OCR 21st Century Core Science – Physics P3

Radioactive Materials

P3.1 Why are some materials radioactive?

- recall that some elements emit ionising radiation all the time and are called radioactive;
- understand that radioactive elements are naturally found in the environment, emitting background radiation;
- recall that electrons, protons, neutrons and the nucleus are all parts of an atom;
- **understand that an atom has a nucleus, made of protons and neutrons;**
- **understand that every atom of any element has the same number of protons but the number of neutrons may differ, and that forms of the same element with different numbers of neutrons are called isotopes;**
- understand that the behaviour of radioactive materials cannot be changed by chemical or physical processes;
- recall three types of ionising radiation (alpha, beta and gamma) emitted by radioactive materials;
- recall the penetration properties of each type of radiation;
- **describe radioactive materials in terms of the instability of the nucleus, radiation emitted and the element left behind;**
- understand that, over time, the activity of radioactive sources decreases;
- understand the meaning of the term half-life;
- understand that radioactive elements have a wide range of half-life values;
- **carry out simple calculations involving half-life.**

P3.2 How can radioactive materials be used and handled safely, including wastes?

- understand that ionising radiation can damage living cells;
- understand that ionising radiation is able to break molecules into bits (called ions), **which can then take part in other chemical reactions;**
- understand that when ionising radiation strikes living cells these may be killed or may become cancerous;
- recall how ionising radiation can be used to:
    - treat cancer;
    - sterilise surgical instruments;
    - sterilise food;
- recall that radiation dose (in sieverts) (based on both amount and type of radiation) is a measure of the possible harm done to your body;
- interpret given data on risk related to radiation dose;
- understand that radioactive materials expose people to risk by irradiation and contamination;
- understand that we are irradiated and contaminated all the time and name some sources of this background radiation;
- relate ideas about half life and background radiation to the time taken for a radioactive source to become safe;
- recall categories of people who are regularly exposed to risk of radiation and that their exposure is carefully monitored.

P3.3 How can electricity be generated? What can be done with nuclear wastes?

- understand why electricity is called a secondary energy source;
- understand that electricity is convenient because it is easily transmitted over distances and can be used in many ways;
- label a block diagram showing the basic steps by which electricity is generated;
- interpret a Sankey diagram of electricity generation and distribution to include the efficiency of energy transfers;
- recall two examples to show that we can use renewable energy sources instead of fuels to generate electricity;
- recall that power stations which burn carbon fuels will produce carbon dioxide;
- understand that a nuclear fuel is one where energy is released from changes in the nucleus;
- **know that in nuclear fission a neutron splits a large and unstable nucleus (limited to uranium) into two smaller parts, roughly equal in size, releasing more neutrons;**
- **compare the amount of energy released during nuclear fission with that released in a chemical reaction;**
- **understand how the nuclear fission process in nuclear power stations is controlled, and use the terms chain reaction, fuel rod, control rod and coolant;**

- understand that nuclear power stations produce radioactive waste;
- understand that nuclear wastes are categorised as high level, intermediate level and low level, and relate this to disposal methods;
- interpret and evaluate information about different energy sources for generating electricity, considering efficiency, economic and environmental costs, **power output** and **lifetime**.

P3.4 What are the health risks from radioactive materials?

- when provided with additional information on the health risks associated with radioactive materials, and the steps taken to limit these:
    - can explain why it is impossible for anything to be completely safe;
    - can identify examples of risks which arise from new scientific or technological advances;
    - can suggest ways of reducing specific risks;
    - can interpret and discuss information on the size of risks, presented in different ways;
    - **can discuss a given risk, taking account of both the chance of it occurring and the consequences if it did;**
    - can suggest benefits of activities with known risk;
    - can offer reasons for people's willingness (or reluctance) to accept the risk of a given activity;
    - can discuss personal and social choices in terms of a balance of risk and benefit;
    - **can identify, or propose, an argument based on the 'precautionary principle';**
    - **can distinguish between actual risk and perceived risk, when discussing personal and social choices;**
    - **can suggest reasons for given examples of differences between actual and perceived risk;**
    - **can explain what the ALARA (as low as reasonably achievable) principle means and how it applies to the issue in question;**
- in the context of health risks associated with radioactive materials:
    - can identify the groups affected and the main benefits and costs of a course of action for each group;
    - can explain the idea of sustainable development, and apply it to specific situations;
    - shows awareness that scientific research and applications are subject to official regulations and laws;
    - **can distinguish what can be done (technical feasibility), from what should be done (values);**
    - **can explain why different courses of action may be taken in different social and economic contexts.**