

Please check the examination details below before entering your candidate information	
Candidate surname	Other names
Centre Number	Candidate Number
Pearson Edexcel Level 1/Level 2 GCSE (9–1)	
Monday 22 May 2023	
Morning (Time: 1 hour 45 minutes)	Paper reference 1CH0/1H
Chemistry PAPER 1	
Higher Tier	
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.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- There is a periodic table on the back cover of the paper.

Advice

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

Turn over ►

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

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 ☒.

- 1** (a) Figure 1 shows information about two isotopes of hydrogen, **A** and **B**.

Complete the table to show the number of subatomic particles in each isotope.

(2)

	isotope A	isotope B
atomic number	1	1
mass number	1	2
number of protons		
number of electrons		
number of neutrons		

Figure 1

- (b) Hydrogen gas and oxygen gas are used in a hydrogen–oxygen fuel cell.

Separate containers of hydrogen and oxygen are used to supply the gases.

A student tests the voltage supplied by the fuel cell every 15 minutes.

The results are shown in Figure 2.

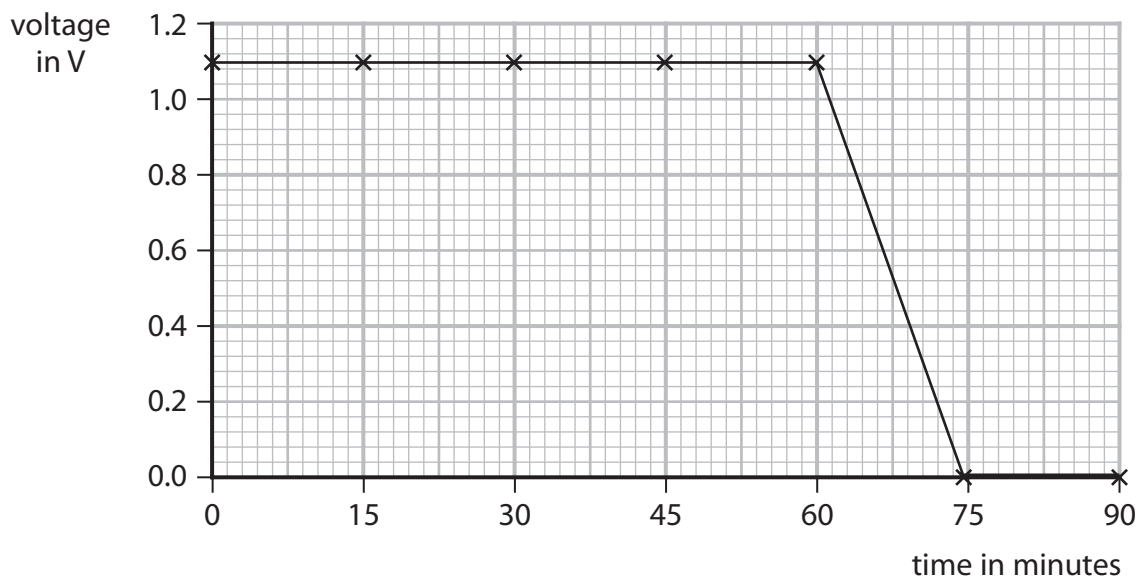


Figure 2



Describe what Figure 2 shows about how the voltage of this fuel cell varies with time.

(2)

(c) A chemical cell is made by placing two electrodes into an aqueous electrolyte.

Figure 3 shows a chemical cell.

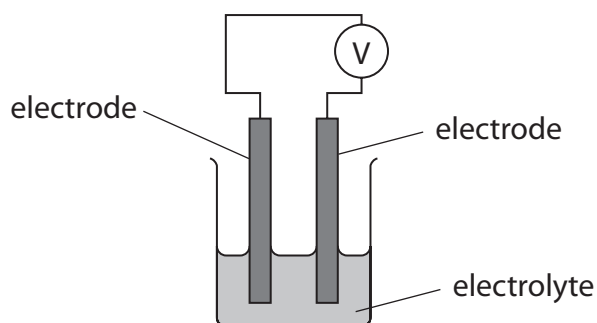


Figure 3

State why sodium and sulfur electrodes are **not** suitable for this experiment.

(2)

sodium

sulfur

(Total for Question 1 = 6 marks)



- 2 In an experiment, powdered calcium hydroxide was added to dilute hydrochloric acid and the pH was measured.

The method used was

step 1 measure 200 cm^3 dilute hydrochloric acid into a beaker

step 2 add 0.1 g of powdered calcium hydroxide to the beaker

step 3 find the pH of the mixture

step 4 repeat steps 2 and 3 until the pH stops changing.

- (a) State what should be done after **step 2** to make sure that any reaction is complete.

(1)

- (b) Complete the word equation for the reaction.

(2)

calcium hydroxide + hydrochloric acid $\rightarrow$

- (c) Which row of the table shows the state symbols for powdered calcium hydroxide and dilute hydrochloric acid in the balanced chemical equation?

(1)

	calcium hydroxide	hydrochloric acid
☐ A	aq	l
☐ B	l	aq
☐ C	s	aq
☐ D	s	l



(d) The results of the experiment are shown in Figure 4.

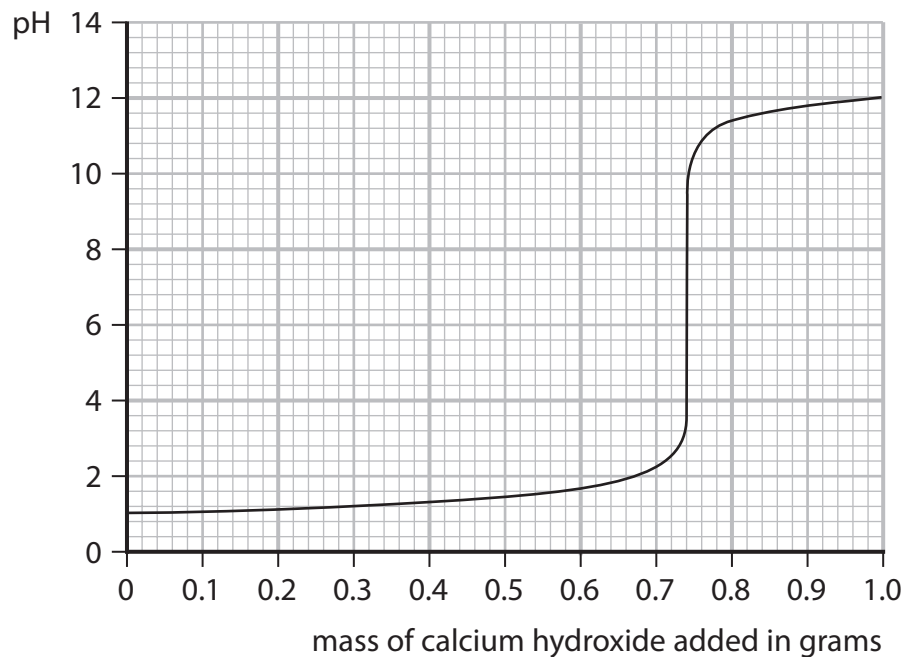


Figure 4

(i) Using Figure 4, give the pH of the acid at the start of the experiment.

(1)

pH =

(ii) Using Figure 4, give the mass of calcium hydroxide required to make a neutral mixture.

(1)

mass of calcium hydroxide = g

(iii) Explain why the pH starts at a low value and ends at a higher value.

(3)

.....

.....

.....

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.....

.....

.....

(Total for Question 2 = 9 marks)



P 7 2 6 3 1 A 0 5 3 2

3 Figure 5 shows part of the reactivity series of metals.

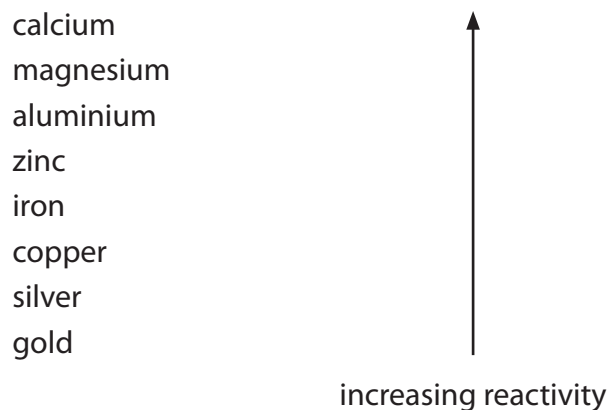


Figure 5

(a) Which metal reacts when added to cold water?

(1)

- ☐ **A** calcium
- ☐ **B** copper
- ☐ **C** gold
- ☐ **D** silver

(b) A student investigates the reactivity of four different metals.

The student adds an equal-sized piece of each metal to separate test tubes containing dilute hydrochloric acid.

The student's observations for zinc and copper are recorded in Figure 6.

metal	observations
magnesium	
zinc	bubbles produced at a steady rate test tube feels slightly warm
iron	
copper	no reaction

Figure 6



- (i) Use the information in Figure 5 and in Figure 6 to predict the observations for the reactions of magnesium and of iron with dilute hydrochloric acid.

(2)

magnesium

iron

- (ii) When metals react with acids, hydrogen gas is produced.

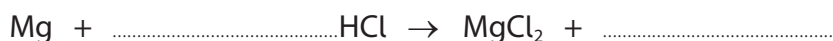
Describe the test to show that the gas is hydrogen.

(2)

- (iii) When magnesium reacts with hydrochloric acid, magnesium chloride and hydrogen are formed.

Complete the balanced equation for the reaction.

(2)



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- (c) An excess of magnesium is added to some dilute hydrochloric acid of pH 2.
The mass of hydrogen gas produced is measured.

The experiment is repeated with excess magnesium but with the same volume of dilute hydrochloric acid of pH 1.

- (i) State how many times greater the concentration of hydrogen ions is in the acid of pH 1 than in the acid of pH 2.

(1)

- (ii) With the acid of pH 2, the mass of hydrogen gas produced when the reaction is complete is 0.005 g.

Predict the mass of hydrogen gas produced in the reaction with acid of pH 1.

(1)

mass = g

(Total for Question 3 = 9 marks)



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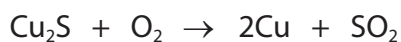
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4 There are several stages to the production of sulfuric acid in industry.

- (a) Sulfur dioxide is required for the production of sulfuric acid.

Sulfur dioxide can be obtained by heating copper sulfide, Cu_2S , in excess air.



Calculate the atom economy for the production of sulfur dioxide, SO_2 , in this reaction.

(relative atomic mass: $\text{Cu} = 63.5$)

relative formula masses: $\text{O}_2 = 32.0$, $\text{Cu}_2\text{S} = 159.0$, $\text{SO}_2 = 64.0$)

Give your answer to two significant figures.

(4)

atom economy = %

- (b) In one stage vanadium oxide, V_2O_5 , is used.

Based on the position of vanadium in the periodic table, which row shows the most likely melting point of vanadium and colour of vanadium oxide?

(1)

		melting point of vanadium in $^{\circ}\text{C}$	colour of vanadium oxide
☐	A	50	white
☐	B	1910	white
☐	C	50	orange
☐	D	1910	orange



(c) The equation shows a reaction forming sulfuric acid.



- (i) Calculate the maximum mass of sulfuric acid that could be produced from 400 tonnes of sulfur trioxide, SO_3 .

(relative formula masses: $\text{SO}_3 = 80$, $\text{H}_2\text{SO}_4 = 98$)

(2)

maximum mass of sulfuric acid = tonnes

- (ii) Using a different amount of sulfur trioxide, it was calculated that 700 tonnes of sulfuric acid could be made.

The actual mass produced was 672 tonnes.

Calculate the percentage yield of sulfuric acid.

(2)

percentage yield =

- (iii) State **two** reasons why the percentage yield is less than 100%.

(2)

1

2

(Total for Question 4 = 11 marks)



5 (a) Ammonia is manufactured in the Haber process by the reversible reaction between nitrogen and hydrogen.

- (i) Write the balanced equation for the reversible reaction between nitrogen and hydrogen to make ammonia, NH_3 .

(3)

- (ii) Which row shows the typical conditions of temperature and pressure used in the Haber process?

(1)

	temperature in $^{\circ}\text{C}$	pressure in atmospheres
☐ A	250	100
☐ B	250	200
☐ C	450	500
☐ D	450	200

- (iii) In the Haber process, iron is added to the vessel where the nitrogen and hydrogen react.

State the purpose of the iron.

(1)

- (iv) The reaction between nitrogen and hydrogen to make ammonia can reach dynamic equilibrium.

The reaction gives out heat.

Explain how the position of equilibrium changes if the temperature is decreased.

(2)

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(b) Compound **A** is a dark brown gas.

Compound **B** is a colourless gas.

Two molecules of **A** combine to form one molecule of **B** in a reversible reaction.

You are given

- a sealed glass tube containing an equilibrium mixture of **A** and **B**
- a beaker
- a kettle
- some ice

At room temperature, the equilibrium mixture is a pale brown colour.

Devise an experiment to show how the position of equilibrium of this reaction is affected by temperature.

The sealed tube must **not** be opened.

(3)

(Total for Question 5 = 10 marks)



- 6 A student investigates the mass of copper produced when copper chloride solution in a beaker is electrolysed using inert electrodes.

(a) Where is copper formed during the electrolysis?

(1)

- ☐ **A** at the anode
- ☐ **B** at the bottom of the beaker
- ☐ **C** at the cathode
- ☐ **D** on the surface of the electrolyte

- (b) The student investigated the change in the mass of copper formed when the current was altered.

The results are shown in Figure 7.

current in A	mass of copper formed in g
0.0	0.000
0.2	0.040
0.4	0.080
0.6	0.118
0.8	0.158
1.0	0.196

Figure 7

- (i) State and explain the trend shown in these results.

(3)

.....

.....

.....

.....

.....

.....



(2)

(relative atomic mass Cu = 63.5; Avogadro constant = 6.02×10^{23})

(3)

number of atoms =

(Total for Question 6 = 9 marks)



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7 Titration is used to carry out some neutralisation reactions.

(a) Ammonium nitrate can be made by neutralisation.

- (i) State the name of the two reactants that are neutralised to make the salt ammonium nitrate.

(2)

..... and

- (ii) Ammonium nitrate is a fertiliser.
Another fertiliser is ammonium phosphate.

Which elements are combined in ammonium phosphate?

(1)

- ☐ **A** nitrogen, oxygen and phosphorus only
- ☐ **B** hydrogen, oxygen and phosphorus only
- ☐ **C** hydrogen, nitrogen and phosphorus only
- ☐ **D** hydrogen, nitrogen, oxygen and phosphorus only

(b) Titrations involve aqueous solutions and the use of burettes.

- (i) Figure 8 shows readings on part of a burette at the start and at the end of a titration.

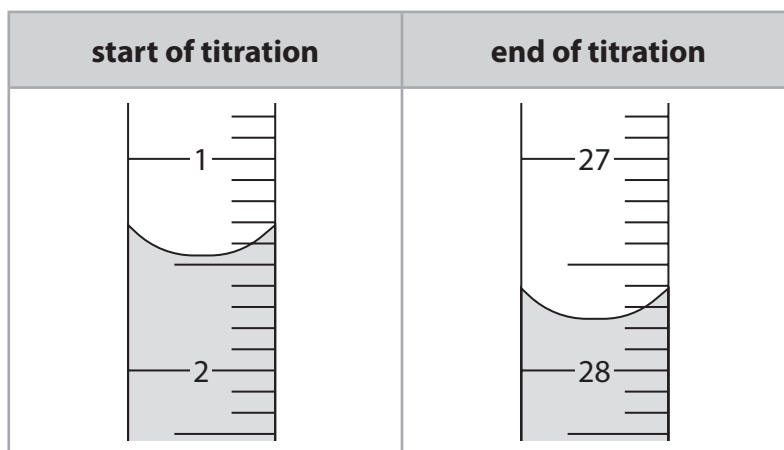


Figure 8

Calculate the volume of solution added from this burette.

Give your answer to a suitable number of decimal places.

(2)

.....
.....
volume = cm³



- (ii) A student carries out a titration four times.

The volumes from the student's results table are shown in Figure 9.

	rough	titration 1	titration 2	titration 3
volume in cm^3	25.90	24.90	24.60	25.00
used to calculate mean volume				

Figure 9

Tick the volumes that should be used to calculate the mean volume.

(1)

- (iii) Figure 10 shows the burette and flask prepared for use by the student. The burette is supported vertically by a clamp that is not shown in the diagram.

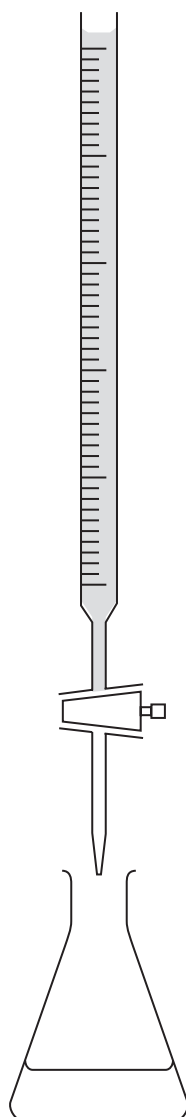


Figure 10



The student wrote a description of how they used the burette.

I took the burette from the cupboard. I closed the tap and filled the burette with the correct solution. I added the solution from the burette drop by drop to the flask until the indicator changed colour.

Give **three** improvements to the way that the student used the **burette**.

(3)

1

2

3

(c) In a titration a student placed alkali in the flask.

By mistake a few drops of litmus **and** a few drops of phenolphthalein were added to the flask.

The student added acid to the flask until the mixture was acidic.

Predict the colour change that would be seen.

(1)

from to

(d) In a titration a student rinsed out the flask with distilled water and did not dry it.

They used the flask for titration, adding the solution from the burette until the indicator changed colour.

State the effect, if any, on the titre volume of using the wet flask rather than a dry flask.

(1)

(Total for Question 7 = 11 marks)



- 8 Crystals of copper sulfate are prepared by reacting copper oxide, a base, with dilute sulfuric acid.

(a) Name the other product of this reaction.

(1)

- (b) During the experiment, a spatula measure of copper oxide, a black powder, is added to warm, dilute sulfuric acid in a beaker.

When the mixture is stirred, the black powder disappears and the mixture turns pale blue.

The student then adds more copper oxide until the maximum amount of copper sulfate is formed without wasting copper oxide.

Explain how the student knows when to stop adding copper oxide.

(3)

- (c) The reaction produces an aqueous solution of copper sulfate.

What is the best way to obtain crystals of copper sulfate from an aqueous solution?

(1)

- ☐ **A** pour the solution through filter paper in a funnel
- ☐ **B** heat the solution with a Bunsen burner until dry
- ☐ **C** heat the solution using a water bath
- ☐ **D** leave the solution in a cold, damp place

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- (d) When some water is removed from the aqueous solution of copper sulfate, crystals of copper sulfate are made.

Describe how the arrangement and movement of the particles change as crystals are formed from a solution.

(3)

- (e) In this reaction, copper oxide, CuO , forms copper sulfate, CuSO_4 .

Explain, in terms of electrons, whether the copper in copper oxide has been oxidised, has been reduced, or has not been oxidised or reduced.

(2)

- (f) In another experiment, a copper sulfate solution with a concentration of 39.875 g dm^{-3} is used.

Calculate the mass of copper sulfate dissolved in 0.300 dm^3 of this solution.

(1)

mass = g

(Total for Question 8 = 11 marks)

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P 7 2 6 3 1 A 0 2 1 3 2

- 9 (a) Figure 11 shows the structure of a molecule of compound **S**.

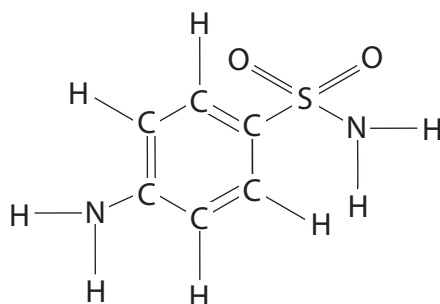


Figure 11

- (i) Use Figure 11 to deduce the empirical formula of compound **S**.

(1)

- (ii) The melting points of three samples of **S** are shown in Figure 12.

sample	melting point in °C
A	160–164
B	166
C	163–165

Figure 12

State whether each of these samples, **A**, **B** and **C**, is pure or impure and justify your answers using the information in Figure 12.

(3)

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(b) A scientist uses chromatography in an investigation of compound **S**.

In the conditions used, compound **S** has an R_f value of 0.22.

Calculate the distance the spot of compound **S** moves if the solvent front has moved by 2.4 cm.

(2)

distance = cm

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- *(c) A solution of sodium chloride in water needs to be separated to obtain a sample of pure, dry sodium chloride and a sample of pure water.

Figure 13 shows the boiling points of sodium chloride and water.

substance	boiling point in °C
sodium chloride	1465
water	100

Figure 13

Explain this difference in boiling points in terms of the structure and bonding of sodium chloride and water and how this difference is used to choose a method to separate sodium chloride solution into pure, dry sodium chloride and pure water.

(6)



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(Total for Question 9 = 12 marks)



10 (a) Buildings sometimes have water sprinklers to put out fires.

The pipes in some water sprinklers are filled with nitrogen gas to prevent corrosion when the system is not in use.

(i) State what is meant by the term **corrosion**.

(2)

(ii) Nitrogen can be made from sodium azide, NaN_3 .



Calculate the maximum volume, in cm^3 , of nitrogen produced from 110 g of sodium azide.

(relative formula mass: $\text{NaN}_3 = 65$;

1 mol of gas occupies 24 dm^3 in the conditions used)

(4)

volume = cm^3

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- *(b) Compare and contrast the properties and uses of pure aluminium and pure copper with the alloys of aluminium and the alloys of copper.

Include in your answer an **explanation** of the similarities and the differences in the properties and the uses of a pure metal and its alloy.

(6)

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TOTAL FOR PAPER = 100 MARKS



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The periodic table of the elements

1	2	Key										3	4	5	6	7	0
		relative atomic mass atomic symbol name atomic (proton) number															
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
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] 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	178 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	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86

1	H	1
	hydrogen	

relative atomic mass
atomic symbol
name
atomic (proton) number

* The elements with atomic numbers from 58 to 71 are omitted from this part of the periodic table.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

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