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SCIENCE
LEVEL 1/2

UNIT R071 - HOW SCIENTIFIC IDEAS HAVE AN IMPACT ON OUR LIVES

LEARNER STYLE WORK

LEVEL 2 DISTINCTION

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OCR

CONTENTS

INTRODUCTION

This work has been developed to provide examples of the content and standard of work required to evidence the identified assessment criteria (Level 2, R071 Model Assignment). This is one approach that could be used but it must not be directly replicated or any part plagiarised by learners.

Teachers may choose to identify their own approach for learners to follow but evidence submitted must clearly meet the assessment criteria.

This is not real learner work; its purpose is to provide ideas and approaches.

The text in the blue boxes are examples of annotations teachers may add to work. The annotations are examples of good practice and are not a compulsory element of teacher marking.

All centres should complete a unit record sheet for each candidate. The unit record sheet should include comments related to the marking of candidates work. The unit record sheet should not be returned to candidates once work has been marked.

LEVEL 2 DISTINCTION

TASK 1 - ANALYTICAL TASK: CHOOSING AN ENERGY SUPPLY

Demand for electricity is increasing. Planners are considering possible ways of supplying energy to a new community on the west coast of South West Wales.

Planning material which presents an analysis of the advantages and disadvantages of possible different energy supply schemes is produced for the public enquiry.

Plan

As a representative for the planning department at the enquiry I will provide briefing material for the enquiry so all interested groups will have information to be able to develop an informed opinion. The briefing material will include:

1. Physical characteristics of the general location
2. Welsh Assembly's energy target
3. Description of different energy sources available for electrical generation
4. Generation efficiency
5. General considerations when building a power station

LO1- MB3 bullet 2

1. Physical characteristics of the general location

Wales is a generally mountainous country which is about 274 km from north to south and at least 97 km (60 mi) wide and it has over 1,200 km of coastline, and includes offshore islands of which the largest is Anglesey.

The total land area of Wales is 2,064,000 hectares. Crops and fallow land account for 3 per cent of the land area, grasses and rough grazing 73 per cent, other agricultural land 1 per cent, forest and woodland 13 per cent, and urban development 10 per cent.[1]

There are three national parks located in: Snowdonia, Brecon Beacons and Pembrokeshire.

Climate:

On average, Wales is cloudier than England, because of the hilly nature of the terrain and the proximity to the Atlantic. Rainfall in Wales varies widely, with the highest average annual totals in Snowdonia and the Brecon Beacons, and the lowest in the east, close to the English border. Throughout Wales, the months from October to January are significantly wetter than those between February and September. Snow is comparatively rare near sea level in Wales, but much more frequent over the hills. The average number of days each year when sleet or snow falls in Wales varies from about 10 or less in some south-western coastal areas to over 40 in Snowdonia.

- Highest maximum temperature: 34.2 °C on 2 August 1990.
- Bright sunshine: Maximum duration in a month: 354.3 hours at Dale Fort, Pembrokeshire in July 1955; minimum duration in a month: 2.7 hours at Llwynon, Brecknockshire in January 1962.
- Rainfall: Maximum in a day 8.3 in Glamorgan

Land usage

The total land area of Wales is 2,064,000 hectares. Crops and fallow land account for 3 per cent of the land area, grasses and rough grazing 73 per cent, other agricultural land 1 per cent, forest and woodland 13 per cent, and urban development 10 per cent.[1]

2. Welsh Assembly's energy target

The Welsh Assembly Government's target is, that as far as reasonably practicable, no household in Wales should be living in fuel poverty by 2018. [3]

There is a need to focus on two central problems:
- the need to reduce CO_2 emissions; and
- the need to ensure a permanent secure energy supply.

The future portfolio of energy provision in Wales is likely to include:
- Nuclear Energy
- Wind Farms
- Geothermal Energy
- Tidal and Wave Energy
- Hydroelectric Energy

The Assembly Government's Technical Advice Note Planning for Renewable Energy [11] sets a 4 TWh per annum renewable electricity production target by 2010 and a 7 TWh target by 2020.
Its micro-generation action plan contains targets for the installation of 20,000 micro heating systems by 2012, rising to 100,000 by 2020; 10,000 micro electricity systems by 2012, rising to 200,000 by 2020; and 50 combined heat and power and/or district heating systems in place by 2020

3. Description of different energy sources available for electrical generation

Energy source - Nuclear Energy

LO1- MB3 bullet 1

Uranium undergoing fission, a nuclear reaction, gives out large amounts of heat which is used to produce steam which can generate electricity via a turbine and an electrical generator which provides around 16% of the world's electricity needs.

The UK currently has 10 nuclear power stations, which provide approximately 20% of the country's electricity with one in Anglesey.

Over a 60 year lifetime new nuclear power stations could save 1.7 billion tonnes of carbon dioxide (CO_2) compared with generating the same energy from gas-fired power stations.

Advantages: The Government sees a clear need for the generation of electricity by new Nuclear power stations as they will:
- Secure the UK's energy supplies;
- Help the UK decarbonise and meet legal low-carbon obligations;
- Benefit the economy more widely;
- Produce large quantities of low carbon electricity over an extended period
- It is the cheapest in terms of £/MWh of the energy sources however this when Governmental subsidies are taken into account (real costs may be much higher).

Disadvantages: The Government considers that the risk of health from the building and operation of new Nuclear power stations is very low:
Radiation dose which the public would receive would be below detectable risk levels;

Safety features in design will keep gaseous and aqueous emissions to a minimum;
Risk of accidental release of radioactive will be reduced and mitigated.[4]
But there still needs greater thought going into the safe storage of radioactive waste in terms of length of storage time, safety and locations.

Energy sources - Wind farms

Wind turbines require roughly 0.1 square kilometres of unobstructed land per megawatt of electricity production. A 2 GW wind farm, which might produce as much energy each year as a 1 GW might have turbines spread out over an area of approximately 200 square kilometres.

As at 1st July 2007 there are 148 UK grid-connected wind farms containing 1866 wind turbines with the capacity to generate 2175.8 MW.

The aim for onshore wind is to have 4.5 kWh/d/p of installed capacity by 2017, which it will do by ensuring that wind farms fully deliver wider community benefits, and addressing transportation concerns associated with larger wind turbines. Wales will work closely with the grid company and regulator to ensure that new grid connections are provided sensitively, and promote further use of brownfield sites for smaller-scale projects.
Advantages: The UK is surrounded by shallow water so many are suitable for the development of offshore wind farms. This will produce many more sites with reduced environmental impacts, as well as improved turbine efficiency due to less turbulent winds.

There will be greater initial costs in building offshore but overall offshore wind farms may be the viable option due to a more useable and dependable source of wind, also less environmental impact to local communities.

Disadvantages: However the land under wind turbines can still be used for farming.
The number of birds killed by wind turbines is negligible compared to the number that die as a result of other human activities. For example, in the UK, where there are several hundred turbines, about one bird is killed per turbine per year; 10 million per year are killed by cars alone.

Opposition to large-scale wind farm developments has become a significant social and political issue in Wales, and other parts of the UK, due to their visual intrusion, noise, impact on residential amenity (and thus house prices), and tourism. The technical limitations of wind, in regard to its stochastic nature, is now well known, and it is widely judged by those familiar with the arguments that the impact of wind development vastly outweighs the benefits. [4]

In 2003 an independent study was commissioned by Welsh Tourist Board of the "Impact of Wind Farms on Tourism in Wales". In the survey of visitors, four out of five respondents indicated that "the beautiful scenery" was a key influencer. Other key positive elements were "a good place to relax and get away from it all" and the "unspoilt environment". 88% of those interviewed agreed that "The attraction of peace and quiet in the countryside and the coast of Wales" was an important factor. The visual effect of the on-shore turbines is so extensive because turbines need to be placed on the high ground. With the scale of turbines now in use it is not possible to find areas to site them that cannot be seen for many miles around.

Energy sources - Geothermal

Geothermal energy source produces steam from which electricity was generated. There are four types of geothermal resources that could be used for energy:

- Hydrothermal - using hot water and steam
- Geo-pressured - using hot water under extreme pressure (which was saturated with natural gas)
- Hot dry rock as an energy source;
- Magma.

To generate electricity temperatures in excess of 120 degrees Celsius were necessary. However, temperatures of above 40 degrees Celsius, could be used to generate geothermal energy which could be used for heating services. [7]

But Wales has "old geology" and therefore the rock was too cool for electricity production.
The potential for generating electricity from geothermal energy in Wales remains open to question, for both technical and economic reasons

Energy sources - Tidal and wave energy

Wave and Tidal use the power from the movement of large amounts of water that is not confined.

Technologies being explored are:
- Pressure differences under wave crests to drive water flows through turbine chambers,
- Floating buoys that use the kinetic energy of the buoy's rise and fall to drive a turbine, and
- Using the motion of joints in an articulated structure to drive hydraulic rams that power motors.
- Oscillating compressed air columns

Advantages: Wave and tidal energy is free and is sustainable and dependable.

Examples in Wales

A Tidal Lagoon in Swansea Bay
The Environment Trust is working to create the UK's first tidal lagoon in Swansea Bay, with a declared net capacity (DNC) of 60MW. This would provide the whole of Swansea with electricity. This plant would save up to 194,332 tonnes of carbon emissions per year, which over the 50 year lifeof the plant amounts to 3,886,641 tonnes of carbon saved. Tidal lagoons could therefore play a vital part in allowing the UK to meet its carbon emissions targets

Electricity is generated as the tidal lagoon fills and empties on the ebb and flow of the tide. The hydroelectric generating equipment is housed in a self-contained structure or atoll
built from loose rock. Water is impounded at high tide and delivered to turbines at low tide, and then the water is held out at low tide and delivered through the turbines at high tide.

Cardiff-based Company Tidal Energy has been given permission to install its 1.2MW DeltaStream tidal energy array in Ramsey Sound off Pembrokeshire.
The installation will provide electricity to the local distribution network during its 12-month test period, with the potential to power up to 1,000 homes.

DeltaStream rests on the seabed without the need for a positive anchoring system, generating electricity from three separate horizontal-axis turbines mounted on a common frame.
The use of three turbines on a single, 30m-wide, triangular frame produces a low centre of gravity that stops the device overturning and sliding.

This removes an visual impact however there is a potential threat to both fishing and to marine life.

Severn Barrage

The Severn Barrage built between Lavernock and Brean Down costing £10 billion plus raises many local but serious environmental issues, the barrage would be equivalent to two nuclear power stations operating continuously, lasting not 40–50 years with a problematic legacy but operating for 150 years plus.
Throughout its life the barrage would produce zero-carbon electricity on a totally predictable, low-cost and reliable basis, which may have considerable long term financial investment attractions in the present economic climate.

Energy sources - Hydroelectric energy

Hydroelectric power uses water flowing through a turbine to drive a generator which produces electricity. The faster the water is flowing and the bigger the drop, the more electricity will be generated. You can either:
- use a water wheel or a turbine for run-of-the-river schemes which use the natural flow of the water to generate hydroelectricity
- store water in a reservoir to be passed though an underwater turbine at pressure

Advantages of hydroelectric power

- Hydroelectric power systems are very efficient and convert 70-90 per cent of water energy to electricity.
- Generating hydroelectric power produces no waste.
- Once installed, hydroelectric power systems should run for many years.
- Hydroelectric power is a well-developed technology.

Disadvantages of hydroelectric power

- You may need an additional power supply available to compensate for seasonal variations in water flow.
- Significant development work is required to install small-scale hydroelectric energy equipment.
- You must get planning permission and may need other authorisations such as a water abstraction and/or impoundment licence.
- Hydroelectric power is highly site specific.
- Hydroelectric power systems require regular maintenance.

Example of a large Hydroelectric power station in Wales

The Dinorwig Power Station in Wales was commission in 1984 and has a huge 1.7GW power rating. 10 miles of underground tunnels buried beneath Elidir mountain carry water down from Marchlyn Mawr to the six 288MW turbine generators situated in Europe's largest man-made cavern. During construction 12 million tonnes of material was excavated and 1 million tonnes of concrete and 4,500 tonnes of steel used.

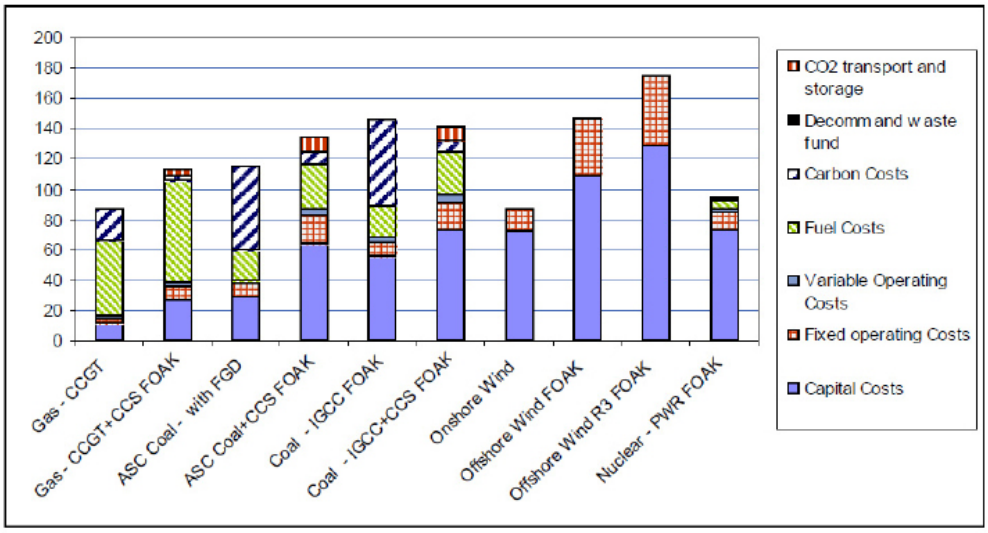
Example of a small Hydroelectric power station in Wales

Howell Williams spent £25,000 ($41,000) on a water turbine, housed in a small shed over the stream, just next to his farm. A £2,500 grant from the Brecon Beacons National Park helped him reduce the cost.
He showed me the equipment after a rainy few days and it was generating at its maximum rate, a constant 11kW, all of it sold to the local electricity company.
"I think I am generating enough electricity for 20 houses," Mr Howell says.

Comparison of electricity generation

UK ELECTRICITY GENERATION BY FUEL ($TWh_{(1)}$)

	2000 (%)	*2005 (%)*	*2010 (%)*	*2015 (%)*	*2020 (%)*
Coal	111.9 (32)	116 (32)	90 (26)	81 (22.6)	62 (16.3)
Oil	2.1 (0.5)	2 (0.5)	2 (0.5)	1 (0.2)	1 (0.5)
Gas	127.0 (37)	135 (38)	145 (41)	167 (46.5)	221 (58.1)
Nuclear	78.3 (23)	80 (22)	65 (19)	41 (12)	27 (7.1)
Renewables$_{(2)}$	10.1 (3)	15 (4)	40 (11)	58 (16)	58 (15.5)
Imports	14.3 (4)	10 (3)	8 (2)	8 (2.2)	8 (2)
Pumped storage	2.6 (0.5)	2 (0.5)	2 (0.5)	2 (0.5)	2 (0.5)
TOTAL	**346.3 (100)**	**361 (100)**	**352 (100)**	**359 (100)**	**381 (100)**



Source: Mott Macdonald

£/MWh

Advanced Super Critical (ASC)
Anaerobic Digestion (AD)
Carbon Capture and Storage (CCS)
Combined Heat and Power (CHP)
Combined Cycle Gas Turbine (CCGT)
Flue Gas Desulphurisation (FGD)
First Of A Kind (FOAK)
Gas Turbine (GT)
Integrated Gas Combined Cycle (IGCC)
Pressurised Water Reactor (PWR)

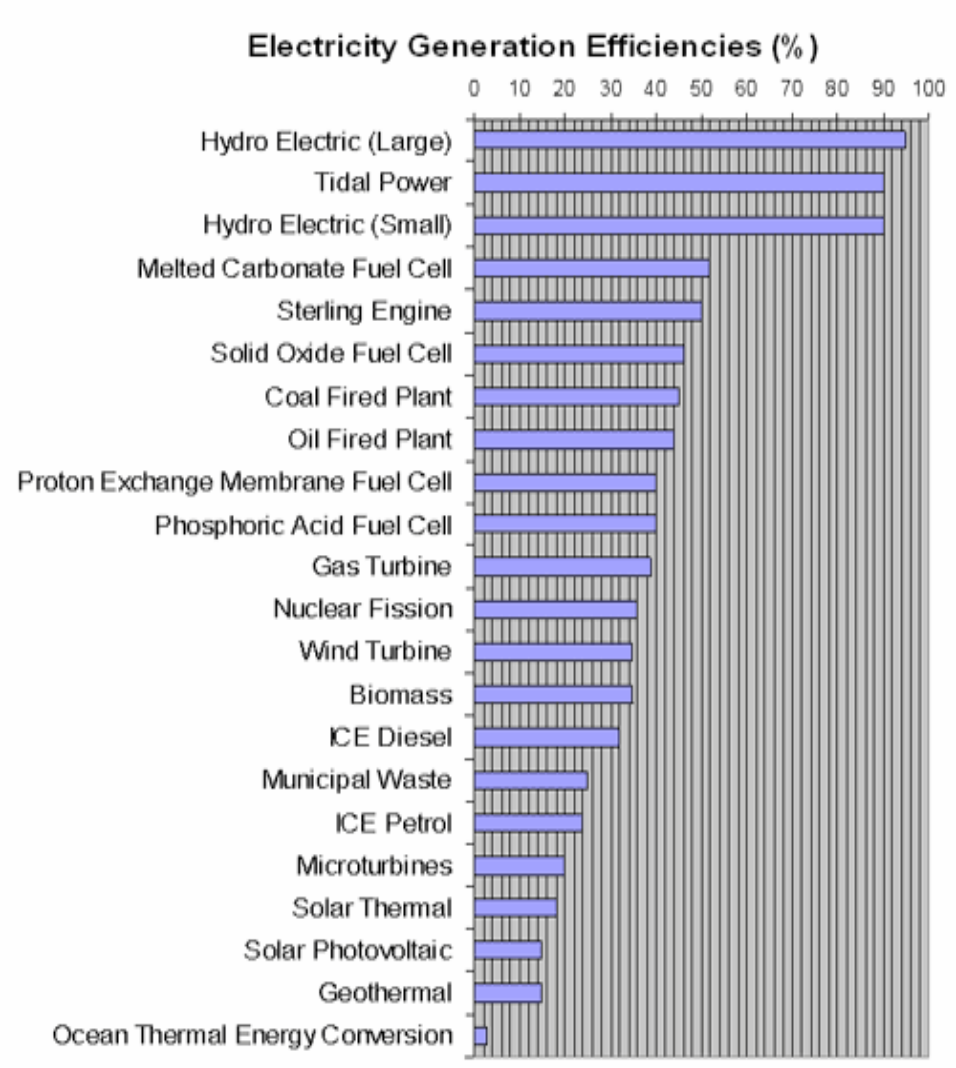
LO1- MB3 bullet 3

4. Generating Efficiency

In a conventional fossil fuelled generating plant, there are energy losses:

- In combustion 10% of the energy content of the fuel is lost
- The generator conversion efficiency can be as high as 98% or 99%.
- Transmission of the electrical energy over the distribution grid between the power station and the consumer results in a distribution loss of 10% mainly due to the resistance of the electrical cables.

For electricity generation based on steam turbines 65% of all prime energy is wasted as heat. For modern practical systems efficiency is about 40% but less for older generating plant.
The efficiency falls still further if fuels with lower energy content such as biomass are used to supply the plant.



The table below shows the theoretical efficiency of converting various energy sources into useful electrical energy. [10]
Although hydro generation is the most efficient at generating electricity, at 90% or more the initial capital costs are the largest.
Generation using fossil fuels are 50% to 40% efficient and are approximately 10% more efficient than nuclear and wind generation.
However there are large initial and decommissioning costs for nuclear power, but not with wind power, as a wind turbine is approximately £1million to build with small running costs.
So compared to burning fossil fuels wind power is 10% less efficient but, cost £/MWh is almost 40% less with no environmental impact on global warming.

5. General considerations when building a power station

Interested groups may be aware of the factors that the planning department stringently considers.

Power station technical details
Consider will the energy supply

LO1- MB3 bullet 2

- meet demand both locally and nationally
- how will the connection to the National grid be made
- help meet Government target on carbon emission levels
- be efficient of the operational process, will it be cost affective
- will the technology used be reliable and safe
- can the plant be built on the proposed site
- will it meet with application approval, has a similar power station been built and obtained approval

Traffic and Transportation
Consider the concentration of traffic compared to existing highway flow during stages of:

- construction
- operational
- decommissioning

Consider if new access to the site is required for construction.
Also how will goods be brought in for operational reasons – do they have to come by road, could rail, canal, river or conveyor be used. What are the relevant costs involved.
Will the necessary transportation system effect planning approval.
How will the traffic infrastructure effect the transport operation.

Landscape and Visual Assessment
Consider against what is already in the landscape, would be unduly obtrusive, regarding:

- size,
- height
- long-range visibility (may have a limitation to 2 km
- colour – blending in with present landscape
- light reflection – from glass
- landscaping – following construction.

Will it be necessary to landscape the storage of waste products on site.
After decommissioning will landscaping be necessary and at what cost.
Can landscaping enhance the local ecolgy.

Noise and Vibration
Consider noise and vibration levels during stages of:

- construction,
- operation
- decommissioning

Noise levels from plant operations during daytime and night-time periods would have different relevant standards. The highest predicted noise levels from plant operations during daytime would be lower than or similar to typical existing background noise levels;

Noise and vibration might be considered away from the plant with heavy lorries bringing construction material through villages and built-up towns. This would also apply to bringing operational materials to the site.

Consider if the geology of the site might be affected by vibration and how far into the surrounding area may ground vibrations travel.

Construction Management
Consider how the different stages will be managed and controlled are measures in place to ensure that construction activity is well managed and that any effects of this stage, including

- noise
- vibration
- dust
- mud

being transferred to surrounding roads, are controlled and efficiently dealt with.

Hydrology &Soils
Consider the potential effects on surface water groundwater and soil from the phases of:

- construction
- operation
- decommissioning

Ground Conditions
A site investigation must be undertaken to identify:

- potential for flooding
- potential sources of contamination in relation to the site from plant operations
- potential sources of contamination from outside the site, such as from:
  uncontrolled tipping of waste products and residues from the adjacent sewage works
  hazardous gasses from nearby landfill sites.

Ecology
A habitat survey is required for signs of protected, rare or notable species within and associated with the site.
Can the local ecology be enhanced at any time during the operation.

Air Quality
Consider emissions from:

- plant operations
- traffic operations
- delivery operations

are their health implications to workers or to the public during all phases.
What are the health and safety regulations relevant to all parts of the operation.

Regulations
Are there statutory regulations, European, UK or local that have to be met.
Does it support the UK's drive to reduce carbon emission.

Local amenities
Consider the affect of the plant to the public generally.

- whether the processes involved would be such as to cause undue loss of amenity to any nearby residents by reason of noise, smell, air pollution or in any other way
- whether the plant will bring employment to the area
- whether the proposal would have a significant adverse effect on the
- character of the area such as house prices or its intended land use, such as recreational.

The information supplied is for the benefit of the local people and the relevant interest groups. Further information or answer to questions will be supplied by the planning department.

Sources:
[1] UK 2005. The Official Yearbook of the United Kingdom of Great Britain and Northern Ireland.. London: The Stationery Office. 2004. pp. 279. ISBN 0-11-621738-3

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[5] BBC News Monday, 28 November 2005
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TASK 2 - RESEARCH REPORT: NUCLEAR RADIATION - THE BENEFITS, DRAWBACKS AND RISKS

Briefing material for journalists to explain why nuclear ionising radiation is used despite the associated risks.

Plan

LO2 - MB3 bullet 1

Briefing material:

1. What is radiation – a general summary of its sources and uses.
2. Its potential danger.
3. Ionising radiation used in health care
4. Ionising radiation in industry
5. The potential risks and dangers of ionising radiation to the public.
6. Why use nuclear power

1. What is radiation

Electromagnetic spectrum consists of seven parts ranging in intensity from low energy to high energy. Each part has a distinctive name given to it.

Type of electromagnetic wave	Wavelength	Frequency (Hz)	Energy of 1 photon (electron volts)
Radio	1km – 100 km	10^{6}-10^{9}	10^{-9}-10^{-4}
Microwaves	1mm – 300mm	10^{9}-10^{12}	10^{-4}-10^{-2}
Infrared	700nm -1mm	10^{12}-10^{15}	10^{-2}-1
Visible	400nm -700nm	10^{15}	1
Ultraviolet	10nm – 400nm	10^{15}-10^{16}	1-10^{2}
X-rays	between 0.01 – 10 nm	10^{16}-10^{20+}	10^{2}-10^{6+}
Gamma rays	less than 0.01 nm	10^{19}-10^{20+}	10^{5}-10^{6+}

Each part has a distinctive name

Name	Energy	Sources	Use	Detection
Radio	Low energy	Radio transmitters including radar and TV Neutron stars	Radios Television Walky-talkies Baby alarms	Radio aerial Radio telescope NRAO VLBI
Microwave		Phone masts Electronic control systems Microwave ovens Cosmic background radiation	Heating food Mobile phones Speed cameras Radar Motion detectors Sterilising containers	Aerials Electrical interference in speakers
Infra red		Sun Warm objects Protostars	Night-vision goggles Medical scans to detect temperature TV remote	Skin Blackened thermometer Thermistor Infrared Astronomical Satellite(IRAS)

Visible	High energy	Sun Stars Hot objects Light bulbs Fluorescent substances Lasers	TV screens Lighting Solar panels Distance measuring	Eye Photographic film Light dependent resistor Hubble Space Telescope (ACS camera)
Ultra violet		Sun Stars Very hot objects Mercury lamps Space plasma	Sun beds Sterilise medical equipment, Sterilise food Sterilise humans for "clean operations"	Photographic film Fluorescent glow Photocell Suntan On board telescope of the Ultraviolet Explorer (IUE)
X-ray		Sun X-ray tubes Super novas	Cancer therapy Medical scans Scanning welds Airport security	Photographic film Geiger counter Scintillator counter Semiconductors XMM-Newton telescope
Gamma ray		Radioactive substances Centre of galaxies	Radiotherapy in Cancer therapy Sterilisation of medical equipment, Sterilise food	Geiger counter Scintillator counter Semiconductors NASAs FGST (Fermi Gamma-ray Space Telescope)

2. Potential Danger

Radioactive substances can radiate different types of ionising radiation which can be penetrative and long lasting.

Source	Plutonium-239	Strontium-90	Cobalt-60
Radiation	α- particles	β -particles	γ-ray
Type of particle	Helium nucleus positive particle	Electron negative particle	Electromagnetic wave
Penetration	Absorbed by paper Absorbed by 6cm air	Absorbed by 3mm aluminium	Absorbed by lead
Causes ionisation	Yes strongly	Yes weakly	Yes Very weakly

The radioactive of a substance will decay away over time

α- decay

Radium-226 decays by emitting α- particles (helium nucleus) to form Radon-222

LO2 - MB3 bullet 2

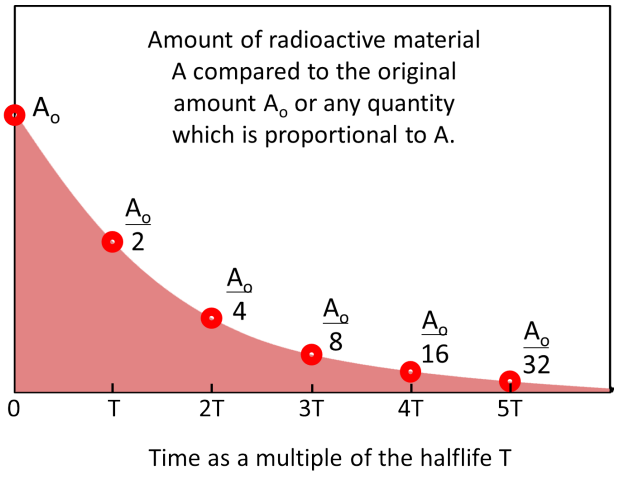
β - decay

Polonium-218 decays by emitting β –particles (an electron) to form Astatine-218

Gamma – emission

When a α- particle or a β –particle is emitted the nucleus of the atom is in an exited state and loses energy in the form of γ-rays

The half-life of a substance is the time taken for half the number of atoms to decay and that half-life of different substances can be fractions of a second or millions of years.



Uranium 238 which makes up 99% of uranium ore has a half life of 4.46 billion years
Uranium 234 has a half life of 245,500years

The danger of ionising radiation (γ-ray) is that it can penetrate lead (a dense metal) shielding unless it is quite thick and so pass into a person destroying tissue and potentially causing cancer, as seen at April/May 1986 Chernobyl Russia. And that the radiation will remain for many decades.
The affect it has will depend on the dose (type), intensity and length of exposure.
Small localised exposure can cause:

- redness of the skin
- cataracts in the eyes
- loss of fertility.

General whole body exposure can result in:

- nausea, vomiting and diarrhoea
- cancer of the skin and other organs
- leukaemia

LO2 - MB3 bullet 1/4

3. Ionising radiation in Health care

However, even with its dangers, radiation is used for its benefits despite the risks in healthcare, especially in its use in:

- nuclear medicine
- how does radiation effect the body and the precautions taken to lessen its risk

Nuclear medicine

Nuclear medicine can be used to

- determine whether or not organs are functioning normally
- show whether the blood supply to the heart is adequate
- detect cancers at an early stage
- determine the extent of cancer and assess the response of cancer to treatment
- discover whether the heart can pump blood adequately
- identify abnormal brain lesions without exploratory surgery
- detect whether the brain is receiving an adequate blood suppy and if brain cells are functioning or not
- check whether or not kidneys are functioning normally and whether the stomach is emptying properly
- ascertain lung function and bone density and locate a bone fracture before it can be seen on an X-ray

In diagnosis small amounts of radiopharmaceuticals are introduced into the body by injection, swallowing or breathing in. They are designed to go to specific organs (e.g. liver, heart). A radiation camera is used to see how the radiopharmaceuticals move the body. PET (positron emission tomography) scans can study many types of disease in the body and how the disease uses the radiopharmaceuticals that have been introduced into the body.

A typical nuclear medicine procedure - radiotherapy may give a radiation dose to the patient comparable to about one to four years of natural background radiation depending on the type of study. Radiotherapy works by using high doses of radiation targeted to kill cancer cells but to leave surrounded tissues unharmed. This is either through a beam of radiation or by planting sources of radiation close enough to the tumour to kill it.

Typical Radiation Doses	
Medical chest X-ray (one film)	0.1 mSv [2]
Nuclear medicine thyroid scan	0.14 mSv
Full set of dental X-rays	0.4 mSv/year
Mammogram (four views)	0.7 mSv
Cancer treatment (tumor receives)5	50,000 mSv

Diagnostic radiopharmaceuticals will be undetectable after 1 to 4 days. The use of Iodine-131in the treatment of thyroid cancer might last as long as 3 months.

The risks are reduced by only using recognised doses of radiation. Also staff using radioactive material are protected by special clothing with lead protectors. Where equipment is located then a secondary operations room used by staff so they can leave the room containing the equipment and are so further shielded.

Levels of radiation doses

X-rays are the most common use of ionising radiation in medicine. There use on an individual tends to be limited to 4 exposures a year.

Levels of radiation doses in medical procedures [2]	
Medical chest X-ray	0.1 mSv
Dental X-rays	0.4 mSv
Mammogram – 4 exposures	0.7 mSv

LO2 - MB3 bullet 3

Where Ionising Radiations Regulations 1999 DOSE LIMITS states

1 Radiation workers >18 years: The effective dose shall be 20 mSv in any calendar year

2 Members of the public: The effective dose shall be 1 mSv in any calendar year

3 Trainees aged under 18 years: The effective dose shall be 6 mSv in any calendar year

So the use of medical X-rays pose a low risk to health given the benefits that might accrue.

X-rays don't make the patient radioactive and expose them to low doses of radiation – typically a chest X-ray is equivalent to the normal background dose of radiation received every three days.
However, healthcare workers who are routinely involved in X-rays, such as dentists, risk multiple exposures to very small amounts of radiation unless precautions are taken. For example, a dentist would only need to do approx. 50 dental x-rays (20/0.4) before the allowed 'safe limit'.

Ionising Radiation Regulations 1999 [1]

The regulations lay down how radiation may be used and the limits of exposure for operators, these include:

- restriction of employees' exposure
- control of access to areas where radiations may be present
- appointment of suitably trained or qualified persons to ensure safe use of sources
- implementation of rules for the safe use of sources
- training and instructing any employee who uses radiation sources
- measuring the exposure levels of employees working with radiations
- provision of medical examinations for staff exposed to sources
- keeping accurate records of the use and locations of all sources
- reporting to the Health and Safety Executive (HSE) any damage to or loss ofa source
- investigating cases of over-exposure and taking corrective action.

For NHS workers the limit on effective dose to the whole body are for employees aged 18 years or over, 20 millisieverts in a calendar year

There is a lower limit for trainees of six millisieverts in a calendar year; and one millisievert in a calendar year for any other person, including members of the public and employees under 18, who cannot be classed as trainees.
Limits for pregnant women are lower than this.

In comparison, a single chest X-ray would expose a patient to 0.02 millisieverts.

4. Ionising radiation in industry

In industry, ionising radiation is used in:
- quality control of materials
- measuring the level of containers
- monitoring the thickness or consistency of paper

Devices which monitor industrial processes consist of radiation sources and detectors. When the material between the radioactive source emitting α- particles and the detector changes thickness or density, the level of radiation detected also changes. The process can be controlled by weakening or strengthening the signal from the detector.

Industrial radiography is a method of non-destructive testing, used to check for flaws in metal structures and welding seals, among others. The principle is the same as in medical imaging: radiation passes through the object to be tested and exposes the X-ray film placed behind it. Dark patches in the developed film reveal flaws. Radiography devices create radiation using either X-ray machines, or for thicker material, a gamma source or linear accelerator.

Radioactive isotopes are used as tracers in many biochemical and physiological examinations. The path of material marked with tracers is monitored with an activity determination. Radioactive isotopes of carbon and hydrogen can be used to examine the path of nutrients into plants.

Instruments such as Ionizing smoke detectors, using a tiny bit of americium-241
Gauges containing radioisotopes measure the amount of air whipped into our ice cream.
Gauges containing radioisotopes prevent spillover as our soda bottles are carefully filled at the factory.
gauges containing radioactive substances to measure the thickness of paper products, fluid levels in oil and chemical tanks, and the moisture and density of soils and material at construction sites.

In irradiation of foods and medical equipment, kill germs without harming the them to disinfected them without making it radioactive. Foods take much longer to spoil, and medical equipment such as bandages, hypodermic syringes,

and surgical instruments are sterilized without being exposed to toxic chemicals or extreme heat.

Research into the use of ionising radiation continues

Examples of Ionising radiation research:
- the modification and preparation of polymeric materials and composites, such as using an electron beam in curing epoxy resin at room temperature in filament winding to produce composite materials.
- degradation of cellulose from sugarcane bagasse to obtain ethanol from natural polymers. The radiation process accelerates the hydrolysis reaction breaking down the sugars to suitable for fermentation.
- Irradiation of food for disinfection and extending shelf life

5. The potential risks and dangers of ionising radiation to the public.

LO2 - MB3 bullet 3

Rupture of radiation confinement vessel, for example:

1986 Chernobyl disaster emitting radiation ranging from 800 to 16,000 mSv.
Belarussian evacuees, the average was 31 mSv.

Fukushima Daiichi plant, radiation dose levels reaching 400 mSv per hour in one of the reactors.

Which can result in depending on the exposure
- redness of the skin
- cataracts in the eyes
- loss of fertility.
- nausea, vomiting and diarrhoea
- cancer of the skin and other organs
- leukaemia
- death

In general, starting at exposure levels of about 1,000 mSv (or 1 sievert) per hour, radiation sickness can cause nausea, vomiting, diarrhea and skin blisters.
Exposures of between 3,500 and 5,000 mSv for a period of minutes to hours lead to death within 30 days for about half of people, higher levels cause immediate death.
Few to no problems have been detected from relatively small exposures -- such as the 10-mSv doses for people closest to atomic bomb testing sites, or the 20-mSv peak that occurred during a 1979 accident at the Three-Mile Island power-plant in Pennsylvania.

The 1945 atomic bomb explosions in Hiroshima and Nagasaki, peak radiation levels ranged from 10,000 mSv to more than 100,000 mSv, Many people died instantly, and radiation sickness killed many more within months. For most of the people who survived the blast, had an average doses ranged from 10 to 100 mSv,

Workers and firefighters at the 1986 Chernobyl disaster experienced exposures, ranging from 800 to 16,000 mSv.
Belarussian evacuees, the average was 31 mSv.

6. Why use nuclear power

LO2 - MB3 bullet 3

The present Government sees nuclear power, despite its risks, as a means to reduce carbon dioxide emissions.
The Secretary of State sees a clear need for the generation of electricity by new Nuclear power stations they will:

- secure the UK's energy supplies
- help the UK decarbonise and meet legal low-carbon obligations
- benefit the economy more widely
- produce large quantities of low carbon electricity over an extended period.

The Secretary of State considers that the risk of health from the building and operation of new Nuclear power stations is very low.

- radiation dose which the public would receive would be below detectable risk levels
- safety features in design will keep gaseous and aqueous emissions to a minimum
- risk of accidental release of radioactive will be reduced and mitigated

The UK has signed up reduce the emissions of CO_2, it is important that the UK is able to generate large quantities of electricity from low carbon sources.
By 2050 virtually all of the UK's electricity will need to come from low-carbon sources
Modern Pressurised Water Reactors (PWRs) have a strong reliability record and can produce large quantities of low carbon electricity over an extended period.

- emissions across the entire life cycle comparable to those from wind generation
- over a 60 year lifetime new nuclear power stations could save 1.7 billion tonnes of carbon dioxide (CO_2) compared with generating the same energy from gas-fired power stations.

Human activities are causing global climate change. The burning of fossil fuels, changes in revolution, and such high levels have not been experienced on earth for at least 800,000 years. The effects of these additional gases can already be seen (global average temperatures have risen by 0.75°C since about 1990) with consequences for both the environment and people's lives. If climate change continues unchecked then the consequences for the UK will be severe. Action on climate change is urgently needed to prevent widespread human suffering, ecological catastrophe, and political and economic instability.

.
Electricity cannot be stored in bulk, unlike some other fuels. Instead it must be generated at the time it is needed and in sufficient quantity so as to meet demands from users. It is therefore important to secure diversity of supply in electricity to contribution to the security of energy supplies.

Comparisons show that nuclear has the advantages of secure fuel supplies and continuous generation, and is in relative terms a low-cost form of electricity generation which can yield economic benefits to the UK.

The Secretary of State is conscious that

- there are secure supplies of uranium in the world
- supplies are part of a stable market

The reactor's fuel also forms a low proportion of the cost of generation so the cost of generating electricity is unlikely to fluctuate greatly even if the cost of uranium changes significantly.

A risk associated with all nuclear power stations, is the potential for the release of ionising radiation. The overall average annual dose to a member of the public from all sources of radioactivity is 2.7 millisieverts (mSv)per year. Of this,

- about 84% is from natural sources,
- about 15% from medical procedures and
- about 1% from all other sources, including existing nuclear power stations

Health Protection Agency (HPA)limits the radiation to which the public are exposed from a new nuclear power station, should be no more than 0.3 millisieverts

HPA says t a dose of 1 mSv per year is equivalent to an additional risk of fatal cancer of one in twenty thousand (0.005%) per year, and that a risk at this level is not detectable among normal background levels of cancer risk.
Geological disposal is the way higher activity waste will be managed in the long term.

On balance, the Secretary of State considers that potential environmental risks arising from the construction, operation and decommissioning of the new Nuclear power stations are likely to be avoided or adequately mitigated.

The Secretary of State acknowledges the risk from an accident or terrorist incident at a nuclear power stations could happen consequently contingency plans have been drawn up.

- Stable operation
- Physical plant boundaries
- Passive safety-related systems
- Diversity within safety-related systems
- Non-safety systems
- Containing core damage

New nuclear power stations have the potential to provide significant economic benefits to the UK. The civil nuclear industry currently employs 44,000 people. Current plans by industry to build 16GW of new nuclear capacity by 2025 will create significant supply chain and job creation opportunities. Based on this build rate, employment of about 110,000-140,000 person years is predicted, which is three times the size of the requirements for the 2012 Olympics construction project.

It is estimated that 1,000 new apprentices and 1,000 graduates of science, technology, engineering and mathematics (STEM) subjects are required each year to 2025 to support existing operations and new build capacity, throughout the nuclear industry and supply chain.

Environmental impacts of new nuclear power stations would be comparable with, or less than, those of other forms of large scale electricity generation.

Source
Department for business Enterprise & Regulatory Reform Meeting the Energy Challenge – A White paper on nuclear Power January 2008
www.official-documents.gov.uk/document/cm72/7296/7296.pdf

Reference
[1] Ionising Radiation Regulations 1999
www.legislation.gov.uk/uksi/1999/3232/contents/made -

[2] Health protection agency – radiation dose
http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/DoseComparisonsForIonisingRadiation/

TASK 3 - BE ABLE TO MEASURE ENERGY TRANSFERS AND CALCULATE EFFICIENCIES: EFFICIENCY OF AN IMMERSION HEATER

Your task is to measure the efficiency of an electric immersion heater.

I will measure the temperature rise of a known volume of water over a period of time.
The volume needs to be contained in a vessel that will:

- allow the water to cover the whole of the immersion heater so all of the heat energy goes into the water from the immersion heater
- enough water to allow a measureable temperature increase

The vessel should

- have the smallest surface area as possible to have the least surrounding air to it to reduce heat loss to the environment
- be insulated and have a lid to reduce loss of heat to the environment

LO3 - MB3 bullet 1

The period of time should:

- allow the immersion heater to get up to its working temperature
- long enough to give a significant water temperature rise
- short enough to reduce the amount of heat being lost to the environment

Equipment:

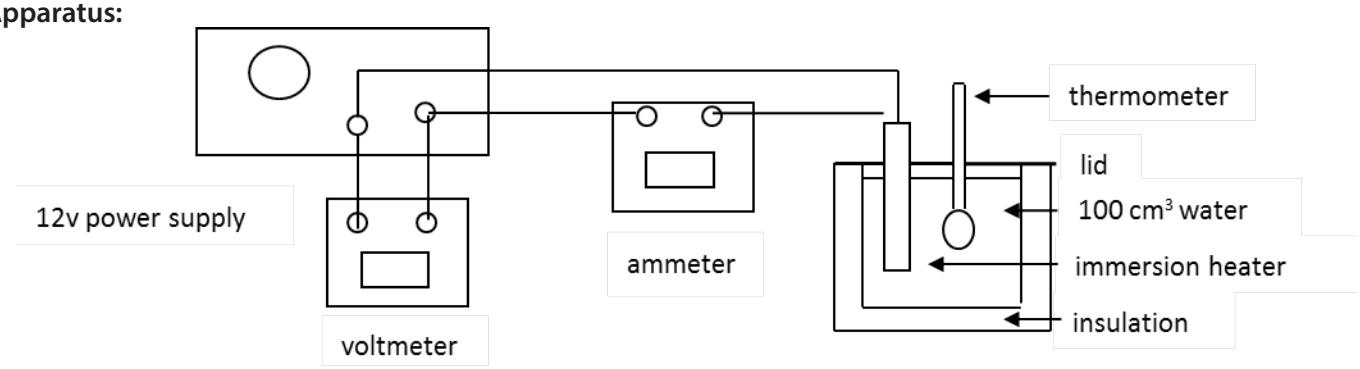
- 12V power supply – a safe working voltage
- ammeter ; voltmeter will measure electrical energy supplied to immersion heater – the instruments will initially be roed; be sensitive and be able to measure to 0.01
- 5 x connecting wires – the wire should have the lowest electrical resistance as possible to reduce and electrical energy loss in heat or magnetism; energy loss will also be reduced if the wires are short and thick.
- immersion heater
- aluminium can
- stop-clock will measure the period of time – digital is used to give a faster reaction control.
- 100 cm^3 measuring cylinder will measure the known amount of water

Procedure:

- With the measuring cylinder, measure water 100cm^3 and pour into the insulated aluminium can.
- Check that the power supply is switched off.
- Set up the apparatus as shown in the diagram.
- Measure the temperature of the water before heating.
- Switch on the circuit and measure the, electric current and voltage.

- After 180s switch off the power supply.
- Stir the water and measure final temperature of water
- Repeat the procedure to be able to obtain reliable results

Apparatus:



LO3 - MB3 bullet 2

Results:

Water (cm3)	Time (s)	Voltage (V)	Current (A)	Initial temp. (°C)	Final temp (°C)	Temp. Rise (°C)
100	180	12.08	2.05	21.4	29.8	8.4
100	180	12.08	2.05	21.5	30.1	8.6
100	180	12.08	2.05	21.4	30.0	8.6
Average temperature rise						8.50

Temperature rise is repeatable and the range is within 0.20C a 2.4% range.

Calculation 1: Heat energy absorbed by the water over 180s
This is equal to 4.2 x water volume in cm^3 x temperature rise

4.2 x 100 x 8.5 = 3570.0J

Calculation 2: Heat energy supplied by the immersion heater over180s
This is equal to 300 x current x voltage

180 x 2.05 x 12.08 = 4457.52J

LO3 - MB3 bullet 3/4

Calculation 3: Percentage efficiency of the immersion heater

This is equal to: $\frac{\text{Heat energy absorbed by the water}}{\text{Heat energy supplied by the immersion heater}} \times 100 = \frac{3570.0 \times 100}{4457.52}$

Efficiency of the heater = 80.1%

Evaluation:

Readings
Temperature rise varied from 8.4 to 8.6 which is a 1.2% variation and was repeated two times, so temperature reading is reliable.

The temperature rise seen in readings 2 and 3 be due to the heater may have retained heat from the previous procedure.

By stirring the temperature reading would be the temperature throughout the water.
Both voltage and current values were consistent throughout and read to a greater precision of x10 than the final efficiency.

Apparatus
The aluminium can was insulated and had an insulating lid so heat lost to the environment was reduced.
Efficiency was less than 100% because:
Loss of heat to the environment
Electrical energy lost through the wires and meters
Corrosion on the outside of the immersion heater itself.

Further investigation into the immersion heater:

Vary the time to heat up the water to a specific temperature. The heater itself will need time to heat through to its outer casing, this period of time needs to be insignificant to the overall time period of the investigation.
This will find the optimum time that the investigation should be undertaken – optimum time will be when heater heats the water through but not loosing significant heat to the environment.

Vary the amount of water; immersion heaters will be limited by their size as to the amount of water it can heat to give a significant raise in temperature.

Witness Statement

Competency	**MB1**	**MB2**	**MB3**
Taking measurements			
Some support needed to choose correct equipment			
Choose correct equipment			
Independent selection of equipment equipment set up correctly			✓
Zero or calibrate apparatus		✓	
Some data recorded			
Record result			
Recorded data to correct significant figures			✓
Appropriate accuracy and precision using an appropriate format		✓	✓
Correctly position eye when taking measurement			
Repeat reliable readings			✓
Maintaining a safe and uncluttered working environment			
Most of the time			
All of the time			
Rigorously and with prior thought and planning			✓
With support carries out risk assessment			
Carries out risk assessment			
Independently carries out risk assessment			✓
Following standard procedures			
With support follows basic standard procedures correctly			
Follows basic standard procedure correctly			
Follows complex procedure correctly			✓
Makes own adaptations to standard procedure to improve reliability			
Assessors signature: XXXXXXXXX Assessors name: XXXXXXXXXX Date:XXXXXXXX			

TASK 4 - CASE STUDY: DESIGNING A HEALTH EDUCATION PROGRAMME

The bosses of a company are concerned that employees are taking too much time off because of illness.

Design a health education programme for a group of staff who work in a particular role in the company.

The educational programme will be aimed at office workers – they will not get much exercise during working hours as most will be sitting at desks.

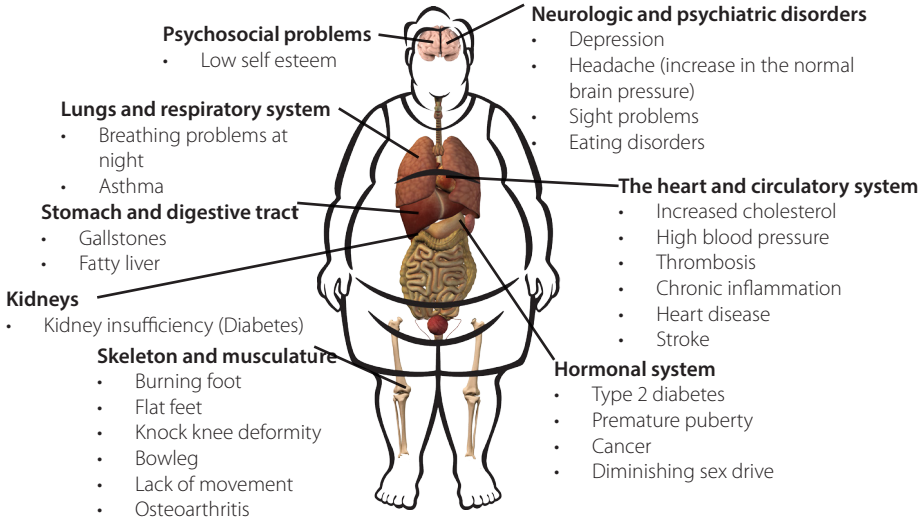
I will produce;

1. A series of leaflets which explain which factors affect health. I will use cartoons and quantitative data to grab peoples' attention.
2. Get fit information
   - Fitness self assessment
   - Healthy exercise
   - Exercise programme
3. Healthy eating information
   - Body Mass Index
   - Healthy balanced diet

LO4 - MB3 bullet 1

1. Factors that can affect your health

Health risks of being Overweight



Lack of exercise can cause overweight which is defined as a condition of weighing more than what is ideal for their height and body frame.
If a person's weight is 20% or more above their ideal body weight, they are considered obese. Being overweight can result in:

- High Blood Pressure - excess body fat retains sodium which leads to increase in blood volume and so blood pressure rises.
- Diabetes - Obesity can cause type 2 diabetes.
- Stroke – blockage in blood vessel that interrupts the flow of blood to the brain
- Increased level of LDL cholesterol.
- Wear on joints.
- Sleep apnea:

LO4 - MB3 bullet 2

- Gallstones: Gallstones are more common in people who are overweight.
- Weak Pelvic Muscles
- Physical Discomfort: As fat accumulates, it crowds the space occupied by organs.
- Difficulty breathing, walking or sitting.
- Men and women who are overweight have a higher risk of developing many different kinds of cancer
- More than 41,000 people were diagnosed with bowel cancer in 2009 in the UK, that's more than 110 people every day whereas a diet rich in fibre will reduce your risk.

Health risks from over exercise

- Women who over exercise are at risk of developing osteoporosis and may have complications with their menstrual cycles and in some cases stop menstruating entirely.
- People may have problems that impede walking later on in life since over exercising can cause stress fractures. Some many even need joint replacement surgery even at a young age because of too much wear and tear on the body's muscle, joints and bones.
- Dehydration and electrolyte imbalance can occur resulting in cramping, heart palpitations, dysphoria, nausea, vomiting and even passing out
- Once you have fatigued your muscles, you put yourself at risk for harm such as muscle pulls and strains even ligament or joint damage is possible.
- If body fat stores are eaten up for energy your body then dips into muscle mass stores. This actually eats away at the muscle you are trying to build and strengthen.
- The body does not have a chance to repair the minor injuries and micro traumas that would normally heal with rest and more moderate fitness habits.

Health risks from smoking

About 100,000 people in the UK die each year due to smoking. Smoking-related deaths are mainly due to cancers, chronic obstructive pulmonary disease (COPD) and heart disease. If you are a long-term smoker, on average, your life expectancy is about 10 years less than a non-smoker.

- **Lung cancer**. About 30,000 people in the UK die from lung cancer each year. More than 8 in 10 cases are directly related to smoking.
- **Chronic obstructive pulmonary disease (COPD)**. About 25,000 people in the UK die each year from this serious lung disease. More than 8 in 10 of these deaths are directly linked to smoking. People who die of COPD are usually quite unwell for several years before they die.
- **Heart disease**. This is the biggest killer illness in the UK. About 120,000 people in the UK die each year from heart disease. About 1 in 6 of these is due to smoking.
- **Other cancers** - of the mouth, nose, throat, larynx, gullet (oesophagus), pancreas, bladder, cervix, blood (leukaemia), and kidney are all more common in smokers.
- **Circulation.** The chemicals in tobacco can damage the lining of the blood vessels and affect the level of fats in the bloodstream. This increases the risk of hardening of the arteries which leads to heart disease, strokes, poor circulation of the legs, and swollen arteries which can burst causing internal bleeding.
- **Sexual problems**. Smokers are more likely than non-smokers to become impotent or have difficulty in maintaining an erection in middle life.
- **Rheumatoid arthritis**. Smoking is known to be a risk factor for developing rheumatoid arthritis. One research study estimated that smoking is responsible for about 1 in 5 cases of rheumatoid arthritis.
- **Ageing**. Smokers tend to develop more lines on their face at an earlier age than non-smokers. This often makes smokers look older than they really are.
- **Fertility** is reduced in smokers .
- **Menopause**. On average, women who smoke have a menopause nearly two years earlier than non-smokers.
- **Other conditions where smoking often causes worse symptoms** include: asthma, colds, flu, chest infections, tuberculosis, chronic rhinitis, diabetic retinopathy, hyperthyroidism, multiple sclerosis, optic neuritis, and Crohn's disease.
- **Smoking increases the risk of developing various other conditions** including: dementia, optic neuropathy, cataracts, macular degeneration, pulmonary fibrosis, psoriasis, gum disease, tooth loss, osteoporosis and Raynaud's phenomenon

Source:Patient.co.uk http://www.patient.co.uk/health/Smoking-The-Facts.htm

Health risks of drug taking

Some physical warning signs of drug abuse:

- Expressing feelings of depression, exhaustion, or hopelessness
- Talking incoherently or making inappropriate remarks
- An inability to relax or to have fun without taking drugs
- Noticeable degradation regarding one's physical appearance and grooming
- Irritability, wide mood swings, manic behaviour, or angry outbursts

- Stimulants can cause - Increased heart rate, blood pressure, body temperature, metabolism as well as tremors; reduced appetite; irritability; anxiety; panic; paranoia; violent behavior; psychosis
- Also weight loss, insomnia; cardiac or cardiovascular complications; stroke; seizures; addiction

- Hallucinogens can cause - altered states of perception and feeling; hallucinations; nausea. Can also Increased body temperature, heart rate, blood pressure; loss of appetite; sweating; sleeplessness; numbness, dizziness, weakness, tremors; impulsive behaviour; rapid shifts in emotion

- Depressants can cause - drowsiness, lowered inhibitions, slurred speech, poor concentration, confusion, dizziness, impaired coordination and memory. Also health consequences - lowered blood pressure, slowed breathing, tolerance, withdrawal, addiction; increased risk of respiratory distress and death when combined with alcohol

- 2,652 drug-related deaths were registered in England and Wales in 2011, down by 3.5% from the previous year's total of 2747. This marked the third consecutive year in which the figure has fallen.

Health risks from Pollution

Air pollution can affect many people as it is in the air we breathe, the main pollutants are:

Pollutant	**Health effects at very high levels**
Nitrogen Dioxide, Sulphur Dioxide, Ozone	These gases irritate the airways of the lungs, increasing the symptoms of those suffering from lung diseases
Particles	Fine particles can be carried deep into the lungs where they can cause inflammation and a worsening of heart and lung diseases
Carbon Monoxide	This gas prevents the uptake of oxygen by the blood. This can lead to a significant reduction in the supply of oxygen to the heart, particularly in people suffering from heart disease

Other triggers in the atmosphere such as dust mites, furry pets, mold, tobacco smoke, and certain chemicals may cause nasal stuffiness, throat irritation, coughing or wheezing, eye irritation, or skin irritation.

Think of others when you start your car, bring your dog to work, spray your deodorant.

Noise is also considered a pollutant. Occupational hearing loss is one of the most common work-related injuries. All worker exposures to noise should be controlled below a level equivalent to 85 dBA for eight hours to minimize occupational noise induced hearing loss.

Health risks of microorganisms

Major Micro-organisms Causing Infection

- Viruses: extremely small, they can only be seen with the electron microscope. Basically they are bundles of DNA or RNA wrapped up in a protein coat. They are not killed by antibiotics but may respond to antiviral medication if taken early on in the infection. Viruses are responsible for many illnesses: flu, chicken pox, AIDS, measles and some types of gastroenteritis to name a few.
- Rickettsia and chlamydia: Larger than viruses and can be seen under the light microscope. They generally respond to antibiotics. Examples of illnesses caused by rickettsia are typhus and Q fever. Chlamydia are responsible for a common form of sexually transmitted disease.
- Bacteria: the many types are responsible for a very large number of diseases such as gastroenteritis, sore throat, abscess, tuberculosis and meningitis. They respond to antibiotics, however resistance is a growing problem.
- Protozoa: single celled organisms; an amoeba is an example. They cause diseases such as trichomonas, sleeping sickness and a type of dysentery. They are not killed by antibiotics but respond to other chemical agents.
- Fungi: related to mushrooms and toadstools, candida and athlete's foot are common manifestations. Often arise opportunistically after antibiotics have killed off all the competing bacteria. They are not susceptible to antibiotics but respond to various chemical agents.

The skin is our first defence against infection; when intact it keeps micro-organisms out of the tissues. The skin is also covered with a thin film of oil and this prevents certain types of bacteria infecting the skin.

Mucus, the viscous fluid that coats the inside of the nose, throat, airways and genital tract is another defence against infection.

When micro-organisms break through these barriers to infect our tissues other types of defence come into play. Phagocytosis, part of the inflammatory process, involves white blood cells engulfing the invading bacteria. This process is aided by antibodies. These are proteins which coat and kill micro-organisms.

Infectious disease	**Microbe that causes the disease**	**Type of microbe**
Cold	Rhinovirus	Virus
Chickenpox	Varicella zoster	Virus
German measles	Rubella	Virus
Whooping cough	Bordatella pertussis	Bacterium
Bubonic plague	Yersinia pestis	Bacterium
TB (Tuberculosis)	Mycobacterium tuberculosis	Bacterium
Malaria	Plasmodium falciparum	Protozoan
Ringworm	Trichophyton rubrum	Fungus

Health checks
Regularly get a health check, you may feel healthy but you never know! Get the once over, you get your car serviced but what about you. You may have something you never knew about. Many diseases and disorders occur as a result of alterations or mutations in a particular gene, and some of these mutations can be passed on to future generations, categories include: • Blood Diseases • Blood Disorders • Inherited Diseases • Genetic Diseases • Gene Mutation Diseases Cystic fibrosis is an inherited genetic disease in which the body produces abnormally thick, sticky mucus which can restrict breathing and lead to repeated lung infections. Hemochromatosis -- also known as genetic iron poisoning or iron overload disease -- is an inherited disorder that results from excessive iron absorption from food. Effects of hemochromatosis can include: hypothyroidism, chronic fatigue, infertility, arthritis, diabetes, sudden heart attack, primary liver cancer, and liver failure/heart failure resulting in the need for a liver and/or heart transplant. Huntington disease, also known as Huntington's chorea, is a hereditary, degenerative disorder of the central nervous system. As the disease develops brain cells are destroyed, it becomes increasingly difficult for the person with Huntington's to concentrate on tasks, and they may have difficulty feeding himself and swallowing. Purposeless movements of the face, arms, and legs, called chorea, may develop.

2. Get fit

Fitness self-assessment for office workers
Just how fit are you, answer the questions and find out.

Fitness self-assessment
QUESTIONS

1. How old are you?

a) 18 and under (0 points)
b) 19 to 30 (0 points)
c) 31 to 45 (0 points)
d) 46 to 64 (0 points)
e) 65 plus (0 points)

2. The Department of Health recommends adults are moderately active for 150 minutes or vigorously active for 75 minutes each week. In an average week, how close are you to achieving this?

a) You achieve this every week (3 points)
b) You're almost there, but not quite (2 points)
c) You do around half of what's recommended (1 points)
d) You're a long way off doing what's recommended (0 points)

3. How many days a week do you do activities that strengthen your muscles?

a) At least two days (2 points)
b) One day (1 point)
c) Hardly ever (0 point)

4. If you're not doing enough physical activity, which of the following best describes why?
(You can pick more than one)
a) 'I don't have time' (0 point)
b) 'I'm too tired' (0 point)
c) 'I don't have the willpower' (0 point)
d) 'I don't like to exercise' (0 point)
e) 'It's hard work' (0 point)
f) 'None of these' (0 point)

5. How would you describe the way you feel after climbing a flight of stairs?
a) Great (4 points)
b) Ok (3 points)
c)Breathless (2 points)
d) Exhausted (1 points)
e) Can't do it (0 points)

6. How many of the following could you do easily? (You can pick more than one.)
a) 10 sit-ups (2 points)
b) 5 push-ups (2 points)
c) Touch your toes (1 points)
d) 20 star jumps (2 points)
e) None of these (0 points)

RESULTS

12-16 points
Based on your responses today you are close to meeting or exceeding the recommended levels of physical activity. This is great for your health. Keep up the good work.

7-12 points
Based on your responses today you're physically active but not quite meeting recommended levels.

0-6 points
Based on your responses today you're not very active and struggling with motivation. Start small and build up. You'll soon gain in confidence and feel better

Healthy Exercise

Healthy Exercise
Being fit can reduce your risk of major illnesses, such as heart disease, stroke, diabetes and cancer by up to 50% and lower your risk of early death by up to 30% Research shows that physical activity can also boost self-esteem, mood, sleep quality and energy, as well as reducing your risk of stress, depression, dementia and Alzheimer's disease.
It's medically proven that people who do regular physical activity have: • up to a 35% lower risk of coronary heart disease and stroke • up to a 50% lower risk of type 2 diabetes • up to a 50% lower risk of colon cancer • up to a 20% lower risk of breast cancer • a 30% lower risk of early death • up to an 83% lower risk of osteoarthritis • up to a 68% lower risk of hip fracture • a 30% lower risk of falls (among older adults) • up to a 30% lower risk of depression • up to a 30% lower risk of dementia **The secret to getting fit for free is to use every opportunity to be active**

Healthy exercise - Walking
Walking Walk everywhere, walking is the easiest ways to get more activity into your day, lose weight and become healthier daily walking burns more energy than a weekly visits to the gym. **Try:** ditching the car for short journeys, walking all or part of your journey to work, getting off the bus or train one stop early aim to walk 10,000 steps a day, which can burn up to 400 calories.

Healthy exercise - Running
Running is great for weight loss, improving heart and lung function, strengthening bones and giving you a general sense of wellbeing. Make sure you: 1. You have a pair of running shoes and running socks can also help reduce your risk of blisters 2. Warming up and down - take a five-minute walk at the beginning and end of the session. 3. Have good running technique it will help make your runs feel less tiring, reduce your risk of injury and ultimately be more enjoyable. • Keep your head straight • Don't hunch your shoulders • Keep your hands relaxed • Keep your arms at 90 degrees • Lean forward while running • Keep your hips stable • Don't lift your knees too high • Aim for a mid-foot strike • Don't strike the ground heavily • Breathe deeply and rhythmically 4. You have energy for your run, but don't overdo it. Avoid having a large meal within two hours of your run. However, a light snack, such as a banana, before to running is fine. 5. You are drinking enough water throughout the day, this should not be problem. Some people like to have a water bottle with them on their run. If you're thirsty, drink – just not too much.

Create your own exercise programme

Exercise programme
To stay healthy, adults aged 19-64 should try to be active daily and should do: At least 150 minutes (2 hours and 30 minutes) of moderate-intensity aerobic activity such as cycling or fast walking every week, and muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs, hips, back, abdomen, chest, shoulders and arms). OR 75 minutes (1 hour and 15 minutes) of vigorous-intensity aerobic activity such as running or a game of singles tennis every week, and muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs, hips, back, abdomen, chest, shoulders and arms). An equivalent mix of moderate- and vigorous-intensity aerobic activity every week (for example 2 30-minute runs plus 30 minutes of fast walking), and muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs, hips, back, abdomen, chest, shoulders and arms).
Moderate-intensity aerobic activity means you're working hard enough to raise your heart rate and break a sweat. One way to tell if you're working at a moderate intensity is if you can still talk, but you can't sing the words to a song. Examples of muscle-strengthening activities for most people include: • lifting weights • working with resistance bands • doing exercises that use your body weight for resistance, such as push-ups d sit-ups • heavy gardening, such as digging and shovelling • yoga Vigorous-intensity aerobic activity means you're breathing hard and fast, and your heart rate has gone up quite a bit. If you're working at this level, you won't be able to say more than a few words without pausing for a breath. But you also need to keep flexible, you still want to be able to put your own socks on when you are 65! Flexibility exercises are activities that improve the ability of a joint to maintain the movement necessary for carrying out daily tasks and physical activity. Examples of flexibility activities include: • stretching • yoga • tai chi • pilates

4. Healthy Eating

The two key things to a healthy diet are:

- Eat the right number of calories
- Eat a balanced diet.

The average man needs around 2,500 calories a day. The average woman needs 2,000 calories. Most adults are eating more calories than they need, and should eat fewer calories.

People should eat enough food to give them energy for their age, it is recommend that the amount of calories consumed is :

Age	Male		Female	
	(MJ)	(kcal)	(MJ)	(kcal)
0-3 months	2.28	545	2.16	515
4-6 months	2.89	690	2.69	645
7-9 months	3.44	825	3.20	765
10-12 months	3.85	920	3.61	865
1-3 years	5.15	1230	4.86	1165
4-6 years	7.16	1715	6.46	1545
7-10 years	8.24	1970	7.28	1740
11-14 years	9.27	2220	7.72	1845
15-18 years	11.51	2755	8.83	2110
19-50 years	10.60	2550	8.10	1940
51-59 years	10.60	2550	8.00	1900
60-64 years	9.93	2380	7.99	1900
65-74 years	Y9.71	2330	7.96	1900
74+ years	8.77	2100	7.61	1810

Certain foods will contain different amounts of calories eg

Food	kJ	kcal
Breakfast		
Cornflakes (30g)	1590	380
Muesli (30g)	1790	425
Porridge (30g)	190	45
Egg, boiled (55g)	610	145
Egg poached (55g)	645	155
Bacon, fried (40g)	1975	475
Bread, brown (25g)	1015	240
Snack		
Biscuit chocolate (20g)	2200	525
Biscuit gingernut (15g)	1925	455
Cake fruit (60g)	1490	355
Coffee (230g)	8	2

1 Base your meals on starchy foods.
Starchy foods should make up around one third of the foods you eat.
Include at least one starchy food with each main meal.
Starchy foods include

- potatoes,
- cereals,
- pasta,
- rice
- bread.

Choose wholegrain varieties when you can: they contain more fibre, and can make you feel full for longer

2 Eat lots of fruit and veg
Eat at least five portions of different types of fruit and veg a day. A glass of 100% unsweetened fruit juice can count as one portion, and vegetables cooked into dishes also count.

3 Eat more fish
Fish is a good source of protein and contains many vitamins and minerals. Aim for at least two portions a week, including at least one portion of oily fish. Oily fish is high in omega-3 fats, which may help to prevent heart disease.

4 Cut down on saturated fat and sugar and eat less salt.
Choose foods that contain unsaturated fats, such as vegetable oils, oily fish and avocados. Do not eat foods that contain saturated fats, such as hard cheese, cakes, biscuits, sausages, cream, butter, lard and pies

5 Eat breakfast: try and eat wholemeal cereal, with fruit sliced over the top is a tasty and nutritious breakfast

Sources
http://www.nhs.uk/Livewell/fitness/Pages/physical-activity-guidelines-for-adults.aspx - diet
http://www.nhs.uk/Livewell/fitness/Pages/physical-activity-guidelines-for-young-people.aspx
-Physical guide to exercise
http://www.talktofrank.com/drug/speed#aka=Amphetamine - drug taking
www.nhs.uk/LiveWell/emotionalhealth - drug taking

TASK 5 - CASE STUDY: THE BENEFITS AND RISKS OF MEDICAL TREATMENT

New developments in healthcare include new drugs and instruments for diagnosis and treatment, including gene therapies and stem cell technologies. For patients in hospital, these new developments can be worrying.

Produce materials should help them make informed judgments about whether or not to have the treatment suggested for them.

Stem cell transplants

Stem cell transplants are used to treat people if their stem cells have been damaged by disease. Stem cell transplants can benefit people with cancer or high doses of chemotherapy and radiation. The stem cells can generate into healthy cells to replace diseased cells.

Stem cell research began in the 1800's, when scientist found that certain types of cell could generate blood cells. There are three different types of stem cell,

- Totipotent stem cells,
- Pluripotent stem cells,
- Multipotent stem cells. The Totipotent stem cells come from the early embryos. These stem cells can create full organisms, although they are the most controversial type of stem cell. Pluripontent stem cells are derived from the inner mass of the blastocyst of a cell. They are able to from any type of blood cell in the human body. Multipotent stem cells are derived from fetal tissue, cord blood, and adult stem cells. Although the Multipotent stem cells do not have as many uses as the other types the are very useful.

LO5 - MB3 bullet 1 qualitative

Stem cell transplants can benefit people with cancer or high doses of chemotherapy and radiation.
Generate healthy cells to replace diseased cells.

Hematopoietic (blood) stem cell transplants are currently the only type of stem cells commonly used for therapy. They are used to treat leukemia, lymphoma and several inherited blood disorders.

Risk
Complications that can arise with a stem cell transplant include:

LO5 - MB3 bullet 3

- Graft-versus-host disease
- Stem cell failure
- Organ injury
- Infections
- Cataracts
- Infertility
- New cancers
- Death

Gene therapy

Gene therapy - can replace the faulty genes that have been inherited and so cure such illnesses.

The gene therapy, treatment targets the cause of cystic fibrosis rather than just treating the symptoms. Although the first gene therapy experiments have involved lung cells, scientists hope that these technologies will be adapted to treat other organs affected by cystic fibrosis

The cause of cystic fibrosis (CF) is a defect in the cystic fibrosis transmembrane conductance regulator (CFTR) gene

The gene for cystic fibrosis makes a protein that controls the movement of salt and water in and out of your cells. In people with cystic fibrosis, the gene does not work effectively. As a result, cells that line the passageways of the lungs, pancreas, and other organs produce abnormally thick, sticky mucus. This mucus obstructs the airways and glands, which causes the characteristic signs and symptoms of cystic fibrosis

Other factors may influence the course of cystic fibrosis. For example, changes in genes other than CFTR might help explain why some people with the disease are more severely affected than others. However, most of these genetic changes have not been identified.

Cystic fibrosis is inherited in an autosomal recessive pattern, which means that two copies of the cystic fibrosis gene in each cell are altered. In most cases, the parents of an individual with an autosomal recessive disorder are carriers of one copy of the altered gene, but do not show signs and symptoms of the disorder

When two cystic fibrosis carriers have a baby, the baby has a

- One in four chance of inheriting two abnormal CFTR genes and having cystic fibrosis
- One in four chance of inheriting two normal CFTR genes and not having cystic fibrosis or being a carrier
- Two in four chance of inheriting one normal CFTR gene and one abnormal CFTR gene. The baby will not have cystic fibrosis, but will be a carrier like its parents

Directly sourced from
http://www.google.co.uk/imgres?imgurl=http://3.bp.blogspot.com

LO5 - MB3 bullet 2

Clinical trials

There is a gene therapy trial to treat haemophilia B, a genetic condition that prevents the body from producing a functional version of a protein called factor IX , which is required for blood clotting. It is currently treated with frequent injections of factor IX protein. In this study, six people with severe haemophilia B were injected with a virus carrying a section of DNA that contained instructions for making the normal form of human factor IX .

All six had increased levels of factor IX in their blood after treatment, and these levels continued throughout the follow-up period of 16 months. Four of the six participants were able to stop their regular injections of p factor IX rotein, and the other two required fewer injections than before.

The trail will need to be on a larger numbers of patients who are followed for longer periods of time to fully understand the benefits and risks of this potentially powerful therapy.
The trail was a combined phase I and phase II trial conducted as a case series, in which all participants received gene therapy.

In this particular study, there was no comparison group who received a placebo or standard treatment.

In a clinical trial there are a number of phases.

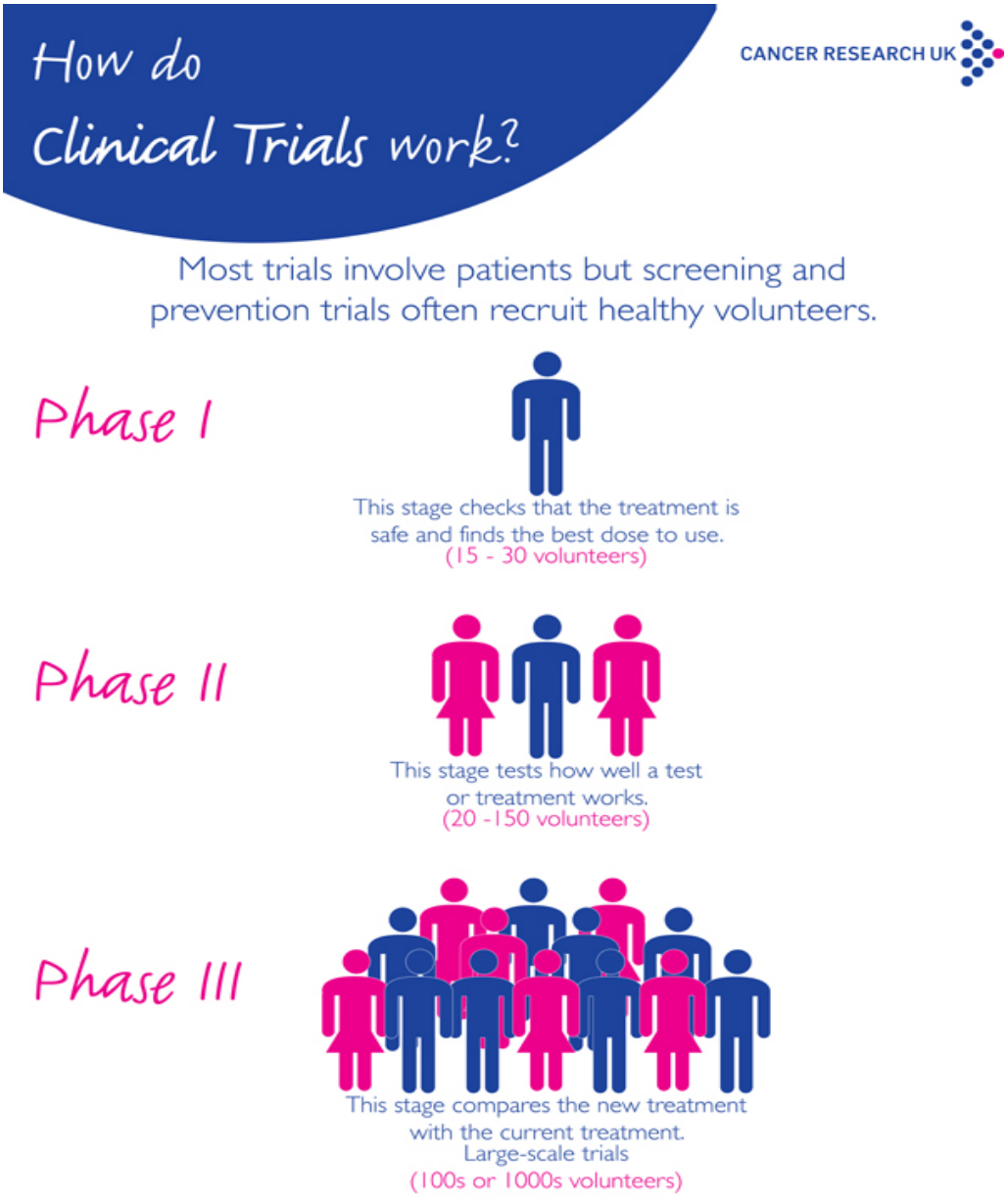
Phase I trials
Phase I trials are the early phases of drug testing in on a small number of humans perhaps 40. It will test the drug's safety and suitability for use in humans, rather than its effectiveness so only very small doses are and then gradually increased until the levels suitable for use in humans are found.

Phase II trials
This stage usually involves a larger group perhaps 100 who have the disease or condition that the drug is designed to treat. The drug's effectiveness is examined and more safety testing and monitoring of the drug's side effects are carried out to find its appropriate dosage levels

Phase III trials
The effectiveness and safety of the drug is rigorously examined in a large controlled trial to see how well it works and

how safe it is.

These controlled tests usually compare the new drug's effectiveness with either existing drugs or a placebo so the trial is an unbiased a test as possible to ensure that the results accurately represent its benefits and risks.
These phases may be blinding is not telling someone what treatment a person has received or, in some cases, the outcome of their treatment. This is to avoid them being influenced by this knowledge. The person who is blinded could be either the person being treated or the researcher assessing the effect of the treatment (single blind), or both of these people (double blind).
Or a case-control study which is often used to identify risk factors for a medical condition. This type of study compares a group of patients who have that condition with a group of patients that do not have it, and looks back in time to see how the characteristics of the two groups differ.



Taken directly from Cancer Research UK

Laboratory testing
Before a medicine is tested in humans, it is tested in the laboratory and/or on animals. This is called pre-clinical testing, and gives us greater confidence in its likely safety in humans.

Studies in laboratory animals first to determine potential toxicity before they can be tried in people. Treatments having acceptable safety profiles and showing the most promise are then moved into clinical trials.

In vitro methods, using cells and tissues outside the body in an artificial environment, are routinely used to determine the safety or effectiveness of a drug or ingredient.

In vitro testing cells from a living organism are grown with a chemical soup that provides the nutrients needed for the cells to survive outside the body. These cells are exposed to the test medicine and each chemical within the medicine is analysed for its effect. The cells are analysed to understand the concentration of the ingredient that makes the cells unhealthy.

The vast majority of medicines that are tested in this pre-clinical testing go no further. This is because it is found that they are likely not to be safe and effective in humans.

If the pre-clinical testing suggests that the medicine is safe, it is then tested on humans

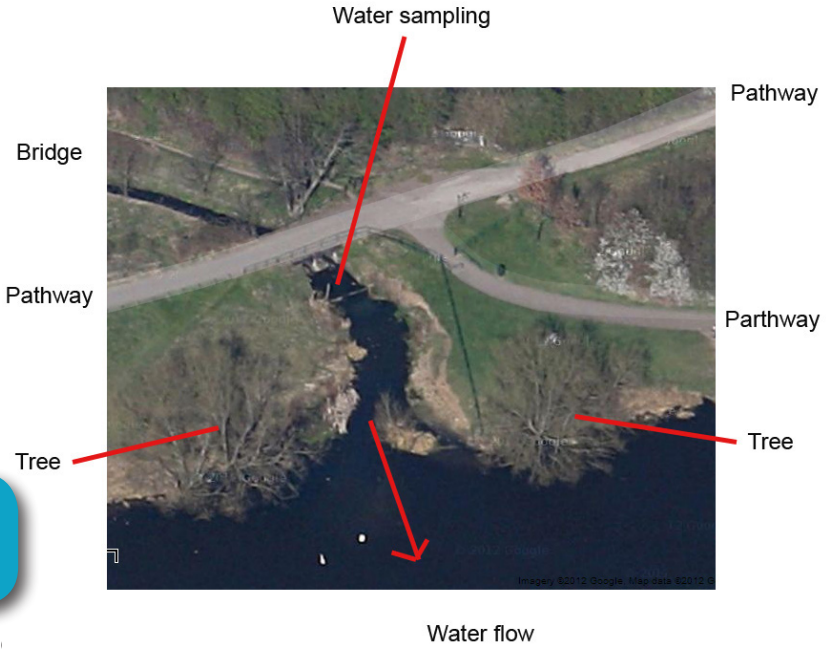
Sources
www.patient.co.uk/directory - medical treatments
Cancer UK – Clinical trials
ghr.nlm.nih.gov/handbook/therapy/genetherapy – Gene therapy
www.closerlookatstemcells.org - Stem cell treatment

TASK 6 - PRACTICAL PROCEDURES:MEASURING THE ENVIRONMENTAL EFFECTS OF HUMAN ACTIVITY

Environment Assessment: Does the pedestrian bridge lead to pollution of the stream below?

Location: Sampling water either side of a footbridge in Kingsway Park.

Purpose: Water purity will be measured by the invertebrates, chemicals and particulates in the water.



LO6 - MB3 bullet 1 little justification of measures taken

The water was taken a s

water	depth 1.5m width 3m
water movement	speed slow direction down stream
weather conditions	sun moderate shade none temperature 70°C wind gentle
pollution	No litter no scum

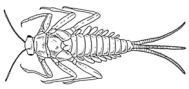
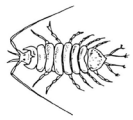
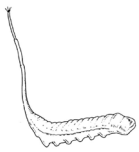
Collect and store Water Sample for Biological analysis

1. Collect the sample use a sweep net and sweep in one direction along the top of the stream water to scoop up organisms. Do not scoop up the soil.

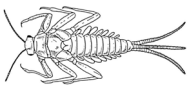
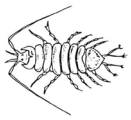
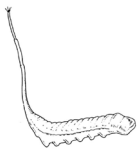
2. Repeat with the sweep net for middle and bottom layers of the stream. Gently place the scooped up organisms from all three sub samples into a clean container with some stream water in.

3. Identify the species you find and the number of each as soon as possible using a magnifying glass. Return organisms back to the stream where they were found.

LO6 - MB3 bullet 2

Location: Stream Above Bridge		Date: XXXXXX	
Invertebrates	**Count from all samples**	**Frequency**	
 Mayfly nymph (about 20 mm)	4	11	Clear water ↑
 Stonefly nymph (about 10 mm)	7		
 Freshwater shrimp (about 20 mm)	5	18	
 Caddis fly larva (about 10 mm)	13		
 Bloodworm (about 20 mm)			
 Water louse (about 10 mm)			
 Sludgeworm (about 120 mm)			
 Rat-tailed maggot (up to 55mm)			
No life			↓ Very polluted water

LO6 - MB3 bullet 3/4

Location: Stream Below Bridge		Date: XXXXXX	
Invertebrates	**Count from all samples**	**Frequency**	
 Mayfly nymph (about 20 mm)	1	7	Clear water
 Stonefly nymph (about 10 mm)	6		
 Freshwater shrimp (about 20 mm)	5	13	
 Caddis fly larva (about 10 mm)	12		
 Bloodworm (about 20 mm)			
 Water louse (about 10 mm)			
 Sludgeworm (about 120 mm)			
 Rat-tailed maggot (up to 55mm)			
No life			Very polluted water

Comparison of Living indicators above/below bridge.
There was no significant difference in living organisms.
Distance between sampling points very short, less than 4 m, with the stream flowing into the lake. Traffic over the bridge – very light.
There was no location between sampling points for pollutants to "back up" and collect.

There is no indication that the pedestrian bridge impacts on the invertebrates in the stream.

Collect and store Water Sample for Chemical
1. Label a clean 500 ml plastic stoppered bottle with:
2. Location of sample, date, time taken, depth, position
3. Hold the water bottle about 300 mm (elbow depth) below the surface Rinse the bottle several times with the water from the area to be tested before collecting the sample.
4. Place the lid on the sample under the water.

5. Store the sample in a cool container until you can place it in a fridge.
6. Place the sample in a fridge.
7. Carry out the test as soon as is possible

LO6 - MB3 bullet 2/3/4

Testing for chloride ions in stream water

Method

- Add 5 ml of the pool sample to a test tube with a clean pipette
- Now add 5 ml of silver nitrate
- If a white precipitate forms then there is chloride present

Testing for chloride ions in stream water

Method

- Add 5 ml of the pool sample to a test tube with a clean pipette
- Now add 5 ml of silver nitrate
- If a white precipitate forms then there is chloride present

Results

Test	Was it present above bridge	Was it present below bridge
Chloride	No – no precipitate formed	No – no precipitate formed

Conclusion

No chloride present

Evaluation

The main problems with the method that we this test is semi-quantitative and it is also subjective. It is semi-quantitative because depending on the amount of chloride present, the whiter the sample would go but it is not know exactly how much is present. Subjective means that different people may interpret the colour that the sample turns in different ways.

Testing for sulphate ions in stream water

Method

- Add 5 ml of the Sample to a test tube using a clean pipette
- Then add 1 ml of barium chloride to the sample
- If a white precipitate forms then sulphate is present

Results

Test	Was it present above bridge	Was it present below bridge
Sulphate	There was some as a slight precipitate formed	No - no precipitate formed

Conclusion

We can tell that above the bridge only a slight precipitate formed, whereas below the bridge no precipitate formed. If the levels of sulphate are too high then the grout used on the brickwork and the concrete surrounding the bridge

supports will be attacked. This will cause weakness when the sulphate breaks through the grout. The difference in amounts may be due to a greater volume of water below the bridge diluting the sulphate.

Evaluation

The problems with this test are that it is semi-quantitative and subjective. Because it is subjective, it means that different people will see the results that the tests give in different ways, because the results are in colours.. As the test is semi-quantitative, it gives us some idea about how much sulphate is in the sample, but not an exact quantity.

Testing for carbonate ions in stream water

Method
- Measure 50ml of sample into a measuring cylinder and then pour it into a beaker.
- Put a calcium hardness tablet into the sample
- Swirl the beaker until the tablet has completely dissolved
- Continue to add tablets one at a time, until the colour changes from pink to purple
- When this happens record the number of calcium hardness tablets that you have used
- Calculate the calcium hardness by doing this:
- Calcium hardness (mg/l $CaCO_3$) = (number of tablets x 40) – 20

Repeat each step for all of the samples

Results

Water sample	Number of calcium hardness tablets per 50 ml	Calcium hardness (mg/l $CaCO_3$)
Above bridge	4	140
Below bridge	3	100

Conclusion

Using colour changes and colour charts also makes the results partially qualitative, as although an actual amount of carbonate can be identified, the result is still down to individual perception of what the colour is and therefore how much is present.
Calcium may be due to the leaching of the bed rock.

Particulates

A 50 ml of each sample was placed in a 50 ml glass measuring cylinder and allowed to stand for two days.
Particulates will then settle out by weight.

The glass measuring cylinders were then examined with a hand lens under the light from a table lamp.

Results

No particulates were seen from samples taken from the surface or middle layers of the stream above the bridge.
Below bridge: surface layer 15 particles 1mm or less
Below bridge: middle layer 3 particles 1 mm to 5mm
Fine grit particles were seen in the samples taken from the bottom of the stream.
These particulates were then examined under a microscope at a magnification of x100.

Bottom – below bridge had 11 particles of grit measuring between 1mm and 3 mm
Bottom – above bridge had 2 particles of grit measuring between 1mm and 3mm.

Conclusion
Dust and grit particles were blown off the bridge into the stream below.

pH
Method
- Calibrate the pH probe
- Rinse the pH probe in water
- Put the pH probe into the sample
- Record both results
- Rinse it in water
- Put in the next sample
- Rinse it in water and repeat for all of the other samples

Results

Sample	1st pH level	2nd pH level	Averages
pH4	4.2	4.2	4.2
pH7	6.7	6.9	6.8
pH9	8.9	9.0	9.0
Above bridge 1	7.2	7.2	7.2
Above bridge 2	7.1	7.1	7.1
Above bridge 3	7.2	7.3	7.25
Below bridge 1	7.1	7.2	7.15
Below bridge 2	7.3	7.3	7.3
Below bridge 3	6.9	7.1	7.0

Conclusion
Water is very nearly neutral between pH 7.0 and pH 7.3 above and below the bridge.
How good was the calibration of the manual PH probe?

Formulae:

$$\left[\frac{\text{Actual reading} - \text{ideal reading}}{\text{Ideal reading}}\right] \text{ (or difference between)}$$

Answer X 100 = % inaccurate

LO6 - MB3 bullet 4

pH4 – $\frac{4.2 - 4.0}{4.0}$ X 100 = 5.0% error

PH7 - $\frac{6.8 - 7.0}{7.0}$ X 100 = 2.9% error

pH9 - $\frac{9.0 - 9.0}{9.0}$ X 100 = 0.0% error

Environmental Report

Concern – does the pedestrian bridge lead to pollution of the stream

- No surface litter was seen on the surface of the stream either above or below the bridge.
- Species of invertebrates above and below the bridge show no discernable difference.
- Chemical make of the water :
- No chloride present above or below the bridge
- A slight presence of sulphate above the bridge and none below the bridge. The difference in amounts may be due to a greater volume of water below the bridge diluting the sulphate.
- There is a slight increase in calcium above the bridge but again this may be to a greater volume of water below the bridge.
- Again pH was slightly higher above the bridge which may be due to the amount of water below bridge.
- The only real difference seen was dust and grit particles being blown off the bridge into the stream below.

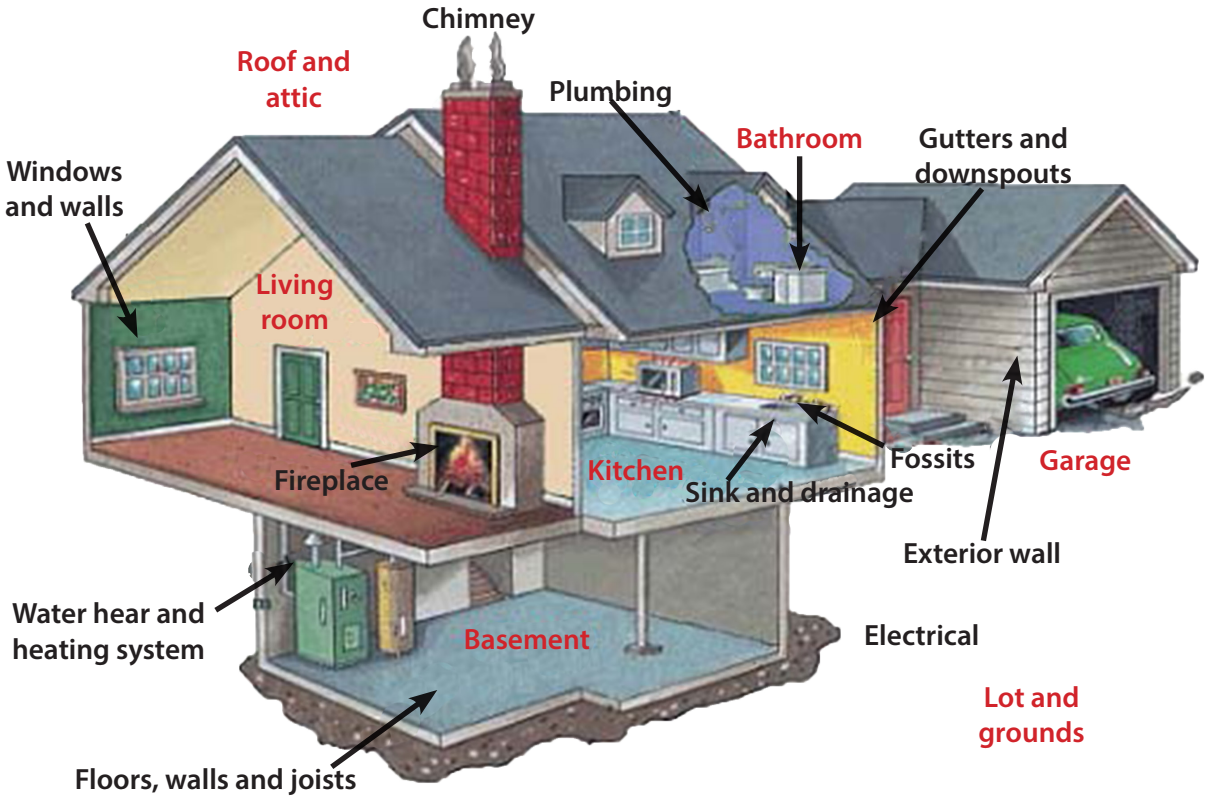
Overall there is no discernible impact made by the bridge.

Witness Statement

Competency	MB1	MB2	MB3
Integrity of samples			
With guidance prevents contamination			
Preventing contamination			✓
Meeting clean room requirements			✓
Correct labelling			
Accurate and complete labelling			✓
Samples stored/disposed		✓	
Measuring a volume of liquid			
Meniscus on line		✓	
Measured at horizontal		✓	
Selecting appropriate equipment			✓
Explanation including reliability and sensitivity		✓	
Calculation of percentage error			✓
Maintaining a safe and uncluttered working environment			
Most of the time			
All of the time			✓
Rigorously and with prior thought and planning			✓
With support carries out risk assessment			
Carries out risk assessment			✓
Following standard procedures			
With support follows basic standard procedures correctly			
Follows basic standard procedure correctly			
Follows complex procedure correctly			
Makes own adaptations to standard procedure to improve reliability			✓
Assessors signature: XXXXXXXXXX			
Assessors name: XXXXXXXXX			
Date: XXXXXXXXXX			

TASK 7 - ANALYTICAL REPORT: THE ENVIRONMENTAL IMPACT OF MATERIALS USED IN HOUSE BUILDING

Identify a range of materials used in the construction of a new house and analyse the environmental impact of the production of the materials from natural resources.



LO7 - MB3 bullet 1

Range of materials used in house construction

Concrete	Properties Concrete is a composite building material made from the combination of aggregate and cement as a binder water is added to set off the chemical reaction. Concrete can easily be transported and as it is a "liquid" it can be easily pumped into location. Concrete has relatively high compressive strength, but much lower tensile strength so it is usually reinforced with steel rods. It provides superior fire resistance, compared with wooden construction and can gain strength over time. Structures made of concrete can have a long construction life. Concrete can be damaged by freezing of trapped water, bacterial corrosion, It provides superior fire resistance, compared with wooden construction and can gain strength over	Uses Foundations, walls, lintels,steps,floors. Precast structures such as windows.

Manufacture

Raw materials: Cement (limestone, sand, shale, clay, iron ore), aggregate, water.

Chemical additives to enhance properties. In normal use, additive dosages are less than 5% by mass of cement and are added to the concrete at the time of batching/mixing, such as:

- Accelerators speed up the hydration (hardening) of the concrete.
- Retarders slow the hydration of concrete.
- Air entrainments to increase durability.
- Plasticizers increase the workability of plastic or "fresh" concrete,.
- Pigments can be used to change the color of concrete, for aesthetics.
- Corrosion inhibitors are used to minimize the corrosion of steel and steel bars in concrete.
- Bonding agents are used to create a bond between old and new concrete
- Pumping aids improve pumpability, thicken the paste and reduce separation.

Limestone used to make the cement.

Calcium carbonate → Calcium oxide + carbon dioxide

$CaCO_3(s) CaO(s) + CO_2(g)$

LO7 - MB3 bullets 2, 3 and 4

Ar values: Ca = 40, C = 12, O = 16

$$\text{Atom economy} = \frac{\text{mass of useful product} \times 100}{\text{total mass of products}} = \frac{CaO \times 100}{CaCO_3}$$

$$= \frac{(40+16) \times 100}{40 + 12 + (3 \times 16)}$$

$$= \frac{56 \times 100}{100}$$

$$= 56\%$$

Environmental impact

The main environmental impact is quarrying:

- Noise and heavy traffic
- Quarrying processes eg, blasting rocks apart with explosives makes lots of noise and dust
- Destruction of the habitats of animals and birds.

In addition, energy is needed to produce cement

- Burning fossil of fuels which causes pollution
- Dust

Alternative method

Alternative sustainable fuels can be used to fuel the kilns. A new type of cement called Eco-cement which is an environmentally sustainable blended cement which incorporates reactive magnesia and produces wastes that are more environmentally sustainable. This new cement aims to reduce the amount of CO_2 emitted by 80% and to reduce the amount of energy consumed by the manufacturing process by 50%.

Clay	Properties	Uses
	Clay is very good at keeping temperatures at a constant level. Homes built with earth tend to be naturally cool in the summer heat and warm in cold weather. Clay holds heat or cold, releasing it over a period of time like stone. Earthen walls change temperature slowly, so artificially raising or lowering the temperature can use more resources than in say a wood built house, but the heat/ coolness stays longer. If glazed clay becomes durable and water resistant	Clay can fabricated into bricks, roof tiles, pipes. It is also used in cement.

Manufacture
Bricks

1.Extraction
Clay is removed from quarries and transported to the factory Once it has reached the factory the clay is ground down using rollers into fine powder before being mixed with water.
2. Forming
The clay is ground down and mixed with water, then either
extruded or forced into a mould
thrown into a mould by hand
3. Drying
Drying takes place in conditions of between 80-120ºC, lasts for between 18 – 40 hours
4. Firing
The dried clay is fired to fuse particles together. to produce the hard brick.

Environmental impact:	**Alternative:**
The firing of clay consumes large amounts of energy produced largely from fossil fuels – causing release of CO_2. sulphur dioxide, hydrogen fluoride and hydrogen chloride. The other major impact is the clay pits the landscape resulting from the extraction of raw materials. Impact can be reduced by having the manufacture close to the quarry so cutting transport. Using Continuous kilns which are efficient and larger capacity so cutting down gas emissions.	Breeze blocks are used instead of bricks because of a combination of higher insulating properties and a lighter unit weight. The lighter block enables time and material cost savings through easier handling and larger units. Blocks are used throughout a building from its foundation walls, through cavity walls, monolithic walls, partition walls, separating walls and as a component of 'beam and block' flooring.

Glass	**Properties**	**Uses**
	Glass is to both transparent let ting light into rooms while at the same time keeping inclement weather outside. Being a poor thermal conductor it will keep heat inside. Being inert it does not deteriorate with the climate. A large spread of glass, having a high tensile strength (but brittle) can be used as a curtain wall which is an outer covering of a building in which the outer walls are non-structural, but merely keep the weather out and the occupants in.	Windows for its transparency. Curtain walls for its own strength, weight and cost

Manufacture

Glass is made by melting sand and then cooling it. Flat sheets of glass for windows are made by floating molten glass on a layer of molten tin.

Limestone heated with sand and soda (sodium carbonate).

The furnace melts cullet (crushed, recycled glass), sand, soda ash, limestone, and other raw materials together. Molten glass usually ranges in temperature over 1200 °C.

Environmental impact:	**Alternative:**
Limestone quarries are visible from long distances and may permanently disfigure the local environment Quarrying is a heavy industry that creates noise and heavy traffic, which damages people's quality of life Sodium carbonate is added to sand during the manufacturing process, to reduce the melting temperature of the sand and so save energy. The sodium carbonate decomposes in the heat to form sodium oxide and carbon dioxide, but this makes the glass soluble in water. Calcium carbonate (limestone) is therefore also added, to stop the glass dissolving in water. The calcium carbonate decomposes in the heat to form calcium oxide and carbon dioxide.	Minimising and controlling emissions For example: Switching from heavy fuel to natural gas reduces CO_2 and SO_2, but increases NO_x. Some technologies that reduce eg NO_x can cause an increase in CO_2 when extra energy input is needed. Technologies that reduce SO_2 can produce non-recyclable waste. Some technologies for reducing SO_2 are not compatible with end-of-pipe de-NO_x technologies. Some technologies can affect the lifetime of the furnace or the quality of the glass Switching from heavy fuel

Plastics	**Properties**	**Uses**
	Thermoplastics can be remoulded by heating as they are linear or branched chains. Thermosetting plastics cannot be melted as they have cross linkages between chains. They can be: • lightweight. • tough • transparent or opaque. • waterproof • insulators. • rigid or flexible. As a foam it can been used in combination with structural materials, such as concrete. It is light weight, easily shaped and an excellent insulator. It is usually used as part of a structural insulated panel where concrete is sandwiched between two layers of foam.	Guttering and drain pipes as it is durable, stay clean and water resistant. Handrail as it has a smooth and decorative finish. Windows as it can be transparent, non-weathered, impact resistant, thermal insulator and strong as well as being light and easier to handle than glass. Soffit board as it is rigid, decorative, non weathered. Wastepipe as it is lightweight, easy installation, smooth. Structural panel being light weight and self supporting.

Manufacture
Crude oil to manufacture plastics
Crude oil is cracked into its different fractions.
Polymerisation reaction is used as ethane molecules are joined together.

can be written as $nC_2H_4 \longrightarrow (C_2H_4)n$

Product yield from a barrel, 42 gallons, of crude oil

Product	Gallons
Petrol	19.5
Fuel oil	9.2
Jet fuel	4.1
Heavy fuel oil	2.3
Liquefied gases	1.9
Still gas	1.9
Coke	1.8
Asphalt	1.3
Petrochemical feedstock	1.2
Lubricants	0.5
Kerosene	0.2
Other	0.3

Figures are based on 1995 average yields for U.S. refineries. One barrel contains 42 gallons of crude oil. The total volume of products made is 2.2 gallons greater than the original 42 gallons of crude oil. This represents "processing gain" due to gases released.

Source: Royal Pacific Petroleum

Environmental impact	**Alternative:**
Oil spills can happen as the oil is being transported by tanker Burning fossil fuels releases CO_2 and SO_2 which contributes to global warming and acid rain Most polymers are not biodegradable and have to be disposed of in landfill sites.	Non-petroleum based plastics are being developed. For example, corn is used to make bio-plastic drinking cups; and soy is used as insulating foam for seat cushions and buildings. Bacteria can be used in making totally biodegradable plastics which completely breaks down in nature in about 9 months.

Iron	Properties Steel is a metal alloy whose major component is iron, and is the usual choice for metal structural building materials. It is strong, flexible, and if treated lasts a long time. However metal is easily corroded if exposed to air and water. Painting is the most common anti-corrosion treatment. It work by providing a barrier of corrosion-resistant material between the damaging environment and the structural material.	Uses Iron is used more in alloys, wrought iron & steel. Construction beams, Reinforcement in concrete. Aluminium tends to be usede for light

	Aluminium is used instead as it has a lower density so lighter and better corrosion resistance as well as being a medium strength metal but it has a greater cost.	weight frames for panelling and as window frames as well as for large power cables

Manufacture

Extracting iron using a blast furnace from iron ore, limestone, coke

Iron oxide + carbon monoxide ⟶ Iron + carbon dioxide

$Fe_2O_3 + 3CO\ (g) \longrightarrow 2Fe\ (l) + 3CO_2\ (g)$

Ar values Fe = 56, C = 12, O = 16

$$\text{Atom economy} = \frac{\text{mass of useful product}}{\text{total mass of products}} \times 100 = \frac{2Fe \times 100}{2\,Fe + 3CO_2} = \frac{(2 \times 56) \times 100}{2 \times 56 + 3 \times 44}$$

$$= \frac{112 \times 100}{244}$$

$$= 45.90\%$$

Impact on environment:	**Alternative:**
Loss of land due to mining and the impact of the mining process itself. Roads will need to be built both to transport the raw materials to the blast furnace and the waste away from it. Air pollution - carbon dioxide gives the greenhouse effect, sulphur dioxide gives acid rain. The visual impact of the furnace will be great due to its height; also there will be noise and fumes emitted. Disposal of slag	A possible alternative method to the blast furnace learners may suggest is called Hismelt. Hismelt is short for 'high intensity smelting'. Hismelt is a direct smelting process where iron is produced with no slag waste product. The process allows iron ore with significant impurities to be used, and cheaper non coking coal instead of coke.

Copper	**Properties**	**Uses**
	Copper has excellent corrosion resistance it surfaces form tough oxide-sulphate patina coatings that protect underlying copper surfaces and resist corrosion for a very long time and so is durable as well as lasting for a long time. It has a low thermal movement so will not open joints and can be used on roofs. Being of medium strength and malleable it can be fabricated into shapes easily. Copper is low maintance and does not require cleaning or maintaining. Being malleable and with a very low electrical resistance it is used in electrical wiring as it conducts electricity very well but also be bent into position.	Copper is incorporated into roofing, flashing, gutters, downspouts, domes, spires, vaults, wall cladding, building expansion joints, and indoor design elements. Used in electrical wiring and water pipes.

Manufacture

Extracting copper by electrolysis

Electricity passed through an electrolyte copper sulphate, pure copper cathode is needed.

(Anode): $Cu \longrightarrow Cu_2^{++}$ 2e-

(Cathode) $Cu_2+ + 2e- \longrightarrow Cu$

Copper can also be produced by Redox when the ore malachite, copper carbonate, is heated in air to form copper oxide which is then reduced with carbon

Balanced equation for the reaction:

$2CuCO_3 = 2CuO + 2CO_2$ first heating it in air, then

$2CuO + C = 2Cu + CO_2$ heating with carbon

Ar values Cu = 63.5, C = 12, O = 16

Atom Economy is

For equation 1, [(79.5 x2) / (2x79.5 + 2 x 44)] x 100 = [159/247] x 100 = 64.3%

For equation 2, [(2x 63.5)/(2x63.5 + 44)] x 100 = [127/171] x100 = 74.3%

Environmental impact:

The electricity used in electrolysis involves burning fossil fuels in power stations, which in turn release greenhouse gases contributing to global warming and acid rain.

Alternative:

Bioleaching - Using bacteria to separate copper from copper sulphide. The solution produced can be filtered to obtain the copper. This process has a low set-up cost, does not need huge pen cast mines that scar the landscape, uses a lot less energy and does not produce sulphur dioxide gas. It can also be used on ores that would pollute the air when smelted.

TASK 8 - RESEARCH REPORT

HOW THE PROPERTIES OF MATERIALS USED IN MANUFACTURING A CAR ARE DETERMINED BY STRUCTURE AND BONDING

Identify a range of solid materials used in a manufacturing a car and explain why they are used and how the structure and bonding of these materials makes them suitable.

Materials used in manufacturing a car

Leather							Polyester (PET)
Cotton	Stainless Steel	Fe Iron	Al	Pd Palladium	O Oxygen	C Carbon	Polyurethane (PU)
Timber	Steel	Pb Lead	Cu Copper	Si Silicon	H Hydrogen	Xe Xenon	Poly-carbonate (PC)
Natural Rubber	Quartz	Cr Chromium	Zn Zinc	Mn Manganese	N Nitrogen	Ne Neon	Poly-propylene (PP)
Natural							Polymers

Elements, polymers and natural materials used in a car

LO8 - MB3 bullet 1

Al	Radiator, intake manifold, cylinder heads, engine block, bumpers, wheels, body panels 	Cotton	Car covers, car seat covers, seats 	Natural Rubber	Tyres, wiper blades, engine mounts, seals, hoses and belts 	Leather	Car seats, interiors 	Steel	Car body 
Stainless Steel	Car mufflers, decorative trims, exhaust silencers, catalytic converters 	Xe	Lightbulbs, headlights 	Polyester	Seat covers, carpets 	Poly-carbonate	Electrical insulator, decorative bezels, optical reflectors, laminated for bullet resistant windows 	Poly-propylene	Bumpers, car batteries 

Materials used in car components

Materials such as high-strength steel, aluminium, composites, and to a much lesser extent magnesium have increased over the past 30 years, while mild steels, regular steel and iron castings have seen a steady decline.

Typical applications for high-strength steels include front end structures, chassis components, rails and body panels.

Aluminium is used in cast parts such as engines blocks, transmission casings and wheels.
Density of Aluminium 2.70 g/cm^3
Density of car Steel 7.87 g/cm^3
So Aluminium is nearly x 3 lighter than Iron

Strength of aluminium 483 MPa
Strength of car steel 531 MPa
So both metals are similar in strength

LO8 - MB3 bullets 1, 3 and 4

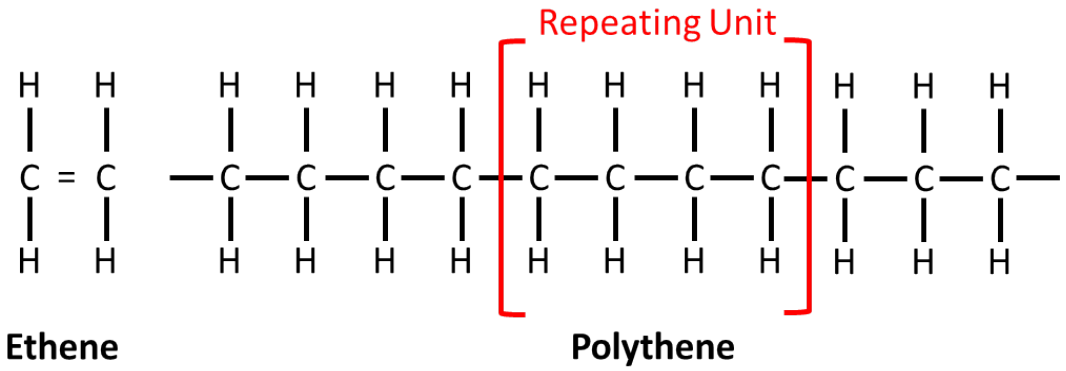
Aluminium could be used rather than car steel, however, costs associated with aluminium reduces its use.

Magnesium is the least dense metal used it is 30% less dense than aluminium and 75%l less dense than steel. Magnesium has its greatest use in thin-wall die castings. Instrument panels and cross car beams make up 40% of the total magnesium content in vehicles.

Polypropylene is used in bumpers and an alternative to metal bodywork. It gives great elastic and plastic deformation characteristics compared to metals - making it ideal for use in impact.

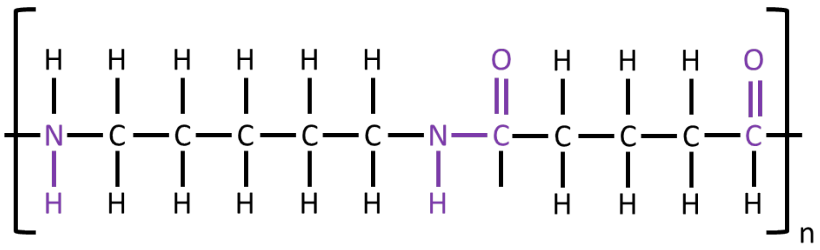
Composites currently represent 50 percent of the total vehicle by volume. There are many applications for composites today which are more for cosmetic purposes rather than structural performance. Glass fibre reinforced plastics make up the majority of applications available today but have limitations in terms of strength.
Glass fibre parts can be formed quickly and at low cost. It can be moulded into complex shapes and does not corrode. However it can only be used with hand built cars due to its moulding processes also it suffers badly in impact collisions.
Carbon fibre is 3 times stronger and more than 4 times lighter than steel
Properties depend on structure and bonding

Polymers
Polymers have molecules arranged into long strings of molecules. Carbon is the main element in the long chain, forming covalent bonds with other elements such hydrogen, as well as other molecules, hanging off the carbon backbone allowing the plastic to become a property of the polymer.



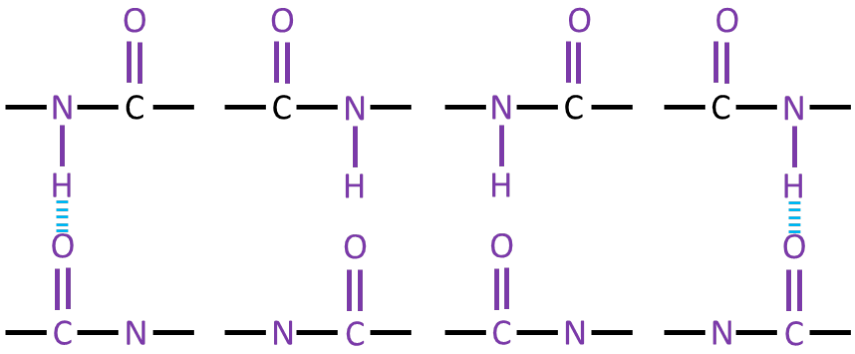
The polymer is strong in the direction of the chain but weak in the direction across the chain. This type of polymer is used for plastic bags as it is has strength to carry loads but weak when a force is applied across the chain which gives clingfilm some of its properties.

Nylon was designed to be a synthetic replacement for silk.



The repeat unit of nylon 6-6

Nylon has a number of repeating NH and CO groups, these groups lock parallel chains together.

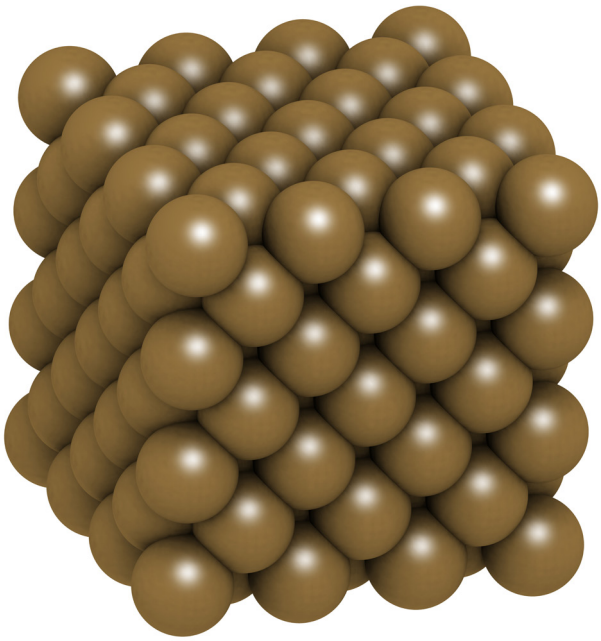


This locking of parallel chain makes nylon one of the strongest synthetic polymers with good ware and heat resistant properties, it can replace metal cogs in gear boxes.

Copper

Copper is a metal with a large structure made up of atoms closely packed.

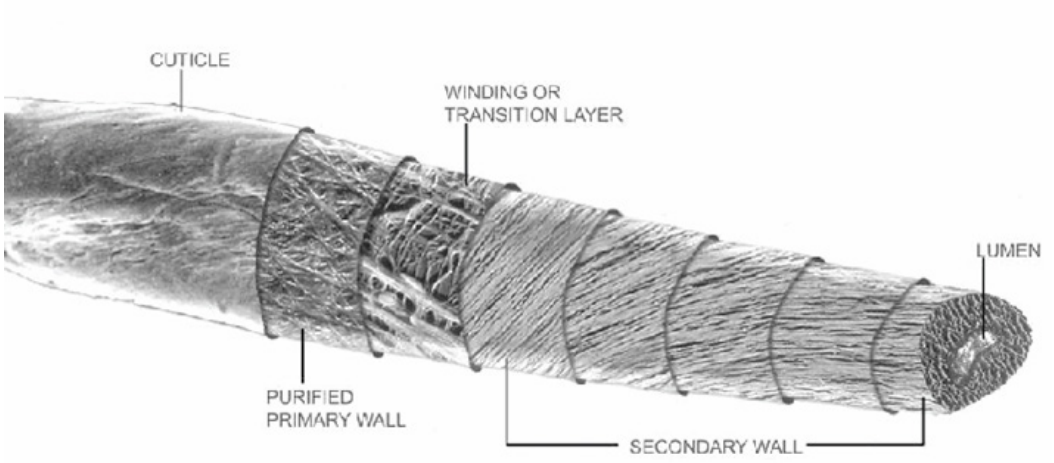
LO8 - MB3 bullet 2



The structure is held together by strong metallic bonds involving many atoms giving tensile strength in all directions to the metal. If enough force is applied atoms can slip over each other creating extension. Electrons from the outer shells of the atoms in the structure are free to move about. This movement of electrons allows conductivity, and copper is a very good conductor of electricity; it is used in a great deal wiring.

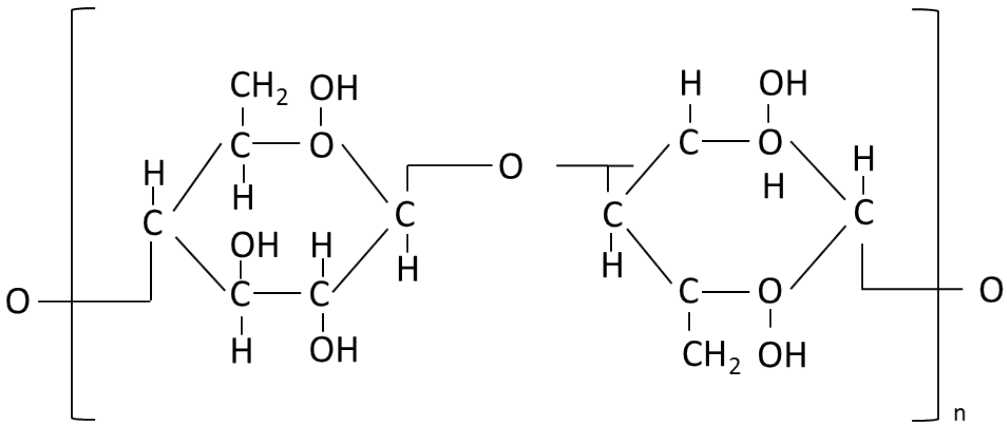
Cotton

Cotton is a natural fibre made from the cellulose of plants.



http://www.ars.usda.gov/main/site_main.htm?docid=4027&modecode=64-35-21-00&page=2

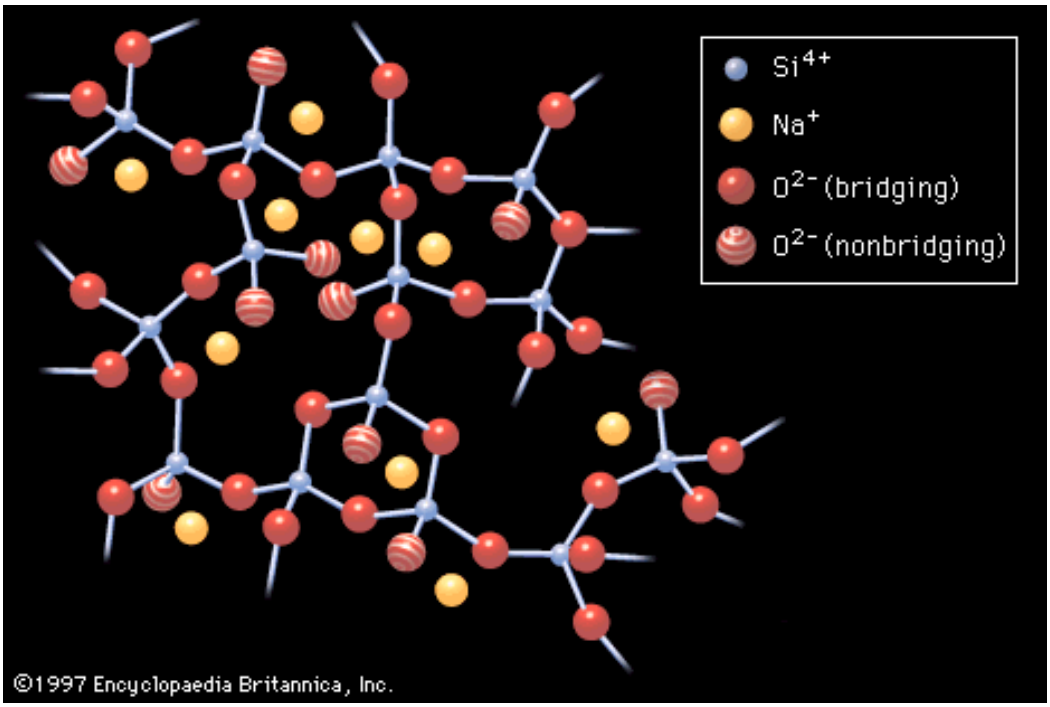
Cellulose is a polymer consisting of anhydroglucose units connected with oxygen.



The polymer is strong in one direction, as the atomic bonds are strong, allowing it to make thread so is strong and hard wearing but is also soft to touch and so is used in car seats.

Glass

Glass is a three-dimensional network of atoms forming a solid that lacks an ordered pattern, it has a random atomic arrangement.



The irregular arrangement of ions in a sodium silicate glass. Encyclopædia Britannica, Inc. http://www.britannica.com/EBchecked/topic/1426115/industrial-glass/76309/Atomic-structure

At ordinary temperatures, glass is a nearly perfect elastic solid, an excellent thermal and electrical insulator, and very resistant to many corrosive media. Its optical properties, however, vary greatly, depending on the light wavelengths employed. The more or less random order of atoms, and glass generally acts if it were a solution, is ultimately responsible for many of the properties that distinguish glass from other solids

Sources
http://www.allianz.com.au/car-insurance/infographic/materials-used-to-make-a-car-infographic/img/allianz-car-insurance-infographic-car-materials.jpg
http://www.drivingworkforcechange.org/reports/lightweightMaterials.pdf - car materials

TASK 9 - PRACTICAL PROCEDURES: MEASURING THE PROPERTIES OF MATERIALS

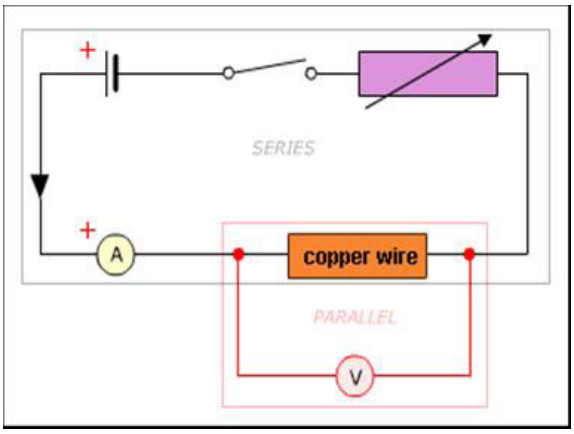
Carry out scientific tests on a range of materials used for a particular purpose to decide which is the best to use.

Would copper or aluminium be best to use as electrical cabling.

1. Investigating the resistivity of copper and aluminium

Aim: To investigate why copper is used to carry electricity in wires rather than aluminium

LO9 - MB3 bullet 1



Equipment:

- Vernier callipers – measure wire diameter
- Metre rule – measure wire length
- Pencil – to coil test wire
- Test wires copper & aluminium
- 4 mm wires with connectors – for circuit
- Power pack – low power for safety
- Variable resistor – alter voltage/current
- Ammeter – measure current to 0.01A
- Voltmeter – measure to 0.01V

Independent variable:
Potential difference across the copper wire (Volts V)
Dependent variable:
Current through the copper wire (Amps A)

Controlled variable
The cross sectional area and length of the wire is kept constant for each wire being tested; as if we increase the cross sectional area the resistance will decrease according to
Ohms law which states that:

$$\text{Resistance } (\Omega) = \frac{\text{potential difference (V)}}{\text{current (A)}}$$

R = resistance
V = potential difference (voltage)
I = current

- The wires were manufactured wires with constant diameters measured with vernier callipers.

To calculate resistivity I will use the calculation

$$\rho = \frac{R\,I}{A}$$

ρ = resistivity of copper
R= Resistance in ohms,
I = length in metres (m),
A= cross sectional area (m^2)

- If we increased the length of the wire the resistivity would increase. The wires all were 1 m long – measured with a meter ruler.

Method

- A 1 m length of copper wire was measured with a meter rule and diameter with venier callipers. The wire was coiled around a pencil to make it easier to handle (being careful the coils don't touch each other). The circuit was set up as above. Digital ammeters and voltmeters were used to record current and voltage. I altered the variable resistor and recorded the current and voltage at each setting.
- Repeat the reading 3 times and record the average results.

Results – average of 3 readings

copper wire

length = 1m
diameter = 0.71mm

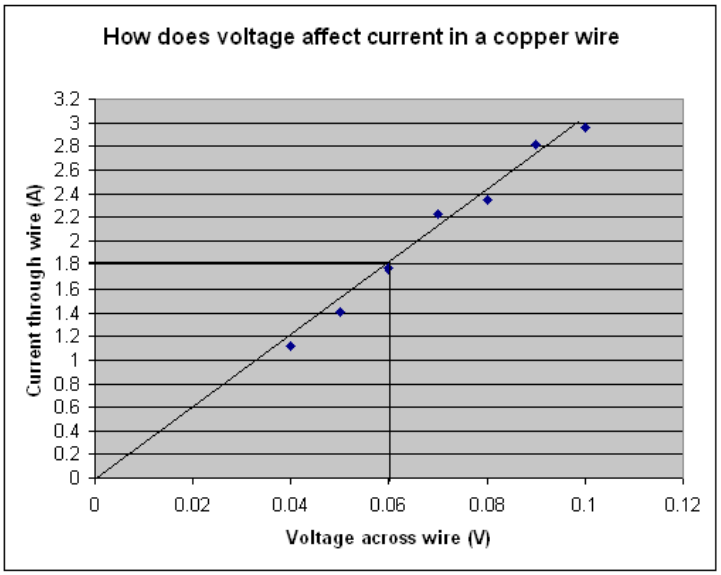
Voltage (V)	Current (A)
0.04	1.12
0.05	1.41
0.06	1.77
0.07	2.23
0.08	2.34
0.09	2.82
0.1	2.96

aluminium wire

length = 1m
diameter = 0.44mm

Voltage (V)	Current (A)
0.2	1.1
0.22	1.19
0.24	1.33
0.26	1.4
0.28	1.51
0.3	1.66
0.32	1.74
0.34	1.84
0.36	1.94
0.38	2.06
0.4	2.16

LO9 - MB3 bullets 2



$$\text{Resistance } (\Omega) = \frac{\text{potential difference (V)}}{\text{current (A)}}$$

$$= \frac{0.06}{1.8}$$

$$= 0.033\ \Omega$$

I have found out that my copper wire with a diameter of 0.90mm has a resistance of 0.033 Ω

Calculating resistivity

$$R = \frac{\rho l}{A}$$

$$\rho = \frac{R A}{l}$$

ρ = resistivity of copper
R= Resistance in ohms,
l = length in metres (m),
A= cross sectional area (m2)

LO8 - MB3 bullet 3

$$\rho = \frac{R A}{l}$$

$$\rho = \frac{R A}{l}$$

L= 1 meter

$A = \prod r^2$
r= radius
radius (m)= diameter/2000 = 0.000355
$A = \prod (0.000355m)^2$
A = 0.000000395919
$A = 3.95919 \times 10^{-7}$

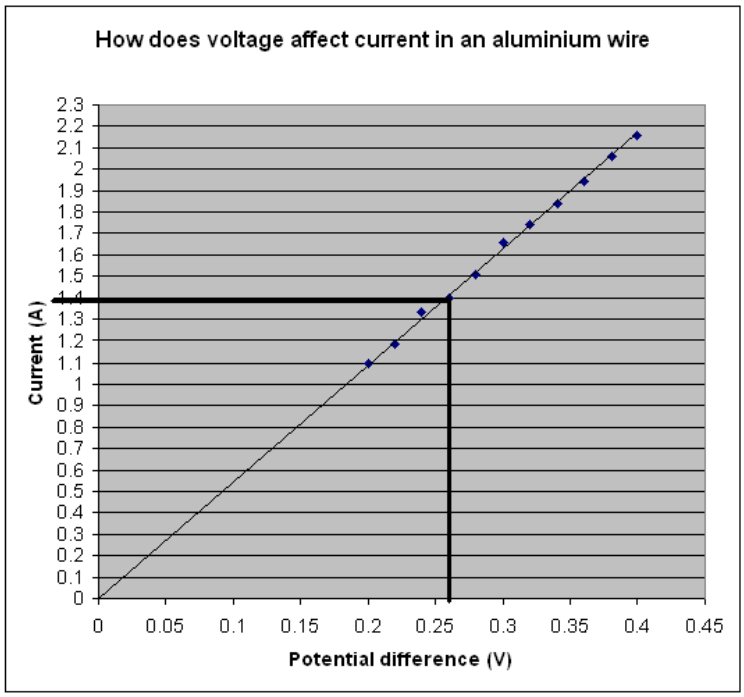
$$\rho = \frac{R A}{l}$$

$$\rho = 0.033 \times 3.95919 \times 10^{-7}$$

$$\rho = 0.0000000.13065\ \Omega m$$

$$\rho = 1.3065 \times 10^{-8}\ \Omega m$$

The resistivity of copper (ρ) $= 1.3065 \times 10^{-8}\ \Omega m$



$$\text{Resistance } (\Omega) = \frac{\text{potential difference (V)}}{\text{current (A)}}$$

$$= \frac{0.26}{1.40}$$

$$= 0.1857142\ \Omega$$

I have found out that my aluminium wire with a diameter of 0.44mm has a resistance of 0.186 Ω to 2dp

Calculating resistivity

$$R = \frac{\rho l}{A}$$

$$\rho = \frac{RA}{l}$$

ρ = resistivity of copper
R= Resistance in ohms,
l = length in metres (m),
A= cross sectional area (m^2)

$$\rho = \frac{R\,A}{l}$$

$$\rho = \frac{R\,A}{l}$$

L= 1 meter

$A = \prod r^2$
r= radius
radius (m)= diameter/2000 = 0.00022
$A = \prod (0.00022m)^2$
$A = 0.000000152053$
$A = 1.52053 \times 10^{-7}$

$$\rho = \frac{R\,A}{l}$$

$\rho =$ 0.1857142 x 1.52053 x 10^{-7}

$\rho =$ 2.82384 x 10^{-8} m

LO9 - MB3 bullet 3

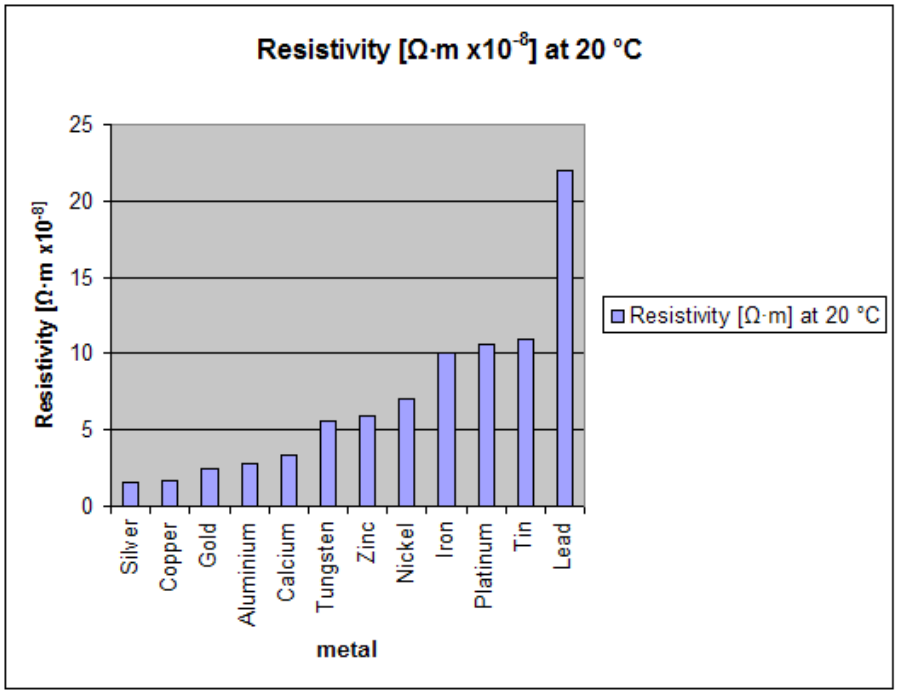
The resistivity of aluminium (ρ) = 2.82384 x 10^{-8} m

% error of resistivity

Material	**Resistivity [Ω•m] at 20 °C**
Copper	1.68
Aluminium	2.82

My results

The resistivity of copper (ρ)	=1. 3065 x 10^{-8} Ωm	
The resistivity of aluminium (ρ)	=2.82384 x 10^{-8} Ωm	
% error of copper experiment	= (1.68-1.31) x 100	= 22.02 % error 1.68
% error of aluminium experiment	= (2.82384-2.82) x 100	= 0.14 % error 2.82

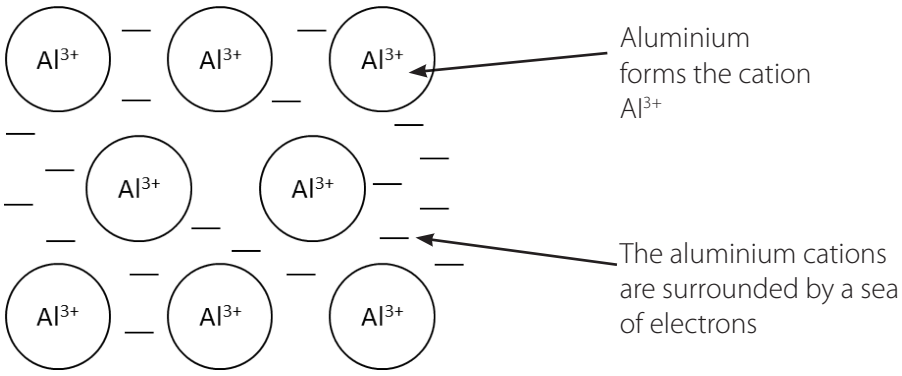


Conclusion

- My value for the resistivity of copper is 1.31 x 10^{-8} Ωm. The researched value is 1.68 x 10^{-8} Ωm. This means my copper experiment had a 20% error.
- My value for the resistivity of aluminium is 2.8234 x 10^{-8} Ωm. The researched value is 2.82 x 10^{-8} Ωm. This means my copper experiment had a 0.14% error.

$$\rho = \frac{R\,A}{l}$$

Aluminium and copper have quite a low resistivity as shown from the graph above. This is because the positively charged aluminium cations ($Al3^{+}$) lose 3 electrons to the sea of electrons around them, and the positively charged copper cations ($Cu2^{+}$) lose 2electrons to the sea of electrons around them. These free electrons are free to flow if a potential difference is applied across the metal. The electrons move from the negative to positive side of a battery through a metal wire, this flow of electrons is called a current. Aluminium and copper both let the electrons flow more easily than some metals such as iron as they have quite low electrical resistance. Silver has the lowest resistance, so lets electricity flow the easiest. However silver is too expensive to use in most wires. Copper has a lower resistivity than aluminium, and is cheaper, so is used in most the wires.



Evaluation

The voltmeters and ammeters only recorded to 2dp, which is not sensitive enough when calculating resistivity. If my reading for voltage was too low or current was too high my resistance would be too low, under - estimating resistivity e.g. copper resistivity was underestimated. If my length of copper wire was less than 1 m again this would cause an underestimate of resistivity. The meter ruler read to the nearest mm, but human error played a part in attaching and coiling the wire. The vernier callipes only measured to 2dp, which could also affect the accuracy of my results.

2. Investigating the density of copper and aluminium

Aim To investigate weight and why aluminium is used in body panels rather than copper.

Equipment
Electronic balance
Measuring cylinder
Vernier callipers
Metre rule

Method
A copper block was placed on the electronic balance and its mass recorded to 0.01g Water was added to a large measuring cylinder and its volume recorded. The measuring cylinder was tilted so we didn't get wet, and the copper block was added. The new volume of water was recorded.
The copper block will displace its volume of water, so the change in water level is the volume of copper.
I then repeated the experiment with aluminium.

Results

Copper

Mass of copper block=		1020.00g
Volume of water at start=		500.0cm^3
Volume of water and copper block =		630.0cm^3
Volume of copper=		630.0-500.0=130.0cm^3
Density g/cm^3 = $\frac{\text{mass}}{\text{volume}}$ =	$\frac{1020.00}{130.0}$ =	7.846g/cm^3

Aluminium

Mass of aluminium block=		97.18g
Volume of water at start=		400.0cm^3
Volume of water and copper block =		440.0cm^3
Volume of aluminium=		440.0-400.0 = 40cm^3
Density g/cm^3 = $\frac{\text{mass}}{\text{volume}}$ =	$\frac{97.18}{40.0}$ =	2.4295g/cm^3

The diameter of the measuring cylinder was large so the metal test blocks could be placed into it. So there will be an error when measuring the water level as a very small vertical increase in the surface of the water will give a large increase in the volume as an error in the vertical height reading will be cubed when calculating volume. The accuracy in reading the water level against the scale graduations of the measuring cylinder was not great perhaps up to 10 cm^3

Alternative method
The diameter of a copper wire was measured with vernier callipers. A 1 metre length was cut and measured with a meter ruler. The copper wire was coiled up and its mass found on weighing scales. I then repeated the experiment with aluminium.

Mass of copper wire =	3.53g
Measured diameter of wire =	0.72 mm =0.072cm
Volume of wire (cylinder)=	$\prod r^2 \times l$
r = radius of wire =	0.036cm

l = length of wire.= 100cm
Volume of wire (cylinder)= ll (0.036)^2 x l00
0.4071 cm^3

Density g/cm^3 = mass / Volume = 3.53 / 0.4071 = 8.671g/cm^3 Mass of aluminium wire = 0.45g
Measured diameter of wire = 0.457 mm =0.0457cm
Volume of wire (cylinder)= ∏ r^2 x l
r = radius of wire = 0.02285cm
l = length of wire.= 100cm
Volume of wire (cylinder)= ll (0.02285)^2 x l00
0.16403 cm^3

Density g/cm^3 = mass / Volume = 0.45 / 0.16403 = 2.743g/cm^3

Summary of results

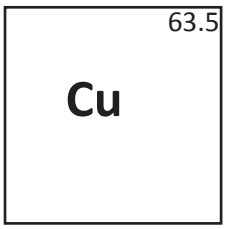
	Water displacement method	∏ r2 x l	Actual value
Density of Copper g/cm^3	7.846	8.671	8.96
Density of Aluminium g/ cm^3	2.4295	2.743	2.7

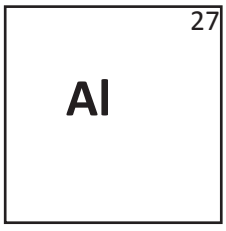
*http://physics.info/density/

- The percentage error for the copper water method was 100 x (8.96 -7.846)/8.96 = 12.4%
- The percentage error for the copper ∏r^2 x l method was 100 x (8.96 -8.671)/8.96 = 3.23%
- The percentage error for the aluminium water method was 100 x (2.7 -2.4295g)/2.7 = 10.0%
- The percentage error for the copper ∏ r^2 x l method was 100 x (2.7 -2.743)/2.7 = 1.59%

Conclusion

I have found that copper wire has a density of 8.671g/cm^3, and aluminium wire has a density of 2.743g/cm^3. The copper is 4 times as dense as the aluminium.





I would expect copper to have a higher density than aluminium as they are both metals so have similar properties, but copper has a higher mass number than aluminium. This means an atom of aluminium contains 13 protons and 14 neutrons in its nucleus, but an atom of copper has 29 protons and 34 or 35 neutrons.

So aluminium is much lighter than copper and if used in car panels or engine block would give a car a better (x4) power to weight ratio.

Evaluation

From this I can see that the most accurate method of measuring density is using the ll r^2 x l as the percentage errors for this were far smaller than the percentage errors for the water displacement method. I measured the diameter of the copper wire to be 0.72mm, the wire was attached in a reel that said 0.71mm, therefore I was 0.01mm underestimating on my vernier calliper reading leading to a mistake in accuracy.

Mass of copper wire =	3.53g
Measured diameter of wire =	0.71 mm =0.071cm
Volume of wire (cylinder)=	ll r^2 x l
r = radius of wire =	0.0355cm
l = length of wire.=	100cm
Volume of wire (cylinder)=	ll $(0.0355)^2$ x l00
	0.3959 cm^3

Density g/cm^3 = mass / Volume = 3.53 / 0.3959 = 8.916 g/cm^3

If I had measured the diameter of the copper wire accurately to 0.71 instead of 0.72, then my density of copper would be 8.96g/cm^3. This would make the percentage error
100 x (8.96 -8.916)/8.96 = 0.491%.

To improve measuring the mass of the wire I could either use more sensitive scales, or record the mass of a longer wire, for example if I recorded the mass of a 10m length of wire and divided it by 10 to get the average mass per meter this would have made my mass reading 10 times more sensitive than just the recording the mass of 1 meter of wire.

Overall conclusion for resistivity and density

I have found that copper wire has a density of 8.671g/cm^3, and aluminium wire has a density of 2.743g/cm^3. The copper is 4 times as dense as the aluminium.

My value for the resistivity of copper is 1.31 x 10^{-8} m. The researched value is 1.68 x 10^{-8} m. This means my copper experiment had a 20% error.
My value for the resistivity of aluminium is 2.8234 x 10^{-8} m. The researched value is 2.82 x 10^{-8} m. This means my copper experiment had a 0.14% error.

From the results above aluminium is about ¼ of the density of copper, but it has about twice the resistance. Aluminium is used to carry electricity in pylons as it is less dense than copper. A thicker wire will allow aluminium to have the same resistance as copper, but it will still weigh less than a thin copper wire. This means that aluminium will not weigh down the wires held by the pylons in the national grid. Although it is more expensive than copper, less pylons are needed to carry aluminium wires than copper wires, so it is cheaper to use aluminium to transport electricity across the country.

Copper is used in household appliances as its density is less of a problem here. It is cheaper than aluminium, and it has a lower resistivity. Copper is better at conducting electricity than aluminium as there are more free electrons to flow if a potential difference is applied across the metal. The electrons move from the negative to positive side of a battery through a metal wire, this flow of electrons is called a current. As copper lets electrons flow easily, it has a low resistance. Silver has a very low resistance, but it is too expensive to use in most wires, so copper is used instead. Copper has a low resistance too, but not as low as silver but copper is used in household wires as it is a lot cheaper than silver.

LO9 - MB3 bullet 3

Witness statement

LO9 - MB3 bullet 1

Assessor XXXXXXXX

Risk assessment carried
Learner was able to make an Independent selection of equipment to take measurements.
Equipment set was set up correctly without help.
Working area was well managed and clear of unwanted apparatus.
Measurements recorded as investigations proceeded.
Equipment dismantled safely

UNIT RECORDING SHEET

OCR
RECOGNISING ACHIEVEMENT

Science

OCR J815 Unit R071 Level 1/Level 2
Cambridge National Certificate in Science
Unit Recording Sheet

Please read the instructions printed at the end of this form. **One** of these sheets, suitably completed, should be attached to the assessed work of **each** candidate.

Unit Title	**How scientific ideas have an impact on our lives**	**Unit Code**	**R071**	**Session**	Jan / June	**Year**				
Centre Name	XXXXXXXXXX				**Centre Number**					
Candidate Name	L2 Distinction				**Candidate Number**					

Criteria			**Teacher Comments**	**Mark**
LO1: Be able to analyse personal and social choices related to energy supply			As a representative of the planning department the Learner has given: • Physical characteristics of the general location • Welsh Assembly's energy targets • A detailed description of different energy sources available for electrical generation and generation efficiency and described stations elsewhere in Wales. Quantitative analysis included in descriptions and after efficiency chart. General considerations when planning a power station.	**16**
MB1: 1 – 7 marks	**MB2: 8 – 13 marks**	**MB3: 14 – 18 marks**		
• **Lists** different energy sources available • **Basic** understanding of factors with influence the choice of energy supply • **Limited qualitative** analysis of efficiencies of energy transfer in electricity generation **[1 2 3 4 5 6 7]**	• **Limited** description of the different energy sources available for electricity generation • **Sound** understanding of some of the relevant factors which influence the choice of energy supply • **Limited quantitative** analysis of efficiencies of energy transfer in electricity generation **[8 9 10 11 12 13]**	• **Detailed** description of the different energy sources available for electricity generation • **Comprehensive** understanding of the relevant factors for the interest group which influence the choice of energy supply • **Complex quantitative** analysis of efficiencies of energy transfer in electricity generation and distribution • Quantitative data displayed in **appropriate** formats **[14 15 (16) 17 18]**		

<table>
<tr><th colspan="3">Criteria</th><th>Teacher Comments</th><th>Mark</th></tr>
<tr><td colspan="3">LO2: Understand the risks and benefits related to the applications of nuclear radiation</td><td rowspan="2">The learner has explained in detail what is radiation and have selected uses with risk and benefits in
• health care
• industry
• nuclear power

Quantitative evaluation of risk, calculations completed by student.

Justification of the use of nuclear radiation has been given.</td><td rowspan="2">9</td></tr>
<tr><td>MB1: 1 – 4 marks</td><td>MB2: 5 – 7 marks</td><td>MB3: 8 – 10 marks</td></tr>
<tr><td>• Identifies a relevant beneficial use (application) of nuclear ionising radiation
• Lists risks and benefits of the application
• Limited justification of application in terms of benefit outweighing risk

[1 2 3 4]</td><td>• Selection of relevant beneficial uses (applications) of nuclear ionising radiation
• Some detailed analysis of applications in terms of characteristics of radiation
• Some detailed analysis of risks and benefits of energy transfer to the individual or wider society, to include a qualitative evaluation of risk
• Relevant analysis of the ways risks from the applications are reduced

[5 6 7]</td><td>• Selection of a wide range of beneficial uses (applications) of nuclear ionising radiation to include healthcare, industrial and power generation examples
• Thorough analysis of applications in terms of characteristics of radiation
• Thorough analysis of the risks and benefits of energy transfer to the individual / wider society, to include a quantitative evaluation of risk
• Well justified realistic analysis of the ways risks from the applications are reduced

[8 (9) 10]</td></tr>
<tr><td colspan="3">LO3: Be able to measure energy transfers and calculate efficiencies</td><td rowspan="2">Independently selected and set up equipment.

Independently selected equations.

Calculations correct.

Supported by a witness statement.</td><td rowspan="2">10</td></tr>
<tr><td>MB1: 1 – 5 marks</td><td>MB2: 6 – 9 marks</td><td>MB3: 10 – 12 marks</td></tr>
<tr><td>• When provided with method and equipment, significant support needed to set it up and to take measurements
• Some measurements taken and recorded
• When provided with equations, data substituted correctly and some calculations carried out correctly

[1 2 3 4 5]</td><td>• Independent selection of equipment to take measurements; little support needed to set up correctly
• Measurements taken and recorded using an appropriate format
• Correct equations independently selected; support needed to manipulate equations where necessary
• Some calculations carried out correctly and one outcome derived correctly

[6 7 8 9]</td><td>• Independent selection of equipment to take measurements; equipment set up correctly
• Measurements taken and recorded to appropriate accuracy and precision using an appropriate format, including use of correct units
• Correct equations independently selected and manipulated where necessary
• Both outcomes calculated correctly to appropriate numbers of significant figures

[(10) 11 12]</td></tr>
</table>

<table>
<tr><th colspan="3">Criteria</th><th>Teacher Comments</th><th>Mark</th></tr>
<tr><td colspan="3">LO4: Understand how human health can be improved</td><td rowspan="3">Learner has produced a series of leaflets for patients which explain which factors affect health covering, in detail:
Fitness and exercise
Healthy eating information

Detailed explanation of the way in which factors affect health.</td><td rowspan="3">15</td></tr>
<tr><td>MB1: 1 – 7 marks</td><td>MB2: 8 – 13 marks</td><td>MB3: 14 – 18 marks</td></tr>
<tr><td>• Lists some of the ways in which factors affect health
• Some suggestions made for a health education programme
• Limited qualitative data displayed on the impact on health of some of the factors identified
• Some brief materials and resources produced

[1 2 3 4 5 6 7]</td><td>• Description of the way in which factors affect health of a client group of workers used to design a health education programme
• Some quantitative data displayed on the impact on health from the factors identified
• A range of relevant materials and resources produced

[8 9 10 11 12 13]</td><td>• Detailed explanation of the way in which factors affect health of a client group of workers used to design a detailed, relevant health education programme
• A range of relevant quantitative data on the impact on health of the factors identified and displayed accurately in appropriate formats
• A wide range of relevant and imaginative materials and resources
[14 (15) 16 17 18]</td></tr>
<tr><td colspan="3">LO5: Understand the risks and benefits of medical treatments</td><td rowspan="3">Information produced covers: stem cell transplants, gene therapy, clinical trials explained.

Qualitative analysis of stem cell transplants.

No quantitative analysis.</td><td rowspan="3">8</td></tr>
<tr><td>MB1: 1 – 4 marks</td><td>MB2: 5 – 7 marks</td><td>MB3: 8 – 10 marks</td></tr>
<tr><td>• Lists risks and benefits of a medical treatment
• Basic understanding of the reasons for the testing of medical treatments
• Some materials produced

[1 2 3 4]</td><td>• Simple qualitative analysis of the risks and benefits of a medical treatment
• Sound understanding of the reasons for the testing of medical treatments
• Materials are relevant to the needs of the client group

[5 6 7]</td><td>• Quantitative and qualitative analysis relevant for the client group of the risks and benefits of a medical treatment
• Thorough understanding of the reasons for the testing of medical treatments
• Materials are concise and sensitive to the needs of the client group
[(8) 9 10]</td></tr>
</table>

<table>
<tr><th colspan="3">Criteria</th><th>Teacher Comments</th><th>Mark</th></tr>
<tr><td colspan="3">LO6: Be able to measure the environmental effects of human activity</td><td rowspan="2">Independently selects and sets up equipment.

A range of data collected successfully to an appropriate accuracy and precision using an appropriate format, including use of correct units.</td><td rowspan="2">10</td></tr>
<tr><td>MB1: 1 – 5 marks</td><td>MB2: 6 – 9 marks</td><td>MB3: 10 – 12 marks</td></tr>
<tr><td>• When provided with method and equipment, some support needed to set up equipment and carry out the testing
• Some data collected and recorded
• Some simple visualisation of data

[1 2 3 4 5]</td><td>• Appropriate choice of measures of effects of human activity on a local environment
• Independent selection of appropriate sampling and testing methods; little support needed to select and set up the equipment needed to carry out testing
• A range of relevant data collected and recorded using an appropriate format
• Some relevant visualisation of data and calculation of simple measures such as frequency

[6 7 8 9]</td><td>• Justification of choice of measures of the effects of human activity on a local environment
• Independent selection of appropriate sampling and testing methods and the equipment needed to carry out testing; equipment set up correctly
• A range of data collected and recorded to appropriate accuracy and precision using an appropriate format, including use of correct units
• Relevant and accurate visualisation of data and correct calculation of complex measures such as indices of biodiversity

[10 11 12]</td></tr>
<tr><td colspan="3">LO7: Understand how materials we use are made from natural resources</td><td rowspan="2">Independent selection of a range of different types of materials were made.

Correctly balanced equations used and calculations correctly processed.

Thorough analysis of the environmental impact of each material included.

Alternative processes given.</td><td rowspan="2">16</td></tr>
<tr><td>MB1: 1 – 7 marks</td><td>MB2: 8 – 13 marks</td><td>MB3: 14 – 18 marks</td></tr>
<tr><td>• Lists some different materials used for a construction project
• Basic knowledge of chemical processes, including some use of word equations
• Limited qualitative analysis of the impact on the environment of the production of materials from natural resources
• Some alternative production methods or materials suggested which would have a lower environmental impact

[1 2 3 4 5 6 7]</td><td>• Some support needed for selection of a range of different materials linked to different parts of a construction project
• Sound knowledge of chemical processes, including some use of symbol equations and chemical nomenclature
• Analysis of the impact on the environment of the production of materials from natural resources, to include some data on production quantities, yields or energy budgets
• Some evaluation of alternative production methods or materials which would have a lower environmental impact

[8 9 10 11 12 13]</td><td>• Independent selection of a range of different types of materials linked to different parts of a construction project, chosen for their properties
• Detailed knowledge of chemical processes, including correct and appropriate use of balanced symbol equations and chemical nomenclature
• Thorough analysis of the impact on the environment of the production of materials from natural resources, to include relevant data on production quantities, yields and energy budgets
• Well justified realistic evaluation of alternative production methods or materials which would have a lower environmental impact

[14 15 16 17 18]</td></tr>
</table>

<table>
<tr><th colspan="3">Criteria</th><th>Teacher Comments</th><th>Mark</th></tr>
<tr><td colspan="3">LO8: Understand how the properties of materials we use are determined by structure and bonding</td><td rowspan="2">Independent selection of an appropriate range of materials in a car and reasons given.

Quantitative data included in justifications.

Quantitative data displayed appropriately.</td><td rowspan="2">8</td></tr>
<tr><td>MB1: 1 – 4 marks</td><td>MB2: 5 – 7 marks</td><td>MB3: 8 – 10 marks</td></tr>
<tr><td>• Significant support needed to identify some different types of materials used in a complex product; some simple reasons for their use suggested
• Limited description of the properties of selected materials and their structures
• Qualitative information on the properties of materials and performance of components
[1 2 3 4]</td><td>• Limited support needed for selection of a range of different materials used in a complex product; sound understanding of the reasons why these materials are used, with some links to their properties
• Limited explanation of how the properties of these materials depend upon structure and bonding
• Some quantitative data displayed on the properties of materials and performance of components
[5 6 7]</td><td>• Independent selection of an appropriate range of different types of materials used in a complex product; thorough understanding of the reasons why these materials are used, clearly related to their properties
• Detailed explanation of how the properties of these materials depend upon structure and bonding
• Independent selection of relevant quantitative data on the properties of materials and performance of components used to support explanations
• Quantitative data displayed in appropriate formats, including use of correct units
[(8) 9 10]</td></tr>
<tr><td colspan="3">LO9: Be able to measure the properties of materials to recommend appropriate uses</td><td rowspan="2">Independent selection of equipment to take measurements; equipment set up correctly for both strength and electrical resistance.
Equations and processing carried out independently.</td><td rowspan="2">10</td></tr>
<tr><td>MB1: 1 – 5 marks</td><td>MB2: 6 – 9 marks</td><td>MB3: 10 – 12 marks</td></tr>
<tr><td>• When provided with method and equipment, some support needed to set up and take measurements.
• Some measurements taken and recorded
• When provided with the mathematical techniques to use, some data processed correctly
[1 2 3 4 5]</td><td>• Independent selection of equipment to take measurements; little support needed to set up correctly
• Measurements taken and recorded using an appropriate format
• Support needed to process data using appropriate mathematical techniques
[6 7 8 9]</td><td>• Independent selection of equipment to take measurements; equipment set up correctly.
• Measurements taken and recorded to appropriate accuracy and precision using an appropriate format, including use of correct units
• Data processed accurately using appropriate mathematical techniques to identify trends or patterns
[(10) 11 12]</td></tr>
<tr><td colspan="4">Total/120</td><td>102</td></tr>
<tr><td colspan="5">If this is a re-sit, please tick ☐ Session and Year of previous submission Jan / June 2 0 ☐ ☐ Please tick to indicate this work has been standardised internally ☐</td></tr>
</table>

MODERATORS COMMENTS

<table>
<tr><td colspan="3">R071: How scientific ideas have an impact on our lives L2 Distinction</td></tr>
<tr><td colspan="3">LO1: Be able to analyse personal and social choices related to energy supply</td></tr>
<tr><td>MB1: 1 – 7 marks</td><td>MB2: 8 – 13 marks</td><td>MB3: 14 – 18 marks</td></tr>
<tr><td>• Lists different energy sources available
• Basic understanding of factors with influence the choice of energy supply
• Limited qualitative analysis of efficiencies of energy transfer in electricity generation</td><td>• Limited description of the different energy sources available for electricity generation
• Sound understanding of some of the relevant factors which influence the choice of energy supply
• Limited quantitative analysis of efficiencies of energy transfer in electricity generation</td><td>• Detailed description of the different energy sources available for electricity generation
• Comprehensive understanding of the relevant factors for the interest group which influence the choice of energy supply
• Complex quantitative analysis of efficiencies of energy transfer in electricity generation and distribution
• Quantitative data displayed in appropriate formats</td></tr>
<tr><td></td><td></td><td>As a representative of the Welsh planning department the learner has been able to give a wide range of information that can be used by a number of other interest groups also. There is a detailed description of different energy sources for Wales based on its geographical characteristics.

There is a comprehensive understanding of the relevant factors for the named interest groups giving the efficiencies of energy transfers and generation supported by quantitative data.

There is limited evidence of complex quantitative analysis, despite including sources which could be used.

The candidate has used a wide range of relevant material which has been referenced.

Encourage learners to draw information together concisely.
[16 marks]</td></tr>
</table>

LO2: Understand the risks and benefits related to the applications of nuclear radiation		
MB1: 1 – 4 marks	**MB2: 5 – 7 marks**	**MB3: 8 – 10 marks**
• Identifies a relevant beneficial use (application) of nuclear ionising radiation • Lists risks and benefits of the application • Limited justification of application in terms of benefit outweighing risk	• Selection of relevant beneficial uses (applications) of nuclear ionising radiation • Some detailed analysis of applications in terms of characteristics of radiation • Some detailed analysis of risks and benefits of energy transfer to the individual or wider society, to include a qualitative evaluation of risk • Relevant analysis of the ways risks from the applications are reduced	• Selection of a wide range of beneficial uses (applications) of nuclear ionising radiation to include healthcare, industrial and power generation examples • Thorough analysis of applications in terms of characteristics of radiation • Thorough analysis of the risks and benefits of energy transfer to the individual / wider society, to include a quantitative evaluation of risk • Well justified realistic analysis of the ways risks from the applications are reduced
		Characteristics of both ionising and non-ionising radiation have been recorded in some detail with half life explained with its potential dangers. A range of healthcare, industrial and power generation applications are described in detail linking to different types of radiation, with detailed analysis of risk with some quantitative data used explaining how risks are reduced. Quantitative data calculated and evaluated by candidate. [9 marks]

LO3: Be able to measure energy transfers and calculate efficiencies		
MB1: 1 – 5 marks	**MB2: 6 – 9 marks**	**MB3: 10 – 12 marks**
• When provided with method and equipment, significant support needed to set it up and to take measurements • Some measurements taken and recorded • When provided with equations, data substituted correctly and some calculations carried out correctly	• Independent selection of equipment to take measurements; little support needed to set up correctly • Measurements taken and recorded using an appropriate format • Correct equations independently selected; support needed to manipulate equations where necessary • Some calculations carried out correctly and one outcome derived correctly	• Independent selection of equipment to take measurements; equipment set up correctly • Measurements taken and recorded to appropriate accuracy and precision using an appropriate format, including use of correct units • Correct equations independently selected and manipulated where necessary • Both outcomes calculated correctly to appropriate numbers of significant figures
		Witness statement supports that there was independent selection of equipment. Calculations were independently selected and correctly used with appropriate significant figures. Measurements have been repeated with them being within a consistent range. Measurements are recorded appropriately. There is an understanding of the energy transfers and loss of energy and how improvements to the procedure could be made. [10 marks]

LO4: Understand how human health can be improved		
MB1: 1 – 7 marks	**MB2: 8 – 13 marks**	**MB3: 14 – 18 marks**
• **Lists some** of the ways in which factors affect health • **Some** suggestions made for a health education programme • **Limited** qualitative data displayed on the impact on health of some of the factors identified • **Some** brief materials and resources produced	• **Description** of the way in which factors affect health of a client group of workers used to design a health education programme • **Some** quantitative data displayed on the impact on health from the factors identified • A **range** of **relevant** materials and resources produced	• **Detailed** explanation of the way in which factors affect health of a client group of workers used to design a **detailed, relevant** health education programme • A **range of relevant** quantitative data on the impact on health of the factors identified and displayed accurately in appropriate formats • A **wide range** of relevant and **imaginative** materials and resources
		Relevant patient material was produced supported by "eye catching" images. Awareness information of the impact on health of certain environmental factors was explained with both qualitative and quantitative data. Diet both in terms of food types and calories was explained in detail with food calorific values listed and an image of the eatwell plate. Practical tips on diet were also given. An exercise regime was described in some detail with an assessment questionnaire. [15 marks]

LO5: Understand the risks and benefits of medical treatments		
MB1: 1 – 4 marks	**MB2: 5 – 7 marks**	**MB3: 8 – 10 marks**
• Lists risks and benefits of a medical treatment • Basic understanding of the reasons for the testing of medical treatments • Some materials produced	• Simple qualitative analysis of the risks and benefits of a medical treatment • Sound understanding of the reasons for the testing of medical treatments • Materials are relevant to the needs of the client group	• Quantitative and qualitative analysis relevant for the client group of the risks and benefits of a medical treatment • Thorough understanding of the reasons for the testing of medical treatments • Materials are concise and sensitive to the needs of the client group
		The learner covered a range of treatments with transplant surgery in some detail with both quantitative and qualitative data. The testing medical treatments was explained with an example of gene therapy trial to treat hemophilia B. The LO was supported by relevant images/diagrams throughout. However the task was to target patients with the information, the information could have been presented in a more "patient friendly" manner (concentrating on one treatment may have produced more patient friendly material). [8 marks]

LO6: Be able to measure the environmental effects of human activity		
MB1: 1 – 5 marks	**MB2: 6 – 9 marks**	**MB3: 10 – 12 marks**
• When provided with method and equipment, some support needed to set up equipment and carry out the testing • Some data collected and recorded • Some simple visualisation of data	• Appropriate choice of measures of effects of human activity on a local environment • Independent selection of appropriate sampling and testing methods; little support needed to select and set up the equipment needed to carry out testing • A range of relevant data collected and recorded using an appropriate format • Some relevant visualisation of data and calculation of simple measures such as frequency	• Justification of choice of measures of the effects of human activity on a local environment • Independent selection of appropriate sampling and testing methods and the equipment needed to carry out testing; equipment set up correctly • A range of data collected and recorded to appropriate accuracy and precision using an appropriate format, including use of correct units • Relevant and accurate visualisation of data and correct calculation of complex measures such as indices of biodiversity
		A witness statement records that the learner independently selected and set up their equipment. Relevant data was collected with an understanding of accuracy, reliability and error shown. The activity chosen lacked the opportunity to obtain greatly varying results which restricted the learner to display a great deal of knowledge and understanding. Also there was little justification for the choice of measures and their effect. However, the practical did just meet the lower end of MB3 which is supported by a witness statement. [10 marks]

LO7: Understand how materials we use are made from natural resources		
MB1: 1 – 7 marks	**MB2: 8 – 13 marks**	**MB3: 14 – 18 marks**
• **Lists some** different materials used for a construction project • **Basic** knowledge of chemical processes, including **some** use of word equations • **Limited qualitative** analysis of the impact on the environment of the production of materials from natural resources • **Some** alternative production methods or materials suggested which would have a lower environmental impact	• **Some support** needed for selection of a **range** of different materials linked to different parts of a construction project • **Sound** knowledge of chemical processes, including some use of symbol equations and chemical nomenclature • Analysis of the impact on the environment of the production of materials from natural resources, to include **some** data on production quantities, yields or energy budgets • **Some** evaluation of alternative production methods or materials which would have a lower environmental impact	• **Independent** selection of a range of different types of materials linked to different parts of a construction project, chosen for their properties • **Detailed** knowledge of chemical processes, including correct and appropriate use of balanced symbol equations and chemical nomenclature • **Thorough** analysis of the impact on the environment of the production of materials from natural resources, to include **relevant** data on production quantities, yields and energy budgets • Well **justified realistic** evaluation of alternative production methods or materials which would have a lower environmental impact
		The teacher on the record sheet stated there was an Independent selection of a range of different types of materials linked to different parts of a house chosen for their properties. Knowledge of chemical processes, including correct and appropriate use of balanced symbol equations and chemical nomenclature with an analysis yields was displayed. Analysis of impact of production on the environment made with some evaluation of alternative production methods. [16 marks]

LO8: Understand how the properties of materials we use are determined by structure and bonding		
MB1: 1 – 4 marks	**MB2: 5 – 7 marks**	**MB3: 8 – 10 marks**
• **Significant support** needed to identify some different types of materials used in a **complex** product; **some simple** reasons for their use suggested • **Limited description** of the properties of selected materials and their structures • Qualitative information on the properties of materials and performance of components	• **Limited support** needed for selection of a **range** of different materials used in a **complex** product; **sound** understanding of the reasons why these materials are used, with **some** links to their properties • **Limited explanation** of how the properties of these materials depend upon structure and bonding • **Some quantitative** data displayed on the properties of materials and performance of components	• **Independent** selection of an **appropriate range** of different types of materials used in a **complex** product; **thorough** understanding of the reasons why these materials are used, **clearly** related to their properties • **Detailed** explanation of how the properties of these materials depend upon structure and bonding • **Independent** selection of **relevant** quantitative data on the properties of materials and performance of components used to support explanations • Quantitative data displayed in **appropriate** formats, including use of correct units
		The teacher on the record sheet stated there was an independent selection of an appropriate range of different types of materials used in a car was made. Thorough understanding of the reasons why these materials are used, clearly related to their properties. An explanation of how the properties of these materials depend upon structure and bonding was given supported by images. Outcome of task within MB3 if more quantitative data had been given then it would have moved the mark upwards. [8 marks]

<table>
<tr><th colspan="3">LO9: Be able to measure the properties of materials to recommend appropriate uses</th></tr>
<tr><th>MB1: 1 – 5 marks</th><th>MB2: 6 – 9 marks</th><th>MB3: 10 – 12 marks</th></tr>
<tr><td>• When provided with method and equipment, some support needed to set up and take measurements.
• Some measurements taken and recorded
• When provided with the mathematical techniques to use, some data processed correctly</td><td>• Independent selection of equipment to take measurements; little support needed to set up correctly
• Measurements taken and recorded using an appropriate format
• Support needed to process data using appropriate mathematical techniques</td><td>• Independent selection of equipment to take measurements; equipment set up correctly.
• Measurements taken and recorded to appropriate accuracy and precision using an appropriate format, including use of correct units
• Data processed accurately using appropriate mathematical techniques to identify trends or patterns</td></tr>
<tr><td></td><td></td><td>Independent selection of equipment to take measurements; equipment setup correctly for both strength and electrical resistance. Simple witness statement supports this.

Measurements taken and recorded to appropriate accuracy and precision using an appropriate format, including use of correct units.

Data processed accurately using appropriate mathematical techniques to identify trends or patterns with graphs However, the found values had large errors when compared to given values.

Conclusions and evaluations are valid.
[10 marks]</td></tr>
<tr><td colspan="3">Overall: Learner in middle range of MB3</td></tr>
<tr><td colspan="3">LO1 16/18 LO2 9/10 LO3 10/12 LO4 15/18 LO5 8/10 LO6 10/12 LO7 16/18 LO8 8/10 LO9 10/12 Total 102/120</td></tr>
</table>

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