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Chemistry

Unit: KCH0/4CH0

Paper: 2C

Tuesday 9 June 2015 – Afternoon

Time: 1 hour

Paper Reference

KCH0/2C
4CH0/2C**You must have:**

Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.
- Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Information

- The total mark for this paper is 60.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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THE PERIODIC TABLE

Period 1 2 3 4 5 6 7 0

Group

4	He	Helium	2
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1	H	Hydrogen	1
---	---	----------	---

7	Li	Lithium	3	9	Be	Beryllium	4	20	Ne	Neon	10
23	Na	Sodium	11	24	Mg	Magnesium	12	31	P	Phosphorus	15
39	K	Potassium	19	40	Ca	Calcium	20	70	Ga	Gallium	31
86	Rb	Rubidium	37	88	Sr	Strontium	38	115	In	Indium	49
133	Cs	Caesium	55	137	Ba	Barium	56	204	Tl	Thallium	81
223	Fr	Francium	87	226	Ra	Radium	88	207	Pb	Lead	82
227	Ac	Actinium	89	227	AC	Actinium	89	208	Bi	Bismuth	83
45	Sc	Scandium	21	46	Ti	Titanium	22	59	Ni	Nickel	28
89	Y	Yttrium	39	90	Zr	Zirconium	40	106	Pd	Palladium	46
139	La	Lanthanum	57	138	Ce	Cerium	58	112	Cd	Cadmium	48
179	Hf	Hafnium	72	180	Ta	Tantalum	73	197	Hg	Mercury	80
181	Nb	Niobium	41	182	Mo	Molybdenum	42	198	Au	Gold	79
91	Zr	Zirconium	40	92	Nb	Niobium	41	101	Ru	Ruthenium	44
48	Ti	Titanium	22	49	V	Vanadium	23	56	Fe	Iron	26
51	V	Vanadium	23	52	Cr	Chromium	24	59	Co	Cobalt	27
55	Mn	Manganese	25	56	Fe	Iron	26	63.5	Cu	Copper	29
99	Tc	Technetium	43	100	Ru	Ruthenium	44	108	Ag	Silver	47
101	Ru	Ruthenium	44	102	Rh	Rhodium	45	112	Cd	Cadmium	48
106	Pd	Palladium	46	107	Rh	Rhodium	45	112	Cd	Cadmium	48
112	Cd	Cadmium	48	113	In	Indium	49	127	I	Iodine	53
127	I	Iodine	53	128	Te	Tellurium	52	128	Te	Tellurium	52
131	Xe	Xenon	54	132	Sb	Antimony	51	137	Ba	Barium	56
137	Ba	Barium	56	138	La	Lanthanum	57	179	Hf	Hafnium	72
179	Hf	Hafnium	72	180	Ta	Tantalum	73	181	Nb	Niobium	41
181	Nb	Niobium	41	182	Mo	Molybdenum	42	186	Re	Rhenium	75
186	Re	Rhenium	75	187	Os	Osmium	76	192	Ir	Iridium	77
192	Ir	Iridium	77	193	Pt	Platinum	78	197	Au	Gold	79
197	Au	Gold	79	198	Hg	Mercury	80	201	Pb	Lead	82
201	Pb	Lead	82	202	Bi	Bismuth	83	208	Po	Polonium	84
208	Po	Polonium	84	209	At	Astatine	85	210	Rn	Radon	86
210	Rn	Radon	86	210	At	Astatine	85	210	Rn	Radon	86

Key

Relative atomic mass
Symbol
Name
Atomic number





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Answer ALL questions.

1 The table shows the numbers of protons, neutrons and electrons in some atoms and ions.

Atom or ion	Protons	Neutrons	Electrons
P	6	8	6
Q	5	6	5
R	9	10	10
S	3	4	2
T	6	6	6

(a) (i) Which particles have the same mass?

(1)

- A electrons and protons
- B electrons and neutrons
- C neutrons and protons
- D electrons, neutrons and protons

(ii) What is the atomic number of P?

(1)

- A 6
- B 8
- C 12
- D 14

(iii) What is the mass number of Q?

(1)

- A 5
- B 6
- C 10
- D 11



(b) Which group of the Periodic Table contains element T? (1)

.....

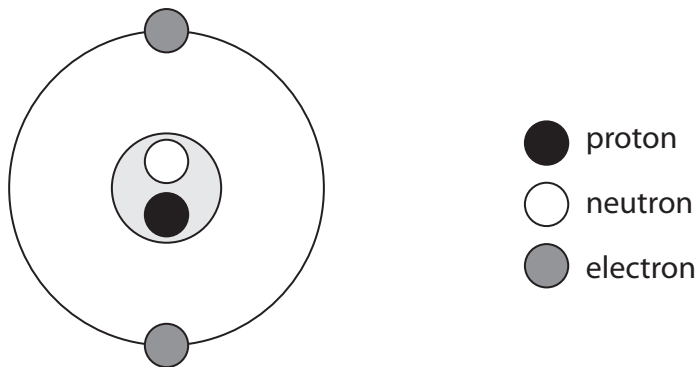
(c) (i) Which two letters represent isotopes of the same element? (1)

..... and

(ii) Which letter represents a positive ion? (1)

.....

(d) The diagram shows the arrangement of particles in another ion.



How does the diagram show that this ion has a negative charge? (1)

.....

.....

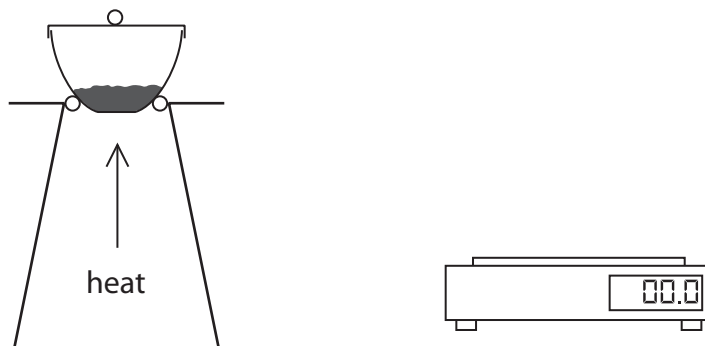
(Total for Question 1 = 7 marks)



2 The equation for the thermal decomposition of copper(II) carbonate is



A student investigates the decomposition of copper(II) carbonate using this apparatus.



She uses this method.

- weigh the crucible, lid and copper(II) carbonate
- heat the crucible, lid and contents for 2 minutes
- allow to cool and then reweigh
- heat for a second period of 2 minutes
- allow to cool and then reweigh
- heat for a third period of 2 minutes
- allow to cool and then reweigh

The table shows the student's results.

Experiment	Mass of crucible, lid and contents in grams			
	before heating	after heating for 2 minutes	after heating for 4 minutes	after heating for 6 minutes
1	26.3	23.0	21.9	21.4
2	25.8	22.7	21.5	21.5
3	26.0	23.0	21.2	21.2
4	26.1	23.2	21.8	21.8

(a) Why does the mass decrease during heating?

(1)

.....

.....



(b) State the colours of the solids in the reaction.

(2)

$\text{CuCO}_3(\text{s})$

$\text{CuO}(\text{s})$

(c) (i) In which experiment might the decomposition **not** be complete?

(1)

(ii) Give a reason for your choice.

(1)

(iii) Which statement could explain why the decomposition might not be complete?

(1)

- A** The student used a higher temperature than in the other experiments.
- B** The student used less copper(II) carbonate than in the other experiments.
- C** The student heated the crucible without a lid on.
- D** The student used a spirit burner instead of a Bunsen burner.

(d) In another experiment, the student calculates that she should obtain a mass of 3.7 g of $\text{CuO}(\text{s})$ after completely decomposing a sample of $\text{CuCO}_3(\text{s})$.

She actually obtains a mass of 3.4 g of $\text{CuO}(\text{s})$.

Calculate the percentage yield in her experiment.

(2)

percentage yield =%

(Total for Question 2 = 8 marks)





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3 This question is about halogens and halides.

(a) At room temperature bromine is

(1)

- A a brown gas
- B a red-brown liquid
- C a colourless liquid
- D a grey solid

(b) Sodium reacts with bromine to form sodium bromide.

Balance the equation for this reaction.

(1)



(c) A student carries out some experiments to investigate displacement reactions.

She adds some halogen solutions to halide solutions and observes whether a reaction occurs.

The table shows her results.

Halide solution	Halogen solution added		
	bromine	chlorine	iodine
lithium chloride	no reaction	(not done)	no reaction
sodium bromide	(not done)	reaction occurs	no reaction
potassium iodide	reaction occurs	reaction occurs	(not done)

(i) The table shows that she did not do three experiments.

Suggest why she did not do these experiments.

(1)

.....

.....

.....

.....

(ii) The table shows that there was no reaction in three experiments.

Why was there no reaction in these experiments?

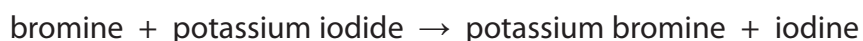
(1)

.....

.....



- (iii) The student writes this word equation for one of the experiments in which a reaction occurs.



The name of one of the substances is incorrect.

Write the correct name of this substance.

(1)

- (iv) A reaction occurs when the student adds chlorine solution to potassium iodide solution.

Complete the chemical equation for this reaction.

(2)

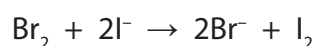


- (v) All displacement reactions are examples of redox reactions.

State the meaning of the term **redox**.

(1)

- (vi) The ionic equation for another reaction is



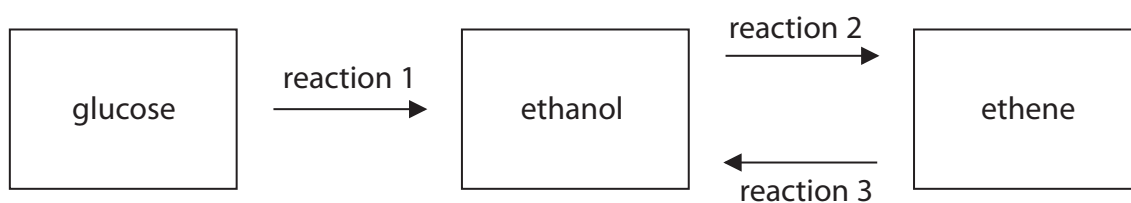
Explain which species is oxidised in this reaction.

(2)

(Total for Question 3 = 10 marks)



4 The scheme shows some reactions involving ethanol.



(a) (i) Two conditions used in reaction 1 are

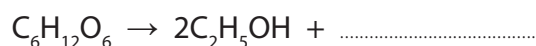
- a temperature of about 30 °C
- the use of water as a solvent for the glucose

State the name of the catalyst used in this reaction.

(1)

(ii) Complete the equation for reaction 1.

(1)



(b) Ethanol can also be manufactured by reaction 3, which uses steam, a catalyst of phosphoric acid and a pressure of about 65 atm.

State the temperature used in reaction 3.

(1)

(c) State the type of reaction that occurs in

(2)

reaction 1

reaction 3



(d) State two advantages of using reaction 3 to manufacture ethanol rather than reaction 1.

(2)

1

.....

2

.....

(e) Give a reason why some countries use reaction 1 to manufacture ethanol.

(1)

.....

.....

(f) Reaction 2 may be used in the future to manufacture ethene.

(i) Write an equation for this reaction.

(1)

.....

(ii) What type of reaction is this?

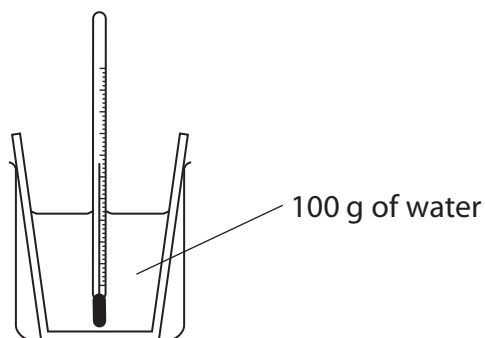
(1)

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(Total for Question 4 = 10 marks)



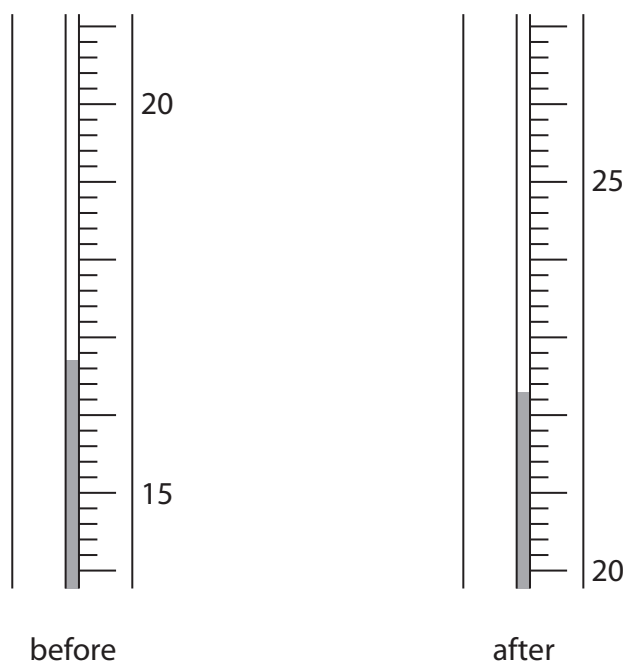
5 A student uses this apparatus to measure the temperature change when lithium iodide dissolves in water.



He measures the steady temperature of the water before adding the lithium iodide.

He then adds the lithium iodide, stirs the mixture until all the solid dissolves and records the maximum temperature reached.

The diagram shows the thermometer readings before and after dissolving the lithium iodide.



(a) Use the readings to complete the table.

(3)

Temperature in °C after adding lithium iodide	
Temperature in °C before adding lithium iodide	
Temperature change in °C	

(b) In a second experiment, using the same mass of water, the student records a temperature increase of 4.9 °C.

(i) Use this expression to calculate the heat energy change in this experiment.

$$\begin{array}{ccccccc} \text{heat energy change} & = & \text{mass of water} & \times & 4.2 & \times & \text{temperature change} \\ \text{(in joules)} & & \text{(in grams)} & & & & \text{(in } ^\circ\text{C)} \end{array} \quad (2)$$

heat energy change = J

(ii) In this experiment, 6.3 g of lithium iodide were used.

Calculate the amount, in moles, of lithium iodide in 6.3 g.

[M_r of lithium iodide = 134]

(2)

amount of LiI = mol



(c) In a third experiment the student obtains these results.

heat energy change in J	2400
amount of lithium iodide in mol	0.048

(i) Calculate the molar enthalpy change, in kJ/mol, in this experiment.

(2)

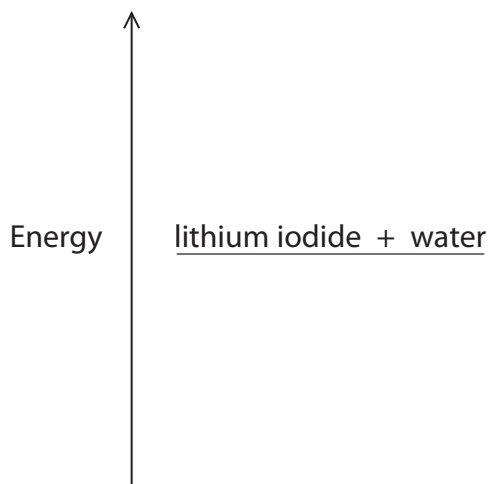
molar enthalpy change = kJ/mol

(ii) The temperature change in this experiment shows that dissolving lithium iodide in water to form lithium iodide solution is an exothermic process.

Complete the energy level diagram to show the position of the lithium iodide solution.

Label the diagram to show ΔH , the molar enthalpy change.

(2)



(Total for Question 5 = 11 marks)





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6 Magnesium and its compounds have many uses.

Magnesium is never found as an element in the Earth's crust, but its compounds occur naturally in rocks and seawater.

(a) Suggest why magnesium is not found as an element in the Earth's crust.

(1)

(b) Magnesium can be extracted from seawater by a multi-stage process.

stage 1 calcium hydroxide reacts with magnesium chloride in seawater to form a precipitate of magnesium hydroxide

stage 2 the magnesium hydroxide is filtered off and converted into magnesium chloride solution by reacting it with hydrochloric acid

stage 3 the magnesium chloride solution is converted into solid magnesium chloride

stage 4 the solid magnesium chloride is melted and electrolysed

(i) Which stage involves a neutralisation reaction?

(1)

A stage 1

B stage 2

C stage 3

D stage 4

(ii) Suggest the name of the other product formed in stage 1.

(1)

(iii) What happens to the ions in magnesium chloride during melting?

(1)



(iv) The ionic half-equation for the reaction at the negative electrode in stage 4 is



Write the ionic half-equation for the reaction at the positive electrode.

(1)

(c) A manufacturer makes a batch of magnesium by electrolysis of magnesium chloride.

(i) Calculate the mass of magnesium chloride (MgCl_2) needed to make 48 kg of magnesium.

(2)

mass of magnesium chloride = kg

(ii) Calculate the amount, in moles, of electrons needed to make 48 kg of magnesium.

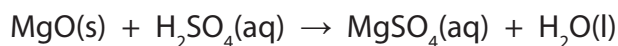
(2)

amount of electrons = mol

QUESTION 6 CONTINUES ON THE NEXT PAGE



(d) Magnesium oxide can be used to make magnesium sulfate by this reaction.



A student is provided with a beaker of dilute sulfuric acid.

Outline the steps she should use to obtain a pure sample of hydrated magnesium sulfate crystals using this reaction.

(5)

(Total for Question 6 = 14 marks)

TOTAL FOR PAPER = 60 MARKS

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