10A2: Module P2 Specification

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2.1 What types of electromagnetic radiation are there? What happens when radiation hits an object?

1. recall that light is one of a family of radiations, the electromagnetic spectrum;
2. understand that a beam of electromagnetic radiation delivers energy in 'packets' called photons;
3. list the electromagnetic radiations in order of the energy delivered by each photon – radio waves, microwaves, infrared, $^{\text{red}}$ light $^{\text{violet}}$, ultraviolet, X-rays, gamma rays;
4. interpret a situation in which one object affects another some distance away in terms of the general model of electromagnetic radiation:
   a. one object (a source) emits radiation;
   b. the radiation travels from the source and can be reflected, transmitted or absorbed by materials on its journey;
   c. radiation may be absorbed by another object (a detector) some distance away;
5. understand that the energy deposited by a beam of electromagnetic radiation depends on both the number of photons arriving and the energy that each photon delivers;
6. recall that the intensity of electromagnetic radiation is the energy arriving at a surface each second;
7. understand that the intensity of a beam of electromagnetic radiation decreases with distance and be able to explain why;
8. understand that ionizing radiation is able to break molecules into bits (called ions), which can then take part in other chemical reactions;
9. recall that ionizing radiation includes ultraviolet radiation, X-rays and gamma rays;
10. understand that microwaves heat materials containing particles that the microwaves can vibrate;
11. relate the heating effect of non-ionizing radiation to its intensity and duration;
12. recall an example of the way in which each of infrared, microwaves and radio waves are used for transmitting information.

2.2 Which types of electromagnetic radiation harm living tissue and why?

1. recall that the heating effect of absorbed radiation can damage living cells;
2. recall that low intensity microwave radiation, for example from mobile phone hand sets and masts, may be a health risk, but this is disputed;
3. recall that ionizing radiation can damage living cells;
4. recall examples of how exposure to different amounts of ionizing radiation can affect living cells;
5. recall that the metal cases and door screens of microwave ovens protect users from the radiation;
6. recall that physical barriers protect people from ionizing radiation, for example, sun-screens and clothing can be used to absorb most of the ultraviolet radiation from the Sun.

2.3 How does electromagnetic radiation make life on Earth possible?

1. recall that the Earth is surrounded by an atmosphere which allows light radiated from the Sun to pass through;
2. recall that this radiation provides the energy for photosynthesis and warms the Earth's surface;
3. recall that photosynthesis removes carbon dioxide from the atmosphere and adds oxygen, and that this reverses the effect of respiration;
4. understand that the Earth emits electromagnetic radiation that is absorbed by some gases in the atmosphere, so keeping the Earth warmer than it would otherwise be. This is called the greenhouse effect;
5. understand that the ozone layer absorbs ultraviolet radiation, producing reversible chemical changes in that part of the atmosphere;
6. understand that the ozone layer protects living organisms, especially animals, from the harmful effects of ultraviolet radiation.

2.4 What is the evidence for global warming, why might it be occurring, and how serious a threat is it?

1. recall that one of the greenhouse gases in the Earth's atmosphere is carbon dioxide, present in small amounts;
2. recall that other greenhouse gases include methane, present in trace amounts, and water vapour;
3. interpret simple diagrams representing the carbon cycle;
4. use the carbon cycle to explain:
    a. why for thousands of years the amount of carbon dioxide in the Earth's atmosphere was approximately constant;

b. how decomposers play an important part in the recycling of carbon; that during the past two hundred years, the amount of carbon dioxide in

c. the atmosphere has been steadily rising;

d. that the rise in atmospheric carbon dioxide is largely the result of:

- burning increased amounts of fossil fuels as an energy source;
- burning forests to clear land;

5. understand that computer climate models provide evidence that human activities are causing global warming;

6. understand that global warming could result in:

a. climate change and how this could make it impossible to continue growing some food crops in particular regions;

b. extreme weather conditions in some regions;

c. rising sea levels due to melting continental ice and expansion of water in the oceans, which would cause flooding of low-lying land.

2.5 What ideas about risk do citizens and scientists use?

1. when provided with necessary additional information about alleged health risks due to radiation (2.2) or global warming (2.4) can:

a. identify examples of risk which arise from new scientific or technological advances;

b. suggest ways of reducing specific risks;

c. interpret and discuss information on the size of risks, presented in different ways;

d. discuss a given risk, taking account of both the chance of it occurring and the consequences if it did;

e. identify, or propose, an argument based on the precautionary principle;

f. use the ideas of correlation and cause appropriately when discussing historical events or topical issues in science;

g. explain why a correlation between a factor and an outcome does not necessarily mean that one causes the other, and give an example to illustrate this;

h. suggest factors that might increase the chance of an outcome, but not invariably lead to it;

i. explain that individual cases do not provide convincing evidence for or against a correlation;

j. use data to develop an argument that a factor does/does not increase the chance of an outcome;

k. identify the presence (or absence) of a plausible mechanism as significant for the acceptance (or rejection) of a claimed causal link.

2. when provided with necessary additional information about alleged health risks due to radiation emitted from technological devices, or ultraviolet radiation from the Sun (2.2), can:

    a. explain why it is impossible for anything to be completely safe;

    b. suggest benefits of activities with known risk;

    c. offer reasons for people's willingness (or reluctance) to accept the risk of a given activity;

    d. discuss personal and social choices in terms of a balance of risk and benefit;

    e. distinguish between actual and perceived risk, when discussing personal and social choices;

    f. suggest reasons for given examples of differences between actual and perceived risk;

    g. explain what the ALARA (as low as reasonably achievable) principle means, and how it applies in a given situation;

    h. identify the outcome and the factors that may affect it;

    i. suggest how an outcome might be affected when a factor is changed;

    j. give an example from everyday life of a correlation between a factor and an outcome;

    k. evaluate the design for a study to test whether or not a factor increases the chance of an outcome, by commenting on sample size and how well the samples are matched.