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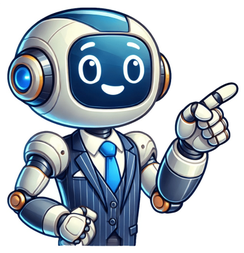

Get Revising Created by: NaomiCreated on: 21-01-13 19:56 View mindmap Uses of radioisotopesBackground radiationBackground radiation is due to:Radioactive substances present in rocks (especially granite) and soil Cosmic rays from space Man-made sources including radioactive waste from industry and hospitals Most background radiation is from natural sources, but some is from human activity Smoke detectorsA smoke detector contains an isotope which emits aplha particlesAlpha is used because it is very ionising and won't get out of the smoke alarm Without smoke, the alpha particles will ionise the air which creates a tiny circuit that can be detected by the circuit in the smoke alarmWith smoke, the alpha particles are partially blocked, so there is less ionisation of the air. The resulting change in current is detected and the alarm sounds The isotope needs to have a long half life so it can last a long time without needing to be replaced Dating rocksSome rock types such as granite contain traces of uranium, a radioactive materialThe uranium isotopes present in the rocks go through a series of decays, eventually forming a stable isotope of lead By comparing the amounts of uranium and lead present in a rock sample, its approximate age can be foundThe proportion of lead increases as time increasesAfter one half life half of it is unchanged, and the other half has changed into leadAfter 2 half lives 1/4 of the uranium is left and 3/4 has changed into lead See all Physics resources »See all Radioactivity resources » A tracer is a radioactive isotope that can be used to track the movement of substances, like blood, around the bodyGamma emitters are usually used for this purposeGamma rays are highly penetrating and so will be able to pass through the body and be detected outside the bodyThis allows an internal image of the body to be createdIodine-131 is an example of a radioactive tracerSince gamma rays are less ionising than some other forms of radiation, the harm caused to the patient is also minimisedAs well as choosing a gamma emitter:The amount of isotope used is kept to a minimum to reduce people's exposure to radiationIsotopes are chosen that have short half-lives of around a few hours: Long enough to carry out the procedure, but not so long that they cause long term harmRadiotherapyRadiotherapy is the name given to the treatment of cancer using radiationAlthough radiation can cause cancer, it is also highly effective at treating itRadiation can kill living cellsSome cells, such as bacteria and cancer cells, are more susceptible to radiation than othersDuring external radiotherapy, beams of gamma rays are directed at the cancerous tumourThe machine rotates to target the tumour from different anglesThis minimises the exposure of healthy tissue to the gamma rays and minimises damage to healthy cellsDuring radiotherapy, the beams are moved around to minimise harm to healthy tissue whilst still being aimed at the tumourDuring internal radiotherapy, small pellets of radioactive materials can also be inserted into a tumour exposing it directly to radiationSterilising Medical EquipmentGamma radiation is widely used to sterilise medical equipmentGamma is most suited to this because:It is the most penetrating out of all the types of radiationIt is penetrating enough to irradiate all sides of the instrumentsInstruments can be sterilised without removing the packagingA new medical tracer is required for investigating the absorption of a particular substance found in blood around the body.Which of the different isotopes in the table would be most suitable?Answer: CA suitable medical tracer must:Be able to penetrate out of the bodyHave a long enough half-life to move around the body before it decays awayHave a short enough half-life that it won't remain in the body at dangerous levels for too longThe answer is not A because alpha radiation cannot penetrate out of the bodyThe answer is not B because the half-life is too shortThe answer is not D because the half-life is too longThe use of radiation in medicine carries riskRadiation can:Kill or damage living cellsCause cancerCause mutationsAs a result, its use needs to be kept to a minimumHowever, the benefits of using radiation in medicine can out weigh the potential risksThe risks posed by the radiation are smaller than the risks associated with leaving the condition untreatedFor example, if a person has a cancerous tumour that is likely to kill them, then it is less of a risk to use radiotherapy than to leave the tumourYou may be given data and asked to evaluate the risk of nuclear radiation in a particular example. Remember to compare the potential dangers with the benefits.Did this page help you? Radioactive decay and half-life - CCEA BBC Science BBC Earth School Science Revision Buddies Subscription ← Back to Library Radiotherapy: High-energy radiation is used to destroy cancer cells in the body. The radiation damages the DNA of the cells, preventing them from dividing and growing. Diagnostic Imaging: Radioisotopes can be used to visualise different processes in the body. For example, Technetium-99m is commonly used in medical imaging to track the flow of blood or to look at the function of organs. Sterilisation: Radioactivity can be used to sterilise medical equipment by killing bacteria and other microorganisms. This is commonly done using gamma rays from Cobalt-60. Dating Fossils and Rock: Radiocarbon dating uses the half-life of Carbon-14 to estimate the age of artefacts and geological samples. Tracing Substances: Radioisotopes can be used to track the movement of substances within an ecosystem or the human body. Improving Crop Yields: Irradiation can cause mutations in plant seeds, which can lead to new plant varieties with improved yield and drought resistance. Thickness Measurement: Beta radiation can be used to measure the thickness of materials in industries. As beta particles are absorbed by the material, a decrease in detected radiation indicates an increase in thickness. Nuclear Power: Nuclear fission in controlled reactors generates heat, which is used to produce electricity in nuclear power plants. Smoke Detectors: Alpha radiation from Americium-241 is used in smoke detectors. Smoke particles decrease the amount of alpha radiation detected, triggering the alarm. While there are many beneficial applications of radioactivity, it is important to remember the safety aspects. All uses of radioactivity must abide by guidelines to prevent unnecessary exposure and minimise potential health risks. Always remember that while radioactivity can provide numerous societal benefits, it should always be handled with caution due to its potential dangers. Exam code: 0625 & 0972Written by: AshikaReviewed by: Caroline CarrollUpdated on 8 April 2025Did this video help you?Extended tier onlyThe type of radiation emitted and the half-life of an isotope determine which isotope is used for the following applications:household fire (smoke) alarmsirradiating food to kill bacteriasterilisation of equipment using gamma raysmeasuring and controlling thicknesses of materials with the choice of radiations used linked to penetration and absorptiondiagnosis and treatment of cancer using gamma raysHousehold fire alarms are a use of alpha radiationAlpha particles are used in smoke detectorsThe alpha radiation ionises the air within the detector, creating a currentThe alpha emitter is blocked when smoke enters the detectorThe alarm is triggered by a microchip when the sensor no longer detects the alpha particlesAn isotope of alpha radiation with a long half-life is used for smoke detectors so they don't need replacing oftenUses of alpha radiation: household fire alarmsIn the diagram at the bottom, alpha particles are stopped by the smoke, preventing the flow of current and triggering the alarmSterilisation of equipment using gamma raysGamma radiation is widely used to sterilise medical equipmentGamma is most suited to this because:It is the most penetrating out of all the types of radiationIt is penetrating enough to irradiate all sides of the instrumentsInstruments can be sterilised without removing the packagingThe source of gamma radiation used for sterilisation has a half-life of around 5 yearsThis means the sterilisation equipment does not need to be replaced oftenIrradiating food to kill bacteria using gamma raysFood can be irradiated to kill any microorganisms that are present on itThis makes the food last longer and reduces the risk of food-borne infectionsUses of gamma radiation: killing bacteriaFood that has been irradiated carries this symbol, called the Radura. Different countries allow different foods to be irradiatedMeasuring the thickness of materials using different radiationBeta radiation is most commonly used to measure the thickness of materials because it will be partially absorbed by most materialsAlpha particles are used for thinner materials because they have a lower penetrating power and are absorbed by a thin sheet of aluminium Gamma radiation can be used for very thick materials because they have a higher penetrating power and are mostly absorbed by thick pieces of lead.A material moves across a radiation sourceThe particles that penetrate it are monitored using a detector aboveThe thickness of the material is monitoredIf the material gets thicker, more particles will be absorbed by the material, meaning that less will get through and be detected by the detectorIf the material gets thinner the opposite happensThe machine makes adjustments to keep the thickness of the material constantRadiation used to measure the thickness of materials has a half-life of many years (10-20 years) so that the count rate remains relatively constant each dayUses of radiation: monitoring material thicknessBeta particles can be used to measure the thickness of thin materials such as paper, cardboard or aluminium foilStudents often get confused about whether beta particles can pass though aluminium foil. Beta particles can be stopped by aluminium foil if it is thick enough (a few mm thick); if the foil is thin enough, they can pass through. This is the basis of using beta radiation to measure the thickness of aluminium foil (a common exam question!). The thicker the foil, the fewer beta particles pass through and are measured by a detector on the other side of the foil. Radiotherapy is the name given to the treatment of cancer using radiationChemotherapy is treatment using chemicalsRadiation can kill living cellsSome cells, such as bacteria and cancer cells, are more susceptible to radiation than othersBeams of gamma rays are directed at the cancerous tumourGamma rays are used because they can penetrate the body, reaching the tumourThe beams are moved around to minimise harm to healthy tissue whilst still being aimed at the tumourGamma radiation used in radiotherapy has a half-life of around 5 yearsThis means that it does not need to be replaced often within the machine that uses itRadiation therapy to remove a tumourA tracer is a radioactive isotope that can be used to track the movement of substances, like blood, around the bodyA PET scan can detect the emissions from a tracer to diagnose cancer and determine the location of a tumourThe half-life of a tracer is several hoursThis provides time for a scan to be conducted and then the radiation to leave the body quicklyUse the diagram to explain why alpha radiation is used in smoke detectors, and beta or gamma radiation is not.Answer:Consider the different properties of alpha, beta and gamma:Alpha is the most weakly penetrating and strongest ioniserBeta and gamma have stronger penetrating power and weaker ionising powerIf beta or gamma radiation were used in this situation then they would pass straight through the smoke and the alarm would not go offTherefore, since alpha is absorbed by smoke, and beta and gamma are not, this makes it most suitable for use in a smoke detectorIf you are presented with an unfamiliar situation in your exam don't panic! Just apply your understanding of the properties of alpha, beta and gamma radiation. Mainly think about the range (how far it can travel) and ionising power of the radiation to help understand which radiation is used in which situation.Did this page help you? AQA CCEA Edexcel OCR 21st Century OCR Gateway WJEC This section explores the uses for nuclear radiation. Nuclear radiation has a wide range of applications in modern life, benefiting industries such as medicine, energy, agriculture, and security. While radiation can be dangerous in excessive amounts, when used properly, it provides valuable tools for improving human life. Below are some examples of how nuclear radiation is used in the world today.Medical UsesNuclear radiation plays a crucial role in medical imaging and treatment. Various radioactive isotopes are used for diagnostic and therapeutic purposes, enabling doctors to detect and treat conditions effectively.Radiotherapy (Cancer Treatment)Radiotherapy is a treatment that uses high-energy radiation, such as gamma rays or X-rays, to kill cancer cells. It is used to treat various types of cancer by targeting and destroying tumours while minimising damage to surrounding healthy tissue.Cobalt-60 is commonly used in radiotherapy machines, as it emits gamma radiation. The controlled use of gamma rays helps shrink or eliminate cancerous growths.Medical ImagingPositron Emission Tomography (PET) Scans: PET scans use a small amount of a radioactive substance, such as fluorine-18, to observe metabolic processes in the body. The substance emits positrons, which are detected to create detailed images of organs or tissues, helping to diagnose conditions like cancer, heart disease, and brain disorders.X-rays: X-ray imaging is commonly used to view the inside of the body, especially bones and teeth. X-rays are a form of electromagnetic radiation and can pass through the body to create images on film or digital detectors.CT Scans: A computed tomography (CT) scan uses X-rays to take cross-sectional images of the body, providing more detailed information than a standard X-ray. It is commonly used for diagnosing internal injuries, diseases, and infections. Tracer StudiesIn nuclear medicine, small amounts of radioactive isotopes, such as technetium-99m, are injected into the body. These isotopes emit gamma rays, which can be detected by a gamma camera to track the movement of substances within the body. This helps in diagnosing issues such as blockages in blood vessels, kidney function, and other conditions.Industrial UsesNuclear radiation is also used in various industrial applications, improving safety, quality control, and efficiency in manufacturing processes.Radiography (Non-Destructive Testing)Radiographic inspection uses gamma rays or X-rays to inspect the internal structure of materials or components without damaging them. This is commonly used in industries such as aerospace, engineering, and construction to detect cracks, flaws, or weaknesses in metals and welded joints.Isotopes like iridium-192 and cobalt-60 are commonly used for industrial radiography.Thickness and Density MeasurementIn manufacturing processes, beta radiation can be used to measure the thickness of materials like paper, plastic, or metal. The material absorbs some of the radiation, and the amount of radiation that passes through is used to determine the thickness.Similarly, gamma rays can be used to measure the density of materials such as concrete or metal, ensuring consistency and quality in production.Smoke DetectorsSmoke detectors commonly use a small amount of americium-241, a radioactive isotope that emits alpha particles. In a smoke detector, the alpha particles ionise the air between two electrodes, allowing a small current to flow. When smoke enters the detector, it disrupts the ionisation process, causing a drop in current that triggers the alarm. This use of alpha radiation is highly effective in providing early warning of fires.Energy ProductionNuclear radiation is most famously used in nuclear power plants to generate electricity. In these plants, the process of nuclear fission releases large amounts of energy.Nuclear Power StationsIn a nuclear reactor, the fission of isotopes like uranium-235 or plutonium-239 releases a huge amount of energy in the form of heat. This heat is used to produce steam, which drives turbines connected to electrical generators, providing electricity.Nuclear power is considered a low-carbon energy source because it does not release greenhouse gases during operation, though concerns about radioactive waste and safety are important considerations.Agricultural UsesNuclear radiation has several applications in agriculture, helping to improve crop production, food preservation, and pest control.Sterilising Food (Food Irradiation)Gamma radiation is used to sterilise food, killing bacteria, parasites, and other pathogens, extending the shelf life of products like meat, fruits, and vegetables. This process is known as food irradiation and is a safe and effective way to reduce the risk of foodborne illness.Pest ControlSterile Insect Technique (SIT) involves using radiation to sterilise male insects, such as mosquitoes or fruit flies. These sterile insects are released into the wild, where they mate with females but produce no offspring, effectively reducing the population of harmful pests over time. This technique is environmentally friendly and reduces the need for chemical pesticides.Other UsesNuclear radiation has a variety of other uses that improve safety, scientific research, and everyday life.MicrowavesMicrowave ovens use microwave radiation (a form of electromagnetic radiation) to heat food. Microwaves cause water molecules in food to vibrate, generating heat, which cooks the food quickly and efficiently. Although microwaves are not the same as nuclear radiation, they are a form of non-ionising radiation that is widely used in households and industries.Radiation in ResearchRadiation is also used in scientific research to study materials, biological systems, and even the Earth's history. For example, carbon-14 dating is used in archaeology to determine the age of ancient artefacts and fossils. Scientists also use radiation to study the structure of materials at the atomic level, such as in neutron scattering experiments.Key Points to Remember:Nuclear radiation has many beneficial uses in areas like medicine (diagnosis and treatment), industry (testing and quality control), energy production (nuclear power), and agriculture (food sterilisation and pest control).Gamma rays, alpha particles, and beta particles are used in different applications depending on their properties and energy levels.While nuclear radiation can be harmful in large doses, controlled and safe use of radiation has greatly improved various fields of human activity, contributing to advancements in healthcare, energy, and technology.Understanding how nuclear radiation is used can help us appreciate its role in improving lives while emphasising the importance of handling it safely. Save shows to listen to later, subscribe to your favourites and get fresh recommendations everyday.View all Stations & SchedulesLISTEN NOWMixes & sets to get you festival-ready Nice to meet you, {{name}}!What is your preferred phone number? What is your preferred phone number? Next Just to check, what are you interested in? 1-1 Tutoring Online Course Bursaries/Resources Other What time works best for you? (UK Time) Pick a time-slot that works best for you ? 8am-2pm 2pm-10pm 10:00-10:30 10:30-11:00 11:00-11:30 11:30-12:00 12:00-12:30 12:30-13:00 15:00-15:30 15:30-16:00 16:00-16:30 16:30-17:00 17:00-17:30 17:30-18:00 18:00-18:30 18:30-19:00 19:00-19:30 19:30-20:00 How many hours of 1-1 tutoring are you looking for? 0-5 10 20-30 40+ Sure, what is your query? Submit Loading... Thank you for your response.We will aim to get back to you within 12-24 hours. 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