Topic 6 Radioactivity - Core questions

You must learn the answers to each of these questions.

What are the properties of alpha radiation?	Alpha particles are equivalent to a helium nucleus as they are made up from 2 protons and 2 neutrons. They have a charge of +2 and a relative mass of 4. They are highly ionising but not very penetrating. They are affected by electric and magnetic fields.
What are the properties of beta radiation?	Beta particles are high energy electrons that are released from the nucleus of the atom. They have a charge of +1 and a relative mass of 1/2000. They are ionising and fairly penetrating. They are affected by electric and magnetic fields.
What are the properties of gamma radiation?	Gamma is a high frequency electromagnetic wave. These waves have no charge or mass. They are weakly ionising but very penetrating. They are not affected by electric and magnetic fields. It is often released in alpha or beta decay to emit the excess energy.
What are the properties of positron radiation?	Positron particles are the anti-particle to the electron. They are released from the nucleus of the atom and have a charge of +1, They have a relative mass of 1/2000. They are ionising and fairly penetrating. They are affected by electric and magnetic fields.
What is the relationship between the number of protons and the number of electrons in an atom?	They are equal and the atom has no overall charge.
What happens in beta minus decay in terms of particles?	A neutron becomes a proton + an electron. This causes the atomic number (proton number) to increase by 1 while the mass number (nucleon number) stays the same.
What happens in beta plus decay in terms of particles?	A proton becomes a neutron + a positron. This causes the atomic number (proton number) to decrease by 1 while the mass number (nucleon number) stays the same.
What is the effect on the mass number (nucleon number) in alpha decay?	Decreases by 4.
What is the effect on the mass number (nucleon number) in gamma decay?	Nothing.
What is the effect on the mass number (nucleon number) in neutron decay?	Decreases by 1.
What is the effect on the atomic number (proton number) in alpha decay?	Decreases by 2.
What is the effect on the atomic number (proton number) in gamma decay?	Nothing.

What is the effect on the atomic number (proton number) in neutron decay?	Nothing.
In a nuclear equation what do you need to balance?	The mass number (nucleon number) before with the total mass numbers (nucleon numbers) of the new isotope and released particles after and the atomic number (proton number) before with the total atomic numbers (proton numbers) of the new isotope and released particles after.
When is gamma radiation emitted?	When a radioisotope undergoes decay by alpha or beta (+ or -) emission, the nuclear rearrangement usually results in the excess energy being released as gamma radiation.
What are the dangers of ionising radiation?	In low doses, can cause cancer as there may be damage to DNA. In high doses, can cause skin burns, radiation sickness and even death.
What precautions are taken to ensure the safety of patients and staff involving in using radiation medically?	Radiation is monitored, dose and exposure time are limited. People are also protected with screening and protective clothing.
What information does the atomic number (proton number) tell you?	How many protons there are in the nucleus of an atom, ion or isotope and so what type of atom it is.
What information does the mass number (nucleon number) tell you?	The total number of protons + neutrons in the nucleus of an atom.
What happens to an atom when an alpha particle is near?	Electrons are pulled out of the atom, attracted by the positive charge of the alpha particle and so the atom is no longer neutral it becomes a positive ion.
What happens to an atom when a beta particle is near?	An electron is pushed out of the atom, repelled by the negative charge of the beta - particle and so the atom is no longer neutral it becomes a positive ion. OR An electron is pulled out of the atom, attracted by the positive charge of the beta + particle and so the atom is no longer neutral it becomes a negative ion.
How ionising are alpha particles?	Highly ionising as they have a +2 charge.
How ionising are beta particles?	Moderately ionising as they have a -1 charge or +1.
How ionising are gamma rays?	Weakly ionising as they are uncharged.
What stops alpha particles?	A few cm of air or thin paper.
What stops beta particles?	A few mm of a metal like aluminium
What stops gamma rays?	A few cm of a dense metal like lead will significantly reduce the amount of gamma rays getting through.
What is meant by background radiation?	Radiation that is around us all the time.
Why are there regional variations in the levels of background radiation?	50% of the background radiation is due to radioactive radon gas. Granite rock contains uranium and as this radio-isotope breaks down it releases radon gas into the atmosphere. Some parts of the country such as Devon, Cornwall and Edinburgh have higher concentrations of granite in the ground and so greater amount of radon gas meaning the background count is greater there.

Where does most the background radiation come from?	Around 50% radon gas. Around 15% from rock, soil and building products emitting gamma rays. Around 10% medical uses like X-rays. Around 10% from cosmic rays from outer space and the sun. About 80% is from natural sources.
How much background radiation is due to the nuclear industry?	Less then 1%
What is meant by the activity of a source?	How many decays there are every second from a radio-isotope.
What is activity measured in?	Becquerels (Bq)
How does activity vary with time?	Activity decreases with time.
What is half-life?	The time it takes for half the un-decayed nuclei to decay
How do you calculate the half life from a graph?	Choose a point on the y-axis and then halve the number of un-decayed nuclei from the y-axis and count the corresponding amount of time on the x-axis.
How do you calculate half-life mathematically?	Calculate the amount of time it takes to halve the activity of a sample from the data provided.
What is the danger of ionising radiation?	Damage to cells and tissues causing cancers or mutations. Possible deformities at birth in future generations.
How should radioactive samples be handled safely?	Always point sources away from yourself and others, never handle sources with your fingers – use tongs, only remove sources from their lead lined box when in use and do not eat or drink when using radioactive sources.
Compare the three types of radiation outside the body.	Alpha cannot penetrate. Beta would be able to penetrate and would be absorbed by cells. Gamma would be able to completely pass through the body and would be absorbed by cells.
Compare the three types of radiation inside the body.	Alpha would not be able to escape from the body and would all be absorbed by localised cells. Beta would be absorbed by cells as it passed through the body. Gamma would be emitted from the body and would be absorbed by cells as it passed through the body.
Why did scientists change their ideas about radioactivity over time?	Scientific knowledge changed over time as more observations and data were collected.
Describe the Bohr model of the atom	It has a tiny, positively charged nucleus (containing almost all the mass in the form of protons and neutrons) surrounded by negatively charged electrons in fixed energy levels (orbits or shells).
What is the typical size of an atom?	1×10^{-10} m (0.1 nanometres)
Describe two ways of measuring and detecting radiation.	Geiger-Muller tube and photographic film.
Describe the plum pudding model of the atom	A sphere of positive charge with electrons spread through it.

Describe Rutherford experiment and state what it proved about the atom	Geiger and Marsden carried out an experiment where alpha particles were fired at some gold foil. Alpha particles are repelled by positive charge. It was detected that most of the alpha particles (7999/8000) went straight through the foil but a small number (1/8000) of the alpha particles were deflected through anything from 1^{o} to 180^{o} (straight back at them). Rutherford explained the results and said that most of the atom is empty space, the nucleus is tiny. The nucleus contains most of the mass and it is positively charged.
Explain why ideas about the structure of the atom have changed over time.	New discoveries were made (like the electron and the charge on it, the neutron, proton and the positron) both using mathematics and experimentation.
What is the difference between contamination and irradiation?	An object or person would be contaminated if unwanted radioactive particle get on them or into them. The object or person would be irradiated if exposed to radiation.