

# Answers to self-assessment questions

## Topic 1

### 1.01.01

It is important to note that each person will have his or her own view on these questions and there is no 'correct' answer.

- 1 Green politics has raised awareness of people worldwide to the plight of the rainforest, Politicians, religious leaders, local communities and environmental groups all discuss the issue, raise funds or lead campaigns to protect the rainforest, so the answer may be that green politics is very important.
- 2 The rate of loss of rainforest has been slowed and people now understand its importance, but it is difficult to say whether the threat has been overemphasised. It might be worth thinking about whether the rainforest has been publicised to the detriment of other less attractive but equally vital ecosystems.
- 3 **Discussion point:** These are local issues so, of course, your discussions will be influenced by local conditions. Consider issues such as recycling, cosmetics produced without animal testing, or use of plastic bags.

### 1.01.02

- 1 An EVS is a particular worldview or set of paradigms that shapes the way individuals or societies perceive and evaluate environmental issues. An EVS has inputs, outputs, storages and transfers.
- 2 Technocentrics believe that technological developments can provide solutions to environmental problems. Ecocentrics put ecology and nature as central to humanity and propose a less materialist approach to life.
- 3 **Discussion point:** Think about how a technocentrist would suggest methods to solve the issue of climate change.

### 1.01.03

- 1 There is no one answer to this; each of us has our own viewpoint.
- 2 People will respond according to their understanding of an issue. This will come from education, experience, religious and sociopolitical concepts.
- 3 D.

- 4 **Discussion point:** What do you understand by a 'good' life? Does it include the natural world?

### 1.02.01

- 1 **a** The systems approach enables us to study an ecosystem as a whole, examining the feeding relationships and cycling of nutrients and so on together, rather than separately.  
**b** In engineering a whole system such as an engine, its inputs (fuel) and outputs (work done) and its performance can be examined rather than just the functioning of, for example, the gears.

2

System	Open	Closed	Isolated
Inputs	energy and mass	energy	none
Outputs	energy and mass	energy	none

- 3 **Discussion point:**

### 1.02.02

- 1 **Discussion point:** A transfer usually involves a flow through a system; transformations occur when there is a change of state (e.g. from water to vapour).
- 2 Input – sunlight; output – heat; storage – biomass (or other suitable examples).
- 3 Advantages: complex systems can be simplified; predictions can be made; different scenarios can be considered. Disadvantages: oversimplification; models depend on the skill of the modellers; different models may predict different outcomes for the same scenario.
- 4 **Discussion point:** Think about computer-generated images and models you have seen, for example in weather forecasting or predictions for changes in sea levels.

### 1.03.01

- 1 Because energy cannot be created or destroyed, energy that moves through an ecosystem is transformed into different forms. Not all of these (e.g. heat) can be used by animals in the food chain. Eventually there is not enough transferable, useful energy to sustain another link in the chain.

## Answers to self-assessment questions

- Entropy is a measure of the evenness of distribution of energy in a system. In a natural system there is more energy at the lower trophic levels and less at the highest.
- Steady-state equilibrium is a stable situation to which a system will return after a disturbance. A static equilibrium is one in which there are no changes because there are no inputs or outputs in the system.
- Research idea:** There is more information on human population growth in Topic 8. Does the information you have researched agree with what is said there?

### 1.04.01

- Sustainability means that resources are used and managed so that full natural replacement of exploited resources can take place.
- Natural income is difficult to monitor because it may cross international boundaries and people using the resource may have different environmental value systems (EVSs). Laws and the cooperation of individuals are needed to protect natural income.
- Discussion point:** Think about whether you had heard of this report before starting this course. How accessible are such reports to ordinary people?

### 1.04.02

- A report to assess the environmental, social and economic impact of a large-scale project. Its purpose is to provide decision-makers with evidence to decide whether a project should go ahead.
- EIAs cannot predict all future outcomes, because systems may change as the project develops and new inputs occur. For example, the EIA for the Three Gorges Dam could not predict whether the risk of landslides would increase, or the effect of the project on social structure of the community after the dam had been built.
- Discussion point:** Consider the value of a project such as an airport or new road in relation to the land that must be used to build it. How can human needs be balanced against the needs of the environment?

### 1.04.03

- Built-up land consumes resources by removing natural capital for housing, transportation and industrial sites.
- You might have begun a recycling scheme or changed to walking to school rather than travelling by car.
- Research idea:** Suitable websites are <http://footprint.wwf.org.uk> or <http://footprintnetwork.org/en/index.php/GFN/page/calculators>

### 1.05.01

- Pollution is the addition of a substance (by humans) to the environment at a rate that is greater than the rate at which it can be rendered harmless.
- Pollution may affect health, metabolism, the nervous system or cause cancer or birth defects.
- Point-source – from one easily identified source; non-point-source – from a variety of dispersed sources.
- Natural sources – volcanoes, wildfires; human activity – burning fossil fuels, emissions, or by-products from factories.
- Discussion point:** This is a local issue so, of course, your discussions will be determined by your local situation.

### 1.05.02

- A pollutant that remains in a food chain for a long time because it is not biodegradable. It will accumulate at higher trophic levels, as animals at higher trophic levels ingest a large number of organisms from lower levels to provide their energy needs.
- Pollutants such as DDT do not remain in one place. They are transferred from country to country by currents in water, as animals move or when produce is exported. One country cannot deal with this problem on its own.
- Research idea:** The precautionary principle can be summarised in the phrase, 'If it's going to cause harm, don't do it.'

## Topic 2

### 2.01.01

- A group of organisms that can interbreed to produce fertile offspring.
- The two species have a similar fundamental niche, but when both are present together they restrict their niche to a smaller size, to avoid competition. In this way both can survive.
- Water, temperature and light (*or other suitable examples*).
- Research idea:** Use books and the internet to find organisms that live together to their mutual benefit.

### 2.01.02

- A Leopard frogs in a stream.
- C One species may be eliminated from that ecosystem.
- Each species occupies a different niche.
- Research idea:** Consider the fact that neither species is native to Australia. What natural predators might they have?

2.02.01

- 1 They convert light energy into chemical energy in biomass, which is used by consumers.
- 2 Trophic level 2.
- 3 Both producers and decomposers *must* be present. (The other groups may be present but are not essential.)
- 4 **Research idea:** This is a local issue so, of course, your discussions will be influenced by the local situation. Use your knowledge of energy use by aquatic and terrestrial organisms to help here.

2.02.02

- 1 **a** Suitable pyramid drawn, base 15 cm.  
**b** There is only one tertiary consumer, because there is insufficient food to support any more in the area.
- 2 Carnivores are relatively rare because at each trophic level less than 10 per cent of the energy captured by the previous level is passed to the next. Energy from the Sun enters producers, but there are then three further transfers to carnivores. There is not enough energy left for large numbers of carnivores. Large carnivores must hunt for food, and they use much energy as they do.
- 3 Pyramids of biomass are constructed at one time of the year. At certain times in certain ecosystems there is little biomass, so a pyramid may be inverted. For example, small plants (phytoplankton) along the seashore grow rapidly in spring, when nutrients and light are abundant, but die later in the year, when a pyramid of biomass would not be pyramid shaped.
- 4 **Discussion point:** Pyramids of productivity show inputs and outputs; these are important factors in agriculture.

2.03.01

- 1 GSP is the biomass gained by consumers as they feed. NSP is the gain in biomass (per unit area per unit time) by consumers minus losses due to respiration.
- 2 B.
- 3 **a**  $3056/21436 = 14.2\%$
- 4 **b**  $125/3056 \times 100\% = 4.09\%$
- 5 **Research idea:** Consider abiotic factors and their effects on NPP.

2.03.02

- 1 Nitrogen in plant and animal tissues; atmospheric nitrogen; nitrate in the soil.

- 2 Nitrogen cycle – humans add nitrate to soils in the form of fertiliser in order to produce higher yields of food crops. Agriculture upsets the natural nitrogen cycle because biomass is harvested and removed from the cycle, so nitrate in the soil is not naturally replenished.

Carbon cycle – burning fossil fuels and biomass removes carbon from storages and increases the amount of carbon dioxide in the atmosphere.

- 3 **Discussion point:** Points to consider: what is the role of decomposers in nutrient cycling? What would happen to organic waste without decomposers? What would happen in an ecosystem if carbon was not recycled?

2.03.03

- 1 Converting nitrogen gas from the atmosphere into a form (nitrates) that can be taken up and used by plants.
- 2 A forest, fishery or herd of cows, or *another suitable example*.
- 3 Use of resources at a rate that allows natural regeneration, for example harvesting timber at a rate that allows natural regrowth of remaining trees.
- 4 **Research idea:** Nutrients and biomass are held in the forest plants. If they are removed, fertility reduces rapidly.

2.04.01

- 1 Rainfall, insolation (sunlight) and temperature range.
- 2 The average temperature is high throughout the year, there is abundant sunlight for photosynthesis, and rainfall is high, providing ideal conditions for plant growth.
- 3 **a** Climate change may increase the temperature of the tundra so that it becomes confined to areas further north, closer to the Arctic.  
**b** Increasing global temperature may extend the range of hot, dry desert areas, as rainfall may be distributed differently across the planet.
- 4 **Discussion point:** Consider how organisms can feed at different trophic levels, and that trophic levels are defined by humans. An ecosystem cannot be precisely defined, but this does not mean that it is not helpful to try to define it.

2.04.02

- 1 Succession is the process of change that occurs over time as a pioneer group of species is replaced by intermediate and finally climax communities in an ecosystem. Zonation, on the other hand, is the spatial arrangement of populations along an environmental gradient in a given area due to their different tolerances of the environmental conditions.

## Answers to self-assessment questions

- Pioneer species are the first organisms to colonise an area of bare ground or rock. Lichens and mosses are examples of pioneer species, but pioneer species will be different in different areas, depending on the terrain.
- Shrubs and grasses can survive in thinner soil which contains less humus. Broadleaved trees require thicker soils with more nutrients to support their larger size. This soil develops later in a succession.
- Discussion point:** Visitors disturb a research site and carry seeds and other debris with them on their feet. They may also damage fragile pioneer species. Without human interference, a newly established island can develop completely naturally.

### 2.04.03

- K*-strategists have few offspring but spend a lot of time caring for them. To survive well they require a good supply of nutrients and stable conditions. These conditions are most likely to be found in a climax community. *r*-strategists can reproduce quickly and make use of short-lived resources in unstable ecosystems.
- There are fewer plants present at the start of a succession, thus GPP is low.
- Research idea:** More biomass is being used or consumed than is being produced; consider why this might be over the course of a year.

### 2.04.04

- A stable community where productivity and respiration losses are balanced.
- As more species colonise an area there are more interactions between them. More complex food chains and webs can form and more species can be supported, leading to an increase in biodiversity.
- Grazing animals reduce the height of grass plants and prevent the succession in an area of grassland from developing further. Thus the area remains grassland – a plagioclimax.
- Managed forests, meadows used for agriculture, farmland used for crops.
- Discussion point:** Discussion could include agriculture, clearing forests, building homes or other local issues.

### 2.05.01

- There are several possible answers here.
- Leaf shape and pattern, formation of bark, pollen grains are useful. These will be unique to a particular species. Colour,

height and other features that vary continuously with a plant's age and development are not useful.

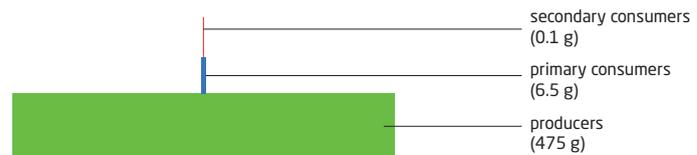
- Discussion point:** Consider that new knowledge is acquired all the time, and equipment to observe species becomes more sophisticated, for example microscopes are available now. Biochemistry has enabled relationships between species to be examined and tested.

### 2.05.02

- 400.
- The estimate would be inaccurate. It would probably lead to an overestimate of the true population.
- Marking the top of the shell would make the snail more vulnerable to predators, as it would be easily spotted. The population size would probably be underestimated, as individuals were removed from it.
- The quadrats should be placed at random locations (chosen using a grid and random number tables). The number of daisies present in each quadrat could be counted and compared. The number of quadrats used depends on the size of the field and the size of the quadrat used.
- Lichens are very small, so the 0.01 m<sup>2</sup> (10 cm × 10 cm) quadrat is best. Larger quadrats would be too large to cover a suitable area of tree trunk.
- Research idea:** Use the internet or reference books and think about how modern technology might be used.

### 2.05.03

- a** Use a scale of 2 cm = 100 g m<sup>-2</sup>.  
The mass of plants is represented by a bar 9.5 cm long, herbivores by a bar 0.1 cm and the carnivores by a single line.  
**b** Trophic level 3.



- The water content of different species varies considerably, and water has no energy value. Dry mass gives a fair comparison of the amount of living material found in different species.
- A = algae, C = birds.
- Discussion point:** Consider factors such as seasons and breeding cycles and how these might affect comparative studies.

2.05.04

- 1 4.79.
- 2 This is a high value for the index and indicates that a good level of diversity is present in the community.
- 3 **Discussion point:** Consider how important it is to be logical in collecting data and how different types of ecosystems can be studied in a comparative manner.

## Topic 3

3.01.01

- 1 A measure of the quantity of living diversity per unit area. Three types are: species diversity, habitat diversity and genetic diversity.
- 2 To allow two similar areas to be compared; to allow one area to be monitored over time.
- 3 That the area has a large number of species present and that there are even numbers of each species (the area is not dominated by one species).
- 4 **Research idea:** The Shannon–Wiener and Shannon–Weaver indexes and the different versions of the Simpson index are worth investigating.

3.02.01

- 1 There is genetic variation within species; some individuals are better adapted to the environment than others; ‘fitter’ individuals tend to survive and reproduce; their offspring inherit the genes that are advantageous.
- 2 Artificial selection occurs when humans choose which individuals will reproduce to produce offspring with certain selected characteristics; natural selection occurs in response to environmental change.
- 3 **Research idea:** Most religions have a view on how organisms originated. Many accept evolution.

3.02.02

- 1 Any species must compete with other members of its own species in order to survive and reproduce. Only those individuals with favourable characteristics are able to do so.
- 2 Geographic isolation involves a physical barrier (such as water or a mountain range) between individuals of a species, so they cannot breed with each other. Behavioural isolation often happens after geographic isolation; separated groups develop their own behaviour patterns, such as courtship rituals or songs, so that when they meet members

of the original population, the two groups do not recognise one another.

- 3 **Discussion point:** Galton proposed that some humans were ‘better’ or ‘fitter’ than others. Nature and nurture can influence the way people develop.

3.02.03

- 1 The tectonic plate on which Australia is found has been isolated for a long time, so the species on Australia (an island) have developed in a different way from species elsewhere.
- 2 Formation of islands, mountain ranges or separation of the continents can cause isolation. This can lead to speciation, because interbreeding and gene flow are reduced; isolated populations adapt to their environment, so new species may form.
- 3 Land bridges link up areas that have been separated. Species may move to new areas and compete with organisms living there; formerly separated groups may meet again and may or may not be able to interbreed.
- 4 **Discussion point:** We can only gather evidence that remains about past events; we cannot go back in time to study them.

3.02.04

- 1 Probably five.
- 2 **a** This one is caused by human activity.  
**b** More than a quarter of species may become extinct, so it is just as catastrophic as previous extinctions – species do not have the opportunity to adapt quickly enough.
- 3 **Research idea:** Consider how data is collected. Can all species on Earth be reached and found?

3.03.01

- 1 Isolation of species, how specialised they are, reproductive potential, trophic level – top predators are more vulnerable.
- 2 Population size, population trend, geographic range, numbers of mature organisms.
- 3 Examples from a named species, e.g. loss of habitat, overexploitation, competition from invasive species.
- 4 **Research idea:** Think about the position of your organisms in their food chains. Are they keystone species? If their numbers decline, how will others be affected?

## Answers to self-assessment questions

### 3.03.02

- 1 Madagascar is a poor country which must use its natural capital to provide for its people. Deforestation to provide land for poor farmers leads to a reduction in habitat for endangered species. As the human population grows, the pressure on the land increases. Invasive species, overhunting and pollution are the main ecological pressures on the country, and these are caused in part by the economic pressures.
- 2 Farming, habitat destruction, hunting, poaching, pollution and introduction of invasive species.
- 3 **Research idea:** Biodiversity hotspots include regions that have 1500 endemic plants found nowhere else and 30 per cent or less of their natural vegetation remaining. About 30 hotspots have been identified.

### 3.04.01

- 1 Ecological reasons, economic reasons and aesthetic reasons.
- 2 Because species do not live in places that are defined by national boundaries; and it is essential to preserve ecosystems that support one another, even if they are in different countries.
- 3 Similarities: both work for the conservation of habitats and preservation of living organisms.  
Differences: funding is from different sources; NGOs work using public opinion while governmental organisations can pass laws. (*Or other suitable examples.*)
- 4 **Discussion point:** Think about an organisation such as Greenpeace and how its work is publicised and how many people know about it. Is it likely that a government could be unaffected by this?

### 3.04.02

- 1 They are independent and can take decisions more quickly. They do not have to consider diplomatic concerns.
- 2 Size – there must be enough space for animals to have territories; shape – a protected area should have as small a perimeter as possible to minimise disturbance and intrusion from outside; edge effects – centre of the area will have different properties to the edges, organisms at the edge will have more disturbance and competition to contend with.
- 3 Corridors link reserves so that two smaller areas can be combined to form one larger one. They ensure that members of separated populations can interbreed and maintain a healthy gene pool.

- 4 Funding, community support, education and good location.
- 5 **Research idea:** This is a local issue so, of course, your findings and discussions will be influenced by the local situation.

## Topic 4

### 4.01.01

- 1 The hydrological cycle is the natural sequence through which water passes into the atmosphere as water vapour, precipitates to earth in liquid or solid form, and ultimately returns to the atmosphere through evaporation.
- 2 Evapotranspiration is the sum of evaporation, sublimation and plant transpiration from the Earth's land and ocean surface to the atmosphere.
- 3 Advection is the horizontal movement of water in the atmosphere, in vapour, liquid or solid states in air masses. Without advection, water could not be transported from the oceans to land masses. Evaporation from water surfaces on land would not be enough to keep rivers and lakes full and provide the human population with drinking water.
- 4 **Research idea:** Statistics for monthly and annual precipitation should be available by city or region for most countries. If you can obtain a climate graph to illustrate the distribution of precipitation over the year, so much the better. If your school/college has its own weather-recording equipment, this information may be directly available to you.

### 4.01.02

- 1 Precipitation that falls on land and is never available for capture or storage because it evaporates from the ground or transpires from plants is called green water. The remaining water that channels into lakes, rivers, wetlands and aquifers that people can tap directly is known as blue water.
- 2 Because the soil is unable to take in any more water, the rain flows on the surface under the influence of gravity. This is called surface runoff or overland flow.
- 3 Stores are places where water is held. Examples are surface storage such as lakes, and groundwater storage.
- 4 **Research idea:** Consult an Ordnance Survey map or a good atlas. The most relevant scale of Ordnance Survey map is probably 1 : 50 000, where 2 cm on the map equals 1 km on the ground.

4.01.03

- 1 Areas that have been deforested often experience reduced infiltration, increased surface runoff and lower groundwater recharge.
- 2 As the area becomes more built up with impervious surfaces, infiltration declines significantly and surface runoff increases. Evapotranspiration declines due to: **a** less surface water because of high runoff, **b** the decrease in vegetation.
- 3 **Research idea:** If you are unaware of an example of a recent flash flood event, then an internet search should provide a number of examples from around the world. You could produce a brief bullet-point summary of your chosen flash flood event.

4.01.04

- 1 Differences in temperature and salinity.
- 2 The warm surface waters of the North Atlantic Drift give north-west Europe a more moderate climate than most regions of similar latitude. Without the warming effect of the North Atlantic Drift, north-west Europe would be on a temperature similar to that of south-east Canada, which suffers harsh winters.
- 3 **Research idea:** A good atlas may contain the two climate graphs you require for this piece of research. If not, an internet search should provide what you need.

4.02.01

- 1 For example: more than 840 000 people die each year from a water-related disease; 750 million people around the world lack access to safe water; women and children spend 140 million hours a day collecting water.
- 2 Two-thirds.
- 3 **Discussion point:** It would be interesting to fill a container with water to a weight of 20 kg and allow each member of the class to attempt to pick it up. For health and safety reasons, you should not try to walk with the full container. Just picking it up will give some indication of the efforts millions of people have to go through to provide a daily water supply for their families.

4.02.02

- 1 Surface irrigation systems vary widely in efficiency, at between 20 and 75 per cent. Aerial systems are considerably more efficient, at 60–80 per cent. The most efficient systems are subsurface, ranging between 75 and 95 per cent.
- 2 For example, for physical factors: the amount of precipitation; the seasonal distribution of precipitation; the physical ability of the surface area to store water.

For example, for human factors: the wealth of a country in terms of its ability to afford water infrastructure; the distribution of population between urban and rural areas, with the concentration of investment in water infrastructure in urban areas; the degree of contamination of rural water.

- 3 **Research idea:** The government department responsible for water supply and related issues should have the data you require, but it may also be generally available from other sources.

4.02.03

- 1 Water stress occurs when water supply is below 1700 m<sup>3</sup> per person per year. Water scarcity occurs when water supply falls below 1000 m<sup>3</sup> per person per year.
- 2 The world's population continues to increase significantly; increasing affluence is inflating per-capita demand for water; the increasing demands of biofuel production – biofuel crops are heavy users of water.
- 3 **Research idea:** The required information will be available from a range of websites including:  
[www.thewaterproject.org/water-in-crisis-india](http://www.thewaterproject.org/water-in-crisis-india)  
[www.un.org/waterforlifedecade/scarcity](http://www.un.org/waterforlifedecade/scarcity)

4.02.04

- 1 Water supply is the provision of water by public utilities, commercial organisations or by community endeavours.
- 2 Aquifers provide approximately half of the world's drinking water, 40 per cent of the water used by industry and up to 30 per cent of irrigation water.
- 3 **Discussion point:** Discussion is likely to focus on the high cost of desalination plants but should also include reference to the environmental disadvantages.

4.03.01

- 1 Fish, prawns, mussels, seaweed (*or other suitable examples*).
- 2 Currents cause upwelling of nutrients from the ocean; currents carry nutrients to the coast zone; temperature of the water and light are beneficial here during certain seasons.
- 3 Education, advertising, labelling, news items.
- 4 **Research idea:** Research the types of nets and fishing methods that were used. Are tuna fish available in your area today?

4.03.02

- 1 Food is expensive and waste would cost the farmer money; waste food settles on the loch floor and causes a build-up

## Answers to self-assessment questions

of waste; waste encourages the growth of bacteria which remove oxygen from the water (*or other suitable examples*).

- Plant life is reduced beneath the sea cage due to the build-up of waste food and fish faeces.
  - Wrasse may increase in number because the high density of salmon means there are more lice in the area.
- Sea lice could be controlled by the use of pesticides; or by introducing wrasse (a natural predator) into the cages.
- Research idea:** Consumers like their salmon to be pink in colour and the farm is supplying its customers with the product that they want.

### 4.04.01

- Biochemical oxygen demand is a measure of the amount of dissolved oxygen required to break down the organic material in a given volume of water aerobically.
- Leaves and woody debris, dead plants and animals, animal manure, effluents from wastewater treatment plants.
- Microorganisms feed on organic waste in effluent. As they remove this material from the water, their numbers fall.
- Research idea:** This is a local issue, so your research will be influenced by local conditions and the local situation.

### 4.04.02

- An indirect measure of pollution made by assaying the impact on species within the community according to their tolerance, diversity and abundance.
- Macro-invertebrates are easy to see, they respond to different levels of pollution and they spend all their life cycle in water, so they are exposed to pollutants for extended periods.
- Poor.
  - Excellent.
  - Fair.
- Discussion point:** Think about how easy you find it to understand. Could a non-scientist use it?

### 4.04.03

- If more nutrients lead to more algal growth, the increase in biomass as nutrients are taken up by plants causes a reduction in nutrients in water so equilibrium is restored.
- Fertilisers, domestic detergents.
- An area of ocean or fresh water where the oxygen content is so low that no living things are present.
- Research idea:** Visit local water systems such as a pond or stream and look for evidence of excessive plant growth.

## Topic 5

### 5.01.01

- A soil profile is the vertical succession down through a soil, which reveals distinct layers or horizons in the soil. A soil horizon is a specific layer that is parallel to the surface and possesses physical characteristics which differ from the layers above and beneath.
- Leaching is a natural process by which water-soluble substances such as calcium are washed out from soil. This reduces the fertility of a soil.
- Research idea:** Try to find an area of bare, loose soil. In terms of organic content the most obvious evidence will be earthworms, snails and other live soil fauna or their decaying remains. For soil flora, look for decomposing leaves and other vegetation. However, your soil sample may not contain such obvious evidence as this. In this case you will be trying to identify humus, which is a dark, crumbly material rather like compost. The inorganic material in your soil will be visible grains of sand, silt or clay. Clay particles are very small and thus are very difficult to discern without magnification. However, the sticky nature of clay is easy to observe.

### 5.01.02

- Because they vary as the factors and processes that influence them change.
- For example: organic material from decaying flora and fauna; precipitation, gases and solid particles from the atmosphere; gases from the respiration of soil fauna.
- For example: nutrients taken up by plants growing in the soil; nutrient losses through leaching; losses of soil through soil erosion and mass movement.
- Discussion point:** Focus on the importance of decomposition, weathering and nutrient cycling. For example, in terms of the latter, some of the plant nutrients lost as an output will return as leaf litter in humus.

### 5.01.03

- The look and feel of a soil is referred to as 'soil texture' and is determined by the size and type of particles that make up the soil. While this includes organic material, it mostly refers to the inorganic material in the soil.
- Soil texture is very important because it affects: moisture content and aeration; retention of nutrients; ease of cultivation; root penetration of crops and other vegetation.
- Soil type can have a major impact on the viability of agricultural communities. All other factors being equal, the

better the soil, the higher the rate of primary productivity. Thus in most circumstances primary productivity would be greatest in loam soils. Clay soils would be in second place, with sandy soils trailing a very clear third.

- 4 **Research idea:** To find out the soil type in an area of farmland near to you, a soil map may well be available, or the local authority/council may have this information, or you could contact a local farmer. The agricultural activities may be known to you if the farmland is close by and the farming activities are obvious. If not, visiting the farm or contacting the farmer should yield this information.

#### 5.02.01

- 1 Food security is when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life.
- 2 Malnutrition is insufficiency in one or more nutritional elements necessary for health and well-being.
- 3 With malnutrition, people are prone to a range of deficiency diseases and more likely to fall ill. People who are continually starved of nutrients never fulfil their physical or intellectual potential. Malnutrition reduces people's capacity to work, so land may not be properly tended and other forms of income may not be successfully pursued. This is threatening to lock at least some LEDCs into an endless cycle of ill-health, low productivity and underdevelopment.
- 4 **Research idea:** Information can be obtained from a range of relevant websites including:  
[www.wfp.org/hunger/malnutrition](http://www.wfp.org/hunger/malnutrition) – UN World Food Programme  
[www.msf.org.uk/malnutrition](http://www.msf.org.uk/malnutrition) – Médecins Sans Frontières/Doctors Without Borders

#### 5.02.02

- 1 Sustainable agriculture involves agricultural systems emphasising biological relationships and natural processes that maintain soil fertility, thus allowing current levels of farm production to continue indefinitely.
- 2 Food waste occurs towards the end of the food chain, at the retail and consumer level. In contrast, food loss occurs mainly at the front of the food chain, during production, post-harvest, and processing.
- 3 Twenty-eight per cent of the world's agricultural area is used to produce food that is lost or wasted; most food waste ends up in landfill; methane emissions from landfill are a significant source of greenhouse gas emissions; the carbon footprint from food waste is estimated at 3.3 billion tonnes of CO<sub>2</sub> equivalent each year; a very large volume of water is used each year to produce food that is lost or wasted.
- 4 **Research idea:** The government department likely to hold statistics on this issue may vary from country to country.

Relevant websites include:

[www.worldfooddayusa.org/food\\_waste\\_the\\_facts](http://www.worldfooddayusa.org/food_waste_the_facts)  
[www.unep.org](http://www.unep.org)  
[www.unric.org/en/food-waste](http://www.unric.org/en/food-waste)

#### 5.02.03

- 1 Physical, economic, political, social/cultural.
- 2 From 0.45 hectares per capita to 0.23.
- 3 The energy in meat passes through two steps before human consumption, compared with the single step for crop production. The yield of food per unit area from lower trophic levels (e.g. crops) is greater in quantity than that from higher trophic levels (e.g. livestock), lower in cost and generally requires fewer resources.
- 4 **Discussion point:** Focus on the efficiency of terrestrial food-production systems. Further information can be obtained from a number of relevant websites, which include:  
[www.worldwatch.org/node/549](http://www.worldwatch.org/node/549)  
[www.sustainweb.org/sustainablefood/meat\\_and\\_dairy\\_products\\_less\\_is\\_more/](http://www.sustainweb.org/sustainablefood/meat_and_dairy_products_less_is_more/)  
[www.worldwatch.org/global-meat-production-and-consumption-continue-rise](http://www.worldwatch.org/global-meat-production-and-consumption-continue-rise)

#### 5.02.04

- 1 Agro-ecosystems are forms of modern farming that involve the industrialised production of livestock, poultry, fish and crops.
- 2 For example: very large farms; concentration on one product (monoculture) or a small number of farm products; a high level of mechanisation; low labour input per unit of production; heavy usage of fertilisers, pesticides and herbicides.
- 3 **Discussion point:** Local food production systems can vary from small-scale organic farming (e.g. smallholdings with hens producing free-range eggs) to very large-scale industrial farms (e.g. major battery hen units). While your and other students' perceptions may vary, people tend to be more sympathetic to smaller-scale low chemical/energy input farming than the larger-scale alternatives. However, you may well feel that large-scale commercial farming is necessary to meet the food demands of growing and more affluent populations.

#### 5.03.01

- 1 **a** Soil degradation is a change in the soil health status resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries.
- b** The short, tough grass is extremely patchy, with the majority of the area being bare soil. The mineral content of the soil is clear to see, but there is a general absence of humus.

## Answers to self-assessment questions

- 2 In temperate areas, much soil degradation is a result of market forces and the attitudes adopted by commercial farmers and governments. In contrast, in the tropics, much degradation results from high population pressure, land shortages and lack of awareness. The greater climatic extremes and poorer soil structures in tropical areas give greater potential for degradation in such areas compared with temperate latitudes. This difference has been a significant factor in development or the lack of it.
- 3 **Research idea:** Information may be available from the department of agriculture, from local farming organisations, from farming journals, and from local farmers themselves. If the problem is severe, the national and local press are likely to have written about the problem.

### 5.03.02

- 1 a Deforestation is the process of destroying a forest and replacing it with something else, especially with an agricultural system.
- b Overgrazing is the grazing of natural pastures at stocking intensities above the livestock carrying capacity.
- 2 Salinisation is the condition in which the salt content of soil accumulates over time to above normal levels. It occurs in some parts of the world where water containing a high salt concentration evaporates from fields irrigated with standing water.
- 3 **Discussion point:** The discussion might recognise that some farming communities may think about short-term profit at the expense of longer-term sustainability. In LEDCs where population pressure is intense, it may be difficult for many communities to think beyond short-term survival.

### 5.03.03

- 1 Desertification is the gradual transformation of habitable land into desert.
- 2 Desertification is usually caused by climate change and/or by destructive use of the land.
- 3 **Research idea:** Desertification affects a considerable number of countries, so there is a wide choice. Individual students could select different examples and report back their findings to the class. Useful websites include:  
[www.greenfacts.org/en/desertification](http://www.greenfacts.org/en/desertification)  
[www.un.org/fr/events/desertificationday/2008/definition.shtml](http://www.un.org/fr/events/desertificationday/2008/definition.shtml)

### 5.03.04

- 1 a Soil conditioning is the process of adding materials to soil to improve soil fertility.
- b Lime is commonly used to reduce soil acidity by increasing the pH level.

- 2 The planting of trees in shelter belts can do much to dissipate the impact of strong winds, reducing the wind's ability to disturb topsoil and erode particles. Shelter belts shelter the soil by reducing wind and evaporation and thus increasing soil temperature. They provide roots at the boundaries of the field, supplying valuable organic matter.
- 3 **Discussion point:** Show awareness of the fragility of marginal lands and the need to cultivate carefully and in a sustainable manner. Failure to appreciate the productive limits of marginal lands can quickly lead to serious soil degradation.

## Topic 6

### 6.01.01

- 1 The division of the atmosphere into a number of layers in terms of temperature variation.
- 2 a Temperature lapse is a decline in temperature with altitude.
- b Temperature inversion is an increase in temperature with altitude.
- 3 Certain gases in the stratosphere and thermosphere absorb solar radiation.
- 4 **Discussion point:** Houses, factories, motor vehicles and other sources of pollution are much more concentrated in urban areas than rural areas. You might debate the contrast between the urban and rural areas closest to you, giving examples of pollution.

### 6.01.02

- 1 Water vapour, liquid water, ice.
- 2 a Energy balance: the balance between incoming solar radiation and outgoing terrestrial radiation.
- b Solar constant: the amount of solar energy received per unit area, per unit time, on a surface at right angles to the Sun's beam at the edge of the Earth's atmosphere.
- 3 **Discussion point:** You might refer to Figure 6.06 to explain how greenhouse gases trap a proportion of outgoing radiation from the Earth, which gives the Earth a much higher average temperature than it would otherwise have. The ability of the atmosphere to capture the Sun's warmth is essential for life on Earth.

### 6.02.01

- 1 Ultraviolet radiation has a wavelength between 100 and 400 nm, compared with between 400 and 780 nm for visible radiation.
- 2 Most of the ozone is in the stratosphere, with only about 10 per cent in the troposphere. The maximum concentration

of ozone is at an altitude of about 20–25 km, where it exceeds 25 millipascals. The fall in ozone concentration either side of this peak is steep on both sides.

- 3 **Discussion point:** Focus on the ‘good’ effect of stratospheric ozone, which shields the Earth from harmful ultraviolet radiation. Contrast this with the pollution problems caused by ‘bad’ ozone in the troposphere.

#### 6.02.02

- 1 a Most ozone-depleting substances contain the halogens chlorine, fluorine and bromine.  
b They are contained in industrial products such as CFCs, hydrochlorofluorocarbons, halons and methyl bromide.
- 2 Volcanic eruptions.
- 3 **Research idea:** Various websites will provide this information including:  
[www.livescience.com](http://www.livescience.com)  
[www.nasa.gov](http://www.nasa.gov)

#### 6.02.03

- 1 Large increase in the occurrence of cataracts and sunburn; significant increase in the incidence of skin cancer; suppression of immune systems in organisms.
- 2 Small amounts of ultraviolet radiation are beneficial and can help prevent diseases such as rickets. However, beyond a certain point ultraviolet radiation poses a danger to human health.
- 3 An increase in ultraviolet radiation can decrease the productivity of phytoplankton in marine ecosystems.
- 4 **Research idea:** Various websites will provide this information. Such sources might include:  
[www.who.int/uv/health/en](http://www.who.int/uv/health/en)  
[www.earthobservatory.nasa.gov](http://www.earthobservatory.nasa.gov)  
<http://www2.epa.gov/sunsafety/health-effects-uv-radiation-1>

#### 6.02.04

- 1 a A refrigerant is a substance used in a heat cycle usually including a reversible phase change from a liquid to a gas.  
b The main use of refrigerants is in refrigerators/freezers and air-conditioning systems.
- 2 Ammonia is a natural refrigerant that is environmentally benign in the atmosphere. It is efficient and cost-effective, with a very good safety record.
- 3 A gas-blown plastic is created when a plastic is ‘blown’ with a gas to create a foam that has a large number of voids incorporating the gas. Foam insulation is a major type of gas-blown plastic.

- 4 **Discussion point:** Note that there are both chemical and non-chemical alternatives to methyl bromide. Non-chemical alternatives include solarisation and crop rotation. Chemical alternatives include chloropicrin and metam sodium.

#### 6.02.05

- 1 1987.
- 2 98 per cent.
- 3 It is often the case that when major agreements are signed, follow-up meetings and amendments are required to maintain international agreement. Also, more detailed scientific information may have become available since the original agreement was signed.
- 4 Under the Montreal Protocol, individual countries have had to show how they plan to phase out ozone-depleting substances.
- 5 **Discussion point:** You are likely to focus on the very significant decline in the emission of ozone-depleting substances since the Montreal Protocol was signed, but you might also discuss the illegal market in ozone-depleting substances. Internet research may yield other criticisms.

#### 6.03.01

- 1 Road vehicles and other transportation account for 38 per cent of total VOC emissions. Printing/surface coating and general solvent use account for 19 per cent and 18 per cent respectively. Fourteen per cent of emissions come from other industrial processes. Residential accounts for 8 per cent, and 3 per cent is classed as miscellaneous.
- 2 a In the northern hemisphere, ozone levels are highest between May and September, because these are the months of most sunlight.  
b On a daily basis, ozone levels are highest between noon and early evening after the Sun’s rays have had time to react with exhaust fumes from high traffic volumes in the morning rush hour.
- 3 It has more than doubled.
- 4 **Research idea:** Most large cities monitor and record levels of ozone and other major pollutants. These figures may appear with weather forecasts or in the daily press. If not, they should be available from the relevant department in the city council.

#### 6.03.02

- 1 Smog is a form of air pollution that generally reduces visibility, produced by the photochemical reaction of sunlight with hydrocarbons and nitrogen oxides that have been released into the atmosphere, especially by vehicle emissions.

## Answers to self-assessment questions

- 2 When the usual decline in temperature with altitude in the troposphere is reversed, a temperature inversion occurs, with warmer air found above colder surface air. The clear skies associated with anticyclones allow the ground to lose heat rapidly at night. The cold surface air is more dense and is prevented from rising upwards by the warmer air overlying it. Thus pollutants contained in the cold air are trapped near the ground, with their levels building up as emissions from vehicles and other sources continue to pollute the environment. Pollutants are not easily dispersed horizontally when there is very little air movement. Katabatic winds can add to the temperature inversion problem (see Figure 6.19); these are currents of cold air that blow downslope from surrounding uplands into a valley or other lowland area, thus creating or increasing the mass of cold air in a valley.
- 3 **Research idea:** An internet search should produce the information you require. Local newspapers may prove to be the best source. Summarise the information you gain in a fact file.

### 6.03.03

- 1 Catalytic reduction and using less air in combustion.
- 2 Switching from petrol to liquefied petroleum gas or compressed natural gas; implementing engine and emission controls being developed by manufacturers; cutting the distances vehicles travel by using alternative transport such as bicycles and public transport.
- 3 Nine of the ten most polluted cities are located in the Indian subcontinent. The remaining city is in Iran, which borders Pakistan.
- 4 **Discussion point:** Refer to the section in this chapter entitled 'Personal strategies to reduce air pollution' for guidance. However, you may think of strategies that are not included here.

### 6.04.01

- 1 Dry deposition is the direct uptake by the ground of pollutants in the form of particles, aerosols and gases in the absence of precipitation. In contrast, wet deposition occurs in the forms of acid rain, snow, fog and mist.
- 2 The burning of fossil fuels.
- 3 Pure water is neutral and has a pH of 7. The pH of unpolluted rainwater ranges from 5 to 6. Acid rain has a pH of less than 5.
- 4 **Research idea:** Wet and dry acid deposition contribute to the corrosion of metals (such as bronze) and the deterioration of paint and stone (such as marble and limestone). Dry deposition of acidic compounds can also dirty buildings, leading to increased maintenance costs.

### 6.04.02

- 1 Acid deposition can damage leaves, limiting the nutrients available to them.
- 2 With acid deposition, the hydrogen ions in sulfuric acid trade places with the metal ions. The hydrogen ions are retained and neutralised by the soil, but the calcium, potassium and magnesium ions are leached or washed out of the topsoil into lower inaccessible subsoil. These ions are then not available as nutrients needed for vegetation growth. Such leaching occurs naturally, but acid deposition speeds up the process.
- 3 Acid deposition can interfere with the ability of fish to take in oxygen, salt and nutrients. For freshwater fish, maintaining osmoregulation is vital to stay alive. Osmoregulation is the ability to maintain a state of balance between salt and minerals in the organism's tissues. Acid molecules cause mucus to develop in the gills of fish, hindering the absorption of oxygen. Some fish are unable to maintain their calcium levels when the water they swim in becomes more acidic. This can result in reproduction problems. Spring is a vulnerable time for many species, as this is the time of the year for reproduction.
- 4 **Research idea:** Acid rain affects crops directly and decreases soil quality to reduce yields from agriculture. Its effects are most severe near sources of sulfur dioxide and nitrogen oxides. Acid rain can damage the leaves of vegetation and cause blemishes on tomatoes and other crops. There has been some debate that crops produced under acidic conditions have lower nutritional value with fewer minerals. In richer economies, farmers can counteract the effect of acid deposition with the use of appropriate chemical additives, but for poorer farmers this is not a viable option.

### 6.04.03

- 1 Neighbouring European countries, primarily the UK, Germany and Poland.
- 2 The capacity of soil to neutralise some or all of the acidity of acid rainwater.
- 3 Granite weathers slowly and does not produce much in terms of neutralising chemicals, making the rock vulnerable to acidification.
- 4 **Research idea:** There are a number of useful websites including:  
<http://environment.nationalgeographic.com/environment>  
[www.sciencephoto.com](http://www.sciencephoto.com)  
Try to select as many different types of environment as you can, both urban and rural.

### 6.04.04

- 1 The Convention on Long-Range Transboundary of Air Pollution (LRTAP) was signed in 1979.

- 2 The Large Combustion Plant Directive (LCPD) aims at reducing sulfur emissions by giving coal-fired plants two options. They can either agree to a very limited running programme and close down by 2015, or install the equipment needed to remove sulfur from plant emissions.
- 3 **Discussion point:** Try to weigh up the advantages of a cleaner environment in terms of much reduced air, water and ground pollution and the redevelopment of derelict industrial sites against economic costs such as unemployment, lost production, reduced export earnings, and so on. In a higher-level discussion you might argue that the rise of the tertiary and quaternary sectors has compensated for the decline of manufacturing industry.

## Topic 7

### 7.01.01

- 1 Non-renewable sources of energy are the fossil fuels (coal, oil, natural gas) and nuclear fuel.
- 2 Renewable energy can be used over and over again. These resources are mainly forces of nature that are sustainable and which usually cause little or no environmental pollution. Renewable energy includes hydroelectricity, biomass, wind, solar, geothermal, tidal and wave power.
- 3 Oil – 33 per cent, coal – 30 per cent, natural gas – 24 per cent, hydroelectricity – 6.6 per cent, nuclear energy – 4.5 per cent, and renewable energy – 1.3 per cent.
- 4 **a** Fuelwood and charcoal are collectively called fuelwood, which accounts for just over half of global wood production.  
**b** In developing countries about 2.5 billion people rely on fuelwood, charcoal and animal dung for cooking. Fuelwood provides much of the energy needs for sub-Saharan Africa. It is also the most important use of wood in Asia. In 2010, 1.2 billion people were still living without electricity.
- 5 **Research idea:** The BP Statistical Review of World Energy is one of the most detailed sources available for this topic. The statistics are updated every year. The energy-charting tool is an interesting way to illustrate energy production, consumption and trends.

### 7.01.02

- 1 Energy pathways are supply routes between energy producers and consumers, which may be pipelines, shipping routes or electricity cables. The political stability of these pathways is important for energy security. Some important

energy pathways are vulnerable to disruption at times of political tension.

- 2 Some countries have built up strategic petroleum reserves so that they have a stockpile of oil to last a number of months if their oil supplies are disrupted.
- 3 **Discussion point:** Discussion will probably focus on the negative aspects of wind power in Table 7.03. You might think of additional disadvantages. The task will be to weigh up the balance between advantages and disadvantages and to assess why more people have become critical of this source of power.

### 7.01.03

- 1 Three main concerns about nuclear energy are:
  - the possibility of power plant accidents, which could release radiation into air, land and sea
  - the problem of radioactive waste storage/disposal – most concern is over the small proportion of ‘high-level waste’; no country has yet implemented a long-term solution to the nuclear waste problem
  - high construction and decommissioning costs – recent estimates put an average price of about US\$6.3 billion on a new nuclear power plant.

Among the advantages of nuclear energy quoted by its supporters are:

- zero emissions of greenhouse gases
  - reduced reliance on imported fossil fuels
  - nuclear power is not as vulnerable to fuel price fluctuations as oil and gas – uranium, the fuel for nuclear plants, is relatively plentiful. Most of the main uranium mines are in politically stable countries.
- 2 Physical factors influencing global variations in energy supply include:
    - Deposits of fossil fuels are only found in a limited number of locations.
    - Large-scale hydroelectric development requires high precipitation, major steep-sided valleys and impermeable rock.
    - Efficient solar power needs a large number of days a year with strong sunlight.
  - 3 **Discussion point:** You might base your discussion on two or three of the bullet points immediately above these self-assessment questions. For example, you might comment on the fact that nuclear electricity has only been available (to a very small number of countries) since the mid-1950s, or refer to the fact that, in richer countries, coal has been replaced as a source of power for railways, for most homes,

## Answers to self-assessment questions

and for other purposes. You might also think of other equally good examples.

### 7.02.01

- a** Climate change is the long-term sustained change in the average global climate.  
**b** Global warming is the increase in the average temperature of the Earth's near-surface air in the 20th and early 21st centuries and its projected continuation.
- The 'tipping point' is the level at which the effects of climate change will become irreversible to varying degrees.
- Discussion point:** Your discussion is likely to focus on the fact that climate change will undoubtedly increase demands on government spending across a range of sectors and that, in pure financial terms, spending money to reduce the extent of climate change will be less expensive than having to adapt to greater degree of climate change.

### 7.02.02

- Water vapour, carbon dioxide, methane, chlorofluorocarbons, nitrous oxides, ozone.
- a** Total emissions – China, USA, India, Russia, Japan.  
**b** Per-capita emissions – Australia, the USA, Saudi Arabia, Canada, South Korea.
- Discussion point:** The bullet-pointed information provided in the text above Self-assessment questions 7.02.02 shows that the electricity and transportation sectors together account for 60 per cent of greenhouse gas emissions in the USA. You will debate why this is so. You will also want to comment on the contributions of the industry, commercial and residential, and agricultural sectors.

### 7.02.03

- Tundra ecosystems in Arctic areas are being significantly affected by temperature increase. A large area of permafrost has started to melt for the first time since it formed 11 000 years ago at the end of the last ice age. The area, which covers the entire sub-Arctic region of western Siberia, is the world's largest frozen peat bog, and scientists fear that, as it thaws, it will release billions of tonnes of methane, a greenhouse gas 20 times more potent than carbon dioxide, into the atmosphere. Scientists are putting together monitoring networks to measure the release of gases from Arctic soils.
- Coral reefs are biologically rich ecosystems, but they are very sensitive to climate change and other forms of stress. An increase in sea temperature along with other factors such as pollution and sedimentation can effectively halt

photosynthesis of the zooxanthellae (algae), resulting in the death of the living part of the coral. The death of the zooxanthellae leaves the coral in an energy deficit and without colour – a process known as coral bleaching. Large areas of coral around the world have been affected by this process.

- This phenomenon is a change in the pattern of wind and ocean currents in the Pacific Ocean. This causes short-term changes in weather for countries bordering the Pacific, such as flooding in Peru and drought in Australia. El Niño events tend to occur every two to seven years. There is concern that rising temperatures could increase the frequency and/or intensity of El Niño events.
- Two separate studies published in 2014 (NASA, and the University of Washington) stated that the loss of the Western Antarctic Ice Sheet is inevitable, although the collapse of the ice sheet is at least several centuries off. This will cause up to 4 m of additional sea level rise, which will change the coastline in many parts of the world. Scientists have concluded that the causes of ice loss are highly complex. It is not just due to warmer temperatures causing surface melting of the ice. Contact between the ice and the relatively warmer water at the ocean depths is a major contributory factor.
- Discussion point:** The website [wwf.panda.org](http://wwf.panda.org) provides a wealth of information on the topic. You could produce a bullet-point summary of the impacts of climate change in the Arctic region.

### 7.02.04

- Feedback is the return of part of the output from a system as input, so as to affect succeeding outputs. Positive feedback is feedback that amplifies or increases change and leads to exponential deviation away from an equilibrium. Negative feedback is feedback that tends to damp down, neutralise or counteract any deviation from an equilibrium, and promotes stability.
- Increasing average temperatures are melting Arctic ice. Until recently, 80 per cent of solar radiation was reflected from the polar ice caps. As the area covered by ice has reduced, the area of open ocean has increased. Because oceans are darker than ice and snow, they absorb more of the Sun's energy and convert it to heat. This increases the warming effect, which melts even more ice. It is, in fact, a vicious circle known as the positive ice albedo effect.
- The thermal inertia of the oceans is sometimes referred to as climate lag. The mass of the oceans is about 500 times that of the atmosphere. Thus the time it takes the oceans to warm is measured in decades. The greatest difficulty is in quantifying the rate at which the warm upper layers of the ocean mix with the cooler deeper waters. Because of this (and other factors), there is significant variation in estimates of climate lag.

- 4 **Research idea:** The Meteorological Office in the UK is an excellent source of information on most aspects of weather and climate. The section on climate feedback is presented in a clear and interesting way. You could note down any additional information that is not contained in the textbook concerning global warming.
- concerning global warming.

#### 7.02.05

- 1 Variations in the tilt of the Earth's axis; variations in the Earth's orbit around the Sun; variations in solar output.
- 2 **a** Global dimming is a worldwide decline in the intensity of the sunlight reaching the Earth's surface, caused by particulate air pollution and natural events.  
**b** Global brightening is an increasing amount of sunlight reaching the Earth's surface.
- 3 **Discussion point:** Prior to discussion, it might be useful to read Figure 7.21 again and make a brief note of the main points of disagreement between George Monbiot and Christopher Booker.

#### 7.03.01

- 1 Climate mitigation attempts to reduce the causes of climate change, while climate adaptation strategies attempt to manage the impacts of climate change. For example: reducing global consumption of meat and dairy products; applying fertiliser more efficiently; planting fallow fields with nitrogen-fixing legume crops.
- 2 Solar radiation management techniques aim to reflect some of the Sun's energy back into space to try to counteract global warming. The objective of CDR techniques is to remove carbon dioxide from the atmosphere to directly reduce the enhanced greenhouse effect and ocean acidification.
- 3 **Discussion point:** Focus on the fact that solar radiation management techniques aim to reflect some of the Sun's energy back into space to try to counteract global warming, while the objective of CDR techniques is to remove carbon dioxide from the atmosphere to directly reduce the enhanced greenhouse effect and ocean acidification.

#### 7.03.02

- 1 For example: building coastal defences to protect against rising sea levels; improving the quality of road surfaces to withstand with higher temperatures; developing drought-resistant crops.
- 2 The term 'adaptive capacity' describes the potential to adjust in order to minimise negative impacts and maximise any benefits from climate change. Adaptive capacity varies from place to place and can be dependent on financial and technological resources.

- 3 **Research idea:** Some such publications may already be known to you and your family. Your school/college library may be a good source of information. Discussion within the group could yield the titles of a number of interesting publications.

## Topic 8

### 8.01.01

- 1 Birth rates: Brazil 15.0, UK 13.0.  
Death rates: Brazil 6.0, UK 8.9.
- 2 World: **a** 12/1000, **b** 1.2 per cent.  
MEDCs: **a** 1/1000, **b** 0.1 per cent.  
LEDCs: **a** 15/1000, **b** 1.5 per cent.  
Africa: **a** 26/1000, **b** 2.6 per cent.  
Asia: **a** 11/1000, **b** 1.1 per cent.  
Latin America/Caribbean: **a** 12/1000, **b** 1.2 per cent.  
North America: **a** 4/1000, **b** 0.4 per cent.  
Oceania: **a** 11/1000, **b** 1.1 per cent.  
Europe: **a** 0/1000, **b** 0.0 per cent.
- 3 China 140 years; India 47 years; Nigeria 28 years; USA 88 years.
- 4 **Research idea:** The government department responsible for population data is the most obvious source of information, although you will probably find it available from other sources as well. For example, in the UK, the Office for National Statistics (ONS) ([www.ons.gov.uk](http://www.ons.gov.uk)) is the original source of such data. The relevant sections of the text above Self-assessment questions 8.01.01 provide the 'reasons' to be discussed.

### 8.01.02

- 1 Better nutrition; improved public health, particularly in terms of clean water supply and efficient sewage systems; and medical advances.
- 2 It takes time for social norms to adjust to the lower level of mortality before the birth rate begins to decline.
- 3 This happens in countries where women in particular make decisions to have only one child or no children at all, and where there is very high use of reliable contraception.
- 4 Critics of the model see it as too Europe-centric. They argue that many LEDCs may not follow the sequence set out in the model. It has also been criticised for its failure to take into account changes due to migration.

## Answers to self-assessment questions

**5 Research idea:** For some countries, the two selected population pyramids might show different stages of population transition. However, significant changes can still be seen in population pyramids for countries within the same stage of demographic transition, for example countries in stage 4 where the population has aged considerably over the last 30 years or so.

### 8.01.03

- 1 Such policies have lowered the death rate through better public health and sanitation, agricultural development, and improved service infrastructure.
- 2 Economic growth allows greater spending on health, housing, nutrition and education, which is important in lowering mortality and in turn reducing fertility. Education, especially improvements in female literacy, is the key to lower fertility. With education comes a knowledge of birth control, greater social awareness, more opportunity for employment and a wider choice of action generally.
- 3 Such countries are concerned about the socioeconomic implications of population ageing, the decrease in the supply of labour, and the long-term prospect of population decline.
- 4 **Discussion point:** The current figures for the total fertility rate for the country in which you live will be available from national sources, but also from The World Population Data Sheet published by the Population Reference Bureau ([www.prb.org](http://www.prb.org)). In terms of government encouragement to have more or fewer children, the relevant sections above Self-assessment questions 8.01.03 should provide the basis for discussion.

### 8.01.04

- 1 Population projections are the prediction of future populations based on the present age–sex structure, and with present rates of fertility, mortality and migration.
- 2 Population projections form the basis for a range of government and intergovernmental policies. It is important, for example, for governments to know: how many children will need places in primary schools, secondary schools and universities; how many older people will require public pensions; how much food will need to be grown/imported to feed the population; how many houses need to be built in the future.
- 3 The development of computing and the massive increase in computing capacity has allowed increasingly complex permutations to be included in projections. Such technological developments have also allowed frequent updating of projections to reflect changes in trends in fertility, mortality and other relevant factors.

**4 Research idea:** The information should be available from the government department responsible for population statistics. The following websites may also be useful:  
[www.unfpa.org/world-population-trends](http://www.unfpa.org/world-population-trends)  
[www.un.org/en/development/desa/population](http://www.un.org/en/development/desa/population)

### 8.02.01

- 1 A resource can be defined as any aspect of the environment that can be used to meet human needs.
- 2 Natural capital refers to the source of supply of resources and services that are derived from nature. Natural income is the annual yield from sources of natural capital.
- 3 **Discussion point:** Think how well endowed or otherwise your country is in terms of forests, soils, cropland, water and sources of energy and minerals. You could produce a bullet-point summary.

### 8.02.02

- 1 **a** Renewable natural capital comprises living species and ecosystems. It is self-producing and self-maintaining and uses solar energy and photosynthesis to produce food and chemical energy.  
**b** Replenishable natural capital consists of stocks of non-living resources. Examples are the atmosphere, fertile soils and groundwater. Such resources are dependent on energy from the Sun for renewal.  
**c** Non-renewable natural capital consists of subsoil assets such as coal, oil, copper and diamonds. Such resources are depleted as they are consumed.
- 2 Recyclable resources can be used over and over, but must first go through a process to prepare them for reuse.
- 3 **Discussion point:** For example, in some countries mines (coal, tin, etc.) have been closed because there is not enough of the resource left to make mining worthwhile. Forests may have been cleared to leave little remaining woodland. Soils may have been degraded to a considerable degree. Groundwater might be depleted.

### 8.02.03

- 1 The development of the nuclear power industry in the UK and other countries found a new use for uranium, which significantly increased its value as a resource. The electrification of the railway system, which was once totally steam-driven, was a major change that significantly reduced the demand for coal.
- 2 Attitudes to plastic bags and the packaging of goods in general are changing in terms of the resources like oil which are used up and the amount of waste created.

- 3 **Discussion point:** Discussion with parents and grandparents would be very valuable here. However, you might also think of examples within your own lifetime. For example, 20 years ago your parents might have used coal as their main source of energy; now their source of energy might be electricity, oil or natural gas.

#### 8.02.04

- 1 The intrinsic value of the environment or any other entity is the value that the entity has in itself. Intrinsic value is usually contrasted with extrinsic or use value.
- 2 Yellowstone in the western USA, 1872.
- 3 **Discussion point:** Your selected natural environment might be a lake, a stretch of coastline, a forest, a hill or mountain, a glacier or an area of open countryside. It may be somewhere where you live or used to live, or somewhere you visited on holiday. It could also be somewhere you have seen in the cinema, on television or in a magazine.

#### 8.02.05

- 1 Environmental sustainability means meeting the needs of the present without compromising the ability of future generations to meet their needs.
- 2 The ESI benchmarks the ability of nations to protect the environment over the next several decades.
- 3 **Discussion point:** Your discussion is likely to focus on the concept of destination footprint and to break this down into its individual components such as air travel, water use and nature of natural environments.

#### 8.03.01

- 1 SDW is waste produced by households as opposed to other sectors of the economy.
- 2 As living standards develop, the nature of SDW changes. The proportion of waste that is organic/biomass declines as waste from higher value products becomes more important. For example, e-waste is a significant contributor to household waste in MEDCs, but only makes a minor contribution in very poor nations.
- 3 **Research idea:** As domestic waste is a current issue, relevant data should be available from your local authority (council). You would expect to find significant changes over time, for example an increase in e-waste. You would also expect to find that recycling had increased considerably.

#### 8.03.02

- 1 Electronic waste, or e-waste, is discarded electrical or electronic devices and their parts.
- 2 The e-waste problem is becoming particularly serious in developing countries due to: lack of legislation and

enforcement; lack of controlled take-back systems; informal sector dominance in recycling; lack of awareness by government, institutions and the general public; illegal importation of e-waste from developing countries, often using false documentation.

- 3 Two huge accumulations of waste in large areas of the Pacific Ocean brought together by the North Pacific Subtropical Gyre. Gyres are regions of the oceans where water rotates in a large circular pattern.
- 4 **Discussion point:** It should be an interesting exercise to total the e-waste for your class. Try to subdivide e-waste into different categories.

#### 8.03.03

- 1 Landfill is a disposal site where solid waste is buried between layers of dirt in such a way as to reduce contamination of the surrounding land. It involves using a natural depression in the landscape or, more usually, digging a large and deep pit.
- 2 Incinerators are expensive to build and operate. Incineration requires a high input of energy, and the tall chimney stacks are viewed by most people as a blot on the landscape. The movement of heavy goods vehicles to and from incinerators is also considerable. The ash produced has to be disposed of in landfill. The environmental and health concerns over incineration are long-standing, with sulfur dioxide, nitrogen dioxide, nitrous oxide, carbon dioxide, chlorine, dioxin and particulates being emitted by the process of incineration. However, considerable technological advances have significantly lowered the emission of pollutants into the atmosphere.
- 3 Composting is where organic material that has been decomposed is recycled as a fertiliser because of its high nutrient value.
- 4 **Discussion point:** The relevant text prior to Self-assessment questions 8.03.03 clearly outlines the advantages and disadvantages of incineration. This is very much a value judgement. If you have ever lived near an incinerator, this might be a considerable influence on your perceptions.

#### 8.04.01

- 1 Carrying capacity is the maximum number of a species, or 'load', that can be sustainably supported by a given area.
- 2 For example: human ingenuity has enabled resource substitution to overcome problems when a particular resource has become depleted, by coming up with a replacement; the resource requirements of local human populations vary significantly because of different lifestyles and levels of development; technological developments can impact considerably on resource requirements and

## Answers to self-assessment questions

availability; affluent local populations can import resources from other geographical areas.

- 3 **Discussion point:** This discussion will focus very much on personal perceptions, as some people will think differently from others. Those living in densely crowded large cities may think that their environment is very close to carrying capacity (or even beyond it), while in rural areas perceptions might be very different.

### 8.04.02

- 1 Product stewardship is an approach to environmental protection in which manufacturers, retailers and consumers are encouraged or required to assume responsibility for reducing a product's impact on the environment.
- 2 Substitution is the use of common and thus less valuable resources in place of rare, more expensive resources.
- 3 **Discussion point:** The inclination to reuse is partly governed by level of income, with people on modest incomes more likely to not want to throw something away that they can find an alternative use for. An example might be an old sink being reused as a plant container. However,

people on higher incomes might reuse because they are environmentally conscious. The technical ability to make minor modifications to a product can also be a factor.

### 8.04.03

- 1 **a** The ecological footprint is a sustainability indicator that expresses the relationship between population and the natural environment. It sums the use of natural resources by a country's population.  
**b** A global hectare (gha) is the equivalent of 1 hectare of biologically productive space with world average productivity.
- 2 Built-up land; fishing ground; forest; grazing land; cropland; carbon footprint.
- 3 **Discussion point:** A useful discussion could look at what might happen in terms of the individual components of the ecological footprint, such as carbon footprint and forested land. Then you might consider the situation of significantly greater pressure on all components. With intense pressure on resources, the results could be starvation, migration and war.