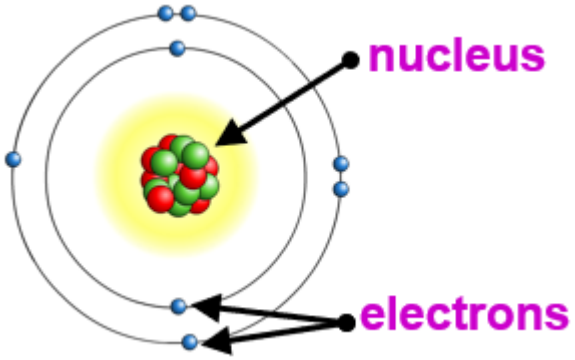
3. Radioactivity

7.1 (units)

- becquerel (Bq)
- centimetre (cm)
- hour (h)
- minute (min)
- second (s)

7.2

Structure of atoms



7.3

Atomic number = number on the periodic table
Mass (nucleon) number = proton number + neutron number

7.4

alpha (α) particles, beta (β−) particles, and gamma (γ) rays are ionising radiations emitted from unstable nuclei in a random process

7.5

What is alpha (α) radiation?

Description	2 neutrons, 2 protons Note:– An alpha particle is the same as a helium nucleus
Electric charge	+2
Relative atomic mass	4
Penetrating power	Stopped by paper or a few centimetres of air
Ionizing effect	Strongly ionizing
Effect of magnetic/ electric field	Weakly deflected

What is beta (β) radiation?

Description	High energy electron
Electric charge	-1
Relative atomic mass	1/1860
Penetrating power	Stopped by a few millimetres of aluminium
Ionizing effect	Weakly ionizing
Effect of magnetic/ electric field	Strongly deflected

Gamma (γ) radiation

Description	High energy electromagnetic radiation 
Electric charge	0
Relative atomic mass	0
Penetrating power	Stopped by several centimetres of lead or several metres of concrete
Ionizing effect	Very weakly ionizing
Effect of magnetic/ electric field	Not deflected

neutron (n) radiation

Description	High energy neutron
Electric charge	0
Relative atomic mass	1
Penetrating power	Can penetrate further than other radiation slowed down by substances containing Hydrogen like water or concrete
Ionizing effect	Indirectly ionising
Effect of magnetic/ electric field	Not deflected

	Particle lost from the nucleus	Change in mass number	Change in atomic number
Alpha (α) decay	Helium nucleus $^{4}_{2}He$	-4	-2
Beta (β) decay	Electron $^{0}_{-1}e$	0	+1
Gamma (γ) decay	Electromagnetic waves	0	0
Neutron (n) decay	Neutron $^{1}_{0}n$	-1	0

7.8

In decay equation, the number of protons and the mass number on both sides of the equation balance

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{90}_{36}Kr + ^{143}_{56}Ba + 3\,^{1}_{0}n$$

7.9

Photographic film and Geiger-Muller detector detects ionizing radiations

7.10

Back ground radiation comes from space and also from Earth

7.11

Activity of a radioactive source decreases over a period of time is measured in becquerels

7.12

Half life - time required for half the nuclei in a sample of a specific isotopic species to undergo radioactive decay

7.13

Half life becomes an asymptote and halves every half life

7.14

Use of radioactivity in industry and medicine:

- paper thinness/quality in factories can be measured by beta radiation
- smoke detectors

7.15

Exposing objects to beams of radiation is called irradiation. The term applies to all types of radiation including radiation from the nuclei of atoms.

Contamination occurs if an object has a radioactive material introduced into (or onto) it. An apple exposed to the radiation from cobalt-60 is irradiated but an apple with cobalt-60 injected into it is contaminated.

7.16

Issues caused by ionizing radiation:

- mutations in living organisms
- damage cells and tissue
- problems arising from the disposal of radioactive waste and how the associated risks can be reduced

7.17

Nuclear reactions, including fission, fusion and radioactive decay, can be a source of energy

7.18

U-235 can be split by collision with neutron which is the process of releasing energy as kinetic energy of the fission products

7.19

Fission of U-235 produces two radioactive daughter nuclei and a small number of neutrons

7.20

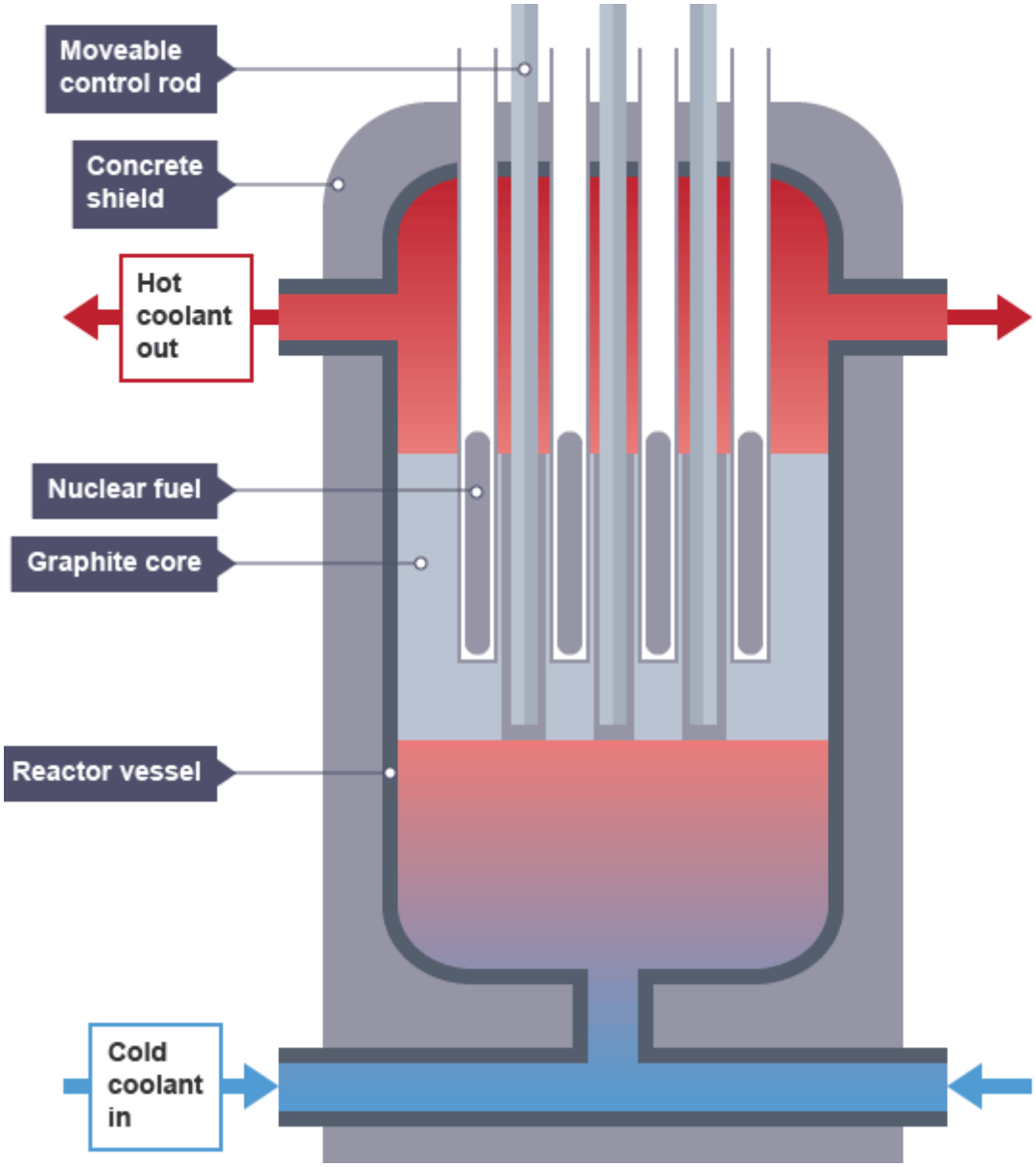
Chain reaction can be set up if the neutrons produced by one fission strike other U-235 nuclei

7.21

Parts of nuclear reactors:

- Nuclear fuel - the uranium or plutonium isotope that will split when triggered by an incoming neutron. The fuel is held in rods so that the neutrons released will fly out and cause nuclear fission in other rods
- Moderator - graphite core - a graphite core, for example, slows the neutrons down so that they are more likely to be absorbed into a nearby fuel rod
- Control rods - these are raised and lowered to stop neutrons from travelling between fuel rods and therefore change the speed of the chain reaction
- Coolant - this is heated up by the energy released from the fission reactions and is used to boil water to drive turbines in the power station

- Concrete shield - the daughter products of the fission reaction are radioactive and can be a hazard.



7.23

Difference Nuclear Fusion & Nuclear Fission

- Nuclear Fusion - type of nuclear reaction in which atomic nuclei combine to form more massive nuclei with the simultaneous release of energy
- Nuclear Fission - nuclear reaction in which a heavy atomic nucleus splits into smaller nuclei with the simultaneous release of energy

7.24

Nuclear fusion creates a large nuclei and result in the loss of mass releasing energy

7.25

Fusion is the energy source for stars

7.26

Nuclear fusion does not happen at low temperatures and pressures, due to electrostatic repulsion of protons (or nuclei)