

Write your name here

Surname					Other names				
Centre Number					Candidate Number				
<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; justify-content: space-around;"> <div style="width: 20%; height: 20px;"></div> <div style="width: 20%; height: 20px;"></div> <div style="width: 20%; height: 20px;"></div> <div style="width: 20%; height: 20px;"></div> <div style="width: 20%; height: 20px;"></div> </div>					<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; justify-content: space-around;"> <div style="width: 20%; height: 20px;"></div> <div style="width: 20%; height: 20px;"></div> <div style="width: 20%; height: 20px;"></div> <div style="width: 20%; height: 20px;"></div> <div style="width: 20%; height: 20px;"></div> </div>				

**Edexcel GCE**

# Chemistry

## Advanced Subsidiary

### Unit 3B: Chemistry Laboratory Skills I Alternative

Thursday 13 May 2010 – Morning <b>Time: 1 hour 15 minutes</b>	Paper Reference <b>6CH07/01</b>
--	------------------------------------

**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.

N35693A

©2010 Edexcel Limited.

7/7/7/2/



Turn over ►

**edexcel**   
advancing learning, changing lives

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

**1** Compound **A** is a white solid that contains one Group 1 cation and one anion.

(a) (i) Describe how you would carry out a flame test on compound **A**.

(3)

.....

.....

.....

.....

.....

.....

(ii) In a flame test, compound **A** gives a red flame. Deduce the formula of the cation present.

(1)

.....

(b) On prolonged strong heating, compound **A** forms a white solid, **B**, and a gas. The gas turns limewater milky.

(i) Identify, by name or formula, the compound that is dissolved in water to make limewater.

(1)

.....

(ii) Suggest the formula for the anion in compound **A**. Justify your answer.

(2)

.....

.....

.....



(c) When water is added to the white solid, **B**, it dissolves completely and exothermically to form solution **C**.

(i) Identify, by name or formula, the anion present in **B**.

(1)

(ii) Identify, by name or formula, the anion present in **C**.

(1)

(iii) Suggest a test for the anion present in **C**. Give the result of your test.

(2)

**Test** .....

**Result** .....

(d) Suggest the **formula** of compound **A**.

(1)

**(Total for Question 1 = 12 marks)**



- 2 This question is about two isomeric halogenoalkanes, **P** and **Q**.
- (a) A hot aqueous solution of silver nitrate is added to each halogenoalkane. Both halogenoalkanes react to form a yellow precipitate.
- (i) Identify, by name or formula, this yellow precipitate. (1)
- 
- (ii) The isomers have relative molecular mass 169.9. Deduce the molecular formula of the isomers. (1)
- (iii) Halogenoalkane **P** forms the yellow precipitate faster than halogenoalkane **Q**. Draw a displayed formula for halogenoalkane **P**. (1)
- (iv) Give the name or structural formula of the alcohol, **R**, formed by the reaction of halogenoalkane, **P**, with hot aqueous silver nitrate. (1)
- 



(b) When **R** is boiled with a mixture of potassium dichromate(VI) and dilute sulfuric acid, the organic product **S** forms.

(i) Give the colour change you would expect to see.

(2)

From ..... to .....

(ii) Give the **name** of **S**.

(1)

(iii) Give the type of reaction involved in the conversion of **R** to **S**.

(1)

(Total for Question 2 = 8 marks)



**BLANK PAGE**



3 The purity of a sample of potassium iodate(V) was determined by titration.

**The steps of the experimental procedure are as follows.**

1. 0.100 g of the sample was dissolved in water in a beaker and the solution made up to 100 cm<sup>3</sup> in an appropriate flask.
2. A 10.0 cm<sup>3</sup> portion of this solution of potassium iodate(V) was transferred to a conical flask.
3. An excess of both potassium iodide solution and sulfuric acid were then added to the conical flask. This produced a solution, **T**, containing iodine.
4. Solution **T** was titrated with 0.0200 mol dm<sup>-3</sup> sodium thiosulfate solution using a suitable indicator.
5. Steps 2, 3 and 4 were repeated twice.

(a) (i) Name the piece of apparatus used to remove the 10.0 cm<sup>3</sup> portions of potassium iodate(V) solution (step 2).

(1)

(ii) Name the indicator you would use for the titration and give the colour change you would expect to see (step 4).

(2)

**Indicator** .....

**Colour change from** ..... **to** .....

(b) The following results were obtained for the titrations.

Titration number	1	2	3
Final burette reading / cm <sup>3</sup>	19.50	33.20	46.95
Initial burette reading / cm <sup>3</sup>	5.00	19.50	33.20
Titre / cm <sup>3</sup>			

(i) Complete the table by calculating the titres.

(1)



(ii) Explain why the correct value for the mean titre is  $13.73 \text{ cm}^3$ .

(1)

.....

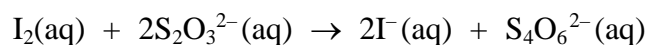
.....

.....

(iii) Calculate the number of moles of sodium thiosulfate in the mean titre.

(1)

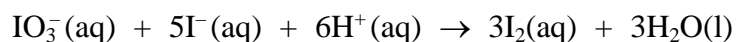
(c) The ionic equation for the reaction between iodine and sodium thiosulfate in the titration is shown below.



Calculate the number of moles of iodine in solution **T** using this equation and your answer to (b)(iii).

(1)

(d) The ionic equation for the reaction of iodate(V) ions with iodide ions is shown below.



Using this equation and your answer to (c), calculate the number of moles of iodate(V) ions which reacted to produce solution **T**.

(1)





(e) (i) Name the appropriate flask used in step 1. (1)

(ii) Describe how you would make up exactly 100 cm<sup>3</sup> of potassium iodate(V) solution in this flask, ready for step 2. (3)

(iii) Calculate the number of moles of potassium iodate(V) in 100 cm<sup>3</sup> of the solution, using your answer to (d). (1)

(iv) Calculate the mass of potassium iodate(V) in the sample.  
[Assume the molar mass of potassium iodate(V) is 214 g mol<sup>-1</sup>] (1)

(v) Calculate the percentage purity of the sample. (1)

(f) Suggest the most significant hazard in step 3. (1)

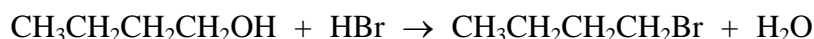
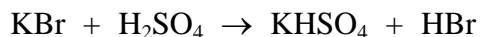
(Total for Question 3 = 16 marks)



- 4 An experiment to prepare 0.100 mol of 1-bromobutane uses the reaction of butan-1-ol with hydrogen bromide.

Hydrogen bromide is formed in the reaction mixture from potassium bromide and moderately concentrated sulfuric acid.

The process has an 80 % yield after purification of the 1-bromobutane.



**The steps of the experimental procedure are as follows.**

1. Add measured amounts of potassium bromide and butan-1-ol to 10 cm<sup>3</sup> of water into a 50 cm<sup>3</sup> two-necked flask.
2. Fit the two-necked flask with a reflux condenser and a tap funnel.
3. Immerse the flask in a beaker of cold water and add 10 cm<sup>3</sup> of concentrated sulfuric acid from the tap funnel, a few drops at a time.
4. Remove the flask from the cold water and close the tap on the tap funnel. Heat the mixture under reflux for 30 minutes.
5. Allow the mixture to cool. Then set up the apparatus for distillation. Boil the mixture and collect the distillate in a measuring cylinder.
6. Transfer the distillate to a separating funnel. The distillate consists of two layers, an aqueous layer and impure 1-bromobutane. Separate the two layers.
7. Wash the impure 1-bromobutane with concentrated hydrochloric acid and separate the two layers.
8. Wash the 1-bromobutane layer with sodium hydrogencarbonate solution, releasing any gas formed.
9. Collect the 1-bromobutane layer in a conical flask and add anhydrous sodium sulfate.
10. Decant the 1-bromobutane into a 50 cm<sup>3</sup> flask.

### Data

Property	Butan-1-ol	1-bromobutane	Water
Density / g cm <sup>-3</sup>	0.81	1.3	1.0
Molar mass / g mol <sup>-1</sup>	74	137	18
Boiling temperature / °C	117.3	101.7	100.0



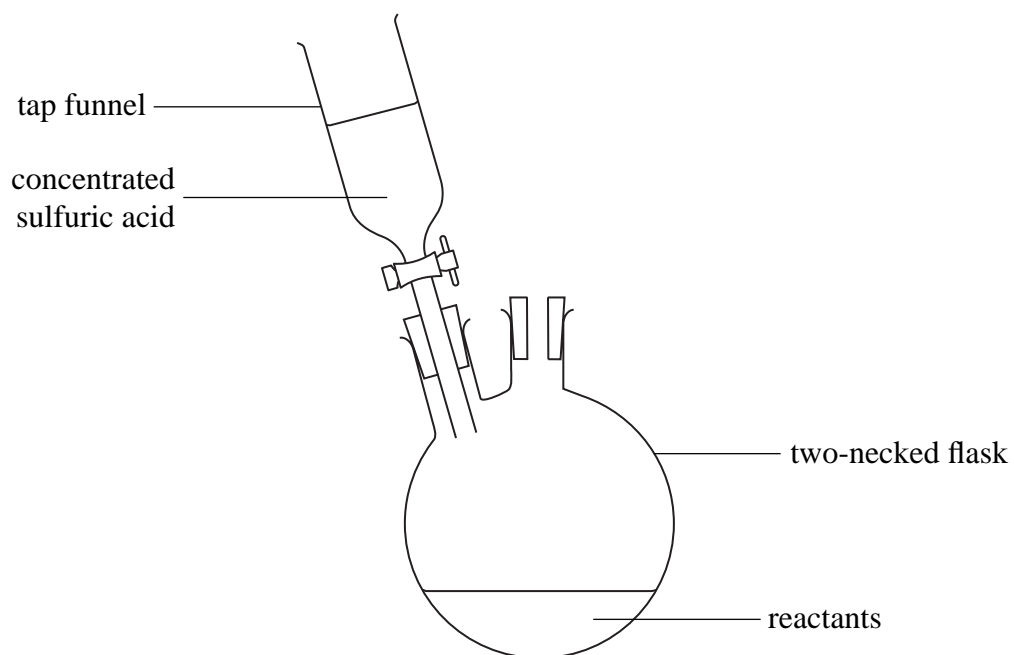
- (a) (i) Show, by calculation, that 0.125 mol of butan-1-ol is needed to make 0.100 mol of 1-bromobutane. (2)
- (ii) Calculate the volume of 0.125 mol of butan-1-ol, in  $\text{cm}^3$ . (2)
- (iii) Calculate the minimum mass of potassium bromide required in step 1. (1)  
[The molar mass of potassium bromide is  $119 \text{ g mol}^{-1}$ ]



(b) Complete and label the diagram below of the apparatus assembled in steps 1, 2 and 3.

[You may assume that the apparatus is suitably clamped.]

(4)



(c) (i) State, with a reason, whether the upper or lower layer contains 1-bromobutane in step 6.

(1)

(ii) The product is washed with concentrated hydrochloric acid in step 7 to remove unreacted butan-1-ol. In step 8, why is the product then washed with sodium hydrogencarbonate solution and what causes a build up of gas?

(2)

(d) (i) What further step is necessary to purify the 1-bromobutane obtained in step 10?

(1)

(ii) How does the step in (d)(i) give information about the purity of the product?

(1)

---

**(Total for Question 4 = 14 marks)**

---

**TOTAL FOR PAPER = 50 MARKS**

---



**BLANK PAGE**



**BLANK PAGE**



# The Periodic Table of Elements

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

Key

relative atomic mass  
atomic symbol  
name  
atomic (proton) number

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

\* Lanthanide series

\* Actinide series

140	Ce	cerium	58	141	Pr	praseodymium	59	142	Nd	neodymium	60	143	Pm	promethium	61	144	Sm	samarium	62	145	Eu	europium	63	146	Gd	gadolinium	64	147	Tb	terbium	65	148	Dy	dysprosium	66	149	Ho	holmium	67	150	Er	erbium	68	151	Tm	thulium	69	152	Yb	ytterbium	70	153	Lu	lutetium	71
232	Th	thorium	90	231	Pa	protactinium	91	230	U	uranium	92	231	Np	neptunium	93	232	Pu	plutonium	94	233	Am	americium	95	234	Cm	curium	96	235	Bk	berkelium	97	236	Cf	californium	98	237	Es	einsteinium	99	238	Fm	fermium	100	239	Md	mendeleevium	101	240	No	nobelium	102	241	Lr	lawrencium	103

