Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3445UB0-1

Z22-3445UB0-1

WEDNESDAY, 15 JUNE 2022 – MORNING

APPLIED SCIENCE (Double Award)
UNIT 2: Space, Health and Life

HIGHER TIER

1 hour 30 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**	**25**	
Section B	**2.**	**7**	
	3.	**14**	
	4.	**10**	
	5.	**9**	
	6.	**10**	
	Total	**75**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you will require a separate Resource Folder, calculator, pencil and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question **5**(b) is a quality of extended response (QER) question where your writing skills will be assessed.

You are reminded to show all your workings. Credit is given for correct workings even when the final answer given is incorrect.

You will need to refer to the separate Resource Folder to answer question **1**.

A Periodic Table is printed on page 16.

Examiner only

Section A

Answer **all** questions in the spaces provided.

Refer to the separate Resource Folder to answer question **1**.

1. (a) (i) The Red Admiral butterfly competes with greenfly for food. The scientific name for one type of greenfly is *Acyrthosiphon pisum.*

Complete the table below to show the scientific classification of greenfly. [3]

Kingdom:	.....
Phylum:	.....
Class:	Insecta
Order:	Hemiptera
Family:	Aphididae
Genus:	.....
Species:	.....
Scientific name:	*Acyrthosiphon pisum*

(ii) Another butterfly is found in Africa. Its scientific name is *Vanessa abyssinica.*

I. State **one** advantage of using scientific names. [1]

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II. State **one** piece of evidence, from its scientific name, that shows it is related to the Red Admiral. [1]

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(b) The variation in population of adult Red Admirals is shown by the graph in **Figure 1**.

(i) I. State the name of the seasonal movement of animals as seen in Red Admirals. [1]

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II. State **one** reason why this seasonal movement occurs. [1]

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(ii) Use the information in the graph in **Figure 1** to compare the variation of the Red Admiral population in 2019 with the mean change since 1976. [2]

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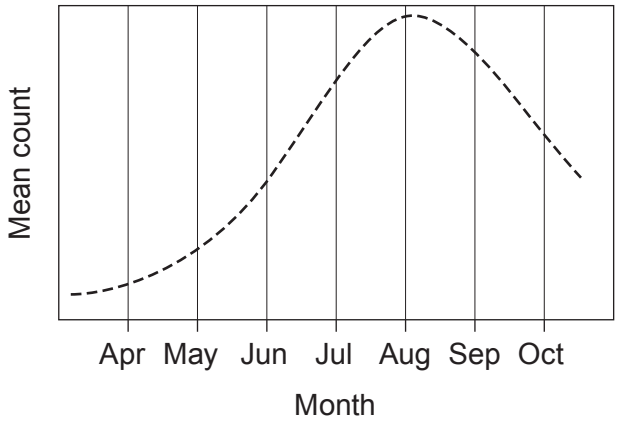
(iii) Red Admirals are a food source for frogs. **Add a line** to the graph below to show how the population of frogs changed between April and October in 2019. [2]



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(iv) Use your line to explain the relationship between numbers of predators (frogs) and the numbers of their prey (Red Admirals). [3]

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(c) (i) Use the information in **Table 2** to construct the part of the food web that depends on berries. [3]

Berries

6

Examiner only

(ii) Explain why the frog can be found at more than one trophic level. [2]

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(d) Refer to **Table 2** to construct a pyramid of biomass for a food chain of **five** trophic levels starting with berries and ending with buzzards. [3]

(e) Use the information in **Figure 2** to calculate the efficiency of energy transfer between the primary and secondary consumers. [3]

% efficiency = ...

8

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Section B

Answer **all** questions in the spaces provided.

2. Medical imaging techniques include ultrasound, X-rays, CAT scans and MRI scans.

(a) (i) Describe how the two strands of DNA are joined in a double helix. [2]

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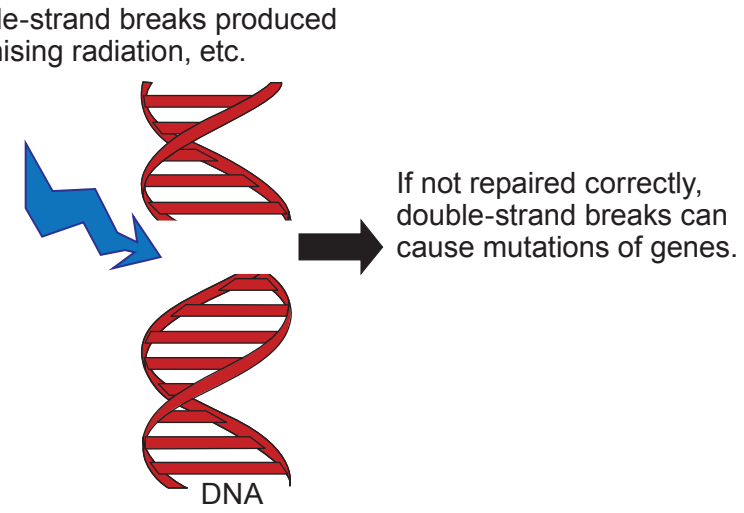
(ii) Ionising radiation can have harmful effects on DNA within a human body. The diagram shows that it can cause a break in the double-strand.



It is suggested that MRI scans are most likely to cause this kind of DNA damage and the other methods listed above are harmless. Explain whether you agree. [3]

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(b) Describe how an ultrasound image is formed. [2]

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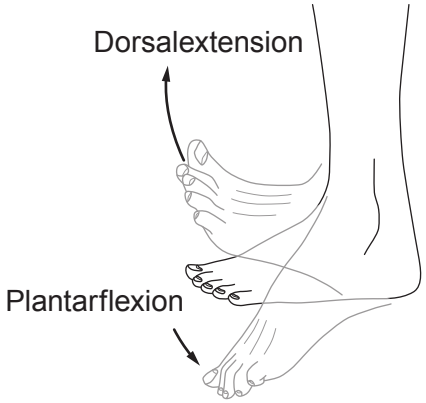
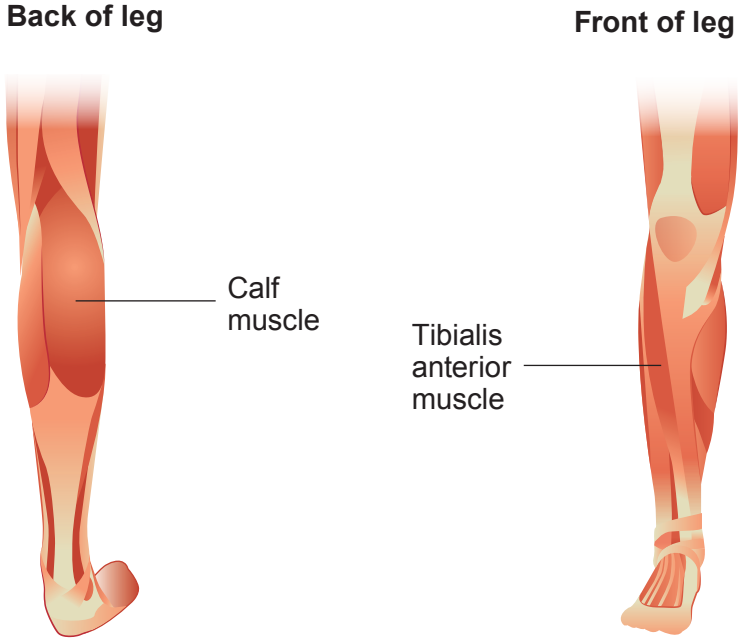
3. Healthy muscles and joints are essential for pain-free movement. These are very important for successful athletes.

(a) The ankle is a type of hinge joint that is used when we walk and run. Its action is shown in the diagram below.



This movement is controlled by an antagonistic pair of muscles called the calf and tibialis anterior. The calf is at the back of the leg and the tibialis anterior is at the front of the leg.



Explain how this pair of muscles produce dorsalextension and plantarflexion. [3]

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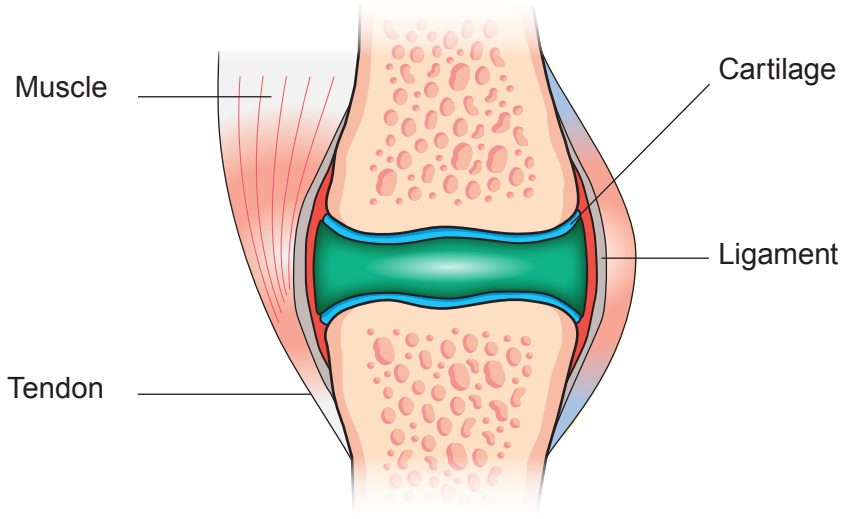
(b) The knee is a synovial hinge joint.



Explain how damage to cartilage and ligaments may affect an athlete. [3]

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(c) Two athletes, Dafydd and Tom, compete in a 400 m training race and their finish times are identical. Their times to travel certain distances within the race are measured and are shown in the table below.

Distance (m)	0	50	100	150	200	300	400
Tom's time (s)	0	7.65	13.65	20.48	27.30	41.93	56.55
Dafydd's time (s)	0	6.10	11.40	18.40	25.40	40.95	56.55

(i) Dafydd thought his fastest speed was for the last 100 m of the race. Explain whether you agree. [3]

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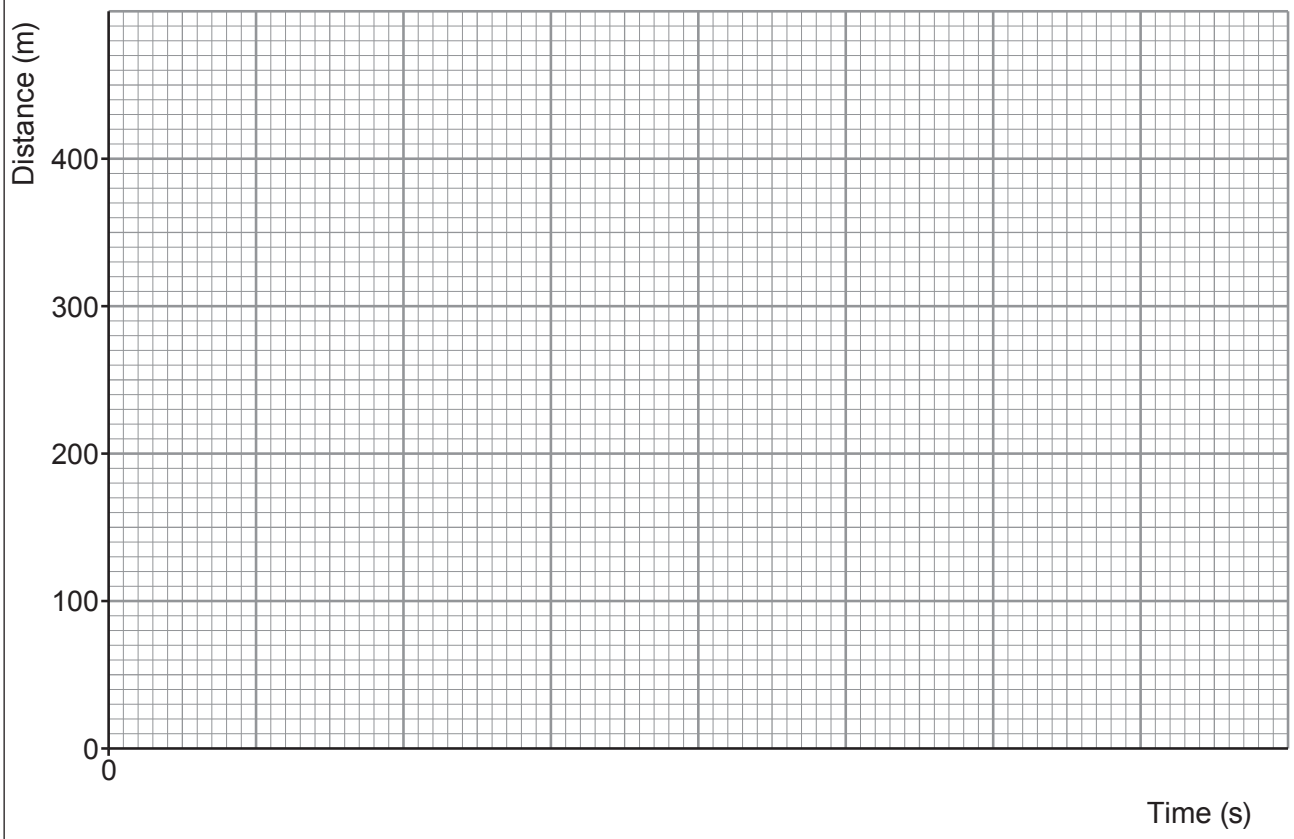
Examiner only

(ii) Since they finished the race in the same time, Tom thought their maximum speed must have been the same. Plot graphs of distance against time for Tom and Dafydd and explain whether you agree with Tom. [5]



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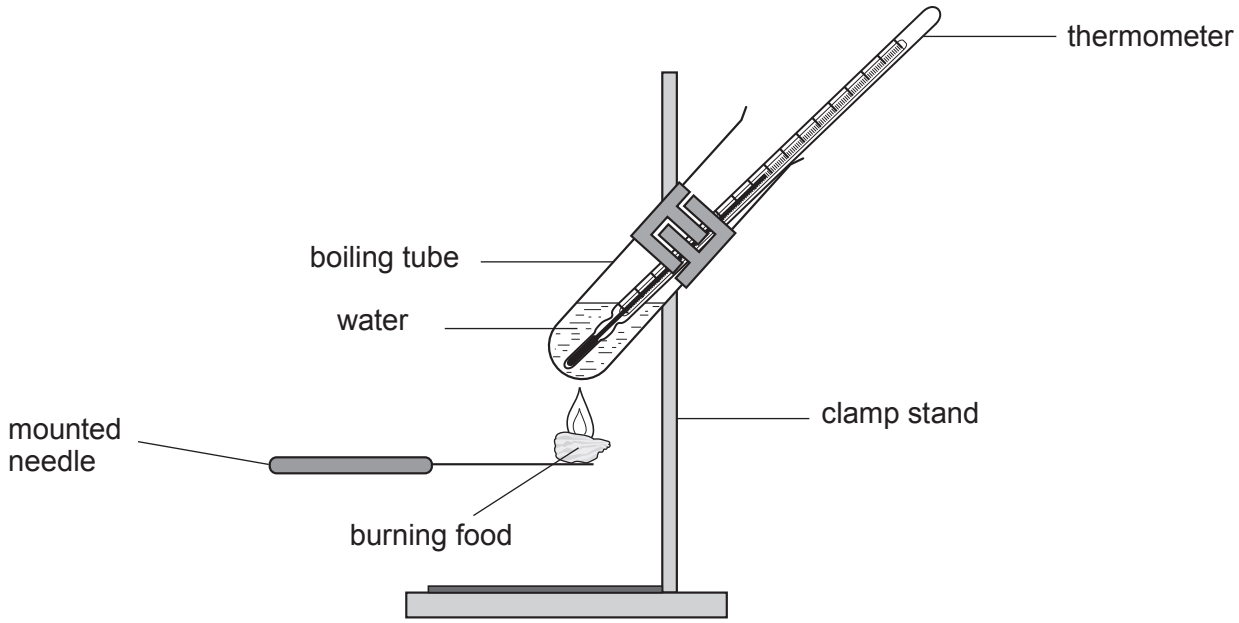
4. The energy your body needs comes from the food you eat. The energy content of food can be measured in the laboratory.

(a) The apparatus below can be used to measure the energy content of food in a school laboratory.



(i) State **two** variables which should be controlled in this experiment **and** explain why they need to be controlled. [2]

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(ii) Explain why the mean results obtained in the school laboratory are different from manufacturers' values given on a food label. [2]

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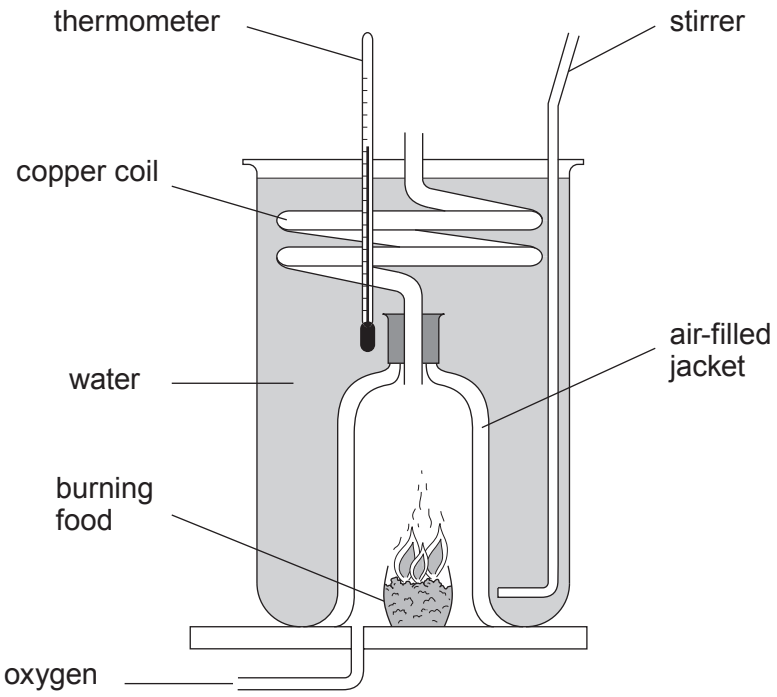
Examiner only

(iii) The energy content of food can also be measured using the calorimeter shown in the diagram below.



Explain why using this calorimeter is likely to improve the quality of the results. [3]

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(b) The energy absorbed by a water sample is given by the equation

energy (J) = mass of water (kg) × temperature rise (°C) × 4 200

Results from the experiment for one food sample are shown below.

- mass of water = 20.0 g
- temperature rise = 15.4 °C
- mass of food sample = 12.4 g

Use the information above to calculate the energy content of the food in J/g. [3]

$1g = 10^{-3}$ kg

energy content = ... J/g

10

Examiner only

5. As the world's population increases, its impact on biodiversity and the environment becomes more and more harmful.

(a) Describe the issues surrounding the creation of nature reserves to maintain biodiversity. [3]

(b) A United Nations report, Our Common Future, states that "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Describe the main issues related to sustainable development. [6 QER]

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PLEASE DO NOT WRITE ON THIS PAGE

Turn over for Question 6

Examiner only

6. Three images have been combined below to show colliding galaxy clusters 5 billion light years from Earth. The background is a Hubble Space Telescope image taken using visible light; the blue area is an X-ray image from the Chandra Space Observatory, and the red area is an image from a radio telescope.

(a) (i) Compare the use of Earth-based and space-based telescopes to produce images of objects in space. [2]

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(ii) Explain how the visible light received by the Hubble Space Telescope provides evidence for the origin of the Universe. [3]

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Examiner only

(b) (i) State how long it takes radio waves to travel from the colliding galaxy clusters to reach the Earth. [1]

time = ...

(ii) X-rays have a higher frequency than radio waves. Tick (✓) the box next to the correct statement below. [1]

X-rays take less time to travel the same distance as radio waves. ☐

X-rays take the same time to travel the same distance as radio waves. ☐

X-rays take more time to travel the same distance as radio waves. ☐

(iii) The X-rays detected by the Chandra Observatory have a frequency range of 3×10^{16} Hz to 3×10^{19} Hz. They travel through space at a speed of 3×10^{8} m/s.

Use the equation

wave speed = frequency × wavelength

to calculate the maximum wavelength of these X-rays. [3]

maximum wavelength = ... m

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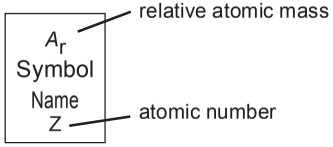
END OF PAPER

THE PERIODIC TABLE

Group 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
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 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	179 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	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key



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