

GENERAL CERTIFICATE OF SECONDARY EDUCATION
TWENTY FIRST CENTURY SCIENCE
ADDITIONAL SCIENCE A

Unit 3: Modules B6 C6 P6
 (Higher Tier)

A217/02



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)

Friday 19 June 2009
Morning

Duration: 40 minutes



Candidate Forename						Candidate Surname					
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Centre Number							Candidate Number				
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MODIFIED LANGUAGE

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **42**.
- A list of physics equations is printed on page 2.
- The Periodic Table is printed on the back page.
- This document consists of **20** pages. Any blank pages are indicated.

TWENTY FIRST CENTURY SCIENCE EQUATIONS

Useful Relationships

Explaining Motion

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

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{change of momentum} = \text{resultant force} \times \text{time for which it acts}$$

$$\text{work done by a force} = \text{force} \times \text{distance moved by the force}$$

$$\text{change in energy} = \text{work done}$$

$$\text{change in GPE} = \text{weight} \times \text{vertical height difference}$$

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

Electric Circuits

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

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

$$\text{energy transferred} = \text{power} \times \text{time}$$

$$\text{power} = \text{potential difference} \times \text{current}$$

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

The Wave Model of Radiation

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

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Question 1 starts on page 4.

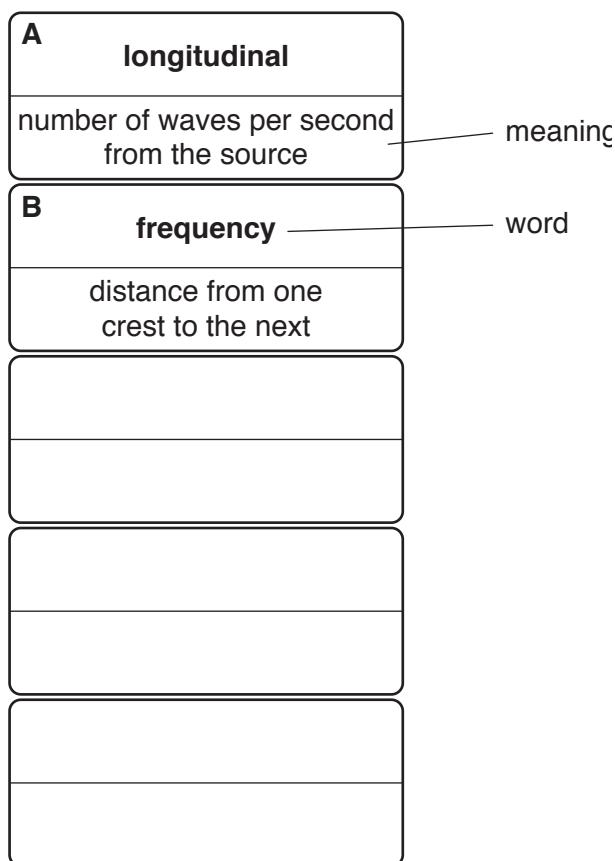
PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

- 1 (a) Micky plays dominoes in a lesson about waves.

Each domino has a **word** at the top and a **meaning** at the bottom. The meaning explains the word at the top of the next domino.

Each word must be placed below its correct meaning, as shown below.



Here are the other three dominoes.

C	amplitude	D	wavelength	E	speed
	how far a wave goes in a second		height of a crest		energy flow parallel to wave disturbance

Write **C**, **D** or **E** in each blank domino so that each word is below its correct meaning. You may fill in the blank dominoes if it helps you work out the answers.

[2]

(b) Which one of these actions could change the speed of a wave?

Put a tick (✓) in the box next to the correct answer.

change the intensity of the wave

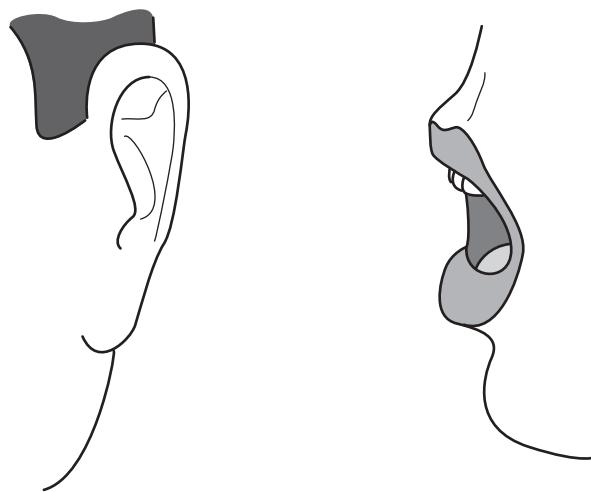
change the amplitude of the wave

change the frequency of the wave source

change the medium that the wave passes through

[1]

(c) Alice talks to Micky about their work.



What do the sound waves transfer from Alice to Micky?

Put a (ring) around the correct answer.

atoms

energy

rays

wavelengths

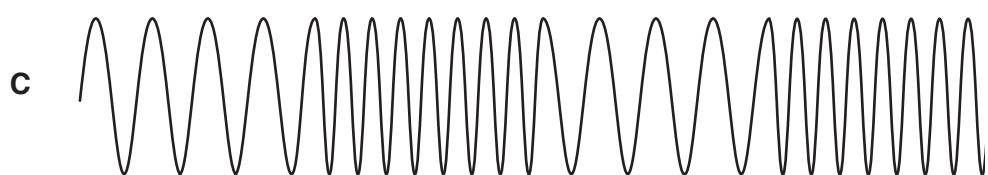
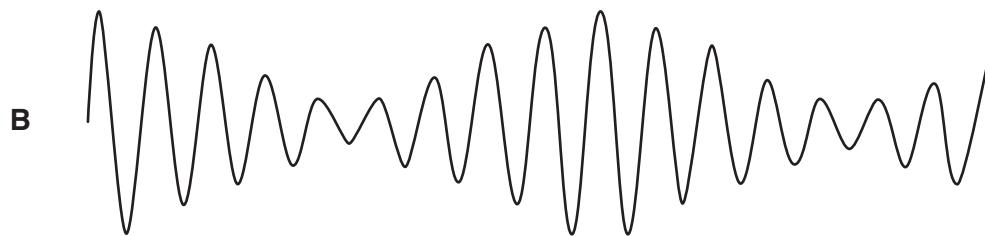
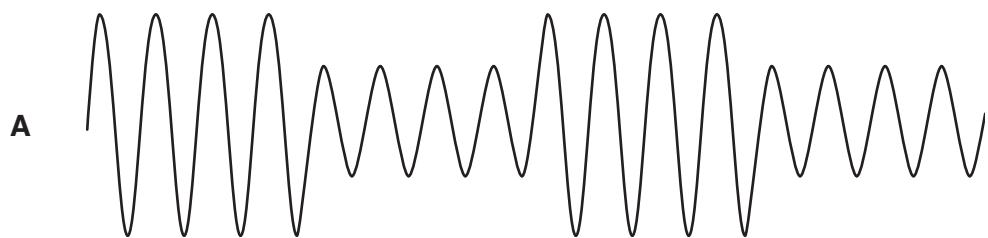
[1]

[Total: 4]

- 2 Jake is a security guard. He uses radio waves to communicate with his boss.



- (a) Here are three wave patterns for the radio waves leaving Jake's radio.



Draw straight lines to match each **wave pattern** with its best **description**.

wave pattern

A

B

C

description

amplitude modulation by a digital signal

frequency modulation by a digital signal

amplitude modulation by an analogue signal

frequency modulation by an analogue signal

[2]

- (b) Jake's radio transmits his voice signal in a digital format.

The sentences explain how the voice signal is sent from Jake to his boss.

They are in the wrong order.

- A The radio wave leaves the transmitter.
- B The radio wave is absorbed by the receiver.
- C The pattern of digital information is recovered.
- D The information and noise signals are amplified.
- E The voice signal is modulated onto the radio wave.
- F The voice signal is recreated from the digital pattern.
- G The intensity of the wave decreases and it picks up noise as it travels.

Fill in the boxes to show the correct order.

The first and last have been done for you.

E						F
---	--	--	--	--	--	---

[2]

- (c) What is the **advantage** of sending Jake's voice signal in a digital format?

Put a tick (✓) in the box next to the **best** answer.

It is easier to switch a wave on and off than to alter its amplitude.

The information is sent as a pattern of two values called 1 and 0.

Digital circuits are much more complicated than analogue ones.

The digital pattern can be recognised even when noise has been added to the wave.

[1]

[Total: 5]

- 3 Ben hurts his foot playing football. The hospital takes an X-ray image of his foot to see if any bones are broken.



- (a) Ben asks his friends why X-rays can be used to make an image of his bones.



Who has the correct idea?

answer [1]

- (b) Ben knows that exposure to X-rays can be dangerous.
This is because X-ray photons carry a lot of energy and can damage cells.

Why do X-ray photons carry a lot of energy?

Put a tick (✓) in the box next to the correct reason.

X-rays have a very high speed.

X-rays have a very big amplitude.

X-rays have a very high frequency.

X-rays have a very big wavelength.

[1]

- (c) The hospital is concerned for Ben's safety.

The hospital measures the intensity of the X-rays before making an image of his bones.

Complete this equation for intensity. Choose words from this list.

energy per photon

energy per second

frequency per wavelength

photons per metre

photons per second

$$\boxed{\text{intensity of X-ray beam}} = \boxed{\quad} = \boxed{\quad} \times \boxed{\quad}$$

[2]

- (d) X-rays are part of the electromagnetic spectrum.

So are ultraviolet waves.

Draw straight lines to link the **start** of each sentence with its correct **end**.

start

end

... speed.

X-rays and ultraviolet waves in empty space always have the same ...

... amplitude.

X-rays and ultraviolet waves always have different values for their ...

... wavelength.

[1]

[Total: 5]

10

- 4 Sam is ironing and accidentally touches the hot plate of the iron.

He pulls his hand away very quickly.

- (a) Which sentences describe his reaction?

Put a tick (✓) in the box next to each of the correct phrases.

His response is ...

- | | |
|---------------------------|--------------------------|
| ... learned. | <input type="checkbox"/> |
| ... deliberate. | <input type="checkbox"/> |
| ... involuntary. | <input type="checkbox"/> |
| ... a simple reflex. | <input type="checkbox"/> |
| ... a conditioned reflex. | <input type="checkbox"/> |

[1]

- (b) Which parts of the nervous system are involved in Sam's reaction?

Put a (ring) around **each** correct part.

- brain
consciousness
intelligence
memory
motor neuron
sensory neuron
spinal cord
synapse

[2]

- (c) Later, Sam prepares a meal. He picks up a hot dish but does **not** drop it.

Why is his response different?

Put a tick (✓) in the box next to the **best** answer.

The receptors in his hand have become less sensitive.

His brain has modified his reflex response.

The smell of the food is a secondary stimulus.

His brain does not have conscious control of his response.

[1]

[Total: 4]

- 5 Animals such as woodlice respond to changes in their environment.



This process follows a series of steps.

- (a) Complete the sentences to explain these steps.

Choose words from the list.

an action	an effector	a hormone
a motor neuron	a receptor	
a sensory neuron	a stimulus	a synapse

The change in the environment is

The change is detected by

Information is carried to the central nervous system by

Information is carried from the central nervous system by

The response is carried out by

[4]

- (b) Receptors and effectors can be found in complex organs.

Draw lines to join each **type of cell** to the **organ** where it is found.

Draw lines to show whether each **type of cell** is an **effector or receptor**.

organ	type of cell	effector or receptor
gland	light sensitive cell	receptor
muscle	hormone secreting cell	effector
eye	muscle cell	

[2]

[Total: 6]
Turn over

6 Scientists have studied the brain and its functions by a variety of methods.

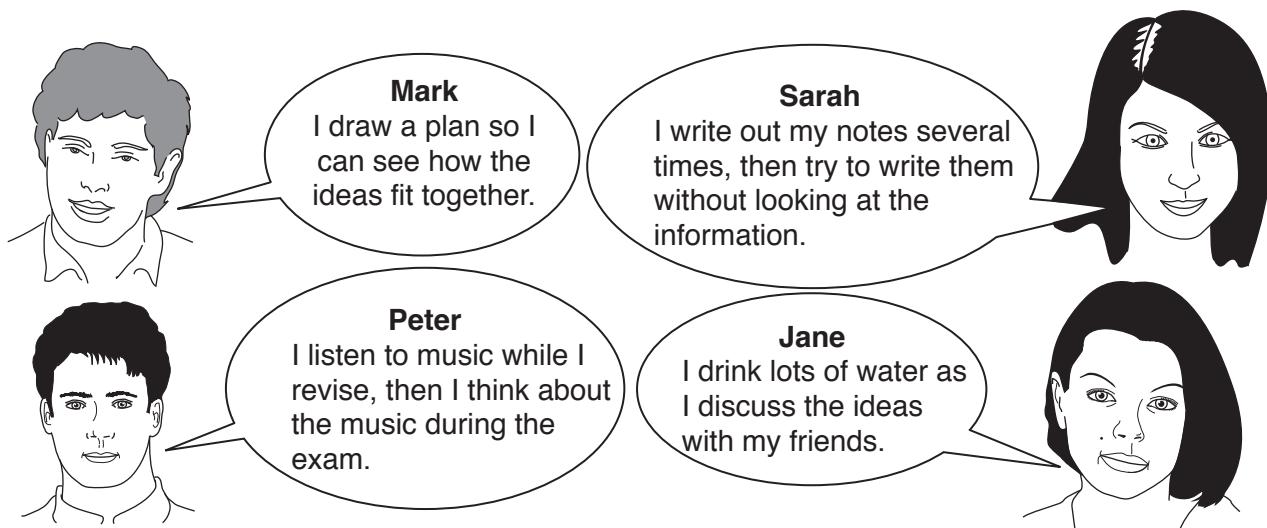
(a) Which of these methods, **A**, **B**, **C** or **D**, requires physical contact with the brain?

- A** MRI scans of the brain
- B** X-ray photographs of the brain
- C** electrical stimulation of the brain
- D** interviews of patients with brain damage

method [1]

(b) Four friends are revising for their exams.

They talk about the methods they use.



(i) Who is remembering by repetition?

answer [1]

(ii) Who is using a stimulus to help them remember?

answer [1]

13

(c) What is memory?

Put a tick (✓) in the box next to each of the **two** phrases that **best** describe memory.

giving information

storing information

inputting information

retrieving information

processing information

[1]

[Total: 4]

- 7 Benzoic acid is added to foods as a preservative.

Benzoic acid forms solid crystals which must be purified before the acid is used.

- (a) The table shows different methods of purifying chemicals, and information about when you would use each method.

Draw lines to link each **method** to the correct piece of **information**.

One has been done for you.

method	information
crystallisation	The solid substance is coated with a solution containing impurities.
evaporation	The impurities are more soluble than the substance.
filtration	The substance is in a very dilute solution.
washing	The impurities do not dissolve.

[2]

15

- (b) Terry does a titration to check the purity of some benzoic acid.

He wants to use an indicator which changes colour when the solution becomes slightly alkaline.

	indicator	pH range for colour change
A	gentian violet	0 to 2
B	methyl red	4 to 6
C	litmus	5 to 8
D	phenolphthalein	8 to 10
E	nitramine	11 to 13

- (i) Which indicator, **A**, **B**, **C**, **D**, or **E**, should he use?

answer [1]

- (ii) Terry does the titration five times.

He writes down his titration results.

titration number	1	2	3	4	5
volume of alkali in cm ³	25.9	25.1	25.0	25.0	25.0

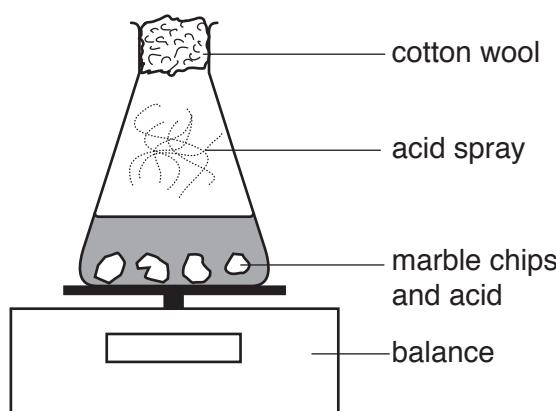
Put a tick (✓) in the box next to the result that he should use for his calculations.

- | | |
|------|--------------------------|
| 25.0 | <input type="checkbox"/> |
| 25.1 | <input type="checkbox"/> |
| 25.2 | <input type="checkbox"/> |
| 25.9 | <input type="checkbox"/> |

[1]

[Total: 4]

- 8 Bobby reacts marble chips (calcium carbonate) with acid. He uses an excess of marble chips. He measures the change in mass as the acid reacts.



- (a) Bobby uses sulfuric acid, but he finds the reaction stops almost immediately.

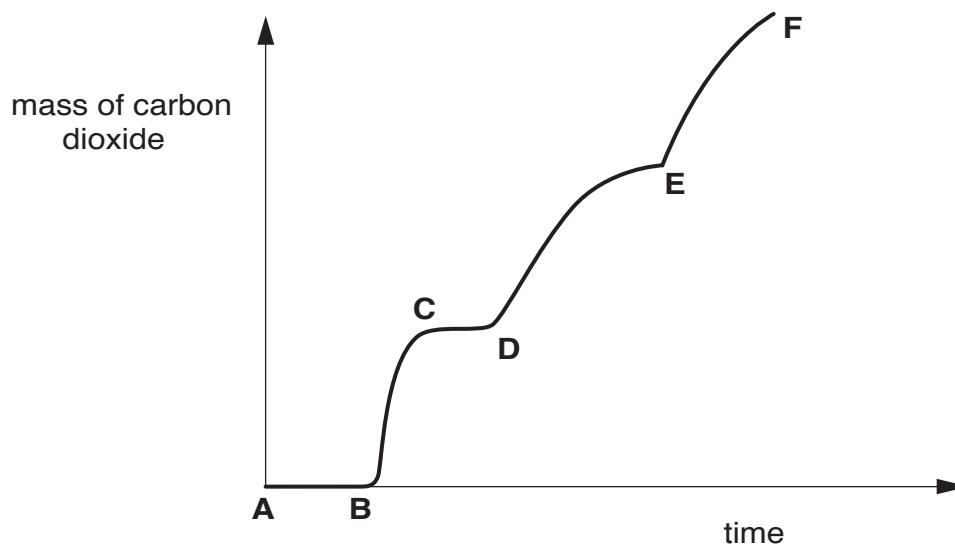
This is because the calcium carbonate becomes covered with a layer of an insoluble salt.

What is the name of the salt?

..... [1]

- (b) Bobby repeats the experiment using hydrochloric acid instead of sulfuric acid.

He starts the reaction by adding some acid. Bobby twice adds more acid part way through. One of these times he lets the reaction stop before he adds the extra acid.



- (i) On the list below, put a **ring** around the letters which show places where acid was added.

One has been ringed for you.

A **B** C D E F

[1]

17

- (ii) Put a tick (✓) in the box next to the region of the graph where the reaction stops.

B to C	<input type="checkbox"/>
C to D	<input type="checkbox"/>
D to E	<input type="checkbox"/>
E to F	<input type="checkbox"/>

[1]

- (c) Susan tells Bobby that he can calculate the mass of carbon dioxide produced using relative formula masses and the equation for the reaction.

Relative atomic masses H=1, C=12, O=16, Cl=35.5, Ca=40

- (i) Put a ring around the relative formula mass of CO_2 .

12 16 32 40 44 56

[1]

- (ii) Calculate the relative formula mass of CaCO_3 .

answer [1]

- (iii) Calcium carbonate reacts with hydrochloric acid to form calcium chloride, carbon dioxide and water.

Complete and balance the equation for the reaction.



[2]

- (d) Bobby does two more experiments.

First, he reacts marble chips with dilute hydrochloric acid. The reaction takes 15 minutes to complete.

Then he repeats this experiment exactly as before, but with concentrated hydrochloric acid. The reaction takes 10 minutes to complete.

Here are some statements about the reaction with concentrated hydrochloric acid.

- A The acid particles move faster.
- B Particles collide more frequently.
- C More gas is produced at each collision.
- D Particles collide with the same average energy.
- E The calcium carbonate has more surface area.
- F Acid particles are closer together in the solution.
- G Particles are closer together in the acid and in the calcium carbonate.

(i) Put a tick (✓) in the box next to each correct statement. [2]

(ii) Which **two** statements make an explanation of why the reaction goes quicker?

statements and [1]

[Total: 10]

END OF QUESTION PAPER

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The Periodic Table of the Elements

1	2	Key									
7	9	relative atomic mass									
Li	Be	atomic symbol									
lithium	beryllium	name									
3	4	atomic (proton) number									
23	24										
Na	Mg										
sodium	magnesium										
11	12										
39	40										
K	Ca										
potassium	calcium										
19	20										
85	88										
Rb	Sr										
rubidium	strontium										
37	38										
133	137										
Cs	Ba										
cesium	barium										
55	56										
[223]	[226]										
Fr	Ra										
francium	radium										
87	88										

3	4	5	6	7	0	1	2	4	5	6	7	0
11	12	C	14	16	19	20	21	He	Ne	Ar	Kr	Xe
B	carbon	nitrogen	oxygen	fluorine	neon	argon	helium	hydrogen	neon	argon	helium	helium
5	6	7	8	9	10	11	12	1	2	3	4	5
27	28	P	31	S	35.5	40	27	28	29	30	31	32
Al	silicon	phosphorus	15	sulfur	16	17	Ge	As	Se	Br	Te	Te
13	14	15	16	17	18	19	32	33	34	35	36	37
70	Ga	gallium	31	Zn	30	31	73	75	79	80	84	85
65	Cu	copper	29	Zn	30	31	Ge	As	Se	Br	Kr	Xe
59	Ni	nickel	28	Ge	32	33	75	79	79	80	84	85
56	Co	cobalt	27	Sn	32	33	73	75	79	80	84	85
55	Mn	manganese	25	In	49	50	115	122	128	127	131	132
54	Cr	chromium	24	Cd	48	49	119	122	128	127	131	132
53	V	vanadium	23	Pd	46	47	108	112	122	127	131	132
52	Ti	titanium	22	Ir	45	46	103	108	112	127	131	132
51	Sc	scandium	21	Os	44	45	101	103	108	127	131	132
50	Ca	calcium	20	Re	42	43	98	96	108	127	131	132
49	Nb	niobium	41	Ru	41	42	93	96	108	127	131	132
48	Zr	zirconium	40	Rh	40	41	98	96	108	127	131	132
47	Y	yttrium	39	Ru	39	40	93	96	108	127	131	132
46	Ta	tautium	73	Rh	73	74	101	103	108	127	131	132
45	Hf	hafnium	72	Ir	72	73	103	108	112	127	131	132
44	Os	osmium	76	Pt	76	77	192	195	197	201	209	210
43	Re	rhenium	75	Ir	75	76	190	192	195	201	209	210
42	W	tungsten	74	Os	76	77	186	188	190	192	195	201
41	Ta	tautium	73	Re	75	76	181	184	186	188	190	192
40	Zr	zirconium	40	Ta	73	74	178	181	184	188	190	192
39	La*	lanthanum	57	Hf	72	73	139	178	181	184	186	188
38	Ba	barium	56	La*	57	58	137	178	181	184	186	188
37	Rb	rubidium	38	La*	57	58	137	178	181	184	186	188
36	Sc	cesium	55	La*	57	58	137	178	181	184	186	188
35	Cs	cesium	55	La*	57	58	137	178	181	184	186	188
34	Fr	francium	87	La*	57	58	137	178	181	184	186	188
33	Ra	radium	88	La*	57	58	137	178	181	184	186	188
32	Ra	radium	88	La*	57	58	137	178	181	184	186	188
31	Ra	radium	88	La*	57	58	137	178	181	184	186	188
30	Ra	radium	88	La*	57	58	137	178	181	184	186	188
29	Ra	radium	88	La*	57	58	137	178	181	184	186	188
28	Ra	radium	88	La*	57	58	137	178	181	184	186	188
27	Ra	radium	88	La*	57	58	137	178	181	184	186	188
26	Ra	radium	88	La*	57	58	137	178	181	184	186	188
25	Ra	radium	88	La*	57	58	137	178	181	184	186	188
24	Mg	magnesium	12	La*	57	58	137	178	181	184	186	188
23	Na	sodium	11	La*	57	58	137	178	181	184	186	188
22	Ca	calcium	20	La*	57	58	137	178	181	184	186	188
21	Sc	scandium	21	La*	57	58	137	178	181	184	186	188
20	K	potassium	19	La*	57	58	137	178	181	184	186	188
19	Rb	rubidium	37	La*	57	58	137	178	181	184	186	188
18	Fr	francium	87	La*	57	58	137	178	181	184	186	188
17	Fr	francium	87	La*	57	58	137	178	181	184	186	188
16	Fr	francium	87	La*	57	58	137	178	181	184	186	188
15	Fr	francium	87	La*	57	58	137	178	181	184	186	188
14	Fr	francium	87	La*	57	58	137	178	181	184	186	188
13	Fr	francium	87	La*	57	58	137	178	181	184	186	188
12	Fr	francium	87	La*	57	58	137	178	181	184	186	188
11	Fr	francium	87	La*	57	58	137	178	181	184	186	188
10	Fr	francium	87	La*	57	58	137	178	181	184	186	188
9	Fr	francium	87	La*	57	58	137	178	181	184	186	188
8	Fr	francium	87	La*	57	58	137	178	181	184	186	188
7	Fr	francium	87	La*	57	58	137	178	181	184	186	188
6	Fr	francium	87	La*	57	58	137	178	181	184	186	188
5	Fr	francium	87	La*	57	58	137	178	181	184	186	188
4	He	helium	2	La*	57	58	137	178	181	184	186	188
3	Fr	francium	87	La*	57	58	137	178	181	184	186	188
2	Fr	francium	87	La*	57	58	137	178	181	184	186	188
1	Fr	francium	87	La*	57	58	137	178	181	184	186	188
0	Fr	francium	87	La*	57	58	137	178	181	184	186	188

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

* 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.