



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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COMBINED SCIENCE

0653/21

Paper 2 (Core)

May/June 2011

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.

A copy of the Periodic Table is printed on page 24.

At the end of the examination, fasten all your work securely together.

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

| For Examiner's Use | |
|--------------------|--|
| 1 | |
| 2 | |
| 3 | |
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| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| Total | |

This document consists of **21** printed pages and **3** blank pages.



- 1 (a) A student carried out an experiment to find which substances in the environment caused nails made of mild steel to become rusty.

She selected three identical nails and placed them in sealed test-tubes, **A**, **B** and **C**, as shown in Fig. 1.1.

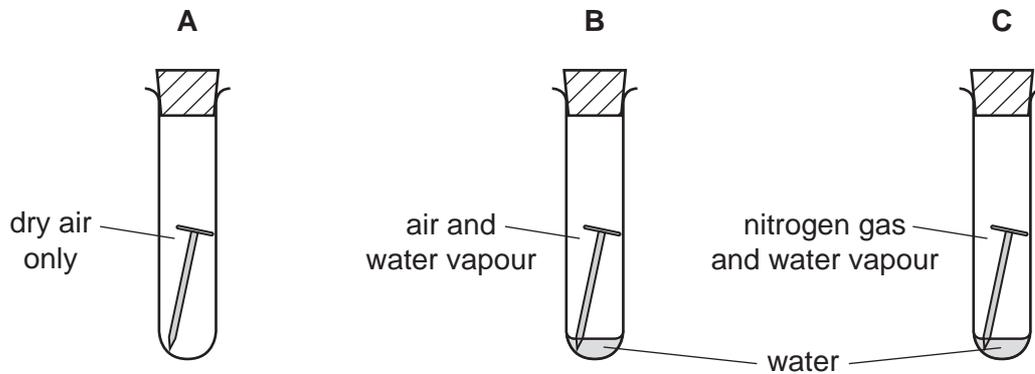


Fig. 1.1

The student observed that the nail in test-tube **B** was the only one to become rusty.

Explain why the nail in test-tube **B** in Fig. 1.1 rusted but the nails in the other two tubes did not.

.....

.....

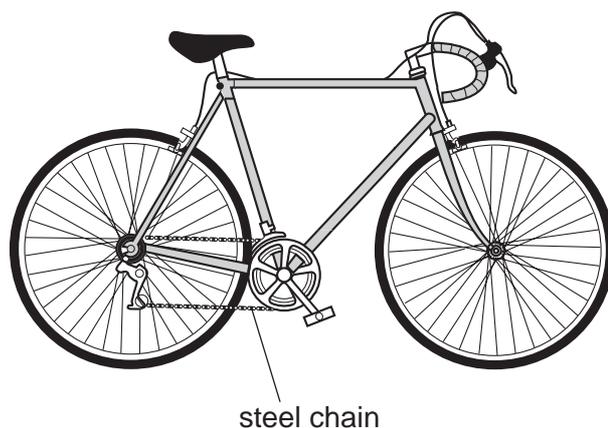
.....

.....

.....

..... [3]

- (b) Bicycle chains that are made of steel are usually covered in oil made of hydrocarbon molecules. This helps to prevent rusting.



- (i) State which of the chemical formulae, **V** to **Z**, represent hydrocarbons. Explain your answer.



chemical formulae

explanation

..... [2]

- (ii) Suggest **one** property of a hydrocarbon oil which makes it suitable for use as a barrier to prevent rusting.

..... [1]

- (iii) Hydrocarbons have many uses.

State **one** important use of hydrocarbons, other than preventing rusting.

..... [1]

- 2 (a) Fig. 2.1 shows a crane powered by an electric motor.

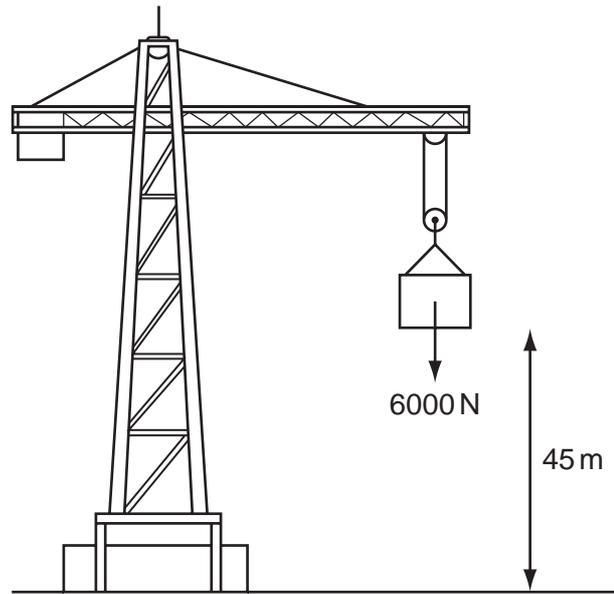


Fig. 2.1

Calculate the work done raising a load of 6000 N by a distance of 45 m.

State the formula that you use and show your working.

formula used

working

..... J [2]

- (b) Fig. 2.2 shows the circuit used by a student to operate the electric motor of a crane.

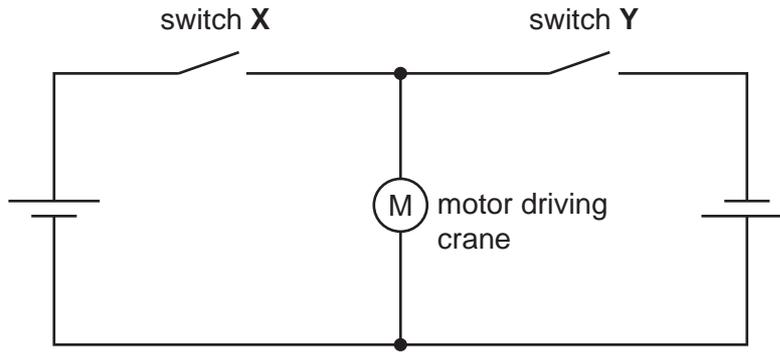


Fig. 2.2

When the student closes switch **X**, the motor runs and the crane is able to lift a load.

- (i) The student then opens switch **X** and closes switch **Y**.

Describe what happens to the motor.

.....

.....

..... [2]

- (ii) The student closes both switches. Describe what happens to the motor.

.....

..... [1]



The smell of food cooking is detected by special cells in a person's nose. The salivary glands may respond to this stimulus by secreting saliva.

(a) Name the receptor and the effector in this response.

receptor

effector

[2]

(b) When food has been taken into a person's mouth, it is mixed with saliva.

Saliva contains the enzyme amylase. Amylase digests large starch molecules to smaller sugar molecules.

(i) What is an *enzyme*?

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

(ii) Explain why digestion is necessary.

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

(c) Fig. 3.1 shows a section through a molar tooth.

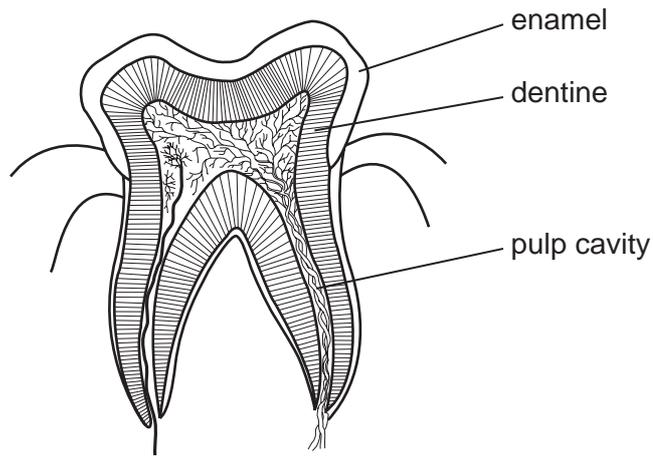


Fig. 3.1

(i) Describe how the molar teeth help in the digestion of food.

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

(ii) Explain why a diet containing milk and other dairy foods can help to form strong teeth.

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

4 (a) (i) Use words from the list to complete the sentences below.

compounds energy fission force fusion nuclei

In nuclear power stations, the generation of electricity begins with the process of nuclear In this process, of atoms like uranium are split. Small amounts of uranium can release large amounts of [3]

(ii) Energy from nuclear fission can be converted into electrical energy. The first stage of this is the conversion of nuclear energy into heat energy.

Describe how heat energy is used to generate electrical energy in a power station.

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

(b) Workers in nuclear power stations may be exposed to radiation from radioactive materials.

(i) Explain why exposure to such radiation may be hazardous to their health.

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

(ii) A badge made from photographic film can be used to check the exposure of the workers to radiation. Fig. 4.1 shows a worker wearing his badge.

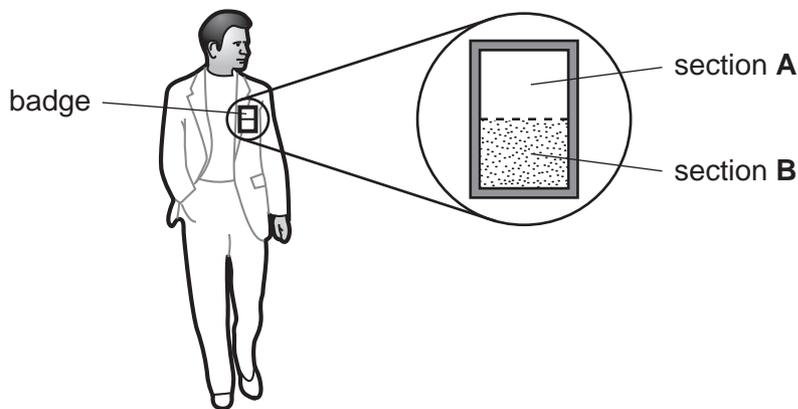


Fig. 4.1

A simple badge has two sections **A** and **B** for the detection of beta and gamma radiation. Fig. 4.2 shows the side view through the badge.

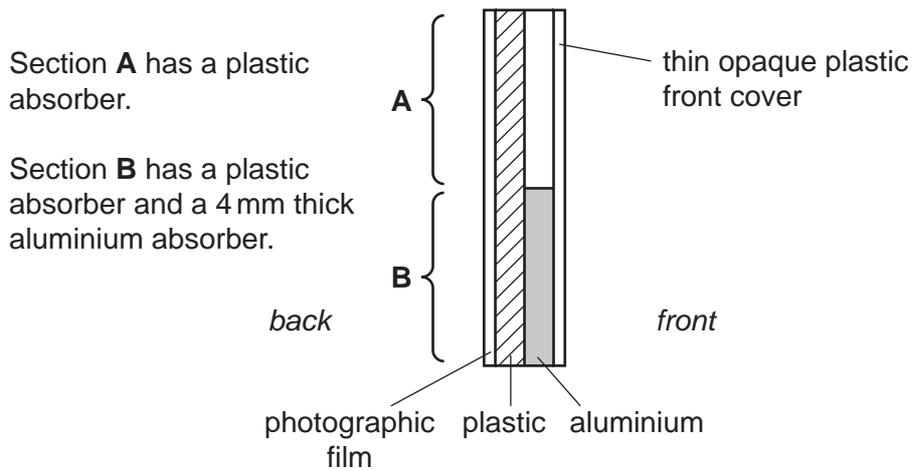


Fig. 4.2

When the photographic film from the badge is developed, it turns black where it has been exposed to radiation.

Complete Table 4.1 to show whether the photographic film will turn black when exposed to beta or gamma radiations.

Table 4.1

| radiation | will section A turn black? | will section B turn black? |
|-----------|----------------------------|----------------------------|
| beta | | |
| gamma | yes | |

[2]

(iii) Explain why the badge can **not** be used to detect alpha radiation.

.....

..... [1]

- 5 Dung beetles live in places where large grass-eating animals, such as cattle, also live. Dung beetles collect dung produced by the cattle and make it into a ball, which they roll away to bury.

The beetles feed on the dung.

Fig. 5.1 shows a dung beetle rolling a ball of dung.

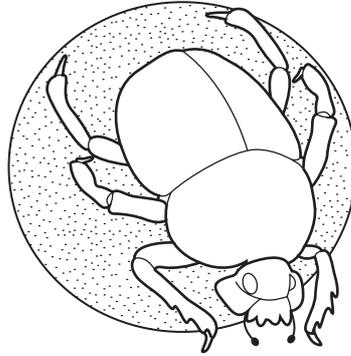
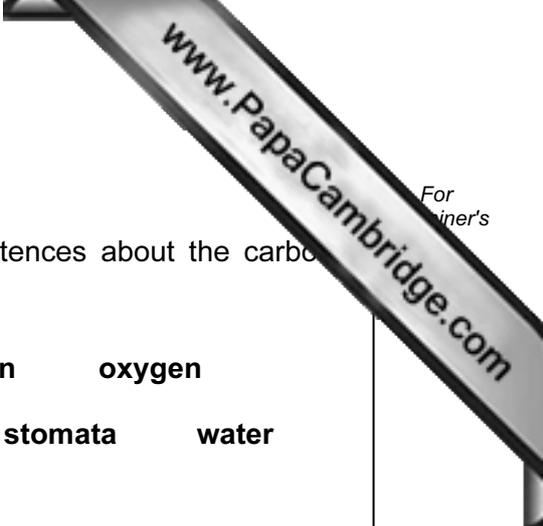


Fig. 5.1

- (a) On the list below, draw lines to link each organism to its correct position in the food chain.

| organism | position in food chain |
|-------------|------------------------|
| dung beetle | producer |
| grass | consumer |
| cattle | decomposer |

[2]



(b) Dung beetles are important in the carbon cycle.

Choose some of the words in the list to complete the sentences about the carbon cycle.

- carbon dioxide
- digestion
- nitrogen
- oxygen
- photosynthesis
- respiration
- roots
- stomata
- water

Dung beetles digest dung, producing sugars that are absorbed into their blood. The sugars are taken into the dung beetles' cells, where they are broken down during This results in the release of into the air. Plants absorb this gas through their The gas is then combined with water to make carbohydrates by [4]

(c) If a farmer keeps too many cattle in one place, the soil may be damaged.

Explain how keeping too many cattle can damage the soil.

.....

 [2]

6 The Earth provides raw materials which are processed into useful products.

(a) Choose products from the list to complete the right hand column of Table 6.1. The first one has been done as an example.

aluminium ceramics chlorine glass steel

Table 6.1

| raw material | useful product |
|-----------------------|----------------|
| sand and metal oxides | glass |
| iron ore | |
| sodium chloride | |

[2]

(b) Air is a **mixture** of elements and compounds.

Nitrogen dioxide, NO₂, is a **compound** of nitrogen and oxygen.

(i) State **two** differences between a mixture of two elements and a compound of the same elements.

1

.....

2

..... [2]

(ii) Air which has been cooled and pressurised turns to a liquid. The gases nitrogen and oxygen can be separated, by fractional distillation, from liquid air.

Suggest why it is possible to separate these elements from liquid air by fractional distillation.

.....

..... [1]

- (c) Nitrogen and hydrogen can be made to react together to form ammonia, NH_3 .

This reaction requires a catalyst and a high temperature.

- (i) Describe the advantages of using a catalyst in a chemical reaction.

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

- (ii) State the effect of a high temperature on the rate of the reaction.

..... [1]

- (iii) Ammonia is used to make the salts ammonium nitrate and ammonium phosphate, which are used as fertilisers.

State the type of substance which reacts with ammonia to make salts, and name the type of chemical reaction which occurs.

type of substance

type of reaction [2]

- 7 In an experiment, weights were hung on a spring and the length of the spring measured.

Fig. 7.1 shows a graph of the results.

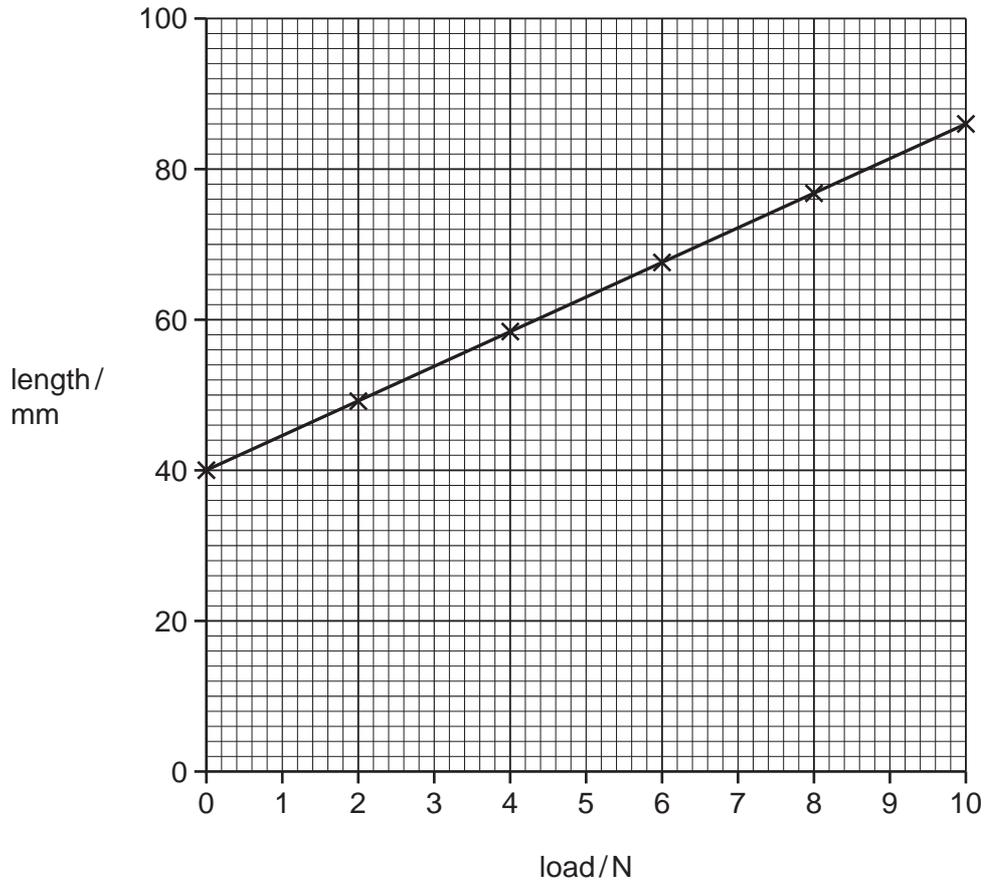


Fig. 7.1

- (a) Describe the relationship between the load on the spring and the length of the spring.

..... [1]

(b) Fig. 7.2 shows a wooden bird suspended from the spring.



Fig. 7.2

The direction of the upward force of the spring has been labelled **A**.

Draw another arrow on the diagram to show the direction of the other force acting on the bird. Label your arrow **B**. [1]

(c) The bird is not moving. What can be stated about the sizes and directions of forces **A** and **B**?

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

(d) The volume of the bird is 30 cm^3 and the density of the wood is 0.8 g/cm^3 .

Show that the mass of the bird is 24 g.

State the formula that you use and show your working.

formula used

working

[2]

(e) The metal in the spring is an example of a solid.

Fig. 7.3 shows the arrangement of particles in a solid, liquid and gas.

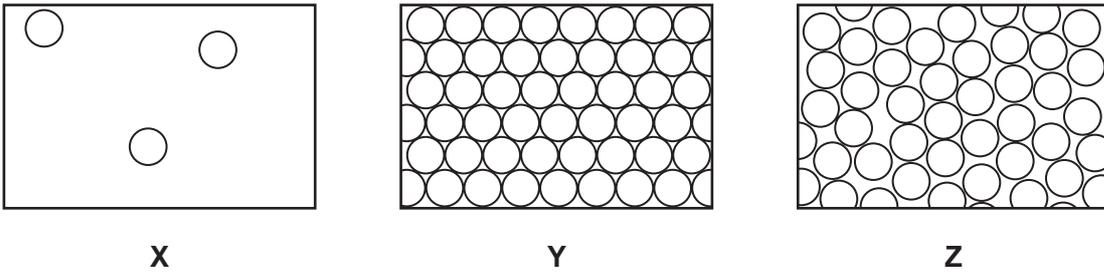


Fig. 7.3

Which diagram **X**, **Y** or **Z** shows the arrangement of particles in the spring?

Explain your answer.

diagram

explanation

.....

..... [2]

8 Fig. 8.1 shows a sperm cell.

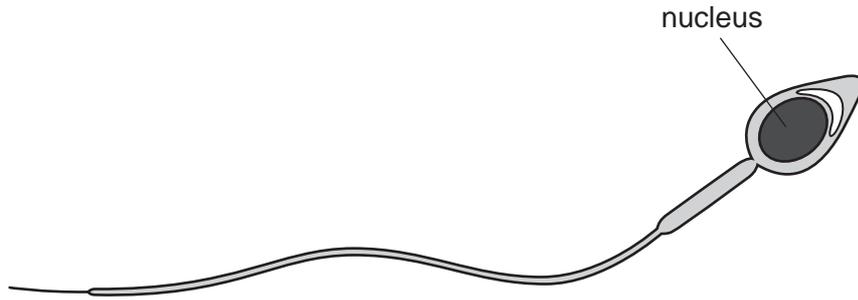


Fig. 8.1

(a) (i) State the name and number of the structures present in the nucleus of a human sperm cell.

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

(ii) On Fig. 8.1, use label lines to label and name **two** structures, other than the nucleus, that are found in **all** animal cells. [2]

(iii) Describe **two** ways in which the shape of a sperm cell helps it to swim to an egg.

1
.....
2
..... [2]

(b) Name the organ in which sperm are produced. [1]

(c) Describe what happens immediately after a sperm meets an egg in the oviduct.

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

9 The chemical formulae for each of three compounds found in rocks are shown below.

| | |
|------------------------------|--------------------|
| $\text{CaMg}(\text{CO}_3)_2$ | dolomite |
| KAlSi_3O_8 | potassium feldspar |
| SiO_2 | quartz |

(a) (i) State the total number of atoms shown in the formula of potassium feldspar.
 [1]

(ii) When a flame test is carried out on **one** of the compounds in the list, a lilac colour is produced.

Suggest, with a reason, which one of the compounds is being tested.

compound

reason

..... [2]

(iii) **Two** of the elements shown in the chemical formulae above are in Period 4 of the Periodic Table.

State the **name** of **one** of these elements. [1]

(b) When calcium carbonate, CaCO_3 , is heated strongly for some time using a Bunsen flame, a chemical reaction occurs.

The word equation for this reaction is



(i) State the type of chemical reaction which occurs.

Explain your answer.

type of reaction

explanation

..... [2]

(ii) Predict whether the mass of calcium oxide which is produced in this reaction

- greater than,
- **or** less than,
- **or** the same as

the mass of the calcium carbonate which is used.

Circle your prediction.

Explain your answer.

.....
 [1]

(iii) The student then added a little of the calcium oxide to some cold water that contains full range indicator solution (Universal Indicator).

The student made two observations which are shown below.

Explain these observations.

observation 1

There was a large increase in the temperature of the mixture.

explanation

.....

observation 2

The indicator changed colour from green to purple.

explanation

..... [2]

10 The speakers of three MP3 music players are being compared.

(a) The speakers are tested to find the range of frequencies they produce.

Table 10.1 shows the results.

Table 10.1

| speaker | range of frequencies / Hz |
|---------|---------------------------|
| A | 100 to 10 000 |
| B | 20 to 25 000 |
| C | 20 to 40 000 |

(i) What is meant by the term *frequency*?

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

(ii) Use the information in Table 10.1 to suggest why the music played through speaker **A** might not sound as good as the other two speakers.

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

(iii) Music played through speakers **B** and **C** sounds the same.

Suggest a reason for this.

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

(b) An MP3 player is able to receive a radio station broadcasting on 102.7MHz/0.28 m.

What does 0.28 m refer to?

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

DATA SHEET
The Periodic Table of the Elements

| | | Group | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | I | II | III | IV | V | VI | VII | VIII | IX | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 H Hydrogen 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 4 He Helium 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 9 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Li Lithium | Be Beryllium | B Boron | C Carbon | N Nitrogen | O Oxygen | F Fluorine | Ne Neon | Na Sodium | Mg Magnesium | Al Aluminium | Si Silicon | P Phosphorus | S Sulfur | Cl Chlorine | Ar Argon | K Potassium | Ca Calcium | Sc Scandium | Ti Titanium | V Vanadium | Cr Chromium | Mn Manganese | Fe Iron | Co Cobalt | Ni Nickel | Cu Copper | Zn Zinc | Ga Gallium | Ge Germanium | As Arsenic | Se Selenium | Br Bromine | Kr Krypton | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | 37 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rb Rubidium | Sr Strontium | Y Yttrium | Zr Zirconium | Nb Niobium | Mo Molybdenum | Tc Technetium | Ru Ruthenium | Rh Rhodium | Pd Palladium | Ag Silver | Cd Cadmium | In Indium | Sn Tin | Sb Antimony | Te Tellurium | I Iodine | Xe Xenon | Cs Caesium | Ba Barium | La Lanthanum | Ce Cerium | Pr Praseodymium | Nd Neodymium | Pm Promethium | Sm Samarium | Eu Europium | Gd Gadolinium | Tb Terbium | Dy Dysprosium | Ho Holmium | Er Erbium | Tm Thulium | Yb Ytterbium | Lu Lutetium | Fr Francium | Ra Radium | Ac Actinium | Th Thorium | Pa Protactinium | U Uranium | Np Neptunium | Pu Plutonium | Am Americium | Cm Curium | Bk Berkelium | Cf Californium | Es Einsteinium | Fm Fermium | Md Mendelevium | No Nobelium | Lr Lawrencium | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 55 | 87 | 89 | 91 | 93 | 96 | 101 | 106 | 112 | 115 | 119 | 122 | 127 | 131 | 133 | 137 | 140 | 141 | 144 | 146 | 147 | 150 | 152 | 157 | 162 | 165 | 167 | 169 | 173 | 175 | 178 | 181 | 182 | 183 | 186 | 188 | 190 | 192 | 195 | 197 | 201 | 204 | 207 | 209 | 210 | 211 | 212 | 214 | 216 | 218 | 220 | 222 | 226 | 228 | 232 | 238 | 239 | 241 | 244 | 247 | 251 | 252 | 256 | 261 | 265 | 269 | 273 | 277 | 281 | 285 | 289 | 293 | 297 | 301 | 305 | 309 | 313 | 317 | 321 | 325 | 329 | 333 | 337 | 341 | 345 | 349 | 353 | 357 | 361 | 365 | 369 | 373 | 377 | 381 | 385 | 389 | 393 | 397 | 401 | 405 | 409 | 413 | 417 | 421 | 425 | 429 | 433 | 437 | 441 | 445 | 449 | 453 | 457 | 461 | 465 | 469 | 473 | 477 | 481 | 485 | 489 | 493 | 497 | 501 | 505 | 509 | 513 | 517 | 521 | 525 | 529 | 533 | 537 | 541 | 545 | 549 | 553 | 557 | 561 | 565 | 569 | 573 | 577 | 581 | 585 | 589 | 593 | 597 | 601 | 605 | 609 | 613 | 617 | 621 | 625 | 629 | 633 | 637 | 641 | 645 | 649 | 653 | 657 | 661 | 665 | 669 | 673 | 677 | 681 | 685 | 689 | 693 | 697 | 701 | 705 | 709 | 713 | 717 | 721 | 725 | 729 | 733 | 737 | 741 | 745 | 749 | 753 | 757 | 761 | 765 | 769 | 773 | 777 | 781 | 785 | 789 | 793 | 797 | 801 | 805 | 809 | 813 | 817 | 821 | 825 | 829 | 833 | 837 | 841 | 845 | 849 | 853 | 857 | 861 | 865 | 869 | 873 | 877 | 881 | 885 | 889 | 893 | 897 | 901 | 905 | 909 | 913 | 917 | 921 | 925 | 929 | 933 | 937 | 941 | 945 | 949 | 953 | 957 | 961 | 965 | 969 | 973 | 977 | 981 | 985 | 989 | 993 | 997 | 1001 | 1005 | 1009 | 1013 | 1017 | 1021 | 1025 | 1029 | 1033 | 1037 | 1041 | 1045 | 1049 | 1053 | 1057 | 1061 | 1065 | 1069 | 1073 | 1077 | 1081 | 1085 | 1089 | 1093 | 1097 | 1101 | 1105 | 1109 | 1113 | 1117 | 1121 | 1125 | 1129 | 1133 | 1137 | 1141 | 1145 | 1149 | 1153 | 1157 | 1161 | 1165 | 1169 | 1173 | 1177 | 1181 | 1185 | 1189 | 1193 | 1197 | 1201 | 1205 | 1209 | 1213 | 1217 | 1221 | 1225 | 1229 | 1233 | 1237 | 1241 | 1245 | 1249 | 1253 | 1257 | 1261 | 1265 | 1269 | 1273 | 1277 | 1281 | 1285 | 1289 | 1293 | 1297 | 1301 | 1305 | 1309 | 1313 | 1317 | 1321 | 1325 | 1329 | 1333 | 1337 | 1341 | 1345 | 1349 | 1353 | 1357 | 1361 | 1365 | 1369 | 1373 | 1377 | 1381 | 1385 | 1389 | 1393 | 1397 | 1401 | 1405 | 1409 | 1413 | 1417 | 1421 | 1425 | 1429 | 1433 | 1437 | 1441 | 1445 | 1449 | 1453 | 1457 | 1461 | 1465 | 1469 | 1473 | 1477 | 1481 | 1485 | 1489 | 1493 | 1497 | 1501 | 1505 | 1509 | 1513 | 1517 | 1521 | 1525 | 1529 | 1533 | 1537 | 1541 | 1545 | 1549 | 1553 | 1557 | 1561 | 1565 | 1569 | 1573 | 1577 | 1581 | 1585 | 1589 | 1593 | 1597 | 1601 | 1605 | 1609 | 1613 | 1617 | 1621 | 1625 | 1629 | 1633 | 1637 | 1641 | 1645 | 1649 | 1653 | 1657 | 1661 | 1665 | 1669 | 1673 | 1677 | 1681 | 1685 | 1689 | 1693 | 1697 | 1701 | 1705 | 1709 | 1713 | 1717 | 1721 | 1725 | 1729 | 1733 | 1737 | 1741 | 1745 | 1749 | 1753 | 1757 | 1761 | 1765 | 1769 | 1773 | 1777 | 1781 | 1785 | 1789 | 1793 | 1797 | 1801 | 1805 | 1809 | 1813 | 1817 | 1821 | 1825 | 1829 | 1833 | 1837 | 1841 | 1845 | 1849 | 1853 | 1857 | 1861 | 1865 | 1869 | 1873 | 1877 | 1881 | 1885 | 1889 | 1893 | 1897 | 1901 | 1905 | 1909 | 1913 | 1917 | 1921 | 1925 | 1929 | 1933 | 1937 | 1941 | 1945 | 1949 | 1953 | 1957 | 1961 | 1965 | 1969 | 1973 | 1977 | 1981 | 1985 | 1989 | 1993 | 1997 | 2001 | 2005 | 2009 | 2013 | 2017 | 2021 | 2025 | 2029 | 2033 | 2037 | 2041 | 2045 | 2049 | 2053 | 2057 | 2061 | 2065 | 2069 | 2073 | 2077 | 2081 | 2085 | 2089 | 2093 | 2097 | 2101 | 2105 | 2109 | 2113 | 2117 | 2121 | 2125 | 2129 | 2133 | 2137 | 2141 | 2145 | 2149 | 2153 | 2157 | 2161 | 2165 | 2169 | 2173 | 2177 | 2181 | 2185 | 2189 | 2193 | 2197 | 2201 | 2205 | 2209 | 2213 | 2217 | 2221 | 2225 | 2229 | 2233 | 2237 | 2241 | 2245 | 2249 | 2253 | 2257 | 2261 | 2265 | 2269 | 2273 | 2277 | 2281 | 2285 | 2289 | 2293 | 2297 | 2301 | 2305 | 2309 | 2313 | 2317 | 2321 | 2325 | 2329 | 2333 | 2337 | 2341 | 2345 | 2349 | 2353 | 2357 | 2361 | 2365 | 2369 | 2373 | 2377 | 2381 | 2385 | 2389 | 2393 | 2397 | 2401 | 2405 | 2409 | 2413 | 2417 | 2421 | 2425 | 2429 | 2433 | 2437 | 2441 | 2445 | 2449 | 2453 | 2457 | 2461 | 2465 | 2469 | 2473 | 2477 | 2481 | 2485 | 2489 | 2493 | 2497 | 2501 | 2505 | 2509 | 2513 | 2517 | 2521 | 2525 | 2529 | 2533 | 2537 | 2541 | 2545 | 2549 | 2553 | 2557 | 2561 | 2565 | 2569 | 2573 | 2577 | 2581 | 2585 | 2589 | 2593 | 2597 | 2601 | 2605 | 2609 | 2613 | 2617 | 2621 | 2625 | 2629 | 2633 | 2637 | 2641 | 2645 | 2649 | 2653 | 2657 | 2661 | 2665 | 2669 | 2673 | 2677 | 2681 | 2685 | 2689 | 2693 | 2697 | 2701 | 2705 | 2709 | 2713 | 2717 | 2721 | 2725 | 2729 | 2733 | 2737 | 2741 | 2745 | 2749 | 2753 | 2757 | 2761 | 2765 | 2769 | 2773 | 2777 | 2781 | 2785 | 2789 | 2793 | 2797 | 2801 | 2805 | 2809 | 2813 | 2817 | 2821 | 2825 | 2829 | 2833 | 2837 | 2841 | 2845 | 2849 | 2853 | 2857 | 2861 | 2865 | 2869 | 2873 | 2877 | 2881 | 2885 | 2889 | 2893 | 2897 | 2901 | 2905 | 2909 | 2913 | 2917 | 2921 | 2925 | 2929 | 2933 | 2937 | 2941 | 2945 | 2949 | 2953 | 2957 | 2961 | 2965 | 2969 | 2973 | 2977 | 2981 | 2985 | 2989 | 2993 | 2997 | 3001 | 3005 | 3009 | 3013 | 3017 | 3021 | 3025 | 3029 | 3033 | 3037 | 3041 | 3045 | 3049 | 3053 | 3057 | 3061 | 3065 | 3069 | 3073 | 3077 | 3081 | 3085 | 3089 | 3093 | 3097 | 3101 | 3105 | 3109 | 3113 | 3117 | 3121 | 3125 | 3129 | 3133 | 3137 | 3141 | 3145 | 3149 | 3153 | 3157 | 3161 | 3165 | 3169 | 3173 | 3177 | 3181 | 3185 | 3189 | 3193 | 3197 | 3201 | 3205 | 3209 | 3213 | 3217 | 3221 | 3225 | 3229 | 3233 | 3237 | 3241 | 3245 | 3249 | 3253 | 3257 | 3261 | 3265 | 3269 | 3273 | 3277 | 3281 | 3285 | 3289 | 3293 | 3297 | 3301 | 3305 | 3309 | 3313 | 3317 | 3321 | 3325 | 3329 | 3333 | 3337 | 3341 | 3345 | 3349 | 3353 | 3357 | 3361 | 3365 | 3369 | 3373 | 3377 | 3381 | 3385 | 3389 | 3393 | 3397 | 3401 | 3405 | 3409 | 3413 | 3417 | 3421 | 3425 | 3429 | 3433 | 3437 | 3441 | 3445 | 3449 | 3453 | 3457 | 3461 | 3465 | 3469 | 3473 | 3477 | 3481 | 3485 | 3489 | 3493 | 3497 | 3501 | 3505 | 3509 | 3513 | 3517 | 3521 | 3525 | 3529 | 3533 | 3537 | 3541 | 3545 | 3549 | 3553 | 3557 | 3561 | 3565 | 3569 | 3573 | 3577 | 3581 | 3585 | 3589 | 3593 | 3597 | 3601 | 3605 | 3609 | 3613 | 3617 | 3621 | 3625 | 3629 | 3633 | 3637 | 3641 | 3645 | 3649 | 3653 | 3657 | 3661 | 3665 | 3669 | 3673 | 3677 | 3681 | 3685 | 3689 | 3693 | 3697 | 3701 | 3705 | 3709 | 3713 | 3717 | 3721 | 3725 | 3729 | 3733 | 3737 | 3741 | 3745 | 3749 | 3753 | 3757 | 3761 | 3765 | 3769 | 3773 | 3777 | 3781 | 3785 | 3789 | 3793 | 3797 | 3801 | 3805 | 3809 | 3813 | 3817 | 3821 | 3825 | 3829 | 3833 | 3837 | 3841 | 3845 | 3849 | 3853 | 3857 | 3861 | 3865 | 3869 | 3873 | 3877 | 3881 | 3885 | 3889 | 3893 | 3897 | 3901 | 3905 | 3909 | 3913 | 3917 | 3921 | 3925 | 3929 | 3933 | 3937 | 3941 | 3945 | 3949 | 3953 | 3957 | 3961 | 3965 | 3969 | 3973 | 3977 | 3981 | 3985 | 3989 | 3993 | 3997 | 4001 | 4005 | 4009 | 4013 | 4017 | 4021 | 4025 | 4029 | 4033 | 4037 | 4041 | 4045 | 4049 | 4053 | 4057 | 4061 | 4 |