MODULE: *Matter 1*

Intervention Session
Teaching Guide

This session has been designed to help your students to practice answering PISA questions, both paper and computer based assessments about Matter. The computer based assessment item is the interactive that goes with this module. This intervention also helps your students to practice reading and interpreting text; analysing and interpreting data; evaluating scientific inquiries; and explaining key concepts and applying their understanding.

It must be emphasised that PISA assessment items are not designed to test knowledge in the approach of TIMSS assessment items. PISA assessment items are designed to test students' ability to read and interpret text, analyse and interpret data, evaluate scientific inquiries; explain the outcomes of enquiries using their scientific understanding; and apply their understanding of how the world of science works. These assessment items have been designed to help students practice those skills.

1. (15 minutes)

Carry out the Hunting for Quarks computer based assessment question on the computer. Read the information, instructions and questions carefully before selecting or typing in your answers.

Remember that you can navigate backwards and forwards to check and change your answers.

When you have finished, print your answers by clicking on the print icon.

Q1 *a. protons and neutons*
b. electrons

Q2 *a. electrons*
b. close to the speed of light
c. particle accelerator
d. how much the electrons would be deflected

Q3 *Labels starting on right and moving clockwise*
electron
target containing protons
some electrons pass straight through
scattering angle
some electrons are deflected

Q4 *a. Theory one suggests the proton is a single particle whereas theory two suggests it is made up of 3 small particles.*

b. If theory one was correct there would be a small scattering of electrons. The quark theory would give a large scattering angle.

Q5 *a. Quark theory*

b. Some of the electrons were scattered between 150 and 180 degrees

c. Protons are made of even tinier particles called quarks

2. (10 minutes)

Read the information below and then answer the questions.

Atoms and Bonding

Atoms are the smallest particle that can exist on their own. One type of atom can't be changed into another type through normal reactions and by physical changes.

Atoms of all the same type make substances called elements. Atoms of two or more different types can join together in fixed combinations; this makes compounds.
The atoms in compounds can be grouped together either as molecules, or as giant structures in an array.

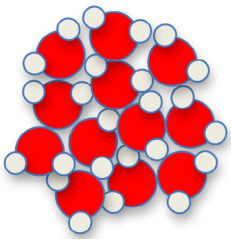
The properties of elements and compounds depend on how the atoms, molecules and giant structures are bonded together.

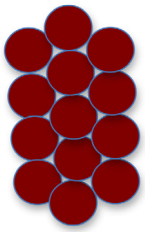
Making new and useful materials depends on knowing how to manipulate atoms.

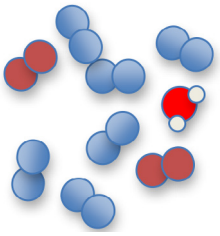
Particle Pictures

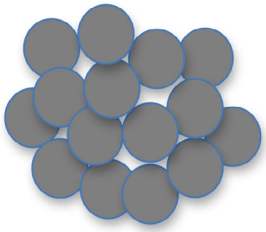
- Particle pictures are a way of showing the structure of particles in a substance. They are not real pictures, because the particles are too small to see with our eyes – even by using a microscope.
- A substance can be classified as either a **mixture** (with two or more different types of molecule in it) or a **pure substance** (with one type of molecule in it).
    - A pure substance can then be classified as a compound (with two or more different types of atom in it) or an element (with one type of atom in it).

A substance can also be classified as a **solid**, a **liquid** or a **gas**. Particle pictures give clues to this, as well.

A 

B 

C 

D 

a. Explain how you would classify substance A. Give reasons for your answer.

A is a (pure substance) compound and a liquid.

Because:

the molecules are made from more than one type of atom

and the molecules are in contact with each other, but not in a pattern.

b. Explain how you would classify substance B. Give reasons for your answer.

B is a (pure substance) element and a solid.

Because:

the particles are made from only one type of atom

and the particles are in contact and in a pattern.

c. Explain how you would classify substance C. Give reasons for your answer.

C is a mixture and a gas

Because

the molecules are of different types.

and the molecules are not in contact with each other.

d. Explain how you would classify substance D. Give reasons for your answer.

D is a (pure substance) element and a liquid.

Because

the particles are made from only one type of atom. (1 mark)

and the particles are in contact but not in a pattern (1 mark).

3. (5 minutes)

Inside atoms

We can only change, or ‘split’, atoms by using huge amounts of energy. So for practical purposes, and under normal circumstances, we think of atoms as being indestructible.

But atoms are actually made up of tiny sub-atomic particles. These particles cannot exist on their own.

They are called protons, neutrons and electrons.

They have different masses and different electrical charges.

They do different jobs in the atom.

The nucleus has the protons and neutrons. They are almost the same as each other, except each proton has a positive electrical charge and each neutron has no charge.

The protons give the atom its ‘atomic weight’, hence its properties.

The neutrons help stop the protons flying apart.

Describe the central nucleus of an atom and explain what particles are found there.

Explain what types of sub-atomic particle are found there.

Describe what each particle is like.

Describe the similarities and differences between the particles in the nucleus.

Describe what each of those particles does in the atom.

Answer

The nucleus is very, very small compared to the size of an atom.

The nucleus contains nearly all the mass of the atom.

The nucleus consists of protons and neutrons.

A proton has a mass equal to that of a neutron.

Protons have a positive electrical charge.

Neutrons have no overall charge.

Protons determine the type of the atom.

Neutrons are the particles that hold the nucleus together.

4. (5 Minutes)

The outer part of an atom

Outside the nucleus are the electrons.

They are very tiny indeed, with almost no mass - much, much smaller than protons and neutrons.

They move so fast around the nucleus that they form one or more ‘shells’ around it.

Each electron has a negative charge.

An atom normally has the same number of electrons as protons.

So the electrons’ negative charge balances the protons’ positive charge. This means that an atom normally has no charge.

The electrons fill the outer part of the atom, and are the part other atoms react with.

Describe the rest of the atom other than the nucleus

State what type of sub-atomic particle is found there, and describe what that particle is like.

Describe the differences between the particles outside the nucleus and those inside it.

Describe what the outer particles do.

Answer

The rest of the atom is made up of shells of electrons.

Electrons are very small in size, even compared to a proton or neutron.

They have a tiny mass, much less than a proton or neutron. Electrons move round the atom very, very fast, so fast that they seem to make complete shells round the nucleus.

Each electron has a negative charge that exactly balances the positive charge of a proton.

So in a neutral atom there has to be an equal number of protons and electrons (1 mark).

Also:

Electrons occupy most of the space in an atom.

As they are the outer part of the atom, they are only part of it that other atoms can interact with.

5. (5 minutes)

Elements and compounds

- When atoms of the same type join up, they make elements.
- When different types of atoms join up in lots of identical combinations, and those combinations then join up, they make compounds.
- Elements and compounds are examples of pure substances, because all their molecules are the same as each other.

Sort the materials in the list into the three boxes below

Helium	Chalk	Gold
Ethanoic acid (vinegar)	Cake	Magnesium oxide
Nitrogen	Brine	Zinc metal
Polythene	Hard rubber for tyres	Diamond

Answers

Elements	***Compounds***	***Mixtures***
Helium	*Chalk*	*Cake*
Gold	*Ethanoic acid (vinegar)*	*Brine*
Nitrogen	*Magnesium oxide*	*Hard rubber for tyres*
Zinc metal	*Polyethene*	
Diamond		

6. (10 minutes)

Atoms make molecules

- Water is no longer defined as an element, despite what the Ancients thought. For them, the elements were fire, earth, air and water. But for us, none of these are elements.
- Water is the most important substance in our lives, and we define water as a pure substance, a compound. When two atoms of hydrogen react with one atom of oxygen, this makes a molecule of water.
- We can make water by burning hydrogen gas in air (which of course has oxygen in it).
- And we can make the reverse happen; passing an electric current through water can break it up into the gases it's made from: oxygen and hydrogen.
- But in water molecules, the oxygen atom and hydrogen atoms are very strongly bonded. So it takes a lot of electrical energy to pull them apart.
- Hydrogen and oxygen cannot be broken down into simpler materials; they are two of the 118 elements we know exist, of which 90 occur on Earth.
- Water is not the only compound made of hydrogen and oxygen. There is a compound made of molecules each with two oxygen atoms bonded to two hydrogen atoms: hydrogen peroxide.

What did the Ancients define as the elements?

Earth, air, fire, water

What do we define as an element?

A substance whose atoms are all the same type

Describe a particle of water; what is this particle called?

Two hydrogen atoms bonded to one oxygen atom

This is a water molecule

How many elements are there? And how many of these can be found in naturally?

118 are known

90 occur naturally

from the text

Describe what a particle of hydrogen peroxide would look like.

Two hydrogen atoms would have chemical bonds to two oxygen atoms, it would look like water molecule with an extra oxygen atom in the middle (correct molecular structure not required at this stage).

Would you expect hydrogen peroxide to have similar properties to water?

Yes

The atoms making up the molecule of hydrogen peroxide are very similar to those making up water, and hydrogen peroxide is, like water, a molecular structure; so its properties are similar to those of water.

7. (10 minutes)

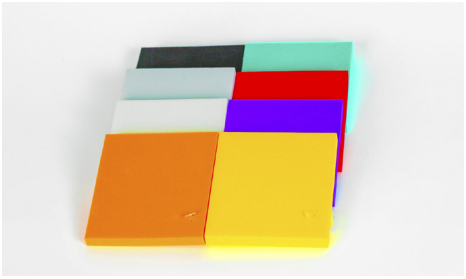
Structure and bonding

Diamond is a giant structure of carbon atoms. Each carbon atom shares electrons with four other carbon atoms around it. This sharing of electrons with four neighbouring carbon atoms extends for millions of atoms in three dimensions.

Because of this giant structure, diamond is one of the hardest materials known to us.

Polystyrene is a common plastic. It is made of long, straight molecules that stick to each other with some force of attraction. Because that force of attraction is weak, polystyrene is fairly flexible, and is used in many places where a rigid material would break.

Diamond



Polystyrene

a. What is it about a diamond that makes it very hard?

Its structure, with all its atoms strongly bonded to each other .

b. Would you expect diamond to melt easily? Explain your answer.

No it would not melt easily.

The strong forces holding the atoms in a fixed arrangement will need a high temperature and lots of particle vibrations before the forces are broken.

c. What hardness would you expect from polystyrene compared to diamond?

Polystyrene would be softer.

The force of attraction between its molecules are weaker than the forces in diamond.

d. Would you expect polystyrene to melt easily? Explain your answer.

Yes, it would melt easily.

The weak forces holding the atoms in a fixed arrangement will need only a moderate temperature and small particle vibrations before the forces are broken.

e. Suggest a use for diamond (other than jewellery) Explain your answer.

A cutting tool

It is one of the hardest substances known so it will scratch away almost any other material.

(Or another appropriate answer, correctly explained – but not jewellery or decorative use).

f. Suggest a use for polystyrene. Explain your answer.

A flexible application such as a box with a sealable lid for food.

The structure of polystyrene and the weak forces between its molecules means it will flex and not break when bent slightly.

(Or another appropriate answer, correctly explained)