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| Australian Government coat of arms and ANSTO logo. |
| Stage 4 Science |
| Student excursion workbook |

# Your visit to ANSTO

At the Discovery Centre, you will:

* explore the features of an atom
* describe the historical development of the periodic table
* investigate the structure of the modern periodic table, including the existence of radioactive elements
* observe a demonstration of the radioactivity of different objects used in the past
* collect data to investigate the weight of atoms of different elements, and relate the weight to the location of the element on the periodic table
* explore the atomic structure of some elements, and recognise that an element is identified by its number of protons
* Investigate the symbols, properties and classification of some elements

On site, you will visit:

* The OPAL (Open Pool Australian Lightwater) Research Reactor to understand the uses of OPAL, including to create radioactive atoms of elements for use in nuclear medicine
* The Australian Centre for Neutron Scattering which makes use of neutrons to see inside materials at the atomic scale
* The Centre for Accelerator Science that uses naturally occurring radioactive atoms to determine the age of materials, and uses accelerated protons to measure and characterise fine particle air pollution

The tour will conclude at the Discovery Centre.

# Pre-Tour Questions

We expect students to have completed this pre-work prior to attending the tour. It consists of questions on concepts that are necessary to an understanding of the activities and science to be covered in the tour.

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## Question 1: Atomic structure

## Read the following information and use it to complete the activities below:

|  |
| --- |
| Everything in the universe is made up of **atoms** –air, water, rocks and soil, stars and you! The atom is the basic building block of all matter. If you could see inside an atom, you would find mostly empty space, and at its centre you would find an extremely tiny **nucleus.** The nucleus of an atom is made up of protons and neutrons, while electrons orbit the nucleus in the empty space that surrounds it. The nucleus contains nearly all the mass of the atom. The mass of an atom is measured in atomic mass units, or amu. Protons and neutrons have a similar mass, of around 1 amu. Electrons are extremely lightweight, with a mass of only 0.0005 amu, which is 1/2000th the mass of a proton or a neutron!Atoms are electrically neutral, having the same number of electrons as they do protons. This is because electrons have a negative (-1) charge, whereas protons have a positive (+1) charge. Neutrons have no charge, and help to bind the nucleus together.A substance that consists of one type of atom only is called an **element**. All the known elements, both naturally occurring and man-made, are listed on a chart called the **periodic table**. |

## Fill in the blanks with the following words:

***Charge neutrons nucleus protons positive atoms electrons***

All matter is made of \_\_\_\_\_\_\_\_\_\_\_\_ .

Atoms are composed of \_\_\_\_\_\_\_\_\_\_\_\_, neutrons and electrons.

Protons have a \_\_\_\_\_\_\_\_\_\_\_\_ charge and are found in the \_\_\_\_\_\_\_\_\_\_\_\_ of an atom.

\_\_\_\_\_\_\_\_\_\_\_\_ have a negative charge and orbit the nucleus.

\_\_\_\_\_\_\_\_\_\_\_\_ have no \_\_\_\_\_\_\_\_\_\_\_\_ and are found in the nucleus.

## Complete the table below to show the difference in location, relative charge and mass of the particles that make up an atom.

|  |  |  |  |
| --- | --- | --- | --- |
| Particle in atom | Location of particle in atom | Relative charge  | Mass of particle (atomic mass units, amu) |
| proton |  |  | 1 |
|  |  | 0 |  |
|  | Orbiting in the empty space surrounding the nucleus  |  |  |

## A neutral atom of an element has 9 protons and 10 neutrons. Use this information to complete a model of this atom on the outline below.

**HINT:** Remember a neutral atom has the same number of electrons as it has protons. Also, only 2 electrons can be in the first electron shell from the nucleus.

Electron shells

nucleus

**Question 2: The Periodic Table**

1. The periodic table lists all the known elements according to the number of protons in the nucleus of their atoms. Use a periodic table to complete the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Name of element** | **Element Symbol** | **Number of protons** | **Number of electrons** |
| Hydrogen |  |  |  |
|  | Li |  |  |
|  |  | 9 |  |
| Nitrogen |  |  |  |
|  | K |  |  |

1. How many elements are listed on the periodic table? …………………………………………………

**Question 3: Radioactive elements**

## Some elements on the periodic table are radioactive. You can see these elements identified on the ANSTO periodic table which you can download from this webpage [Posters | Education resources | ANSTO](https://www.ansto.gov.au/education/school-resources/posters) Being radioactive means that their atoms emit nuclear radiation. Nuclear radiation is energy emitted by the nucleus of their atoms as high speed charged particles or rays. Of these radioactive elements, those beyond element number 92 are human-made, however, neptunium (number 93) and plutonium (number 94) also occur in nature in minute amounts.

1. Draw the symbol that is used to show that something is radioactive.
2. List three naturally occurring radioactive elements.

…………………………………………… …………………………………………… ……………………………………………

1. List three human-made radioactive elements.

…………………………………………… …………………………………………… ……………………………………………

1. Name a naturally occurring radioactive element that is a gas.

……………………………………………

**During-excursion activities**

You will be allocated to a group to complete THREE activities. You will have 10 minutes to complete each activity. An ANSTO Education Officer will time each activity and direct each group to their next activity. **Do not move on** until directed by an Education Officer.

**Activity 1: Mass of atoms**

You have been given pieces of five different elements- tin, carbon, aluminium, lead and copper. All of the element pieces contain the ***same number of atoms***.

Element symbol

Atomic

Number

|  |  |
| --- | --- |
| 1. Weigh each of the element pieces using the digital scales, and record the weight in grams in the table below.
2. Match the element pieces to their element on the periodic table provided. Record the atomic number of the element in the table below.
 |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Element name | tin | carbon | aluminium | lead | copper |
| Weight (grams) |  |  |  |  |  |
| Symbol |  |  |  |  |  |
| Atomic Number |  |  |  |  |  |

1. Write the names of the elements in order from lightest to heaviest piece, and write the atomic number for each element in the box below its name.

 Lightest piece on left Heaviest piece on right
 **↓** **↓**

 **\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_**

All these element pieces contain the **same number of atoms**, so why do they have different weights?

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What can you say about the order of the element pieces by weight and the order the elements are on the periodic table?

…………………………………………………………………………………………………………………………………………………………

**Activity 2: Building Atoms**

## Use the iPad ‘Build an Atom’ simulator to build an atom for each of the elements listed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Element name | Element symbol | Number of protons | Number of neutrons(to be stable) | Number of electrons(to be a neutral atom) |
| beryllium |  |  |  |  |
| nitrogen |  |  |  |  |
| oxygen |  |  |  |  |
| neon |  |  |  |  |

What particle (electron, proton or neutron) do you add to the atom to change it from one element to another? ……………………………

## Now build two different naturally occurring carbon atoms called carbon-12 and carbon-14.

## Note: the number after the element name refers to the total number of protons and neutrons in the nucleus of the atom.

## Draw these atoms showing their protons, neutrons and electrons. Use a key to identify each of the subatomic particles.

**Key**

Proton

Neutron

Electron

nucleus

nucleus

**Carbon-12**

**Carbon-14**

How are these atoms the same?

……………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

How are these atoms different?

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**Activity 3: It’s elementary!**

* You have been given **10** different elements, each enclosed in a clear plastic container.
* **DO NOT OPEN the container** or take the container from the plastic bag if present.
* Look at **the symbol** shown on the element and use it to **place each element in its correct position on the periodic table**, and find its number and name.
* Use the **key** to determine whether the element is a metal, non-metal or metalloid (that is, a semimetal).

|  |  |  |  |
| --- | --- | --- | --- |
| **Element symbol** | **What number is this element on the periodic table?** | **What is this element’s name?**  | **Is the element a metal, non-metal or a metalloid (semimetal)?** |
| Fe |  |  |  |
| S |  |  |  |
| Pb |  |  |  |
| Mo |  |  |  |
| Si |  |  |  |
| C |  |  |  |

1. What does the number on the periodic table for each element tell you about the atom of that element? (**HINT**: Each atom contains protons, neutrons and electrons)

………………………………………………………………………………………………………………………………………………..

1. Some of the symbols for the elements do not match their names. This is because the symbols are from their Latin names.

Which elements from those we have provided have symbols from their Latin names?

…………………………………… …………………………………… ……………………………………

1. Place a magnet on top of each of the clear plastic element containers.

Which of these elements is attracted to the magnet?

(**HINT**: you will see the element go towards the magnet)

…………………………………… …………………………………… ……………………………………

1. State the everyday objects made from the following elements.

(**HINT:** look at the picture for that element)

|  |  |
| --- | --- |
| **Element symbol** | **Object made from this element** |
| C |  |
| Si |  |
| Ti |  |

**Activity 4: Measuring radiation (during presentation)**

An instrument called a scintillation counter can be used to detect and measure nuclear radiation (radioactivity) from radioactive atoms. In this activity, the radioactivity of a variety of different objects will be investigated.

## Fill out the table below stating the radioactivity of each source and the atoms that make the source radioactive.

|  |  |  |
| --- | --- | --- |
| **Radiation source** | **Radioactivity (counts per second)** | **What makes this source radioactive?** |
| Background radiation |  |  |
| Uranium glass |  |  |
| Thorium gas mantle |  |  |
| Radium watch |  |  |
| Fiestaware plate |  |  |

## How does the reading on the scintillation counter change as the detector is moved further away from the fiestaware plate?

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## Post-tour Learning Activity 1: Elements in objects

## Elements are used in objects because they have the properties that suit the use of the object.

## Match the name of the element from the list below with the object for which it is used.

(**HINT**: you can use your ANSTO Periodic table of the elements to help you)

*Lithium nickel iodine americium aluminium lead helium hafnium*

|  |  |
| --- | --- |
| Object  | Element used in object |
| Control plates used in the OPAL reactor to absorb neutrons |  |
| Lining of pots used to transport radioactive material and nuclear medicine |  |
| Soft drink cans and the containers used for the targets that are irradiated in the OPAL reactor |  |
| Electrical wires in our homes |  |
| Smoke detectors in our homes |  |
| Electrode in batteries used in watches, mobile phones and computers |  |
| Gas in party balloons  |  |
| Antiseptic solution for cleaning cuts and wounds  |  |

1. Which of the elements listed is a radioactive element? …………………………………………………………
2. Which of the elements listed are non-metal elements? …………………………………………………………

## Post-tour Learning Activity 2: Exploring the Periodic table

Use your ANSTO Periodic Table of the elements to answer the questions below.

|  |  |  |
| --- | --- | --- |
|  | Question | Answer |
| 1 | Which element is used in making money coins, such as our 5c and 20c coins? |  |
| 2 | In which year was the element silicon discovered? |  |
| 3 | Identify an element named after a planet. |  |
| 4 | What is the number of the element on the periodic table named after the person who is often referred to as the ‘father of the periodic table?  |  |
| 5 |  Name the non-metal element that exists as a liquid at standard room temperature and air pressure (250C and 101 kPa). |  |
| 6 | Name the element that was discovered in 1735 and is used to make jewellery. |  |
| 7 | Name a radioactive element whose compounds were used in glow-in-the-dark paint for clock and watch dials. |  |
| 8 | How many elements on the periodic table were discovered in **2016**? |  |
| 9 | Which element found in compounds in toothpaste strengthens tooth enamel and prevents cavities? |  |
| 10 | Name a metalloid (semimetal) element that was known in ancient times, and one of its compounds was used in mascara known as kohl. (**HINT**: has BC for year of discovery). |  |
| 11 | State one letter of the alphabet that is not found in any of the element symbols. |  |
| 12 | Name an element whose compounds produce red fireworks. |  |