Write your name here

Surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | Candidate Number

Chemistry

Advanced

Unit 6: Chemistry Laboratory Skills II

Friday 15 May 2015 – Morning
Time: 1 hour 15 minutes

Paper Reference
WCH06/01

Candidates may use a calculator.

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.*

Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

Advice

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

Turn over ▶

Answer ALL the questions. Write your answers in the spaces provided.

1 A white solid, **A**, contains one cation and one anion. When water is added slowly, the solid turns blue and then dissolves to form a blue solution, **B**.

(a) When aqueous barium chloride is added to an acidified portion of solution **B**, a white precipitate forms.

(i) Give the **formula** of the anion in **B**.

(1)

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(ii) Name a suitable acid for acidifying solution **B** in this test.

(1)

....

(b) When aqueous ammonia is added to another portion of solution **B**, a blue precipitate forms. When more aqueous ammonia is added, this precipitate dissolves to form a deep blue solution, **C**.

(i) Identify, by name or formula, the blue precipitate.

(1)

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(ii) Give the **formula** of the ion responsible for the deep blue colour of solution **C**.

(1)

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(c) Give the **formula** of the complex ion which gives the blue colour to solution **B**. Include the ligands in your answer.

(1)

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(d) Give the **formula** of the white solid **A**.

(1)

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(e) Why is solid **A** white and not coloured blue? Justify your answer.

(2)

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(Total for Question 1 = 8 marks)

2 A salt, **P**, contains carbon, hydrogen, oxygen and one metallic element.

(a) When a flame test is carried out on **P**, a yellow flame results.

Give the **formula** of the metal ion in the salt.

(1)

....

(b) **P** dissolves in water to form a weakly alkaline solution, **Q**, with pH 8.1.

The pH of **Q** can be measured by using a calibrated pH meter or an indicator.

(i) Describe how to calibrate a pH meter.

(2)

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(ii) Name a suitable indicator you could use and state the colour you would expect to observe.

(2)

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(iii) Which of the two methods will give the more accurate value for the pH of **Q**? Justify your answer.

(1)

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(c) Some of the solution **Q** is acidified with concentrated hydrochloric acid.

An organic compound, **R**, forms in the solution.

Methanol is added and the mixture warmed, forming a new organic compound **S**.

This mixture is added to sodium carbonate solution in an evaporating basin.
A fruity smell is detected.

(i) Describe and explain what you would **see** as the mixture is added to the sodium carbonate solution.

(2)

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(ii) What type of compound is **S**?

(1)

....

(d) The high resolution proton nuclear magnetic resonance (nmr) spectrum of **S** has only two peaks which are both singlets and have the same area.

Deduce the structural formulae of **S**, **R**, and **P**.

(3)

S

R

P

(Total for Question 2 = 12 marks)

3 Cupronickel is an alloy of copper and nickel. It is used to make 'silver' coins.

A coin is analysed by the following method.

Step 1 It is weighed on a balance which reads to two decimal places and found to have mass 4.00 g.

Step 2 Water is added to the coin in a beaker. Concentrated nitric and sulfuric acids are added and the coin dissolves.

Step 3 When the coin is completely dissolved, the solution is neutralized.

Step 4 The neutral solution is transferred, with the washings, to a 100 cm^3 volumetric flask, made up to the mark with water and mixed thoroughly.

Step 5 10 cm^3 samples of the solution are taken and an excess of potassium iodide is added, producing iodine.

Step 6 The iodine is titrated with 0.200 mol dm^{-3} sodium thiosulfate solution.

(a) Why, in **Step 2**, is water added before, rather than after, the acids?

(1)

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....

(b) What is the colour of an aqueous iodine solution?

(1)

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(c) (i) To make the end point of the titration more obvious, an indicator is added just before the colour of the iodine disappears.

Name this indicator.

(1)

....

(ii) Suggest why the indicator is not added to the iodine solution earlier in the titration.

(1)

....

....

(iii) Give the colour change at the end point when the indicator is used in this titration.

(1)

....

(d) The results for the titrations are shown below.

Titration number	1	2	3	4
Burette reading (final) / cm^3	24.10	47.90	23.55	47.00
Burette reading (initial) / cm^3	0.00	24.10	0.00	23.55
Titre / cm^3				

(i) Complete the table.

(1)

(ii) Which titres should be used to calculate the mean? Explain your choice.

(1)

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....

(iii) Calculate the mean titre.

(1)

(iv) Calculate the percentage by mass of copper in the coin.

Use the equations below.

$$2Cu^{2+}(aq) + 4I^-(aq) \rightarrow 2CuI(s) + I_2(aq)$$

$$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

(5)

(v) The uncertainty in each burette reading is ±0.05 cm^3 and the uncertainty in each reading of the balance is ±0.005 g.

Calculate the percentage uncertainty in the third titre value and in the mass measurement. Use your results to decide whether using a balance that weighs to three decimal places would significantly improve the accuracy of the result.

(2)

(Total for Question 3 = 15 marks)

4 Bromobenzene can be prepared from benzene by the following steps.

Step 1 Reflux 20.0 cm^3 of benzene with 6.0 cm^3 of bromine and about 10 g of iron filings, by heating on a water bath at 50 °C.

Step 2 After the reaction has finished, remove the water bath and heat to boiling until no bromine vapour can be seen.

Step 3 Cool the mixture and add 25 cm^3 of ethoxyethane (diethyl ether) to extract the bromobenzene.

Step 4 Wash the ethoxyethane layer with aqueous sodium hydroxide. Separate the ethoxyethane layer.

Step 5 Wash the ethoxyethane layer with water and repeat the separation.

Step 6 Dry the ethoxyethane layer with a suitable drying agent.

Step 7 Decant the dried solution.

Step 8 Distil the separated solution, collecting the fraction boiling around the boiling temperature of bromobenzene, 156 °C.

(a) Calculate the number of moles of bromine, Br_2, used in the experiment.

[Density of bromine 3.1 g cm^{-3}]

(2)

(b) Bromine reacts with iron to form iron(III) bromide, which reacts with bromine to produce the attacking electrophile in **Step 1**.

Write the chemical equations for these reactions.

(2)

(c) Why is the ethoxyethane layer washed with sodium hydroxide solution in **Step 4**?

(1)

....

....

(d) Draw a diagram of the apparatus used to separate the ethoxyethane layer from the aqueous layer in **Step 5**. Clearly label the ethoxyethane layer.

[Densities: water 1.0 g cm^{-3}, ethoxyethane 0.7 g cm^{-3}]

(2)

(e) The bromobenzene formed in this reaction can be nitrated to make 2,4-dinitrobromobenzene.

Identify, by name or formula, the chemicals needed for this reaction.

(1)

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....

(f) 2,4-dinitrobromobenzene reacts with hydrazine hydrate to make 2,4-dinitrophenylhydrazine crystals.

The percentage yields for the reactions are:

75% for the formation of bromobenzene from benzene

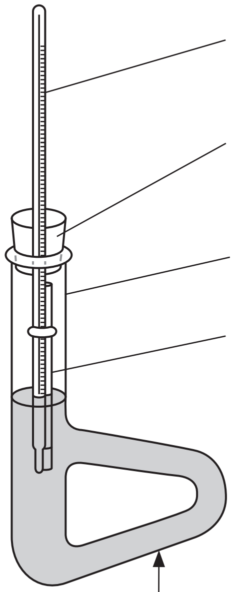
70% for the formation of 2,4-dinitrobromobenzene from bromobenzene

70% for the formation of 2,4-dinitrophenylhydrazine from 2,4-dinitrobromobenzene

Calculate the overall percentage yield of 2,4-dinitrophenylhydrazine from benzene, for this series of reactions.

(1)

(g) The purity of the 2,4-dinitrophenylhydrazine crystals can be checked by carrying out a melting temperature determination using the Thiele tube apparatus shown below.



(i) The capillary tube must be sealed at one end. Describe how this is done.

(1)

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....

(ii) When crystals are placed in the capillary tube they often stick in the top. Describe how to ensure the crystals reach the bottom of the capillary tube.

(1)

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....

(iii) Dibutyl phthalate is often used as the liquid in the Thiele tube.

Suggest **two** properties of dibutyl phthalate that make it a suitable liquid for this purpose.

(2)

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(iv) The melting temperature for crystals of 2,4-dinitrophenylhydrazine is 201°C.

Suggest the temperature **range** over which you would expect the crystals to melt before and after purification by recrystallization.

(2)

Before recrystallization ....

After recrystallization ....

(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

1	2											3	4	5	6	7	0 (8)
							1.0 **H** hydrogen 1										(18) 4.0 **He** helium 2
(1)	(2)											(13)	(14)	(15)	(16)	(17)	
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	95.9 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La*** lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

140 **Ce** cerium 58	141 **Pr** praseodymium 59	144 **Nd** neodymium 60	[147] **Pm** promethium 61	150 **Sm** samarium 62	152 **Eu** europium 63	157 **Gd** gadolinium 64	159 **Tb** terbium 65	163 **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	[231] **Pa** protactinium 91	238 **U** uranium 92	[237] **Np** neptunium 93	[242] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[245] **Bk** berkelium 97	[251] **Cf** californium 98	[254] **Es** einsteinium 99	[253] **Fm** fermium 100	[256] **Md** mendelevium 101	[254] **No** nobelium 102	[257] **Lr** lawrencium 103

* Lanthanide series

* Actinide series