

CANDIDATE  
NAME

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CENTER  
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CANDIDATE  
NUMBER

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**CHEMISTRY (US)**

**0439/33**

Paper 3 (Extended)

**May/June 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 Use your copy of the Periodic Table to help you answer these questions.

(a) Predict the formula of each of the following compounds.

(i) aluminum fluoride ..... [1]

(ii) arsenic oxide ..... [1]

(iii) silicon bromide ..... [1]

(b) Deduce the formula of each of the following ions.

(i) phosphide ..... [1]

(ii) barium ..... [1]

(iii) francium ..... [1]

(c) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound carbon dioxide.

Use x to represent an electron from a carbon atom.

Use o to represent an electron from an oxygen atom.

[3]

[Total: 9]

2 This question is concerned with the following oxides.

aluminum oxide  
carbon monoxide  
copper(II) oxide  
silicon(IV) oxide  
sodium oxide  
sulfur dioxide  
zinc oxide

Choose **one** oxide from the above list to match each of the following descriptions. An oxide may be used once, more than once or not at all.

- (a) This oxide does not react with acid or alkali. .... [1]
- (b) This oxide reacts with water to give a strong alkali solution. .... [1]
- (c) This oxide is used as a bleach. .... [1]
- (d) This oxide is amphoteric. .... [1]
- (e) This oxide has a giant covalent structure. .... [1]
- (f) This oxide is soluble in water and it is acidic. .... [1]

[Total: 6]

- 3 Quicklime, which is calcium oxide, is made by heating limestone in a furnace.



The reaction does not come to equilibrium.

- (a) Suggest why the conversion to calcium oxide is complete.

..... [1]

- (b) Calcium hydroxide, slaked lime, is made from calcium oxide.

Write an equation for this reaction.

..... [2]

- (c) Calculate the maximum mass of calcium oxide which could be made from 12.5 tons of calcium carbonate. 1 ton =  $1 \times 10^6$  g.

.....

.....

..... [2]

- (d) Limestone is used in agriculture to reduce the acidity of soil and for the desulfurization of flue gases in power stations.

- (i) Most crops thrive in soils whose pH is close to 7. Calcium carbonate, which is insoluble in water, and calcium oxide, which is slightly soluble in water, are both used to reduce the acidity of soils.

Suggest **two** advantages of using calcium carbonate for this purpose.

1. ....

2. .... [2]

- (ii) Explain the chemistry of desulfurization of flue gases.

.....

.....

.....

..... [3]

- (iii) Give **one** other use of calcium carbonate.

..... [1]

[Total: 11]

4 (a) (i) Coal is a solid fossil fuel.

Name another fossil fuel.

..... [1]

(ii) Explain what is meant by the term *fossil fuel*.

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

(b) The burning of fossil fuels is largely responsible for the formation of acid rain. Two of the acids in acid rain are sulfuric acid and nitric acid.

(i) Explain how the combustion of coal can form sulfuric acid.

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

(ii) High temperatures generated by the combustion of fossil fuels can lead to the formation of nitric acid. Explain.

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

(iii) Nitric acid contains nitrate ions.

Describe a test for nitrate ions.

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

(iv) Explain how you could determine which one of two samples of acid rain had the higher concentration of hydrogen ions.

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

[Total: 13]

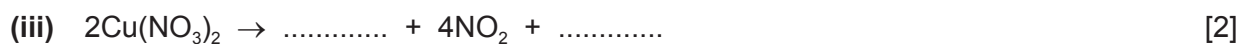
- 5 The law of constant composition states that all pure samples of a compound contain the same elements in the same proportion by weight.

A typical experiment to test this law is to prepare the same compound by different methods and then show that the samples have the same composition.

Methods of making copper(II) oxide include:

- heating copper carbonate,
- heating copper hydroxide,
- heating copper nitrate,
- heating copper foil in air.

(a) Complete the following equations.



(b) Copper oxide can be reduced to copper by heating in hydrogen.

(i) What color change would you observe during the reduction?

..... [1]

(ii) Explain why the copper must be allowed to cool in hydrogen before it is exposed to air.

..... [2]

(iii) Name another gas which can reduce copper(II) oxide to copper.

..... [1]

(iv) Name a solid which can reduce copper(II) oxide to copper.

..... [1]

(c) The table below shows the results obtained by reducing the copper(II) oxide produced by different methods to copper.

(i) Complete the table.

source of copper(II) oxide	mass of copper(II) oxide / g	mass of copper / g	percentage copper / %
$\text{CuCO}_3$	2.37	1.89	79.7
$\text{Cu(OH)}_2$	2.51	1.99	
$\text{Cu(NO}_3)_2$	2.11	1.68	
Cu and $\text{O}_2$	2.29	1.94	

[2]

(ii) One of the samples of copper(II) oxide is impure.

Identify this sample and suggest an explanation why the percentage of copper in this sample is bigger than in the other three samples.

.....

..... [2]

[Total: 13]

6 Chemical reactions are always accompanied by an energy change.

(a) Aluminum is extracted by the electrolysis of a molten mixture which contains aluminum oxide,  $Al_2O_3$ . This decomposes to form aluminum at the negative electrode and oxygen at the positive electrode.

(i) Write an ionic equation for the reaction at the negative electrode.

..... [2]

(ii) Complete the ionic equation for the reaction at the positive electrode.



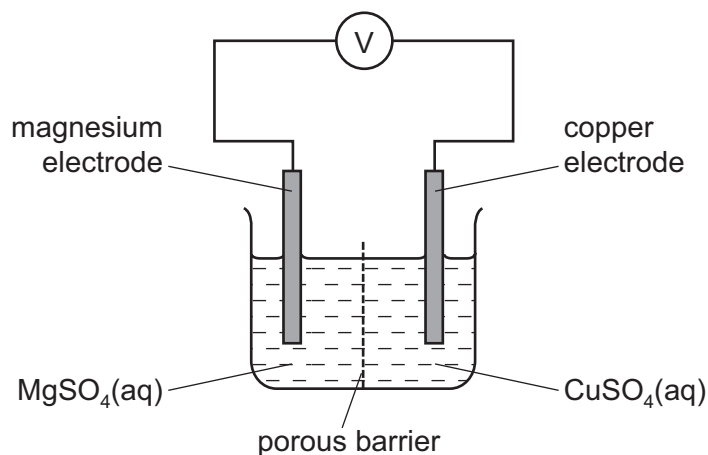
[2]

(iii) Is the reaction exothermic or endothermic? Explain your answer.

.....

..... [1]

(b) The cell shown below can be used to determine the order of reactivity of metals.



(i) Is the reaction in the cell exothermic or endothermic? Explain your answer.

.....

..... [1]



(ii) Explain why the mass of the magnesium electrode decreases and the mass of the copper electrode increases.

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

(iii) How could you use this cell to determine which is the more reactive metal, magnesium or manganese?

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

(c) The combustion of propane,  $C_3H_8$ , is exothermic.

Give an equation for the complete combustion of propane.

..... [2]

(d) Photosynthesis is an unusual endothermic reaction.

(i) Where does the energy for photosynthesis come from?

..... [1]

(ii) Give the word equation for photosynthesis.

..... [1]

[Total: 14]

7 (a) Alkanes and alkenes are both hydrocarbons.

(i) How does the structure of alkenes differ from the structure of alkanes?

..... [1]

(ii) Is the straight-chain hydrocarbon  $C_{22}H_{44}$  an alkane or an alkene? Explain your choice.

.....

..... [2]

(iii) Describe how you could distinguish between pentane and pentene.

test .....

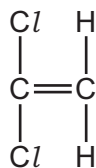
result with pentane .....

result with pentene .....

[3]

(b) Alkenes polymerize to form poly(alkenes).

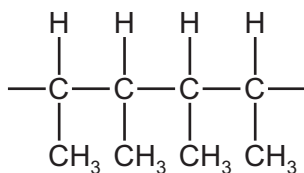
(i) The alkene 1,1-dichloroethene has the structural formula given below.



Draw the structural formula of the polymer formed by the polymerization of 1,1-dichloroethene.

[3]

- (ii) The structural formula of a different polymer is given below.



Deduce the structural formula of the monomer used to form this polymer.

[2]

- (iii) There are two types of polymerization - addition and condensation.

Explain the difference between them.

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

- (iv) There are two types of condensation polymer.

Give the name of **one** type of condensation polymer.

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

[Total: 14]

**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
7 <b>Li</b> Lithium 3	9 <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>Na</b> Sodium 11	12 <b>Mg</b> Magnesium 12			13 <b>Al</b> Aluminum 13	14 <b>Si</b> Silicon 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
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
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
87 <b>Fr</b> Francium 87	88 <b>Ra</b> Radium 88			89 <b>Ac</b> Actinium 89					
					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
				45 <b>Sc</b> Scandium 45	46 <b>Ti</b> Titanium 46	47 <b>V</b> Vanadium 47	48 <b>Cr</b> Chromium 48	49 <b>Mn</b> Manganese 49	50 <b>Fe</b> Iron 50
				59 <b>Co</b> Cobalt 59	60 <b>Ni</b> Nickel 60	61 <b>Cu</b> Copper 61	62 <b>Zn</b> Zinc 62	63 <b>Ga</b> Gallium 63	64 <b>Ge</b> Germanium 64
				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			
				91 <b>Th</b> Thorium 91	92 <b>Pa</b> Protactinium 92	93 <b>U</b> Uranium 93	94 <b>Np</b> Neptunium 94	95 <b>Pu</b> Plutonium 95	96 <b>Am</b> Americium 96
				97 <b>Pm</b> Promethium 97	98 <b>Sm</b> Samarium 98	99 <b>Eu</b> Europium 99	100 <b>Gd</b> Gadolinium 100	101 <b>Tb</b> Terbium 101	102 <b>Dy</b> Dysprosium 102
				103 <b>Ho</b> Holmium 103	104 <b>Er</b> Erbium 104	105 <b>Tm</b> Thulium 105	106 <b>Yb</b> Ytterbium 106	107 <b>Lu</b> Lutetium 107	108 <b>Hf</b> Hafnium 108
				109 <b>Ta</b> Tantalum 109	110 <b>W</b> Tungsten 110	111 <b>Re</b> Rhenium 111	112 <b>Os</b> Osmium 112	113 <b>Ir</b> Iridium 113	114 <b>Pt</b> Platinum 114
				115 <b>Sb</b> Antimony 115	116 <b>Te</b> Tellurium 116	117 <b>I</b> Iodine 117	118 <b>Xe</b> Xenon 118		
				119 <b>Fr</b> Francium 119	120 <b>Ra</b> Radium 120	121 <b>Ac</b> Actinium 121			
				123 <b>Bi</b> Bismuth 123	124 <b>Po</b> Polonium 124	125 <b>At</b> Astatine 125	126 <b>Rn</b> Radon 126		
				127 <b>Fr</b> Francium 127	128 <b>Ra</b> Radium 128	129 <b>Ac</b> Actinium 129			
				131 <b>Sb</b> Antimony 131	132 <b>Te</b> Tellurium 132	133 <b>I</b> Iodine 133	134 <b>Xe</b> Xenon 134		
				135 <b>Fr</b> Francium 135	136 <b>Ra</b> Radium 136	137 <b>Ac</b> Actinium 137			
				139 <b>Bi</b> Bismuth 139	140 <b>Po</b> Polonium 140	141 <b>At</b> Astatine 141	142 <b>Rn</b> Radon 142		
				143 <b>Fr</b> Francium 143	144 <b>Ra</b> Radium 144	145 <b>Ac</b> Actinium 145			
				147 <b>Bi</b> Bismuth 147	148 <b>Po</b> Polonium 148	149 <b>At</b> Astatine 149	150 <b>Rn</b> Radon 150		
				149 <b>Fr</b> Francium 149	150 <b>Ra</b> Radium 150	151 <b>Ac</b> Actinium 151			
				151 <b>Sb</b> Antimony 151	152 <b>Te</b> Tellurium 152	153 <b>I</b> Iodine 153	154 <b>Xe</b> Xenon 154		
				153 <b>Fr</b> Francium 153	154 <b>Ra</b> Radium 154	155 <b>Ac</b> Actinium 155			
				157 <b>Bi</b> Bismuth 157	158 <b>Po</b> Polonium 158	159 <b>At</b> Astatine 159	160 <b>Rn</b> Radon 160		
				159 <b>Fr</b> Francium 159	160 <b>Ra</b> Radium 160	161 <b>Ac</b> Actinium 161			
				161 <b>Sb</b> Antimony 161	162 <b>Te</b> Tellurium 162	163 <b>I</b> Iodine 163	164 <b>Xe</b> Xenon 164		
				163 <b>Fr</b> Francium 163	164 <b>Ra</b> Radium 164	165 <b>Ac</b> Actinium 165			
				165 <b>Bi</b> Bismuth 165	166 <b>Po</b> Polonium 166	167 <b>At</b> Astatine 167	168 <b>Rn</b> Radon 168		
				167 <b>Fr</b> Francium 167	168 <b>Ra</b> Radium 168	169 <b>Ac</b> Actinium 169			
				169 <b>Sb</b> Antimony 169	170 <b>Te</b> Tellurium 170	171 <b>I</b> Iodine 171	172 <b>Xe</b> Xenon 172		
				171 <b>Fr</b> Francium 171	172 <b>Ra</b> Radium 172	173 <b>Ac</b> Actinium 173			
				173 <b>Bi</b> Bismuth 173	174 <b>Po</b> Polonium 174	175 <b>At</b> Astatine 175	176 <b>Rn</b> Radon 176		
				175 <b>Fr</b> Francium 175	176 <b>Ra</b> Radium 176	177 <b>Ac</b> Actinium 177			
				177 <b>Sb</b> Antimony 177	178 <b>Te</b> Tellurium 178	179 <b>I</b> Iodine 179	180 <b>Xe</b> Xenon 180		
				179 <b>Fr</b> Francium 179	180 <b>Ra</b> Radium 180	181 <b>Ac</b> Actinium 181			
				181 <b>Bi</b> Bismuth 181	182 <b>Po</b> Polonium 182	183 <b>At</b> Astatine 183	184 <b>Rn</b> Radon 184		
				183 <b>Fr</b> Francium 183	184 <b>Ra</b> Radium 184	185 <b>Ac</b> Actinium 185			
				185 <b>Sb</b> Antimony 185	186 <b>Te</b> Tellurium 186	187 <b>I</b> Iodine 187	188 <b>Xe</b> Xenon 188		
				187 <b>Fr</b> Francium 187	188 <b>Ra</b> Radium 188	189 <b>Ac</b> Actinium 189			
				189 <b>Bi</b> Bismuth 189	190 <b>Po</b> Polonium 190	191 <b>At</b> Astatine 191	192 <b>Rn</b> Radon 192		
				191 <b>Fr</b> Francium 191	192 <b>Ra</b> Radium 192	193 <b>Ac</b> Actinium 193			
				193 <b>Sb</b> Antimony 193	194 <b>Te</b> Tellurium 194	195 <b>I</b> Iodine 195	196 <b>Xe</b> Xenon 196		
				195 <b>Fr</b> Francium 195	196 <b>Ra</b> Radium 196	197 <b>Ac</b> Actinium 197			
				197 <b>Bi</b> Bismuth 197	198 <b>Po</b> Polonium 198	199 <b>At</b> Astatine 199	200 <b>Rn</b> Radon 200		
				199 <b>Fr</b> Francium 199	200 <b>Ra</b> Radium 200	201 <b>Ac</b> Actinium 201			
				201 <b>Sb</b> Antimony 201	202 <b>Te</b> Tellurium 202	203 <b>I</b> Iodine 203	204 <b>Xe</b> Xenon 204		
				203 <b>Fr</b> Francium 203	204 <b>Ra</b> Radium 204	205 <b>Ac</b> Actinium 205			
				205 <b>Bi</b> Bismuth 205	206 <b>Po</b> Polonium 206	207 <b>At</b> Astatine 207	208 <b>Rn</b> Radon 208		
				207 <b>Fr</b> Francium 207	208 <b>Ra</b> Radium 208	209 <b>Ac</b> Actinium 209			
				209 <b>Sb</b> Antimony 209	210 <b>Te</b> Tellurium 210	211 <b>I</b> Iodine 211	212 <b>Xe</b> Xenon 212		
				211 <b>Fr</b> Francium 211	212 <b>Ra</b> Radium 212	213 <b>Ac</b> Actinium 213			
				213 <b>Bi</b> Bismuth 213	214 <b>Po</b> Polonium 214	215 <b>At</b> Astatine 215	216 <b>Rn</b> Radon 216		
				215 <b>Fr</b> Francium 215	216 <b>Ra</b> Radium 216	217 <b>Ac</b> Actinium 217			
				217 <b>Sb</b> Antimony 217	218 <b>Te</b> Tellurium 218	219 <b>I</b> Iodine 219	220 <b>Xe</b> Xenon 220		
				219 <b>Fr</b> Francium 219	220 <b>Ra</b> Radium 220	221 <b>Ac</b> Actinium 221			
				221 <b>Bi</b> Bismuth 221	222 <b>Po</b> Polonium 222	223 <b>At</b> Astatine 223	224 <b>Rn</b> Radon 224		
				223 <b>Fr</b> Francium 223	224 <b>Ra</b> Radium 224	225 <b>Ac</b> Actinium 225			
				225 <b>Sb</b> Antimony 225	226 <b>Te</b> Tellurium 226	227 <b>I</b> Iodine 227	228 <b>Xe</b> Xenon 228		
				227 <b>Fr</b> Francium 227	228 <b>Ra</b> Radium 228	229 <b>Ac</b> Actinium 229			
				229 <b>Bi</b> Bismuth 229	230 <b>Po</b> Polonium 230	231 <b>At</b> Astatine 231	232 <b>Rn</b> Radon 232		
				231 <b>Fr</b> Francium 231	232 <b>Ra</b> Radium 232	233 <b>Ac</b> Actinium 233			
				233 <b>Sb</b> Antimony 233	234 <b>Te</b> Tellurium 234	235 <b>I</b> Iodine 235	236 <b>Xe</b> Xenon 236		
				235 <b>Fr</b> Francium 235	236 <b>Ra</b> Radium 236	237 <b>Ac</b> Actinium 237			
				237 <b>Bi</b> Bismuth 237	238 <b>Po</b> Polonium 238	239 <b>At</b> Astatine 239	240 <b>Rn</b> Radon 240		
				239 <b>Fr</b> Francium 239	240 <b>Ra</b> Radium 240	241 <b>Ac</b> Actinium 241			
				241 <b>Sb</b> Antimony 241	242 <b>Te</b> Tellurium 242	243 <b>I</b> Iodine 243	244 <b>Xe</b> Xenon 244		
				243 <b>Fr</b> Francium 243	244 <b>Ra</b> Radium 244	245 <b>Ac</b> Actinium 245			
				245 <b>Bi</b> Bismuth 24					