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Monday 10 June 2013 – Afternoon

GCSE TWENTY FIRST CENTURY SCIENCE ADDITIONAL SCIENCE A

A152/02 Modules B5 C5 P5 (Higher Tier)

A137110613

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:
- Pencil
- Ruler (cm/mm)
- Calculator

Duration: 1 hour

A152021

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (✎).
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- A list of physics equations is printed on page 2.
- A list for qualitative tests for ions is printed on page 3.
- A Periodic Table is printed on the back page.
- The total number of marks for this paper is **60**.
- This document consists of **24** pages. Any blank pages are indicated.

TWENTY FIRST CENTURY SCIENCE EQUATIONS

Useful relationships

The Earth in the Universe

distance = wave speed × time

wave speed = frequency × wavelength

Sustainable energy

energy transferred = power × time

power = voltage × current

$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

Explaining motion

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

momentum = mass × velocity

change of momentum = resultant force × time for which it acts

work done by a force = force × distance moved in the direction of the force

amount of energy transferred = work done

change in gravitational potential energy = weight × vertical height difference

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times [\text{velocity}]^2$$

Electric circuits

power = voltage × current

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

$$\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

Radioactive materials

energy = mass × [speed of light in a vacuum]^2

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Qualitative analysis

Tests for ions with a positive charge

Ion	Test	Observation
calcium Ca^{2+}	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper Cu^{2+}	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) Fe^{2+}	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(III) Fe^{3+}	add dilute sodium hydroxide	a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
zinc Zn^{2+}	add dilute sodium hydroxide	a white precipitate forms; the precipitate dissolves in excess sodium hydroxide

Tests for ions with a negative charge

Ion	Test	Observation
carbonate CO_3^{2-}	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride Cl^-	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide Br^-	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide I^-	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate SO_4^{2-}	add dilute acid, then add barium chloride or barium nitrate	a white precipitate forms

Answer **all** the questions.

1 The Vikings dug out small amounts of impure iron from peat bogs.
This 'bog iron' contains iron oxide.

The Vikings heated the bog iron in a charcoal fire to extract the iron.
The fire makes carbon monoxide, which reacts with the iron compounds.

(a) What do we call a reaction where a metal oxide turns into a metal?

..... **[1]**

(b) Several chemical reactions take place in the fire.
In one reaction the iron oxide, Fe_2O_3, reacts with carbon to produce iron and carbon dioxide.

Write a balanced chemical equation for this reaction.

..... **[2]**

(c) Another reaction which happens in the fire is:

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

(i) What mass of iron can be extracted from one gram formula mass of iron oxide?
Use relative atomic masses from the Periodic Table at the back of this paper.

Show your working and give the units.

answer ..... **[2]**

(ii) Modern iron works are sometimes built near where the ore is mined.
Transporting the iron causes less environmental impact than transporting the iron ore.

Use your answer to **(i)** to suggest why.

.....

..... **[1]**

(d) (i) The bog iron contained some aluminium oxide as well as the iron oxide.

Why was the aluminium not extracted along with the iron?

.....

.....

..... **[2]**

(ii) What method is now used to extract aluminium from aluminium oxide?

..... **[1]**

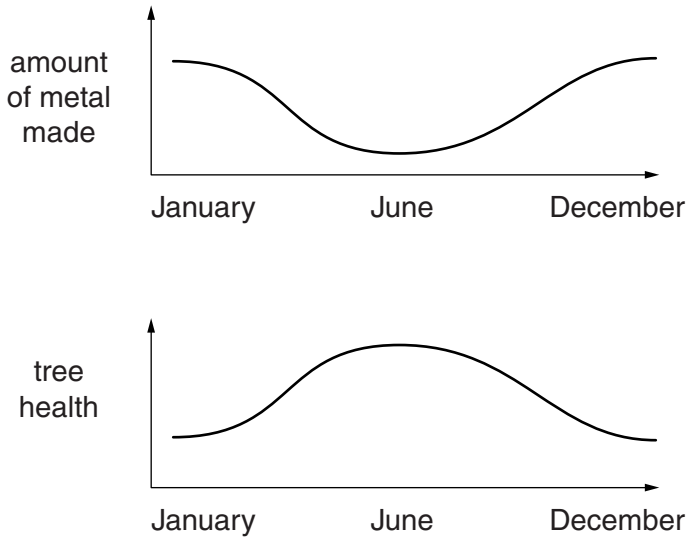
[Total: 9]

Question 2 begins on page 6

2 A factory extracts metal.

The factory gives out acidic fumes of sulfur dioxide.

Scientists have been measuring how healthy the trees are in the area near the factory.



George and Maria look at the graphs.

This is what they think.

Both George and Maria could be right.

Explain why.

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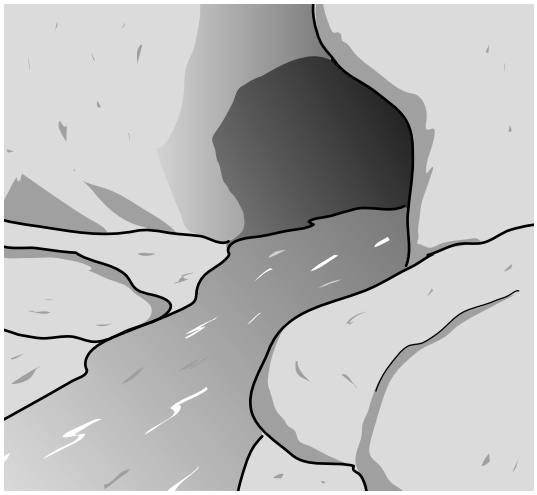
..... **[3]**

[Total: 3]

3 Julie takes samples of water from a disused mine.

She wants to know what ions are dissolved in the mine water.



She does two sets of tests on the mine water.

Test 1

She adds sodium hydroxide solution to a sample of mine water.
It gives her a white precipitate.

She then adds more sodium hydroxide.
The white precipitate disappears.

Test 2

She adds dilute nitric acid to a fresh sample of mine water.
She sees bubbles of gas being given off.

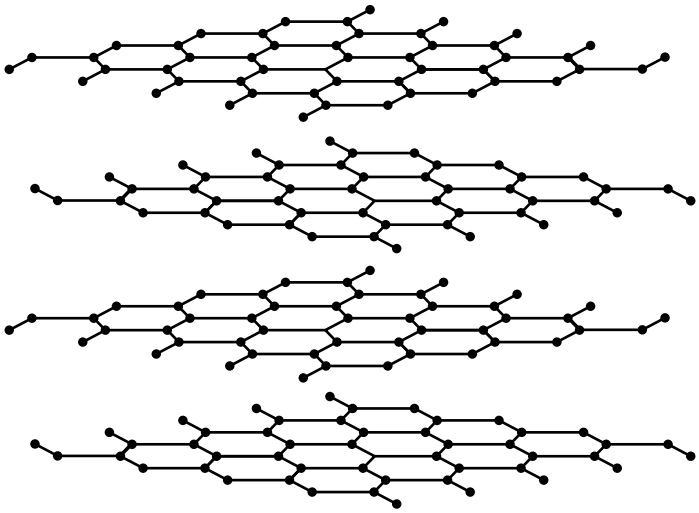
She adds more acid until the gas stops forming.
Then she adds silver nitrate solution.
It gives her a cream precipitate.

Which three ions are dissolved in the mine water?

..... **[2]**

[Total: 2]

4 The diagram shows the structure of graphite.



Graphite electrodes are used for the electrolysis of hot molten compounds at 800 °C.

Explain in detail why graphite will do this job.

The quality of written communication will be assessed in your answer.

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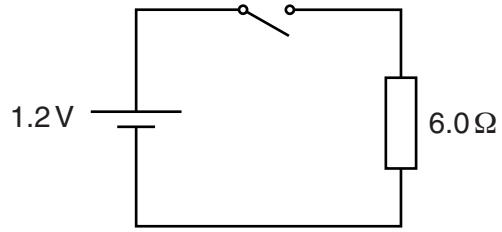
..... **[6]**

[Total: 6]

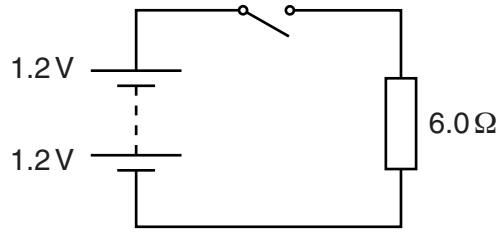
5 Dave keeps insects in a small cage. He uses this circuit to keep them warm.



(a) Calculate the power of the circuit when it is switched on.

power = ...W **[2]**

(b) Dave adds an extra cell to increase the power of the circuit.



Complete the sentences. Choose words from the list.

halves (×½)

doubles (×2)

quadruples (×4)

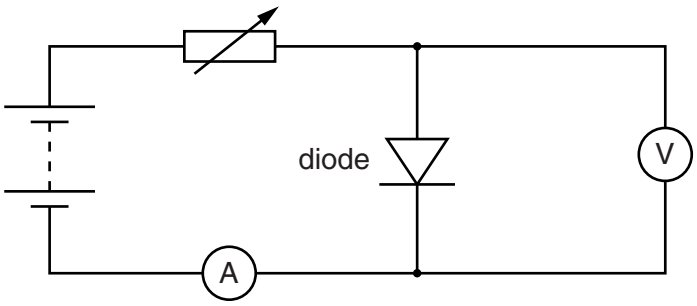
stays the same (×1)

The extra cell ..... the potential difference across the resistor,

so its heating power ..... . **[1]**

[Total: 3]

6 Sally uses this circuit to investigate an electrical component called a diode.



(a) How can she alter the circuit to change the current in the diode?
Explain how the alteration changes the current.

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..... **[2]**

(b) Sally measures the potential difference across the diode for two different currents.
Here are her results.

Current in amps	Potential difference in volts
0.12	0.60
0.45	0.90

What can she conclude about the effect of changing the current on the resistance of the diode?
Justify your answer. You may use calculations.

.....

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..... **[3]**

(c) Sally's friends talk about her experiment.

(i) Who suggests an explanation for Sally's results?

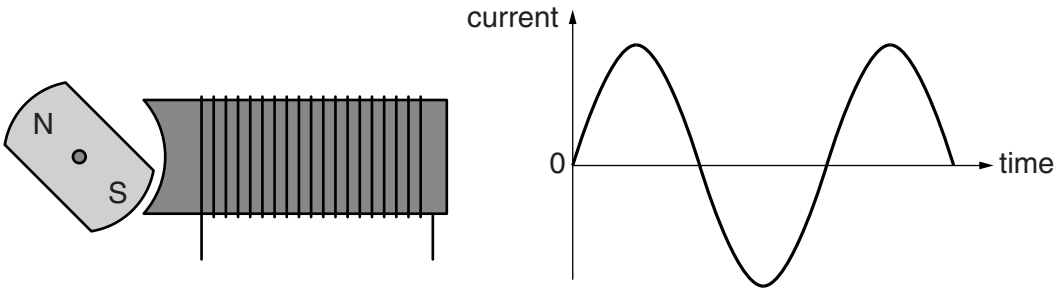
answer ..... **[1]**

(ii) Who talks about improving Sally's experiment?

answer ..... **[1]**

[Total: 7]

7 Here is a generator of alternating current.



Explain the shape of the graph. You may add labels to the diagram.

The quality of written communication will be assessed in your answer.

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..... **[6]**

[Total: 6]

8 Jack and Jill do an experiment with balloons.

Complete the sentences by putting a (ring) around the correct choices in **bold**.

Jack rubs a red balloon on the cloth of his shirt. This charges the balloon.

This is because particles called **atoms / electrons** transfer from the cloth to the red balloon.

This means that the red balloon has a **negative / positive / zero** charge.

The balloon keeps its charge so it must be

a conductor / an insulator / a transformer.

Jill rubs the blue balloon on her hair. The blue balloon is now repelled by the red balloon. This means that they have **different / the same** types of charge. **[2]**

[Total: 2]

9 Use straight lines to link each **part** of an electric motor to its **function**.

part	function
	stops the motor spinning around too fast
magnet	provides a steady field to push the current-carrying coil
commutator	changes the strength of the magnetic field
	makes the current switch direction in the coil

[2]

[Total: 2]

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Question 10 begins on page 16

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10 Dystrophin is a protein found in healthy muscle cells.

The code for dystrophin is found in the DNA of the muscle cells.

(a) Part of the DNA sequence that codes for dystrophin is shown below.

A	**A**	**C**	**G**	**A**	**T**	**T**	**C**	**G**

Write the sequence of bases that would be found on the other strand of this piece of DNA.

[1]

(b) Actin is another protein found in muscle cells.

Dystrophin is a completely different protein from actin.

Put ticks (✓) in the boxes next to the **two** correct explanations for how the same cell can make these two different proteins.

Dystrophin is made in the nucleus and actin is made in the cytoplasm. ☐

The sequences of bases in the genes for actin and dystrophin are different. ☐

The base pairing is different in the genes for actin and myosin. ☐

A cell can combine amino acids in different sequences. ☐

Only the synthesis of actin involves messenger RNA. ☐

[2]

(c) People who cannot make dystrophin in their muscle cells have the condition called Duchenne muscular dystrophy (DMD).

DMD is a fatal disease.

(i) The incidence of DMD is 1 in 3500 births.

Calculate how many new cases of DMD are likely in England in a year when there are 700 000 births.

answer = ... **[1]**

(ii) Doctor Baker wants to study DMD.

Doctor Smith wants to study the common cold.

They are both applying for money for their studies.

Suggest how each doctor might justify their application.

Doctor Baker .....

.....

Doctor Smith .....

..... **[2]**

[Total: 6]

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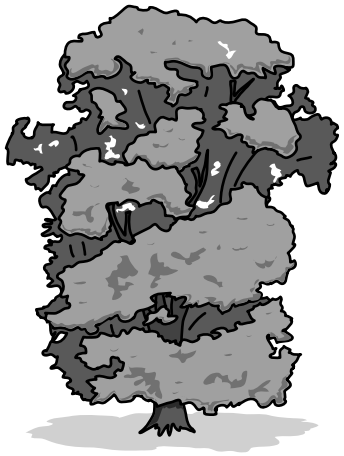
11 Dutch elm disease has killed many elm trees in England.



Some elms are resistant to the disease.

Park keepers want to plant resistant elm trees to replace ones that have been killed.

They decide to use cuttings from the resistant elms, rather than using seeds.

Describe the process of using cuttings, and explain why they choose this method.

The quality of written communication will be assessed in your answer.

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..... **[6]**

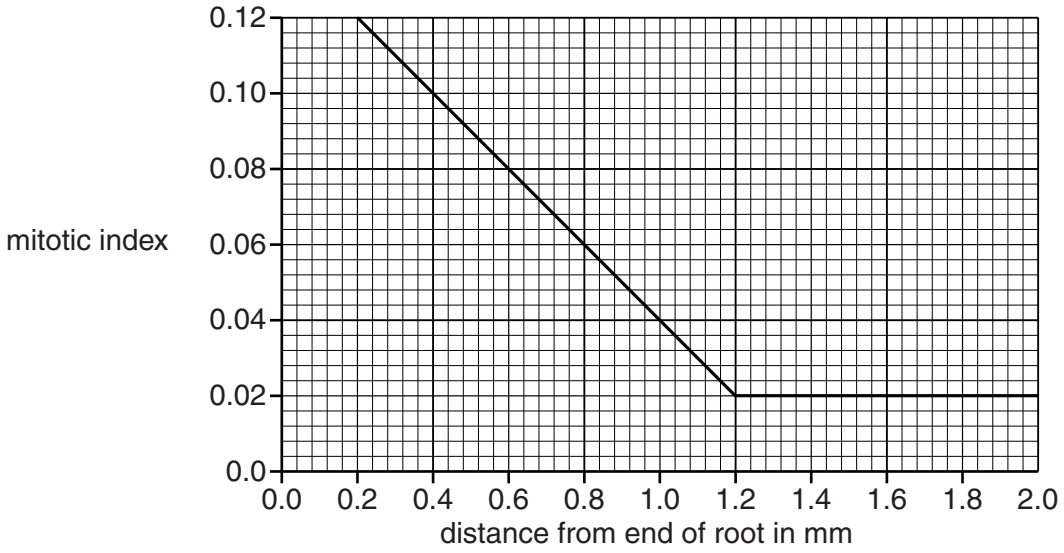
[Total: 6]

12 (a) Gary studies mitosis in a plant root under his microscope.

He calculates the mitotic index using this equation.

$$\text{mitotic index} = \frac{\text{number of cells showing mitosis}}{\text{total number of cells in view}}$$

Gary plots the mitotic index at different distances from the end of the root.



(i) Gary looks at a section taken 1.9 mm from the end of the root.

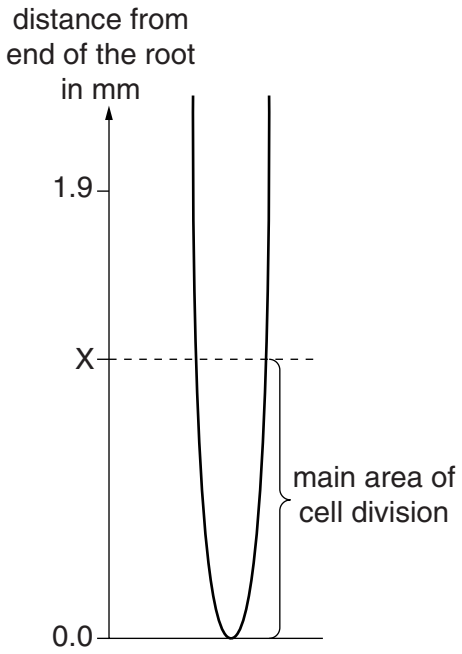
He sees 200 cells.

How many of these cells show mitosis?

answer = ... **[2]**

(ii) The diagram shows the end of the root that Gary has been looking at.

The diagram has **not** been drawn to scale.



Use Gary's **graph** to determine the distance from the tip of the root to point X on the diagram.

answer from graph = ... **[1]**

(b) Root cells divide by mitosis.

This is only part of the cell cycle. There is also a period of cell growth.

Compare what happens to the chromosomes during mitosis and during cell growth.

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.....

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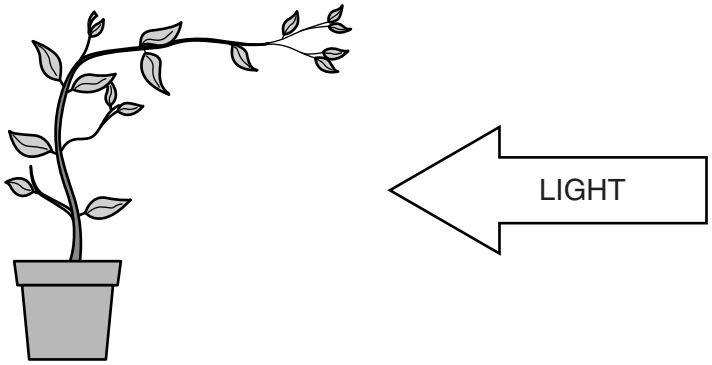
..... **[1]**

(c) Roots growing downwards is one example of plants being affected by the environment.

Another example is phototropism.

Gary grows a seedling with a strong light source on one side.



The shoot grows towards the light.

Which two statements, when taken together, explain this observation?

Put ticks (✓) in the boxes next to the **two** correct answers.

Leaves on the light side photosynthesise more.	☐
More auxin moves to the shaded side of the shoot.	☐
More auxin is made on the light side of the shoot.	☐
The side of the shoot with most auxin grows more.	☐
The side of the shoot with most auxin gets shorter.	☐
Auxin makes no difference to the growth of the shoot.	☐
Auxin absorbs more light on the light side of the shoot.	☐

[2]

[Total: 6]

13 Adult stem cells have been used to grow a new windpipe for a woman whose windpipe was damaged by disease.

Which properties of adult stem cells made this possible?

Put ticks (✓) in the boxes next to the **two** correct answers.

Adult stem cells can become specialised to make specific tissues.	☐
Adult stem cells become specialised by developing new genes.	☐
Adult stem cells can grow to form any tissue.	☐
Adult stem cells are unspecialised.	☐
Adult stem cells have more chromosomes than specialised cells.	☐
Adult stem cells are produced by meiosis.	☐

[2]

[Total: 2]

END OF QUESTION PAPER

The Periodic Table of the Elements

1	2											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
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
[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						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

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