AQA Physics 1b - Radiation and the Universe

13.5 What are the uses and hazards of the waves that form the electromagnetic spectrum?

Electromagnetic radiations are disturbances in an electric field. They travel as waves and move energy from one place to another. They can all travel through a vacuum and do so at the same speed. The waves cover a continuous range of wavelengths called the electromagnetic spectrum. The uses and hazards of the radiations in different parts of the electromagnetic spectrum depend on their wavelength and frequency.

You should be able to:
evaluate the possible hazards associated with the use of different types of electromagnetic radiation
evaluate methods to reduce exposure to different types of electromagnetic radiation.

Know that:

- Electromagnetic radiation travels as waves and moves energy from one place to another.
- All types of electromagnetic waves travel at the same speed through a vacuum (space).
- The electromagnetic spectrum is continuous but the wavelengths within it can be grouped into types of increasing wavelength and decreasing frequency: gamma rays, X-rays, ultraviolet rays, visible light, infra red rays, microwaves and radio waves.
- Different wavelengths of electromagnetic radiation are reflected, absorbed or transmitted differently by different substances and types of surface.
- When radiation is absorbed the energy it carries makes the substance which absorbs it hotter and may create an alternating current with the same frequency as the radiation itself.
- Different wavelengths of electromagnetic radiation have different effects on living cells. Some radiations mostly pass through soft tissue without being absorbed, some produce heat, some may cause cancerous changes and some may kill cells. These effects depend on the type of radiation and the size of the dose.
- The uses and the hazards associated with the use of each type of radiation in the electromagnetic spectrum.
- Radio waves, microwaves, infra red and visible light can be used for communication.
- Microwaves can pass through the Earth's atmosphere and are used to send information to and from satellites and within mobile phone networks.
- Infra red and visible light can be used to send signals along optical fibres and so travel in curved paths.
- Communication signals may be analogue (continuously varying) or digital (discrete values only, generally on and off). Digital signals are less prone to interference than analogue and can be easily processed by computers.
- Electromagnetic waves obey the wave formula:
    - wave speed = frequency wavelength
    - (metre/second, m/s) (hertz, Hz) (metre, m)

13.6 What are the uses and dangers of emissions from radioactive substances?

Radioactive substances emit radiation from the nuclei of their atoms all the time. These nuclear radiations can be very useful but may also be very dangerous. It is important to understand the properties of different types of nuclear radiation.

You should be able to:

- evaluate the possible hazards associated with the use of different types of nuclear radiation
- evaluate measures that can be taken to reduce exposure to nuclear radiations

- evaluate the appropriateness of radioactive sources for particular uses, including as tracers, in terms of the type(s) of radiation emitted and their half-lives.

Know that:
- The basic structure of an atom is a small central nucleus composed of protons and neutrons surrounded by electrons.
- The atoms of an element always have the same number of protons, but have a different number of neutrons for each isotope.
- Some substances give out radiation from the nuclei of their atoms all the time, whatever is done to them. These substances are said to be radioactive.
- Identification of an alpha particle as a helium nucleus, a beta particle as an electron from the nucleus and gamma radiation as electromagnetic radiation.
- Properties of the alpha, beta and gamma radiations limited to their relative ionising power, their penetration through materials and their range in air.
- Alpha and beta radiations are deflected by both electric and magnetic fields but gamma radiation is not.
- The uses of and the dangers associated with each type of nuclear radiation.
- The half-life of a radioactive isotope is defined as the time it takes for the number of nuclei of the isotope in a sample to halve or the time it takes for the count rate from a sample containing the isotope to fall to half its initial level.

13.7 What do we know about the origins of the Universe and how it continues to change?

Current evidence suggests that the universe is expanding and that matter and space expanded violently and rapidly from a very small initial 'point' i.e. the universe began with a 'big bang'.

Be able to:
- compare and contrast the particular advantages and disadvantages of using different types of telescope on Earth and in space to make observations on and deductions about the universe.

Know that:
- If a wave source is moving relative to an observer there will be a change in the observed wavelength and frequency.
- There is a red-shift in light observed from most distant galaxies. The further away galaxies are the bigger the red-shift.
- How the observed red-shift provides evidence that the universe is expanding and supports the 'big bang' theory (that the universe began from a very small initial point).
- Observations of the solar system and the galaxies in the universe can be carried out on the Earth or from space.
- Observations are made with telescopes that may detect visible light or other electromagnetic radiations such as radio waves or X-rays.