 Sm Samarium			
			94 Pu Plutonium	94 Pu Plutonium	94 Pu Plutonium	94 Pu Plutonium	94 Pu Plutonium	94 Pu Plutonium			
			94 Pu Plutonium	94 Pu Plutonium	94 Pu Plutonium	94 Pu Plutonium	94 Pu Plutonium	94 Pu Plutonium			
			157 Gd Gadolinium	157 Gd Gadolinium	157 Gd Gadolinium	157 Gd Gadolinium	157 Gd Gadolinium	157 Gd Gadolinium			
			64 Gd Gadolinium	64 Gd Gadolinium	64 Gd Gadolinium	64 Gd Gadolinium	64 Gd Gadolinium	64 Gd Gadolinium			
			157 Gd Gadolinium	157 Gd Gadolinium	157 Gd Gadolinium	157 Gd Gadolinium	157 Gd Gadolinium	157 Gd Gadolinium			
			162 Dy Dysprosium	162 Dy Dysprosium	162 Dy Dysprosium	162 Dy Dysprosium	162 Dy Dysprosium	162 Dy Dysprosium			
			66 Dy Dysprosium	66 Dy Dysprosium	66 Dy Dysprosium	66 Dy Dysprosium	66 Dy Dysprosium	66 Dy Dysprosium			
			165 Ho Holmium	165 Ho Holmium	165 Ho Holmium	165 Ho Holmium	165 Ho Holmium	165 Ho Holmium			
			67 Ho Holmium	67 Ho Holmium	67 Ho Holmium	67 Ho Holmium	67 Ho Holmium	67 Ho Holmium			
			167 Er Erbium	167 Er Erbium	167 Er Erbium	167 Er Erbium	167 Er Erbium	167 Er Erbium			
			68 Er Erbium	68 Er Erbium	68 Er Erbium	68 Er Erbium	68 Er Erbium	68 Er Erbium			
			169 Tm Thulium	169 Tm Thulium	169 Tm Thulium	169 Tm Thulium	169 Tm Thulium	169 Tm Thulium			
			69 Tm Thulium	69 Tm Thulium	69 Tm Thulium	69 Tm Thulium	69 Tm Thulium	69 Tm Thulium			
			173 Yb Ytterbium	173 Yb Ytterbium	173 Yb Ytterbium	173 Yb Ytterbium	173 Yb Ytterbium	173 Yb Ytterbium			
			70 Yb Ytterbium	70 Yb Ytterbium	70 Yb Ytterbium	70 Yb Ytterbium	70 Yb Ytterbium	70 Yb Ytterbium			
			175 Lu Lutetium	175 Lu Lutetium	175 Lu Lutetium	175 Lu Lutetium	175 Lu Lutetium	175 Lu Lutetium			
			71 Lu Lutetium	71 Lu Lutetium	71 Lu Lutetium	71 Lu Lutetium	71 Lu Lutetium	71 Lu Lutetium			
			103 Lr Lawrencium	103 Lr Lawrencium	103 Lr Lawrencium	103 Lr Lawrencium	103 Lr Lawrencium	103 Lr Lawrencium			
			102 No Nobelium	102 No Nobelium	102 No Nobelium	102 No</					