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Monday 14 January 2013 – Morning

GCSE TWENTY FIRST CENTURY SCIENCE ADDITIONAL SCIENCE A

A151/02 Modules B4 C4 P4 (Higher Tier)

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)

Duration: 1 hour

MODIFIED LANGUAGE

* A 1 5 1 0 2 *

* 1 5 1 9 1 2 3 3 4 8 *

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.
- The Periodic Table is printed on the back page.
- The total number of marks for this paper is **60**.
- This document consists of **20** 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

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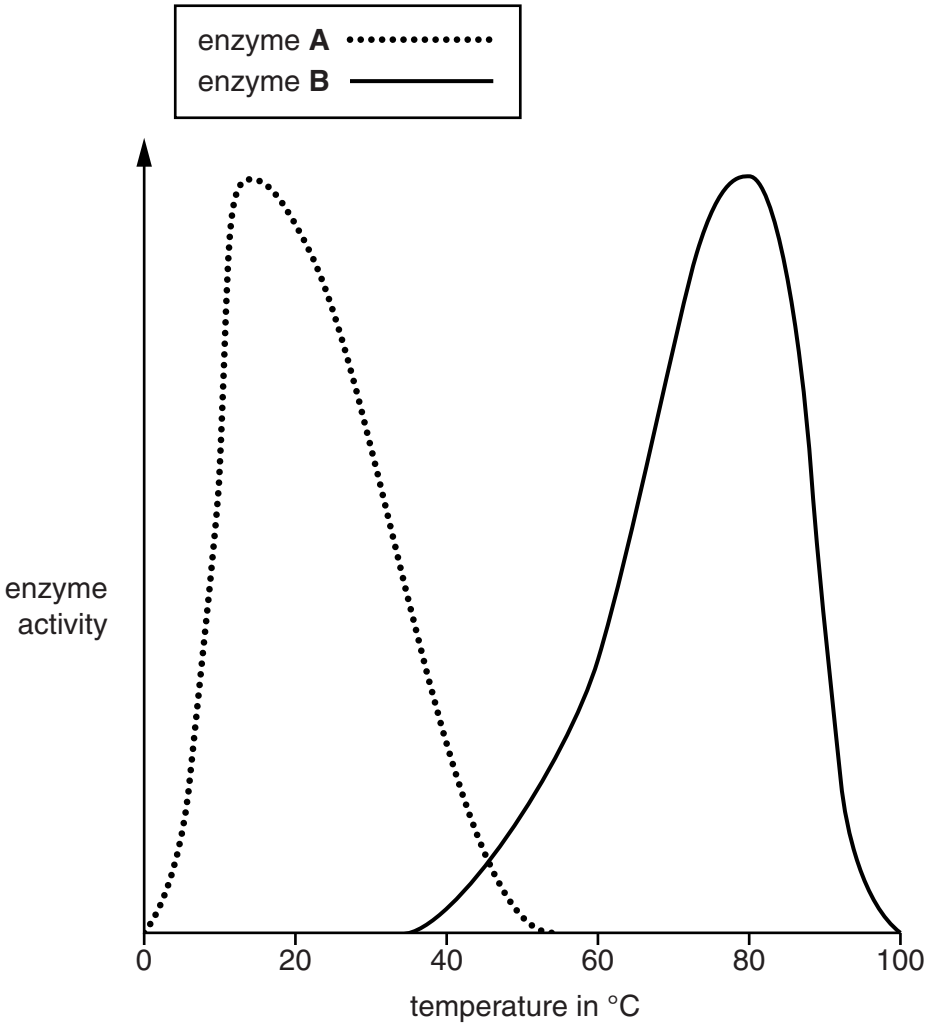
Question 1 begins on page 4

PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

1 Corinne does an experiment using two different enzymes, **A** and **B**.

She records the activity of each enzyme at different temperatures.
She plots her results on a graph.



(a) Both enzymes work on the same chemical.

One of the enzymes is from a bacterium that lives in hot springs at 80 °C. The other enzyme is from a bacterium that lives in the sea at 14 °C.

Corinne concludes that enzyme **A** comes from the bacterium that lives in the sea.

Explain why Corinne's conclusion is correct.

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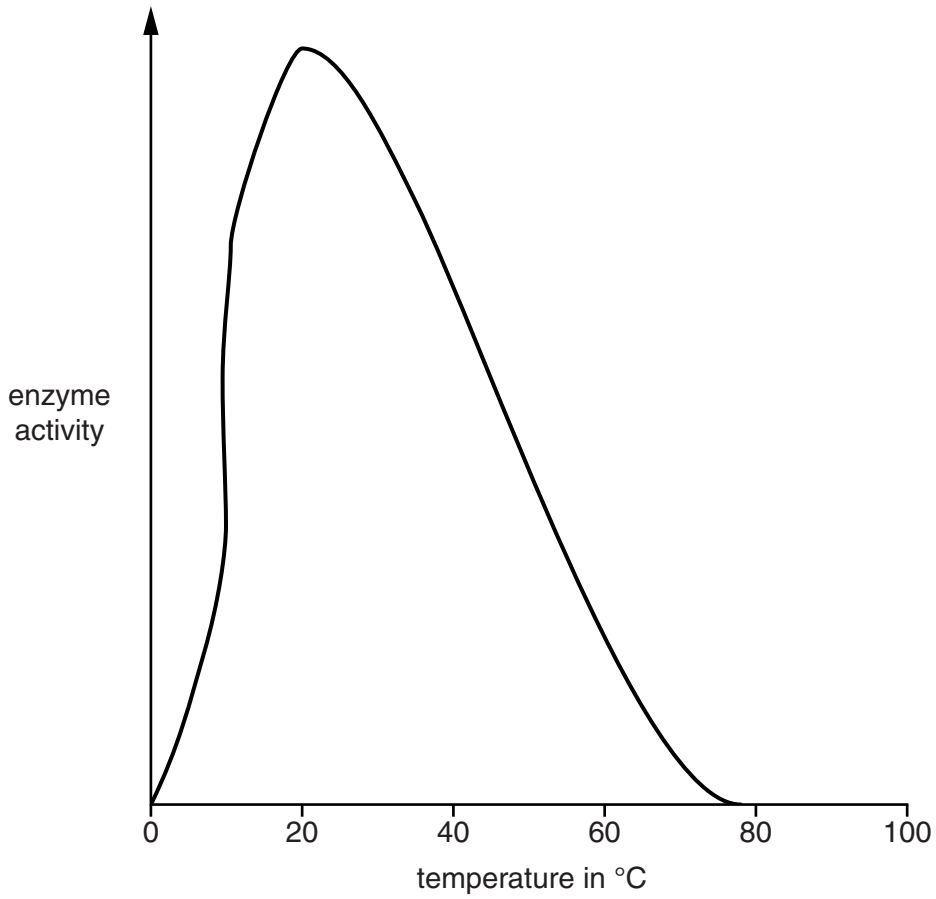
..... **[2]**

(b) Corinne does the same experiment with a different enzyme, **C**.

This enzyme works on the same chemical as enzymes **A** and **B**.

She plots her results on a graph.



After the experiment Corinne extracts and cools enzyme **C**.

She repeats the experiment again with the same sample of enzyme and fresh substrate.

Describe and explain what the graph of enzyme activity will look like.

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

[Total: 4]

2 Wheat plants are grown for food.

Scientists investigate how a wheat plant uses nitrogen.

Nitrogen fertiliser is added to the soil in which the wheat plant grows.

Scientists measure how much of this added nitrogen is present in the soil, roots and seeds over a four week period.

Here are their results.

Time (weeks)	% of nitrogen		
	Soil	Roots	Seeds
1	100	0	0
2	85	15	0
3	80	15	5
4	75	15	10

(a) Describe how the nitrogen gets from the fertiliser into nitrogen-containing molecules in the seeds.

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

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

(b) The soil around the roots of the plant becomes waterlogged.

The way that the root cells release energy from glucose changes.

Complete the sentences.

Waterlogged soil contains less ..... .

The root cells will now start to release energy by the process of .....

..... .

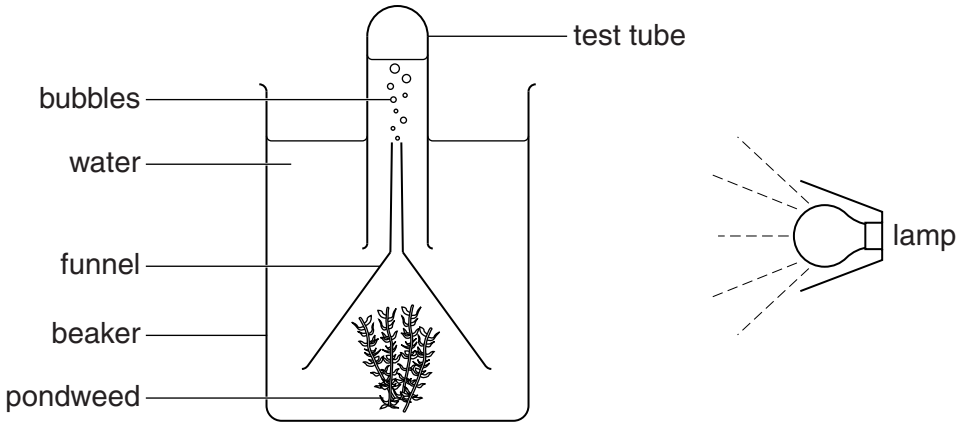
This process also produces ..... and ..... .

[2]

[Total: 8]

Question 3 begins on page 8

3 Anette does an experiment with pondweed.



(a) Write the symbol equation for photosynthesis.

..... + ... → ..... + ...

[1]

(b) Anette changes the distance from the lamp to the pondweed and counts the bubbles produced in 5 minutes. She does this experiment four times at each distance.

During one set of readings she knocks over the lamp, but then puts it back in the same place.

Here are Anette's results.

Distance in cm	Number of bubbles produced in 5 minutes			
	Experiment 1	Experiment 2	Experiment 3	Experiment 4
10	21	21	6	18
15	14	15	15	16
20	11	12	11	14
25	10	8	10	12

Anette looks at her results for the distance of 10 cm.

(i) Using her results, what is the **narrowest range** within which the true value of the number of bubbles lies?

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

(ii) Explain why this is different from the range of results recorded.

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

(c) Anette repeats her experiment using a brighter bulb.

She finds that the most bubbles recorded on any experiment is still 21 bubbles.

Use ideas about photosynthesis to explain why she gets this result.

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

[Total: 5]

Question 4 begins on page 10

4 Ryan investigates osmosis in pieces of raw potato.

He cuts six cylinders of potato, each with the same shape and mass.

He places each potato cylinder in a sugar solution.

Each solution contains the same sugar, but at a different concentration.

After 2 hours, he records the mass of each cylinder and calculates its percentage (%) change in mass.

Here are his results.

Concentration of sugar solution in g/dm^3	**Percentage (%) change in mass of potato cylinder**
0	+7
20	+3
40	+1
60	
80	–4
100	–6

(a) (i) Predict the value for the 60 g/dm^3 sugar solution.

percentage change at 60 g/dm^3 = ... **[1]**

(ii) Suggest the concentration of cell contents.

concentration = ...g/dm^3 **[1]**

(b) Ryan suggests ways to get a better estimate of the concentration of the cell contents.

Put a tick (✓) in the box next to Ryan's best suggestion.

Record the change in mass in g instead of percentage change. ☐

Repeat the experiment using different sizes of potato cylinder. ☐

Repeat the experiment with concentrations greater than 100 g/dm^3 of sugar. ☐

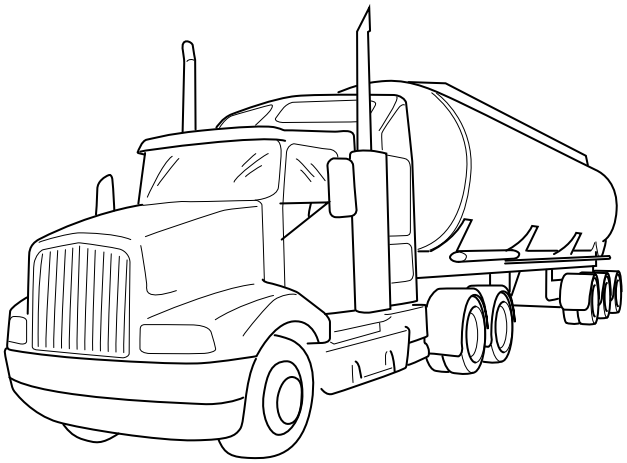
Repeat each concentration and calculate the average percentage change in mass. ☐

Soak the potato in pure water before the experiment. ☐

[1]

[Total: 3]

5 The chemical industry uses large amounts of chlorine.
Some of this chlorine is transported across the country.



(a) The chlorine is carried in steel tanks.
Steel is mainly iron.
The chlorine only reacts with the tank if there is a very hot fire.
At high temperatures chlorine reacts with iron to make small crystals of iron chloride, $FeCl_3$.

(i) Fill in the boxes to balance the equation for this reaction.

$$\square\ Cl_2 + \square\ Fe \rightarrow 2\ FeCl_3$$

[1]

(ii) The equation should also include state symbols.
Put a tick (✓) in the box next to each substance to show its state symbol at room temperature and pressure.

	s	**l**	**g**	**aq**
chlorine				
iron				
iron chloride				

[1]

(b) Here is some information about one atom of chlorine.

atomic (proton) number	17
relative mass of the atom	35

Use this information to work out the number of particles in the atom.

protons .....

neutrons .....

electrons .....

[2]

(c) Describe and explain what happens when a chlorine atom changes into a chloride ion.

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

(d) Chlorine reacts with sodium to make sodium chloride.
The word equation for this reaction is

sodium + chlorine → sodium chloride

Write a balanced symbol equation for this reaction.

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

(e) Sodium chloride forms crystals.
Describe the structure of a sodium chloride crystal.

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

(f) Sodium chloride crystals do not conduct electricity.
Sodium chloride does conduct electricity when it is dissolved in water.
Explain why.

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

[Total: 14]

6 **X**, **Y** and **Z** are three elements in the Periodic Table.

Element	X	Y	Z
atomic (proton) number	less than 12	12	more than 12
melting point in °C	1278	649	839
density in g/cm^3	1.85	1.74	1.54
reaction with water	no reaction	slow	rapid
formula of chloride	XCl_2	YCl_2	ZCl_2
formula of oxide	XO	YO	ZO
melting point of oxide in °C	2550	2852	2554

Jo thinks that **X**, **Y** and **Z** are in the same Group.
Ann thinks that they are not.

Who is right?
Use evidence from the table to support your answer.

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

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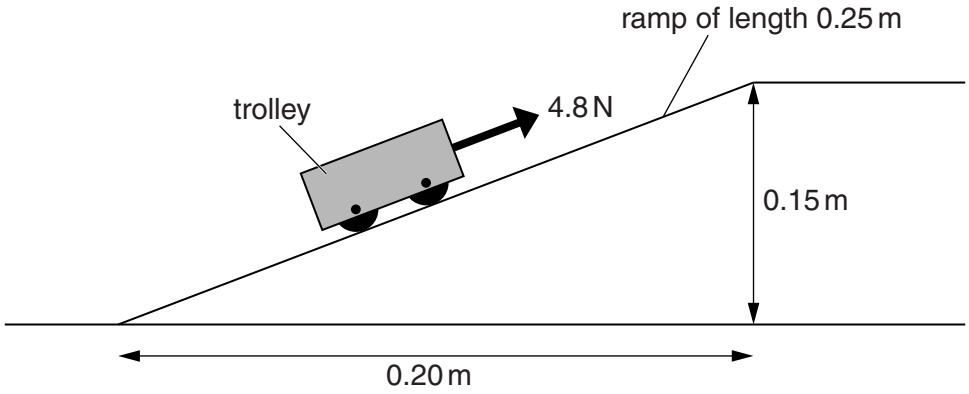
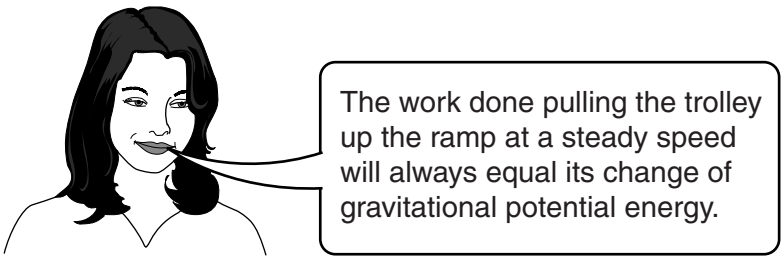
..... **[6]**

[Total: 6]

7 Enid uses this apparatus to investigate the force needed to pull a trolley up a ramp.



Enid makes a prediction about the experiment.



(a) Put ticks (✓) in the boxes next to the **two** assumptions that she is making **for this prediction**.

There is no friction to transfer energy as heat. ☐

The kinetic energy of the trolley does not change as it moves. ☐

The total energy of an isolated system always stays the same. ☐

The weight of the trolley decreases as it moves up the ramp. ☐

The force pulling the trolley along the ramp will increase its momentum. ☐

[1]

(b) Enid finds that a 4.8 N force is needed to pull a trolley of weight 6.0 N and mass 0.60 kg up the ramp.
She thinks that this agrees with her prediction.
Is she correct? Justify your answer.

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

[Total: 4]

8 Mike stands on some ice.
Every time he tries to start walking, he stays in the same place.

Explain why it is easy to start walking across grass, but difficult to start walking across ice.

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

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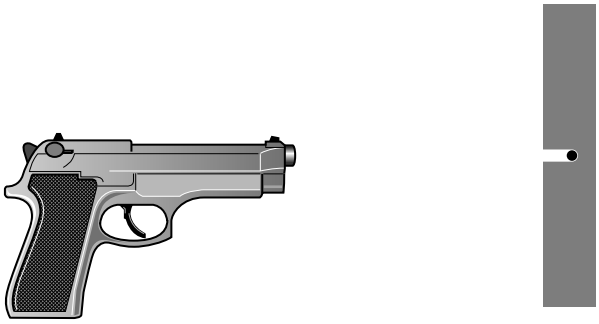
[Total: 6]

9 Clint does some research on bullet-proof vests.



(a) In one experiment, he finds that a vest can stop a bullet of mass 15 g travelling at a speed of 420 m/s in just 3.0×10^{-5} s.
$1\,g = 1.0 \times 10^{-3}$ kg.

(i) What is the momentum change of the bullet, in **kg m/s**, as it stops?
Put a ring around the correct value.

6.3 kg m/s **63 kg m/s** **630 kg m/s** **6300 kg m/s**

[1]

(ii) Calculate the force exerted on the vest by the bullet as it stops.

force = ... N **[1]**

(b) Clint investigates the use of foam materials in bullet-proof vests.
These vests have the same weight, but are much thicker.

(i) Explain how the thicker vest could be better for the wearer when it stops a bullet.

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

(ii) Clint decides to publish the results of his research.
Five of these sentences describe the process of getting his work published.
One of them is **not** part of the peer-review process.

A Clint sends an article to the publishers.

B Clint uses the reports to amend the article.

C The publisher sends the article to some other scientists.

D The article is published in the scientific journal.

E The article is read critically and reports are written about it.

F The publisher pays a scientist to repeat Clint's experiments.

Complete the grid to show the **five** sentences in the correct order.

[2]

(iii) Here are some critical comments scientists make about Clint's work.

Who gives a good scientific reason for **not** publishing Clint's work?

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

[Total: 7]

10 Here is some data for three different electric cars.

Name of car	Top speed in m/s	Accelerating time in s	Total mass in kg
CitiStroll	25	10	200
EasyShop	15	5	400
GoFar	20	4	600

The **accelerating time** is how long it takes for each car to reach its top speed from a standing start.

(a) The manufacturers of GoFar claim that their car has the greatest acceleration.
Are they right? Justify your answer.

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

(b) Calculate the kinetic energy of a GoFar car at its top speed.

kinetic energy = ... J **[1]**

[Total: 3]

END OF QUESTION PAPER

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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

20

**** 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.