



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

CENTER
NUMBER

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CHEMISTRY (US)

0439/31

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 Center 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.

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]

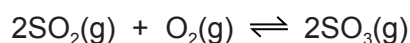
3 Sulfuric acid is made by the Contact process.

(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]

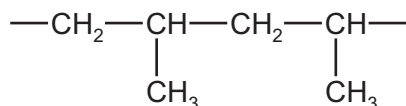
(ii) Describe **one** problem caused by burning synthetic polymers.

..... [1]

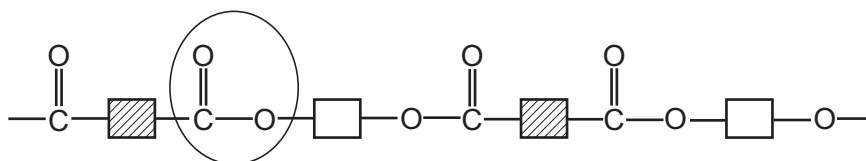
(b) State **two** uses of synthetic polymers.

.....
 [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 colorless 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]

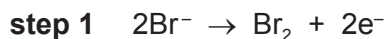
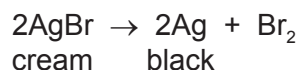
(b) Explain why the physical properties of carbon dioxide are different from those of diamond and silicon(IV) oxide.

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



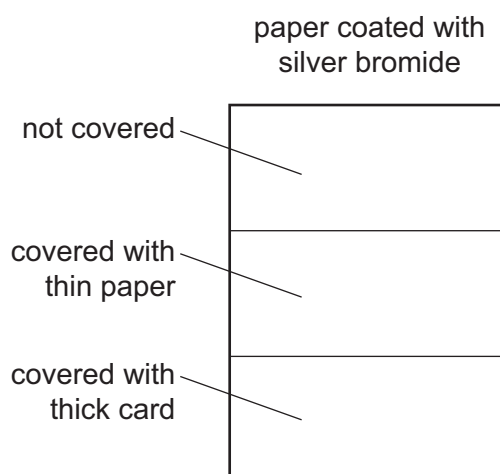
(i) Which step is reduction? Explain your answer.

..... [1]

(ii) Which ion is the oxidizing 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 polymerize 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 color 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

I		II		Group																		III	IV	V	VI	VII	0				
7 Li Lithium 3	9 Be Beryllium 4																			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					
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																			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																			93 Nb Niobium 41	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 Cesium 55	137 Ba Barium 56																			181 Ta Tantalum 73	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 Pb Lead 82	207 Bi Bismuth 83	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
87 Fr Francium	226 Ra Radium																			227 Ac Actinium †											

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	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	238 U Uranium 92	238 Pa Protactinium 91	238 Np Neptunium 93	238 Pu Plutonium 94	238 Am Americium 95	238 Cm Curium 96	238 Bk Berkelium 97	238 Cf Californium 98	238 Es Einsteinium 99	238 Fm Fermium 100	238 Md Mendelevium 101	238 No Nobelium 102	238 Lr Lawrencium 103

a	X
b	

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

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

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).