| Surname | Centre Number | Candidate Number |
|---|---|---|
| First name(s) | | 0 |

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# GCSE

3445UA0-1

Z22-3445UA0-1

**MONDAY, 20 JUNE 2022 – MORNING**

# APPLIED SCIENCE (Double Award)

## UNIT 1: Energy, Resources and the Environment

## HIGHER TIER

1 hour 30 minutes

| For Examiner's use only | | |
|---|---|---|
| **Question** | **Maximum Mark** | **Mark Awarded** |
| **1.** | **19** | |
| **2.** | **8** | |
| **3.** | **6** | |
| **4.** | **14** | |
| **5.** | **12** | |
| **6.** | **16** | |
| **Total** | **75** | |

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### ADDITIONAL MATERIALS

In addition to this paper you will require a calculator 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. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

### INFORMATION FOR CANDIDATES

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

Question **3** is a quality of extended response (QER) question where your writing skills will be assessed.

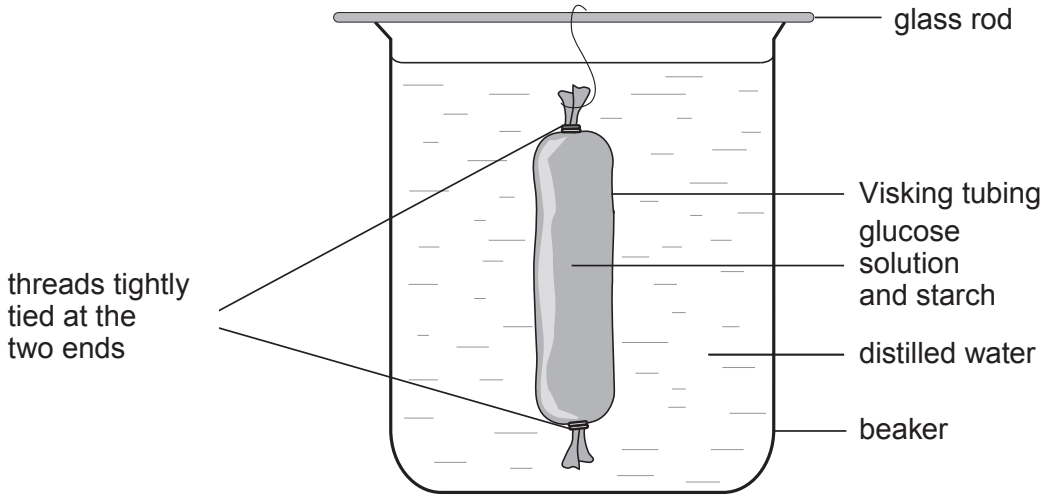
You are reminded to show all your workings. Credit is given for correct workings even when the final answer given is incorrect.

A Periodic Table is printed on page 20.

Examiner only

Answer **all** questions.

**1.** A student set up the following experiment to show how diffusion of digested foods occurs in the small intestine. The Visking tubing contained starch and a solution of glucose with a concentration of 100 g / $dm^3$. This was placed in a beaker containing distilled water at 20 °C and left for 2 hours.




(a) (i) Explain what is expected to happen to the starch and the glucose in the Visking tubing during the experiment. [4]

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(ii) Describe **two** chemical tests the student should carry out on the contents of the beaker to confirm your answer to (a)(i) and state the expected results. [4]

1. .....

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2. .....

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Examiner only

(b) Explain how each of the following changes would affect the diffusion process in this experiment.

(i) Carbohydrase is added to the contents of the Visking tubing. [2]

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(ii) The investigation is carried out at 35 °C. [2]

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(iii) The experiment is carried out with a solution of glucose of 100 g / $dm^3$ concentration replacing the distilled water in the beaker. [2]

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(c) State **one** of the limitations of using Visking tubing as a model intestine. [1]

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(d) Explain **two** adaptations of the small intestine for the absorption of digested food. [4]

1. .....

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2. .....

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**Turn over.**

Examiner only

**2.** Sodium oxide is formed when sodium burns in oxygen.

(a) Use the Periodic Table on page 20 to describe the structure of the oxygen atom. [3]

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(b) During the production of sodium oxide the $Na^+$ and $O^{2-}$ ions are formed.

(i) Give the electronic structures of the ions. [2]

$Na^+$ .....

$O^{2-}$ .....

(ii) Sodium reacts violently with water to form a strong alkali.
State the name of the alkali formed in this reaction. [1]

.....

(c) Small amounts of sodium peroxide, $Na_2O_2$, are also formed when sodium burns.
Calculate the relative formula mass ($M_r$) of sodium peroxide. [2]

$A_r$: Na = 23, $A_r$: O = 16

$M_r$ = .....

8

Examiner only

**3.** Describe how the elements are arranged in the Periodic Table and explain, with examples, how their properties relate to their position. [6 QER]



6

Examiner only

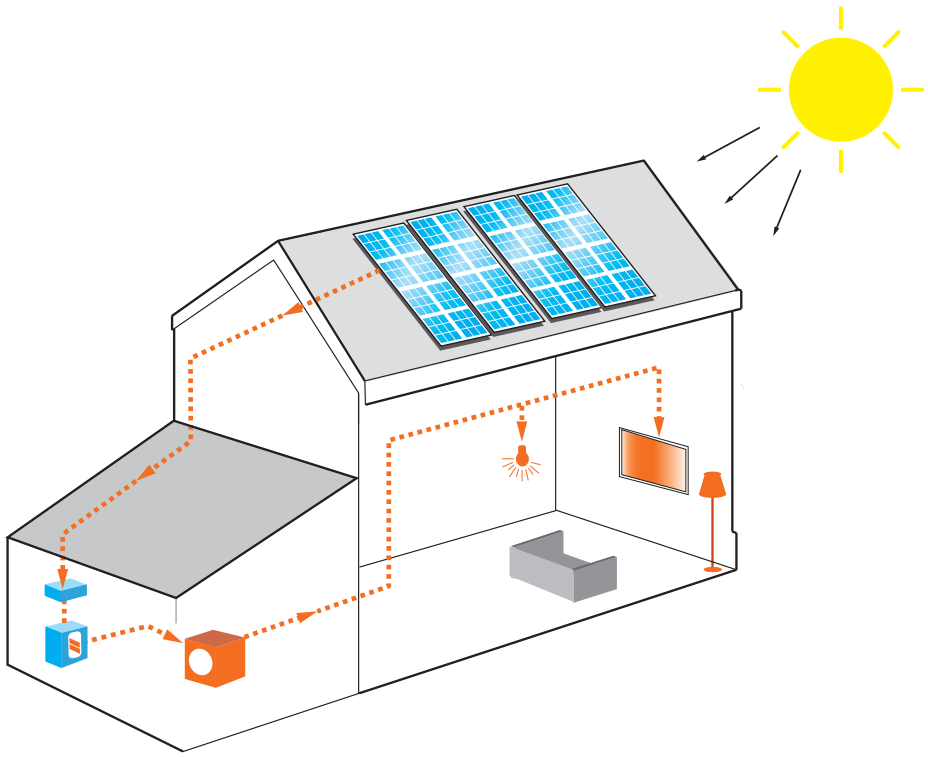
**4.** In the UK there are now a range of companies that will offer to install solar panels to homes.

Adverts like the one below are becoming quite common.

# Sunny Sun Panels

## You can save an average of £50 each month on your fuel bill!

When the Sun's radiation hits your solar panels it is converted into electrical energy. This energy travels to a device called an inverter, which converts it into usable household electricity. With over 1500 hours of sunshine per year what could be better!



Your own Sunny Sun panel system fully installed for £3800! What a price!
Add battery storage at only £2900 – you can use your solar electricity whenever you like.

## Get your money back in 10 years!

Designed to work alongside your existing electricity supplier or as part of a new combined home solar system, battery storage will make it much easier to save on your electricity bills by utilising more of the electricity generated by your solar panels. This system will satisfy all your home electrical needs.

The excess power from your solar panels charges your battery during the day. The battery then supplies electricity to your home during the night and on cloudy days. This maximises your electricity savings and makes your house free from electricity from the National Grid.

Examiner only

(a) In January 2018 a householder invested in the Sunny Sun panel system and battery storage.

(i) Use the equation

$$\text{payback time} = \frac{\text{installation costs}}{\text{annual savings}}$$

and the information provided to determine whether the claim 'get your money back in 10 years' is true. [3]

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(ii) State **three** reasons why payback time might be more than expected. [3]

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(b) In 2018 the mean household electricity consumption for the UK was 4420 kWh per year.

An independent energy expert assessed the system and found they absorb a mean power of 14 000 W of sunlight and converted this to electrical power with an efficiency of 23 %.

Sunny Sun claim that their panel system can satisfy the electrical needs of the average home in the UK.

Use this information together with information in the advert and the equation

$$\text{units produced (kWh)} = \text{power (kW)} \times \text{time (h)}$$

to determine if the Sunny Sun claim is valid. [4]

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Examiner only

(c) One of the largest solar power plants proposed in the UK is being developed in Kent. This solar power plant is capable of generating a maximum of $3.5 \times 10^6$ kWh per year. At present the UK generates $5.3 \times 10^{10}$ kWh of electricity per year.

Use the information provided to:

(i) Calculate how many homes this solar power plant could supply with electricity assuming that the mean household electricity consumption is 4420 kWh per year. [2]

number of homes = .....

(ii) Calculate how many solar power plants of this size would be required to supply the UK electrical energy demand. [2]

number of plants = .....

14

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Examiner only

**5.** Pancreatitis is a disease that causes inflammation of the pancreas and can result in a very low rate of enzyme production and secretion into the small intestine. Enzymes can be given to patients as a treatment for this disease. The enzymes are taken as a slow-release capsule which is not affected by acid.

(a) State the function of an enzyme. [1]

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(b) Suggest a reason why the enzyme is not given to the patient as a liquid. [2]

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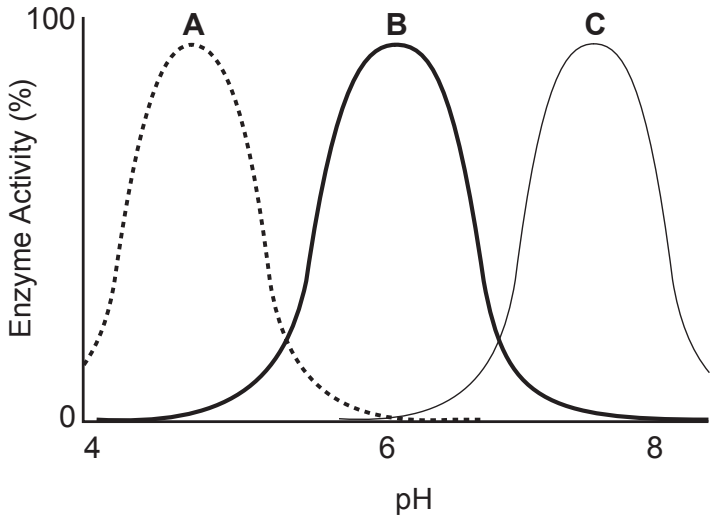
(c) The activity of enzymes **A**, **B**, and **C** at different pH levels are shown below.




Explain whether enzymes **A**, **B**, or **C** are suitable for use in treating a patient with pancreatitis. [4]

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Examiner only

(d) Enzymes are also used in the manufacture of biological washing powders. Biological washing powders contain proteases, carbohydrases and lipases.

(i) Suggest why washing powders need these three types of enzymes to remove food stains from clothes. [1]

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(ii) Explain why washing at 80 °C using biological washing powders would not be recommended for removing food stains. [4]

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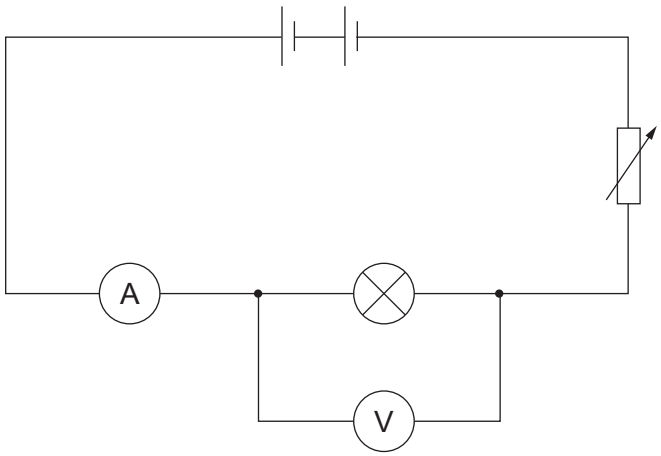
Examiner only

**6.** A student was investigating how current changes with voltage for various components.

She used the following circuit to investigate a lamp.




She followed the method below.

1. Connect the circuit as shown in the diagram.
2. Set the variable resistor to give the lowest voltage and record the readings on the voltmeter and ammeter.
3. Alter the variable resistor to increase the voltage by 0.5 V.
4. Record the new readings on the voltmeter and ammeter.
5. Repeat steps 3 and 4.

(a) Some of the results are shown below.

| Voltage (V) | Current (A) |
|---|---|
| 0.0 | 0.00 |
| 2.5 | 0.65 |
| 3.5 | 0.90 |
| 4.5 | 1.16 |
| 5.0 | 1.20 |
| 5.5 | 1.26 |
| 6.5 | 1.36 |
| 8.0 | 1.46 |

(i) State the independent variable in this experiment. [1]

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(ii) State the dependent variable in this experiment. [1]

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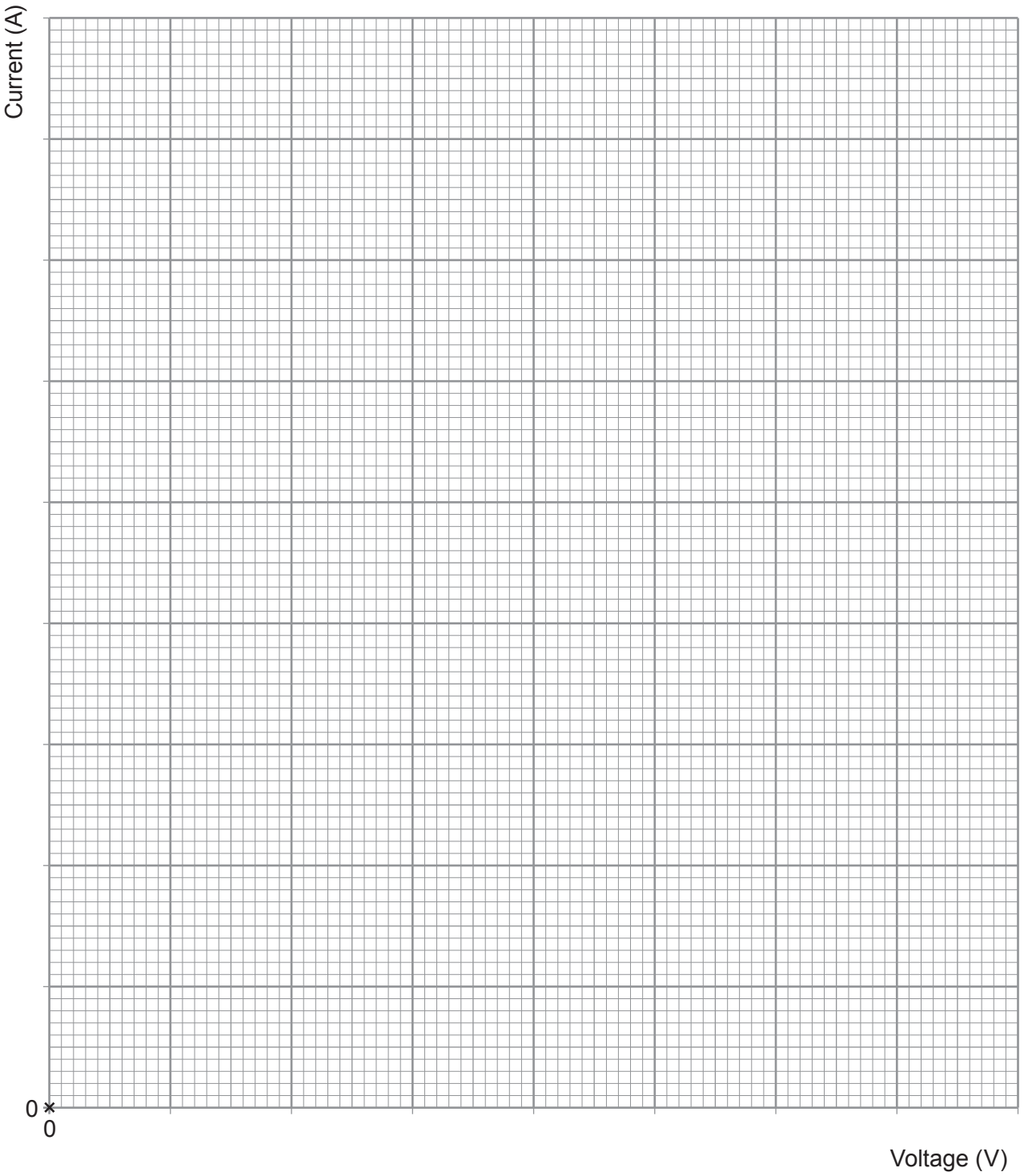
Examiner only

(iii) Plot the results on the grid below and draw a suitable line. [4]



Examiner only

(iv) Use your graph in (a)(iii) and the following equation

voltage = current × resistance

to calculate the resistance of the lamp when the voltage is 7.2 V. [3]

resistance = ..... Ω

(v) Explain whether the resistance of the lamp is constant throughout the experiment. [3]

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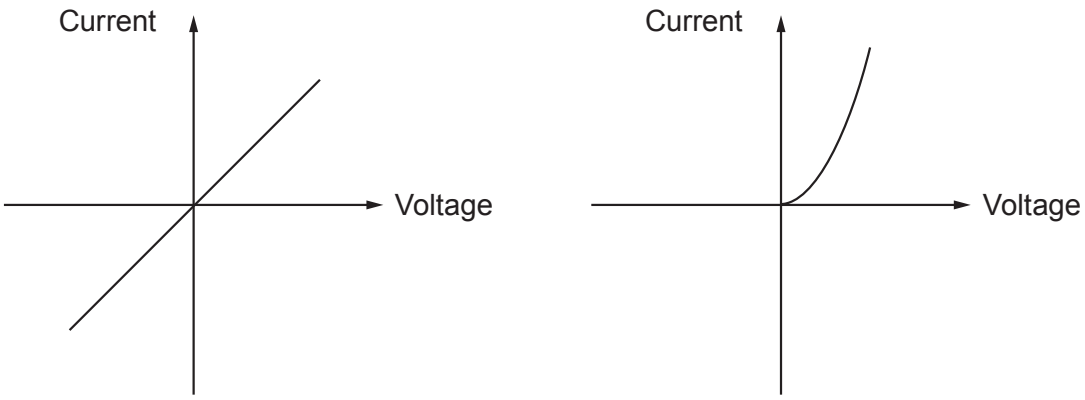
Examiner only

(b) The investigation was repeated with a resistor and then a diode.
The graphs of the results are shown below.




Use the graphs to compare the variation in resistance for these components. [4]

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**END OF PAPER**

| Question number | Additional page, if required. Write the question number(s) in the left-hand margin. |
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Examiner only

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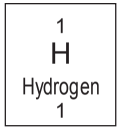
# THE PERIODIC TABLE




| Group 1 | Group 2 | | | | | | | | | | | Group 3 | Group 4 | Group 5 | Group 6 | Group 7 | Group 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | 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 | | | | | | | | | | | | | | | |

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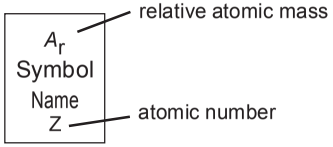






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