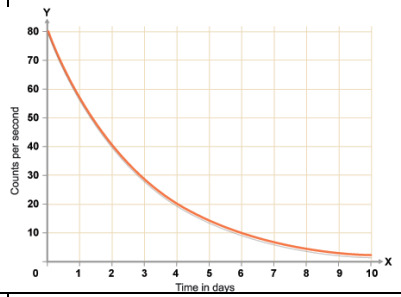
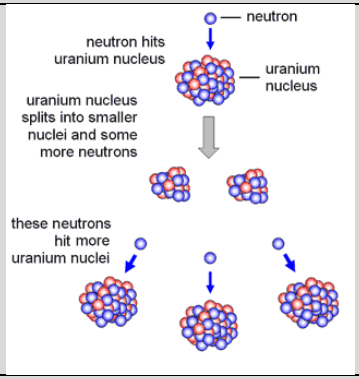
Core Questions – Physics unit 4 - Atomic Structure

No.	Question	Answer
1	What did scientists think about atoms before the discovery of the electron?	They were tiny spheres that could not be broken up
2	Which sub-atomic particle did JJ Thomson discover?	Electrons
3	What model did JJ Thomson use, following the discovery of an electron, to describe the structure of an atom?	Plum pudding model
4	How did Thomson describe an atom?	Spheres of positive charge with tiny negative electrons stuck in them
5	Which sub atomic particle was discovered by Rutherford and Marsden?	Protons
6	Describe the experiment Rutherford and Marsden did	Fired alpha particles at a thin piece of gold foil.
7	If the plum pudding model was correct what should have happened to the alpha particles when fired at the gold foil?	Pass straight through or be deflected only slightly
8	What did happen to the alpha particles when fired at the gold foil?	Most passed straight through, some were deflected more than expected and some were deflected backwards off the foil.
9	What new ideas about the atom were concluded from the gold foil experiment?	1. Most of the mass was in the centre of atom in a tiny nucleus 2. The nucleus had a positive charge 3. Most of the atom is empty space
10	What name was given to the model of the atom following the gold foil experiment?	The nuclear model
11	How was the atom described in the first nuclear model?	A positively charged nucleus surrounded by a *cloud* of electrons
12	How did the work of Niels Bohr improve the nuclear model?	He suggested that electrons orbit the nucleus at specific distances
13	How did Bohr realise that his suggestions were correct?	His theoretical calculations agreed with experimental observations
14	What did later experiments show that led to the understanding of protons?	Scientists discovered that the positive charge of a nucleus can be divided into a whole number of smaller particles that each have the same positive charge.
15	Which sub-atomic particle was identified by James Chadwick?	The neutron
16	What is the current model of an atom?	There is a positively charged nucleus (made up of protons and neutrons), surrounded by negatively charged electrons.
17	Where is most of the mass of the atom?	In the nucleus
18	What is the average radius of an atom	1×10^{-10} m or 0.1nm (nanometres)
19	How big is the radius of the nucleus?	It is less than 1/10,000th of the radius of the atom.
20	What are energy levels?	The electrons are arranged at different distances from the nucleus in "energy levels" which are sometimes called "shells".
21	What happens to an electron if it **absorbs** EM radiation?	They move up an energy level, further away from the nucleus
22	What happens when an electron **emits** EM radiation?	They move to a lower energy level, closer to the nucleus
23	What happens if one or more electrons leave an atom?	Atom becomes a positive ion
24	What does the proton or atomic number tell you about an atom?	What element it is

25	What does the mass number tell you about an atom?	The number of protons plus the number of neutrons in a the nucleus of an atom
26	What are isotopes?	Atoms of the same element with a different number of neutrons
27	Some isotopes are unstable, what does this mean?	They decay into other elements by emitting radiation
28	What is radioactive decay?	Unstable nuclei give out radiation as they change to become more stable
29	What is the "activity" of a radioactive source?	It is the rate at which a source of unstable nuclei decays
30	What key word can be used to describe the nature of radioactive decay?	Random
31	Name the four types of radiation emitted by unstable isotopes	Alpha, beta, gamma and neutrons
32	Alpha, beta and gamma radiation is ionising. What does it mean?	Knocks electrons off atoms creating positive ions.
33	What is the symbol for an alpha particle?	α
34	What does an alpha particle consist of?	2 protons and 2 neutrons
35	What is another name for an alpha particle?	Helium **nucleus**
36	How far can alpha particles travel in air?	A few centimetres
37	What materials can absorb alpha particles and stop them travelling?	Paper and skin
38	Is the ionising power of alpha particles strong or weak? Give a reason	Strong due to their big size and positive charge
39	Name a use of alpha radiation	Smoke Detector
40	What is the symbol for beta particle?	β
41	What is a beta particle?	A fast moving electron emitted by the nucleus of an atom
42	How far can beta travel through air?	A few metres
43	How ionising are beta particles?	Moderately (less than alpha, more than gamma)
44	What is an example of material that can absorb beta radiation?	Thin sheet of aluminium
45	How can an electron be emitted from the nucleus of an atom?	A neutron splits into a proton and an electron, the proton stays in the nucleus.
46	What is a use of beta radiation?	Testing the thickness of sheets of paper or metal
47	What is gamma radiation?	High frequency waves of electromagnetic radiation
48	How ionising are gamma waves?	Weakly
49	How far can gamma waves through air?	Very far
50	What materials can absorb gamma radiation?	Very thick lead or Concrete
51	Give two uses of gamma radiation?	Medical tracers and radiotherapy
52	What is a nuclear equation?	It shows radioactive decay using element symbols
53	What must be true about a nuclear equation?	Total mass and atomic numbers must be equal on both sides.
54	What happens to the mass and atomic number of an element after alpha decay?	Mass number decreases by 4 Atomic Number decreases by 2
55	How is an alpha particle represented in a nuclear equation?	$^{4}_{2}\mathrm{He}$
56	Write an equation for the alpha decay of radon-219.	$^{219}_{86}\mathrm{radon} \longrightarrow {}^{215}_{84}\mathrm{polonium} + {}^{4}_{2}\mathrm{He}$
57	What happens to the mass and atomic number of an element after beta decay?	Mass number stays the same Atomic number increases by 1

58	How is a beta particle represented in a nuclear equation?	$^{0}_{-1}e$
59	Write an equation for the beta decay of carbon-14.	$^{14}_{6}\text{carbon} \longrightarrow {}^{14}_{7}\text{nitrogen} + {}^{0}_{-1}e$
60	Gamma radiation does not have a nuclear equation, why?	No particle is lost from the nucleus, just energy
61	What piece of equipment measures radiation?	Geiger-Muller Tube and Counter (Geiger Counter)
62	What is the count-rate?	It is the number of decays recorded each second by a detector (such as a Geiger-Muller tube).
63	What is the unit and unit symbol for radioactivity?	Becquerels, Bq
64	Define the term half-life?	The time taken for the number of radioactive nuclei in an isotope to halve ***or*** The time taken for the radioactive count-rate to halve
65	What happens to the half-life of a source over time?	It stays the same
66	Why are sources with a short half-life dangerous?	The isotopes are very unstable and decay rapidly releasing a high amount of radiation very quickly
67	Why are sources with a long half-life dangerous?	They emit radiation over a very long period of time
68	What is the shape of all half-life graphs?	A downwards curve.
69	How do you use a half-life graph to find the half-life value?	Halve the initial activity on the y-axis Draw a line horizontally over to the curve Draw a line vertically down from the curve to the x-axis Read the time off the x-axis
70	What is the half-life of this substance? 	2 days
71	What is radioactive contamination?	The unwanted presence of materials containing radioactive atoms on other materials.
72	Why is radioactive contamination dangerous?	Due to the decay of the contaminating atoms. The type of radiation emitted affects the level of hazard.
73	What is irradiation?	Exposure to a radiation without physical contact to a radioactive source. The irradiated object **does not** become radioactive.
74	What precautions should people take when working with radioactive substances?	Distance, gloves, suits, screens, minimise exposure time
75	Which type of sources are most dangerous outside of the body and why?	Beta and Gamma as they emit radiation that can penetrate the skin

76	Why is an alpha source very dangerous inside of the body?	Alpha radiation is trapped inside the body and is very localised (does not travel very far)
77	How does radiation damage living tissue?	It ionises atoms and molecules inside cells.
78	What does a high dose of radiation do to a living cell?	Kills it
79	What damage can lower level doses do to cells	Mutate the DNA which may lead to cancer
80	Why is it important for the findings of studies into the effects of radiation on humans to be published and shared with other scientists?	So that the findings can be checked by peer-review and shared more widely if important.
80T	What is background radiation? **(Triple only)**	Low-level radiation that is always in the environment
81T	State the three main sources of background radiation **(Triple only)**	1. Naturally occurring isotopes in the air, food, building materials and rocks 2. Cosmic Rays from space 3. Man-made source e.g. nuclear power, medical usage and nuclear bombs
82T	What is meant by the term “radiation dose”? **(Triple only)**	The risk of damage to body tissues due to exposure to radiation
83T	What is the unit and unit symbol for radiation dose? **(Triple only)**	Sieverts, Sv
84T	What sized unit is usually used to measure background radiation and why? **(Triple only)**	**Milli**sievert (mSv) because background radiation is very low
85T	What can affect the level of background radiation or a person's radiation dose? **(Triple only)**	Location or occupation
86T	How is nuclear radiation used in medicine? **(Triple only)**	Exploration of internal organs (tracers) & control or destruction of unwanted tissue (radiotherapy)
87T	What is a medical tracers? **(Triple only)**	A radioactive isotope injected (or swallowed) into a person and their movement around the body is monitored by an external detector
88T	Give an example of a radioactive tracer and its use **(Triple only)**	Iodine-123, used to find out if the thyroid gland is absorbing iodine normally
89T	Why must radioactive tracers be either beta or gamma emitters? **(Triple only)**	So that the radiation passes out of the body and can be detected
90T	What is radiotherapy? **(Triple only)**	Using high dose radiation to kill cancer cells
91T	State the main problem associated with radiotherapy **(Triple only)**	Normal, healthy cells will also be killed making patients feel very ill
92T	If radiation is dangerous, why do we use it for some medical treatments **(Triple only)**	The benefits i.e killing cancer cells, outweigh the risks
93T	What is nuclear fission? **(Triple only)**	A nuclear reaction where a large unstable **nucleus** split in smaller nuclei, releasing large amounts so energy.
94T	Nuclear fission is not usually spontaneous, what does this mean? **(Triple only)**	It does not occur on its own
95T	What event can initiate a fission reaction? **(Triple only)**	A large unstable nucleus absorbs a neutron
96T	What are the normal products of a fission reaction? **(Triple only)**	Two smaller nuclei and two or three neutrons plus gamma rays
97T	What may happen to the neutrons released by a fission reaction? **(Triple only)**	Absorbed by other atoms causing more fission reactions.

98T	What is it called when the neutrons released are absorbed by more nuclei, causing more fission reactions? **(Triple only)**	A chain reaction
99T	Draw a diagram to represent nuclear fission and show how a chain reaction might happen: **(Triple only)**	
100T	What are two uses of fission reactions? **(Triple only)**	Nuclear power stations (generating electricity) and nuclear weapons
101T	How is an uncontrollable chain reaction avoided in nuclear power stations? **(Triple only)**	Control rods are used to absorb neutrons, reducing the amount of energy released
102T	What is the explosion caused by in a nuclear weapon? **(Triple only)**	An uncontrolled chain reaction
103T	What is nuclear fusion? **(Triple only)**	The joining of two light nuclei to form a heavier nucleus
104T	How is energy released in nuclear fusion? **(Triple only)**	Some of the mass from the colliding nuclei is converted into energy
105T	Why is nuclear fusion difficult to achieve? **(Triple only)**	Very high temperatures and pressures are required and so reactors would be very difficult and expensive to build