# OCR
RECOGNISING ACHIEVEMENT

**H**

## GENERAL CERTIFICATE OF SECONDARY EDUCATION
## TWENTY FIRST CENTURY SCIENCE
## ADDITIONAL SCIENCE A
Unit 3: Modules B6 C6 P6 (Higher Tier)

**A217/02**

| 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. Pencil may be used for graphs and diagrams only.
* 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).
* Answer **all** the questions.
* Do **not** write in the bar codes.

## 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.

**Turn over**

# TWENTY FIRST CENTURY SCIENCE EQUATIONS

## Useful Relationships

### Explaining Motion

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

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

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

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

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

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

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

### Electric Circuits

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

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

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

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

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

### The Wave Model of Radiation

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

**3**

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**Question 1 starts on page 4**

**PLEASE DO NOT WRITE ON THIS PAGE**

**4**

Answer **all** the questions.

**1** Isaac knows that light is made of waves.

**(a)** Draw a straight line to link the **start** of each sentence about light to its correct **end**.

**start**

| The energy of a light wave … |

| The amplitude of a light wave … |

| The wavelength of a light wave … |

**end**

| … decreases with increasing speed. |

| … is transferred by the transfer of matter. |

| … is the maximum value of its disturbance. |

| … is transferred without the transfer of matter |

| … is the distance from a crest to the next crest. |

| … is the distance from a crest to the next trough. |

**[2]**

**(b)** Isaac shines a beam of white light at a glass prism.
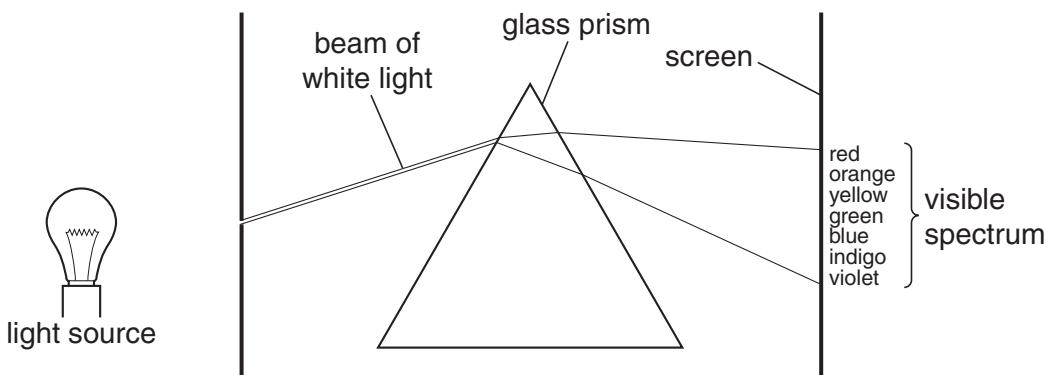


Isaac notices the spectrum of coloured light on the screen.

He uses the idea of photons to explain it.

Complete the sentences. Choose words from this list.

**absorbs        amplitude        diffracts        emits**

**reflects        refracts        shape        wavelength**

The light source continually …………………… a large number of different photons.

The prism …………………… each photon by an amount that depends on its …………………… .

The screen …………………… these photons into Isaac's eyes so that he can see their colour.

**[3]**

**(c)** Here are some possible equations for calculating the intensity of the light arriving at a point on the screen.
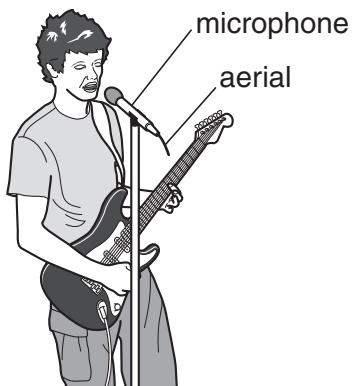
Which equation, **A**, **B**, **C** or **D**, is correct?

**A**    intensity = photon energy × photon rate

**B**    intensity = photon power × photon speed

**C**    intensity = photon speed × photon frequency

**D**    intensity = photon amplitude × photon wavelength

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

**[Total: 6]**

**Turn over**

**2** Paul uses a radio microphone to record a song.

microphone
aerial

**(a)** The microphone aerial emits an amplitude modulated radio wave.

radio wave

time
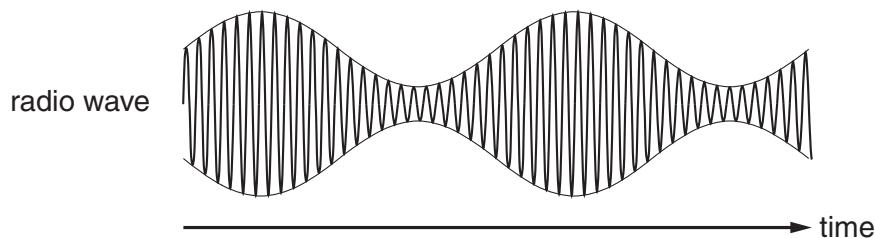
Draw **in the space below** what a radio wave would look like if **frequency modulation** were used instead.

**[1]**

**(b)** Paul is not pleased with the quality of sound from the radio microphone.

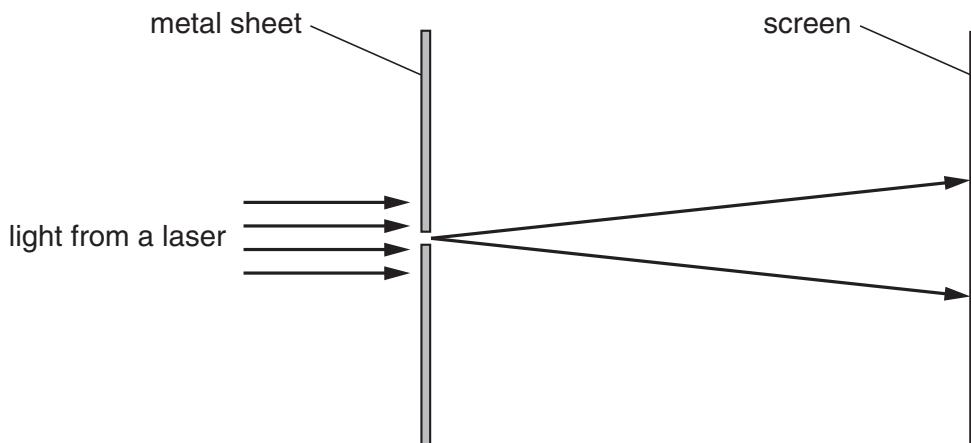He decides to use a microphone that sends the sound by **digital transmission**.

Explain how digital transmission improves the quality of the sound.

...................................................................................................................................................

...................................................................................................................................................

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.......................................................................................................................... **[3]**
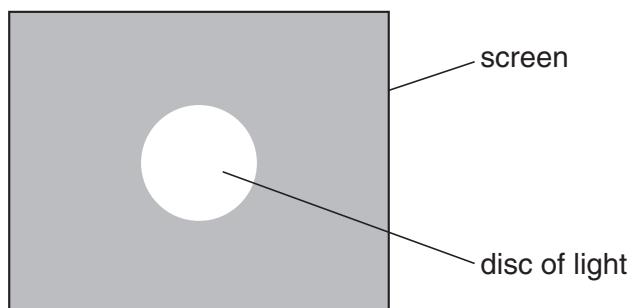
**[Total: 4]**

**3** Thomas passes light from a laser through a small hole in a metal sheet.



**(a)** Thomas sees a disc of light when he looks at the screen.



The disc is much larger than the hole.

Light that passes through the hole spreads out before it hits the screen.

**(i)** What is the name of this effect?

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

**(ii)** What does this observation suggest about light?

Put a tick (✓) in the box next to each of the **two** correct explanations.

Light has a wave nature. ☐

Light is a longitudinal wave. ☐
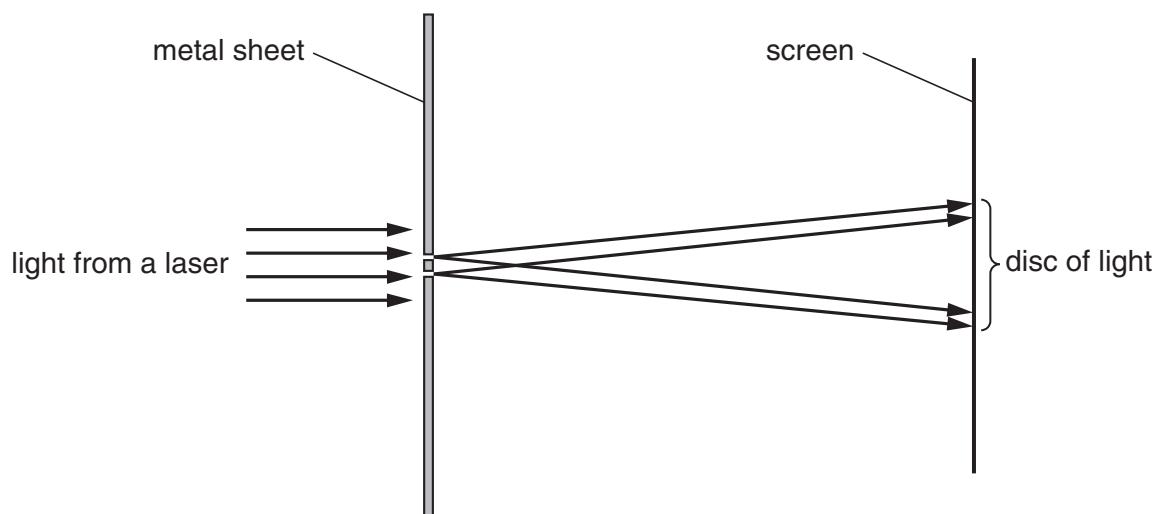
Light from the source has only one wavelength. ☐

The size of the hole is similar to the wavelength of the light. ☐

Photons carry the energy of the light from the source to the screen. ☐

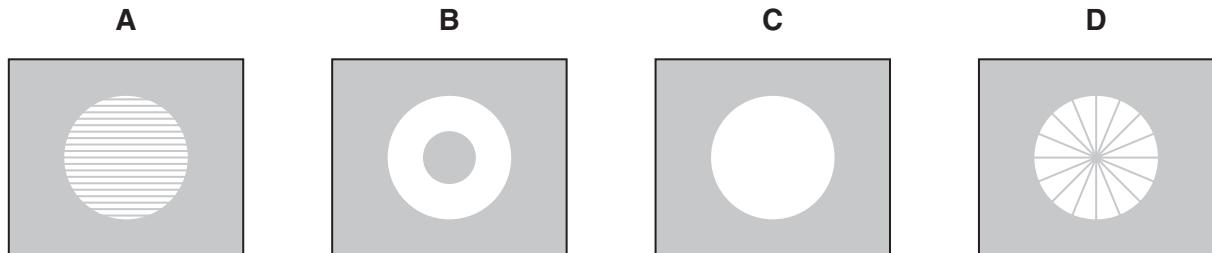The amplitude of the light is much smaller than the size of the pinhole. ☐

**[2]**

**(b)** Thomas makes a second hole in the metal sheet just above the first hole.



Thomas looks at the screen for an interference pattern.
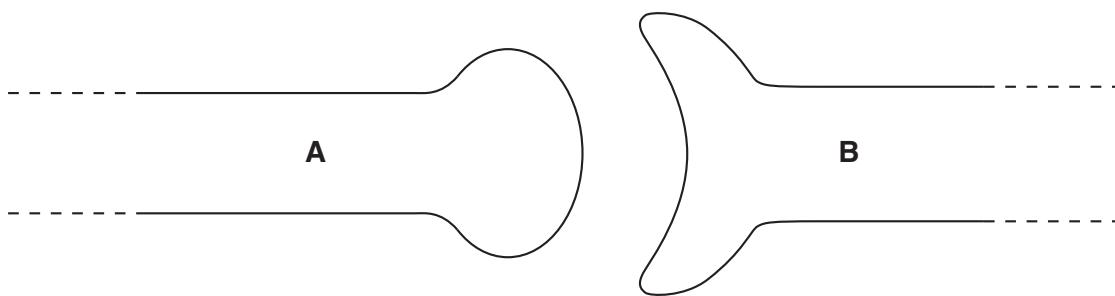
Here are four possible patterns.

| A | B | C | D |
|---|---|---|---|



Which pattern, **A**, **B**, **C** or **D**, will Thomas see?

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

**[Total: 4]**

**4** The diagram shows the synapse between neuron **A** and neuron **B**.



**(a)** Explain how the release of a chemical from neuron **A** can lead to an electrical impulse in neuron **B**.

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

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

**(b)** Serotonin is a chemical found in some synapses in the brain.

The drug Ecstasy alters the concentration of serotonin.

Draw **one** line to join the correct **effect of Ecstasy** with the correct **consequence**.

**effect of Ecstasy**                                     **consequence**

| increases serotonin release from neuron **A** | | reduces serotonin concentration in synapse |
|---|---|---|
| reduces serotonin removal by neuron **A** | | reduces serotonin concentration in neuron **B** |
| reduces serotonin release from neuron **A** | | increases serotonin concentration in synapse |
| increases serotonin removal by neuron **A** | | increases serotonin concentration in neuron **B** |

**[2]**

**[Total: 5]**

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**Question 5 starts on page 12**

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**Turn over**

**5** This question is about reflexes.

**(a)** Reflexes such as the knee jerk reflex help an animal to survive.

Give **another** example of a reflex response and explain how it helps an animal's chances of survival.

reflex response ..................................................................................................................

............................................................................................................................................

how it helps survival .........................................................................................................

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

**(b)** Barbara is being served dinner in the canteen.

She is handed a hot plate.

Her reflex is to drop it, but she does not.

Complete the sentences to explain why Barbara does not drop the plate.

Use words from this list. You may use each word once, more than once, or not at all.

**involuntary          motor          sensory          voluntary**

In a simple reflex arc the …........………………… neuron transmits impulses to the

spinal cord. To modify this reflex, Barbara's brain transmits impulses through a neuron to

the …........………………… neuron in the reflex arc.

This allows her response to be …........………………… .
**[2]**

**(c)** A conditioned reflex has certain characteristics.

Put a tick (✓) in the box next to each of the **two** correct characteristics.

A secondary stimulus is associated with a primary stimulus. ☐

A stimulus is not needed. ☐

More than one secondary stimulus is used. ☐

The final response has no direct connection to the stimulus. ☐

It does not involve learning. ☐
**[1]**

**(d)** Some brightly coloured caterpillars taste bitter.

Many birds will avoid eating all brightly coloured caterpillars after eating a few of them.

Complete the sentences to explain why. Use words from this list.

<div align="center">

**conditioned**      **modified**      **peripheral**

**primary**      **secondary**      **simple**

</div>

The bitter taste is a ..................................... stimulus.

The bright colour is a ..................................... stimulus.

This is a ..................................... reflex.                                   **[2]**

**[Total: 7]**

**14**

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**6** Colin plays his clarinet in a school concert.
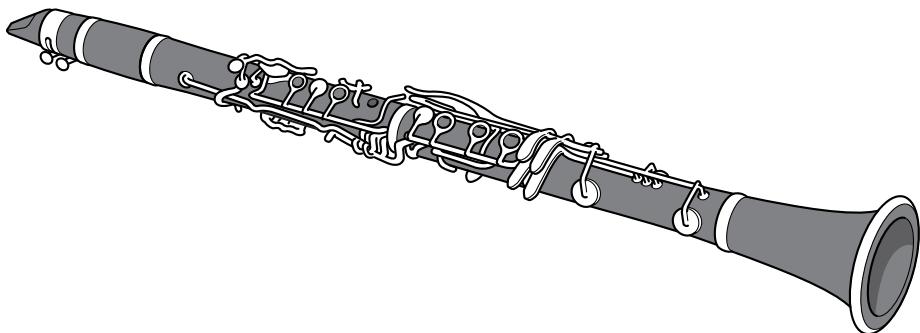
He has to practise playing to be able to perform.

Put ticks (✓) in the boxes next to the **two** statements that best explain what is happening in Colin's brain as he learns some new music.

Repetition causes neuron pathways to wear out. ☐

New experiences cause new neuron pathways to form. ☐

Repetition makes new pathways more likely to transmit impulses. ☐

Repetition makes all new neurons more likely to transmit impulses. ☐

New experiences cause neurons to make bigger electrical impulses. ☐

**[2]**

**[Total: 2]**

**Turn over**

**7** Ann has some solid sodium hydroxide and she wants to know how pure it is.

She weighs out a sample and dissolves it in water to make an alkali solution.

burette

**(a)** Ann carries out an accurate titration to find out how much acid reacts with 25.0 cm³ of the alkali solution.

She puts 25.0 cm³ of the alkali solution into a conical flask.

She then adds a few drops of indicator solution.

She puts the acid into a burette.
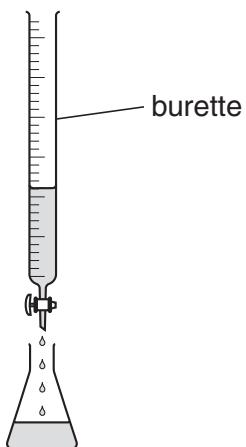
Describe how Ann should carry out the rest of the titration.

Include any measurements that she should make.

.......................................................................................................................................

.......................................................................................................................................

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.......................................................................................................................................

.................................................................................................................................. **[4]**

**(b)** Ann finds that her sodium hydroxide solution reacts with less acid than she expected.

Put a tick (✓) in the box next to the most likely reason for this.

Titration results always vary.  ☐

The acid contained impurities.  ☐

Not all the sodium hydroxide reacts.  ☐
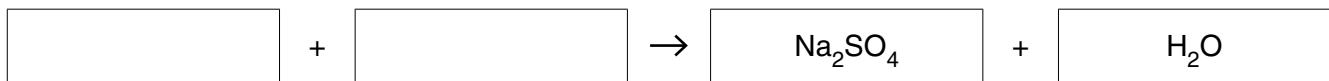
The sodium hydroxide contained impurities.  ☐

**[1]**

(c) Ann writes the equation for her reaction.

(i) The acid she used was sulfuric acid.

The alkali she used was sodium hydroxide.

Write the formula of each chemical in its box, then balance the whole equation.

| | | | | |
|---|---|---|---|---|
| | + | | $\rightarrow$ | $Na_2SO_4$ + $H_2O$ |

**[2]**

(ii) The reaction between any acid and any alkali involves two ions.

Write the equation for this in the empty boxes.

| | | |
|---|---|---|
| | + | $\rightarrow$ |

**[1]**

**[Total: 8]**

**8** Bernie buys stomach powder from his supermarket.

**AMAZING STOMACH POWDER**

Empty into a glass of water and stir.

Drink while it is still fizzing.

The powder contains magnesium carbonate and an acid.

**(a)** Put a ring around the acid that is most likely to be in the powder.

   **citric acid**          **ethanoic acid**          **hydrogen chloride**          **sulfuric acid**

[1]

**(b)** The statements below explain what happens as the powder is added to water.

Put the statements in the correct order. One has been done for you.

   **A**  A gas is produced.

   **B**  The acid dissolves.

   **C**  The carbonate reacts.

   **D**  Hydrogen ions spread through the water.

|  |  |  | A |
|---|---|---|---|

[2]

**(c)** The magnesium carbonate reacts with hydrochloric acid in the stomach to form a salt.

Write down the name of the salt and its formula.

The symbols for the ions are $Mg^{2+}$ and $Cl^-$.

name ..............................................................

formula ..............................................................

[2]

**(d)** What other magnesium compound also reacts with acids?

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

magnesium chloride ☐

magnesium oxide ☐

magnesium sulfate ☐

magnesium nitrate ☐

**[1]**

**[Total: 6]**

**END OF QUESTION PAPER**

# The Periodic Table of the Elements

**Key**

relative atomic mass
**atomic symbol**
name
atomic (proton) number

| 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

*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.