

CANDIDATE
NAME

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CHEMISTRY

0620/32

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.

1 Use your copy of the Periodic Table to help you answer some of these questions.

(a) Predict the formulae of the following compounds.

(i) nitrogen fluoride

(ii) phosphorus sulfide

[2]

(b) Deduce the formulae of the following ions.

(i) selenide

(ii) gallium

[2]

(c) Use the following ions to determine the formulae of the compounds.

ions OH^- Cr^{3+} Ba^{2+} SO_4^{2-}

compounds

(i) chromium(III) sulfate

(ii) barium hydroxide

[2]

[Total: 6]

2 (a) Polluted air contains two oxides of carbon and two oxides of nitrogen. A major source of these pollutants is motor vehicles.

(i) Describe how carbon dioxide and carbon monoxide are formed in motor vehicle engines.

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

(ii) State **one** adverse effect of each of these gases.

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

(iii) Nitrogen monoxide, NO, is released by motor vehicle exhausts.

Explain how nitrogen monoxide is formed in motor vehicle engines.

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

(iv) When nitrogen monoxide is released into the atmosphere, nitrogen dioxide, NO₂, is formed.

Suggest an explanation why this happens.

..... [1]

(b) Predict the possible adverse effect on the environment when this non-metal oxide, NO₂, reacts with water and oxygen.

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

(c) How are the amounts of carbon monoxide and nitrogen monoxide emitted by modern motor vehicles reduced? Include an equation in your answer.

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

[Total: 13]

- 3 Two of the main uses of zinc are for galvanising and for making alloys.

One of the main ores of zinc is zinc blende, ZnS. There are two stages in the extraction of zinc from this ore.

- (a) **Stage 1** Zinc oxide is made from zinc blende.

Describe how this is done and write a word equation for the reaction.

.....

 [2]

- (b) **Stage 2** Zinc oxide is reduced to zinc.

Write a word equation for the reduction of zinc oxide by coke.

..... [1]

- (c) The zinc produced by this process is impure. It can be purified by electrolysis using a method which is similar to the purification of copper. Under the conditions used in the process, zinc is the product at the negative electrode (cathode).

Complete the following description of this purification.

The electrolyte is aqueous [1]

The negative electrode (cathode) is made of [1]

The positive electrode (anode) is impure zinc.

The equation for the reaction at the cathode is [1]

The equation for the reaction at the anode is [1]

Explain why the concentration of the electrolyte does **not** change.

.....
 [2]

(d) Brass is an alloy which contains zinc.

(i) Name the other metal in brass.

..... [1]

(ii) Suggest **two** reasons why an alloy such as brass is preferred to either of its constituent metals.

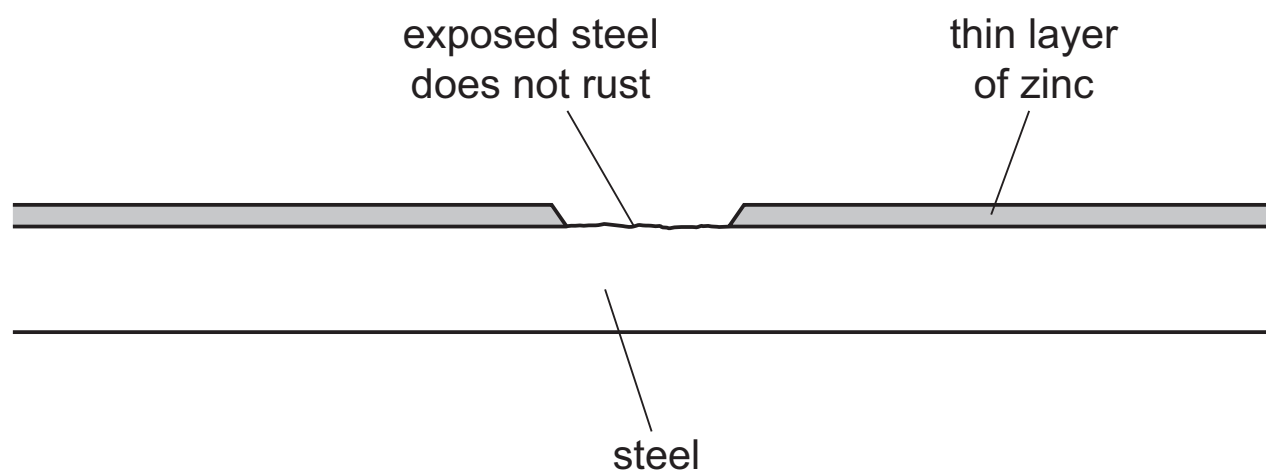
.....
 [2]

(e) In an experiment to investigate the rate of rusting of steel, three pieces of steel were used. One piece of steel was completely coated with copper, one piece completely coated with zinc and the third piece was left uncoated. All three pieces were left exposed to the atmosphere.

(i) Explain why the uncoated piece started to rust.

.....
 [1]

(ii) The coating on both of the other two pieces was scratched, exposing the steel.



The piece of steel coated with zinc still did not rust but the copper-coated piece of steel rusted very rapidly.

Explain these observations in terms of the formation of ions and the transfer of electrons.

.....

 [4]

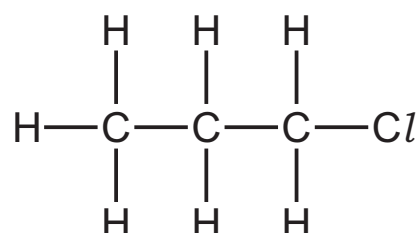
[Total: 17]

4 (a) Propane reacts with chlorine to form a mixture of chloropropanes. This is a photochemical reaction.

(i) What is meant by the phrase *photochemical reaction*?

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

(ii) The products of this reaction include two isomers, one of which has the following structural formula.



Draw the structural formula of the other isomer.

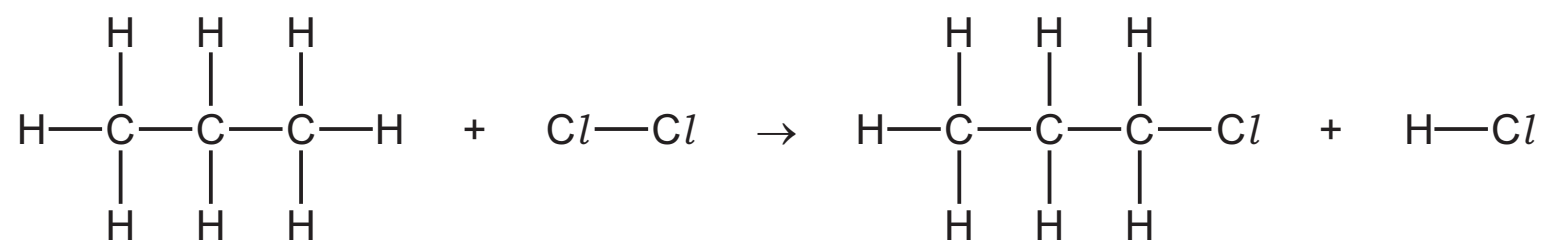
[1]

(iii) Explain why these two different compounds are isomers.

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

(b) Bond breaking is an endothermic change and bond forming is an exothermic change.

Bond energy is the amount of energy in kJ/mol needed to break one mole of the specified bond.



Use the following bond energies to determine whether this reaction is exothermic or endothermic. You must show your reasoning.

bond	bond energies in kJ/mol
C-Cl	338
C-H	412
Cl-Cl	242
H-Cl	431
C-C	348

.....

.....

.....

..... [3]

- (c) (i) Chloropropane can be hydrolysed to propanol, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$, by sodium hydroxide.

Write the equation for this reaction.

..... [2]

- (ii) Propanol can be dehydrated. It loses a water molecule to form a hydrocarbon.

Give the name and structural formula of this hydrocarbon.

name

structural formula

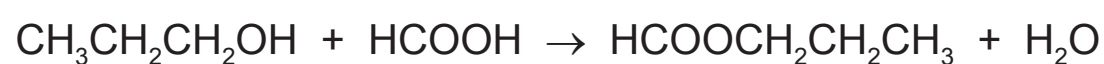
[2]

- (iii) Propanol is oxidised to a carboxylic acid by acidified potassium manganate(VII).

Deduce the name of this acid.

..... [1]

- (d) Propanol reacts with methanoic acid to form the ester propyl methanoate.



4.0g of methanoic acid was reacted with 6.0g of propanol.

- (i) Calculate the M_r of methanoic acid = [1]

- (ii) Calculate the M_r of propanol = [1]

- (iii) Determine which one is the limiting reagent. Show your reasoning.

.....

.....

..... [2]

- (iv) Calculate the maximum yield in grams of propyl methanoate, $M_r = 88$.

..... [1]

[Total: 17]

5 Iron is extracted from its ore, hematite, in a blast furnace.

Substances added to the furnace are:

- iron ore, hematite, containing impurities such as silica, SiO_2
- air
- coke, C
- limestone, CaCO_3

Substances formed in the blast furnace are:

- molten iron
- molten slag
- waste gases such as carbon dioxide

(a) State the **two** functions of the coke used in the blast furnace.

.....
 [2]

(b) Write an equation for the conversion of hematite, Fe_2O_3 , to iron.

..... [2]

(c) Explain how the silica impurity is removed and separated from the molten iron.

.....

 [3]

(d) The molten iron from the furnace is impure.
 It contains impurities which include the element carbon.

Explain how the carbon is removed. Include an equation in your answer.

.....

 [3]

[Total: 10]

- 6 The table below shows the elements in the third period of the Periodic Table, the number of electrons in their outer energy level, their oxidation state in their common compounds and their melting points.

element	Na	Mg	Al	Si	P	S	Cl	Ar
number of outer electrons	1	2	3	4	5	6	7	8
oxidation state	+1	+2	+3	+4/−4	−3	−2	−1	0
melting point/°C	98	650	660	1414	317	115	−101	−189

- (a) Describe and explain the variation in oxidation state across the period.

.....

 [3]

- (b) The first three elements, Na, Mg and Al, are metals.

Describe the structure of a typical metal.

.....

 [3]

- (c) Explain why Na, Mg and Al are good conductors of electricity.

..... [1]

- (d) Which element exists as diatomic molecules of the type X_2 ?

..... [1]

- (e) Silicon has a similar structure to diamond.

Explain why silicon has the highest melting point in the period.

.....
 [2]

- (f) Sodium chloride is a crystalline solid with a high melting point. It dissolves in water to give a neutral solution. Phosphorus trichloride is a liquid at room temperature. It reacts with water to form an acidic solution.

Suggest an explanation for these differences in properties.

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

- (g) Describe how you could show that magnesium oxide is a basic oxide and not an amphoteric oxide.

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

- (h) Draw a dot-and-cross diagram showing the bonding in magnesium oxide. Show outer electrons only.

[3]

[Total: 17]

DATA SHEET
The Periodic Table of the Elements

		Group										
I	II	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	13 Al Aluminium 13	14 N Nitrogen 7	15 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10	18 Ar Argon 18	19 K Potassium 19	20 Ca Calcium 20
23 Na Sodium 11	24 Mg Magnesium 12	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	37 Rb Rubidium 37	38 Sr Strontium 38
39 K Potassium 19	40 Ca Calcium 20	41 V Vanadium 23	42 Cr Chromium 24	43 Mn Manganese 25	44 Fe Iron 26	45 Sc Scandium 21	46 Ti Titanium 22	47 V Vanadium 23	48 Cr Chromium 24	49 Mn Manganese 25	50 Fe Iron 26	51 Nb Niobium 41
85 Rb Rubidium 37	88 Sr Strontium 38	52 Co Cobalt 27	53 Ni Nickel 28	54 Cu Copper 29	55 Zn Zinc 30	56 Y Yttrium 39	57 Zr Zirconium 40	58 Rh Rhodium 45	59 Pd Palladium 46	60 Ag Silver 47	61 Cd Cadmium 48	62 Hf Hafnium 72
133 Cs Caesium 55	137 Ba Barium 56	63 Ru Ruthenium 44	64 Rh Rhodium 45	65 Pd Palladium 46	66 Ag Silver 47	67 Os Osmium 76	68 Ir Iridium 77	69 Pt Platinum 78	70 Au Gold 79	71 Hg Mercury 80	72 Ta Tantalum 73	73 Hf Hafnium 72
226 Fr Francium 87	227 Ra Radium 88	74 Mo Molybdenum 42	75 Tc Technetium 43	76 Ru Ruthenium 44	77 Rh Rhodium 45	78 Pd Palladium 46	79 Ag Silver 47	80 Cd Cadmium 48	81 In Indium 49	82 Sn Tin 50	83 Pb Lead 82	84 Bi Bismuth 83
		89 La Lanthanum 57	90 Ce Cerium 58	91 Pr Praseodymium 59	92 Nd Neodymium 60	93 Pm Promethium 61	94 Sm Samarium 62	95 Eu Europium 63	96 Gd Gadolinium 64	97 Tb Terbium 65	98 Dy Dysprosium 66	99 Ho Holmium 67
		100 Er Erbium 68	101 Tm Thulium 69	102 Yb Ytterbium 70	103 Lu Lutetium 71	104 Hf Hafnium 72	105 Ta Tantalum 73	106 W Tungsten 74	107 Re Rhenium 75	108 Os Osmium 76	109 Ir Iridium 77	110 Pt Platinum 78
		111 Cs Caesium 55	112 Ba Barium 56	113 La Lanthanum 57	114 Ce Cerium 58	115 Pr Praseodymium 59	116 Nd Neodymium 60	117 Pm Promethium 61	118 Sm Samarium 62	119 Eu Europium 63	120 Gd Gadolinium 64	121 Tb Terbium 65
		122 Sb Antimony 51	123 Te Tellurium 52	124 I Iodine 53	125 Xe Xenon 54	126 Ba Barium 56	127 La Lanthanum 57	128 Ce Cerium 58	129 Pr Praseodymium 59	130 Nd Neodymium 60	131 Pm Promethium 61	132 Sm Samarium 62
		135 At Astatine 85	136 Rn Radon 86	137 Fr Francium 87	138 Ra Radium 88	139 Ac Actinium 89	140 Th Thorium 90	141 Pa Protactinium 91	142 U Uranium 92	143 Np Neptunium 93	144 Pu Plutonium 94	145 Am Americium 95
		147 Er Erbium 68	148 Tm Thulium 69	149 Yb Ytterbium 70	150 Lu Lutetium 71	151 La Lanthanum 57	152 Ce Cerium 58	153 Pr Praseodymium 59	154 Nd Neodymium 60	155 Pm Promethium 61	156 Sm Samarium 62	157 Eu Europium 63
		161 Bi Bismuth 83	162 Po Polonium 84	163 At Astatine 85	164 Rn Radon 86	165 La Lanthanum 57	166 Ce Cerium 58	167 Pr Praseodymium 59	168 Nd Neodymium 60	169 Pm Promethium 61	170 Sm Samarium 62	171 Eu Europium 63
		173 Er Erbium 68	174 Tm Thulium 69	175 Yb Ytterbium 70	176 Lu Lutetium 71	177 La Lanthanum 57	178 Ce Cerium 58	179 Pr Praseodymium 59	180 Nd Neodymium 60	181 Pm Promethium 61	182 Sm Samarium 62	183 Eu Europium 63
		187 Bi Bismuth 83	188 Po Polonium 84	189 At Astatine 85	190 Rn Radon 86	191 La Lanthanum 57	192 Ce Cerium 58	193 Pr Praseodymium 59	194 Nd Neodymium 60	195 Pm Promethium 61	196 Sm Samarium 62	197 Eu Europium 63
		199 Er Erbium 68	200 Tm Thulium 69	201 Yb Ytterbium 70	202 Lu Lutetium 71	203 La Lanthanum 57	204 Ce Cerium 58	205 Pr Praseodymium 59	206 Nd Neodymium 60	207 Pm Promethium 61	208 Sm Samarium 62	209 Eu Europium 63
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		223 Er Erbium 68	224 Tm Thulium 69	225 Yb Ytterbium 70	226 Lu Lutetium 71	227 La Lanthanum 57	228 Ce Cerium 58	229 Pr Praseodymium 59	230 Nd Neodymium 60	231 Pm Promethium 61	232 Sm Samarium 62	233 Eu Europium 63
		235 Bi Bismuth 83	236 Po Polonium 84	237 At Astatine 85	238 Rn Radon 86	239 La Lanthanum 57	240 Ce Cerium 58	241 Pr Praseodymium 59	242 Nd Neodymium 60	243 Pm Promethium 61	244 Sm Samarium 62	245 Eu Europium 63
		247 Er Erbium 68	248 Tm Thulium 69	249 Yb Ytterbium 70	250 Lu Lutetium 71	251 La Lanthanum 57	252 Ce Cerium 58	253 Pr Praseodymium 59	254 Nd Neodymium 60	255 Pm Promethium 61	256 Sm Samarium 62	257 Eu Europium 63
		259 Bi Bismuth 83	260 Po Polonium 84	261 At Astatine 85	262 Rn Radon 86	263 La Lanthanum 57	264 Ce Cerium 58	265 Pr Praseodymium 59	266 Nd Neodymium 60	267 Pm Promethium 61	268 Sm Samarium 62	269 Eu Europium 63
		271 Er Erbium 68	272 Tm Thulium 69	273 Yb Ytterbium 70	274 Lu Lutetium 71	275 La Lanthanum 57	276 Ce Cerium 58	277 Pr Praseodymium 59	278 Nd Neodymium 60	279 Pm Promethium 61	280 Sm Samarium 62	281 Eu Europium 63
		283 Bi Bismuth 83	284 Po Polonium 84	285 At Astatine 85	286 Rn Radon 86	287 La Lanthanum 57	288 Ce Cerium 58	289 Pr Praseodymium 59	290 Nd Neodymium 60	291 Pm Promethium 61	292 Sm Samarium 62	293 Eu Europium 63
		295 Er Erbium 68	296 Tm Thulium 69	297 Yb Ytterbium 70	298 Lu Lutetium 71	299 La Lanthanum 57	300 Ce Cerium 58	301 Pr Praseodymium 59	302 Nd Neodymium 60	303 Pm Promethium 61	304 Sm Samarium 62	305 Eu Europium 63
		307 Bi Bismuth 83	308 Po Polonium 84	309 At Astatine 85	310 Rn Radon 86	311 La Lanthanum 57	312 Ce Cerium 58	313 Pr Praseodymium 59	314 Nd Neodymium 60	315 Pm Promethium 61	316 Sm Samarium 62	317 Eu Europium 63
		319 Er Erbium 68	320 Tm Thulium 69	321 Yb Ytterbium 70	322 Lu Lutetium 71	323 La Lanthanum 57	324 Ce Cerium 58	325 Pr Praseodymium 59	326 Nd Neodymium 60	327 Pm Promethium 61	328 Sm Samarium 62	329 Eu Europium 63
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		343 Er Erbium 68	344 Tm Thulium 69	345 Yb Ytterbium 70	346 Lu Lutetium 71	347 La Lanthanum 57	348 Ce Cerium 58	349 Pr Praseodymium 59	350 Nd Neodymium 60	351 Pm Promethium 61	352 Sm Samarium 62	353 Eu Europium 63
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		367 Er Erbium 68	368 Tm Thulium 69	369 Yb Ytterbium 70	370 Lu Lutetium 71	371 La Lanthanum 57	372 Ce Cerium 58	373 Pr Praseodymium 59	374 Nd Neodymium 60	375 Pm Promethium 61	376 Sm Samarium 62	377 Eu Europium 63
		379 Bi Bismuth 83	380 Po Polonium 84	381 At Astatine 85	382 Rn Radon 86	383 La Lanthanum 57	384 Ce Cerium 58	385 Pr Praseodymium 59	386 Nd Neodymium 60	387 Pm Promethium 61	388 Sm Samarium 62	389 Eu Europium 63
		391 Er Erbium 68	392 Tm Thulium 69	393 Yb Ytterbium 70	394 Lu Lutetium 71	395 La Lanthanum 57	396 Ce Cerium 58	397 Pr Praseodymium 59	398 Nd Neodymium 60	399 Pm Promethium 61	400 Sm Samarium 62	401 Eu Europium 63
		403 Bi Bismuth 83	404 Po Polonium 84	405 At Astatine 85	406 Rn Radon 86	407 La Lanthanum 57	408 Ce Cerium 58	409 Pr Praseodymium 59	410 Nd Neodymium 60	411 Pm Promethium 61	412 Sm Samarium 62	413 Eu Europium 63
		415 Er Erbium 68	416 Tm Thulium 69	417 Yb Ytterbium 70	418 Lu Lutetium 71	419 La Lanthanum 57	420 Ce Cerium 58	421 Pr Praseodymium 59	422 Nd Neodymium 60	423 Pm Promethium 61	424 Sm Samarium 62	425 Eu Europium 63
		427 Bi Bismuth 83	428 Po Polonium 84	429 At Astatine 85	430 Rn Radon 86	431 La Lanthanum 57	432 Ce Cerium 58	433 Pr Praseodymium 59	434 Nd Neodymium 60	435 Pm Promethium 61	436 Sm Samarium 62	437 Eu Europium 63
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