Surname	Centre Number	Candidate Number
Other Names		0

GCSE

C410UB0-1

S19-C410UB0-1

WEDNESDAY, 12 JUNE 2019 – MORNING

CHEMISTRY – Component 2
Applications in Chemistry

HIGHER TIER

1 hour 15 minutes

	For Examiner's use only		
	Question	Maximum Mark	Mark Awarded
Section A	1.	15	
Section B	2.	16	
	3.	11	
	4.	7	
	5.	5	
	6.	6	
	Total	60	

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ADDITIONAL MATERIALS

In addition to this examination paper you will need a:
- calculator and ruler;
- **Resource Booklet**.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

This paper is in two sections.

Section A (15 marks). You are advised to spend about 25 minutes on this section.
Section B (45 marks). You are advised to spend about 50 minutes on this section.

The number of marks is given in brackets at the end of each question or part-question.

Question **6** is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

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SECTION A

Read the article in the **Resource Booklet** *and answer* **all** *the questions that follow.*

1. *(a)* State **three** reasons for recycling steel. [3]

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(b) (i) Suggest why some steel car parts may not be directly reused as shown in **Figure 1**. [1]

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....

(ii) Use information from lines 4-8 to calculate the mass of carbon dioxide produced when one tonne of iron is recycled. Give your answer to **three** significant figures. [1]

Mass = ... tonnes

(c) (i) Use information from lines 9-11 to calculate the percentage of steel used by the UK construction industry that goes to landfill each year. [1]

Percentage = ... %

(ii) Use lines 7-8 to calculate the value of the material sent to landfill in 2017. [1]

Value = £ .... million

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(d) (i) Give the term that is used to describe steel, tool grade steel, stainless steel and other mixtures of metals. [1]

....

(ii) Suggest why the addition of tungsten makes steel suitable for use in drill tips. [1]

....

....

(iii) Suggest why stainless steel is used to make cutlery. [1]

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....

(e) Describe the trend in worldwide stainless steel production shown in **Figure 3**. [2]

....

....

(f) Lines 20-23 provide a method of estimating the mass of stainless steel that was produced 20 years ago.

$$\text{production 20 years ago} = \text{production now} \times \frac{35}{100}$$

For example, the mass produced in 2010 was around 35 Mt and that in 1990 was around 12 Mt.

$$\text{production in 1990} = 35 \times \frac{35}{100} = 12.25\,\text{Mt}$$

This is the same value to two significant figures as the graph reading so the method provides a good estimate of stainless steel production in 1990.

Evaluate whether this method is suitable for estimating the production in 1970. [3]

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SECTION B

Answer **all** *questions.*

2. *(a)* A teacher asked a group of students to investigate the displacement reaction between aluminium powder and copper(II) sulfate solution.

$$2Al + 3CuSO_4 \longrightarrow Al_2(SO_4)_3 + 3Cu$$

She gave them the following method.

- Add 5.4 g of aluminium powder to excess copper(II) sulfate solution in a conical flask.
- Once the reaction is complete, filter off the copper powder that is formed.
- Dry the copper powder and weigh.

(i) Calculate the maximum mass of copper that would be expected to form from 5.4 g of aluminium powder. [2]

$A_r(Al) = 27$ $\qquad$ $A_r(Cu) = 63.5$

Mass of copper = ... g

(ii) Give **one** possible reason that would explain the students recording a greater mass of copper than expected. Suggest how this problem could be overcome. [2]

....

....

....

(iii) It is important to remove all of the copper formed from the conical flask during the filtration stage in order to get an accurate mass.

State what the students should do to ensure that all of the copper is removed. [1]

....

....

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(b) The table shows the mass of copper formed when different groups of students added different masses of aluminium powder to excess copper(II) sulfate solution.

Group	Mass of aluminium added (g)	Mass of copper formed (g)
1	0.5	1.74
2	1.0	3.45
3	1.5	5.16
4	2.0	6.94
5	2.5	8.70

(i) Plot the results from the table **on the grid opposite**. Draw a suitable line. [3]

(ii) Describe the relationship between the mass of aluminium added and the mass of copper formed. [2]

....

....

....

(iii) Use your graph to find the mass of copper that would be formed when 3.0 g of aluminium powder is added to excess copper(II) sulfate solution. **Show clearly on your graph how you obtained your answer.** [2]

Mass of copper .... g

(c) Group 2 thought that repeating their experiment was good experimental practice and would improve the accuracy of their result. State whether you agree with group 2. Explain your answer. [2]

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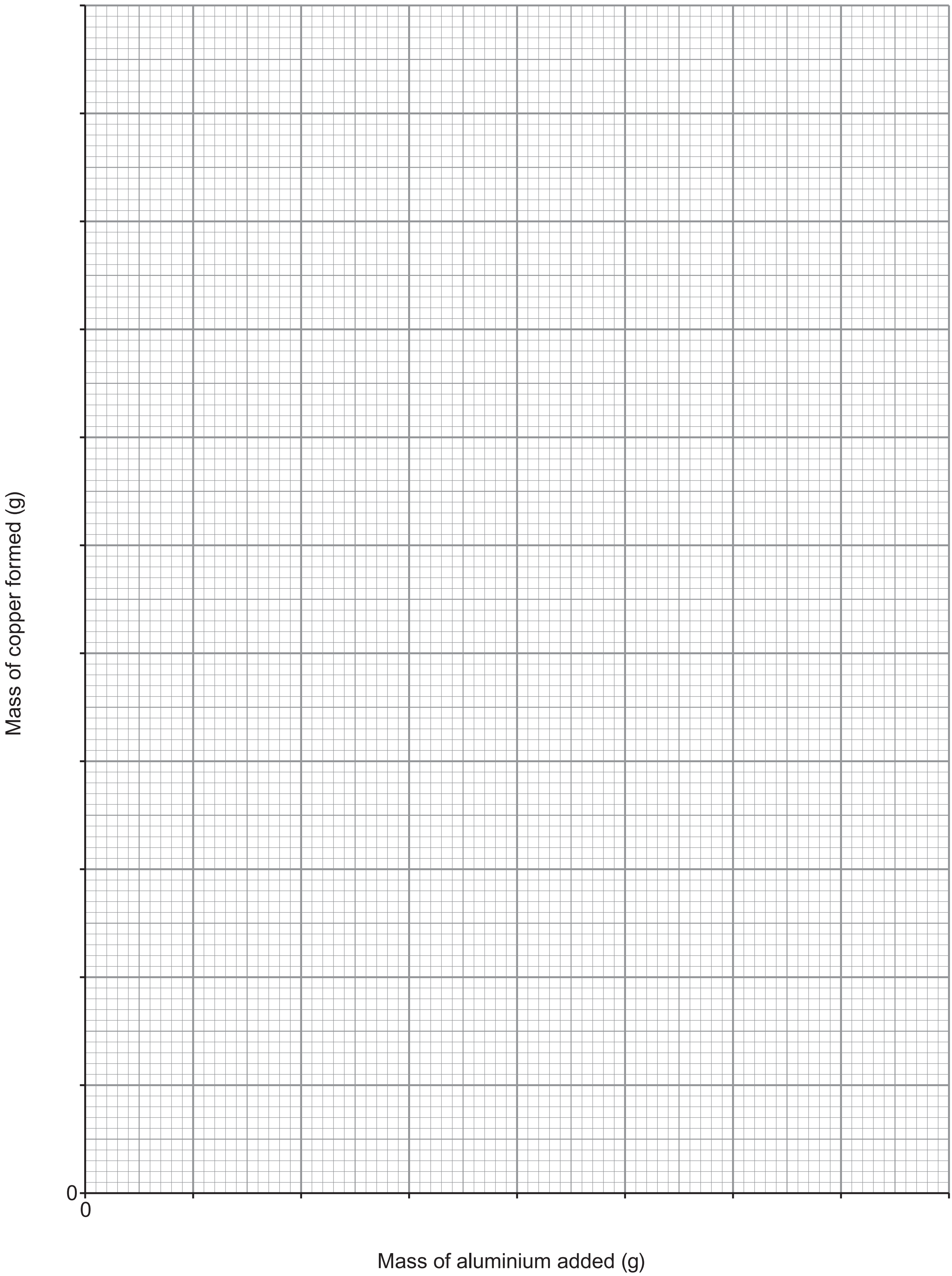

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(d) The teacher wanted to show whether or not the method was reproducible. She asked each group to obtain a result using 1.0 g of aluminium. Their results are shown in the table.

Group	Mass of copper formed from 1.0 g of aluminium (g)
1	3.42
2	3.46
3	3.43
4	3.83
5	3.48

Comment on the reproducibility of the method. [2]

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3. *(a)* Megan and Grace were asked to carry out a series of tests to identify the different ions present in the following compounds.

sodium chloride	copper(II) sulfate
sodium carbonate	ammonium bromide
copper(II) oxide	magnesium oxide
lithium iodide	ammonium carbonate

(i) They added hydrochloric acid to each of the compounds.

State the names of the compounds that produced bubbles when hydrochloric acid was added to them. Give the reason for this observation. [2]

....

....

....

(ii) State the names of the compounds that can be identified using silver nitrate solution. Give the reason for your answer. [2]

....

....

....

(iii) Name the gas that was produced when sodium hydroxide solution was added to the ammonium compounds and heated. Describe how Grace and Megan would positively identify this gas. [2]

....

....

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(b) Megan and Grace were given a solution that is suspected to either be iron(II) sulfate or iron(III) sulfate.

(i) Describe a test that they could carry out to show whether the solution contains iron(II) or iron(III) ions. Include the expected observation for both ions. [3]

....

....

....

....

....

(ii) Describe how they would test for the presence of the sulfate ions in the solution. Include the expected observation. [2]

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....

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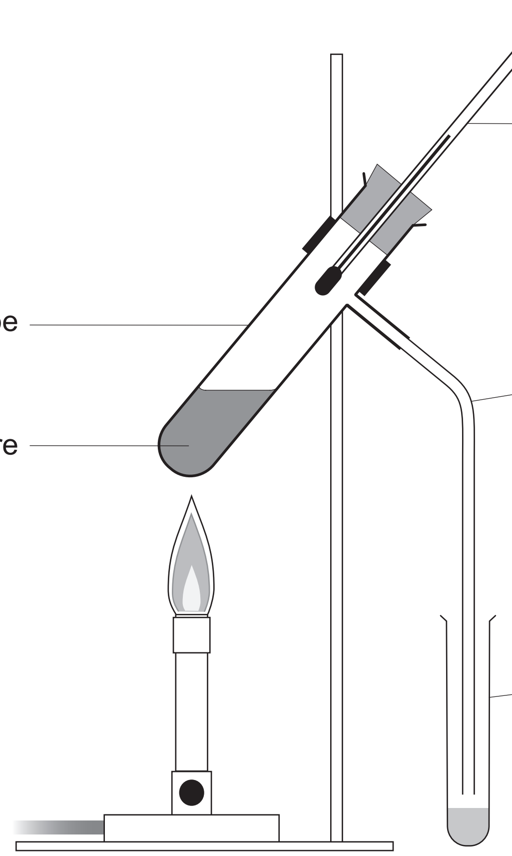
4. Lois used the following apparatus to demonstrate the industrial fractional distillation of crude oil in the laboratory.



In her experiment, Lois gently heated 10 cm^3 of an alternative crude oil mixture in a side-arm boiling tube.

She collected the first fraction from the time she started heating the mixture until the temperature on the thermometer reached 100 °C.

Once the temperature had reached 100 °C, she replaced the collecting tube with an empty one. She repeated this until she had collected four fractions over the following temperature ranges.

Fraction 1	room temperature to 100 °C
Fraction 2	100-150 °C
Fraction 3	150-200 °C
Fraction 4	200-250 °C

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(a) (i) I. Give the reason why the bulb of the thermometer should be level with or just below the side-arm throughout the experiment. [1]

....

....

II. Suggest why a beaker of cold water was placed around the collecting tube when collecting the first fraction. [1]

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....

(ii) The four collection tubes were unfortunately mixed up whilst carrying out the separation.

Give **one** way Lois could use the **appearance** of the fractions to match them to the boiling point range over which they were collected. [1]

....

....

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(b) Luke was given a sample of an organic compound. He was told that the compound was pentane, pentene or pentanol.

Complete the following flow diagram to give a sequence of tests that Luke could carry out to positively identify his organic compound. [3]

unknown organic compound

↓

Test 1

add ....

....

to the organic compound

positive result → the unknown organic compound must be

....

↓ no positive result

Test 2

add ....

....

to the organic compound

positive result → the unknown organic compound must be

....

↓ no positive result

the unknown organic compound must be

....

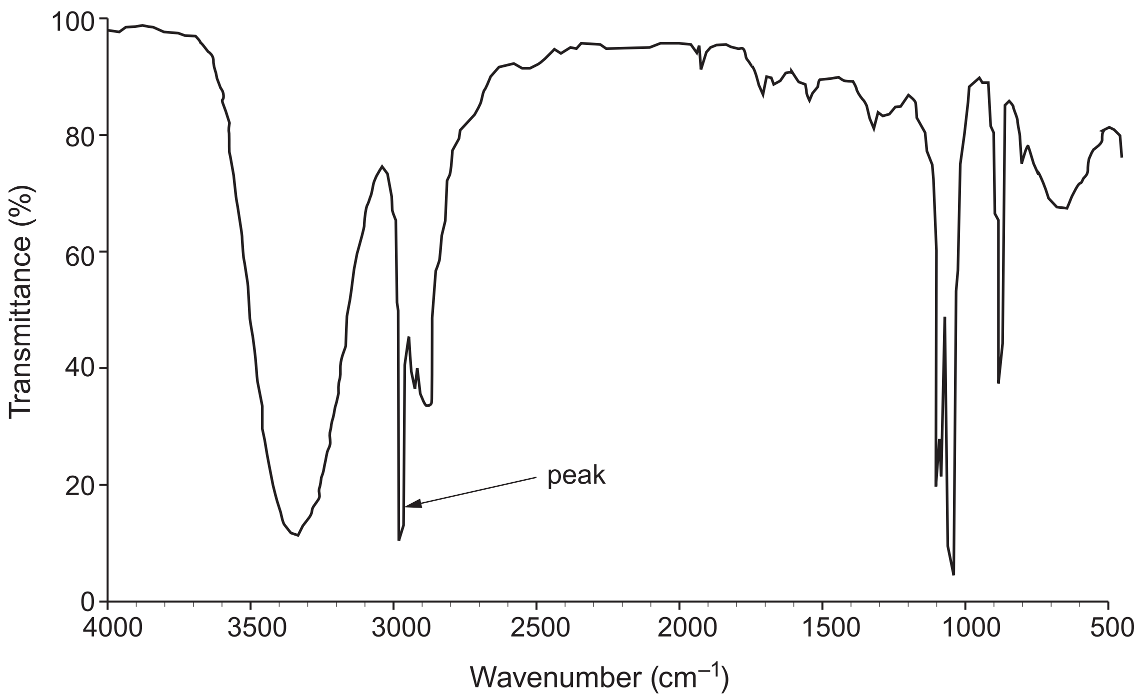
Examiner only

(c) Infrared spectroscopy is commonly used by forensic scientists to identify organic compounds. The technique identifies the different types of bonds present within organic compounds.

An infrared spectrum contains a series of peaks. Each major peak corresponds to a specific type of bond within a molecule. Each one is formed when the molecule absorbs infrared radiation of a specific frequency (or wavenumber). The wavenumber ranges corresponding to various bonds are shown in the table below.

Bond	Wavenumber (cm^{-1})
O—H	3600-3200
C—H	3200-2800
C=O	1800-1600
C—O	1250-1000
C=C	1600-1500

When tested, Luke's sample gave the following infrared spectrum.



Luke analysed the infrared spectrum and decided that his compound must be pentanol and not pentane or pentene. State how he came to this conclusion. [1]

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....

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5. A technician at a local chemical plant prepared a sample of sodium hydroxide solution by dissolving sodium hydroxide pellets in 500 cm^3 of water. He forgot to record the mass of sodium hydroxide weighed out, therefore he did not know the concentration of the solution.

(a) To determine the concentration of the solution, the technician carried out a titration using the sodium hydroxide solution and sulfuric acid solution. The equation for the reaction is given below.

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$

He found that 16.5 cm^3 of the sodium hydroxide solution was required to completely neutralise 25.0 cm^3 of sulfuric acid of concentration 0.40 mol / dm^3.

Use this information to calculate the concentration of the sodium hydroxide solution in mol / dm^3. Give your answer to **two** decimal places. [3]

Concentration = ... mol / dm^3

(b) Use the concentration calculated in part *(a)* to determine the mass of sodium hydroxide pellets that must have been used to make up the original 500 cm^3 sample of the solution. The relative formula mass, M_r, of sodium hydroxide is 40. [2]

Mass = ... g

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6. Describe and explain the similarities and differences between the reactions taking place during the electrolysis of sodium chloride solution and copper(II) chloride solution.

A description of the practical details are not required. [6 QER]

6

END OF PAPER

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Additional page.

FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
aluminium	Al^{3+}	bromide	Br^{-}
ammonium	NH_4^{+}	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^{-}
calcium	Ca^{2+}	fluoride	F^{-}
copper(II)	Cu^{2+}	hydroxide	OH^{-}
hydrogen	H^{+}	iodide	I^{-}
iron(II)	Fe^{2+}	nitrate	NO_3^{-}
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^{+}	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^{+}		
silver	Ag^{+}		
sodium	Na^{+}		
zinc	Zn^{2+}		

THE PERIODIC TABLE

1	2					Group						3	4	5	6	7	0
						1 H Hydrogen 1											4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											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	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 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
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	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 Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	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 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

A_r — relative atomic mass
Symbol
Name
Z — atomic number