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Teaching Pack

For BTEC First Award in Applied Science

Unit 1: Principles of Science

2nd Edition, January 2013

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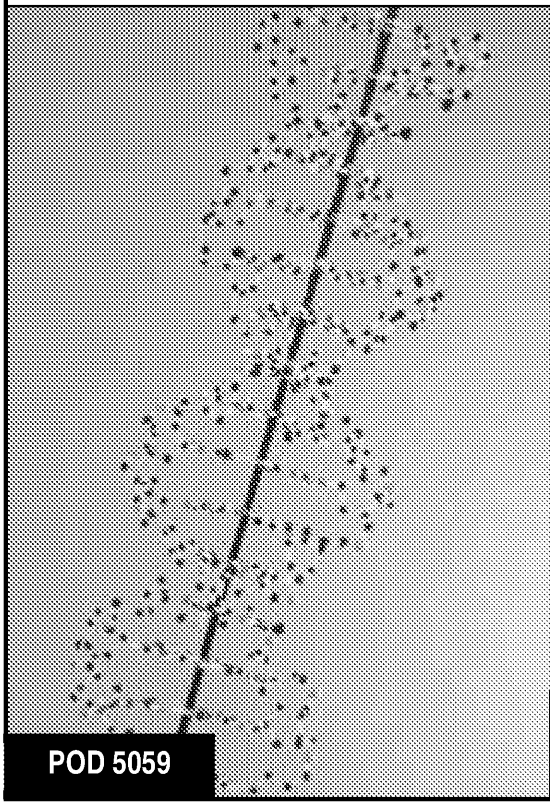

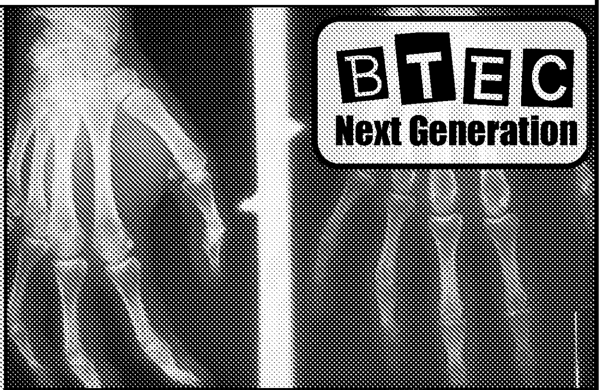

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It is the teacher's responsibility to ensure the safety of their students in the classroom instructions carefully and are confident in your own knowledge before carrying out demonstrations suggested in this resource. If you are unsure about anything, seek a experiments in the classroom.

Teacher's Introduction

This unit is taught over 30 guided learning hours (GLH). Teachers will ha
balance between teaching and exam practise – this scheme of work sugges
teacher-taught hours and 13 lessons for exam practise and catch-up time f
lessons or need extra support. 'Did you know' boxes are included to give s
information about the topic – they do not need to know this information f

This pack contains the following materials:

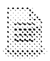
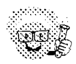
1. A single-page overview scheme of work
2. 17 lesson plans
3. Notes for each lessons covering all the learning aims between them
4. Exam-Style questions in non-write-on and write-on formats to reinfor

This resource is designed to be flexible in the following ways:

- For each lesson there is a lesson plan followed by student notes and q repeated provided in write-on format. You could use the material in o
  1. Use the notes to support your classroom teaching and then hand o questions or the write-on questions at the end of the lesson (possi
  2. Use the notes to supplement your own notes or the textbook and the lesson as a summary with the questions so students can comp notes as support.
  3. Just use the questions (either write-on or non-write-on as approp and subsequently hand out the notes at revision time.

Suggested Scheme of Work

	GLH/LP	Learning Aim	T
Biology	**1**	A.1 & A.2	The structure, function and ada
	2	A.3, A.4 & A.5	Cells, tissues, organs, organ sys
	3	A.6, A.7 & A.8	DNA, chromosomes and genes
	4	A.9, A.11 & A.12	Inheritance and genetic diagram
	5	A.10, A.11 & A.13	Pedigree analysis and genetic m
	6	B.1–B.7	Homeostasis, the nervous syste
	7	B.8 & B.9	Blood glucose and body tempe
Chemistry	**8**	C	Atomic structure and the period
	9	D.1–D.5 & D.14	Chemical substances, reactions
	10	D.3–4, D.6–D.7 & D.12–14	Hazard symbols and neutralisa
	11	D.3, D.4, D.8, D.10 & D.14	Exploring chemical reactions
	12	D.11 & D.14	pH and Universal indicator
Physics	**13**	E.1 & E.2	Energy forms and energy stores
	14	E.3 & E.4	Energy transformations and tra
	15	E.4 & E.5	Power and efficiency
	16	E.6	Sources of energy
	17	F	The electromagnetic spectrum
	18–30	**Opportunity for catch-up and exam practise*	

Lesson Plan Key	
	content provided in teaching notes
	suggested class practical
	suggested teacher demonstration

Lesson Plan 1 – The Structure, Functions and Eukaryotic Cells

Learning Aims

Pupils should understand:

The basic structure, function and adaptations of the following eukaryotic

- motor and sensory neurones
- red blood cells
- white blood cells
- egg cells
- sperm cells
- root hair cells
- xylem and phloe
- guard cells

The function of the following components of eukaryotic cells:

- nucleus: contains genetic information that controls the activities of the cell.
- cytoplasm: where most chemical reactions take place.
- cell membrane: allows entry and exit of substances.
- chloroplasts: the
- cell wall: provide
- vacuole: contains support for the ce
- mitochondria: th

Key words: eukaryotic cells, cell function and structure, specialised cells,

Starter

Ask pupils what a cell is and what they could find in it.

Main

1. Elicit answers.
2. Explain the difference between a prokaryotic cell and a eukaryoti
3. Explain the function of the nucleus, cell membrane, cytoplasm, ch and mitochondria.
4. Explain the functions and adaptations of: a. motor and sensory ne role play – arrange the class in a line, give the first pupil a messag message along. Compare the two messages.) b. red blood cells, c. e. sperm cells, f. root hair cells, g. xylem and phloem cells, h. guar two long balloons with tape on one side).
5. Answer Questions 1–6 from the pack.
6. Go through the answers.
7. Preparation of onion cell slide. Cut onions into 2 cm slices. Snap t peel back the membrane. Place on a slide and add a few drops of microscope and draw the image.
8. Discuss the results. Draw and label pictures.

Plenary

On large sheets of paper write all the types of cell and organelle studied (c to the walls around the classroom. Gather the class in the middle of the ro function of any cell or organelle and pupils need to move to stand next to cells and organelles. This can be adapted if facilities allow by taking the pu competitive edge, i.e. last person to the correct sign is out. Winner gets a p

Eukaryotic Cells

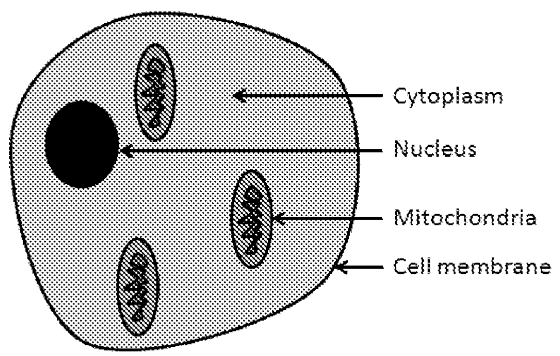
Eukaryotic cells are one of two main types of cells, the other being prokaryotic ce which have a true nucleus, such as animal and plant cells. Prokaryotic cells are th such as bacterial cells. Cells are the basic unit of life; some organisms such as an a of just one cell), and other organisms such as you are multicellular (made up of m things are made up of cells which are typically around 10–100 µm (1 µm = 0.001 m

Cell Function and Structure

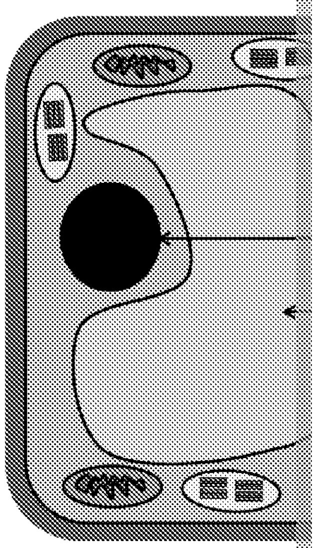
Cells themselves are made up of components called organelles. There are three o nearly all cells; they are a nucleus, a cell membrane and cytoplasm. However, ne means they have adaptations that make them better for their job.

Organelle	Function
Nucleus	Contains the genetic information (e.g. DNA) and contro the cells activities
Cell Membrane	Partially permeable layer which surrounds the cell and controls which substances enter and leave the cell
Cytoplasm	The location where most of the cells' vital chemical reactions occur
Chloroplast	Contains chlorophyll, where photosynthesis (plants' wa of making food through light) occurs
Cell walls	Provide the structural support needed to keep organis upright without bones. Made from cellulose
Vacuole	Contains cell sap and gives more structural support
Mitochondria	Where respiration (conversion of sugar into energy) occurs; therefore producing energy for the cell

A typical animal cell



A typical plant cell



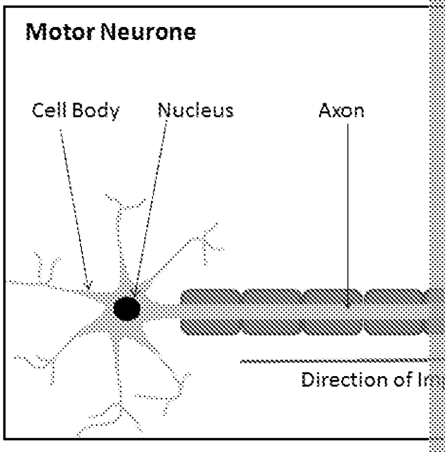
Specialised Cells

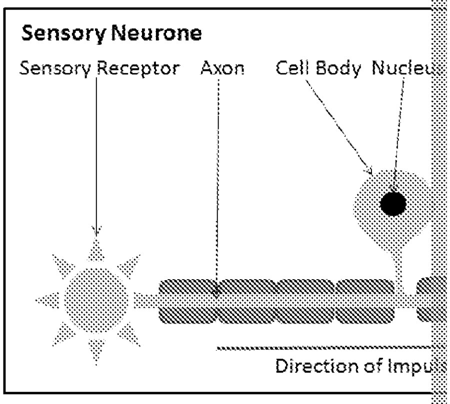
Neurones

Neurones are animal cells that allow the transfer of electrical signals from one pa
are the cells that pass the signal from your brain to your muscles to move your b
from your hands to your brain telling you something is hot, plus countless other

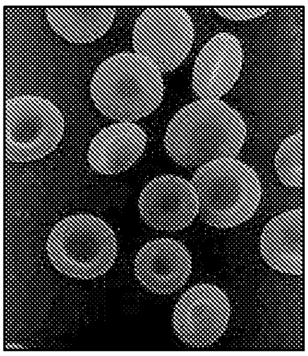
There are several types of neurones. One is the **sensory neurone**. These pass a s
the skin) to the spinal cord (which then goes on to the brain). Another is the **mot**
messages from the spinal cord to effectors such as muscles.

The major adaptation of neurones is their size. Unlike many cells, which are only around 10–100 μm in length, neurones can be up to a metre long and can go from the tip of your toe all the way to the spine. This is very important because it means that messages can be sent from one part of the body to another quickly and without interruption or corruption. Imagine if the job of passing on a message from your toe to your spinal cord was done by millions of cells next to each other. It would be like a game of Chinese whispers. Not only would the final message likely be very different from the original one, it would take very long and any one of the cells could make an error and ruin the message. They are also capable of linking with many other cells, making them very versatile.





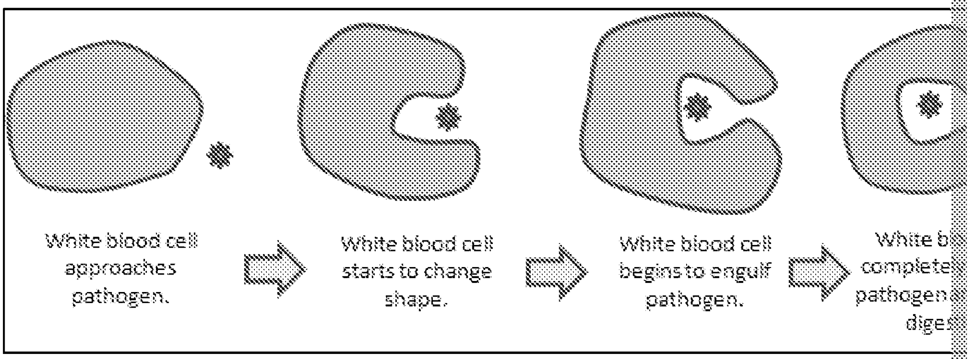
Red Blood Cells



Red blood cells are the animal cells responsible for ca
to the cells that need it for respiration. Red blood cell
to suit their function; firstly they are filled with a red
binds the oxygen inside the cell. The second adaptati
blood cells do not need to replicate themselves (they
body) or do many other normal cell functions, they d
be a little like taking all your school books with you w
of the nucleus means there is more room for more ha
more oxygen. Another adaptation is their shape; they
small ball of plasticine pinched in the middle). This sh
easily through the narrow capillaries (blood vessels) o
cells' surface area, meaning that oxygen can move ou

White Blood Cells

White blood cells are the animal cells responsible for fighting off infection. They
white blood cell is responsible for a process called **phagocytosis**. This is a way of
(disease-causing microorganisms) that may have invaded your body. To allow th
change shape in order to engulf the foreign cells.

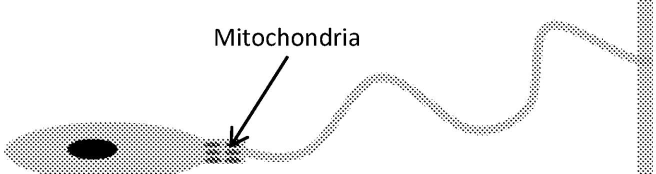


Phagocytosis

Egg Cells

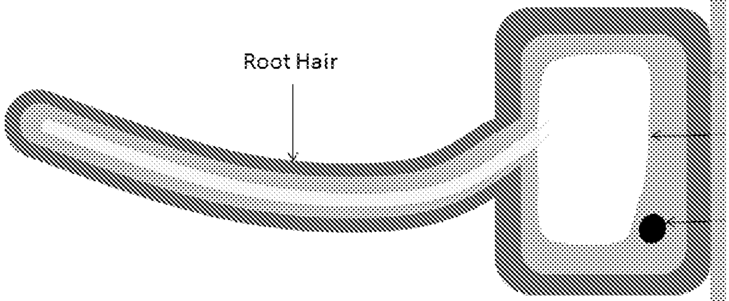
Egg cells are the reproductive cells produced by the female and are needed in th
production of new offspring. The egg cell has three main adaptations. The first is
relatively large size; this allows the egg to provide energy and nutrients to the gr
embryo and foetus. The eggs that you may have for your breakfast are still only o
cell big. The second adaptation is the genetic information contained within its nu
Most human cells have 46 chromosomes (23 pairs) worth of genetic information
is always split up into sections called **chromosomes**). Egg cells only contain half t
genetic information needed to make another cell. The other half comes from the
sperm at fertilisation. The third important adaptation is the fact that once a sper
has broken through the membrane and fertilised the egg a chemical reaction ha
in the membrane which prevents any other sperm cells from entering.

Sperm Cells



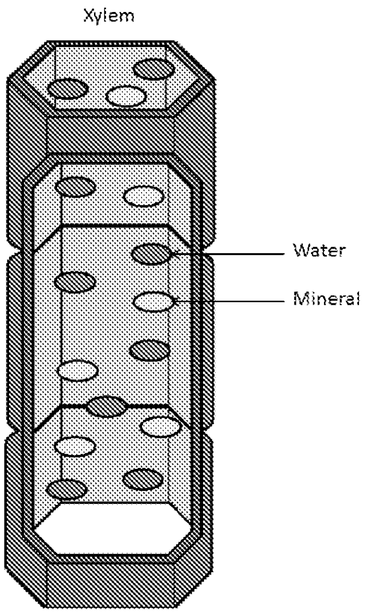
Sperm cells are the male animal reproductive cell. Their job is to reach the egg a
This is not an easy job considering the size of the sperm (about 30µm including t
adaptations to help it, most noticeably a tail that allows it to swim with greater s
sperm contains enzymes making it easier to penetrate the egg if it eventually ma
adaptation is mirrored in the egg; sperm cells only contain half the genetic inform
cell. The other half comes from the egg at fertilisation. Also within the base of th
mitochondria which provide energy for the movement of the tail.

Root Hair Cells



Root hair cells are plant cells that can be found, unsurprisingly, in the roots. Thei
water and dissolved minerals from the soil into the plant tissue. The root hair ce
having long hair-like projections, which give it a large surface area to help speed
large vacuole which helps the water move from the soil into the cell. Finally they
(which carries the water around the plant).

Xylem



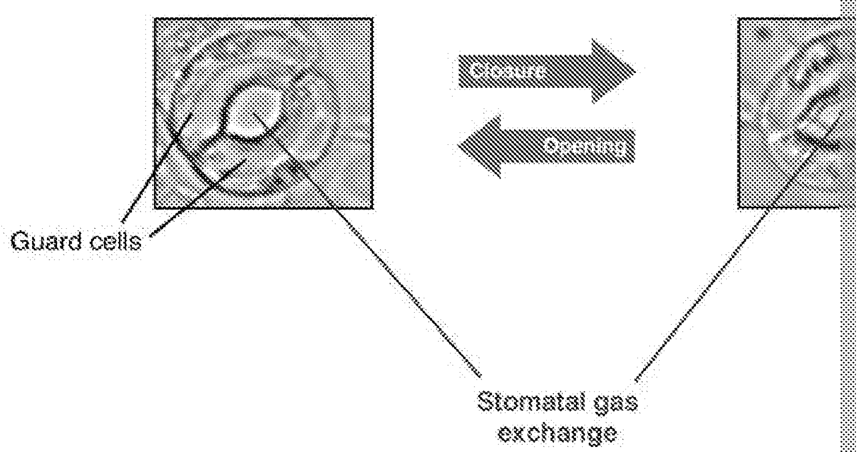
Xylem is a part of a plant's transport system
veins). The function of xylem is to transport
leaves, where it is required for photosynthe
number of adaptations; firstly the cells are b
are joined end on end up the stem. The side
other xylem cells, have no ends allowing the
to the next. They are also very narrow, allow
phenomenon of water moving up very narro
intermolecular forces between water molec
Another adaptation is the fact that xylem is
impermeable to water, to prevent water lea

Phloem

Phloem is another part of a plant's transport system. The function of phloem is to transport sugars from the leaves to the parts of the plant where it is needed. It has similar adaptations to xylem in that it forms long connected hollow tubes; however unlike xylem phloem is alive. Phloem cells are located next to companion cells; these are filled with mitochondria which allow the sugars to be actively transported (transported against the concentration gradient from low concentration to high concentration) around the plant.

Guard Cells

Guard cells are located on the underside of leaves and form holes called stoma (
carbon dioxide gas to move into the leaves for use in photosynthesis, and oxygen
having one wall thicker than the other side. Then at times when there is plenty o
thinner side swells more than the thicker side, causing it to bend. Another guard
thus forming a hole in between the cells.



Eukaryotic Cells Summary

Cell	Function	
Neurones	To pass electrical signals around the body.	Very long.
Red blood cells	Carry oxygen around the body.	No nucleus. Bico Co
White blood cells	To fight infection.	C
Egg	Female reproductive cell. Provides nourishment.	Large size. Conta o
Sperm	Male reproductive cell. Swims to the egg.	Tail. Enzymes normal an
Root hair	Absorption of water and dissolved minerals.	Large surface ar
Xylem	Transport of water through a plant.	Dead. Narro Connected to ot
Phloem	Transport of sugar through a plant.	Hollow tubes. C near companio fo
Guard cells	Allows passage of carbon dioxide into the leaves and oxygen out of the leaves.	One wall thicker

Exam-Style Questions – Eukaryotic Cells

1. Cells can be placed into one of two categories: prokaryotic and eukary between a eukaryotic cell and a prokaryotic cell?

2. Copy and complete the table using the cell organelles you will find in e

Animal Cells Only	Plant Cells Only	Bot

3. Neurones can be found all over the body. State the function of a neuro

4. What type of signal is transmitted through a neurone?

5. Describe the differences between sensory neurones and motor neuron

6. It is crucial that cells are adapted to suit their function. For each of the are adapted to suit their function:
   a. Neurones
   b. Red blood cells
   c. White blood cells
   d. Egg cells
   e. Sperm cells
   f. Root hairs
   g. Xylem
   h. Phloem
   i. Guard cells

Exam-Style Questions – Eukaryotic Cells

1. Cells can be placed into one of two categories: prokaryotic and eukary between a eukaryotic cell and a prokaryotic cell?

....

....

....

2. Complete the table using the cell organelles you will find in each type

Animal Cells Only	Plant Cells Only	Bot

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5. Describe the differences between sensory neurones and motor neuro

Sensory neurone: ....

....

Motor neurone: ....

....

6. It is crucial that cells are adapted to suit their function. For each of the are adapted to suit their function:

   a. Neurones

   ....

   ....

   b. Red blood cells

   ....

   ....

c. White blood cells

....

....

d. Egg cells

....

....

e. Sperm cells

....

....

f. Root hairs

....

....

g. Xylem

....

....

h. Phloem

....

....

i. Guard cells

....

....

Lesson Plan 2 – Cells, Tissues, Organs, Orga
Transpiration

Learning Aims

Pupils should understand:

- That cells form tissues and tissues form organs and organs work toget illustrated by the cardiovascular system.
- The functions of the following plant organs:
  - ★ roots: take in water from the soil and provide anchorage
  - ★ xylem and phloem vessels
  - ★ leaves: where photosynthesis takes place

Key words: cells, tissues, organs, organ systems, xylem, phloem, leaf, tran

Starter

Cell/function/adaptation mix and match. Ask pupils to match 10 specialise adaptations e.g. neurones: pass electrical signals around the body; very lo

Main

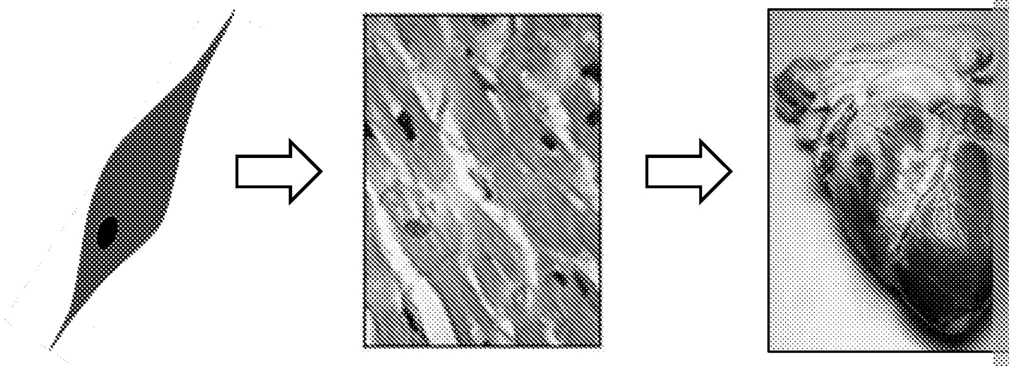
1. Go through the answers.
2. Explain how cells form tissues and tissues form organs and organ systems.
3. Use the cardiovascular system as an example.
4. Describe the structure and function of the roots (to take in water f anchorage), xylem and phloem vessels and the leaf, where photos
5. Answer Questions 1–9 from the pack.
6. Go through the answers.
7. Heart dissection. Pupils to dissect a heart identifying the main fea chambers and valve, etc.
8. Discuss the results and display any good dissections.

Plenary

Pupils work in pairs. Each person writes four questions (with answers) an One point is gained for every question they get correct; one point is lost fo

Tissues and Organs

Cells in multicellular organisms need to work together. One of the ways they do
themselves into tissues and organs. A **tissue** is a grouping of cells with the same
would be muscle; muscle tissue is made out of a large collection of muscle cells.
together to make **organs**, so the heart is a combination of muscle tissue and oth
alone and would be useless without other organs. They work together in groups
heart will work with the blood vessels (arteries, veins and capillaries) and the bl
system, whose job it is to transport blood around the body.



Cell	*Tissue*	*Organ*
Muscle Cell	**Muscle Tissue**	**Heart**

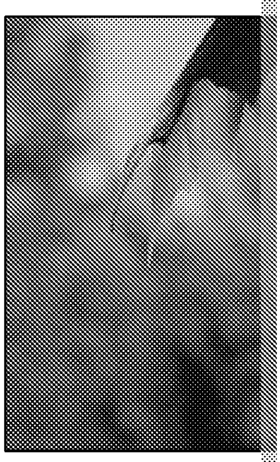
Plant Organs

It isn't just animals that have organs – plants have them too. We have already lo
organs.

Our arteries and veins are organs whose job it is to help in the transport of blood
need to transport materials such as water and sugars around them. They do this
are the plant's transport system. The xylem is a system of dead hollow cells that
of tubes running throughout the plant. The function of the xylem is to allow the
salts from the roots to the leaves where it is needed in the production of sugars
phloem is another part of the transport system. Its function is to pass those suga
parts of the plant where they are needed, e.g. fruits, storage in stems, etc.

Roots are also an example of a plant organ. The **roots** function is twofold. Their f
water and dissolved minerals from the soil. To do this they increase their surface
large number of root hairs; these are long thin hair-like projections. The second
provide anchorage and support to the ground, thus preventing the plant from fa

Leaves are another plant organ. The function of the leaves is the manufacture of sugars via photosynthesis. They do this by having a large surface area. They also tend to be very flat so that the sunlight does not have to travel far into the leaves. Plants also require carbon dioxide for photosynthesis via small holes, stomata, on the underside of the leaf. These stomata are regulated by guard cells which cause them to open or close depending on the weather conditions.

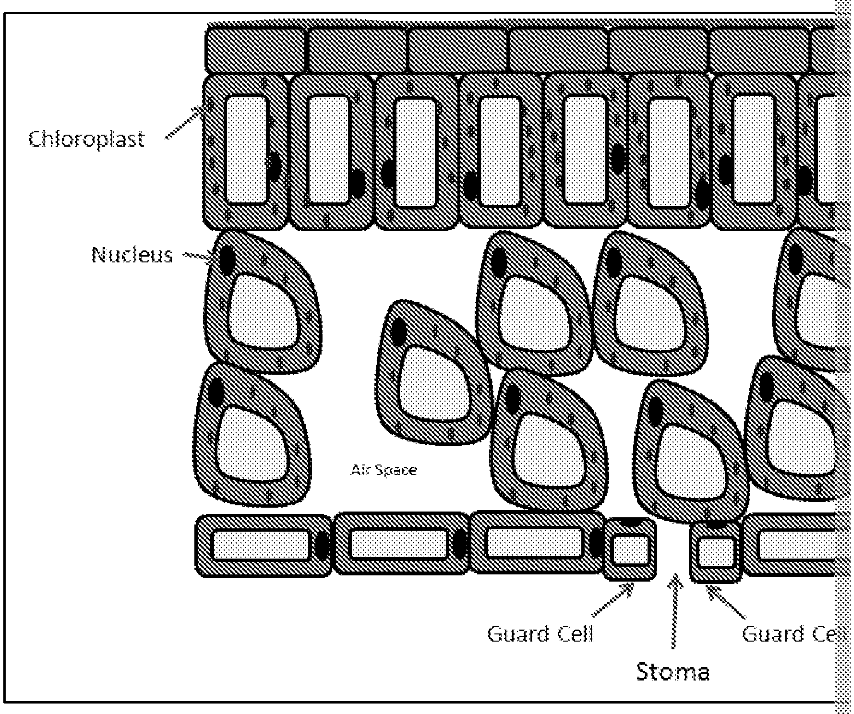


Transpiration

If you wanted to get water to the top of your house you would need a very large pump indeed; but plants have no pumps to rely on to get water to their leaves from the roots and they can be much taller than houses. So how do they do it?

The answer is in a process called transpiration. When the stomata are opened to let carbon dioxide in and oxygen out water vapour is lost to the environment. Because of the way water molecules are attracted to each other, as they evaporate into the air other water molecules are pulled through the xylem to take its place. This movement of water up through the xylem is called the transpiration stream.

Transpiration is increased when the plant is photosynthesising as the stomata need to be open to let in the carbon dioxide. Transpiration can also be affected by environmental factors such as increased temperature, increased wind and decreased humidity, all of which increase transpiration.



A cross-section of a leaf

Exam-Style Questions – Cells, Tissues, Organs and Tran

1. Our bodies are made of cells, tissues, organs and organ systems. How and an organ system linked to each other?
2. Each organ has its specific function. What is the function of the human
3. Each organ system is responsible for a range of functions. What is the system?
4. Plants also have organs. What is the function of xylem?
5. What is the function of phloem?
6. What is the function of roots?
7. It is crucial that organs are adapted to suit their function. How are roo function?
8. What is the function of leaves?
9. How are leaves adapted to suit their function?
10. Transpiration is vital for plant life. What is transpiration?

Exam-Style Questions – Cells, Tissues, Organs and Tran

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9. How are leaves adapted to suit their function?

   ....

   ....

   ....

   ....

   ....

10. Transpiration is vital for plant life. What is transpiration?

    ....

Lesson Plan 3 – DNA, Chromosomes a

Learning Aims

Pupils should understand:

- That DNA is a double helix containing a sequence of complementary
  - ★ adenine pairs with thymine
  - ★ guanine pairs with cytosine
- That chromosomes, in the nucleus, are made up of DNA, and sections which give instructions for individual characteristics.
- That alleles are different forms of the same gene that give rise to heter genotypes.

Key words: DNA, double helix, base pairs, chromosomes, genes, alleles, q

Starter

Ask pupils: What is DNA?

Main

1. Explain that DNA is a double helix. This can be demonstrated wi available, or a model can be made from pipe cleaners and straws.
2. Describe sequence of complementary base pairs, adenine pairs w with cytosine.
3. Describe chromosomes as being made of DNA.
4. Describe genes as sections of DNA which give instructions for in
5. Describe alleles as different forms of the same gene that give rise homozygous genotypes.
6. Pupils to answer Questions 1–12.
7. Go through the answers.
8. DNA extraction. Add sodium chloride solution to a beaker. In an liquid hand soap with 3 cm^3 of distilled water. Pour 1 cm^3 of the s test tube using a pipette. Place 10 cm^3 of bottled water into a plas free from any food debris. Rinse the bottled water in mouth for a scraping the inside of cheeks with teeth to remove extra cells. Spi Place the contents of the cup into the test tube containing the sod 1 cm^3 of liquid hand soap solution to the test tube using the pipet

   Place a bung on the test tube. Mix the contents by turning the test 5 cm^3 of alcohol to the test tube by pouring it slowly at an angle d from a clean pipette. Leave for around 5 minutes. The DNA shou of alcohol into an Eppendorf tube using a pipette. Use the thin sti from the test tube by twisting the rod gently. Place the DNA into close the lid.

Plenary

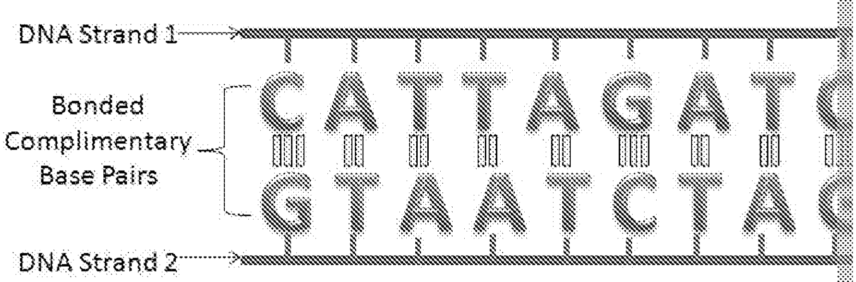
Science Boggle. Pupils work in groups of five and write down as many thi they can in two minutes. After this time they should compare their list to t facts they have in common. The winner is the one with the greatest numb expanded to find the class winner as well.

DNA

DNA (deoxyribonucleic acid) is the genetic material found in the nucleus that controls the cell's activity and acts as a guide in the development of living creatu such as ourselves. All DNA, whether it comes from humans, dogs, plants or bacte has the same make-up; in fact we share 96% of our DNA with chimps and more t 50% with bananas. DNA is a very long molecule made up of two joined strands w twist around each other and looks a little like a twisted ladder. We call this struc a **double helix.**

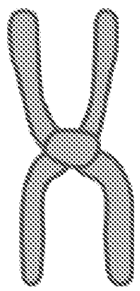
DNA is the language of the cell, and like all languages it needs letters. In the case DNA the letters are chemicals, or bases, called **adenine, thymine, guanine** and **cytosine,** or A, T, G and C as they are commonly abbreviated.

These chemicals – called nucleotides – stick together in different sequences alon the order they arrange themselves in determine everything about us. But whate themselves in they always pair up with the same molecules on the opposite stra Thymine and Guanine always pairs with Cytosine. We call this **complementary b**



Complementary base pairing in DNA

Chromosomes



DNA is split up into sections called **chromosomes**. Chromosomes DNA that typically form in a shape resembling an X, and which ar have 23 pairs of chromosomes which we inherit from our parent thought of as volumes of a book and just as volumes of books ar chromosomes themselves are split up into sections called **genes**. pairs that give instructions for individual characteristics such as e make a protein such as an enzyme.

We have two copies of every chromosome: one we inherit from our mothers, th chromosome has the same arrangement of genes, resulting in us having two cop Different forms of the same gene are called **alleles**. So with the blood group gen e.g. the O allele, the B allele or the A allele. If both of your alleles of a gene is the (your genetic makeup) for that gene is **homozygous**; if both alleles of a gene are **heterozygous**.

Exam-Style Questions – DNA, Chromosomes and Genes

1. DNA is vital for life. What does DNA stand for?
2. DNA can be found in nearly every cell. Where will you find DNA in a eu
3. What is the function of DNA?
4. What shape is DNA?
5. DNA consists of four bases. Give the names of the four DNA bases.
6. DNA bases pair up in a consistent way. How do the bases pair up?
7. What do we call this pairing?
8. Chromosomes can be found in the nuclei of cells. What are chromoso
9. How many pairs of chromosomes do humans normally have and wher
10. Our body has tens of thousands of genes. What is a gene?
11. What is the difference between a gene and an allele?
12. Define the terms:
    a. Genotype
    b. Homozygous
    c. Heterozygous

Exam-Style Questions – DNA, Chromosomes and Genes

1. DNA is vital for life. What does DNA stand for?

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11. What is the difference between a gene and an allele?

    ....

    ....

12. Define the terms:
    a. Genotype

       ....

    b. Homozygous

       ....

    c. Heterozygous

       ....

Lesson Plan 4 – Inheritance and Geneti

Learning Aims

Pupils should understand:

- how to represent monohybrid inheritance using Punnett squares
- how to determine genotypes and phenotypes of offspring from geneti
- how to calculate the probability, percentage or ratio of offspring displ
- characteristics from genetic crosses

Key words: monohybrid inheritance, alleles, dominant, recessive, Punnett

Starter

Ask pupils: what does the word inheritance mean to you?

Main

1. Explain the concept of monohybrid inheritance using a Punnett sq
2. Explain the difference between the terms 'dominant' and 'recessi
3. Introduce the term 'phenotype'.
4. Demonstrate genetic cross diagrams using heterozygous and hon
5. Show how to calculate percentage probability of offspring.
6. Pupils to answer Questions 1–7 from the pack.
7. Go through the answers.

Plenary

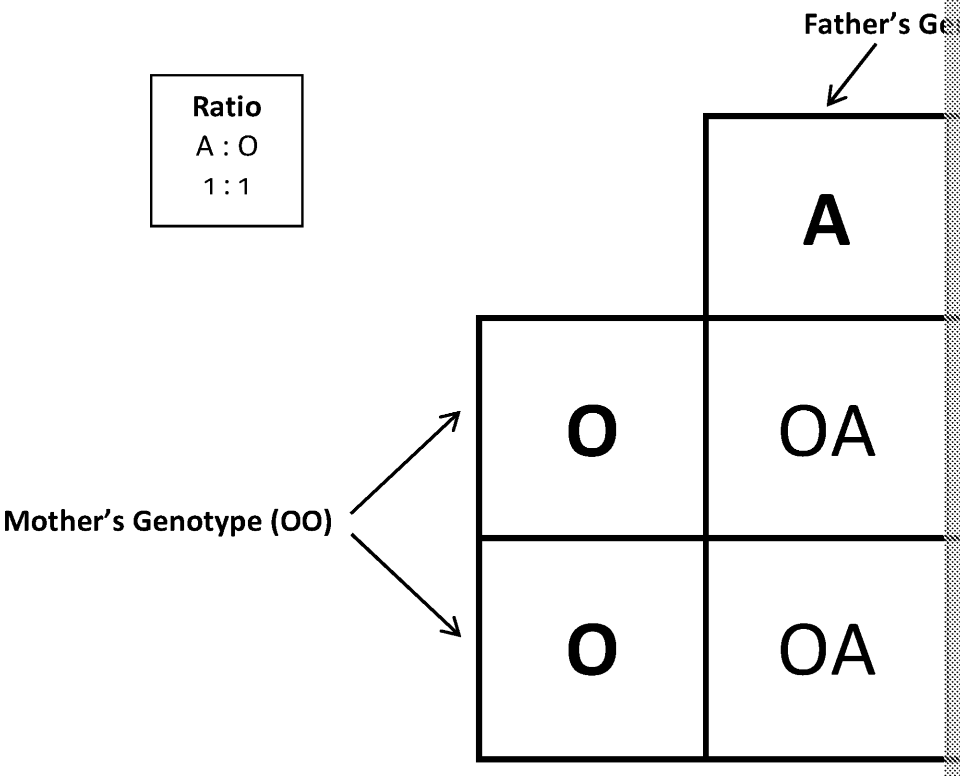
On a post-it note pupils should write three things about inheritance that th
beginning of the lesson.

Inheritance

What determines what genes you have? Each of your parents have two copies o in turn got from their parents and so on all the way back. However, the sperm an at fertilisation only contained half their genetic make-up, i.e. one copy of every g entirely random and this results in genetic diversity and explains why you don't l parents. We call this passing on of genes **monohybrid inheritance**.

Let's look at an example.

We will assume that a mother's genotype for her blood group is OO (homozygou is AO (heterozygous). They could pass either allele on to their offspring so there can represent monohybrid inheritance in Punnett squares or genetic cross diagra



This Punnett square or genetic cross diagram shows that the potential offspring OA, OO or OO. So they have a 50% chance of being OO and a 50% chance of bei order of the alleles: OA or AO is fine.)

But what would be their actual blood groups?

To understand this we need to know about something called dominance.

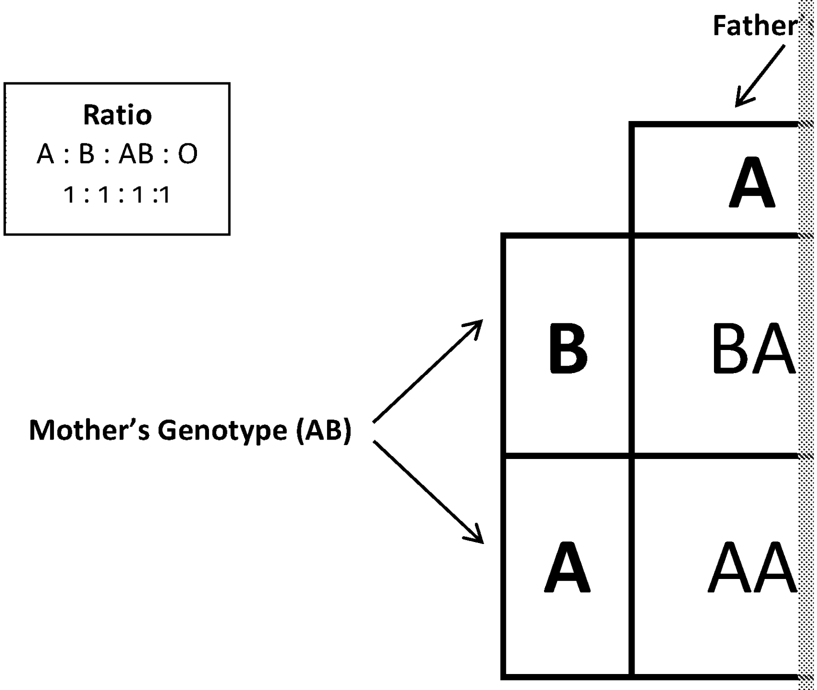
Dominant and Recessive Alleles

Alleles are either **dominant** (strong) or **recessive** (weak). That means if you inher allele the recessive one will not play a part in determining that particular charact two copies of the recessive allele the recessive allele will determine that charact

With blood groups O is the recessive allele and A and B are the dominant alleles case where there is not just one dominant allele). This means that because the m (homozygous recessive) she had blood group O; we call this her **phenotype** (mea characteristic). The father has the genotype AO (heterozygous); because the A al is recessive he has blood group A (his phenotype).

As the potential offspring have the same genotypes as the parents the phenotyp genotype is OO the phenotype is O and if the genotype is OA the phenotype is A

Let's look at another example. This time we will assume the mother's genotype i AO. This means the mother's blood group is AB (because of the co-dominance) a This time the potential offspring's genotype is more varied.



They could be BA, BO, AO or AA. But what would their phenotype and blood grou

Genotype	Phenotype	Blood Grou
OO	O	O
OA	A	A
OB	B	B
AA	A	A
BB	B	B
AB	AB	AB

Let’s take a look at one more example. Eye colour is a commonly studied form of a number of different alleles for eye colour but we will only look at two, brown a allele whilst blue is the recessive allele.

It is common to represent the dominant allele with a capital letter and the reces (especially important in this case as blue and brown both begin with the same le

In this example the mother’s genotype is BB (homozygous dominant) so she has genotype is bb (homozygous recessive) so he has blue eyes.

	b	**b**
B	Bb	Bb
B	Bb	Bb

So all the offspring would have the same genotype Bb and would all have brown chance of the genotype Bb.

But it is possible for a brown-eyed parent and a blue-eyed parent to have blue-ey

Ratio
Brown : Blue
1 : 1

	b	**b**
b	bb	bb
B	Bb	Bb

If the mother’s genotype is Bb her eyes would still be brown but she would be ab time the chances are: **50% bb** and **50% Bb**

Half the offspring would have blue eyes and half would have brown.

Genotype	
BB	
Bb	
bb	

Exam-Style Questions – Inheritance and Genetic Diagra

1. Define the terms in relation to inheritance.
   a. Dominant
   b. Recessive
   c. Phenotype

2. What is the difference between phenotype and genotype?

3. Draw genetic cross diagrams for the crosses between the following pe
   offspring in each cross state the percentage of each phenotype and th
   a. Someone with a blood group genotype AB and another person w
      OO.
   b. Someone with a blood group genotype AO and another person w
      BO.
   c. Someone with a blood group genotype AA and another person w
      BB.
   d. Two people both of whom have the eye colour genotype Bb wher
   e. A person with the eye colour genotype BB and another person wi

Exam-Style Questions – Inheritance and Genetic Diagra

1. Define the terms in relation to inheritance.
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Phenotypes ....

....

Blood groups ....

....

   b. Someone with a blood group genotype AO and another person w BO.

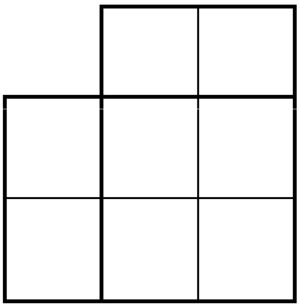
Phenotypes ....

....

Blood groups ....

....

c. Someone with a blood group genotype AA and another person w
BB.



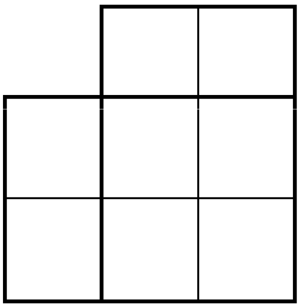
Phenotypes ....

....

Blood groups ....

....

d. Two people both of whom have the eye colour genotype Bb whe



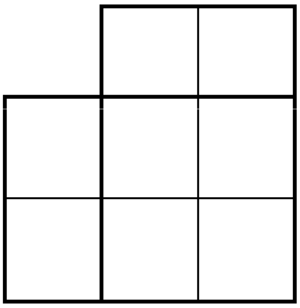
Phenotypes ....

....

Eye colours ....

....

e. A person with the eye colour genotype BB and another person wi



Phenotypes ....

....

Eye colours ....

....

Lesson Plan 5 – Pedigree Analysis and Gen

Learning Aims

Pupils should understand:

- pedigree analysis using homozygous and heterozygous individuals
- determination of genotypes and phenotypes of offspring from pedigr
- that gene mutations occur when the base sequence on a DNA molecul
  - ★ genetic mutations can change the characteristics of organisms
  - ★ genetic mutations can be beneficial or harmful to organisms.

Key words: pedigree analysis, carriers, genetic mutations, questions.

Starter

Ask the pupils to draw a genetic cross diagram for an example you have n them to calculate the probability of characteristics of offspring.

Main

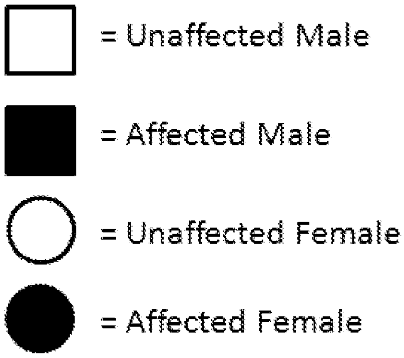
1. Explain that it is also possible to track genetic conditions and cha analysis.
2. Show how to construct a pedigree analysis diagram.
3. Work through an example of a dominant genetic condition in a fa out the phenotype and genotype.
4. Work through an example of a recessive genetic condition in a fa out the phenotype and genotype. Show that it is sometimes harde a person with a recessive characteristic.
5. Answer Questions 1–4 from the pack.
6. Go through the answers.
7. Explain what a genetic mutation is in terms of base pair alteration
8. Describe the possible causes of genetic mutation.
9. Describe harmful and beneficial gene mutations.
10. Answer Questions 1–6 from the pack.
11. Go through the answers.

Plenary

Text it: pupils to explain the causes and effects of genetic mutations in 160

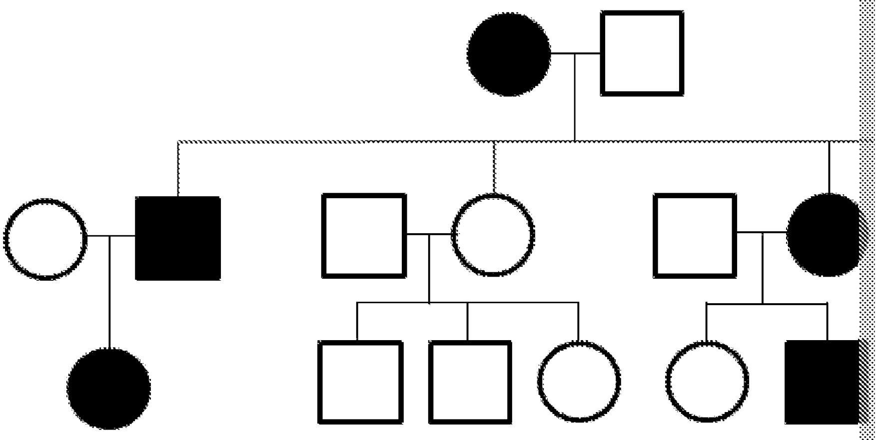
Pedigree Analysis

We can track the occurrence of a trait such as eye colour, or more commonly ge[...]
analysis. To carry out pedigree analysis doctors will find out who in the family ha[...]
construct a chart, similar to a family tree, using the following symbols:

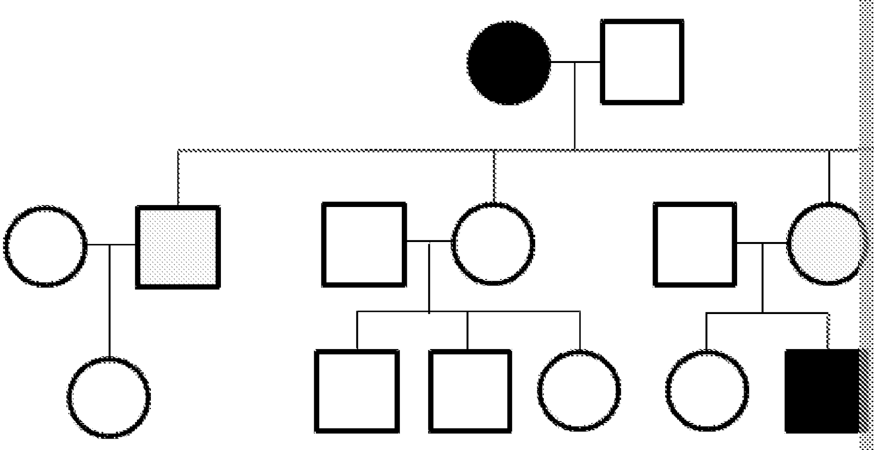


This way it is possible to determine the likelihood of that characteristic appearin[...]

A dominant characteristic will normally appear frequently throughout the genera[...]



Whereas a recessive characteristic will only appear infrequently.

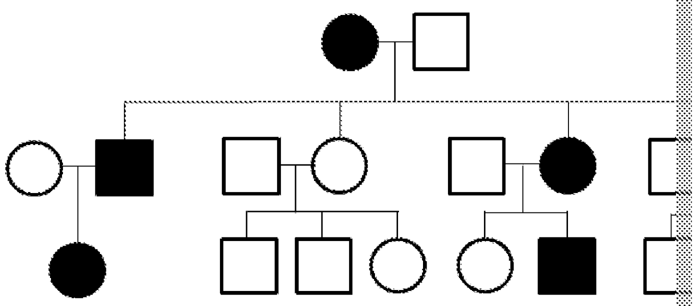


Using Pedigree Analysis

It is possible to determine the genotypes of individuals by analysis of the chart. W
characteristic.

Dominant Characteristics

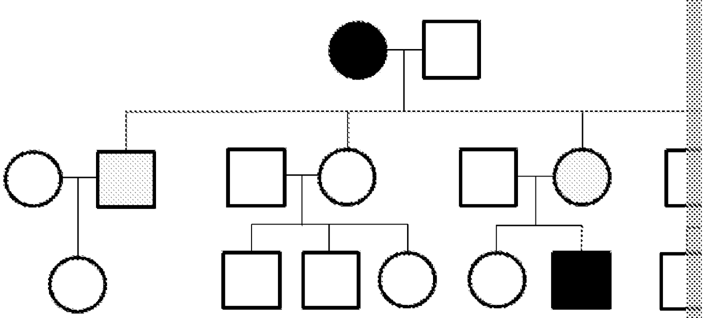
N = dominant, n = recessive – NN and Nn would both have the characteristic; nn



- ☆ The grandfather (the top white square) is unaffected; his genotype must be
- ☆ The grandmother (the top black circle) is affected; her genotype could be N children is unaffected the grandmother must be Nn.
- ☆ The first son must be Nn as he is affected but his father isn't.
- ☆ The first daughter must be nn as she is not affected.
- ☆ The second daughter must be Nn as she is affected but her father isn't.
- ☆ The third daughter must be Nn as she is affected but her father isn't.
- ☆ The first granddaughter must be Nn as she is affected but her mother isn't.
- ☆ The first and second grandsons and the second granddaughter must be nn a
- ☆ The third granddaughter must be nn as she is unaffected.
- ☆ The third grandson must be Nn as he is affected but his father isn't.
- ☆ The fourth grandson must be nn as he is unaffected.
- ☆ The fourth granddaughter must be Nn as she is affected but her father isn't.

Recessive Characteristics

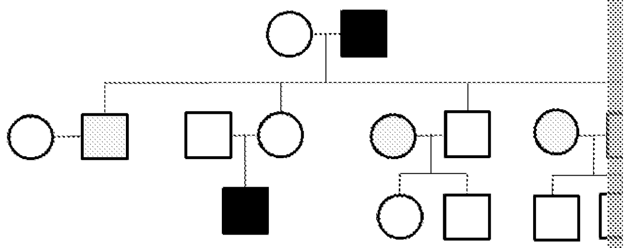
With a recessive characteristic it is more difficult to tell the genotypes of all the f
carry the gene in their genotype but not express that gene in their phenotype. W
nn would have the characteristic; NN and Nn would not.



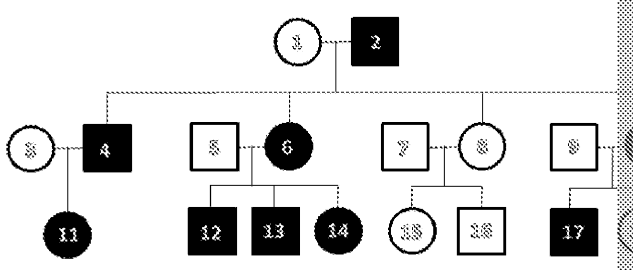
- ☆ The grandmother (top black circle) has the characteristic so must be nn.
- ☆ The grandfather (top white square) does not have the characteristic so coul of his children have the characteristic he is probably NN (if he were Nn we w to be affected).
- ☆ All the children are Nn and are carriers of the characteristic.
- ☆ The affected grandson must be nn as he is affected.
- ☆ His father must also be a carrier (Nn) to have had an affected son.
- ☆ The rest of the grandchildren's genotype is uncertain from the information a

Exam-Style Questions – Pedigree Analysis

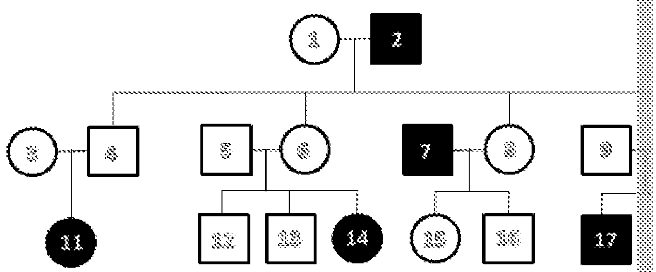
1. Is this chart more likely to show a recessive or a dominant characterist



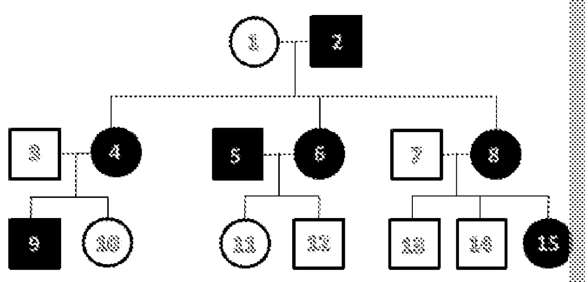
2. The following chart shows a dominant genetic trait, i.e. NN and Nn wo nn would not. For each person determine their genotype from the info person has been numbered to make distinguishing between people e



3. The following chart shows the occurrence of blue eyes in a family. For genotype from the information in the chart, or state if it is not possible provided. Each person has been numbered to make distinguishing bet

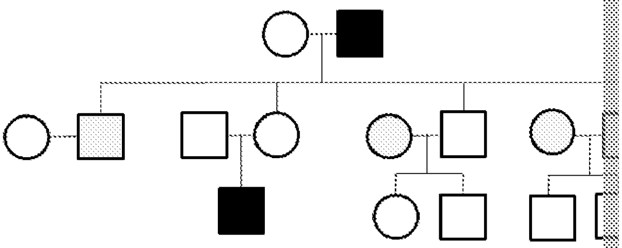


4. The following chart shows the occurrence of a dominant trait in a fam homozygous: one for, one against the trait. For each person determine information in the chart or state if it is not possible to tell from the inf person has been numbered to make distinguishing between people e



Exam-Style Questions – Pedigree Analysis

1. Is this chart more likely to show a recessive or a dominant characterist



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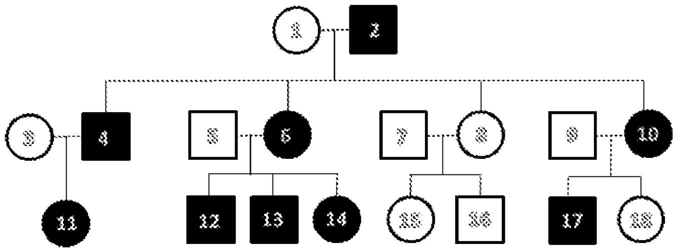

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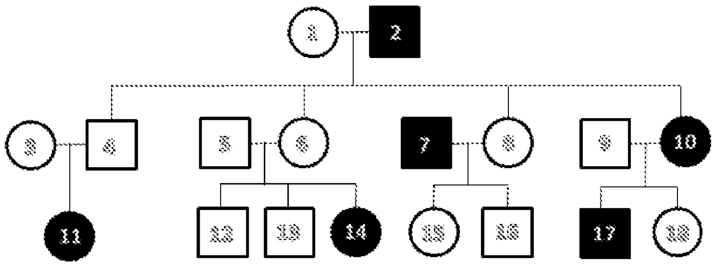

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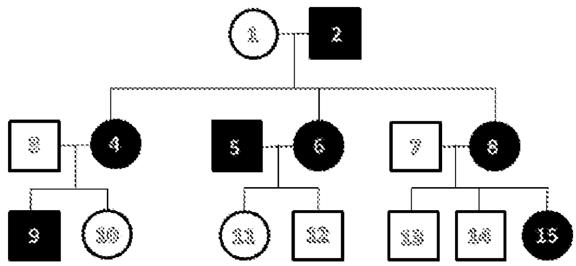


Genetic Mutations

When the base sequence (GCTA) on a DNA molecule is changed genetic mutatio
be caused by a number of different things including a failure to copy DNA correc
common with age), radiation including UV light, and certain chemicals.

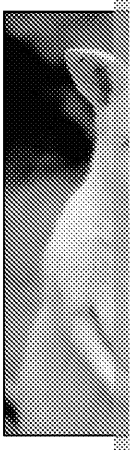
If the mutation happens in a body cell it will only affect the organism it is in; if th
(sperm and egg) then the individual will be unaffected but the offspring will be.

As a great deal of DNA is non-coding (has no known function) a large number of
However, where this mutation occurs in a gene it can result in a change in the ch

Genetic mutations can be harmful or negative to an organism; cancer is an exam
multiple gene mutations. In cancer, the section of a gene telling the cells to stop
Therefore, the cells proliferate, each copy having the same gene mutation and la
replication, resulting in the formation of a lump of cells called a tumour.

Other genetic mutations can be beneficial or good for an organism. In fact witho
would have likely been far less successful. Sometimes genetic mutations provide
the function of an old gene. For example genetic mutations have been seen to ca
to heat and antibiotics which, although it is not good for us, it is good for them.

Did you know?
Albinism is just one condition that is caused by a genetic mutation. Albino animals are born when one of the genes involved in the production of melanin (which determines their skin colour) mutates or is deleted during their development.



An alb

Exam-Style Questions – Genetic Mutations

1. There are many factors which cause genetic mutations. What factors c
2. The type of cell that becomes mutated affects who will be affected by affected by a mutation in a body cell?
3. Who would be affected by a mutation in a sex cell?
4. What could happen if a mutation happens in a gene?
5. Mutations can be harmful, beneficial or neutral. Give an example of a
6. Give an example of a beneficial mutation.

✂ --

Exam-Style Questions – Genetic Mutations

1. There are many factors which cause genetic mutations. What factors c

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   ....

   ....

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5. Mutations can be harmful, beneficial or neutral. Give an example of a

   ....

6. Give an example of a beneficial mutation.

   ....

Lesson Plan 6 – Homeostasis, the Nervous Syste
System

Learning Aims

Pupils should understand:

- That homeostasis is the maintenance of a constant internal environme nervous and hormonal communication.
- The structure of the nervous system is made up of the central nervous spinal cord) and the peripheral nervous system (PNS) (sensory and m electrical impulses to and from the CNS.
- The difference between involuntary and voluntary responses.
- The transmission of electrical impulses from receptor to effector and t transmission across synapses.
- The components of a simple reflex arc and its role in protecting the bo
- The endocrine system consists of glands that release hormones into th through the blood to target organs.
- The differences in communication between the endocrine and nervou
  - ★ speed of communication
  - ★ method of transport or transmission
  - ★ duration of response

Key words: Homeostasis, nervous communication, hormonal communica stimulus, receptor, effector, synapse, reflex arc, the endocrine system, que

Starter

Ask pupils to list as many forms of communication as they can.

Main

1. Explain that organs and cells within the bodies of multicellular or communicate with each other for various reasons including home
2. Explain that cells can communicate via nervous or hormonal com
3. Explain the function and structure of the nervous system.
4. Explain the difference between voluntary and involuntary respon
5. Describe a signal from stimulus to effector.
6. Explain how a synapse works.
7. Describe a reflex arc.
8. Knee-jerk reaction. One pupil should sit on a bench with their leg then tap their knee tendon to elicit a knee-jerk response.
9. Explain how the endocrine system works.
10. Highlight the difference between both methods of communicatio communication, method of communication, transport/transmissi specificity of response.
11. Answer Questions 1–9 from the pack.
12. Go through the answers.

Plenary

Pupils to think of a reflex pathway and describe it from stimulus to effecto

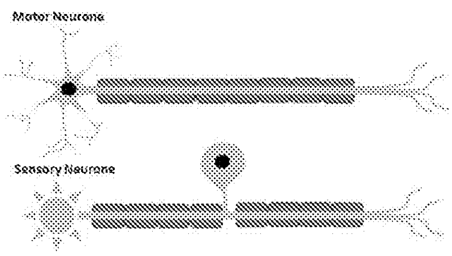
Homeostasis

During the day you may find yourself hot, cold, thirsty, hungry or even in pain. H
survival that the internal conditions of your body are kept within a strict set of li
a consistent internal environment **homeostasis**.

Homeostasis is controlled (regulated) in two ways. The first is by **nervous comm**
hormonal communication.

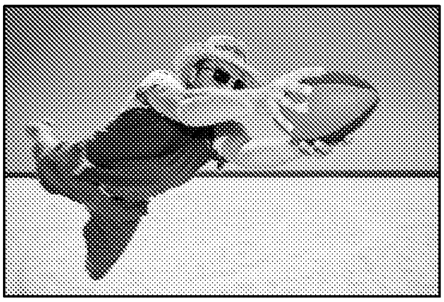
The Nervous System

The nervous system is of vital importance to your daily life; not only does it allow
your body at will, it also protects you when you place your hand on a hot surface
misfortune to sit down on a pin.

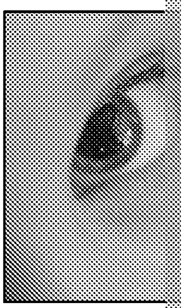


The nervous system is a collection of diff
and cells working together. These includ
nervous system or **CNS,** which is made u
brain and the spinal cord; and the **periph**
system or **PNS,** which is made up of sens
motor neurones (which we looked at ear
transmit electrical signals to and from th

There are two main types of nervous response: **voluntary** and **involuntary**. Volu
you are aware of consciously; this could include scratching an itch, or catching a
responses are those that you are not consciously aware of; they could include bl
you or your pupils dilating in the dark.



Catching a ball
A voluntary response



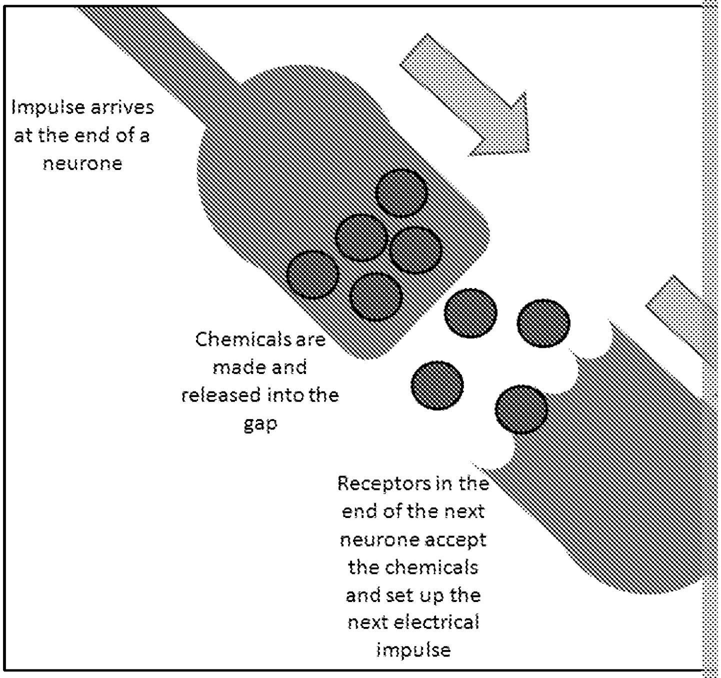
Pu
An invo

We sense our environment in a number of ways, through sight, sound, touch an
sensory organs are responsible for picking up the **stimulus** that will eventually ca
impulse is generated and passed along the **sensory neurone** towards the **CNS**. O
needs to be relayed or sent on (think of a relay race during sports day when a ba
the next). It is first sent to a relay neurone within the CNS and the relay neurone
appropriate **motor neurone**. The signal then reaches an **effector,** which is norm
occurs, e.g. you move.

Receptor ⇒ Sensory Neurone ⇒ CNS ⇒ Mo Neu

Synapse

Neurones are not physically connected to other neurones, but instead there is a v
between two neurones.

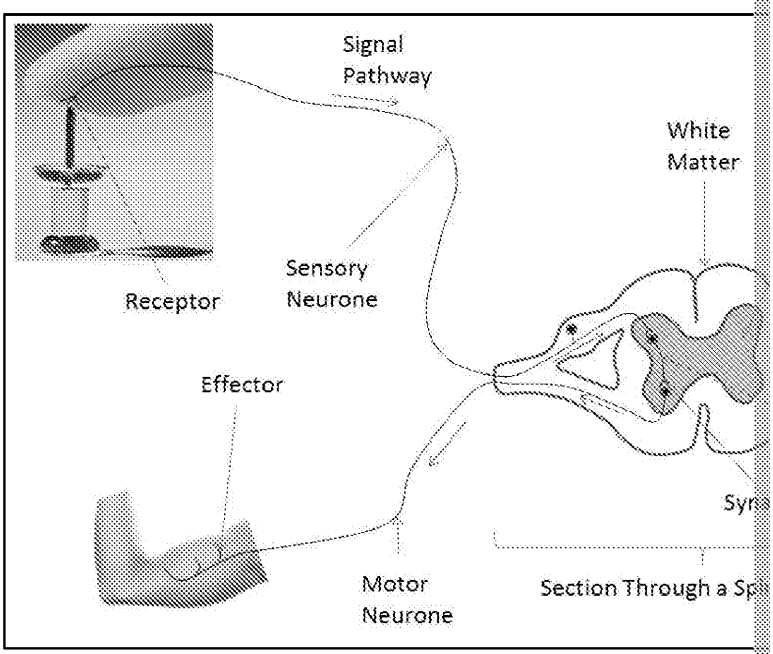


Having synapses means that neurones are able to communicate with numerous o
allows specific responses to specific stimuli. If neurones were connected to each o
always lead to the same response whether it was appropriate or not. Communica
through chemical transmission.

Reflex Arc

Sometimes you have to act quickly to avoid damage such as placing your hand on
The pathway for a reflex arc is very similar to the pathway we looked at earlier. T
arc is that it will bypass the conscious part of your mind. This speeds up the respo
damage.

Reflexes are also vital for carrying out other everyday activities which you would n
single time they happened, e.g. breathing.



The Endocrine System

The **endocrine system** is the way parts of our body communicate with other par
Hormones are chemicals produced by the body in organs called glands. The horn
and travel in the blood to the target organs where they have their effect.

Differences between the endocrine system and nervous system

Although the basic outcome is the same, i.e. a response, the endocrine and nerv ways. The nervous system is very fast indeed (shine a light in someone's eyes an contract) whilst the endocrine system is far slower making its effects, relying upo blood to flow around the body, or even longer. Also the method of communicati chemicals which are transported in the blood whilst the nervous system transmit Another difference is the duration of the response (how long the response lasts) a one-off instant response; once you have removed your hand from the pin you may get odd looks if you do); whilst the endocrine system is much longer-acting, days and weeks. In addition, the endocrine system is very non-specific; it sends the body and can be picked up by any organ with the correct receptors. The nerv very specific; if when you put your hand on the pin you contracted every muscle useful (and you'd definitely get odd looks).

Property	Nervous System	Endocr
Speed of Communication	Fast	S
Method of Communication	Electrical	Ch
Transport/Transmission	Nerves	B
Duration of Response	Short	L
Specificity of Response	Specific	Non

Did you know?
The glands responsible for hormone production are located in differe and make hormones that regulate different things – e.g. the testes pr and control male secondary sexual characteristics. The thyroid gland thyroxin which controls metabolism. There are many others.

Exam-Style Questions – Homeostasis

1. Homeostasis is vital for life. What is homeostasis?
2. The CNS is a crucial part of our nervous system. What does CNS stand
3. The PNS works with the CNS in controlling our bodies. What does PNS up of?
4. What is the functional difference between a sensory neurone and a m
5. Describe, with examples, the difference between a voluntary and an in
6. Draw and label a reflex arc and explain how it helps protect the body.
7. Describe the similarities and differences between nervous communica communication.
8. Draw a flow diagram of the transmission of an electrical signal from re
9. Describe how a synapse functions.

Exam-Style Questions – Homeostasis

1. Homeostasis is vital for life. What is homeostasis?

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8. Draw a flow diagram of the transmission of an electrical signal from re

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9. Describe how a synapse functions.

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Lesson Plan 7 – Blood Glucose and Body Temp

Learning Aims

Pupils should understand:

- An example of nervous communication.
- That blood glucose concentration is regulated by the endocrine syst (insulin lowers blood glucose concentrations and glucagon raises it).
- That body temperature is regulated by the nervous system using the f
  - ★ sweating
  - ★ shivering
  - ★ raising/lowering of body hair
  - ★ vasoconstriction and vasodilation

Key words: reflex, blood glucose, insulin, glycogen, glucagon, body temp thermoregulatory centre, sweating, body hair, vasodilation, vasoconstricti

Starter

Ask pupils what the differences are between nervous and hormonal comm

Main

1. Drop the ruler reflex to demonstrate the reflex arc. Pupils to work a dropped meter stick or ruler. One pupil extends their index fing holds a ruler between the fingers and drops it at a random interv and measure reaction response. Do this again after exercise and c likely find an initial decrease in reaction after exercise but it could
2. Discuss results.
3. Explain how blood glucose level is regulated by hormones.
4. Explain how body temperature is regulated by the nervous syste
5. Answer Questions 1 and 2 from the pack.
6. Go through the answers.

Plenary

Endocrine and hormonal mix and match: ask pupils to match properties o communication to either the nervous or endocrine systems, e.g. nervous s electrical.

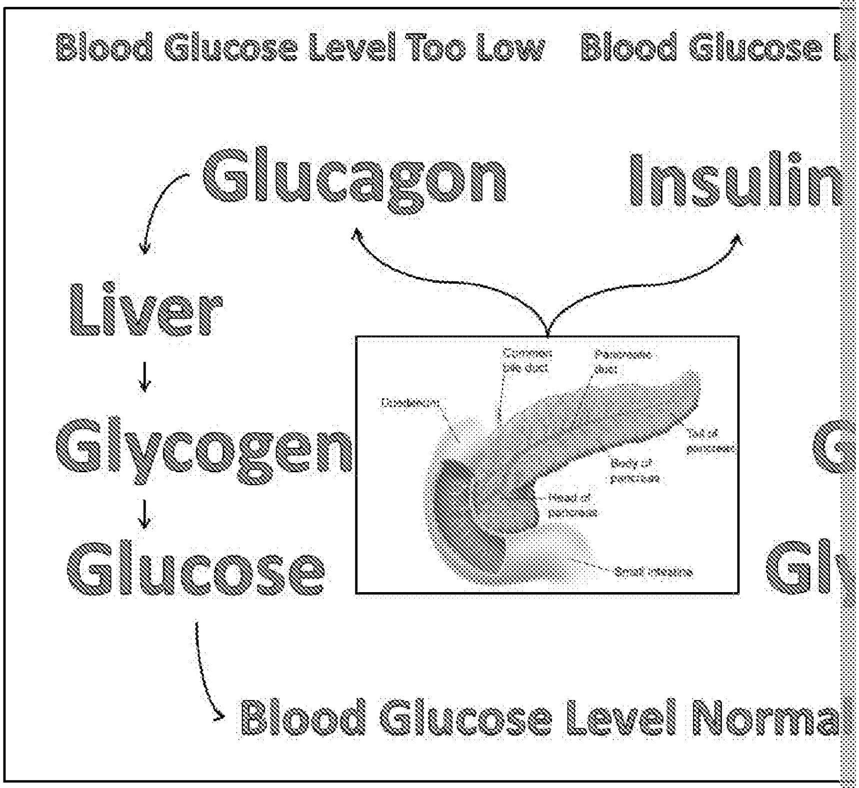
Blood Glucose Level

Blood glucose level is very important to regulate, not allowing it to go too high c
to regulate blood glucose levels we call the condition diabetes; this can have som
not treated, including death. Blood glucose level is regulated by the endocrine sy

Blood glucose level is regulated by a gland called the **pancreas** (which is just und
pancreas senses that the blood sugar level is too high it manufactures and **secret**
the blood. Insulin's target organ is the **liver** and it causes the liver to remove any
blood and converts it to the insoluble **glycogen**.

If sugar levels decrease too much the pancreas secretes the hormone **glucagon**.
the liver; this time the glucagon converts the glycogen back into glucose.

Using these two hormones the pancreas is able to keep the average blood gluco
100cm^3 of blood.



Regulation of blood glucose level

Glucagon = hormone
Glucose = soluble carbohydrate
Glycogen = insoluble carbohydrate

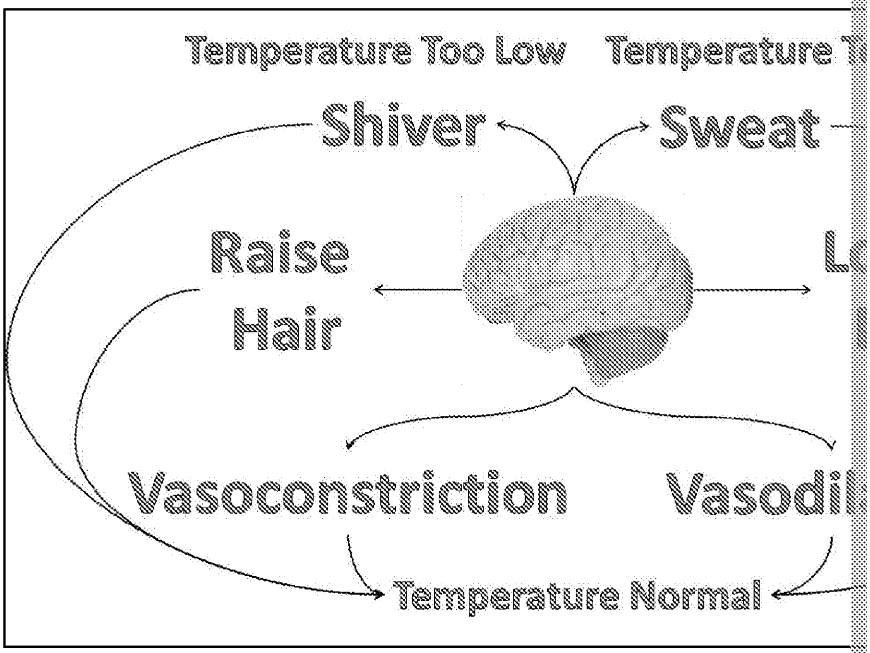
Body Temperature

Body temperature is another important internal environment we need to regula temperature fluctuates by more than a few degrees from the normal 37°C we ca Our internal environment relies on a number of chemical reactions, including the body gets too cold then the **enzymes** that regulate these reactions stop working energy, your cells start to die and so, eventually, will you. On the other hand, if y **denature** (stop working) and will not be able to carry out the same reactions, an to imagine an enzyme denaturing, think of the changes in an egg when you fry it by the nervous system.

Body temperature is controlled in a number of ways by the **thermoregulatory ce** thermoregulatory centre detects tiny temperature changes in the blood running sensitive it can detect temperature changes of just half of one degree, and will g temperature receptors in the skin as well. If it detects that the blood is too hot it number of effects. One of the things that will happen is you will begin to sweat. S temperature because it uses the heat energy in your body to evaporate. As it eva the energy that used to be inside you. That is why it is very uncomfortable on hu sweat does not evaporate easily and so it is more difficult to control your body te

Your **body hair** will also flatten closer to your skin reducing any insulating air tha and your skin. The **blood vessels** near your skin will also dilate (get wider); we ca greater amount of blood to enter the vessels near your skin where it will be the c air around you. This is why you go red when you get hot; it is the extra blood run your skin.

If the thermoregulatory centre detects a drop in temperature it is also able to re muscles to cause them to twitch a little. This twitching releases energy in the for the body. We know this better as **shivering**. The **body hair** will also rise trapping between the skin and the hairs. Finally the blood vessels close to the skin constri **vasoconstriction**. This prevents blood from entering the cooler parts of your bod the reason you start to turn white or blue in the cold; it is the lack of blood runni



Regulation of temperature

Exam-Style Questions – Blood Glucose and Body Temp

1. It is vital that our internal environment be kept at a constant level. Des is regulated by the endocrine system.
2. Describe how body temperature is regulated by the nervous system.

✂ --

Exam-Style Questions – Blood Glucose and Body Temp

1. It is vital that our internal environment be kept at a constant level. Des is regulated by the endocrine system.

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2. Describe how body temperature is regulated by the nervous system

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Lesson Plan 8 – Atomic Structure and the P

Learning Aims

Pupils should understand:

- Elements as metals or non-metals according to their position in the pe
- The structure of the atom as a nucleus containing protons and neutron shells (energy levels).
- That the nucleus of an atom is very small compared to the overall size
- That atoms of a given element have the same number of protons in th unique to that element.
- the meaning of the terms 'atomic number', 'mass number' and 'relativ
- The relative charge and relative mass of a proton, a neutron and an el
- That atoms contain equal numbers of protons and electrons.
- That elements are arranged in the periodic table in order of increasing called periods, and elements with similar properties are placed in the groups.
- The existence of isotopes means some relative atomic masses are not w
- The relative atomic mass of an element from the relative masses and a
- The rules about the filling of electron shells (energy levels) to predict t the first 20 elements in the periodic table as diagrams and in the form
- The connection between the number of outer electrons and the positio table.

Key words: atomic structure, periodic table, charge and mass, isotopes, ele

Starter

Show clip: **http://www.youtube.com/watch?v=zGM-wSKFBpo**

Main

1. Explain that the periodic table is an arrangement of all the known number, with the metals on the left and the non-metals on the rig
2. Explain the structure of the atom.
3. Describe the data found on the periodic table and what it tells us a
4. Describe the relative charge and mass of the sub-atomic particles.
5. Explain the terms 'period' and 'group', and that elements within g properties.
6. Explain the term 'isotope' and why not all atomic masses are who
7. Explain how to draw the electronic configuration of the first 20 ele
8. Explain how to represent electrons of the first 20 elements in the f
9. Point out the link between group number and outer electron shel
10. Pupils to answer Questions 1–17 from the pack.
11. Go through the answers.

Plenary

Show clip. **http://www.youtube.com/watch?v=SmwlzwGMMwc**
Pupils are to invent their own element song or try to memorise Tom Lehre

Atomic Structure

Atoms are the smallest unit of matter and are arranged in the **periodic table of elements**. There are many ways of dividing the elements. One such way is into **metals** and **non-metals**. In general the metals are located on the left-hand side of the table whilst the non-metals (with the exception of hydrogen) can be found on the right of the table. On the periodic table on page 47, the non-metals are shaded.

Atoms (the smallest unit of matter) are made up of three things: **protons, neutrons** and **electrons**. The protons and neutrons are arranged together in the middle of the atom (we call this the **nucleus**); the electrons orbit around the outside of the nucleus in **shells** or **energy levels.**

An atom's nucleus is very small when related to the overall size of the atom. Mo
by the empty space in between the electrons. Although all atoms are different si
nucleus size and atom size can be made. If you imagine an atom scaled up to the
imagine a fly buzzing around the centre spot then that would be the equivalent o
of the stadium would be empty space with a few specs of dust (the electrons) fly
however, account for the vast majority of the mass of the atom.

All atoms of a specific element have the same number of protons, and that numb
example, if you examined every carbon atom in the world you would find that th
then found the time to check all the atoms in the world you would find that none
protons. Clearly it is the number of protons that decides what that element is, so
special and it is given a special name. The number of protons in an element is the

The meaning of the data on the periodic table:

12 ← Relative atomic mass is the (average) relative mass of an atom on the scale where a c the mass number.

C ← Chemical symbol (the first letter is always capital; if there is a second it is lower case).

carbon ← Chemical name.

6 ← Atomic number is the number of protons (it is also the number of electrons).

Relative Atomic Mass

The relative atomic masses in the table are based on **a comparison with** the mas
they are called **relative** atomic masses.

Carbon atoms contain six protons and six neutrons in their nucleus and six electr
hardly have any mass so we ignore them when talking about mass. The mass of a
due to the protons and neutrons. Since protons and neutrons have **the same ma**
atoms have 12 'mass units' (six protons + six neutrons = 12 mass units). Normally
units; we just say carbon has a relative atomic mass of 12.

The masses of all other atoms are compared to carbon, taking one atom of carbo
of 12; e.g. magnesium atoms are double the mass of carbon (twice as heavy) so t
of 24. A magnesium atom has 12 protons and 12 neutrons so you can see that it i
atomic mass of magnesium is 24 (12 p + 12n = 24 mass units). Sometimes, howev
relative atomic masses; e.g. the relative atomic mass of chlorine on the table is 3

Here the idea of mass units seems to break down. The table shows that chlorine
of 17 so it has 17 protons, but to get 35.5 it would have to have 18.5 neutrons! Th
that chlorine exists as different atoms. Most chlorine atoms have 17p and 18n (3
atoms have 17p and 20n (37 mass units). These different forms of chlorine are ca
number 35.5 therefore represents an **average** value for the relative atomic mass

Mass Number
We can use chlorine to talk about another special number for atoms, the **mass n** total number of protons and neutrons in atoms.

Mass number = total number of protons and neutrons

Atomic number = number of protons

The two different types (isotopes) of chlorine mentioned above can be represen

$${}^{35}_{17}\mathrm{Cl} \quad \text{and} \quad {}^{37}_{17}\mathrm{Cl}$$

Similarly an atom of carbon can be represented by:

12 = Mass number of carbon (6 protons and 6 neutrons)

6 = Atomic number of carbon (6 protons)

Mass Number and Relative Atomic Mass

Why are the mass number and the relative atomic mass of an element often the

Carbon: mass number = 12 relative atomic mass =

Carbon exists almost entirely of carbon-12 isotope so its relative atomic mass is 1

Chlorine: has mass numbers 35 and 37 relative atomic mass =

(¾ of chlorine atoms are chlorine-35, and ¼ of chlorine atoms are chlorine-37, so out to be 35.5)

Normally the **mass number** of an element is the same number as the **relative at** only when elements exist in significant numbers as isotopes that this general rul

The Periodic Table of Elem

Key

relative atomic mass **atomic symbol** name atomic (proton) number

Transition Metals

1	2									
							1 **H** hydrogen 1			
7 **Li** lithium 3	9 **Be** beryllium 4									
23 **Na** sodium 11	24 **Mg** magnesium 12									
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
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **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
223 **Fr** francium 87	226 **Ra** radium 88	227 **Ac*** actinium 89	261 **Rf** rutherfordium 104	262 **Db** dubnium 105	266 **Sg** seaborgium 106	264 **Bh** bohrium 107	277 **Hs** hassium 108	268 **Mt** meitnerium 109	271 **Ds** darmstadtium 110	272 **Rg** roentgeniu 111

**** The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have bee***
The relative atomic masses of copper and chlorine have not been rounded to the nearest whole

Charge and Mass

Each subatomic particle (proton, neutron, electron) has a charge and a mass.

Subatomic Particle	Relative Charge	Relative
Proton	+ 1	1
Neutron	0 (No Charge)	1
Electron	- 1	Neglig (1/1836)

In an atom, the number of electrons is equal to the number of protons. As proto electrons have a negative charge they cancel each other out giving atoms a neut

Arranging the Elements in the Periodic Table

Over the years there have been a number of attempts at arranging the elements periodic table arranges the elements in order of increasing atomic number. The called **periods**. Atoms in period 1 will have one electron shell, atoms in period 2 w so on (more on electron shells later). The columns of the periodic table are called same group have similar chemical properties.

Isotopes

We have already seen that chlorine exists in two forms:

The two different types (isotopes) of chlorine mentioned above can be represent

$$^{35}_{17}\mathrm{Cl} \quad \text{and} \quad ^{37}_{17}\mathrm{Cl}$$

These are known as chlorine 35 and chlorine 37 and are called the **isotopes** of ch

Using this example you can see that **both** isotopes have 17 protons (the atomic n number of protons which decides what element it is. However one isotope has 1 isotope has 20 (37–17) neutrons.

From this we can write: atoms which have the same number of protons but a dif known as **isotopes**.

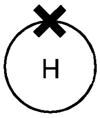
In the case of chlorine there are two types, chlorine-35 and chlorine-37. This mea atoms in a sample of chlorine gas, some would have a mass of 35 and some wou mass of 35 would have 18 neutrons; those with a mass of 37 would have 20 neut the average mass of all the atoms in a sample. If there were equal amounts of ch average would be 36, but as there is greater abundance of chlorine-35 than chlo

Electron Shells

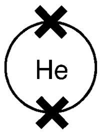
Electrons are arranged in shells or energy levels. The first shell is small, so can on purposes the other shells can hold up to eight electrons each.

Electrons fill up the shells from the inner shell to the outer shell; the inner shells placing electrons in the next shell.

If we look at hydrogen we can see that its atomic number is 1; this means that it has one electron. As there is only one it goes into the first shell.

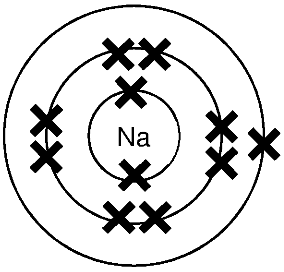


If we look at helium we can see that its atomic number is 2; this means that it has two electrons. As there are only two they can both still go into the first shell.

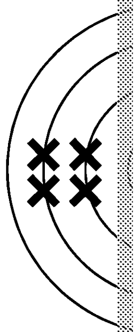


Lith so i two thi

Sodium has an atomic number of 11 (11 electrons); the first two electrons go into the first shell, the next eight electrons go into the second shell, and the final electron goes into a third shell.



Potassium has an aton the first two electrons eight electrons go into electron goes into a th goes into a fourth shel



This can be a complicated way to show the electron arrangement of atoms, so a number of electrons in each shell with each number separated by a full stop.

For example:

Hydrogen = 1	Oxygen = 2.6	Pho
Helium = 2	Fluorine = 2.7	Sul
Lithium = 2.1	Neon = 2.8	Chl
Beryllium = 2.2	Sodium = 2.8.1	Arg
Boron = 2.3	Magnesium = 2.8.2	Pot
Carbon = 2.4	Aluminium = 2.8.3	Cal
Nitrogen = 2.5	Silicon = 2.8.4	

As we noted earlier, atoms in period 2 had two shells, etc. There is a similar patt the outer shell and the group number. All atoms in group 1 have one electron in t group 2 have two electrons in the outer shell and so on.

Exam-Style Questions – Atomic Structure and The Peri

1. The periodic table is an arrangement of elements. Where on the perio metals?
2. Where on the periodic table would you find the non-metals?
3. An atom is the simplest form of matter. Where in an atom will you fin
   a. Protons
   b. Neutrons
   c. Electrons
   d. Nucleus
4. True or false? The nucleus accounts for most of the mass of an atom.
5. True or false? The nucleus accounts for most of the space within an at
6. Choose the correct words.
   All atoms of an element have **the same / a different** number of proto
   Different types of atoms have **the same / a different** number of prot
   Atoms have **the same / a different** number of electrons and protons.
7. Define the terms:
   a. Relative atomic mass
   b. Atomic number
8. How are atoms arranged in the periodic table?
9. What do we call the rows in the periodic table?
10. What do we call the columns in the periodic table?
11. Some atoms have isotopes. What are isotopes?
12. Give an example of an isotope.
13. Why is the relative atomic mass of chlorine not 36?
14. Draw the electronic configuration of:
    a. Hydrogen
    b. Helium
    c. Lithium
    d. Oxygen
    e. Sodium
    f. Magnesium
    g. Potassium
    h. Carbon
    i. Fluorine
    j. Chlorine
15. Write the electronic configuration for the first 20 elements in the peri
16. How is the number of electrons in the outer shell of an atom related t
17. Copy and complete.

Subatomic Particle	Relative Charge	Relative
	+ 1	1
Neutron		
Electron		

Exam-Style Questions – Atomic Structure and The Peri

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14. Draw the electronic configuration of:
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    b. Helium
    c. Lithium
    d. Oxygen
    e. Sodium
    f. Magnesium
    g. Potassium
    h. Carbon

i. Fluorine

j. Chlorine

15. Write the electronic configuration for the first 20 elements in the perio

1 ....

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19 ....

20 ....

16. How is the number of electrons in the outer shell of an atom related t

....

17. Complete the table.

Subatomic Particle	Relative Charge	Relative
	+ 1	1
Neutron		
Electron		

Lesson Plan 9 – Chemical Substances, Reactio

Learning Aims

Pupils should understand:

- How to use the periodic table to recognise elements and formulae of s
- The difference between elements, compounds, mixtures, molecules
- How to write word chemical equations and simple balanced equation
- That chemicals react to form products with different properties inclu

Key words: chemical substances, chemical reactions, atom, element, comp equations, word equations, symbol equations, questions.

Starter

Pupils are to sing their songs from last lesson.

Main

1. Explain how to use the periodic table to identify elements and co
2. Explain the difference between the words 'atom', 'element', 'com 'molecule' with examples.
3. Explain the basics of a chemical reaction.
4. Explain how to write simple word and balanced symbol equation
5. Answer Questions 1–4 from the pack.
6. Go through the answers.

Plenary

Atom, element, compound, mixture bingo. Make bingo cards of various a and mixtures and hand out to class. Call out a description of the atoms, el pupils to mark off as they are called.

Chemical Substances and Chemical R

The periodic table is a list of all the known types of atoms. An element can be described as a substance in which all the atoms are the same.

So for example if you were lucky enough to discover some pure gold all the atoms within it would be gold atoms.

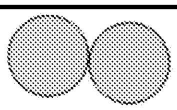
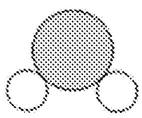
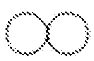
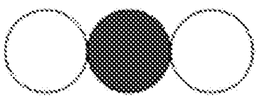
All atoms have their own symbol; for example gold is Au. The first letter of every symbol **must** be a capital letter; if there is a second letter it **must** be written in lower case. This is very important to avoid confusion; e.g. Co is the symbol for a cobalt atom whereas CO is the formula for a molecule of carbon monoxide.

We can use these symbols to construct the formulae of compounds too. Compounds are substances in which two or more atoms have been chemically joined together to form a different substance; e.g. oxygen (element) and hydrogen (element) can be chemically joined to form water (compound).

Commonly Confused Words

Atom	Atoms are the smallest unit of matter. They are made up of three **electrons**. The protons and neutrons are arranged together in the the **nucleus**); the electrons orbit around the outside of the nucleu
Element	All the atoms in a substance are the same, e.g. hydrogen gas.
Compound	A substance in which two or more different atoms have been che different substance, e.g. hydrogen and oxygen combining to make
Mixture	When two or more substances have been jumbled together (not j separated again; e.g. the air is a mixture of nitrogen, oxygen, wate
Molecule	A small unit of matter made of two or more atoms bonded togeth compound or an element.

Examples of elements and compounds

	oxygen molecule	O_2	units of matter in a **element**
	water molecule	H_2O	units of matter in a **compound**
	hydrogen molecule	H_2	units of matter in a **element**
	carbon dioxide molecule	CO_2	units of matter in a **compound**

Equations

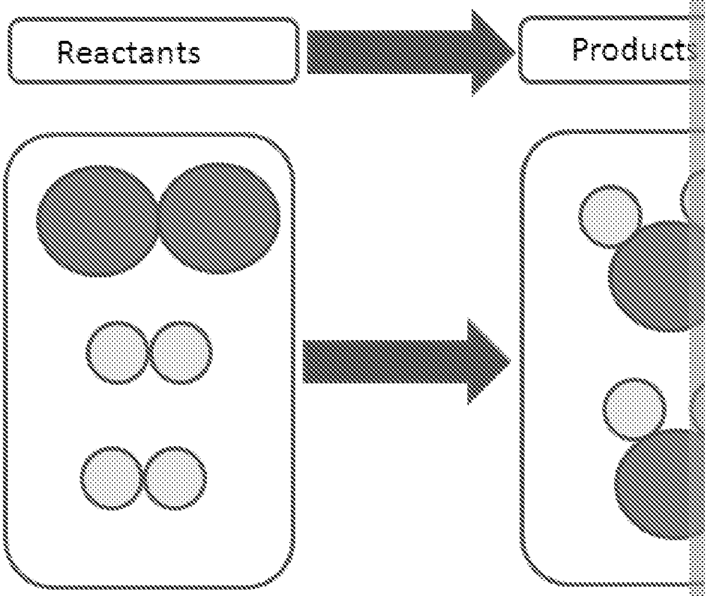
In Chemistry we frequently need to represent chemical reactions. Chemical reac
chemically combine with other substances to create a different substance. Think
ingredients undergo a chemical reaction in the oven. We can do this in one of tw
equation, and the other is using a symbol equation. We will look at these in turn.

Word Equations

Words equations are the simplest way to represent a chemical equation. All you need to know to create one is what you started with (the **reactants**) and what you ended with (the **products**).

The reactants always go on the left-hand side.
The products always go on the right-hand side.
Normally we use an arrow to separate them.

W
n
p
An e
reac



Symbol Equations

For this section we will consider the task of writing the **symbol** equation for the r
oxygen producing water.

The **word** equation for this is simple:

Hydrogen + Oxygen → Water

We will now try to construct the **symbol** equation for this reaction.

There are many steps in writing a symbol equation; all but the last step is incomp
we need to know a little bit more.

Step 1: First we need to know the symbols of elements which we can look up on
symbol equation for the above reaction would be:

$$H_2 + O_2 \rightarrow H_2O$$

Remember that the first letter of every atomic symbol **must** be capital and the se
lower case.

We must also check the formula; for example we must put O_2 because the oxyge
form. Also note that the 2 is small and just below the O.

Step 2 involves adding states of matter symbols to the equation. Remember the solid, liquid and gas. These are shown on the equation by (s), (l), and (g). Someti be dissolved in water, in which case we say it is aqueous or (aq). So our equation

$$H_{2\,(g)} + O_{2\,(g)} \rightarrow H_2O_{\,(l)}$$

But it's still not quite right yet. A basic scientific law states 'matter cannot be cre that we must always have the same number of atoms of each element at the en beginning of the reaction.

$$H_{2\,(g)} + O_{2\,(g)} \rightarrow H_2O_{\,(l)}$$

In the reactants we have two hydrogen atoms and two oxygen atoms.
In the products we have two hydrogen atoms but only one oxygen atom.

Step 3: To overcome this we must **balance** the equation. To balance equations w beginning of the substances in question. At the moment we don't have enough o of the equation; we have one but we need two. To solve this we place the figure simple place a number in the middle or end of a substance as that would be a di be at the beginning. So it becomes:

$$H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{\,(l)}$$

That solves the oxygen problem but has created a new problem. Now our produ atoms on the product side but only two on the reactant side. To overcome this w front of the H_2. So it becomes:

$$2H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{\,(l)}$$

We call this a balanced chemical equation.

It might help your understanding if you realise that when you are 'balancing equ the 'ratio' of the molecules involved until you get the same number of atoms at t change the ratio of molecules involved we clearly have to put numbers **in front** o

Remember

Step 1

Write the symbol equation and check formul

$$H_2 + O_2 \rightarrow H_2O$$

Step 2

Add the state symbols

$$H_{2\,(g)} + O_{2\,(g)} \rightarrow H_2O_{\,(l)}$$

Step 3

Balance

$$2H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{\,(l)}$$

Differences between Number Meaning

H_2O means two hydrogen atoms and one oxygen atom. The small number **only** r before it.

Adding a number at the beginning multiplies **everything** by that number. So:

$2H_2O$ means four hydrogen atoms and two oxygen atoms.

Exam-Style Questions – Chemical Substances, Reaction

1. Complete the table, writing the formula/symbol for each substance an that substance is a compound or an element.

Substance	Formula/Symbol	Compoun
Water	+ 1	
Oxygen		
Carbon Dioxide		
Hydrogen		
Carbon Monoxide		
Methane		
Magnesium Oxide		
Gold		
Sodium Chloride		
Carbon		
Silicon		
Nitrogen		
Ammonia		
Iron		

2. Describe the differences between an atom, an element, a compound a

3. Balance the following equations:
   a. $FeO_{(s)} + HCl_{(aq)} \rightarrow FeCl_{2(aq)} + H_2O_{(l)}$
   b. $CuO_{(s)} + HCl_{(aq)} + CuCl_{2(aq)} + H_2O_{(l)}$
   c. $CaCO_{3(s)} + HNO_{3(aq)} \rightarrow Ca(NO_3)_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$
   d. $Na_2CO_{3(s)} + HNO_{3(aq)} \rightarrow NaNO_{3(aq)} + CO_{2(g)} + H_2O_{(l)}$
   e. $CuCO_{3(s)} + HCl_{(aq)} \rightarrow CuCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$
   f. $Ca_{(s)} + HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_{2(g)}$
   g. $Mg_{(s)} + HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

4. Use the periodic table to identify the following elements and compou
   a. H_2
   b. O_2
   c. MgO
   d. C
   e. CO
   f. Co
   g. Element with atomic number 17
   h. Element with 6 protons
   i. Element with 5 neutrons
   j. Element with 79 electrons
   k. An isotope
   l. A non-metal in group 3
   m. Two elements with a relative atomic mass of 40
   n. An element with no neutrons

Exam-Style Questions – Chemical Substances, Reaction

1. Copy and complete the table, writing the formula/symbol for each sub or not that substance is a compound or an element.

Substance	Formula/Symbol	Compoun
Water	+ 1	
Oxygen		
Carbon Dioxide		
Hydrogen		
Carbon Monoxide		
Methane		
Magnesium Oxide		
Gold		
Sodium Chloride		
Carbon		
Silicon		
Nitrogen		
Ammonia		
Iron		

2. Describe the differences between an atom, an element, a compound a

....

....

....

....

....

....

3. Balance the following equations:

a. $FeO_{(s)}$ + $HCl_{(aq)}$ → $FeCl_{2(aq)}$ + $H_2O_{(l)}$

b. $CuO_{(s)}$ + $HCl_{(aq)}$ → $CuCl_{2(aq)}$ + $H_2O_{(l)}$

c. $CaCO_{3(s)}$ + $HNO_{3(aq)}$ → $Ca(NO_3)_{2(aq)}$ + CO

d. $Na_2CO_{3(s)}$ + $HNO_{3(aq)}$ → $NaNO_{3(aq)}$ + CO

e. $CuCO_{3(s)}$ + $HCl_{(aq)}$ → $CuCl_{2(aq)}$ + $CO_{2(g)}$

f. $Ca_{(s)}$ + $HCl_{(aq)}$ → $CaCl_{2(aq)}$ + $H_{2(g)}$

g. $Mg_{(s)}$ + $HCl_{(aq)}$ → $MgCl_{2(aq)}$ + $H_{2(g)}$

4. Use the periodic table to identify the following elements and compou

a. H_2 ....

b. O_2 ....

c. MgO ....

d. C ....

e. CO ....

f. Co ....

g. Element with atomic number 17 ....

h. Element with 6 protons ....

i. Element with 5 neutrons ....

j. Element with 79 electrons ....

k. An isotope ....

l. A non-metal in group 3 ....

m. Two elements with a relative atomic mass of 40 ....

n. An element with no neutrons ....

Lesson Plan 10 – Hazard Symbols and Neutral

Learning Aims

Pupils should understand:

- Hazard symbols
- Neutralisation reactions using hydrochloric acid, nitric acid and sulp or a metal hydroxide
- How to write word chemical equations and simple balanced equation

Key words: hazard symbols, neutralisation reactions, metal hydroxides an acids, questions.

Starter

Ask pupils to list any warning or hazard signs they have seen this week.

Main

1. Go through responses.
2. Show pupils common hazard symbols including examples of lab household substances displaying such symbols.
3. Explain what a neutralisation reaction is.
4. Pupils to react metal hydroxides and metal oxides with acid. For universal indicator and $10cm^3$ of hydrochloric acid into a small be sodium hydroxide drop-wise and note the change in colour. Once reaction is complete.
5. Pupils to note the reaction. They should be able to write the word balance the symbol equation for all reactions.
6. Pupils to produce a poster on the applications of neutralisation re
7. Answer Questions 1–5 from the pack.
8. Go through the answers.

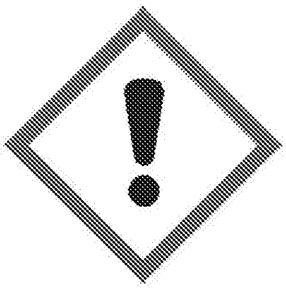
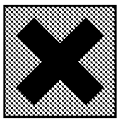
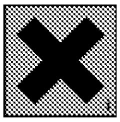
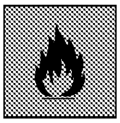
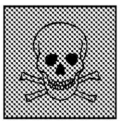
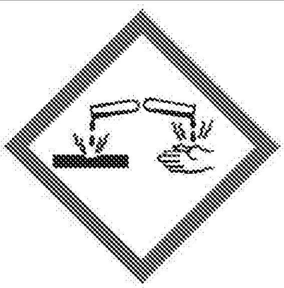
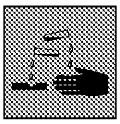
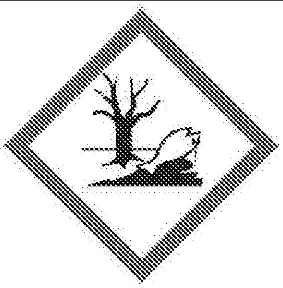
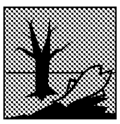
Plenary

Match the products to the reactants mix and match. Ask pupils to match a products; e.g. Copper (II) Oxide + Hydrochloric Acid → Copper (II) Chlor

Hazard Symbols

You have probably seen warning signs or hazard symbols on roads and on househ
products. Hazard symbols are there to grab our attention and highlight possible d
misusing items and causing harm to ourselves and others.

The square hazard symbols in the table below are the ones that you are most lik
containers in the lab. These were updated in December 2010 with new diamond
remember to learn these new symbols for your exam.

Hazard	Symbol	Old symbol(s)	Descrip
CAUTION *(previously 'harmful' and 'irritant')*		 Harmful  Irritant	*Substances labelled w 'caution' symbol use as either 'harmful' o* Harmful substances c damage if they are in swallowed, or absorb Irritant substances a but can cause irritati skin upon contact.
FLAMMABLE			Flammable substanc very easily.
TOXIC *(also called 'acute toxicity')*			Toxic substances can swallowed or cause v effects on contact.
CORROSIVE			Corrosive substances living tissues upon co
HAZARDOUS TO THE AQUATIC ENVIRONMENT *(previously 'dangerous for the environment')*			These substances ca immediate or delaye aquatic environmen

Neutralisation Reactions

Neutralisation reactions are reactions between acids (chemicals which have a pH which have a pH of 8–14) to produce a neutral salt (pH 7) and water. If the base i alkali.

Metal Hydroxides and Acids

There are many different types of neutralisation reaction. One example is betwe example:

Sodium Hydroxide + Hydrochloric Acid → Sodium Chloric

$NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

Sodium Hydroxide + Sulphuric Acid → Sodium Sulphate

$2NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow 2Na_2SO_{4(aq)} + H_2O_{(l)}$

Sodium Hydroxide + Nitric Acid → Sodium Nitrate +

$NaOH_{(aq)} + HNO_{3(aq)} \rightarrow NaNO_{3(aq)} + H_2O_{(l)}$

Lithium Hydroxide + Hydrochloric Acid → Lithium Chloric

$LiOH_{(aq)} + HCl_{(aq)} \rightarrow LiCl_{(aq)} + H_2O_{(l)}$

This can be summarised by the equation:

Metal Hydroxide + Acid → Salt + Water

Metal Oxides and Acids

Another type is between metal oxides and acid, for example:

Copper (II) Oxide + Hydrochloric Acid → Copper (II) Chlori

$CuO_{(s)} + 2HCl_{(aq)} \rightarrow CuCl_{2(aq)} + H_2O_{(l)}$

Copper (II) Oxide + Sulphuric Acid → Copper (II) Sulphate

$CuO_{(s)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + H_2O_{(l)}$

Copper (II) Oxide + Nitric Acid → Copper (II) Nitrate +

$CuO_{(s)} + 2HNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + H_2O_{(l)}$

Iron (II) Oxide + Hydrochloric Acid → Iron (II) Chloride +

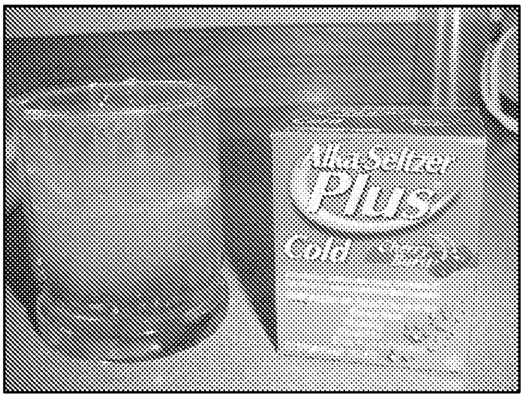
$FeO_{(s)} + 2HCl_{(aq)} \rightarrow FeCl_{2(aq)} + H_2O_{(l)}$

This can be summarised by the equation:

Metal Oxide + Acid → Salt + Water

Applications of Neutralisation Reactions

Neutralisation reactions can be very useful.



If you have ever had heartburn or a
used Gaviscon or other indigestion

Heartburn or acid indigestion is ca
the oesophagus (the pipe connecti
The stomach is lined with protecti
in the stomach from harming it; ho
protection in the oesophagus and s
Gaviscon and other remedies conta
carbonate and **sodium bicarbonat**
acid in a neutralisation reaction an
the lining. The safe dose of these r
16 tablets per day.

Neutralisation reactions are also used in agriculture and gardening to reduce the acidity of soils. Acidic soils can cause a number of problems to plants such as aluminium toxicity and damage to the roots. The most common way to increase soil pH is the addition of calcium carbonate and magnesium carbonate ($CaCO_3$ or $MgCO_3$), which is finely ground into a powder called lime. Other substances that can be used to increase the pH of soil include wood ash, calcium oxide (CaO) and oyster shells. These all react with the acid in the soil to produce carbon dioxide, water and a variety of salts (the particular salt formed depends on which acid w present).

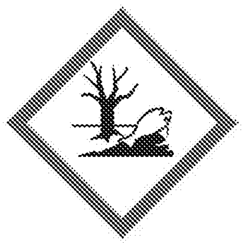
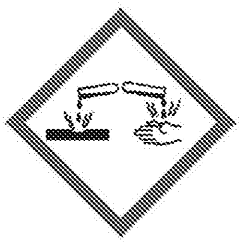
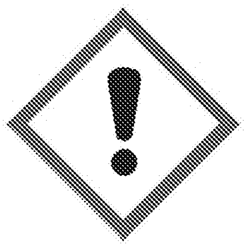
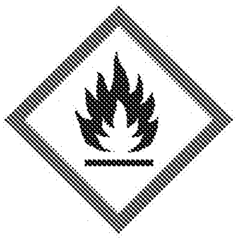
Acid rain causes increased acidity in large bodies of water such as lakes

Acid rain, caused by man-made pollutants react
the increased acidity of the water in rivers and l
negative impact on the plants and animals that l
acidity a number of things can be done.

One treatment is the addition of calcium oxide
the water to form calcium hydroxide ($Ca(OH)_2$),
turn reacts with the acid in a neutralisation rea

Exam-Style Questions – Hazard Symbols and Neutralis

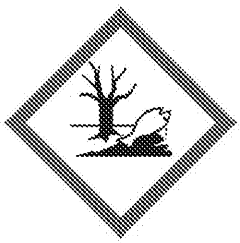
1. Match the hazard symbol with the meaning.

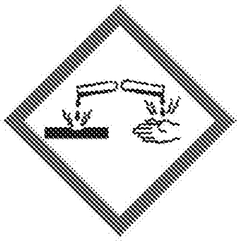
	**Ca** Includes harmful and ir substances can cause dam absorbed via the skin. Ir corrosive but can cause irr co
	**T** These substances can caus very serious ef
	**Flam** These substances c
	**Dangerous to the** These substances can ca damage to the aq
	**Cor** These substances can d co

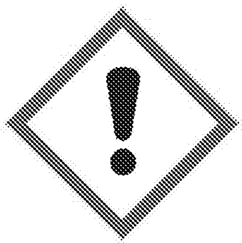
2. Write the balanced chemical equations for the following reactions:
   a. Sodium Hydroxide + Hydrochloric Acid → Sodium Chloride + Wa
   b. Sodium Hydroxide + Sulphuric Acid → Sodium Sulphate + Water
   c. Iron (II) Oxide + Nitric Acid → Iron(II) Nitrate + Water
   d. Copper (II) Oxide + Hydrochloric Acid → Copper (II) Chloride + W
3. Write the word equations for the following chemical reactions:
   a. $NaOH_{(aq)} + HNO_{3(aq)} \rightarrow NaNO_{3(aq)} + H_2O_{(l)}$
   b. $LiOH_{(aq)} + HCl_{(aq)} \rightarrow LiCl_{(aq)} + H_2O_{(l)}$
   c. $FeO_{(s)} + 2HCl_{(aq)} \rightarrow FeCl_{2(aq)} + H_2O_{(l)}$
   d. $FeO_{(s)} + H_2SO_{4(aq)} \rightarrow FeSO_{4(aq)} + H_2O_{(l)}$
4. What is the generalised word equation for the reaction of an acid with
5. What is the generalised word equation for the reaction of an acid with

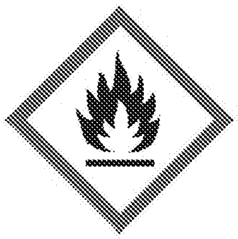
Exam-Style Questions – Hazard Symbols and Neutralisa

1. Match the hazard symbol with the meaning.









Ca Includes harmful and ir substances can cause dam absorbed via the skin. Ir corrosive but can cause irr co
T These substances can caus very serious ef
Flam These substances c
Dangerous to the A These substances can ca damage to the aq
Cor These substances can d co

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   ....

   c. Iron (II) Oxide + Nitric Acid → Iron(II) Nitrate + Water

   ....

d. Copper (II) Oxide + Hydrochloric Acid → Copper (II) Chloride + W

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

3. Write the word equations for the following chemical reactions:

a. $NaOH_{(aq)} + HNO_{3(aq)} \rightarrow NaNO_{3(aq)} + H_2O_{(l)}$

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

b. $LiOH_{(aq)} + HCl_{(aq)} \rightarrow LiCl_{(aq)} + H_2O_{(l)}$

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

c. $FeO_{(s)} + 2HCl_{(aq)} \rightarrow FeCl_{2(aq)} + H_2O_{(l)}$

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

d. $FeO_{(s)} + H_2SO_{4(aq)} \rightarrow FeSO_{4(aq)} + H_2O_{(l)}$

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

4. What is the generalised word equation for the reaction of an acid with

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

5. What is the generalised word equation for the reaction of an acid with

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

Lesson Plan 11 – Exploring Chemical R

Learning Aims

Pupils should understand:

- The reactions of hydrochloric acid and sulphuric acid with metals (no
- The reactions of hydrochloric acid, sulphuric acid and nitric acid w carbonate and calcium carbonate.
- The chemical tests for hydrogen and carbon dioxide.

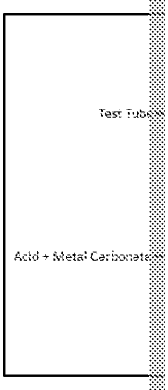
Key words: metal carbonates and acid, metals and acids, testing for carbon hydrogen, questions.

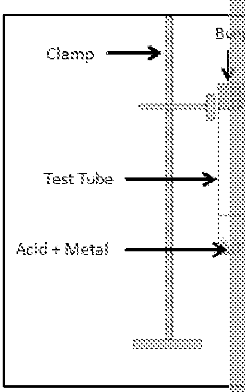
Starter

Ask pupils: what is a neutralisation reaction?

Main

1. Explain how metal carbonates react with hydrochloric acid, sulp
2. Explain how metals react with hydrochloric acid and sulphuric a
3. Demonstrate how to test for carbon dioxide and hydrogen.
4. Answer Questions 1–5 from the pack.
5. Go through the answers.
6. Pupils to react metal carbonates, e.g. 2 g of calcium carbonate reacted with 6 cm^3 2 mol dm^{-3} hydrochloric acid and test the gas coming off. See diagram (right).





7. Pupils to react metal with acid and test the gas coming off, e.g. 4 cm of magnesium ribbon reacted with 6 cm^3 2 mol dm^{-3} hydrochloric acid. Place a lit splint next to the gas in the tube, which will create a pop. See diagram (right).
8. Pupils to note the reaction. They should be able to write the wor balance the symbol equation for all reactions.
9. Go through results.

Plenary

Text it: Pupils to describe the reactions of acids with metals and carbonates

Metal Carbonates and Acids

Acids will also undergo a neutralisation reaction with metal carbonates. The gen

Metal Carbonate + Acid → Salt + Carbon Dioxide + W

Examples:

Calcium Carbonate + Hydrochloric Acid → Calcium Chloride + Carb

$CaCO_{3(S)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

Calcium Carbonate + Sulphuric Acid → Calcium Sulphate + Carbo

$CaCO_{3(S)} + H_2SO_{4(aq)} \rightarrow CaSO_{4(aq)} + CO_{2(g)} + H_2O_{(l)}$

Calcium Carbonate + Nitric Acid → Calcium Nitrate + Carbon D

$CaCO_{3(S)} + 2HNO_{3(aq)} \rightarrow Ca(NO_3)_{2(aq)} + CO_{2(g)} + H_2O$

Sodium Carbonate + Hydrochloric Acid → Sodium Chloride + Carb

$Na_2CO_{3(S)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$

Sodium Carbonate + Sulphuric Acid → Sodium Sulphate + Carbo

$Na_2CO_{3(S)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + CO_{2(g)} + H_2O$

Sodium Carbonate + Nitric Acid → Sodium Nitrate + Carbon D

$Na_2CO_{3(S)} + 2HNO_{3(aq)} \rightarrow 2NaNO_{3(aq)} + CO_{2(g)} + H_2O$

Copper Carbonate + Hydrochloric Acid → Copper Chloride + Carb

$CuCO_{3(s)} + 2HCl_{(aq)} \rightarrow CuCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

Copper Carbonate + Sulphuric Acid → Copper Sulphate + Carbon

$CuCO_{3(s)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + CO_{2(g)} + H_2O_{(l)}$

Copper Carbonate + Nitric Acid → Copper Nitrate + Carbon D

$CuCO_{3(s)} + 2HNO_{3(aq)} \rightarrow Cu(NO3)_{2(aq)} + CO_{2(g)} + H_2O$

Metals and Acids

Metals also react with acids. The general equation for this is:

Metal + Acid → Salt + Hydrogen

Examples:

Magnesium + Hydrochloric Acid → Magnesium Chloride +

$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

Calcium + Hydrochloric Acid → Calcium Chloride + Hy

$Ca_{(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_{2(g)}$

Magnesium + Sulphuric Acid → Magnesium Sulphate + H

$Mg_{(s)} + H_2SO_{4(aq)} \rightarrow MgSO_{4(aq)} + H_{2(g)}$

Calcium + Sulphuric Acid → Calcium Sulphate + Hyd

$Ca_{(s)} + H_2SO_{4(aq)} \rightarrow CaSO_{4(aq)} + H_{2(g)}$

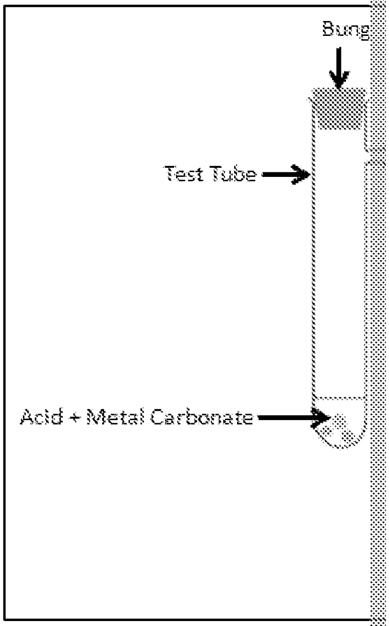
Testing for Gases

As we have seen, sometimes a gas is evolved (given off) during a chemical reacti to distinguish between the gases which are given off if they have no smell or col test tube reactions we can carry out to determine which gas has been evolved.

Carbon Dioxide

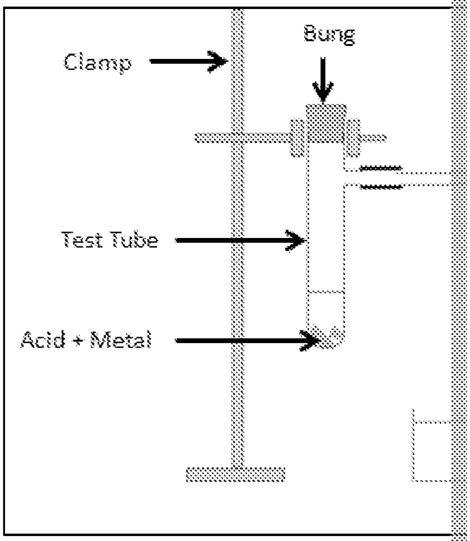
If you bubble carbon dioxide through lime water the lime water will turn from colourless to milky.

In addition carbon dioxide can also be tested for with a flaming splint. Carbon dioxide will cause the splint to go out.



Hydrogen

Hydrogen can be collected using the apparatus shown on the right. Hydrogen will be made in the reaction and will collect in the second test tube displacing the water within. Once the test tube is filled with gas remove the test tube from the water and immediately place a lit splint next to the open end of the tube. You will hear a high pitched sound. This is commonly called the squeaky pop test.



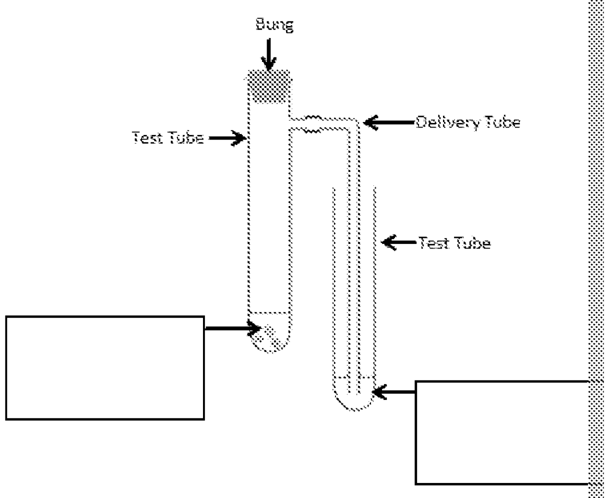
Another common test is the test for oxygen. Collect oxygen i as described in the hydrogen method, only substituting suit The test is to place a recently blown-out splint inside the test is present the splint will reignite.

Exam-Style Questions – Exploring Chemical Reactions

1. Write the balanced chemical equations for the following reactions:
   a. Calcium Carbonate + Hydrochloric Acid → Calcium Chloride + Ca
   b. Sodium Carbonate + Sulphuric Acid → Sodium Sulphate + Carbo
   c. Copper Carbonate + Nitric Acid → Copper Nitrate + Carbon Diox
   d. Magnesium + Hydrochloric Acid → Magnesium Chloride + Hydro
   e. Calcium + Sulphuric Acid → Calcium Sulphate + Hydrogen

2. Write the word equations for the following chemical reaction:
   a. $CaCO_{3(s)} + H_2SO_{4(aq)} \rightarrow CaSO_{4(aq)} + CO_{2(g)} + H_2O_{(l)}$
   b. $Na_2CO_{3(s)} + 2HNO_{3(aq)} \rightarrow 2NaNO_{3(aq)} + CO_{2(g)} + H_2O_{(l)}$
   c. $CuCO_{3(s)} + 2HCl_{(aq)} \rightarrow CuCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$
   d. $Mg_{(s)} + H_2SO_{4(aq)} \rightarrow MgSO_{4(aq)} + H_{2(g)}$
   e. $Ca_{(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_{2(g)}$

3. Carbon dioxide is often given off during a chemical reaction. Copy and collection and testing of carbon dioxide.



4. Another gas which is often given off in a chemical reaction is hydroge hydrogen.

Exam-Style Questions – Exploring Chemical Reactions

1. Write the balanced chemical equations for the following reactions:
   a. Calcium Carbonate + Hydrochloric Acid → Calcium Chloride + Ca

      ....

   b. Sodium Carbonate + Sulphuric Acid → Sodium Sulphate + Carbo

      ....

   c. Copper Carbonate + Nitric Acid → Copper Nitrate + Carbon Diox

      ....

   d. Magnesium + Hydrochloric Acid → Magnesium Chloride + Hydro

      ....

   e. Calcium + Sulphuric Acid → Calcium Sulphate + Hydrogen

      ....

2. Write the word equations for the following chemical reaction:
   a. $CaCO_{3(s)} + H_2SO_{4(aq)} \rightarrow CaSO_{4(aq)} + CO_{2(g)} + H_2O_{(l)}$

      ....

      ....

   b. $Na_2CO_{3(s)} + 2HNO_{3(aq)} \rightarrow 2NaNO_{3(aq)} + CO_{2(g)} + H_2O_{(l)}$

      ....

      ....

   c. $CuCO_{3(s)} + 2HCl_{(aq)} \rightarrow CuCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

      ....

      ....

   d. $Mg_{(s)} + H_2SO_{4(aq)} \rightarrow MgSO_{4(aq)} + H_{2(g)}$

      ....

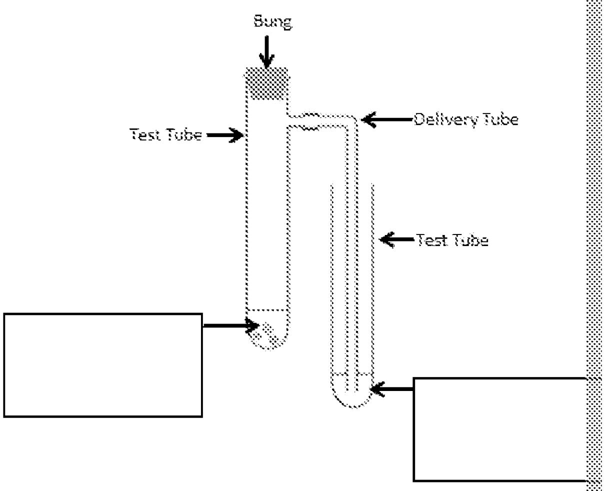
      ....

   e. $Ca_{(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_{2(g)}$

      ....

      ....

3. Carbon dioxide is often given off during a chemical reaction. Complete and testing of carbon dioxide.



4. Another gas which is often given off in a chemical reaction is hydrogen hydrogen.

....

....

Lesson Plan 12 – pH and Universal I

Learning Aims

Pupils should understand:

- How to use pH tests using universal indicator and litmus

Key words: pH scale, universal indicator, litmus, questions.

Starter

Ask pupils to describe the importance of car indicators.

Main

1. Explain the pH scale.
2. Explain how to use universal indicator and litmus paper.
3. Answer Questions 1 and 2 from the pack.
4. Go through the answers.
5. Using universal indicator to identify unknown samples. Place hydrochloric acid, 1 mol dm^{-3} sodium hydroxide and water int add 2 cm^3 of samples to a few drops of indicator and identify b universal indicator will turn red in the presence of acid.
6. Making your own universal indicator. Calibration and identifi Same as above but pupils to make their own indicator by boili such as red cabbage for five minutes and use filtrate as the ind method as before for acid/alkali/neutral identification.
7. Go through results and show the most vivid colour changes.

Plenary

Pupils to write a rap/song/poem about the importance of indicators in scie

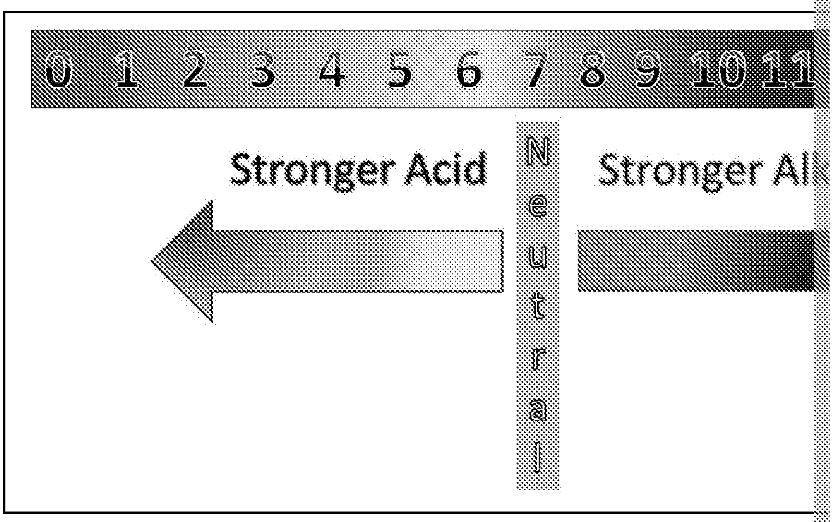
pH Tests

pH is a measure of the acidity or alkalinity of a substance. If the substance has a
substance has a pH of 8–14 it is alkaline and if the substance has a pH of 7 it is ne
There are a number of different indicators we can use to tell if a substance is alk
common are universal indicator and litmus paper.

Universal Indicator

Universal indicator can either be in the form of small strips of paper or in the for
drops of the liquid or a piece of the paper are placed in a sample of the substanc
colour change.

- Acids will turn the indicator red.
- Alkalis will turn the indicator blue.
- Neutral substances will turn the indicator green.



Litmus Paper

There are a number of different types of litmus paper. In general it works in the
paper; it will turn red in the presence of acids, blue in the presence of an alkalin
unchanged in the presence of a neutral substance.

Exam-Style Questions – pH and Universal Indicator

1. Copy and complete:

   _____________ is a measure of the acidity or alkalinity of a substance. I

   0–6 it is an _____________, if the substance has a pH of 8–14 it is _____

   has a pH of 7 it is _____________.

2. Copy the sentences with the correct word.
   Acids will turn universal indicator **red/blue/green.**
   Alkalis will turn the universal indicator **red/blue/green.**
   Neutral substances will turn the universal indicator **red/blue/green.**

✂ --

Exam-Style Questions – pH and Universal Indicator

1. Complete:

   _____________ is a measure of the acidity or alkalinity of a substance. I

   0–6 it is an _____________, if the substance has a pH of 8–14 it is _____

   has a pH of 7 it is _____________.

2. Circle the correct word.

   Acids will turn universal indicator **red/blue/green.**

   Alkalis will turn the universal indicator **red/blue/green.**

   Neutral substances will turn the universal indicator **red/blue/green.**

Lesson Plan 13 – Energy Forms and Ene

Learning Aims

Pupils should understand:
Forms of energy and their uses:
- thermal
- electrical
- light
- sound
- mechanical (kinetic and potential)
- nuclear

Energy stores and their uses:
- chemical
- kinetic (in a moving object)
- gravitational potential (due to the position of an object in a gravitation
- elastic potential (in a stretched or compressed spring)
- thermal (in a warm object)
- nuclear

Key words: energy; thermal, electrical, light, sound, kinetic, gravitational p elastic potential, questions.

Starter
Ask pupils to list as many forms of energy they can think of.

Main
1. State the listed forms of energy (thermal, electrical, light, sound, k nuclear, chemical, elastic potential) showing examples of each.

2. For each of the forms of energy listed (thermal, electrical, light, so potential, nuclear, chemical, elastic potential), describe the human time.

3. Pupils to answer Questions 1–11.

4. Go through the answers.

Plenary
Energy and their uses mix and match. Ask pupils to match a list of nine en their uses, e.g. light → illumination.

Energy

Energy can be defined as having the ability to do work and is measured in a unit
number of different forms of energy including:

Energy Forms

- **Thermal** – also known as heat energy
- **Electrical** – the energy between objects of different electrical charge and ge
- **Light** – such as the energy from the Sun
- **Sound** – the energy transmitted by vibrating objects
- **Kinetic** – energy within a moving object
- **Potential** – energy an object has owing to its position
- **Mechanical** – the sum of the kinetic energy and the potential energy of an o
- **Nuclear** – energy in the nuclei of atoms

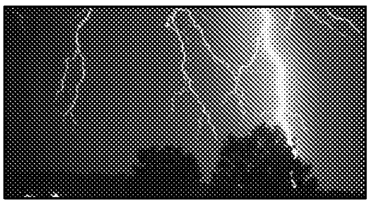
Energy Stores

- **Chemical** – stored in substances like food and within batteries
- **Kinetic** – energy within a moving object such as a falling ball
- **Gravitational potential** – energy an object has owing to its position within a
- **Elastic potential** – the energy within a stretched or compressed object like a
- **Thermal –** energy stored in hot objects like hot water
- **Nuclear** – stored in the nuclei of atoms.

Thermal Energy

Thermal or heat energy is the energy stored in a warm object such as a cup of te or a hot bath. The amount of energy in an object depends on the size of the obje and the temperature of the object. You may think that a cup of hot tea has more thermal energy than a hot bath because it is hotter but because there is only a v small volume of water in the cup of tea the bath of hot water will have far more energy. Another example could be a spark from a sparkler. Whilst the temperatu of it is several hundred degrees the amount of energy within it is very small as it virtually no mass. Generally we use thermal energy to keep us and other objects warm. It can also be used to generate electricity.

Electrical Energy



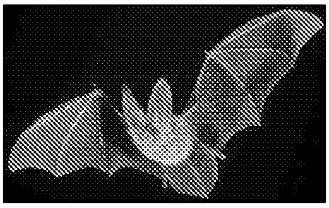
Electrical energy is very useful indeed. It can be but basically by moving a metal object through energy can be used to power all sorts of items

Light Energy

Light energy, such as from the Sun or from a fire, is given out by any luminous object. Its most common use is to light a room. More recently it has been used in fibre optic cables as a mechanism for transmitting data.

Sound Energy

An ultrasound scan of a foetus (unborn baby)



Bats use sound energy for navigation

When we think of sound energy we n but sound energy can also be used in pregnant woman goes for a scan ultra of the baby. Ultrasound waves are ge penetrate the woman and are reboun such as the baby. A sensor times how rebound and a computer turns this in used to scan concrete and metal for f and is also how bats and submarines also be used to clean delicate objects object is placed within a liquid togeth The speaker causes the liquid to vibra causes the dirt to vibrate and be rem object.

Kinetic Energy

Kinetic energy is the energy an object has as a result of moving. A ball falling thr car moving has kinetic energy. It is most commonly seen when energy is transfor form to another.

Thi

Gravitational Potential Energy

Gravitational potential energy is the energy an object has owing to its location. F shelf has more gravitational potential energy than an identical object on a lower effect on roller coasters where gravitational potential energy is transformed into rollercoasters later!

Nuclear

Nuclear Fusion

Nuclear fusion is the way energy is released inside stars. The extreme heat and p atoms of their electrons, thus turning them into **plasma**. These nuclei (atoms wit bombarded together with such force that they actually stick together to form lar vast amounts of energy. The reactant in this process is hydrogen and the produc

Nuclear Fission

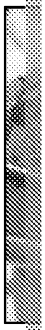
Nuclear power stations generate their electricity via nuclear fission. This form of energy production is free from carbon dioxide production and so does not cause global warming. Some people are concerned that the radioactive waste products can be dangerous if not stored correctly and that power stations could be the target of a terrorist attack. Nuclear fission works by bombarding atoms with neutrons. This causes the atom to increase in size and become unstable. The instability is so great that the atom breaks into two separate smaller atoms, releasing a huge amount of energy and also releasing other neutrons, which in turn collide with other atoms and propagate the reaction. We call this a chain reaction. To stop the reaction becoming unmanageable control rods are placed within the reaction chamber of a nuclear reactor which absorb the extra neutrons.

Chemical

Chemical energy is a type of stored energy which can be found in food and batte
large food molecules we eat; then we break down the molecules in our bodies in
other forms of energy are released.

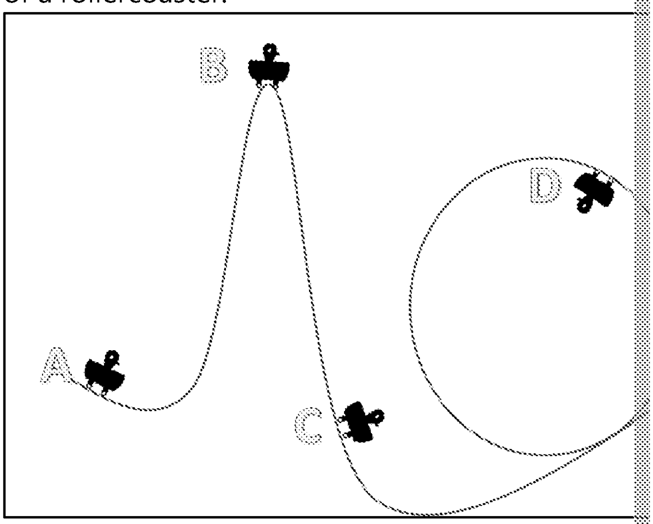
Elastic Potential

Elastic potential energy is the energy stored in an object as a result of it being stretched or compressed, such as a tightly wound spring. Energy was stored in the object at the time of its distortion; that energy will in turn be released into the surroundings once the original shape returns. One example of this is winding a watch spring which slowly unwinds driving a watch mechanism.



Exam-Style Questions – Energy Forms and Energy Store

1. There are many different types and stores of energy. List nine forms o for each one give a use of that energy.
2. Give another name for thermal energy.
3. Energies have their own specific uses. What type of energy do submar
4. Different objects have different types of energy. If an object is moving
5. Which has more gravitational potential energy: a book on a high shelf shelf?
6. Which has more thermal energy: a hot cup of coffee or a warm bath?
7. Look at the diagram of a rollercoaster.



   a. Which carriage has the most kinetic energy?
   b. Which carriage has the most gravitational potential energy?
   c. Which carriage has the least gravitational potential energy?
8. Explain the term "nuclear fusion".
9. Explain the term "nuclear fission".
10. Give an example of an object with elastic potential.
11. Explain how sound energy can be used to detect the outline of a foetu

Exam-Style Questions – Energy Forms and Energy Stor

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   ....

   ....

   ....

   ....

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   ....

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   ....

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   ....

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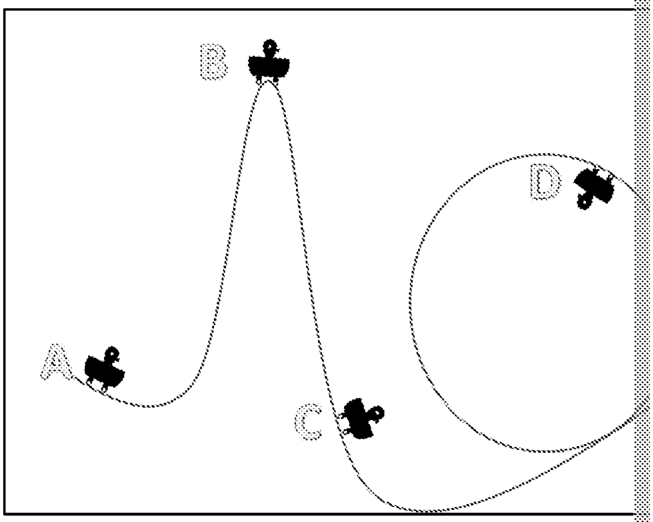

   a. Which carriage has the most kinetic energy?..........

   b. Which carriage has the most gravitational potential energy?..........

   c. Which carriage has the least gravitational potential energy? ....

8. Explain the term 'nuclear fusion'.

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9. Explain the term 'nuclear fission'.

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10. Give an example of an object with elastic potential.

....

11. Explain how sound energy can be used to detect the outline of a foetu

....

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Lesson Plan 14 – Energy Transformations a

Learning Aims

Pupils should understand:

Energy transformations (from one form of energy to another).

Energy transfers:

- mechanically
- electrically
- by conduction
- convection
- radiation

Energy transfer measurement:

- joule (J) as the unit of energy
- principle of conservation of energy
- diagrams to represent energy transfers and energy dissipation

Key words: law of energy conservation, energy transformations, Sankey d conduction, convection, infrared radiation, electrical transfer, mechanical questions.

Starter

Ask pupils to list as many forms of energy as they can. (This should be mo

Main

1. Explain the law of conservation of energy.
2. Explain the difference between energy transformation and transfer.
3. Demonstrate the energy transformation in a bulb by connectin or battery in a Locktronics (or similar) circuit and switching it o
4. Discuss other energy transformation, e.g. roller coasters, huma
5. Explain how to use Sankey diagrams.
6. Discuss and explain conduction.
7. Demonstrate conduction in action, e.g. pins stuck with Vaselin of the rod and watch the pins drop off one by one as the heat p the Vaseline.
8. Explain convection.
9. Demonstrate convection of water with a small amount of pota dissolve and show the movement of water as the water is heat convection square. Place the potassium manganate (VII) in the filled with water. Heat one side of the square. The potassium m move away from the heat source and show a convection curre
10. Explain infrared and electrical transfer.
11. Explain work done with examples.
12. Describe sound energy transfer.
13. Pupils answer Questions 1–20.
14. Go through answers.

Plenary

Pupils work in pairs. Each person writes four questions (with answers) an One point is gained for every question they get correct; one point is lost fo

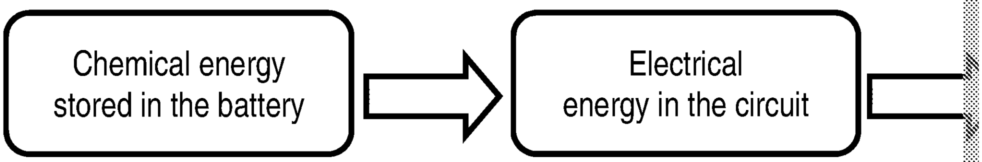
Energy Transformations

Law of Energy Conservation

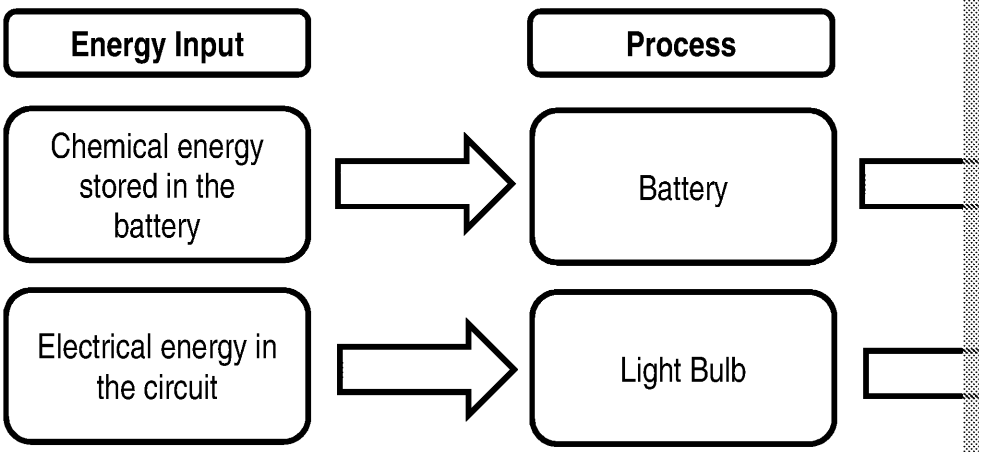
The first law of thermodynamics and the law of energy conservation (two of the f
state 'energy cannot be created or destroyed', but only change forms from one t
transferred into other objects. But the amount of energy you end with is exactly t
started with. The only problem is that the energy we end up with could be less u
started with.

For energy to be useful it needs to be able to undergo energy transformations, i.e
energy to another. For example, if a battery is connected to a light bulb in an ele
transformations are taking place:

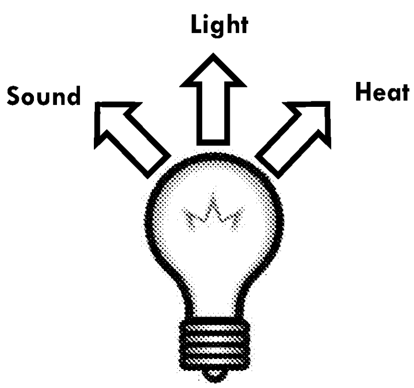
An energy transfer diagram simply displays each of the conversions as an energy i
energy is converted, and an energy output:



It is important to note that both of these processes also produce heat energy as a
useful energy output is included in the above diagram. Heat energy is not the for
these processes, but a by-product which is lost to the surroundings, and so is con

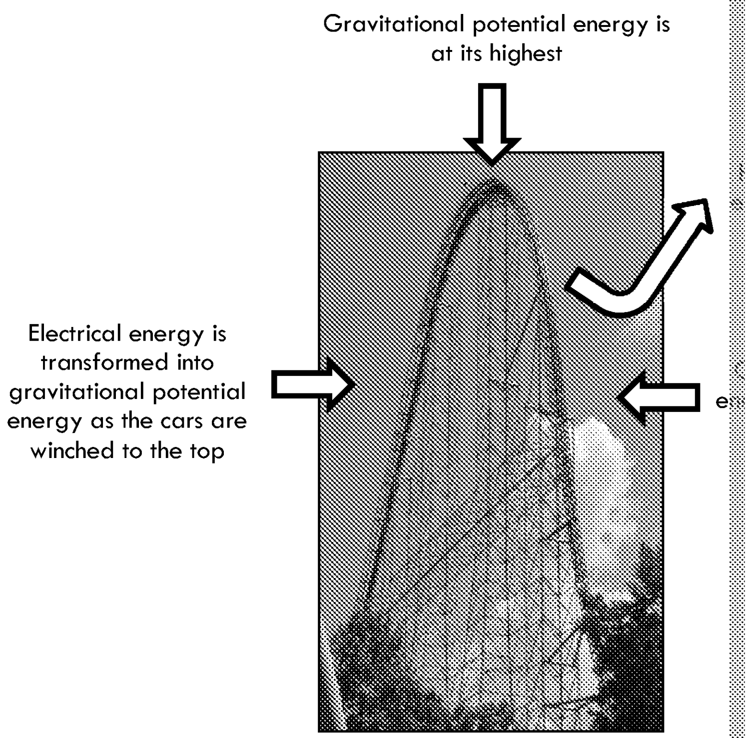


So, the amount of energy we ended up is exactly the same; however the light, so
dispersed into the surroundings and is no longer easily available for us to use.

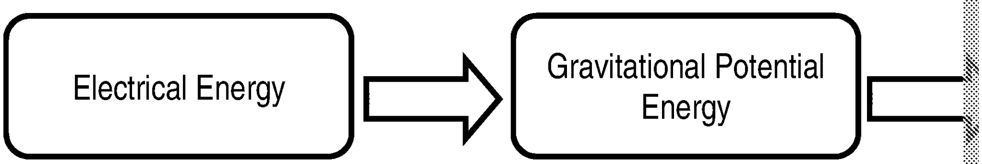


Rollercoasters

Other examples of energy transformations include rollercoasters. Rollercoasters the cars to the top. So, electrical energy is transformed into gravitational potenti potential energy is transformed into kinetic energy as the cars plummet over the are also produced as a wasted by-product).

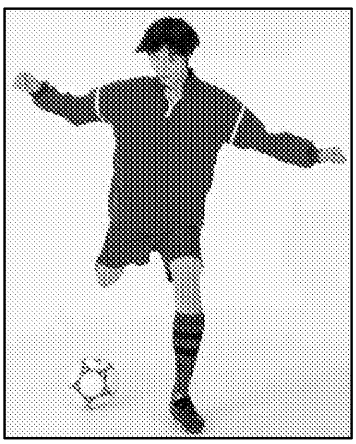


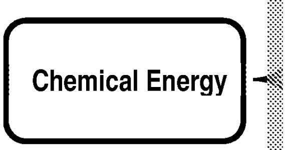
Energy transformations during a rollercoaster ride



Humans

Energy transformations also happen inside us. The chemical energy stored in the food you have eaten is transformed into kinetic energy as you move, heat energy to keep you warm, sound energy as you speak, or gravitational energy as you walk up the stairs etc.



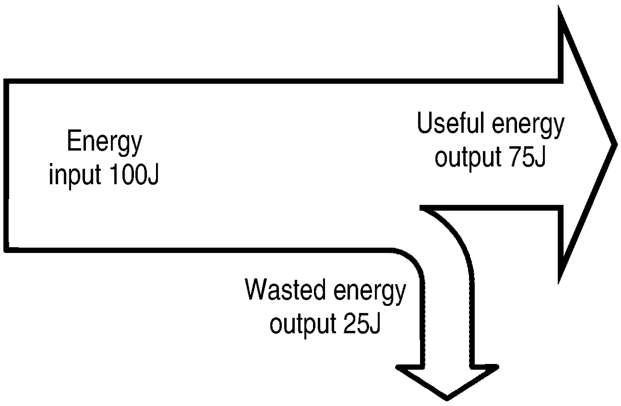


Energy transfor

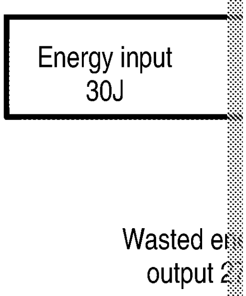
Sankey Diagrams

Sankey diagrams are a different way of showing energy transformations which in
inputs and outputs of a process. They use arrows of different thickness to repres
of energy involved. For example, if the diagram were describing a tumble dryer, t
electrical energy from the mains. The useful energy output would be kinetic ene
to dry them. The wasted energy output would be the heat lost to the surroundin

Not all energy transformations produce such a large proportion of useful energy
example wasted most of its energy in heat and sound. Very little was transforme

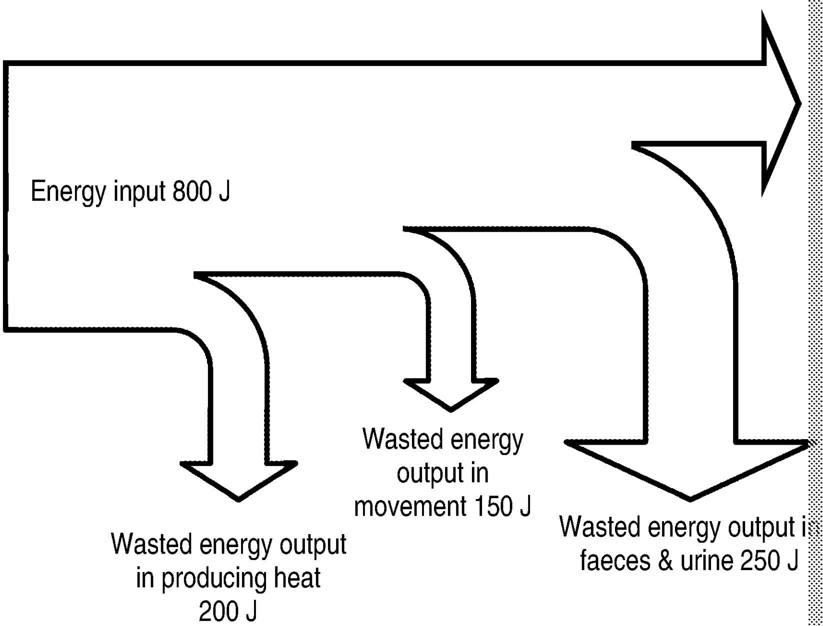


Sankey diagram showing the energy tranformations in a tumble dryer



Sanke transfo

Some Sankey diagrams can be more complicated. The following diagram shows t
can be very useful to the farmer who wants as much of the energy he puts into t
making more cow, not to be wasted in movement, heat or excreted in the form o



As you can see in the diagram most of the energy the farmer puts in is actually lo

Energy Transfers

Energy is not only transformed from one type of energy to another but it is also t
another.

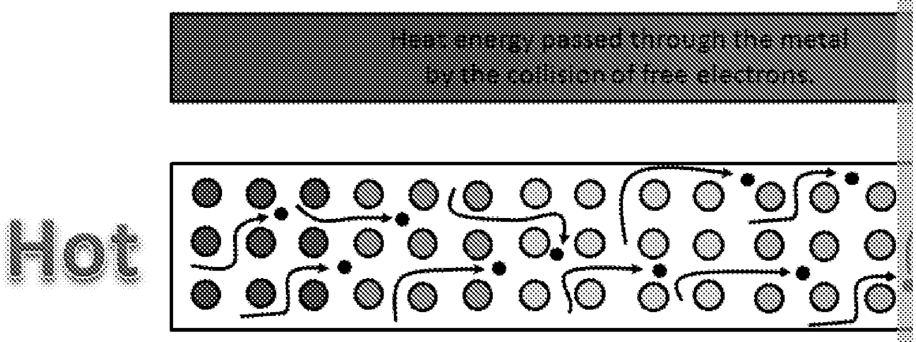
Conduction

Heat is always transferred from warmer areas to colder areas. Heat can move th
most commonly through solids.

Conduction involves the transfer of energy from one particle to the next; this is e
are very close together, although some solids are very poor conductors; we call t
metals are especially good conductors because their structure contains free elec
through the metal carrying energy with them.

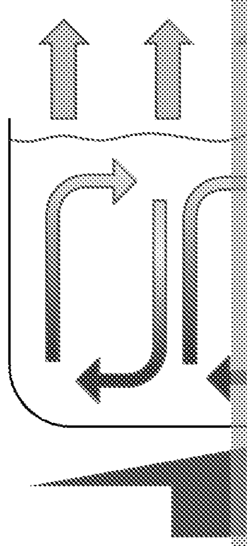
Imagine one end of a metal rod placed in a Bunsen burner flame. The metal aton
begin to vibrate faster. They bump into neighbouring cooler metal atoms making
way begin to pass the heat down the length of the rod.

However, at the same time, and more importantly, the heating makes the loose e
about more excitedly (more kinetic energy). They collide with other electrons wh
structure colliding with metal atoms and passing on their heat energy. It is this se
makes metals so good at conducting heat.



Convection

Heat energy can be transferred through a liquid or a gas via convection. Whilst conduction involves the vibration of particles convection requires the movement of particles through the substance.

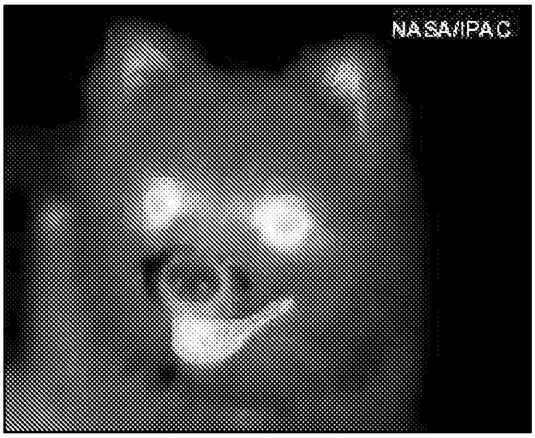


As the substance is heated it expands. This is because the particles are given more kinetic energy and move faster, widening the gaps between individual particles. Because they expand they are less dense (less dense objects will float on more dense ones).

Because the particles are free to move within the substance, the warmer, less dense particles will tend to rise towards the top, while the colder, denser particles will fall to the bottom. If the colder parts of the substance are then heated when they reach the bottom, they will in turn rise, while the fluid at the top will cool and return to the bottom. This is called a convection current; examples include radiators heating a room and the water in a saucepan heating.

Infrared Radiation

Infrared or thermal radiation is a form of electromagnetic radiation which transf exposed to infrared radiation will heat up whilst an object which emits infrared r result.



An infrared
The darker regions are and are emitting low the lighter parts are th and are emitting highe

Infrared radiation travels in electromagnetic waves, meaning that like other form (such as visible light) it can travel through a vacuum. This is why you can feel the

All objects are absorbers and emitters of infrared radiation. The hotter an object will emit in a given time; the colder it is the more it will absorb.

The nature of an object's surface also affects the rate at which it absorbs or emit surfaces are good absorbers and good emitters of infrared radiation but poor ref poor absorbers and poor emitters of infrared radiation, but good reflectors.

Sound Radiation

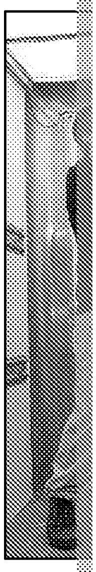
Sound energy would be useless to us if it didn't move from one place to another. Sound energy moves in a similar way to heat being moved via convection. When sound is made it causes the particles in the air around the object to vibrate and move. These movements cause adjoining particles to move and so on until the vibrations reach our ears, where they are converted into recognisable sound insi us. You probably see the picture on the right every day without thinking about it. The picture shows a speaker vibrating the air particles and those vibrations spreading out into the surrounding air. Sound waves can be transferred through solids, liquids or gases, although they tend to move a much smaller distance through solids and liquids.

Electrical Transfer

Electrical energy can also move from one place to another within an electrical device. Electrical energy most commonly passes through metal wires. This is because metal wires are made of positively charged ions (atoms with a charge) surrounded by a 'sea of free electrons' with a negative charge. These electrons can also be called delocalised electrons, meaning they are not local to the atom from which they came. Because the electrons are free to move it means that they can move throughout the metal structure carrying electrical energy with them. We call this flow of electrons an electric current.

Electrical transfer in metals

Mechanical Transfer



Mechanical transfer is when a force moves through a distance. We generally call this 'work done', i.e. it is the energy transferred into something when we move it.

To calculate the work done we use the equation:

$$W=Fd$$

Where: **W** = work done (J or Nm)
F = force (N)
d = distance (m)

The force is simply the weight of the object moved measured in newtons (N).

The distance is the distance the object has been moved measured in metres (m).

Examples

If you lifted boxes weighing 100 N from the floor to a height of 1.5 m the calculat

100 N × 1.5 m = 150 J of work done

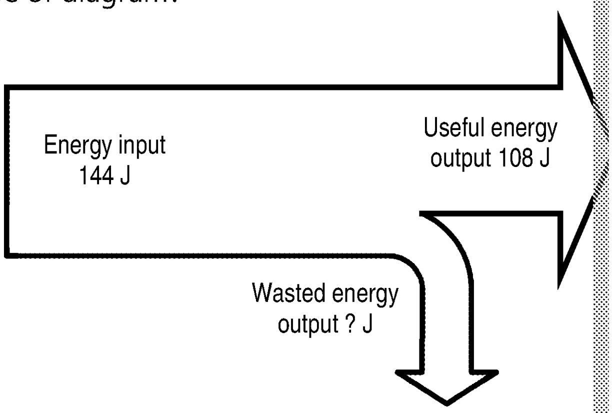
Don't be confused by the way questions are asked in the exam, as they often sou are. Let's look at a possible way the exam could ask the question:

Calculate the energy transferred if a force of 100 newtons acts along a path of 1.5

This is exactly the same as the example we have just looked at: 100 × 1.5 = 150 J.

Exam-Style Questions – Energy Transformations and Tr

1. State the law of energy conservation.
2. What is the difference between an energy transformation and an ener
3. Draw a flow diagram of the energy transformations that occur in boili
4. Draw a flow diagram of the energy transformations that occur whilst j
5. Draw a flow diagram of the energy transformations that occur when w
6. Describe the process of conduction.
7. Describe the process of convection.
8. What type of surface emits infrared radiation best?
9. What type of surface absorbs infrared radiation best?
10. What do we call the electrons within metal structures?
11. What unit do we measure energy in?
12. What do we call this type of diagram?



13. For the diagram shown in Question 12, calculate the missing number.
14. What does the term 'mechanical transfer' mean?
15. What equation do we use to calculate the amount of work done?
16. Calculate the work done if a 15 N object is raised vertically 12 metres.
17. Calculate the energy transferred if a force of 15 N acts along a path of
18. Calculate the energy transferred if a force of 7.5 N acts along a path o
19. Explain how sound is transferred from a speaker to an ear.
20. Can sound move through a vacuum?

Exam-Style Questions – Energy Transformations and Tr

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    ....

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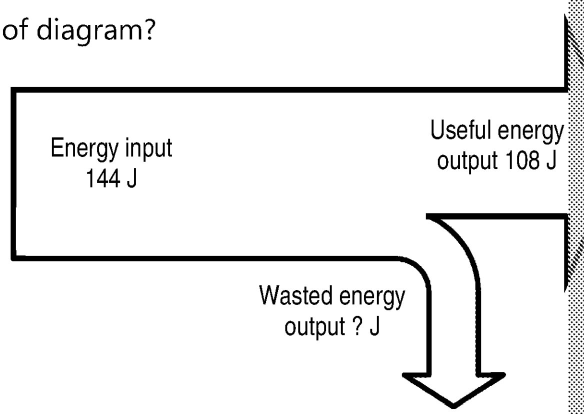

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....

19. Explain how sound is transferred from a speaker to an ear.

....

....

20. Can sound move through a vacuum?

....

Lesson Plan 15 – Power and Effici

Learning Aims

Pupils should understand:
Energy transfer measurement:
- joule (J) as the unit of energy
- principle of conservation of energy
- diagrams to represent energy transfers and energy dissipation
- watt (W) as the unit of power
- power calculations

Efficiency of energy transfers and transformations:
- efficiency as the proportion of energy transferred to useful forms
- calculations involving efficiency

Key words: power, efficiency, questions.

Starter
Ask pupils to list two energy transfers and two energy transformations.

Main
1. Explain the concept of electrical power.
2. State the equation to calculate electrical power.
3. State the units.
4. Demonstrate how to rearrange the equation to make energy the s
5. Explain how to use the equations to calculate power and energy c
6. State the equation to calculate efficiency.
7. State the units.
8. Explain how to use the equations to calculate efficiency.
9. Pupils to answer Questions 1–18 from the pack.
10. Go through the answers.

Plenary
Pupils are to list some everyday examples of efficiency and inefficiency.

Energy Calculations – Power

Electrical appliances play an increasingly important part in our everyday lives, du
electrical energy into other forms of energy. Without electricity, we could not lig
Internet or keep our food fresh in the fridge.

Electrical appliances are designed to convert electrical energy into another form

- **Heat energy** – kettles, toasters, microwaves and electric heaters are just a f convert electrical energy into heat.
- **Light energy** – light bulbs and fluorescent tubes provide us with light within computer displays also emit light.
- **Sound** – appliances such as MP3 players and the speakers in TVs convert ele
- **Kinetic energy** – any appliance designed to cause movement, such as a fan, processor, works by converting electrical energy into movement (kinetic) en

Electrical power measures the rate at which an appliance is able to transfer ener
and is calculated using the equation:

$$\text{Power (watts)} = \frac{\text{Energy (joules)}}{\text{Time (seconds)}}$$

Which can be rearranged to make: Energy (joule

Examples

Calculate the power rating of an appliance that uses 780 J of energy in one minu
Power = 780/60 = 13 W

Calculate how much energy is used by a 60 W appliance in an hour.
Energy = 60 × (60 × 60) = 216,000 watts.

Kilowatt-Hours

Energy is normally measured in joules but as this is such a small amount of energ
the energy you use in kilowatt-hours or kWh. We can use the same equations as
and seconds we use kilowatts (1000 watts) and hours. So the equation becomes

$$\text{Energy (kWh)} = \text{Power (kilowatts)} \times \text{Time (Hours)}$$

The cost is calculated by multiplying the number of kWh of energy you have used
calculate the cost of running a 60 W light bulb for two hours if the cost of 1 kWh
Energy = (60/1000 or 0.06) × 2 = 0.12kWh
Cost = 0.12 × 9 = 1.08p

Energy Calculations – Efficienc

As we have seen, every energy transfer and transformation will result in some us
some energy which is wasted and is lost to the surroundings as unwanted heat, s

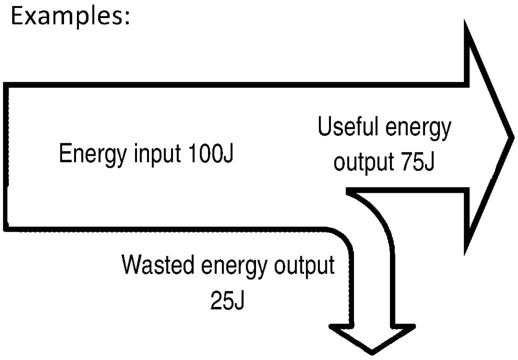
The efficiency of a process is the proportion of the energy input which is convert
less energy a process wastes, the more efficient it is.

$$\text{Efficiency} = \frac{\text{Useful Energy}}{\text{Total Energy Supplied}}$$

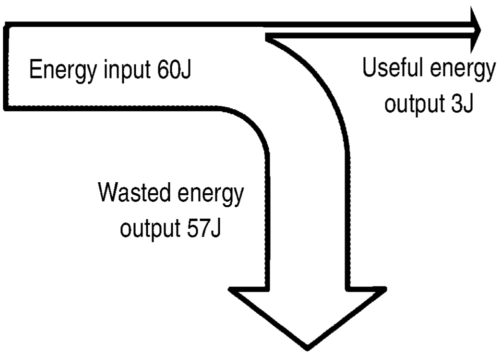
Efficiency is calculated using the equation:

The more efficient a process is, the less energy is wasted and so it is cheaper to r
damaging to the environment. Therefore, it is important to try and make devices
possible.

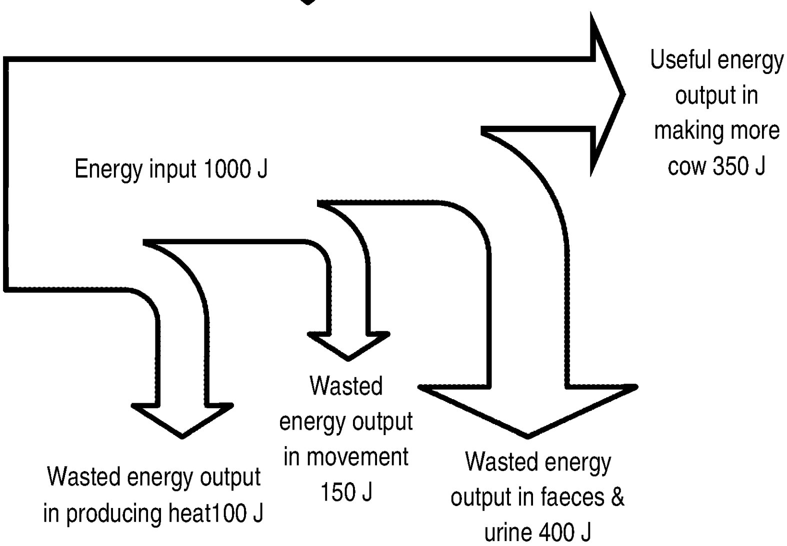
Examples:



Efficiency =



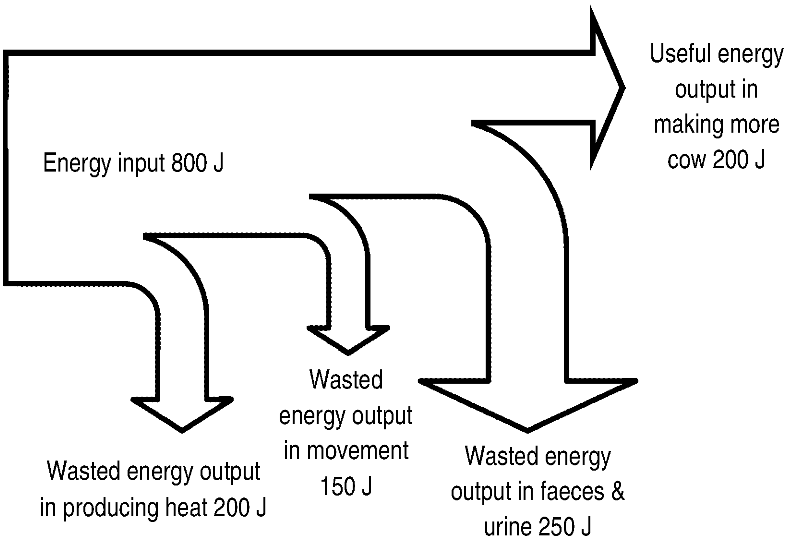
Efficiency =



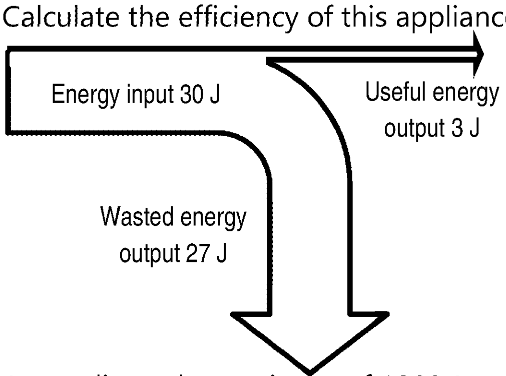
Efficiency =

Exam-Style Questions – Power and Efficiency

1. What is electrical power?
2. What unit do we use to measure power?
3. Give the equation to calculate power.
4. Give the equation to calculate the amount of energy consumed.
5. Calculate the power rating of an appliance that uses 1,569 J of energy
6. Calculate the power rating of an appliance that uses 195 J of energy in
7. Calculate the power rating of an appliance that uses 780 J of energy in
8. Calculate the power rating of an appliance that uses 1,000 J of energy
9. Calculate how much energy is used by a 30 W appliance in an hour.
10. Calculate how much energy is used by a 12 W appliance in 30 minutes
11. Calculate how much energy is used by a 15 W appliance in three minu
12. Calculate how much energy is used by a 3 W appliance in a day.
13. What does the term efficiency mean?
14. Give the equation used to calculate efficiency.
15. Calculate the efficiency of this cow.



16. Calculate the efficiency of this appliance.



17. An appliance has an input of 1200 J and wastes 800 J. Draw a Sankey d calculate its efficiency.
18. An appliance uses 250 J of energy usefully and wastes 800 J. Draw a Sa appliance and calculate its efficiency.

Exam-Style Questions – Power and Efficiency

1. What is electrical power?

....

2. What unit do we use to measure power?

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3. Give the equation to calculate power.

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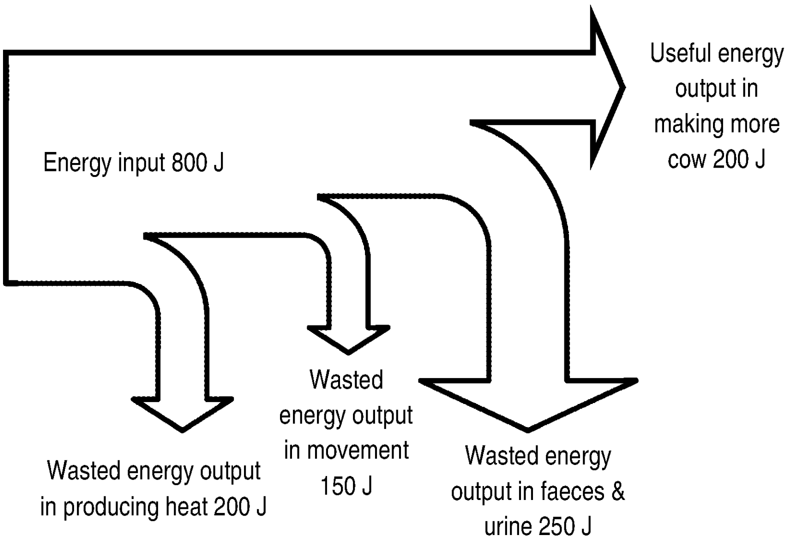
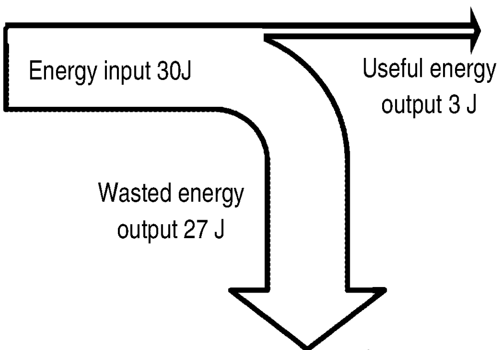


16. Calculate the efficiency of this appliance.



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Efficiency ....

18. An appliance uses 250 J of energy usefully and wastes 800 J. Draw a S
appliance and calculate its efficiency.

Efficiency ....

Lesson Plan 16 – Sources and Stores o

Learning Aims

Pupils should understand:
Sources of energy:
- renewable (solar, wind, biofuels, hydroelectric, wave, tidal, geotherm
- non-renewable (fossil fuels, nuclear)
- using energy sources effectively

Key words: sources of energy, renewable, solar, wind, biofuels, hydroelec non-renewable, fossil fuels, nuclear, using energy sources effectively, ques

Starter
Ask pupils 'Where do we get our energy from?'

Main
Independent research project:

1. Pupils answer Questions 1–6.
2. Pupils create a poster explaining renewable and non-renewable e the end of the lesson.
3. Teacher to monitor and provide assistance where needed.

Plenary
Pupils are to present their posters.

Sources and Stores of Energy

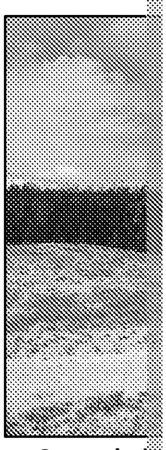
Electricity is generated from a variety of energy sources. Each source has its own
based on factors such as cost, reliability or environmental impact.

An energy source is described as a renewable energy source if it is not going to ru
For example, solar energy is renewable because it will always be available for the
about 4 billion years or so, while wood is also renewable because new trees can b
which are chopped down.

If there is only a finite (fixed) amount of an energy source available, it is known as
such as coal and natural gas are examples of non-renewable energy sources beca
amount of these resources left on Earth. Non-renewable energy sources are a co
they will run out, and we will no longer be able to rely on them for supplying ene

Geothermal Energy

Geothermal energy is the energy from the heat generated by the core of the Earth.



Steam bei

In some cases, rocks in volcanic areas contain radioactive material which decays, releasing heat; this heats water between the rocks, causing it to rise to the surface of the Earth as steam. This steam can be used to drive turbines and generators which convert kinetic energy into electrical energy.

In other cases, the rocks can be hot but have no water between them. Instead, the water is pumped down through wells to reach the rocks. As it runs through cracks between the rocks, it heats up and evaporates into steam, which then rises through other wells and is used to drive the turbines.

The advantages of geothermal energy are:

- There are no fuel costs whatsoever.
- There are no waste products or harmful substances released as a by-pro
- Once set up, the energy source is reliable.
- Geothermal energy is a renewable source – it will not run out in the fore

The disadvantages of geothermal energy are:

- The start-up time and initial cost are both very high, particularly where it towards the rocks.
- It is difficult to find suitable locations for this type of power station.
- Earth's crust needs to be thin enough for drilling to be beneficial.

Solar Energy

Solar energy is energy sourced directly from the light of the Sun. It is usually coll
using either solar panels or solar cells.

Solar panels are supplied with cold water, and placed in locations likely to get a l
direct sunlight, e.g. on a roof. The solar panel absorbs light from the Sun, which h
the water. The water is then taken to a storage tank, and more cold water is sup
the solar panel.

Solar cells, on the other hand, convert light energy from the Sun directly into ele
energy. Solar cells are used to power most man-made satellites orbiting the Eart
can also be found in more common places such as pocket calculators.

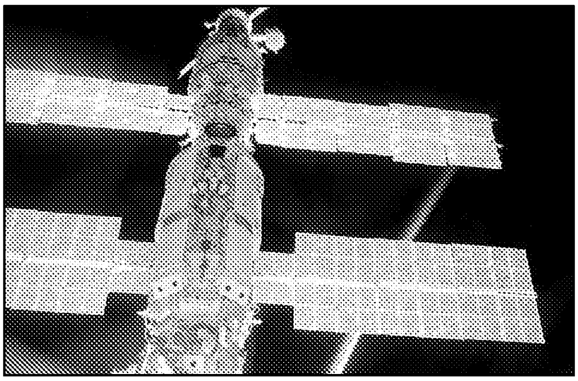
The advantages of solar energy are:

- The source is renewable – the Sun will outlast us by many billions of years.
- There are no fuel costs.
- The start-up time of both solar panels and solar cells is fairly quick.
- There are no waste products or harmful by-products.

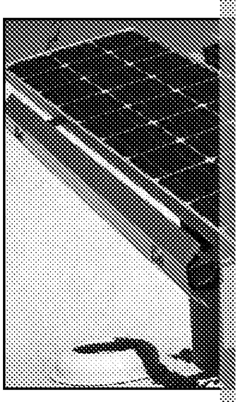
The disadvantages of solar energy are:

- Solar cells in particular are very expensive, which means the electricity they costs are beginning to fall as the technology becomes more popular.
- The heat generated by solar panels depends strongly on the climate – they locations.
- At night there is no sunlight, so no solar energy can be collected: the same i
- Large solar power stations require lots of space.

Solar energy can be most useful in local settings where only a small amount of e
is used increasingly to power road signs in isolated areas, where it can be easier
install a solar cell than to try and connect it to the National Grid.



Solar cells can be a good source of energy in space



A sc

Water

Hydroelectric

At a hydroelectric plant, a large reservoir of water is stored high up in a river valley behind a dam. The height at which the water is stored means that it has a lot of gravitational potential energy, which is then converted to kinetic energy when the water falls down pipes inside the dam. Turbines within the dam are then driven by the falling water, transferring the energy to electrical generators.

During times of low demand, energy from a hydroelectric plant can be used to pump water back up into the reservoir, to be released again at peak times. This is known as a pumped storage system.

Smaller-scale hydroelectric systems can be useful in remote areas where it is harder to supply energy from other sources.

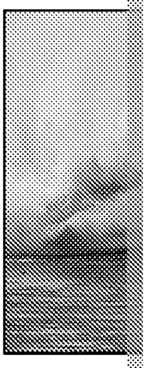
H

Tidal

Tidal barrages are built in river estuaries where there is a lot of tidal variation (bi high and low tide). Electrical generators are kept in tubes in the barrage, which w moves in or out. The kinetic energy of the water drives the generators.

Wave

Wave machines work in a similar way to tidal barrages, except that instead of using the inward and outward motion of water in estuaries, they use the up and down motion of waves in the sea to convert kinetic energy.

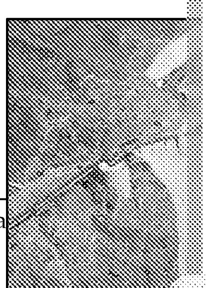


The advantages of water as an energy source are:

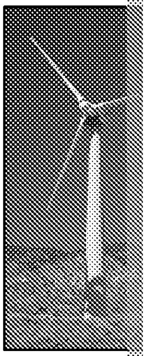
- Water is a renewable source – it does not get used up by any of the processes.
- There are little or no fuel costs.
- The start-up time is fairly short.
- Hydroelectric dams (particularly pumped storage systems) and tidal barrages are reliable sources.
- No harmful by-products are formed.
- Useful for islands that cannot connect to the national grid.

The disadvantages of water energy are:

- Hydroelectric dams and tidal barrages both disturb their ecosystems – tidal estuary-dwelling species, such as wading birds, while hydroelectric dams ca farmland and force people to leave their homes.
- In the flooding caused by hydroelectric dams, plant life under the water can is a greenhouse gas and contributes towards global warming.
- Wave machines are inefficient and cannot generate a large amount of elect
- Problems with getting electricity generated at sea back to land.
- Building dams is expensive.



Wind



Wind occurs as a result of huge convection currents in the air of the Earth's atmosphere. The kinetic energy of wind can be harnessed by wind turbines, which have large blades that are pushed by the movement of the wind so that they rotate. The rotating blades are attached to an electrical generator inside the wind turbine.

The advantages of wind energy are:

- It is renewable – the convection currents are driven by heat from the Sun, which will not be exhausted in the foreseeable future.
- There are no fuel costs.
- There are no harmful by-products or waste products.
- Wind turbines are fairly cheap and have an almost immediate start-up time.

The disadvantages of wind energy are:

- A single turbine cannot generate much electricity on its own – huge wind fa significant amount.
- It is unreliable – the amount of electricity generated depends entirely on th time. If there is no wind, then no electricity can be generated at all.
- Wind farms are considered by some to be an eyesore. They can also be very residents. These issues are known as visual and noise pollution.
- Turbines can cause damage to wildlife such as birds that try to fly through th

Biofuels

Biofuels can be solids, liquids or gases. methane can be obtained by the decom methane can then be channelled off an

People are also trying to develop altern ethanol. These are fuels made from pla carbon dioxide produced when you bur of the plants and the carbon dioxide it photosynthesis.

The advantages of biofuels are:

- They are renewable – the organisms involved are not endangered and will la
- Low fuel cost – biofuels are mostly generated from substances that would o
- Cheap and quick start-up.
- Although burning biogases produces CO_2, the organic waste used to produc These plants took in CO_2 from the air as they grew (photosynthesis) so the b replacing this CO_2 back in the atmosphere. For this reason we say this proce no **overall** change to the carbon dioxide in the air.

The disadvantages of biofuels are:

- The decomposition process produces a very unpleasant smell.
- The amount of land required for significant biofuel generation is very large.
- It reduces the amount of land for growing food crops.

Fossil Fuels

Coal

Fossil fuels provide approximately 75% of the electricity used in t oil and coal. Fossil fuels are formed from dead organic matter wh the surface of the Earth for millions of years.

Fossil fuels are burnt in power stations to release heat. The heat evaporate water into steam, which then rises and drives turbines electrical generators.

The main advantages of using fossil fuels are:

- Their relatively quick start-up time – gas power stations take the shortest ti and then coal.
- They are more reliable energy sources – the amount burnt in power station according to demand. Matching supply and demand is very important when

The disadvantages of using fossil fuels are:

- Because they are non-renewable, fossil fuels will one day run out and we wi longer be able to rely on them.
- Fossil fuels release carbon dioxide (CO_2) when they are burnt. Carbon dioxid greenhouse gas, and so releasing large amounts of it into the atmosphere ca contribute to global warming. Coal produces the most carbon dioxide, follow oil and then gas.
- Additionally, fossil fuels can release sulphur dioxide when burnt. Sulphur dio toxic and can be harmful to organisms which breathe it in, and can also reac water in the atmosphere to produce acid rain which damages trees and buil

It should be noted that although carbon dioxide emission is a problem when bur rapidly evolving which is able to 'capture' the carbon dioxide before it is released can be stored elsewhere. Often the carbon dioxide can be stored in natural conta fields which have already been mined – there are many of these underneath the

Nuclear Fuels

Radioactive elements uranium and plutonium are used as nuclear fuels. The process is similar to that of fossil fuels, except that nuclear fuels are not burnt – the heat supplied to the water comes from nuclear reactions in the reactor of the power plant. The process is called nuclear fission.

The advantages of nuclear power are:

- Like fossil fuels, nuclear fuels are reliable sources of energy, which can be used to provide energy whenever it is needed to meet demand.
- Unlike fossil fuels, nuclear fuels do not release any harmful gases into the atmosphere.
- Nuclear fuels are relatively cheap.

The disadvantages of using nuclear fuels are:

- Again, nuclear fuels are non-renewable, and so the amount available to us i
- Radioactive material is dangerous to deal with. In the event of an accident, very harmful radioactive substances.
- When the fuel is used up, the remaining waste is still radioactive and remai years, so it is difficult to dispose of safely.
- Nuclear plants have a longer start-up time than fossil fuel plants, and are m dismantle.
- Security issues.

Using Energy Sources Effectively

However we generate our electricity, whether it's via nuclear, fossil, solar or any
important to use our energy sources effectively.

Doing this will reduce waste, and reduce the price to the consumer and to indust
could in turn lead to a reduced cost of manufacturing, which could also cost the

In addition, effective use of energy resources will lead to less of an environment
reduced carbon dioxide emissions into the atmosphere or fewer wind turbines r

Storing Energy in Batteries and Fuel Cells

Batteries contain chemicals and convert chemical energy into electrical energy.

Advantages of batteries include:

- Portability
- Appliances do not need to be plugged in
- Can be used in areas where electricity is not provided
- Can easily be replaced

Disadvantages of batteries include:

- Can only be used for a limited amount of time
- There are environmental concerns over their manufacture and disposal
- They can leak and damage the appliance
- They can add weight to an appliance
- Some batteries can be dangerous, with a risk of exploding

Fuel cells are similar to batteries in the sense that they convert chemical energy
electrical energy but are different as they require a constant supply of fuel in ord
do this.

Hydrogen can also be used in fuel cells to produce electricity to power vehicles. W
commercially available they too provide clean energy, with only water as a by-pr
long journeys (unlike battery powered cars that are limited to city driving) and ca
battery powered cars that take many hours to recharge). Disadvantages include
batteries are very expensive to produce and need rare metals to build and have a
a lack of hydrogen refuelling stations and a change to manufacturing would need
different car.

Exam-Style Questions – Sources and Stores of Energy

1. What is the difference between a renewable energy source and a non-
2. Name seven renewable energy sources.
3. Name two non-renewable energy sources.
4. Name one advantage and one disadvantage of the following sources
    a. geothermal energy
    b. solar energy
    c. water
    d. wind
    e. biofuels
    f. fossil fuels
    g. nuclear
5. Why is it important to use energy sources effectively?
6. Every energy resource has its own advantages and disadvantages. Giv
human race should do in the future to maintain its energy levels and a
must argue your point clearly, giving reasons and examples when app

Exam-Style Questions – Sources and Stores of Energy

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    ....

    ....

2. Name seven renewable energy sources.

    ....

3. Name two non-renewable energy sources.

    ....

4. Name one advantage and one disadvantage of the following sources

    a. geothermal energy

        ....

        ....

    b. solar energy

        ....

        ....

    c. water

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        ....

    d. wind

        ....

        ....

    e. biofuels

        ....

        ....

    f. fossil fuels

        ....

        ....

    g. nuclear

        ....

        ....

5. Why is it important to use energy sources effectively?

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6. Every energy resource has its own advantages and disadvantages. Giv human race should do in the future to maintain its energy levels and a must argue your point clearly, giving reasons and examples when app

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Lesson Plan 17 – The Electromagnetic

Learning Aims

Pupils should understand:

Wave characteristics:

- amplitude (m)
- frequency (Hz)
- wavelength (m
- wave speed (m

Wave calculations:

- using wave speed (m/s) = wavelength (m) × frequency (Hz)
- using values expressed in standard form

The electromagnetic (EM) spectrum:

- radio waves, microwaves, infrared, visible (including the colours of ultraviolet, X-rays and gamma rays
- the EM spectrum is continuous from radio waves to gamma rays, gr or frequency
- each group has a range of wavelengths with different uses and dang

Uses of electromagnetic radiation in transferring energy:

- radio waves
- microwaves
- infrared
- visible light
- ultraviolet
- X-rays
- gamma rays

Harmful effects of excessive exposure to electromagnetic radiation:

- microwaves (internal heating of body cells)
- infrared (skin burns)
- ultraviolet (damage to surface cells and eyes, leading to skin cancer
- X-rays and gamma rays (mutation or damage to cells in the body)

Key words: properties and applications of the electromagnetic spectrum, infrared, visible light, UV, X-rays, gamma rays, harmful effects, questions

Starter

Ask pupils to give the pros and cons of renewable energy sources.

Main

1. Describe the characteristics of a wave.
2. Describe the electromagnetic spectrum.
3. Explain the uses of electromagnetic spectrum, radio waves, micro UV, X-rays and gamma rays, giving examples.
4. Discussion of the harmful effects of excessive exposure to EM rad
5. Pupils to answer Questions 1–10.
6. Go through answers.

Plenary

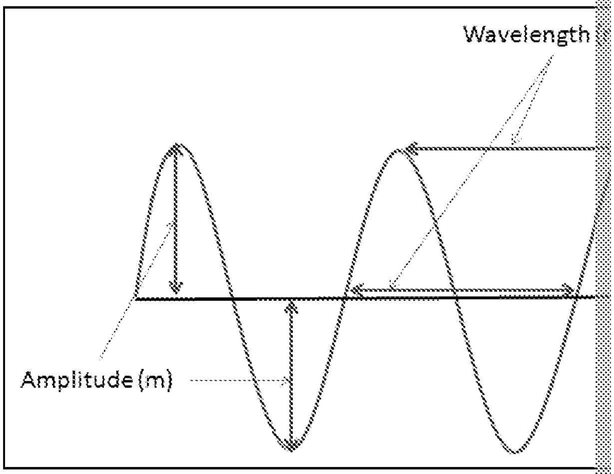
EM uses, and dangers mix and match. Ask pupils to match a list of EM wa dangers, e.g. UV → sunburn.

Properties and Applications of the Electroma

Waves are vibrations which transfer energy from one place to another, without t

A wave can be described by its wavelength, frequency and amplitude.

- The wavelength of a wave is the distance between any point on a wave and example, the distance between two crests or two troughs in a series of wav
- The frequency of a wave is the number of wavelengths that pass a certain p



The amplitude of a wave is its maximum displacement from its undisturbed posi between the top and bottom of the wave – it is half the distance (see below).

We can use the wavelength and frequency of a wave to calculate its speed using

$$\text{Wave Speed (m/s)} = \text{Wavelength (m)} \times \text{Freque (Hz)}$$

Example

Calculate the wavelength of a wave with a wave speed of 299,792,458 m/s and a

Wavelength = wave speed/frequency = $\frac{299{,}792{,}458 \text{ m/s}}{30{,}000 \text{ hz}} = 9{,}993 \text{ m}$

As these numbers can often be very big they may well be expressed in a way kno 300,000,000 may be written 3×10^8, meaning eight zeros are added to the end places to the right.

Example

Calculate the wavelength of a wave of speed 3×10^8 m/s and a frequency of 2.5

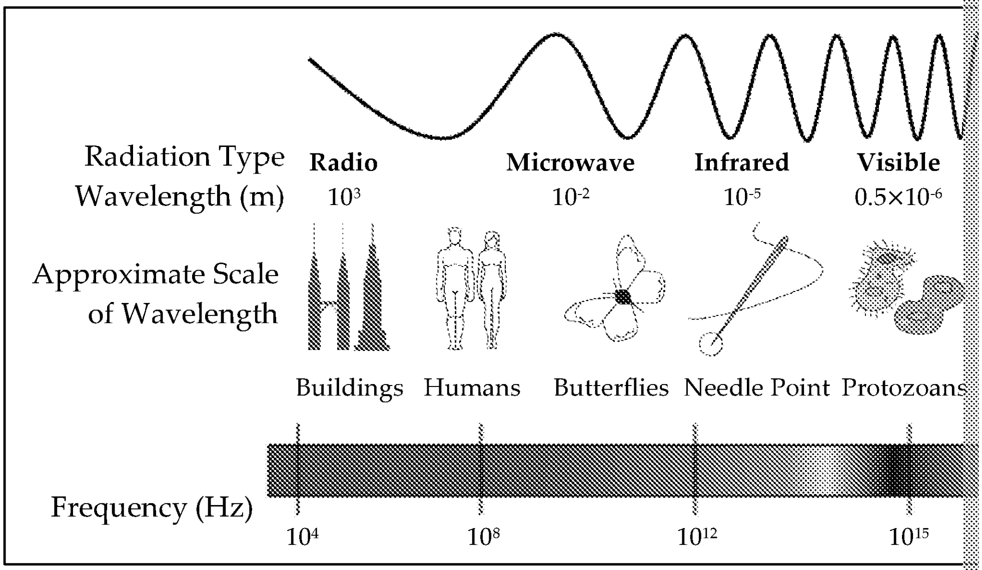
Wavelength = wave speed/frequency = $3 \times 10^8 / 2.5 \times 10^4$ = 12,000 m or 1.2×10^4

This can be calculated on your calculator by typing:
[3] [Exp] [8] [÷] [2] [.] [5] [Exp] [4] [=]

The Electromagnetic (EM) Spect

Electromagnetic waves do not need a substance (such as air) to travel through, a through a vacuum (such as space). Instead of particles, electric fields and magne transmission of the wave.

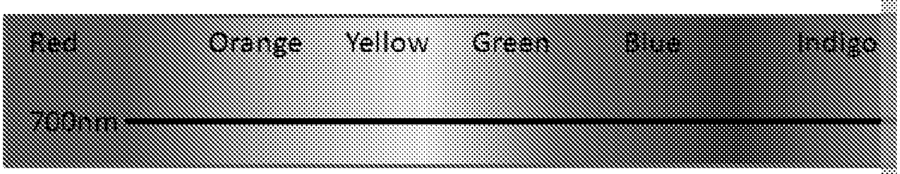
All electromagnetic waves travel at the speed of light in a vacuum. However, the wavelengths which form a continuous electromagnetic spectrum from radio wav order of wavelength (or frequency). Each group has a wide range of wavelengths dangers. Listed below are the waves that make up the spectrum, listed from long frequency) down to shortest wavelength (highest frequency).



The electromagnetic spectrum, in order of increasing frequency and energy

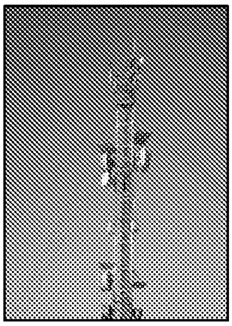
Visible Light

The most familiar of these will be visible light. Visible light, like all other groups c frequencies and wavelengths. Light's colour depends upon the wave's waveleng



Spectrum of visible light

Uses of Electromagnetic Radiation in Transferring Energy



A mast transmitting radio waves

Radio waves have the longest wavelengths of electroma centimetres up to several metres or even kilometres long. T transmit radio and television (broadcasting) signals, with tel slightly shorter wavelength (higher frequency), and also are

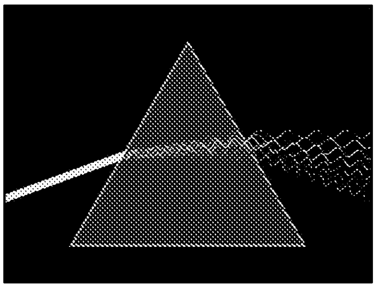
Because of their long wavelengths, radio waves have the us diffract around obstacles such as tall buildings and hills (see diffraction). This means they can reach receivers situated be

Microwaves have slightly shorter wavelengths than radio waves, typically fro millimetres to a few centimetres long. They are strongly absorbed by water mole and so are used to cook food in microwave ovens.

Microwaves are also used in communications. Mobile phone masts transmit and mobile phones. Some microwaves are also capable of passing through the Earth' used to communicate with satellites. In addition microwaves can be used by met weather patterns.

Infrared radiation, as mentioned earlier, transmits heat energy and so is us appliances such as toasters and electric heaters. It is also used in communicatio particularly in fibre-optic cables and short-range remote controls. It can also be u thermal imaging to detect people trapped under snow or rubble, and to see peo through walls. A similar technology is used in security systems.

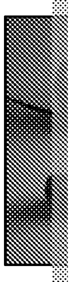
Infrared waves have a wavelength in the micrometre range, slightly longer than visible light.



The splitting of visible light

Visible light ranges from red, at the longer w the shorter wavelength end. The wavelengths o nanometres long. The visible light spectrum all and is also used in photography.

Ultraviolet rays naturally occur in sunlight, and are of slightly shorter wavelength than visible light.



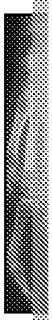
Ultraviolet radiation is used to tan skin in sun beds. It is also used for security – security pens have an ink which absorbs UV rays and emits visible light, so it can only be seen using an ultraviolet light. Fluorescent lights also work by absorbing UV and emitting visible light. UV is also used to detect forged bank notes as real bank notes contain a dye that is only visible under UV. Water and food can also be sterilised by shining UV light on them. It disrupts the DNA within the bacteria and kills them.

X-rays have a very short wavelength and high frequency. X-rays are electromagnetic waves which lie in between UV and gamma rays in the electromagnetic spectrum, with very short wavelength (between 0.1 and 10 nm) roughly the size of the diameter of an atom.

They are capable of passing through most skin and living tissue, but tend to be absorbed by bones and metals. This property makes them very useful in medicin where they can be used to produce images of bones within the human body. However, precautions have to be taken as too much exposure to X-rays poses a significant risk of turning cells cancerous.

X-rays are also used to check for faults in metal machinery.

X-rays have certain properties which make them very useful for medical applicat ionisation and can be harmful to living cells, so it is important to take safety prec using X-rays.



The most common medical use of X-rays is to generate a radiograph – a photograph formed from X-rays. This is done by beaming X-rays out of an X-ray tube through the relevant part of the human body on to a background of photographic film.

The X-rays are absorbed by bones, teeth and any metal objects inside the body (such as a plate). This means detailed images can be formed of bone fractures or tooth cavities, or any other related problems.

Images of internal organs can also be formed by filling the organ with a contrast substance which absorbs X-rays, so the organ will show up on a radiograph. For e of a patient using X-rays, the patient eats food containing a barium compound. O stomach, X-rays are beamed through the patient and absorbed by the barium co

Gamma rays can be used to detect cancer and are usually used to kill off cancer bacteria in food, and any cells on medical equipment in a similar way to UV radia

Harmful Effects of Excessive Exposure to

Microwaves

As mentioned microwaves are strongly absorbed by water molecules, and so are ovens. One danger of this is that microwaves are also strongly absorbed by wate this can be fatal to cell tissue.

Infrared

Infrared radiation, as mentioned earlier, transmits heat energy and so is used in electric heaters. Too much exposure to this can cause skin and tissue burns.

UV

Too much exposure to ultraviolet (UV) light can cause cancer in skin cells; our skin responds to ultraviolet light by darkening. The darker skin then absorbs more UV radiation, protecting the more vulnerable skin underneath. In addition it can damage the cells within our eyes, causing a number of eye conditions such as macular degeneration.

X-rays

X-rays can potentially be dangerous, since they ionise (remove electrons) substa A high enough dose can kill living tissue, while lower doses are capable of mutati become cancerous. Therefore, it is essential for patients and medical staff to tak whenever X-rays are being used.

Thick lead plates are used to shield people from X-rays, since the X-rays are unab millimetres into lead. When an X-ray machine is used to examine a patient, lead ray tube and the patient, leaving a small gap over the area of examination but pr body from radiation. The staff operating the machine have a lead screen to stand they too are protected from radiation.

In some places of work, employees who frequently have to work with X-ray equi badge. The badge reacts when it is exposed to X-rays – if it displays signs of over the badge must stop operating the X-ray equipment.

Gamma rays

Gamma rays have the shortest wavelength (highest frequency) of the electroma are capable of penetrating most skin and tissue and causing mutations within th pose a cancer risk when used.

Exam-Style Questions – The Electromagnetic Spectrum

1. Define the terms:
   a. Wavelength
   b. Frequency
   c. Amplitude

2. Give the unit we use to measure:
   a. Wavelength
   b. Frequency
   c. Amplitude

3. Draw at least one complete wave. On it label:
   a. the wavelength
   b. the amplitude

4. What equation do we use to calculate wave speed?

5. What unit do we use to measure wave speed?

6. Calculate the wavelength of a wave with a wave speed of 299,792,458 45,000 hertz.

7. Calculate the frequency of a wave with a wave speed of 299,792,458 m 3,000 m.

8. Place the waves of the electromagnetic spectrum in order from smalle

9. For each of the electromagnetic waves state one use.

10. Give a harmful effect of excessive exposure to:
    a. Microwaves
    b. Infrared
    c. X-rays
    d. Gamma rays

Exam-Style Questions – The Electromagnetic Spectrum

1. Define the terms:
   a. Wavelength

   ....

   ....

   b. Frequency

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10. Give a harmful effect of excessive exposure to:
    a. Microwaves

    ....

    ....

    b. Infrared

    ....

    ....

    c. X-rays

    ....

    ....

    d. Gamma rays

    ....

Answers to Exam-Style Questio

Lesson Plan 1 – Eukaryotic Cells

1. Eukaryotic cells are cells which have a true nucleus, such as animal and plan cells that lack a true nucleus, such as bacterial cells.
2.

Animal Cells Only	Plant Cells Only	B
	Chloroplasts	Nu
	Cell walls	Cell M
	Vacuole	Cyto
		Mitoc

3. To transfer of electrical signals from one part of the body to another.
4. Electrical.
5. Sensory neurone: These pass a signal from a sense organ (such as the skin) to on to the brain). Motor neurone: These pass messages from the spinal cord to
6. a. Neurones – Very long, linked to many other cells to pass electrical signals loss or corruption.
   b. Red blood cells –No nucleus to carry more haemoglobin to carry oxygen a increases large surface area and decreases the amount of time it takes for
   c. White blood cells – Can change shape to engulf bacteria and to fight infec
   d. Egg cells – Female reproductive cell. Large size provides nourishment. C amount of genetic material.
   e. Sperm cells – Male reproductive cell. Tail to swim to the egg. Enzymes in through egg membrane. Contains only half the normal amount of genetic
   f. Root hairs – Large surface area and large vacuole aids in absorption of wa Located near xylem for ease of water transport.
   g. Xylem – Dead, narrow, hollow cells with no ends which are connected to impermeable to water to allow the transport of water through a plant.
   h. Phloem – Hollow tubes connected to other cells and located near compan for active transport to allow the transport of sugar through a plant.
   i. Guard cells – One wall thicker than the other causing unequal expansion to form and allow the passage of carbon dioxide into the leaves and oxyg

Lesson Plan 2 – Cells, Tissues, Organs, Organ Systems and Transpiration

1. A tissue is a grouping of cells with the same function. In turn different tissue Organs do not work alone and would be useless without other organs. They organ systems.
2. To pump blood around the cardiovascular system.
3. To move blood around the body.
4. To transport water around the plant.
5. To transport sugar around the plant.
6. To provide anchorage and to collect water and nutrients from the soil.
7. Large surface area. Contains root hairs.
8. To absorb sunlight and carbon dioxide for use in photosynthesis.
9. They have a large surface area. They also tend to be very flat so that the sunl into the leaves. Plants also require carbon dioxide for photosynthesis which on the underside of the leaf. These stomata are regulated by guard cells whic close depending on the weather conditions.
10. The loss of water through the leaves.

Lesson Plan 3 – DNA, Chromosomes and Genes

1. Deoxyribonucleic acid.
2. In the nucleus.
3. To regulate the cell activity. Provides genetic code / instructions for developm
4. Double helix.

5. Adenine, thymine, guanine and cytosine.
6. A→T, G→C.
7. Complementary base pairing.
8. Chromosomes are tightly spiralled sections of DNA that typically form in a s
9. 23 pairs. 23 from each of our parents.
10. Genes are long sections of base pairs that give instructions for individual cha
11. Genes give instructions for individual characteristics whilst alleles are differe
12. a. Genotype is a genetic makeup.
    b. When both alleles of a gene are the same.
    c. When both alleles of a gene are different.

Lesson Plan 4 – Inheritance and Genetic Diagrams

1. a. strong
   b. weak
   c. observable characteristic.
2. The genotype is both alleles for a characteristic whilst the phenotype is only t
3. a.

	O	O
B	BO	BO
A	AO	AO

Phenotypes
50% A
50% B

Blood groups
Top left = B
Top right = B
Bottom left = A
Bottom right = A

b.

	B	O
A	OB	OO
O	AB	AO

Phenotypes
25% AB
25% B
25% A
25% O

Blood groups
Top left = OB
Top right = OO
Bottom left = AB
Bottom right = AO

c.

	B	B
A	AB	AB
A	AB	AB

Phenotypes
100% AB

Blood groups
Top left = AB
Top right = AB
Bottom left = AB
Bottom right = AB

d.

	B	b
b	bB	bb
B	BB	Bb

Phenotypes
75% B
25% b

Eye colour
Top left = Brown
Top right = Blue
Bottom left = Brown
Bottom right = Brown

e.

	b	b
B	Bb	Bb
B	Bb	Bb

Phenotypes
100% Bb

Eye colour
Top left = Brown
Top right = Brown
Bottom left = Brown
Bottom right = Brown

Lesson Plan 5 (1) – Pedigree Analysis

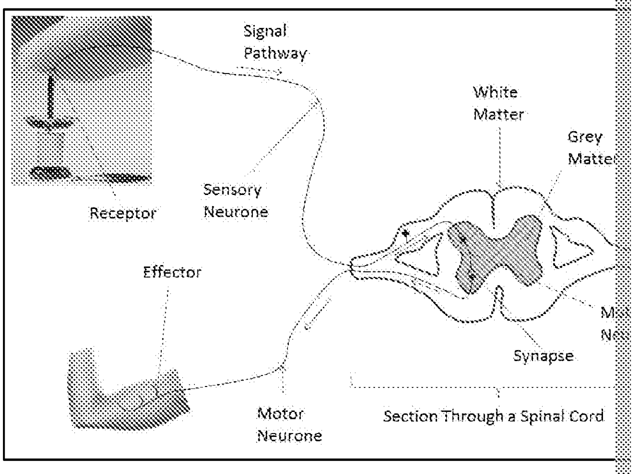
1. Recessive as it is only sporadically demonstrated.
2. 1, 3, 5, 7, 8, 9, 15, 16, 18 = nn
   2, 4, 6, 10, 11, 12, 13, 14, 17 = Nn
3. 2, 7, 10, 11, 14, 17 = bb
   1, 3, 4, 5, 6, 8, 9, 15, 16, 18 = Bb
   12 and 13 unsure either BB of Bb
4. 1, 3, 7, 10, 11, 12, 13, 14 = nn
   4, 5, 6, 8, 9, 15 = Nn
   2 = NN

Lesson Plan 5 (2) – Genetic Mutations

1. Genetic mutations can be caused by a failure to copy DNA correctly by the b
   light and certain chemicals.
2. The individual.
3. The offspring of an individual.
4. A change in function of that gene / change in characteristic.
5. Any sensible answer, e.g. cancer.
6. Any sensible answer, e.g. bacterial resistance.

Lesson Plan 6 – Homeostasis

1. The maintenance of a constant internal environment.
2. Central nervous system. The brain and spinal cord.
3. Peripheral nervous system. The sensory and motor neurones.
4. Sensory neurones transmit signals towards the CNS. Motor neurones transm
5. Any sensible answer, e.g. Voluntary responses are those that you are aware o
   include scratching an itch, or catching a falling object. Involuntary responses
   consciously aware of; these could include blinking when someone goes to sla
   the dark.
6. The reflex will bypass the conscious part of your mind. This speeds up the re
   damage.



7. Similarities: Both are methods of communication from one part of the body
   Differences: Speed of Communication – nervous is fast, hormonal is slow
   Method of Communication – nervous is electrical, hormonal is
   Transport/Transmission – nervous is blood, hormonal is nerve
   Duration of Response – nervous is short, hormonal is long
   Specificity of Response – nervous is specific, hormonal is non-
8. Receptor ⇨ Sensory Neurone ⇨ CNS ⇨
9. An impulse arrives at the end of a neurone.

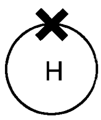
Chemicals are made and released into the gap.
Receptors in the end of the next neurone accept the chemicals and set up the

Lesson Plan 7 – Blood Glucose and Body Temperature Regulation

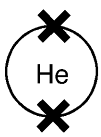
1. Blood glucose level is regulated by the pancreas. When the pancreas senses t high it manufactures and secretes a hormone called insulin into the blood. In and it causes the liver to remove any extra dissolved glucose in the blood and glycogen. If sugar levels decrease too much the pancreas secretes the hormo organ is the liver; this time the glucagon converts the glycogen back into glu the pancreas is able to keep the average blood glucose level at around 90 mg
2. Body temperature is controlled by the thermoregulatory centre in the brain. detects temperature differences in the blood running through the brain and temperature receptors in the skin as well. If it detects the blood is too hot it w number of effects. Sweating reduces body temperature because it uses the he evaporate. As it evaporates it takes with it some of the energy from the body to the skin reducing any insulating air that may be trapped between it and th skin will also dilate; this is vasodilation. This allows a greater amount of blo skin where it will be the coolest and heat is lost into the air. If the thermoreg temperature it is also able to react. An impulse is sent to the muscles to caus energy in the form of heat and is used to warm the body. This is known as sh trapping a small amount of insulating air between the skin and the hairs. Fin skin constrict; this is vasoconstriction. This prevents blood from entering the reduces heat loss.

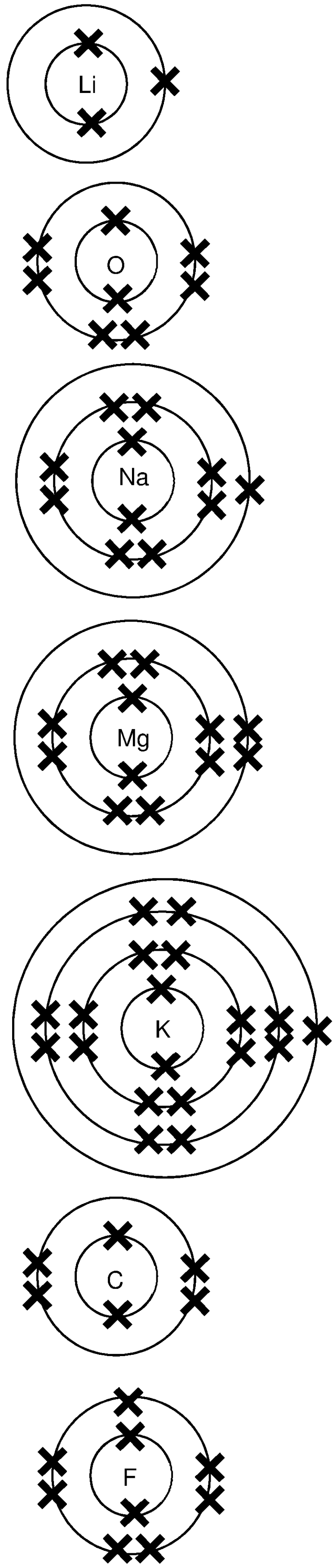
Lesson Plan 8 – Atomic Structure and The Periodic Table

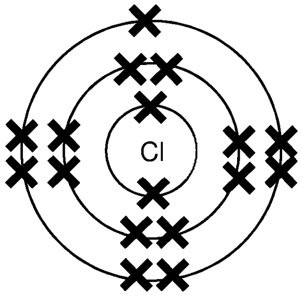
1. Left.
2. Right (except hydrogen).
3. a. nucleus
   b. nucleus
   c. in orbit in shells
   d. in the centre.
4. True.
5. False.
6. All atoms of an element have **the same** number of protons.
   Different types of atoms have **a different** number of protons.
   Atoms have **the same** number of electrons as protons.
7. a. The mass of an atom compared to an atom of carbon
   b. The number of protons in an atom.
8. In order of atomic number.
9. Periods.
10. Groups.
11. Isotopes are atoms of the same element with the same number of protons bu
12. E.g. Chlorine-35 or chlorine-37. Carbon-12 or carbon-14.
13. Because of the relatively large abundance of chlorine 35 in comparison to ch
14. The electronic configuration of :
    a. Hydrogen



    b. Helium




Li
O
Na
Mg
K
C
F



Helium = 2
Beryllium = 2.2
Carbon = 2.4
Oxygen = 2.6
Neon = 2.8
Magnesium = 2.8.2
Silicon = 2.8.4
Sulphur = 2.8.6
Argon = 2.8.8
Calcium = 2.8.8.2

ic Particle	Charge	Mass
ton		
	0	1
	- 1	Negligible / (1/1836) / 0

l Substances, Reactions and Equations

Substance	Formula/Symbol	Compound/Element
Water	H_2O	Compound
Oxygen	O_2	Element
Carbon Dioxide	CO_2	Compound
Hydrogen	H_2	Element
arbon Monoxide	CO	Compound
Methane	CH_4	Compound
lagnesium Oxide	MgO	Compound
Gold	Au	Element
odium Chloride	NaCl	Compound
Carbon	C	Element
Silicon	Si	Element
Nitrogen	N_2	Element
Ammonia	NH_3	Compound
Iron	Fe	Element

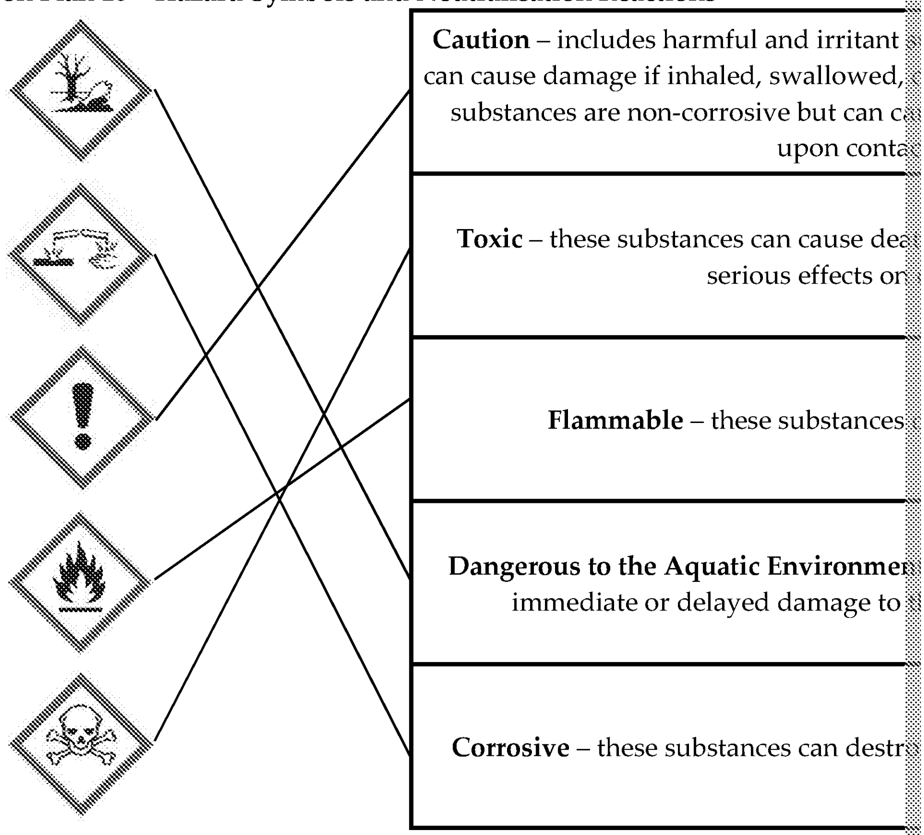
2.

Atom	Atoms are the smallest unit of matter. They are mad **protons, neutrons** and **electrons**. The protons and n together in the middle of the atom; we call this the **n** orbit around the outside of the nucleus in **shells** or e
Element	All the atoms in a substance are the same, e.g. hydro
Compound	A substance in which two or more atoms have been together to form a different substance, e.g. hydrogen to make water.
Mixture	When two or more substances have been jumbled to can easily be separated again, e.g. the air is a mixtur water and other gases.

3. a. $FeO_{(s)} + 2HCl_{(aq)} \rightarrow FeCl_{2(aq)} + H_2O_{(l)}$
   b. $CuO_{(s)} + 2HCl_{(aq)} + CuCl_{2(aq)} + H_2O_{(l)}$
   c. $CaCO_{3(s)} + 2HNO_{3(aq)} \rightarrow Ca(NO_3)_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$
   d. $Na_2CO_{3(s)} + 2HNO_{3(aq)} \rightarrow 2NaNO_{3(aq)} + CO_{2(g)} + H_2O_{(l)}$
   e. $CuCO_{3(s)} + 2HCl_{(aq)} \rightarrow CuCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$
   f. $Ca_{(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_{2(g)}$
   g. $Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

4. a. hydrogen
   b. oxygen
   c. magnesium oxide
   d. carbon
   e. carbon monoxide
   f. cobalt
   g. chlorine
   h. carbon
   i. beryllium
   j. gold
   k. e.g. chlorine-35 or chlorine-37. Carbon-12 or carbon-14
   l. boron
   m. argon and calcium
   n. hydrogen

Lesson Plan 10 – Hazard Symbols and Neutralisation Reactions

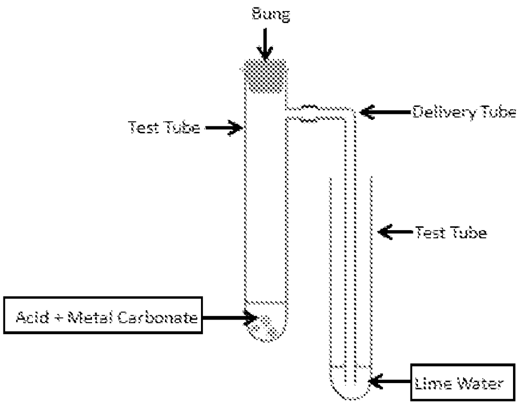


2. a $NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$.
   b. $2NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$
   c. $FeO_{(s)} + 2HNO_{3(aq)} \rightarrow Fe(NO_3)_{2(aq)} + H_2O_{(l)}$
   d. $CuO_{(s)} + 2HCl_{(aq)} + CuCl_{2(aq)} + H_2O_{(l)}$
3. a. Sodium Hydroxide + Nitric Acid → Sodium Nitrate + Water
   b. Lithium Hydroxide + Hydrochloric Acid → Lithium Chloride + Water
   c. Iron (II) Oxide + Hydrochloric Acid → Iron(II) Chloride + Water
   d. Iron (II) Oxide + Sulphuric Acid → Iron(II) Sulphate + Water
4. Metal Hydroxide + Acid → Salt + Water
5. Metal Oxide + Acid → Salt + Water

Lesson Plan 11 – Exploring Chemical Reactions

1. a. $CaCO_{3(S)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$
   b. $Na_2CO_{3(S)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4\,(aq)} + CO_{2(g)} + H_2O_{(l)}$
   c. $CuCO_{3(s)} + 2HNO_{3(aq)} \rightarrow Cu(NO3)_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$
   d. $Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$
   e. $Ca_{(s)} + H_2SO_{4(aq)} \rightarrow CaSO_{4(aq)} + H_{2(g)}$
2. a. Calcium Carbonate + Sulphuric Acid → Calcium Sulphate + Carbon Dio
   b. Sodium Carbonate + Nitric Acid → Sodium Nitrate + Carbon Dioxide + W
   c. Copper Carbonate + Hydrochloric Acid → Copper Chloride + Carbon Di
   d. Magnesium + Sulphuric Acid → Magnesium Sulphate + Hydrogen
   e. Calcium + Hydrochloric Acid → Calcium Chloride + Hydrogen

3.



4. Place a lit splint next to the open end of the tube. You will hear a high pitche
squeaky pop test.

Lesson Plan 12 – pH and Universal Indicator

1. **pH** is a measure of the acidity or alkalinity of a substance. If the substance ha
substance has a pH of 8–14 it is **alkaline** and if the substance has a pH of 7 it
2. Acids will turn universal indicator **red**.
Alkalis will turn the universal indicator **blue**.
Neutral substances will turn the universal indicator **green**.

Lesson Plan 13 – Energy Forms and Energy Stores

1. Thermal, electrical, light, sound, kinetic, gravitational potential, nuclear, che
sensible example.
2. Heat.
3. Sound.
4. Kinetic.
5. High shelf.
6. Warm bath.
7. a. C, b. B, c. C.
8. Nuclear fusion is the way energy is released inside stars. The extreme heat a
the atoms of their electrons thus turning them into plasma. These nuclei (ato
bombarded together with such force that they stick together to form larger n
amounts of energy. The reactant in this process is hydrogen and the product
9. Nuclear fission works by bombarding atoms with neutrons; this causes the a
become unstable. The instability is so great that the atom breaks into two sep
huge amount of energy and also releasing other neutrons, which in turn colli
propagate the reaction. This is a chain reaction. To stop the reaction becomin
placed within the reaction chamber which absorb the extra neutrons.
10. Any sensible answer, e.g. spring under compression.
11. Ultrasound waves are generated which harmlessly penetrate the woman and
surface, such as a foetus. A sensor times how long it takes for the signal to re
into a picture.

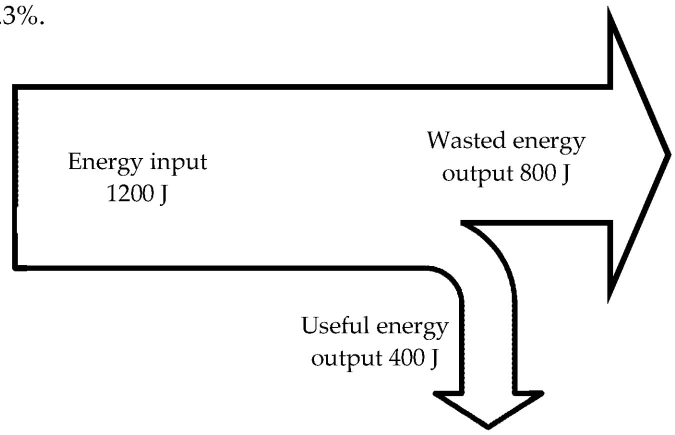
Lesson Plan 14 – Energy Transformations and Transfers

1. 'Energy cannot be created nor destroyed'.
2. Transformed = from one type of energy to another. Transferred = from one p
3. Electrical → thermal + sound
4. Gravitational potential → kinetic
5. Chemical → heat, light, sound
6. Conduction involves the transfer of energy from one particle to the next. Thi atoms are very close together, although some solids are very poor conductor insulators. Most metals are especially good conductors because their structu can move freely through the metal carrying energy with it.
7. As a substance is heated it expands. As they expand they become less dense particles will tend to rise towards the top, while the colder, denser particles w colder parts of the substance are then heated when they reach the bottom, th at the top will cool and return to the bottom.
8. Dark, matt surfaces.
9. Dark, matt surfaces.
10. Delocalised electrons or a sea of free electrons.
11. Joules (J).
12. Sankey diagram.
13. 36
14. Work done.
15. W = Fd.
16. 180 J.
17. 180 J.
18. 6.75 J.
19. When a sound is made it causes the particles in the air around the object to vi movements cause adjoining particles to move and so on until the vibrations r
20. No.

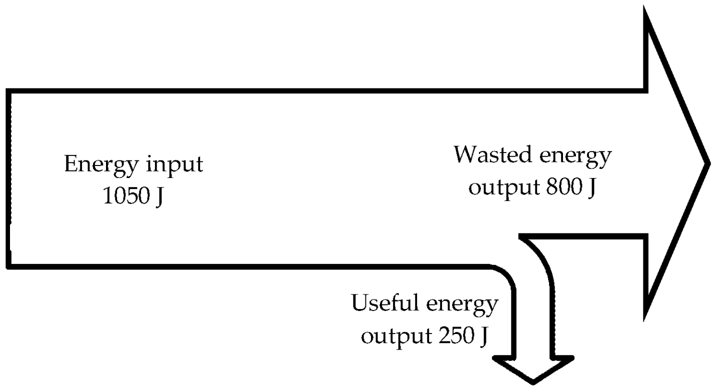
Lesson Plan 15 – Power and Efficiency

1. Electrical power measures the rate at which an appliance is able to transfer e
2. Watts (W).
3. Power (W) = energy (J) / time (S).
4. Energy (J) = power (W) × time (S).
5. 13 W.
6. 3.25 W.
7. 26 W.
8. 11.11 W.
9. 108,000 J.
10. 21,600 J.
11. 2,700 J.
12. 259,200 J.
13. The efficiency of a process is the proportion of the energy input which is con
14. Efficiency = (useful energy output/ total energy input) × 100%.
15. 25%.
16. 10%.

17. 33.3%.



18. 23.8%.



Lesson Plan 16 – Sources an Stores of Energy

1. An energy source is described as a renewable energy source if it is not going future. If there is only a finite (fixed) amount of an energy source available, i
2. Solar, wind, biofuels, hydroelectric, wave, tidal, geothermal.
3. Fossil fuel and nuclear.
4. Any sensible answer or combination, e.g.
   a. *The advantages of geothermal energy are:*
      - There are no fuel costs.
      - There are no waste products or harmful substances released as a by-pr
      - Once set up, the energy source is reliable.
      - It is a renewable source – it will not run out in the foreseeable future.

      The disadvantages of geothermal energy are:
      - The start-up time and initial cost are both very high, particularly wher towards the rocks.
      - It is difficult to find suitable locations for this type of power station.

   b. *The advantages of solar energy are:*
      - Renewable – the Sun will outlast us by many billions of years.
      - There are no fuel costs.
      - The start-up time of both solar panels and solar cells is fairly quick.
      - There are no waste products or harmful by-products.

      The disadvantages of solar energy are:
      - Solar cells in particular are very expensive, which means the electricity
      - The heat generated by solar panels depends strongly on the climate – locations.
      - At night there is no sunlight, so no solar energy can be collected.

c. *The advantages of water as an energy source are:*
- Water is a renewable source – it does not get used up by any of the pro
- There are little or no fuel costs.
- The start-up time is fairly short.
- Hydroelectric dams (particularly pumped storage systems) and tidal b
- No harmful by-products are formed.

The disadvantages of water energy are:
- Hydroelectric dams and tidal barrages both disturb their ecosystems – habitat of estuary-dwelling species, such as wading birds, while hydro which can destroy farmland and force people to leave their homes.
- In the flooding caused by hydroelectric dams, plant life under the wat which is a greenhouse gas and contributes towards global warming.
- Wave machines are inefficient and cannot generate a large amount of e

d. *The advantages of wind energy are:*
- It is renewable – the convection currents are driven by heat from the S in the foreseeable future.
- There are no fuel costs.
- There are no harmful by-products or waste products.
- Wind turbines are fairly cheap and have an almost immediate start-up

The disadvantages of wind energy are:
- A single turbine cannot generate much electricity on its own – huge wi a significant amount.
- It is unreliable – the amount of electricity generated depends entirely o time. If there is no wind, then no electricity can be generated at all.
- Wind farms are considered by some to be an eyesore. They can also be nearby residents. These issues are known as visual and noise pollution

e. *The advantages of biofuels are:*
- They are renewable – the organisms involved are not endangered and
- Low fuel cost – biofuels are mostly generated from substances that wo
- Cheap and quick start-up.
- Although burning the gas produces carbon dioxide, it also takes some process. The intake and output roughly balance out – this is referred to

The disadvantages of biofuels are:
- The decomposition process produces a very unpleasant smell.
- The amount of land required for significant biofuel generation is very l

f. *The main advantages of using fossil fuels are:*
- Their relatively quick start-up time – gas power stations take the short oil and then coal.
- They are more reliable energy sources – the amount burnt in power sta decreased according to demand. Matching supply and demand is very energy.

The disadvantages of using fossil fuels are:
- Because they are non-renewable, fossil fuels will one day run out and w on them.
- Fossil fuels release carbon dioxide (CO_2) when they are burnt. Carbon d so releasing large amounts of it into the atmosphere can contribute to g the most carbon dioxide, followed by oil and then gas.
- Additionally, fossil fuels can release sulphur dioxide when burnt. Sulp harmful to organisms which breathe it in, and can also react with wate acid rain.

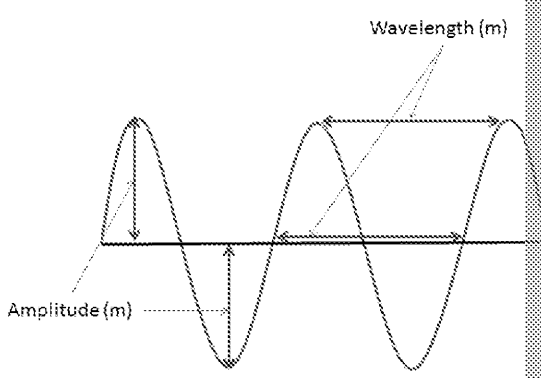
g. *The advantages of nuclear power are:*
   - Like fossil fuels, nuclear fuels are reliable sources of energy, which car whenever it is needed to meet demand.
   - Unlike fossil fuels, nuclear fuels do not release any harmful gases into
   - Nuclear fuels are relatively cheap.

   The disadvantages of using nuclear fuels are:
   - Nuclear fuels are non-renewable, and so the amount available to us is
   - Radioactive material is dangerous to deal with. In the event of an accid exposed to very harmful radioactive substances.
   - When the fuel is used up, the remaining waste is still radioactive and r of years, so it is difficult to dispose of safely.
   - Nuclear plants have a longer start-up time than fossil fuel plants, and or dismantle.

5. Doing this will reduce waste, and reduce price to the consumer and to indus could in turn lead to a reduced cost of manufacturing, which could also cost In addition effective use of energy resources will lead to less of an environme reduced carbon dioxide emissions into the atmosphere or fewer wind turbin
6. Any sensible reasoned answer.

Lesson Plan 17 – The Electromagnetic Spectrum

1. a. The wavelength of a wave is the distance between any point on a wave example, the distance between two crests or two troughs in a series of w
   b. The frequency of a wave is the number of wavelengths that pass a certa
   c. The amplitude of a wave is its maximum displacement from its undistu
2. a. m, b. Hz, c. M.
3.



4. Wave speed (m/s) = wavelength (m) × frequency (Hz).
5. m/s.
6. 6,662 m.
7. 99,930.8 Hz.
8. Gamma, X-ray, UV, visible, infrared, microwaves, radio.
9. Any sensible answers, for example:
   - radio waves (broadcasting and satellite transmissions)
   - microwaves (cooking, satellite transmissions, communications and weath
   - infrared (cooking, thermal imaging, optical fibres, television remote contr
   - visible light (vision, photography and illumination)
   - ultraviolet (fluorescent lamps, detecting forged bank notes and disinfecti
   - X-rays (observing the internal structure of objects and medical X-rays)
   - gamma rays (sterilising food and medical equipment, and the detection o
10. Any sensible answer, for example:
    a. microwaves (internal heating of body cells)
    b. infrared (skin burns)
    c. ultraviolet (damage to surface cells and eyes, leading to skin cancer and
    d. X-rays and gamma rays (mutation or damage to cells in the body)