CITY OF LONDON
FREEMEN'S SCHOOL

SAMPLE ENTRANCE EXAMINATION PAPER

For pupils currently in Year 9

SCIENCE

(BIOLOGY, CHEMISTRY, PHYSICS)

Time: 1 hour

You should spend no more than 20 minutes on each section.

Answer all questions in the spaces provided.

S0613	✓	SCI

Science Department

14+ Entrance Examination Requirements

Candidates may be required to plot graphs and measure lengths and angles, so should bring a pen, pencil, ruler, rubber and protractor to the exam. As well as the specific topics listed below, candidates may be asked to answer questions on a comprehension passage or use their knowledge of graphs and practical skills.

Biology

- Variety of living things
- Cells
- Movement into and out of cells
- Biological molecules, including enzymes
- Nutrition in animals and plants
- Respiration
- Gas exchange

Chemistry

- Acids and Alkalis: acids and alkalis, indicators, pH, everyday applications
- Physical Separations and Changes: filtering, evaporation, distillation, fractional distillation, chromatography, states of matter, changes of state, effect of impurities, diffusion
- Chemical changes and corrosion: thermal decomposition, burning and oxidation, rusting, precipitates and effervescence
- Elements, Compounds and Mixtures: atoms and symbols for elements, compounds and mixtures, interpretation of formulae
- Metals: extraction, properties of metals and non-metals, alloys and superconductors, reactions with oxygen, water and acids, competitions and displacement reactions
- Atomic Structure: nuclear particles, electron configuration, isotopes
- The Periodic Table
- Data handling and graphical skills

Physics

- Light and sound, including reflection and refraction
- Satellites and the Solar System
- Forces and springs
- Speed
- Electric circuits
- Electromagnets
- Energy changes

B I O L O G Y

B1. This is an extract from the brochure of a company specialising in unusual holidays.
"A journey to the end of the earth for the ambitious adventurer! ... We'll load up our sleds at 89° South and travel the unmarked landscape to the South Pole"



(a) People who are active in cold conditions need a lot of energy.
(i) What is the name of the process that releases energy in living organisms?

.....

(1)

(ii) Complete the word equation for the process that releases energy.

..... + oxygen ⟶ energy + carbon dioxide + ...

(2)

(iii) The oxygen needed for this process is present in the air.
Describe how air is taken into the lungs.

.....

.....

.....

.....

.....

(3)

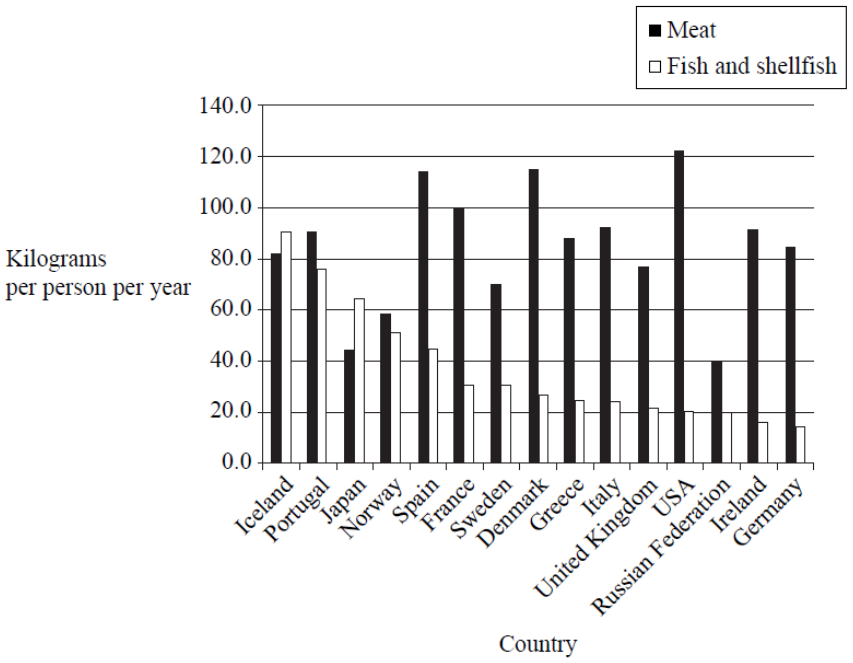
(b) The people pulling the sleds have to work hard and may find it difficult to take in enough oxygen.
When this occurs, a substance is produced in the muscles and this causes cramp.
What is the name of this substance?

.....

(1)
(Total 7 marks)

Turn-over

B2. The graph shows the mass of fish and meat eaten in some countries.



(a) (i) In which countries do people eat more fish than meat?

.....

(1)

(ii) Meat and fish contain approximately 100 g of protein per kilogram.
Calculate how many kg of protein a person in France obtains in one year from eating meat and fish. Show your working.

Answer = ... kg

(2)

(iii) Why is protein important for growth?

.....

.....

(1)



(b) The photograph shows a fish farm. A fish farm produces large numbers of fish of the same species. The fish are kept in cages in the water. Water is able to circulate through the cages. The fish are given small amounts of food at regular intervals during the day.

(i) Suggest why it is important that water can circulate through the cages.

.....

.....

.....

.....

(2)

(ii) Suggest why fish farmers supply small amounts of food at regular intervals.

.....

.....

(1)

(c) Some fish farmers calculate a 'Food Conversion Efficiency' (FCE).
The formula they use is shown below

$$\text{food conversion efficiency} = \frac{\text{total fish body mass gained}}{\text{total mass of food eaten}} \times 100$$

Suggest why fish farmers aim to have a high FCE.

.....

.....

.....

.....

(2)
(Total 9 marks)

Turn-over

B3. Read the passage below and then answer the questions which follow it

Seeing inside cells

Each individual blade of grass consists of various tissues, each made of cells in their thousands. In these cells an as yet unknown number of reactions and interactions are constantly taking place. The cells contain different parts known as organelles, which can be thought of as the cellular equivalent of the organs in animals and plants. Plant and animal cells differ in many ways (see the table below).

Plant Cells	Animal Cells
Have cell wall so stronger but less flexible than animal cells	No cell wall
Have vacuoles, membrane bound sacs which store various substances. They also contain water in variable amounts which can alter the rigidity of the cell	No permanent large vacuole
Have chloroplasts which trap light energy which is used to make food such as sugars. The chloroplasts also give off all the oxygen which is in the atmosphere.	No chloroplasts

The secretory pathway

If you zoom into the cell cytoplasm you will see intricate organization of the different organelles which have processes occurring inside them.

The genetic information that codes for all of the proteins of the cell is in the nucleus. Once a protein has been assembled in the cytoplasm, it enters the part of the endomembrane system known as the endoplasmic reticulum, or ER for short. The basic protein molecules, just a chain of amino acids, travel through this membrane system along a route we call the secretory pathway. Like an initially unmodified product sent down the production line of a factory, the proteins are folded and modified with additional components to produce the final product. Any faulty proteins are sent to be destroyed, like quality control on factory products. Following this the proteins are moved to the next station in the secretory pathway, the Golgi apparatus. This is similar to the sorting centre of the factory where the proteins are packaged and sent for distribution based on the associated sorting signal, like an address. This occurs in little 'bubbles', or vesicles, made of lipids and proteins, which can merge with membranes, expelling their contents. This can be to the outer membrane so that the proteins are released into the surrounding area, to other organelles inside of the cell for a specific function, or to be destroyed.

Source: Catalyst April 2013

a) Explain what is meant by the term "tissue".

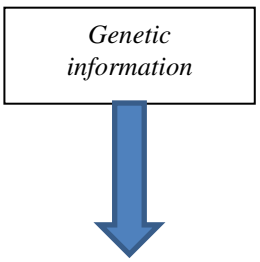
……

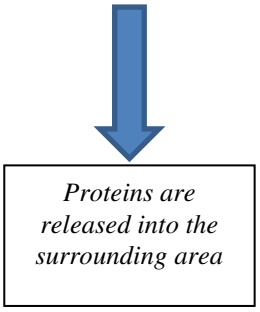
……

(2 marks)

b) Re-read the paragraph “The secretory pathway” and summarise the information in a flow chart to show how genetic information is used to make proteins which are released into the surrounding area

(2 marks)





(Total = 4 marks)

C H E M I S T R Y

C1. Use the Periodic Table to help you answer this question.

State the name of:

a] the first group in the Periodic table.

_____ [1]

b] State the symbol of the element that has the atomic number of 12.

_____ [1]

c] State the symbol of the element that has a relative atomic mass of 12.

_____ [1]

d] State the number of the group that contains the noble gases.

_____ [1]

e] Which group contains elements whose atoms form ions with a 2+ charge?

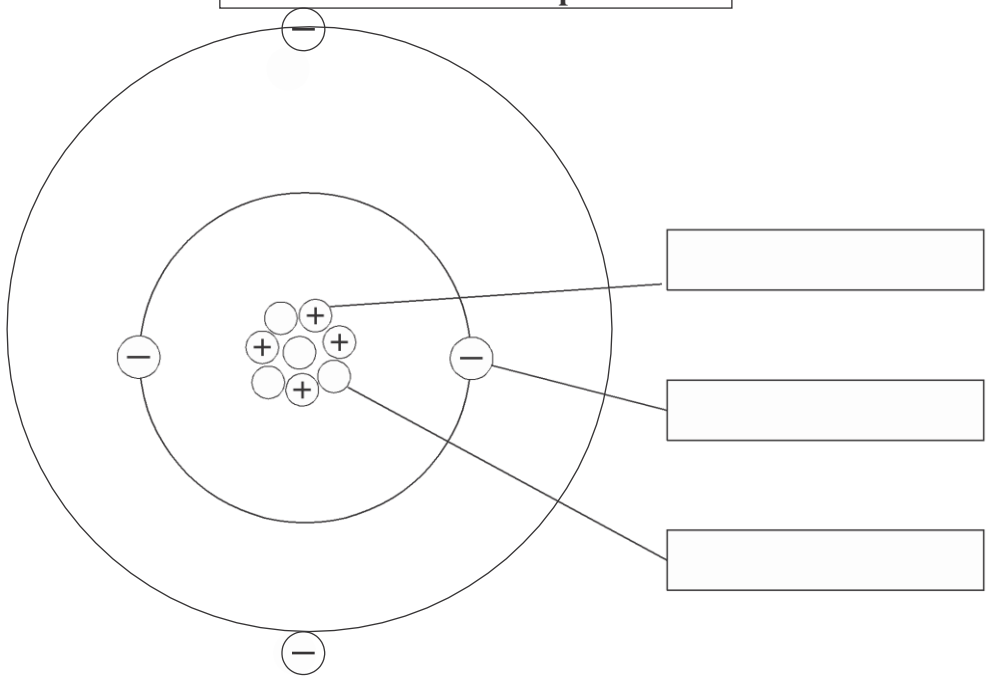
_____ [1]

(Total 5 marks)

C2. This question is about atoms.

(a) (i) Choose words from the box to label the diagram of an atom.

electron	**ion**
neutron	**proton**



[1]

(ii) State the mass number of this atom.

..... [1]

(iii) The diagram above represents the atom of an element.
State the name of the element. Use the Periodic Table to help you.

..... [1]

(b) Chlorine has two isotopes. State one way in which atoms of the two isotopes are:

the same .....

.....

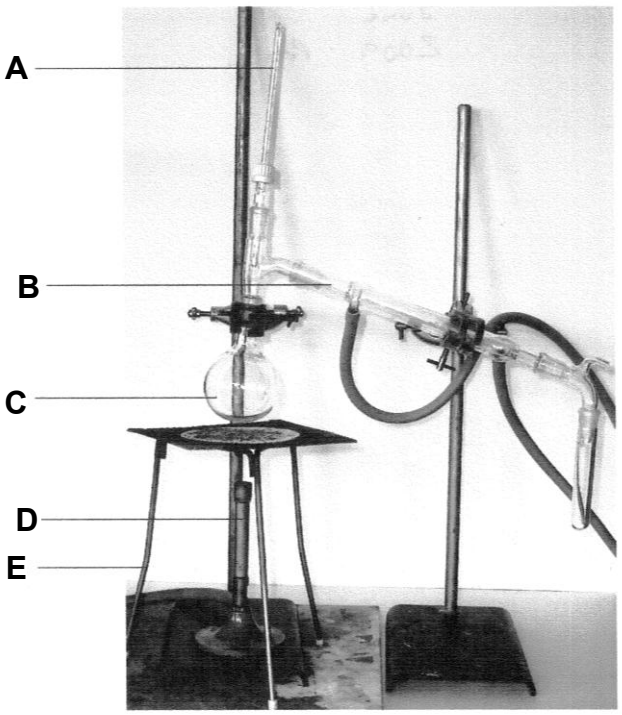
different .....

..... [2]

(Total 5 marks)

Turn-over

C3. The picture shows apparatus used to carry out distillation.



a] Use words from the box to name the items of equipment labelled A – E. The first has been done for you

beaker	**Bunsen burner**	**clamp stand**
condenser	**conical flask**	**funnel**
round bottomed flask	**thermometer**	**tripod**

A thermometer

B _____

C _____

D _____

E _____ [4]

b] Place a cross **X** in the box to show which mixture the apparatus in the picture could be used to separate

ethanol and water ☐

iron filings and sulphur ☐

sodium chloride and sugar ☐ [1]

(Total 5 marks)

C4. Dilute hydrochloric acid reacts with solid calcium carbonate.
The equation below shows this equation.

$$2HCl(aq) + CaCO_3(s) \longrightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Some students investigate the effect on the rate of the reaction of changing the temperature of the hydrochloric acid. The method is:

- use a measuring cylinder to pour 50 cm^3 of dilute hydrochloric acid into a conical flask
- heat the acid to the required temperature
- place the flask on a balance
- add 10 g (an excess) of calcium carbonate chips to the flask
- time how long it takes for the mass to decrease by 1.00 g
- the experiment is repeated at different temperatures.

The table shows the students' results.

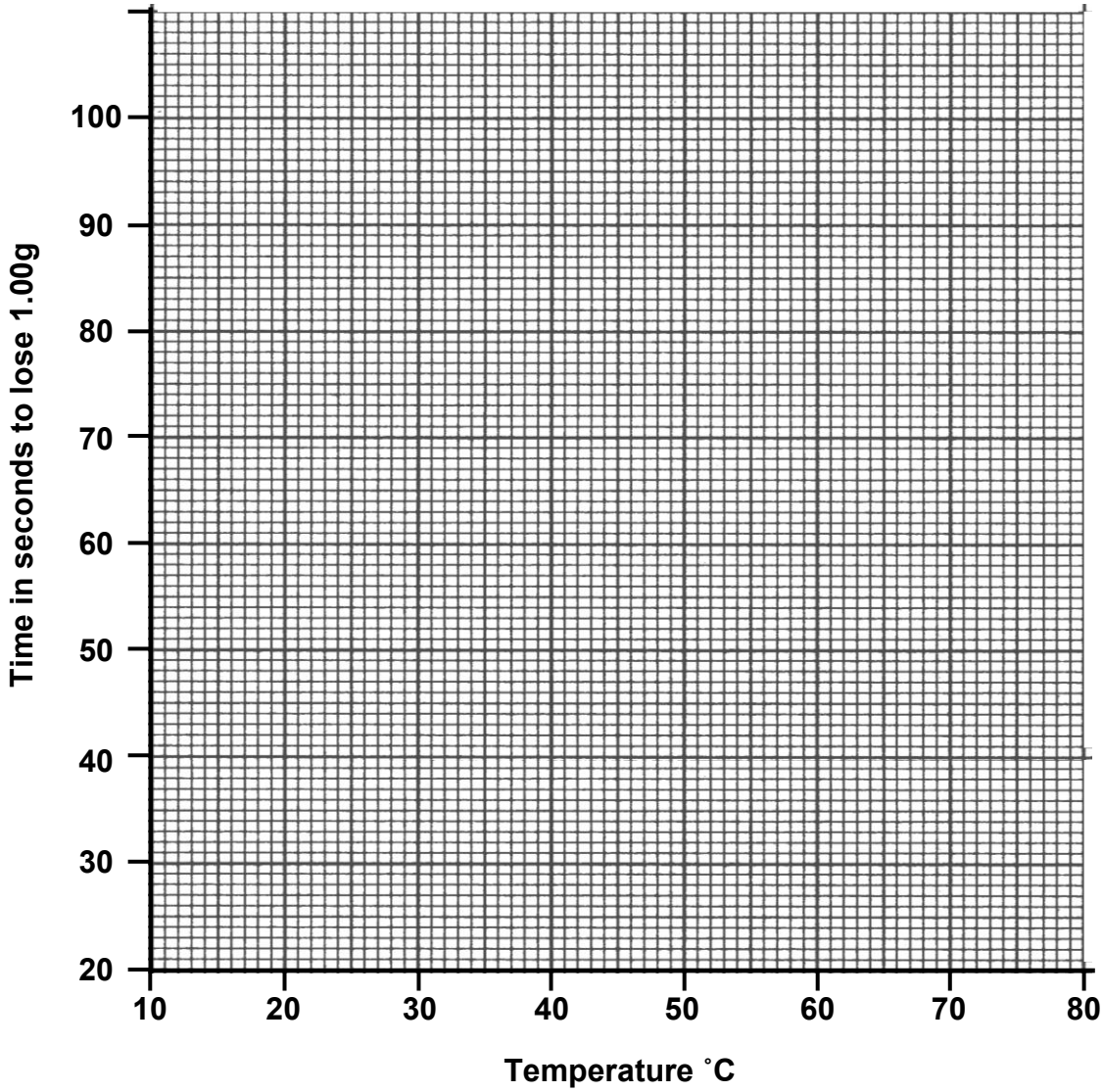
Temperature of acid (°C)	Time to lose 1.00 g (s)
22	93
35	68
46	65
57	40
65	33
78	26

(a) (i) On the grid below, draw a graph of these results.
The axes and scales have been provided for you.

[2]

Turn-over

(ii) One of the points is anomalous. Circle this point on your graph. [1]



(b) (i) Use your graph to find the time taken to lose 1.00 g at 30 °C.

Time at 30 °C ..... s [1]

(iii) State how the rate of reaction changes when the temperature increases.

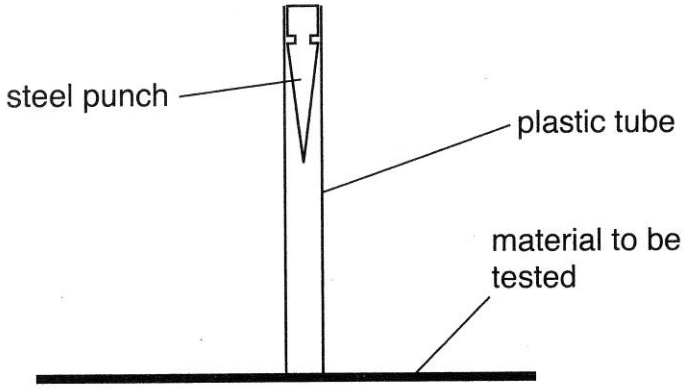
..... [1]

(Total 5 marks)

PHYSICS

P1. A student wanted to investigate the hardness of different materials.

She set up the following equipment:



She decided to drop a sharp steel punch from the same height onto different materials and to measure the diameter of the mark in each material.

(a) Why is it important to drop the punch from the same height each time?

.....

..... (2)

(b) The plastic tube helps her drop the punch from the same height each time.

Suggest another sensible reason for using it.

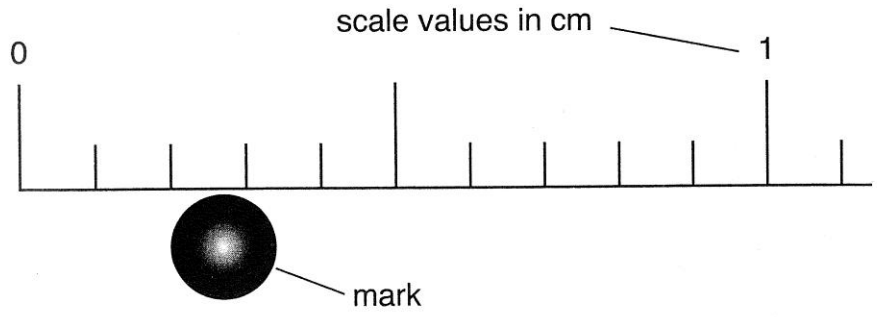
.....

..... (1)

To measure the diameter of the mark made in the material, she placed a ruler beside it and looked at it through a microscope.

This magnified the image 10 times.

The diagram shows what she saw when looking at one of the marks.



(c) (i) Estimate the diameter of the mark shown as accurately as you can. *(Give the unit.)*

..... (3)

(ii) What is the advantage of using a microscope to help her to measure the diameter of the mark?

..... (1)

She obtained the following results:

material	diameter of mark, in mm	hardness
oak	1.7	
copper	0.8	
steel	0.1	
polythene	1.4	
aluminium	1.0	
pine	2.0	

(d) Add numbers to the hardness column, putting 1 for the material which is the hardest, 2 for the next hardest etc. for all six materials. (3)

She suggests that the results for polythene, aluminium and pine may be unreliable because they have been tested after the steel.

(e) (i) Explain why this suggestion is sensible.

.....

..... (1)

(ii) Explain what she could do to see if her test is reliable.

.....

.....

..... (2)

(Total 13 marks)

P2. A scientist measures the speed at which sound travels through different materials by timing how long a pulse of sound takes to get through a measured length of the material. Some of her results are shown in the table below.

material	length / m	time / s	speed m/s
aluminium	1	0.0002	5000
sea water	6	0.004	1500
air	170	0.5	

(a) Use the information in the table to calculate the speed of sound in air. Use the space below to do your calculations and then write your answer in the 'speed' column.

.....

.....

..... (2)

(b) In which of these materials does sound travel fastest?

..... (1)

(c) Short pulses of sound are sent downwards from the bottom of a ship. The time taken for the sound to return to the ship enables the depth of the water to be found.

(i) Why does the sound return to the ship?

..... (1)

(ii) If it takes 0.5 seconds for the sound to return to the ship, how deep is the sea beneath it?

.....

.....

.....

..... (3)

(Total 7 marks)

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.