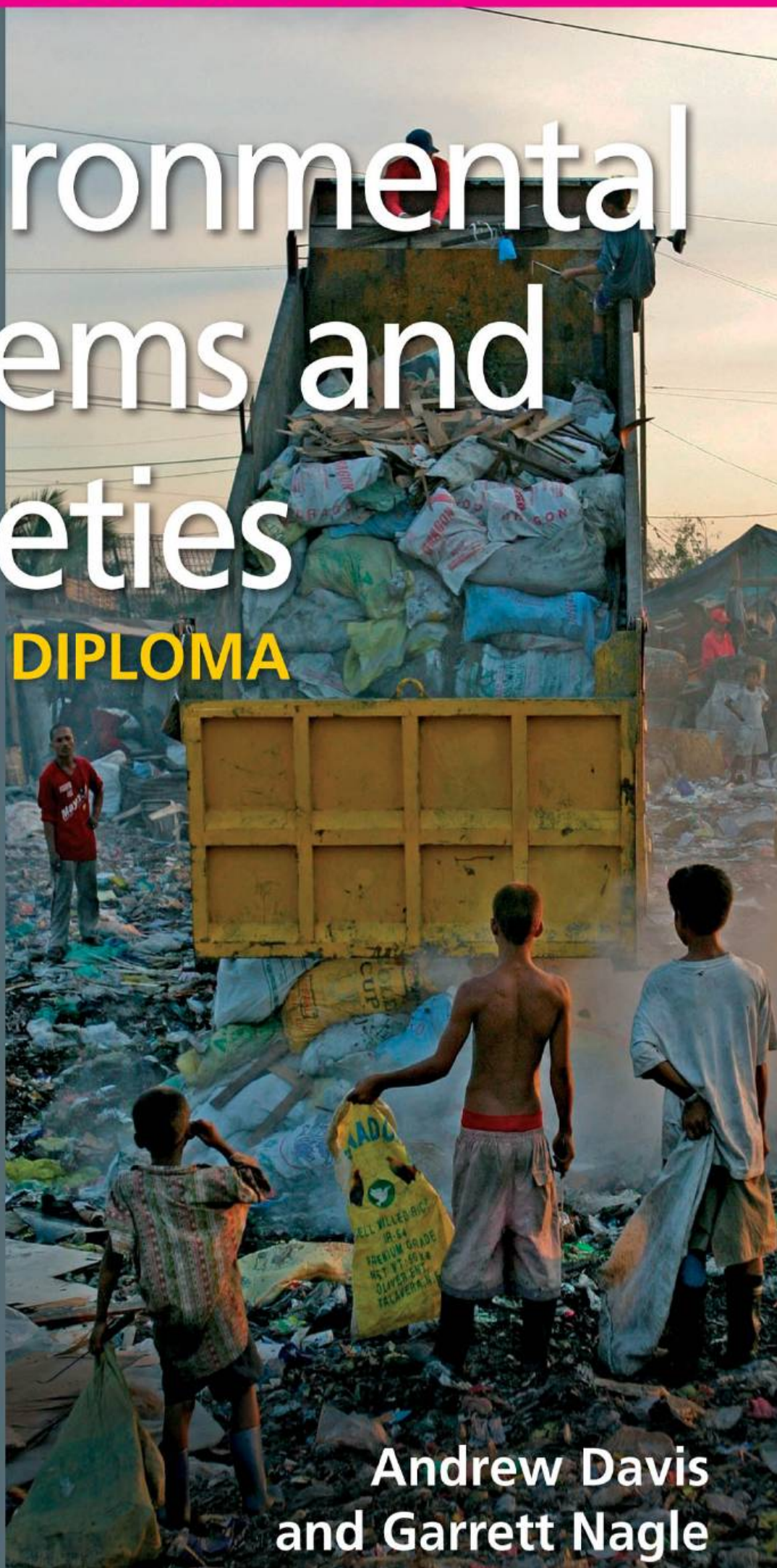
REVISION GUIDE

Environmental Systems and Societies

for the IB DIPLOMA

ANSWERS



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HODDER EDUCATION

Answers

Topic 1 Systems and models

Quick check questions

1 Allows systems to be divided into parts, or components, which can each be studied separately (reductionist approach). Allows a system to be studied as a whole, and patterns and processes described for the whole system (holistic approach). Allows different subjects to be approached in the same way and cross-linkages between them explored. Can be applied equally to ecological, economic, social and value systems.

2 Transfers are processes involving a change in location within the system but no change in state, for example water flowing from groundwater into a river. Transformations lead to the formation of new products (e.g. photosynthesis that converts sunlight energy, carbon dioxide and water into glucose and oxygen) or involve a change in state (e.g. water evaporating from a leaf into the atmosphere).

3 Open systems exchange both matter and energy with their surroundings (e.g. an ecosystem). Closed systems exchange only energy but not matter with their surroundings (e.g. the Earth). Isolated systems do not exchange either matter or energy with their surroundings (e.g. the Universe).

4 The condition of an open system in which there are no changes over the longer term, but in which there may be oscillations in the very short term.

5 In stable equilibrium there is the tendency in a system for it to return to a previous equilibrium condition following disturbance; this is in contrast to unstable equilibrium, which forms a new equilibrium following disturbance.

6 Positive feedback is feedback that increases change; it promotes deviation away from equilibrium. Negative feedback is feedback that tends to counteract any deviation from equilibrium, and promotes stability. Negative feedback mechanisms help to maintain stability whereas positive feedback tends to amplify change away from equilibrium.

7 Negative feedback: E.g. predator–prey relationship between snowshoe hare and lynx in the boreal forest of North America. The snowshoe hare increases due to few predators and abundant food, this leads to an increase in the lynx population (the predator), which in turn leads to a reduction in hare population, leading to a reduction in lynx population as its prey decreases in abundance. E.g. increased CO_2 levels in atmosphere lead to increase in photosynthesis and productivity, which leads to increased plant biomass and increased CO_2 sequestration, which leads to reduction in CO_2 levels.

Positive feedback: E.g. eutrophication, i.e. nutrient enrichment of water leads to algal blooms, which results in less light reaching the lake floor, which in turn leads to death of submerged plants and breakdown of dead plant material by bacteria, further increasing nutrients in the lake. E.g. increase in global temperatures leads to increased melting of ice, which leads to reduced albedo and increased heating of oceans, which leads to further increase in global temperatures and further melting of ice.

8

Advantages	Disadvantages
■ They simplify complex systems and allow predictions to be made ■ Inputs can be changed to see their effects and outputs, without having to wait for real events ■ Results can be shown to other scientists and to the public. Models are easier to understand than detailed information about the whole system	■ They may not be accurate and may be too simple ■ They rely on the level of expertise of the people making them ■ Different people may interpret them in different ways ■ They may be used politically ■ They depend on the quality of the data that go into the inputs ■ Different models may show different outputs even if they are given the same data

Exam practice

1 a Earth is a closed system [1]; energy: input = solar radiation, output = heat energy [1]; materials cycle within the system (can include, for example, meteorites introducing a small amount of matter) [1].

b *Any 2 of the following:* Gaia (named after an ancient Greek goddess) is a model developed by James Lovelock; the Earth is considered a single, self-regulating system; in which feedback mechanisms maintain equilibrium. [2 max]

Any 5 of the following: Enhanced climate change will be mitigated by negative feedback mechanisms; negative feedback dampens down deviation from equilibrium and increases stability; e.g. increased sequestering of carbon dioxide in plant biomass; some effects of increased greenhouse gas emissions cannot be mitigated by components of the system as they will result in positive feedback mechanisms; positive feedback allows for movement away from equilibrium and decreases stability; e.g. increased methane release from permafrost as ice melts; pollution from greenhouse gases can have a global impact; different equilibrium may be established; e.g. adaptations of populations/species to the change in climatic conditions; management must reduce greenhouse gas emissions so that the Earth system does not reach a tipping point, leading to a new equilibrium from which it cannot return. [5 max]

c *Maximum marks awarded for an evaluation, i.e. comparison of strengths and weaknesses; if only strengths or weaknesses given, 2 marks max awarded.*

Strengths: global perspective is useful because global warming has global consequences; so understanding knock-on effects outside national boundaries helps governments to act more responsibly; understanding that local actions can have an impact on others is good for getting societies to take action against climate change; the solution to climate change requires international cooperation, e.g. the Kyoto Protocol, which set limits to carbon dioxide emissions; a global perspective stresses the interrelationships between systems, so knock-on effects can be reduced. [2 max]

Weaknesses: may discourage people from taking local action if they do not think their actions will have an effect, as global cooperation is ultimately needed; people may think that the problem is too big for realistic solutions to be sought; human responses to climate change can be culturally specific and so a global perspective may not encourage local societal involvement; local action is needed to reduce greenhouse gas emissions and this needs to be encouraged. [2 max]

d A simplified description designed to show the structure or workings of an object, system or concept. [1]

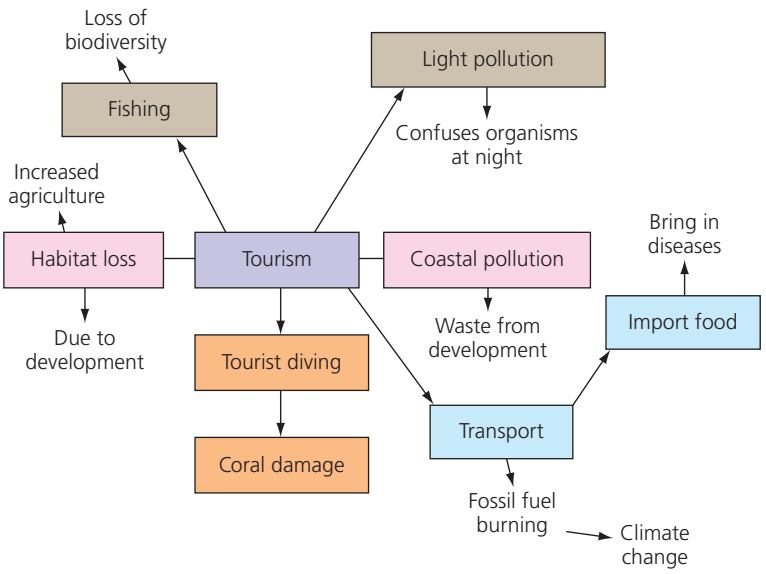
e *3 marks awarded for advantages and disadvantages; if only advantages (or disadvantages) given, 2 marks max awarded; 2 marks awarded for discussion on the uncertainty of predictions.*

Advantages: allow predictions to be made; simplify complex systems; can change inputs and see what happens. Disadvantages: may not be

accurate; rely on expertise of the people making them; rely on validity of input data; different people interpret them differently; can be used politically. [3 max]

Uncertainty: complexity of the issue leads to uncertainty as climate models are incomplete and leave out aspects of the climate system; the impact of positive and negative feedback is unclear; climate models using differing data can give different results; different ways of measuring data give a high level of uncertainty in the models that use them; models do not take into account changes in human behaviour and how this may impact on future trends. [2 max]

2 a



[1] for each impact [up to 4 max]; accept any other reasonable points and model design.

b Feedback that tends to dampen down/counteract any deviation from an equilibrium, and promotes stability. [1]

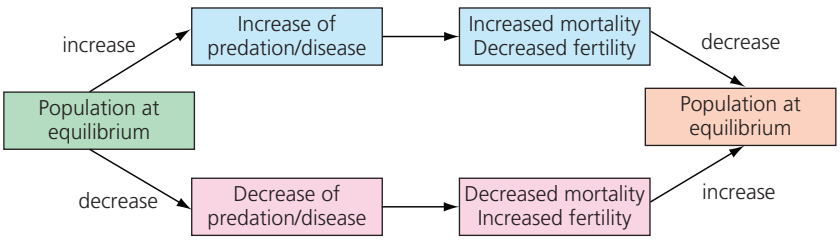
c Feedback that increases change, leading to exponential deviation away from equilibrium. [1]

d Most ecosystems contain inbuilt checks and balances; without internal balance an ecosystem would move away from stable equilibrium; without negative feedback, no ecosystem could be self-sustaining. [1]

e *See Figure 2.21 on page 23 [7]. Award [3 max] for the diagram as follows: four storages [1], three processes [1], general accuracy and appearance of diagram [1].*

3 a Since energy for work is dissipated (second law of thermodynamics) there needs to be an input of energy to maintain the natural system hence the system cannot be isolated (isolated systems do not have an input of energy). [1]

b



[2] marks for a clearly labelled model demonstrating negative feedback. [1 max] for a poor diagram or labelling. There are many other possible models, however, they must demonstrate a return to an equilibrium position for full marks.

Topic 2 The ecosystem

Quick check questions

1 A community of interdependent organisms and the physical environment they inhabit.

2 Biotic: e.g. plants, animals, fungi (or specific examples e.g. oak trees, blackbirds, toadstools); abiotic e.g. air, wind, temperature, water, soil, minerals, landscape, climate.

3 A pyramid of numbers represents the number of organisms (producers and consumers) coexisting in an ecosystem; a pyramid of biomass represents the standing stock of each trophic level measured in units, such as grams of biomass per square metre ($g m^{-2}$); both pyramids of numbers and pyramids of biomass represent storages, and are 'snapshots' of the community in time; pyramids of numbers and biomass simply represent the momentary stock, whereas pyramids of productivity show the rate at which that stock is being generated; pyramids of productivity represent the flow of energy through trophic levels and always show a decrease in energy along the food chain; productivity is measured in units of flow and is measured over a specific period of time (for example, $g m^{-2} yr^{-1}$ or $J m^{-2} yr^{-1}$).

4 Data for numbers and biomass pyramids are taken at a point in time. The biomass of the producers may be less than the consumers that feed on them – this leads to the pyramid of biomass being inverted.

5 Crop farming increases producers (base of pyramid) and decreases higher trophic levels; livestock farming increases primary consumers and decreases secondary and tertiary consumers; hunting removes top carnivores; deforestation reduces the producer bar on biomass pyramids; the use of non-biodegradable toxins (such as DDT or mercury) can lead to reduction in the length of food chains.

6 A group of organisms that interbreed and are capable of producing fertile offspring.

7 A habitat is where a species lives, whereas a niche is where, when and how a species lives; a niche is a complete description of the ecology and behaviour of a species; two species can occupy the same habitat, but they cannot occupy the same niche.

8 E.g. temperature, measured using a thermometer – put thermometer at set distance below water; light measured using a light-meter – put light-meter at set distance above or below water; flow velocity measured using a flow-meter – put propeller at set distance below water and count revolutions per minute; dissolved oxygen measured using an oxygen-meter. For each measurement repeat several times to improve reliability.

9 E.g. light – would decrease with depth; turbidity – would increase with depth; temperature – would decrease with depth.

10 E.g. soil moisture – if soil is too hot when evaporating water the organic content can also burn off.

11 E.g. wind speed – gusty conditions can lead to large variations in data; temperature – problems in data if temperature not taken from consistent depth; light – cloud cover changes light intensity, as does shading from plants or light-meter operator.

12 Percentage frequency is the percentage of quadrats in an area in which at least one individual of the species is found; percentage cover is the proportion of a quadrat covered by a species, measured as a percentage.

13 A sample population needs to be captured, marked, released and recaptured. The formula for the Lincoln index is:

$$N = \frac{n_1 \times n_2}{M}$$

Where: N = total population size of animals in the study site; n_1 = total number of animals captured and marked on first day; n_2 = number of animals

recaptured on second day; M = number of marked animals recaptured on second day.

14 All biomass from sample area (e.g. 1 m^2) is removed; with plant material, roots are dug up and removed as well as above-ground biomass; the sample is weighed in a container of known weight; the sample is put in a hot oven (80°C); after a specific length of time the sample is reweighed; the sample is put back in the oven; this is repeated until the same mass is recorded from two successive readings; no further loss in mass indicates that water is no longer present.

15 The habitat with D = 1.83 is simpler/younger than the habitat with D = 3.65, which could be in a mature ecosystem.

16 E.g. sunlight, temperature, precipitation [any two].

17 Found between the tropics of Cancer and Capricorn (23.5° N and S) and so high insolation and temperature throughout the year; high rainfall (over 2500 mm yr^{-1}); optimum conditions for photosynthesis and therefore productivity.

18 Tundra: has a simple structure; vegetation is low scrub and grasses; vegetation forms a single layer; there is an absence of tall trees.

Temperate forest: may contain seasonal (deciduous) trees, evergreen (e.g. coniferous) trees, or both; more complex structure than tundra, with some layering of forest, with tallest trees around 30 m; light can reach forest floor, leading to growth of rich shrub layer (e.g. brambles, grasses, bracken and ferns).

19 Producers make their own food, whereas consumers need to eat other organisms to obtain their food.

20 Producers convert inorganic molecules into organic molecules that can be used by the rest of the food chain; decomposers convert organic molecules into inorganic molecules to allow matter to cycle in ecosystems.

21 Photosynthesis is the transformation of light energy into the chemical energy of organic matter; respiration is the transformation of glucose into carbon dioxide, water and energy; raw materials needed for photosynthesis and respiration are transferred into the organisms, and waste products transferred out from them (e.g. oxygen in, and carbon dioxide out, from animals).

22 Energy enters the ecosystem as sunlight energy, is transformed into chemical energy/biomass, transferred between trophic levels by consumers, ultimately leaving the ecosystem as heat energy.

23 Ecological efficiency is the percentage of energy transferred from one trophic level to the next; efficiencies of transfer are low and account for energy loss, varying from 5% to 20% with an average of 10%.

24 Transfers: feeding on plant material by herbivores; feeding on herbivores by carnivores; feeding on dead organisms by decomposers; CO_2 from atmosphere dissolves in rainwater; CO_2 from atmosphere dissolves in oceans. Transformations: photosynthesis; respiration; combustion; biomineralisation; incomplete decomposition and fossilisation.

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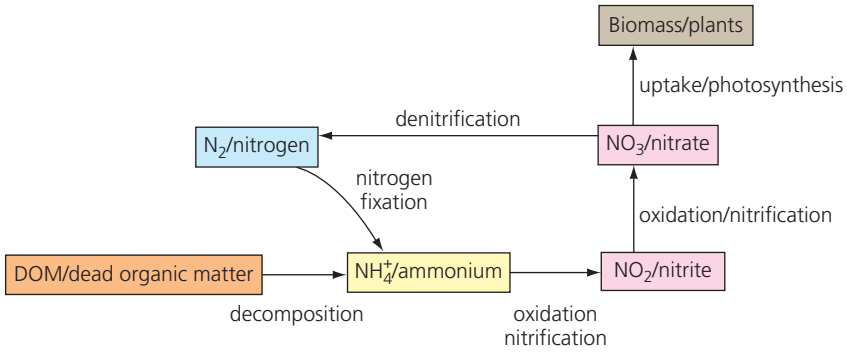

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Transfers	Transformations
■ Precipitation ■ Runoff ■ Absorption by plants	■ Evaporation ■ Transpiration ■ Condensation

27 Primary productivity is the gain in energy/biomass by producers and involves the conversion of solar energy into stored chemical energy; secondary productivity is the gain in energy/biomass by consumers and involves feeding and absorption.

28 NPP is the gain by producers in energy or biomass per unit area per unit time remaining after allowing for respiratory losses (R). This is potentially available to consumers in an ecosystem, i.e. NPP = GPP – R (where R = respiration).

29 Gross secondary productivity (GSP) is the total gain by consumers in energy or biomass per unit area per unit time through absorption; net secondary productivity (NSP) is the gain by consumers in energy or biomass per unit area per unit time remaining after allowing for respiratory losses (R).

30 The maximum number of a species or 'load' that can be sustainably supported by a given environment.

31 Resources change over time causing populations to fluctuate; seasonal differences; changes in limiting factors cause the population size to increase and decrease; increases and decreases around the carrying capacity are controlled by negative feedback mechanisms.

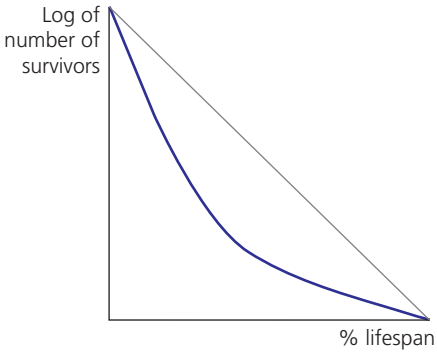
32 Lag phase, where population numbers are low, leading to low birth rates; exponential growth stage, where limiting factors are not restricting the growth of the population; transitional phase as limiting factors begin to affect the population and restrict its growth; plateau phase where limiting factors restrict the population to its carrying capacity.

33 S-shaped curves are controlled by biotic (density-dependent) factors whereas J-shaped curves are controlled by abiotic factors (density-independent).

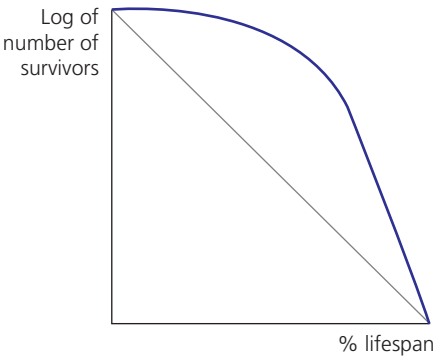
34

***r*-strategist**	***K*-strategist**
Smaller in size	Larger in size
Early maturity and reproduction	Late maturity and delayed reproduction
Little or no parental care	Large amount of parental care
Large number of offspring	Few offspring
Little investment in individual offspring	High investment in individual offspring
Rapid growth and development	Slow development
Short life	Longer life
Thrive in unstable environments	Thrive in stable environments
J-shaped population growth curve	S-shaped population growth curve
Generalist species	Specialist species

35 *r*-strategist:



K-strategist:



36 The orderly process of change over time in a community. Changes in the community of organisms frequently cause changes in the physical environment that allow another community to become established and replace the former through competition. Often, but not inevitably, the later communities in such a sequence or sere are more complex than those that appear earlier.

37 Succession is the change in communities over time, whereas zonation is the change over space/distance.

38 A community of organisms that is more or less stable, and that is in equilibrium with natural environmental conditions such as climate; the end point of ecological succession.

39 Pioneer communities are at the start of a succession whereas climax communities are at the end. Other differences:

	Pioneer community	**Climax community**
Organic matter	Small	Large
Soil depth	Shallow	Deep
Soil quality	Immature/little organic material	Mature/much organic matter
Nutrients	External	Internal
Nutrient cycles	Open system	Closed system
Nutrient conservation	Poor	Good
Role of detritus	Small	Large
Stability	Poor	Good
Niches	Wide	Narrow
Species richness	Low	High
Diversity	Low	High
Size of organisms	Small	Large
Life cycles	Simple	Complex
Growth form	*r*-selected species	*K*-selected species

40 E.g. succession in freshwater: aquatic plants (e.g. water lilies) → reeds → low woodland species (e.g. willow).

41 Ecological gradients are found where two ecosystems meet (e.g. on beaches or on lake shores) or where an ecosystem suddenly ends (e.g. at forest edges); both biotic and abiotic factors vary with distance and form gradients.

42 Transects are used to measure changes along the gradient, which ensures all parts of the gradient are measured; abiotic factors would be measured at regular intervals (e.g. every 5 m) using a standard method.

43 Frame quadrats, which are empty frames of known area (e.g. 1 m^2); grid quadrats, which are frames divided into 100 small squares; point quadrats, which are made from a frame with 10 holes, inserted into the ground by a leg.

44 A cross staff is used to move a set distance (e.g. 0.6 m) vertically up the transect; the staff is set vertically and a point measured horizontally from an eyesight 0.6 m from the base of the staff; biotic and abiotic factors are measured at each height interval.

45 E.g. logging can cause large areas of forest to be degraded; deforestation is being carried out to provide timber, and to clear land for agriculture and housing; remaining areas can become fragmented, forming islands of habitat; abiotic factors – light, temperature and wind speed – increase in logged forests, and humidity decreases; biotic factors – species diversity decreases in logged forests due to fewer niches and proliferation of edge effects.

46 E.g. disturbance from logging; abiotic and biotic factors must be measured in both undisturbed and disturbed habitats so comparisons can be made; habitat islands of different sizes will have different environmental conditions, and so a variety of different-sized patches must be measured; samples must be repeated so that data are reliable; abiotic factors can include temperature, humidity and sunlight; biotic factors can include the species of plants and animals present, and the population size of selected indicator species; where environmental gradients are present, factors must be measured along the full extent of the gradient so that valid comparisons can be made; factors must be measured over a long period of time to take into account daily and seasonal variations; see pages 14–16 for description and evaluation of methods for measuring abiotic and biotic factors.

47 A baseline study examines the area before development takes place, and is used to try to forecast what changes may be caused by the development; possible impacts are identified; the scale of potential impacts is predicted; ways to lower the impacts are found; a non-technical summary is produced so that the general public can understand the issues; monitoring of change occurs during and after the development.

48 Environmental impact assessments (EIAs) are a method of detailed survey required, in many countries, before a major development; ideally they should be independent of, but paid for by, the developer; they predict possible impacts on habitats, species and ecosystems, and help decision makers decide if the development should go ahead; they allow potential impacts of developments to be predicted; and suggest possible alleviation methods to minimise negative impacts; some countries incorporate EIAs within their legal framework, with penalties and measures that can be taken if the conditions of the EIA are broken, whereas other countries simply use the assessment to inform policy decisions; in some countries, the information and suggestions of the EIA are often ignored, or take second place to economic concerns; it is often difficult to put together a complete baseline study due to lack of data, and sometimes not all of the impacts are identified; an EIA can be limited by the quality of the baseline study; environmental impact prediction is speculative due to the complexity of natural systems and the uncertainty of feedback mechanisms, thus making environmental decisions more difficult – the predictions of the EIA may, therefore, prove to be inaccurate in the long term; at their best, EIAs can lead to changes in the development plans, avoiding negative environmental impact; it could be argued that any improvement to a development outweighs any negative aspects.

Exam practice

1 *To achieve 5 marks answers must have examples and at least one point distinguishing chains from webs. Answer may be expressed in diagram form.*

Food chain: a single series of organisms within an ecosystem linked by feeding relationships [1]; example – see Figure 2.2, page 9 [1]. Food web: made up of the many food chains in an ecosystem as food chains branch and reunite; shows the network of food consumption in an ecosystem [1]; example: see Figure 2.3, page 9 [1]. *Answer must have one of the following*

distinguishing points: food chains rarely have more than four or five members, whereas food webs may contain dozens of species; organisms in a food chain feed at only one trophic level, but in a web may feed at several levels [1].

2 Parasites (e.g. fleas on a rabbit); spread more rapidly when host population is high; because it is easier for parasite to locate a host at high densities (i.e. parasitic infection is a density-dependent factor); large infections of parasites reduce reproductive success/kill host; which reduces population to lower densities so parasites become less abundant [3 max]. *Award 2 max if both parasite and host are not named.*

3 **a** E.g. lake ecosystem – temperature; light; turbidity; dissolved oxygen [1 max]. *0 marks awarded if the ecosystem is not stated.*

b The method has to be appropriate for the named factor, e.g. temperature: use thermometer at fixed depth of water; repeat measurements regularly over 24 hours; take several measurements and calculate the mean; repeat measurements at different times of year. [2 max]

c Responses should indicate that factors affecting diversity are understood and relate to the chosen abiotic factor. E.g. dissolved oxygen: some organisms can only live in water with high levels of dissolved oxygen; in a highly oxygenated environment, the number of species (species richness) will be higher and hence the diversity will be greater; *or* in water with low levels of dissolved oxygen, only a few specially adapted organisms can survive; a few species tend to be dominant (and a few others may exist in small numbers), so diversity is low. [2 max]

4 Research question: e.g. how do abiotic factors affect the distribution of organisms in an ecosystem? Example: e.g. in a terrestrial ecosystem, how do changes in the amount of light reaching the ground affect community structure?; in an aquatic ecosystem, how does the depth of water affect species diversity at the edge of a small pond? [1 research question, 1 example for 2 marks]

5 *If no species or ecosystem is named a maximum of 2 marks awarded. Method must be compatible with ecosystem and species named.*

Description [2 max]: establish grid over area; use random number generator to select quadrat locations within grid; estimate % cover of plants in quadrats; multiply by total area to get total number in area. Evaluation [1]: quadrat method is difficult for very large or possibly very small plants; there are problems with plants that grow in colonies/tufts; sometimes apparently separate plants are linked at roots, e.g. some European trees; difficult to measure outside main growing season when plants are largely invisible.

6 Method: count the number of rhino at ground level; tag/mark counted individuals; use capture–mark–release–recapture/Lincoln index; use of aircraft/count from air; count individuals in a known area and extrapolate for the area of the whole park; use information from previous census/survey.

Evaluation: problems due to very large areas; animals may move in and out of sample area, making capture–mark–release–recapture method invalid; density of population in different habitats might vary; some individuals might be concealed by vegetation; seasonal variations/migration habits of elephants; high cost of some methods. [4 max]

To receive full marks, answers must have at least one evaluation, i.e. 3 max given for only describing method.

7 **a** Biodiversity of an area depends on both the number of species occurring and the relative abundance of these species; e.g. Simpson's index (give equation – see page 17). [2]

b Count and identify organisms; in a specified period of time; calculate relative abundance of organisms; use Simpson's index to calculate diversity; e.g. higher index value implies greater diversity; use replicate countings in both ecosystems under similar conditions; compare values. [5 max]

8 **a** For habitat B:

$$D = \frac{100(99)}{50(49) + 30(29) + 15(14) + 5(4)}$$ [2]

b i) Habitat A has the greatest diversity and habitat E the lowest; habitat A has the greatest evenness between species, with habitat E dominated by one species; species diversity is a combination of the number of species and their relative abundance – higher diversity indices are recorded when all species are equally abundant, indicating a large range of available niches; low species diversity indicates a low number of available niches. [2 max]

ii) Habitat A is more complex with a greater array of niches than habitat E indicating a more complex habitat; habitat E is more simple with fewer available niches; habitat A may be older than habitat E. [2 max]

9 *[4] marks awarded only if both biomes are mentioned.*

E.g. tropical rainforest and tundra: tropical rainforest has abundant light/insolation and high rates of precipitation/rainfall so rates of photosynthesis are high; this climate is due to its position in low latitudes with the Sun directly over-head; tundra has shorter day lengths/less light due to its location in high latitudes; rainfall rates are also low in tundra so rates of photosynthesis are low; most water locked up in ice in tundra so productivity low; temperature will affect the rate of photosynthesis so low temperatures can be a limiting factor in tundra. [4 max]

10 Water/light/temperature is limiting; water is frozen for most of year in permafrost; precipitation rates are low; snow cover prevents light reaching plants for part of year; it is dark for 4 months of the year; precipitation is lowest in months when light levels are highest; temperature is low due to low intensity of solar insolation; infertile soil due to low temperatures/acidity/waterlogging/low nutrient turnover. [3 max]

11 Mean NPP in tropical rainforest greater than tundra/mean biomass of tropical rainforest far greater than tundra; NPP per kg biomass of tropical rainforest far lower than tundra; tropical rainforest is hot and wet so there is a greater opportunity to develop large biomass; NPP per kg biomass far lower in rainforest than tundra because rainforest has a high rate of photosynthesis *and* high rate of respiration so NPP per kg biomass per year is low; tundra is cold and dry so low rates of photosynthesis and respiration are low, and plants are slow growing, with a gradual accumulation of biomass but relatively large growth in biomass per year. [4 max]

2 marks for comparison 2 marks for explanation.

12 *3 marks for any different comparisons of storages size, and 4 marks for any four links to climate.*

a Biomass:

Explanation – biomass is greater in tropical forest due to optimum conditions for photosynthesis/lower in temperate forest due to limiting conditions for photosynthesis.

Link to climate – optimum conditions in tropical forest provided by higher precipitation, insolation and temperatures/conditions limited in temperate forest by low temperatures.

Dead organic matter:

Explanation – dead organic matter (DOM) is less in tropical forest due to higher rates of decomposition/more in temperate forest due to lower rates of decomposition.

Link to climate – climate provides higher temperatures in tropics, which increase rate of decomposition/lower temperatures in temperate forests decrease rate of decomposition.

Explanation – DOM also greater in temperate forest due to deciduous leaf-fall/less in tropical forest because of evergreen vegetation.

Link to climate – greater leaf fall in temperate forests linked to more seasonal variation in climate (winters)/relatively non-seasonal climate variations in tropical forest make leaf-fall unnecessary.

Soil:

Explanation – nutrient storages in soil are smaller in tropical forest due to faster uptake by plants due to their higher photosynthetic rates/larger in temperate forest due to lower photosynthetic rates; higher rates of photosynthesis in tropical forest related to optimum climatic conditions/ and limited conditions in temperate forests.

Link to climate – higher evapotranspiration rates in tropical forest reduce soil nutrients through plant uptake/lower rates of evapotranspiration in temperate forests reduce plant uptake so storages increase soil nutrients; evapotranspiration affected by high temperatures in tropical forest/lower in temperate forests. [7 max]

b *See Figure 2.22 page 24. 1 mark for correct diagram, using boxes to show storages and arrows to show flows; 1 mark for correct links between storages and flows. 3 marks max for any three correct flows.*

13 *Any two contrasting biomes can be used. 3 marks max awarded if specific biomes are not mentioned. Credit given if appropriate diagrams are included.*

Climate determines the global distribution of the productivity of biomes; climate is a limiting factor as it controls the amount of photosynthesis which can occur in plants; water availability, light and temperature are the key climate controls; photosynthesis is a chemical reaction, therefore temperature will also affect rates of photosynthesis; e.g. tropical rainforests and hot desert; water: tropical rainforests receive lots of rainfall each year and so have higher NPP whereas deserts have little rain which is limiting to plant growth; temperature: rainforests are warm throughout the year so have a constant growing season and higher productivity.

Answers for other biomes include: availability of light, e.g. deep oceans dark below surface, which limits productivity of plants; nutrient availability, e.g. estuaries receive lots of sediment from rivers. [7 max]

14 Either – food eaten; faecal waste; *or* – increase in biomass/NPP; respiratory loss [2]. *Award 1 max if one from each list given.*

15 *Must include a comparison between pioneer and climax community species for full marks. Marks awarded for any of the following:*

Pioneer species are usually *r*-strategists and climax species are usually *K*-strategists; pioneer species are likely to have higher (specific) growth rate/climax species are likely to have lower (specific) growth rate; pioneer species are likely to invest less in parental care/climax species are likely to show greater investment in parental care; pioneer species are likely to have competitive advantage in the short term (while the environment is unmodified)/climax species are likely to have long-term competitive advantage (achieving the carrying capacity of the modified environment); *r*-species produce large numbers of offspring, opportunistic, pioneer species/ first to colonise an area; *K*-species produce small number of offspring and are suited to long-term climax communities. [4 max]

16 Ecological succession [2 max]

The (orderly) process of change over time in a community/ecosystem; changes in organisms may be associated with changes in abiotic environment (e.g. soil, microclimate); successive communities displace each other through competition; e.g. volcanic island developing into tropical rainforest.

Pioneer community [2 max]

The first organisms to colonise a new environment; usually dominated by producers/plants; usually dominated by *r*-strategists; pioneer communities often very simple in structure/low diversity; tolerate harsh conditions, e.g. strong light/ low nutrient levels; e.g. community of lichens covering bare rock (lithosere).

Climax community [2 max]

The end-point of ecological succession; in equilibrium/relatively stable; may have a high level of complexity; usually dominated by *K*-strategists; characteristics of climax community determined by climate and soil; e.g. mature woodland/rainforest ecosystem.

17 *6 marks for any of the following points:*

Gross primary productivity (GPP) is the total amount of organic matter produced/solar energy fixed by photosynthesising plants per unit area per unit time; gross productivity initially very low; due to initial absence of photosynthesising organisms; GPP increases through pioneer stage as colonisation by photosynthesising plants increases; and structural complexity/number of layers increases; as green plant biomass increases, gross primary productivity increases; GPP is limited at climax by abiotic factors, e.g. nutrients/sunlight/temperature/water; GPP declines as older/more woody plants dominate; productivity varies seasonally; productivity may be affected by human interference. [6 max]

18 Succession: the orderly process of change in a community or ecosystem over time; e.g. the colonisation of lava following an eruption; pioneer species (e.g. lichens); seral communities as soil forms and adapted plant species invade; climax community with maximum diversity; examples of characteristic species, e.g. oak trees in temperate forest. [3 max]

Zonation: the arrangement or patterning of communities or ecosystems, over a distance, in response to differences in some environmental factor; e.g. the arrangement of sea-shore plant and animal communities into zones, e.g. seaweeds, barnacles, molluscs; as the result of differences in times of exposure to air; as the result of rise and fall of tides/effect of waves, etc. [3 max]

19 a E.g. terrestrial – as a terrestrial community matures the number of trees and shrubs increases; causing a decrease in the amount of light reaching the ground; *or* aquatic – as vegetation along a forest gradient increases in density, shading of a river increases; temperature of water decreases as shading increases. [2 max]

b *Method will depend on factor selected. E.g. for temperature and number of water beetles in freshwater:*

i) Method [2 max]: count number of water beetles in a scoop (with net) of water; preferably at same time as temperature measurements; under identical conditions each time.

ii) Method [2 max]: use thermometer; repeat at regular intervals; e.g. at different times of day/times of year; under identical conditions.

iii) Evaluation [2 max]: subjectivity of observation (different people observe/record in different ways); standardisation of procedures; 'generalisability' (avoidance of atypical conditions, e.g. a shaded area); difficulties in qualitative measurements (e.g. poor light conditions); correlation not necessarily indicative of causality.

Full marks are not allowed for a detailed description of the method, plus evaluation of that method, of a single factor, however detailed. For the full 6 marks the answer must emphasise the relationship with the second factor. Thus a very full account of the measurement of soil moisture, even if some evaluation is included, cannot obtain full marks if there is no comment about the factor supposedly influenced by it.

20 *1 mark for named ecosystem and how affected by human activity:* e.g. if tropical forest named as the ecosystem, removal of tree cover through logging operations [1].

1 mark each awarded for four valid points. 0 marks awarded if no abiotic factor is named. Any abiotic factor allowed as long as it is appropriate to the ecosystem: e.g. temperature, pH, salinity, wind velocity.

For above named example: abiotic factor = light; use light meter; take several observations and calculate mean; important to take measurements before and after logging operations; observations must be consistent, e.g. same height above ground/with same instrument; problem of variation in weather conditions. [4 max]

21 a Non-motile; discrete units; possessing clear boundaries (e.g. lichen); visible with naked eye; primarily two-dimensional distribution. [2 max]

Allow for measurement of individuals or percentage cover.

b Mark a grid on graph paper of the plots e.g. 10 × 10 m; use random number generator to generate random coordinates; use coordinates to locate quadrat within grid. [2 max]

22 a A method of detailed survey required, in many countries, before a major development; the survey should include a baseline study to measure environmental conditions before development commences, and to identify areas and species of conservation importance; the report produced is known as an environmental impact statement (EIS) or environmental management review in some countries; the monitoring should continue for some time after the development. [2 max]

Mention of a document without reference to a survey or study would not be accepted.

b Baseline study; assessment of possible impacts; proposals for mitigation of impact; monitoring of change during development; monitoring of change after development. [any 3]

Topic 3 Human population, carrying capacity and resource use

Quick check questions

1 a 6 billion

b 7 billion

2

	Afghanistan	USA
Natural increase (%)	2.47	0.53
Doubling time (years)	28	132

3 There is an imbalanced population. There is a bulge in the male population aged 40–54 years. These are likely to have been migrants attracted to the country some 20 years earlier. There is a smaller bulge of females aged 40–54. These are likely to have been the wives of some of the male migrants coming to join their husbands. There is also a large bulge of young people aged 10–24 years. These are the children of the migrants. There is an even distribution of males and females.

4 Any two from reduction in flooding, tourism, recreation, fishing, conservation of some freshwater species, controlled water supply, drinking water, irrigation, improved river transport.

5 Renewable natural capital, such as living species and ecosystems, is self-producing and self-maintaining and uses solar energy and photosynthesis. This natural capital can yield marketable goods such as wood, but may also provide unaccounted essential services when left in place – for example, climate regulation.

Replenishable natural capital, such as groundwater and the ozone layer, is non-living but is also often dependent on the solar 'engine' for renewal.

6 Groundwater – replenishable; potatoes – renewable; iron ore in rocks – non-renewable; sheep's wool – renewable; ozone layer – replenishable; water used for the generation of HEP – replenishable.

7 Possible answers include reduced economic value for hunting because products for which the deer were once hunted are no longer considered valuable; the ecological value of the species has now been recognised; deer are still hunted by 'trophy hunters'; deer are considered to be attractive to

tourists/recreationalists; however, deer are now seen as a problem by some – prevent natural succession, damage farmland, disease transmission, damage fences, vehicle collisions.

8 At one stage the wood may have been an important source of timber for building material, fuelwood and as a source of food. Now it may be valued more for climate regulation, recreational potential and as a potential provider of medicines.

9 Ecological services, e.g. climate regulation; supporting biological diversity; cultural and heritage value; recreation.

10 Sustainability is the use of global resources at a rate that allows natural regeneration and minimises damage to the environment.

11 Natural income is the portion of natural capital (resources) that is produced as 'interest', i.e. the sustainable income produced by natural capital – harvesting resources at a rate that will be replaced by natural growth demonstrates sustainability.

12 Sustainable development is development that meets current needs without compromising the ability of future generations to meet their own needs.

13 The draft Rio agreement claimed that there is a 'techno fix for every problem'. In addition, it stated that any agreements would not be legally binding.

14 Sustainable yield (SY) is the rate of increase in natural capital, that is, that which can be exploited without depleting the original stock or its potential for replenishment.

15 **a** Coal

b Oil

c Coal

16 Shale/tar sands and solar, wind, geothermal

17 Shale and tar sands are non-renewable; solar, wind and geothermal are renewable.

18 Oil has been a relatively cheap and efficient form of energy, and a versatile raw material. It is also relatively easy to transport by tanker or pipeline. At present rates of production and consumption reserves could last for another 40 years. Coal is a competitive energy source. Thick, level, continuous seams are the most competitive and facilitate the use of machinery. The two principal users of coal as a fuel are production of electricity in thermal power stations and the smelting industry, e.g. iron and steel.

19 HEP plants, for example, are very costly to build. Not all places have a sufficient head of water. Migratory fish and mammals may have their routes affected. There may be increased evaporation behind the dam and the deposition of silt. Diseases such as schistosomiasis may be spread by the stagnant water. Fish yields downstream may be adversely affected by the trapping of sediments behind the dam. Wind power suffers from visual impact – although some people like the appearance of wind turbines, others dislike them. They are also noisy and may injure migrating birds. Winds can be unreliable.

20 Total energy has increased fourfold. Coal remains the dominant form of energy. There have been small increases in other forms of energy but these are relatively small compared with coal.

21 Over half the energy is used for manufacturing. The next largest is residential, followed by transport. However, these two combined account for just over 20% of energy use.

22 Energy use is dominated by fossil fuels – there are continued emissions of greenhouse gases contributing to global warming. In addition, emissions of sulfur dioxide contribute to acidification. Even the development of hydroelectric and nuclear involves the use of fossil fuels in the construction of the facilities.

23 Soil is the outermost layer of the earth's surface, consisting of weathered bedrock (regolith), air, water and living organisms.

24 Bedrock influences soil drainage and soil fertility. The amount of heat, evaporation and precipitation determine the main movements of water within the soil.

25 A – 60% clay, 10% silt and 30% sand; B – 10% sand, 70% silt and 20% clay

26 a Sandy clay loam

b Loam

27 Sandy loam

28 About 80%

29 Reduced crop yields and decreased incomes for farmers; less food to eat (an increase in hunger and malnutrition); reduced success at school (more hungry children and less ability to concentrate).

30 Four measures could include afforestation, contour ploughing, crop rotation, use of shelter belts, organic farming.

31 Afforestation increases the amount of organic material in the soil. This helps to bind the soil and make it more resistant to erosion. In addition, it increases the return of nutrients and organic matter to the soil. It also increases the rate of interception, thereby reducing rain splash erosion and overland flow, and promoting infiltration into the soil.

32 Measures include soil conditioners or fertilisers, afforestation, wind reduction techniques such as wind breaks, shelter belts or strip cultivation; terracing and/or contour ploughing; (sustainable) irrigation; a reduction in overgrazing, deforestation, trampling and use of soil.

33 Soils in the tropical rainforest are very infertile. To increase the fertility of the soil, cultivators cut down the vegetation and burn it, thereby releasing some of the nutrients into the soil. This increases the soil fertility in the short term and allows agriculture to take place. However, over the following few years, these nutrients are washed away and the soil fertility drops. This forces the cultivators to abandon the plot they are farming and move to another plot – hence the term 'shifting cultivation'. This allows soil fertility to recover in the abandoned plot.

34 Soil conservation techniques included: contour ploughing, strip cultivation with an alternation of cultivated and fallow (crop-free) land, temporary cover crops, shallow ploughing to eliminate weeds and conserve crop residues on the surface, summer fallow and some areas being converted to permanent grazing.

35 The increase in food production was largely due to the Green Revolution – the application of science and technology to agriculture, e.g. high-yielding varieties, breeding programmes, widespread use of chemical fertilisers and pesticides, and irrigation.

36 The decline of food availability was due to increases in the price of oil, changes in diet, more land being used for biofuels and natural hazards.

37 Dairy farming – pastoral (animals), commercial, intensive and sedentary; nomadic pastoralism – pastoral, subsistence, extensive and nomadic.

38 Terrestrial food systems are generally more efficient because most food is harvested from relatively low trophic levels, whereas in aquatic systems most food is harvested from higher trophic levels. In addition, in aquatic systems, the fixing of solar energy by primary producers tends to be less efficient due to the absorption and reflection of light by water.

39 Shifting cultivation is said to be labour-intensive as a large amount of human labour is used in a small amount of land.

40 For example, pig farming in Denmark is capital intensive as a large financial investment (machinery, transport, feed) is used per unit area. For example, hormones are used to increase productivity while antibiotics are used to reduce the spread of disease.

41 Flower producers in Kenya are using excessive water to grow vast quantities of flowers for export. This means that there is much less water available (e.g. groundwater) and the greatest impact is being felt by the nomadic pastoralists

in the semi-arid areas to the north and east of Mt Kenya. The flower farms have taken over land that the pastoralists used and there is now less water.

42 The wastefulness of a Christmas dinner could be as much as 24 000 food miles.

43 **a** 12%

b 1%

44 Possible answers include: population growth outstripping rate of replenishment; current LEDCs will need more water as they become more developed; improved standards of hygiene/health require more water; climate change leading to extensive drought; some freshwater resources/aquifers becoming contaminated by pollution.

45 The maximum number of a species/individuals that can be (sustainably) supported by a given environment.

46 It may be difficult to give a precise figure for a country's carrying capacity because the range of resources used by humans is usually much greater than for any other species; humans can also substitute one resource for another, e.g. plastic for glass; resource requirements vary according to lifestyles, e.g. shifting cultivators in the rainforest compared with urban dwellers in New York; technological developments lead to changes in resources demand/availability for consumption, e.g. the rise of nuclear power since the 1950s; can be artificially altered by importing goods, e.g. foods from LEDCs into MEDCs.

47 Population grows slowly at first, and then quite rapidly. However, it does not appear to be J-shaped or exponential growth. It then falls very rapidly, and begins to level off in the latter part of the twenty-first century.

48 Resources fall very slowly initially, then they decline rapidly (negative exponential). This is almost the opposite from what happens to population and pollution (at first). In the early twenty-first century as food output and industrial output increase, resources decline. However, in the latter part of the twenty-first century all aspects are in decline.

49 An ecological footprint is the area of land and water required to support a defined human population at a given standard of living. The measure takes account of the area required to provide all the resources needed by the population, and the assimilation of all wastes. The highest ecological footprints (6 ha and over) are found mainly in MEDCs in North America, Western Europe, Japan, Australia and New Zealand. There are also some located in the Middle East (oil-rich countries). In contrast, the lowest ecological footprints (< 1 gha) are found in LEDCs, especially in Central Africa and South Asia.

50 Ecological footprints include data on: land appropriated by fossil energy use; built environment; gardens; crop land; pasture; managed forest; untouched forests and non-productive areas.

51 gha (global hectares)

52 **a** Carbon

b Grazing

c Cropland

53 The highest ecological footprints are found in MEDCs, such as those of North America, Western Europe, Australia, New Zealand and Japan. Some oil-rich countries also have high ecological footprints, such as the UAE and Libya. In contrast, the lowest ecological footprints are found in sub-Saharan Africa and in parts of South Asia.

54 China 2.39 billion gha; India 1.07 billion gha; USA 3.7 billion gha; UK 377 million gha

55 Pro-natalist population policies are those in favour of more births, whereas anti-natalist population policies are those trying to reduce the birth rate and thereby population size.

56 Policies that target female education and female participation in the job market are believed to be the most effective method for reducing population pressure.

57 Globalised consumer culture refers to the way in which the world is increasingly inter-connected in a system in which resources are extracted, manufactured into goods, transported, stored, sold and thrown away, to make way for new goods.

58 As standards of living rise, there is increased use of cars, computers, electrical goods and personal travel (at home and abroad), thereby increasing the demand for more energy resources.

Exam practice

1 Population growth in Europe has been relatively slow but steady until about 2000 [1], peaking at about 500 million [1]; it is projected to decrease slightly by 2050 [1].

2 Exponential population growth can create:

- great pressures on governments to provide for their people due to ever-increasing demands for food, housing, schooling and employment [1]
- increased pressure on the environment as habitats are destroyed to make way for more settlements, roads, farms etc. [1]
- increased risk of famine and malnutrition as population growth may out-strip the development of resources, such as food and water [1]
- greater differences between the richer countries and the poorer countries, with richer countries using poorer countries to supply the resources they need – such as China buying up land in Ethiopia or the UK using farmland in Kenya to produce cut flowers – so that the countries experiencing rapid growth have even less of their land for their own food production [1]

3 *Award 1 mark for each valid point. Maximum 5 marks if only socio-cultural or economic factors are discussed.*

In countries where the status of women is low and few women are educated or involved in paid employment, birth rates are high. In countries such as Singapore, where the status of women has improved, the birth rate has fallen. In general, the higher the level of parental education, the fewer the children. The high cost of children in a wealthy society helps to explain the falling birth rates in rich countries. The role of religion in relation to fertility rates is commonly confused. In general, most religions are pro-natalist, i.e. they favour large families.

Economic prosperity favours an increase in the birth rate, while increasing costs lead to a decline in the birth rate. Recession and unemployment are also linked with a decline in the birth rate. High infant mortality rates increase the pressure on women to have more children. Such births are termed replacement births or compensatory births to offset the high mortality losses. In some agricultural societies, parents have larger families to provide labour for the farm and as security for the parents in old age.

4 The demographic transition model is a description of demographic change but does not explain why rates change [1]. The DTM is based on the data from just three countries – England, Wales and Sweden [1]. Not only is the time-scale for the DTM in these countries longer than in many LEDCs, there are other types of DTM [1]. For example, Ireland's DTM was based on falling birth rates and rising death rates as a result of emigration following the 1845–49 famine [1]. The DTM in Japan shows a period of population expansion before the Second World War, followed by population contraction once the country's expansionist plans could not be fulfilled. Other nations have experienced a similar drop in birth rates and death rates (e.g. former Yugoslavia). The demographic transition model does not take account of migration, and this is a major component of population change [1]. Nevertheless, it is a simplified model against which we can compare a country's demographic changes [1].

5 *Award 1 mark for each valid point made.*

The table shows that for South Africa population growth rates are relatively low [1].The population will double in 50 years [1]. However, life expectancy

is low (only just over 50 years), infant mortality rates are quite high and the prevalence of HIV is high [1]. For Ethiopia, the population will double in 33 years [1]. So, by 2043 the population will be a staggering 166 million [1]. Surprisingly, although it has a higher life expectancy than South Africa it has a higher infant mortality rate [1]. Unfortunately, the World Bank does not provide data on the HIV prevalence rate, which is disappointing when trying to compare two locations. [5 max]

6 **a** It is likely to expand [1] rapidly due to its youthful population structure, i.e. it has a large population in the reproductive age group and an increasing number coming into that group [1].

b There are many reasons. One could be a rise in female education, leading to a fall in the birth rate [1]. More working women (which is related to a rise in female education) might see women put careers ahead of children [2]. There could be a government programme to increase the use of contraceptives [1].

Haiti was hit by a massive earthquake in 2011 which killed upwards of 300 000 people – this will greatly reduce population growth [1].

7 Sustainability means living within the means of nature [1]. This means harvesting lower amounts so not to surpass natural income (natural regrowth) [1]. Natural capital renews itself and so is renewable/replenishable [1]. Natural income comes from natural capital. Natural income is income that nature can replenish [1]. If natural income is overexploited then future generations will have fewer resources [1]. [3 max]

8 Sustainability is the use of global resources at a rate that allows natural regeneration and minimises damage to the environment – harvesting renewable resources at a rate that will be replaced by natural growth demonstrates sustainability [1]. In contrast, sustainable development is development that meets current needs without compromising the ability of future generations to meet their own needs [1]. Sustainable development is a harder concept to define because different groups emphasise different aspects of it [1]. Sustainability focuses on the rate of resource use, whereas sustainable development is more about a general approach to development [1]. Sustainability suggests maintaining a balance, whereas development suggests progress/improvement/change for the better [1]. [4 max]

Award 2 marks for answers that define the two terms but do not distinguish between them.

9 **a** Environmental sustainability, economic sustainability and social sustainability. [3]

b For example, when people are educated, free and have equal opportunities, they may accept new processes (innovations) more readily than those who are poor or uneducated [1]. They may decide or vote for new policies (economic policies/government policies) that will use energy and water more sustainably [1], thereby preserving and maintaining environmental sustainability [1].

10 *Award 2 max for each energy source. Award 3 max for reasons why it plays a greater role.*

Any two energy sources are acceptable. E.g. coal and HEP in China. Coal is efficient in the generation of energy when burned; once found it can be relatively cheaply accessed – e.g. opencast mines; supplies of coal are relatively abundant; it is also important in the chemicals industry and provides a range of products from aspirin to nylon. Hydroelectric power (HEP) is a renewable form of energy that harnesses fast-flowing water with a sufficient head. It is considered to be a clean form of energy as it does not emit greenhouse gases. HEP stations are often associated with aluminium smelters to use up excess energy. It is renewable, so will not run out and will help meet increasing energy demands in future. Reservoirs created may be multipurpose – e.g. recreational, irrigation, flood control, fishing.

China has a greater emphasis on coal compared with HEP. This is because China has vast coal reserves, and coal is also a raw material in the iron

and steel industry. It is cheaper to mine coal than it is to build expensive reservoirs such as the Three Gorges Dam. [5 max]

11 *Award 4 max for evaluation, covering both advantages and disadvantages rather than as a general list. Award 1 max for two clearly named societies. Award 4 max for any reasonable society and economic factors given.*

You will need two contrasting sources (one non-renewable and one renewable) [1]. You need to cover both advantages and disadvantages of both (unlike the last question) and discuss the economic factors that affect the choice of these energy sources used in different societies.

E.g. wind and nuclear. Wind power is good for small-scale production. It needs an exposed site, such as a hillside, flat land or close to the coast. It also requires strong, reliable winds. There is no pollution of air, ground or water. No finite resources involved. It reduces environmental damage elsewhere.

However, there may be disadvantages: visual impact; they are noisy; they can injure migrating birds; winds may be unreliable. Large-scale development is hampered by the high cost of development, the large number of wind pumps needed, and the high cost of new transmission grids. Suitable locations for wind farms are normally quite distant from centres of demand.

Nuclear power does not emit greenhouse gases. Uranium can generate vast quantities of energy for the amount of raw material used. However, nuclear power stations are very expensive to build. The decommissioning costs of obsolete nuclear power stations are enormous. There are serious risks related to radiation (e.g. Chernobyl, Fukushima). The 2011 Fukushima disaster in Japan led to Japan turning its back on nuclear power.

Japan lacks energy raw materials (oil and coal) and so has to import these from other countries. By developing its nuclear industry it has been able to generate electricity and reduce its imports of coal and oil. It has to an extent achieved partial 'energy security' as a result of nuclear power, although this was weakened in 2011 following the Fukushima disaster.

Denmark has a long tradition of using windmills. Now it uses wind turbines to generate electricity. It is a rich country and so can afford the technology to develop large-scale and micro-scale wind energy. It has also been able to develop a grid system for distributing the electricity produced from wind power.

12 Symbiotic bacteria fix atmospheric nitrogen, converting it into a usable form for plant roots [1]. Mycorrhizal fungi on tree roots take up soil phosphate and pass to the tree, increasing growth [1]. Decomposers break down litter, releasing nutrients into the soil [1]. Soil organisms help to mix the soil, improving its structure [1]. Soil organisms also occupy niches as prey and predators within food chains. In addition, their burrows help to aerate the soil [1]. However, they can feed off roots, reducing crop productivity and damaging plants [1].

As they decompose their faeces will contribute to organic matter within the soil [1]. [5 max]

13 *Award 1 mark for a definition. Do not credit responses that go into detail on one or two causes, as this question asks for a range of activities.*

Soil degradation is an (umbrella) term for a range of processes that lead to a reduction in the productivity of a soil. Soil degradation is the loss of fertility and/or quality of a soil [1]. For example, overgrazing can lead to compaction, so soil is more likely to be eroded [1]. Over cultivation can lead to nutrient depletion and loss of soil structure [1]. Deforestation and overgrazing can lead to loss of vegetation, so soil is more easily dried out or eroded [1].

In some areas, overgrazing, over cultivation and deforestation can lead to desertification [1]. Salinisation can be caused by excessive irrigation [1]. There are more large-scale factors at work. For example, overpopulation forces people to farm marginal areas [1].

14 Energy efficiency will depend on the specific food being produced in the system; for example, absorption of solar energy by producers in aquatic

systems tends to be less efficient as some light is absorbed or reflected by water hence less light reaches aquatic producers. Food chains in aquatic systems are much longer so available energy is reduced from the original input energy. In aquatic systems most is harvested from higher trophic levels. There is lower energy efficiency in aquatic food production systems.

In contrast, in terrestrial crop systems, most food is harvested from relatively low trophic levels. However, energy conversions along the food chain are more efficient in aquatic systems as less biomass is locked up in bone and skeletal materials compared to mammals and birds. Aquatic producers achieve faster growth rates than terrestrial producers.

15 High population growth is often in countries of high rural population *e.g.* Kenya.

In contrast, low population growth is often in countries with a high urban population *e.g.* USA. Kenya needs many children to work in the subsistence farming they practice - the low level of technology in the farming system means that the labour needed is high and so the fertility rate is high. There are low yields since no pesticides or chemical fertilisers are used means. Hence more land has to be farmed and so more workers are needed. The economic costs of children in Kenya are low as the social system is for low consumption so many children are not a major monetary burden. In contrast, the USA can feed its population, with a surplus, despite having changed from labour intensive to capital intensive farming. In MEDCs subsidies lower production costs, encouraging increased food production. The poor infrastructure in many LEDCs means that there may be sufficient food production but insufficient distribution to population. In addition, LEDCs such as Kenya may export large volumes of food produce at low costs to MEDCs, which then adds value to the produce, but this rarely benefits the rural population in the LEDC. The USA has less than 5 % of the population working in farming so not many children are expected or want to work in farming. High levels of mechanization mean few people are needed on the farm. Large amounts of food are produced per person working.

The social system encourages consumption and a high standard of living which is expensive with many children.

16 a Water scarcity relates to water availability and/or demand. It is a human concept rather than a natural phenomenon. Water scarcity can be due to humans using water unsustainably or by not having the economic means to access sufficient water. [1]

b There is a broad band of economic water scarcity in tropical areas, especially sub-Saharan Africa [1]. Economic water scarcity is largely to be found in LEDCs [1]. In contrast, MEDCs generally have little or no water scarcity [1].

17 *Award 1 mark for a definition. Award up to 3 marks for identification of factors. Award up to 3 marks for discussion of relative importance. Award up to 2 marks for appropriate case studies/examples.*

Factors include: inequalities in terms of access to resources and use; political conflict; population size/growth; industrialisation; increased food production and the need for more irrigation; socio-economic levels (levels of development); climate change; available technology; and cost of water development schemes.

Sustainable use means using water at a rate that allows natural replenishment and/or using water in a way that minimises damage to the environment. The relative importance of different factors will depend on the context of the area, e.g. whether it is a semi-arid area where there is a smaller reserve of water; conflicts over water can be made worse when there are political tensions between different user groups; in countries near to carrying capacity, population numbers will be more significant than in countries where water supplies are abundant; in countries where water is abundant it may be perceived as an unlimited resource and therefore wasted; in societies where there is good awareness of sustainability issues individuals may take steps to ensure their own level of water use is sustainable, e.g. recycling rain water; in

countries with oil resources technological solutions to water shortages such as desalinisation are a more affordable option. *Note: a case study is required.*

18 *Award 2 marks for definitions of carrying capacity and environmental value systems. Award up to 4 marks if only one quote is referred to, or if only carrying capacity or environmental value systems are considered.*

Carrying capacity is the maximum number of a species that can be sustainably supported by a given environment. Environmental value systems are a particular world view that shapes the way individuals or groups of people perceive and evaluate environmental issues.

Gandhi quote: At the current rate of resource consumption Earth's carrying capacity is being exceeded. However, he suggests that the Earth's resources are sufficient for the world's people provided they meet their needs sustainably. However, far fewer people could be supported/sustained if each lived like the average person from an MEDC. Critics may argue that technology could increase carrying capacity.

Kenyan proverb: We should leave resources for future generations to use. Unsustainable practices mean there are few/no choices for future generations. In future, the carrying capacity will be reduced if the current generation uses up the resources.

Environmental value systems: Both views are ecocentric. Gandhi's words show that he believed that consuming resources beyond the basic level is greedy. Some value systems encourage greed, i.e. unsustainable consumption. Many economic systems assume continued economic growth/increasing consumption of resources, and Gandhi is perhaps challenging this.

The value system in the Kenyan proverb prioritises the rights and needs of future generations, and would prefer a more sustainable approach to development. Traditional views often help preserve the environment.

19 *Award up to 2 marks max for an outline of carrying capacity. Award 1 mark for stating a viewpoint. Award up to 5 marks for either viewpoint and evidence to support that viewpoint.*

There are many reasons to suggest that the world's population has exceeded its carrying capacity:

- resource distribution is uneven
- overuse of resources in some places – a more equal use is required
- not enough recycling/reuse/renewal of resources
- technology solutions to enhance our carrying capacity are required
- substitution of old resources and new resource usage through new technologies
- adaptation of old technology allows for a larger population
- the problem is more geopolitical rather than ecological
- reliance on non-renewable resources, which are running out
- quality of life/standard of living is low in majority of the world's population, indicating too many people in the world
- technology often has unforeseen consequences linked to pollution, which can reduce the human population carrying capacity
- famine indicates that resources are too few for the population
- war over resources, such as oil, indicate overpopulation
- increasing migration rates out of an area might indicate overpopulation

20 *Award up to 4 marks for an explanation of ecological footprint and why it should be reduced. Award up to 5 marks for an ecocentric/technocentric approach – 1mark for a definition, 1 mark for a specific example and up to 3 marks for arguments as to why such an approach is more likely to be successful.*

The ecological footprint (EF) is the area of land (and water) required to support a population (at a given standard of living). It is a measure of the amount of land needed by a population to meet its needs/absorb waste and provide its resources.

An EF greater than the biocapacity of a country indicates unsustainability. Many countries currently have an EF that is greater than their Earth-share (currently about 2.1 hectares per person). People in MEDCs have a higher

ecological footprint than people in LEDCs; e.g. the US EF is over 9 (global) hectares per person whereas in Bangladesh it is 1.4.

Technocentric approach:

- □ emphasises technological solutions to environmental problems
- □ can reduce footprints by increasing the productivity (biocapacity) of an area, e.g. intensive agriculture
- □ enables people to maintain their lifestyles while they are reducing their footprints
- □ is more likely to be (politically) popular and therefore adopted
- □ can reduce waste, e.g. recycling
- □ can be introduced at a national level, so can have a broader impact

Ecocentric approach:

- □ emphasises minimum disturbance of natural processes
- □ emphasises need for sustainability/that we need to live within our Earth-share
- □ encourages individual responsibility for reducing the resources we use/waste
- □ can reduce waste, e.g. growing own food would reduce food miles
- □ is local/community-based/bottom-up, so people feel part of the process
- □ can be simple/cheap, e.g. composting, so is possible even in LEDCs
- □ can still involve technology, e.g. community sharing cost of a wind turbine
- □ can be introduced in schools quite easily so can have a (broader) impact over the long term

[9 max]

21 *Award up to 5 marks if only development policies or cultural influences are discussed.*

Development policies: policies that target reduced death rate.

E.g. improved public health and sanitation – access to a clean water supply, increased food supply, vaccination/immunisation programmes, increased education for children to improve nutrition/farming/healthcare. Increased life expectancy can increase the population growth as fewer people die; improved health care increases the ageing population and thus the population of a country.

Policies that target fertility: incentives to have children.

E.g. generous maternal benefits; disincentives to have children, e.g. fines for having extra children above the approved government number; increased education for girls often decreases fertility; anti-natal policies decrease population growth, whereas pro-natal policies increase population growth.

Policies that influence migration: policies can encourage immigration to facilitate gap in labour market in countries with a falling birth rate. Cultural influences: cultural/religious influence on contraception usage/non-usage can decrease/increase fertility; education on birth control and contraception usually decreases fertility; boys are more valued than girls in some cultures, leading to increased fertility so more boys are born; the culture of having children to support in old age/help farm the land; marriage patterns – marrying young usually means increased fertility; women's emancipation/increased freedom/control over their own life can decrease fertility. [8 max]

Topic 4 Conservation and biodiversity

Quick check questions

1 The amount of biological or living diversity per unit area. It includes the concepts of species diversity, habitat diversity and genetic diversity.

2 Species richness is the number of species in an area, whereas species diversity also includes the relative abundance of each species.

3 Habitat diversity is the range of different habitats or number of ecological niches per unit area in an ecosystem or biome. Genetic diversity is the range of genetic material present in a gene pool or population of a species. Genetic diversity lies within the population of a species, whereas habitat diversity refers to where the species lives.

4 The cumulative, gradual change in the genetic characteristics of successive generations of a species or race of an organism, ultimately giving rise to species or races different from the common ancestor. Evolution reflects changes in the genetic composition of a population over time.

5 Populations show variation; populations always over-reproduce to produce excess offspring; resources, such as food and space, are limited and there are not enough for all offspring; there is competition for resources; the best adapted survive ('survival of the fittest'); the individuals that survive contain genes that give them an adaptive advantage; these genes are inherited by offspring and passed on to the next generation; over time there is a change in the gene pool, which can lead to the formation of new species.

6 Geographical isolation is caused by a physical barrier that leads to populations becoming separated due to, for example, plate activity, eventually leading to speciation; examples of geographical isolation include the formation of mountains, seas, lakes, rivers, deserts; isolated areas have different environments/habitats/ecosystems; each isolated population adapts to the local conditions via natural selection; over time the gene pools of isolated populations become distinct from each other; speciation occurs; if the isolated populations/species meet, fertile offspring cannot be produced.

7 Reproductive isolation is caused by processes that prevent the members of two different species from producing offspring together; there are several types – environmental isolation, temporal isolation, behavioural isolation, mechanical isolation and gametic isolation; because there is no exchange of genetic material; gene pools of the separate populations become genetically different, leading to the formation of new species.

8 Plate movement separates organisms with a common ancestor; there is a separation of gene pools, resulting in divergent evolution; collision of plates can lead to uplift, leading to mountain formation; the mountains form a physical barrier that isolates populations; the uplift creates new habitats promoting biodiversity; adaptation to new habitats occurs through natural selection; collision of plates can cause the spread of species through the creation of land bridges; which leads to a mixing of gene pools and possible hybridisation; plate activity can create new islands, usually through volcanic activity; which can lead to adaptations to fill new habitats/niches; the movement of plates to new climate regions leads to evolutionary change to adapt to new conditions.

9 Pioneer species arrive (e.g. lichens, mosses, bacteria); as pioneers die, soil is created; new species of plant arrive that need soil to survive – these displace pioneer species; growth in plants causes changes in the environment (e.g. light, wind, moisture); growth in roots enables soil to be retained – nutrients and water in the soil increase; nitrogen-fixing plants arrive, adding nitrates to soil; soil depth increases further, allowing shrubs and other taller plants to arrive; animal species arrive as species of plant they rely on become established; a climax community is established.

10 Succession of e.g. bare rock (i.e. no soil) is called primary succession; succession in areas that already have soil is called secondary succession.

11 Diversity is the number and relative abundance of species present; inertia (or persistence) is the resistance of an ecosystem to being altered; resilience is the ability of an ecosystem to recover after disturbance.

12 Tropical rainforests have high diversity and inertia, but if they undergo large-scale disturbance through logging or fires they have low resilience (i.e. take a long time to recover); complex ecosystems such as rainforests have complex food webs that provide high inertia – if one part of a food web is lost other organisms are likely to be there to replace it; they also contain long-lived species and dormant seeds and seedlings that promote inertia; rainforests

have low resilience because they have thin, low-nutrient soils – nutrients are locked up in decomposing plant matter on the surface and in rapidly growing plants within the forest, so when the forest is disturbed, nutrients are quickly lost when the leaf layer and top soil are washed away.

13 Volcanic activity; drought; floods; ice ages; meteor impacts

14 Agricultural practices; habitat degradation, fragmentation and loss; introduction of non-native (invasive) species; pollution; human population growth; overhunting, collecting and harvesting.

15 Monocultures have replaced diverse ecosystems with single plant species; pesticides can destroy native wildlife as well as the target species, reducing biodiversity; a genetically modified (GM) crop plant modified to be toxic to insect pests could have a direct harmful effect on non-target insects if they eat the plant; GM crops could have an indirect effect by reducing the insects that are a food source for other wildlife, such as farmland birds; GM crops can be grown as monocultures, replacing biodiverse ecosystems.

16 Mass extinctions include events in which 75% of the species on Earth disappear within a geologically short time period, usually between a few hundred thousand to a few million years.

17 The first five mass extinctions have a natural/abiotic cause; the sixth mass extinction is being caused by humans/has a biotic cause.

18 Any three from the following: small population size; limited distribution; high degree of specialisation, slow reproductive rate; low reproductive potential; non-competitive/altruistic behaviour; high trophic level; long migration routes; complex migration routes; habitat is under threat; under human pressure from hunting, collecting, trade, etc.

19 Background extinction is going on all the time at a local level, caused by e.g. droughts, floods, habitat loss, disease, the evolution of a superior competitor; mass extinctions are events that occur rarely over the geological time period, and are caused by global catastrophic events (e.g. volcanic activity; meteor impact; glaciation events causing changes in sea level).

20 Highlights species threatened with extinction; promotes conservation of threatened species.

21 Population size/reduction in population size; the number of mature individuals; geographic range and degree of fragmentation; quality of habitat; area of occupancy; degree of endemicity; probability of extinction.

22 E.g. elephant bird; would have fed on vegetation and seeds on the island of Madagascar; the loss of the elephant bird would have affected the dispersal of the endemic plant *Uncarina*, the seeds of which were dispersed on the feet of the bird; the disappearance of the bird could also have led to the current poor dispersion of the critically endangered forest coconut, an endemic species that may have been adapted for passage through the elephant bird gut; the loss of the elephant bird would have left more vegetation for other species, e.g. Sifaka lemurs.

23 E.g. Sumatran tiger; loss of habitat (tropical rainforest) through logging; hunting because seen as danger to humans and livestock; fragmentation of habitat, which makes breeding difficult; high market value of body parts, which encourages poaching.

24 E.g. golden lion tamarin monkey; numbers in the wild have increased from a low of 400 in the 1970s to around 1000 today; captive breeding programmes in zoos have increased numbers for release into the wild; there have been successful efforts to preserve native forests, e.g. Reserva Biologica de Poyo das Antas, near Rio de Janeiro.

25 E.g. Borneo tropical rainforest; the rainforest has high species diversity, with 15 000 plant species, 220 mammal species and 420 bird species; 300 species of tree can be found in 1 hectare of forest; forest contains many species on the Red List, e.g. orang-utan, sun bear, Asian elephant and Sumatran rhino.

Natural threats: forest fires; drought; dry periods (El Niño).

Human threats: logging; conversion to plantations (e.g. oil palm); insecticide and herbicide use in plantations are used to control insect pests and weeds,

which also reduces biodiversity; animals (e.g. Asian elephants and orang-utans that stray into the plantations) may be illegally killed; without forest cover, soil is eroded making it difficult/impossible for the original vegetation to regrow; loss of forest cover causes changes to stream flow and reduces stream diversity; loss of forest reduces transpiration from leaves, which affects local weather patterns, leading to drier areas more prone to fire; the valuable role that the ecosystem provides (e.g. biodiversity, controlling weather patterns) has been reduced; the role of the rainforest as an economic resource through e.g. ecotourism has been reduced.

26 Ethical; aesthetic; economic; ecological

27 Easier to give commercial value – e.g. goods such as timber, medicine and food; more difficult to give commercial value – e.g. ecosystem support services, ecosystem regulatory services, cultural services, and ethical and aesthetic factors.

28

	NGO	IGO
Speed of response	Rapid: organisations can make their own decisions	Slow: there must be agreement between governments
Use of media	Use film of activities (e.g. chasing whaling boats) to gain media attention	Professional media liaison officers prepare and read written statements
Diplomatic constraints	Unaffected by political considerations Activities may be illegal, although this is discouraged	Many constraints: cannot make decisions without agreement from all parties Disagreements can cause serious constraints
Political influence	Green politics can establish environmental issues as part of the political process	Direct access to the governments of many countries
Enforceability	No direct power: must use public opinion to persuade governments to act	Use international treaties and national or state laws to protect the environment, ecosystems and biodiversity

29 Protected area should provide vital habitat for indigenous species; this can include habitat and food for migrating species (e.g. birds); there should be local community support for the area; it should be adequately funded and supplied with resources; relevant ecological research and monitoring should be carried out; it should play an important role in education; it should be protected by legislation; it should have policing and guarding policies; all aspects of education and tourism should give the site economic value; a multifaceted approach to conservation can create a hot-spot for environmental education and tourism; the protected area should have a holistic approach to conservation – i.e. the area is not just used for wildlife protection, but also one where educational activities are encouraged, research takes place, people use it as an area of relaxation and its cultural value is encouraged; a holistic approach to ecosystem management is important as experience demonstrates that protection without considering other factors (e.g. economics, culture and development) is unlikely to be successful; multiple-use reserves are more popular and easier to fund, and are more sustainable in the long-run; mixing education, research and protection has long-term benefits, and is the strength of a holistic approach to conservation and ecosystem management.

30 E.g. the Kabili-Sepilok forest reserve – a 4300 ha area of lowland rainforest in Sabah, Malaysian Borneo; the area is successful because it has a holistic approach to conservation.

Local community involvement: local guides and rangers earn a living assisting tourists within the park and protect the forest and its biodiversity; there are many ecotourism resorts near the reserve run by local people; their economic future and the future of the park are closely linked; they have a positive vested interest in the conservation area; they have a respect and pride in the reserve.

Involvement of government agencies: The Sabah Wildlife Department and Forestry Department help to manage the reserve; the government through its employees, wildlife agencies, rangers and guides, provides the park with security and infrastructure; these government departments monitor and control visitor

numbers and help to protect the reserve; they provide resources; they liaise with local groups, non-government groups and international organisations.

Research: The Forest Research Centre (FRC) at Sepilok carries out scientific research within the reserve; this allows its ecosystems and biodiversity to be monitored; it allows new information to be discovered; research identifies new hazards and new goals; the FRC produces information that supports the park's existence and informs management decisions; it helps educate those inside and those outside the park, both nationally and internationally; research is also carried out by the orang-utan rehabilitation centre at the edge of the reserve, which returns captive animals to the wild.

Education: an orang-utan rehabilitation centre rehabilitates orphaned orang-utans. It is a major international tourist attraction, focused on public education, research and conservation; a Rainforest Discovery Centre (RDC) provides environmental education facilities for students, teachers and overseas tourists; the Bornean Sun Bear Conservation Centre (BSBCC) was created to rehabilitate captive sun bears back into the wild; it promotes greater awareness of the ecology of the bear and the threats they face.

31 Focuses on vulnerable species and raising their profile; high-profile/charismatic species catch public attention both nationally and internationally (e.g. Madagascan lemurs) and can raise the profile of conservation issues; attracts attention and therefore funding for conservation; can be very successful for saving keystone species (i.e. species that are essential for ecosystem functioning); can successfully preserve a species in zoos/botanic gardens; e.g. golden lion tamarin; CITES addresses the cross-border issues and can prevent illegal trade of protected species; seedbanks can preserve genetic diversity for future restocking of habitats; however, species-based conservation favours charismatic organisms and is less successful at saving less charismatic species (e.g. Madagascan hissing cockroach); saving a named species requires preserving the animal's habitat, which benefits all other organisms in that habitat: the species-based approach might not do this; a species can be artificially preserved (e.g. in a zoo) while its natural habitat is destroyed (e.g. Sumatran tiger); the ecosystem is a holistic unit and all food sources, habitats and niches need preserving too; there is a high cost of species-based conservation due to enforcing trade restrictions at border crossings/maintenance costs in zoos/botanic gardens.

Exam practice

1 **a** Variety of species per unit area. [1]

b Environmental pressures (e.g. predation, climate); act on variations within a population (e.g. size, colour, resistance to disease); to change the frequency of genes in a population; where this reaches the point that the individuals cannot interbreed (i.e. gene pools are very different), speciation has occurred. [2 max]

2 *Any 4 from the following points – examples must correspond to the correct type of plate movement:*

Plate tectonic movement leads to divergence of plates, resulting in isolation of populations (separation of gene pools, resulting in new species); Examples: formation of barriers and/or land bridges; example illustrating this; movement of plates to new climate regions (leading to evolutionary change to adapt to new conditions); example illustrating this (see page 81); volcanic activity/plate collisions producing islands/mountains (leading to diversity of habitats/evolution of new species); example illustrating this (see pages 80–81); convergence of plates (leading to mixing of gene pools causing new adaptations); example illustrating this (see pages 80–81). [4 max]

3 *Any 6 from the following points:*

Succession is the change in the community of an area over time until the climax community of that biome is reached; the more diverse an ecosystem the more stable it is; succession increases diversity and so

stability increases; each stage/sere of succession helps create a deeper and more nutrient-rich soil, so allowing larger plants to grow; this increases the habitat diversity, which leads to greater species and genetic diversity and thus greater stability; climax communities have a more complex system, which is more stable; more complex food webs have greater diversity, so more stability if one organism goes extinct; humans often try to recreate pioneer seres in agriculture, these are less stable and so humans have to constantly monitor/work with the crops; monocultures in agriculture are more vulnerable to disease and pests and so less stable; succession can be interrupted naturally and by humans and this also reduces the stability of the ecosystem. [6 max]

4 **a** The orderly process of change over time in a community; changes in the community of organisms frequently cause changes in the physical environment that allow another community to become established and replace the former through competition. [1]

b *Any 5 from the following points*:

Pioneer community consists of hardy specialists that are few in number, and the ecosystem is very simple, so diversity is low; when pioneer species die they decay and produce soil, so plants with root systems can colonise, increasing diversity; new plants alter abiotic conditions (e.g. temperature, wind) so that larger species (e.g. shrubs) can survive; as soil depth increases, water content also increases allowing larger plants to survive; plant community increases habit complexity, with a larger number of niches and therefore number of species; as the succession progresses, and complexity increases, an increased number of niches allows a greater number of species to coexist and therefore diversity increases; the presence of one or a few dominant species in the climax community can lead to diversity in the climax being lower than in the preceding seral stage. [5 max]

c *Any 6 from the following points (the ecosystem must be named):*

Named ecosystem – e.g. grasslands have low diversity and inertia, but if they undergo large-scale disturbance through e.g. fires they have high resilience (i.e. take a short time to recover); they have low diversity because they are simple ecosystems with fewer niches than complex ones (e.g. forests); they have low inertia as they burn very easily; relatively simple ecosystems such as grasslands have simple food webs that provide low inertia: if one part of a food web is lost then there are no other organisms to replace it; grasslands have high resilience because they have thick, nutrient-rich soils, so when the ecosystem is disturbed, nutrients are quickly made available to growing plants; nutrient-rich soils can promote new growth; dormant seeds in the soil are resistant to fire and provide rapid new growth following disturbance. [6 max]

5 *3 marks for naming any from this list:*

Found in parts of the world with high population density, so pressure on the land to remove forest and grow food; it takes a long time to recover from logging/destruction; have biological hotspots with high biodiversity, so many species affected; valuable timber is removed and so forest damaged. [3 max]

6 *2 marks for naming any from this list:*

Name of species, e.g. dodo; *factors will depend on example selected – e.g. for the dodo:* confined to small island/limited distribution (Mauritius); small population; useful source of food for visiting sailors; extreme tameness; large and conspicuous; slow rate of reproduction; habitat destruction; predation by introduced organisms (e.g. rats ate dodo eggs). [2 max]

7 *2 marks for naming any from this list:*

Degree of specialisation, e.g. dietary needs too specialised; distribution limited to specific islands; slow reproductive rate/*K*-selected species/small number of young; higher trophic levels; may accumulate toxins; have long migration routes. [2 max]

8 *Any 5 from the following points:*

With the exception of fishes and invertebrates, many more island species have been rendered extinct than continental species; island communities

are particularly vulnerable because of high degree of endemism; small size of populations on islands; there is less genetic diversity in small island populations; absence of predators on islands and therefore vulnerability of organisms when these are introduced; specialised nature of island forms; small number of fish extinctions on islands due to rarity of suitable habitats; small number of species originally. [5 max]

9 *5 marks awarded for any human threats, 3 marks for any natural threats, and 2 marks for any consequences of disturbance.*

Named ecosystem, e.g. Great Barrier Reef off the coast of Queensland, Australia.

Human threats: tourism – coral very fragile and easily damaged by divers touching coral or breaking bits off for souvenirs; over-fishing can disrupt the balance of species in the food chain; inadvertent damage from anchors and pollution from boats; runoff of fertilisers from sugar plantations on the coast; sewage and pollution from coastal settlements such as Cairns can lead to excessive nutrients and algal blooms; increased sedimentation due to deforestation of mangroves to make space for tourist developments make water cloudy, reducing productivity; disrupting the interdependence of coral ecosystem with sea grass beds and mangrove ecosystems; global warming increases sea temperatures, leading to coral bleaching. [5 max]

Natural threats: all of these make coral more vulnerable to natural threats such as disease; natural predators (e.g. crown of thorns starfish); structural damage from storms/cyclones; increased sea temperatures due to El Niño; can lead to coral bleaching; which has knock-on effects on the fish species that depend on the reef for food, protection and nurseries for young. [3 max]

Consequences: coral reefs are able to withstand some threats but the collective effect of human and natural processes can lead to damage of the reef and species which depend on it, and the breakdown of the ecosystem; when the 'critical threshold' is reached (when even if threats stop, the ecosystem will not recover); leading to a loss of biodiversity; the valuable role that the ecosystem provides, e.g. in conjunction with mangroves, sea grass beds as a line of coastal defence; as an economic resource. [2 max]

10 *6 marks awarded for any of the following points:*

Ethical arguments stress the right (bio rights) of living organisms to remain unmolested. [1 max for ethical arguments]

Aesthetic arguments stress the importance of beauty/intrinsic appeal of diversity in landscapes/environments/species. [1 max for aesthetic arguments]

Genetic resource arguments stress the value of genetic diversity for the future; either because of the potential socio/economic benefits of different species in helping humanity to solve e.g. medical/food supply issues; or because of the importance of preserving genetic diversity to ensure the health of endangered populations. [2 max for genetic resource arguments]

Ecological arguments stress the value of diversity in maintaining stability (on every scale); e.g. ecosystems with high species and habitat diversity can withstand environmental changes better/are more stable; e.g. preserving a diversity of ecosystems maintains global stability as some ecosystems play unique roles in providing global life support systems, such as climate regulation/global productivity/balance of mineral cycles. [2 max for ecological arguments]

11 a Governmental – UNEP/United Nations Environment Programme; national (e.g. United States National Parks Services/English Nature), state (e.g. Victoria Parks and Wildlife Services).

Non-governmental – Greenpeace/WWF/World Wide Fund for Nature. [2]

b See Table 4.6, page 93. [4 marks for any correct statement from the table]

12 *Any 4 from the following points:*

Established in 1980 by the World Conservation Union (IUCN), which is concerned with the importance of conservation of resources for sustainable economic development; it consists of three factors:

□ maintaining ecological processes
□ preserving genetic diversity
□ utilising species and ecosystems in a sustainable fashion.

The strategy outlined a series of global priorities for action; and recommended that each country prepare its own national strategy as a developing plan that would take into account the conservation of natural resources for long-term human welfare; it drew attention to a fundamental issue – the importance of making the users of natural resources become their guardians; without the support and understanding of the local community – those whose lives are most closely dependent upon the careful management of natural resources – the strategies cannot succeed. [4 max]

13 *Any 4 from the following points:*

Large areas usually preferred to small; as they can conserve a greater variety of habitats; and higher numbers of individual organisms; and thus greater genetic variability; larger areas have smaller proportional length of perimeter; and thus fewer edge effects than small areas; e.g. wind, heat, low humidity, disturbance, drift of pollutants; similarly, compact areas preferred to elongated/irregular; corridors sometimes useful for connecting isolated or small reserves to allow movement of larger animals. [4 max]

14 Description: [2 max]

Predators/diseases controlled; populations can build up quickly; habitat and food abundant; so reduced competition; usually done in zoos/occasionally in semi-wild enclosures; small population obtained from wild or captive stock; enclosures often made as similar to natural environment as possible; sometimes individual animals exchanged between collections to prevent inbreeding; specific examples of successful prospects (e.g. Cambodian sun bear); breeding may be assisted (by artificial insemination).

Evaluation: [3 max]

Conservation of habitat diversity should lead to conservation of species; not all species breed easily in captivity; it is difficult to maintain genetic diversity; released animals may be easy targets for predators; aesthetic values lead to an imbalance in conservation activity; e.g. 'cute and cuddly' (giant panda) or large and conspicuous (elephant) animals are conserved, but small and obscure species (such as Madagascan hissing cockroach) may not be part of the conservation programme; technical/economic difficulties for some countries. [5 max]

15 *Answer must give at least one strength and one weakness. Evaluation needed for full marks; if no evaluation, 3 marks max awarded.*

Strengths: supported by many countries (177); lists many species (around 35 000); bans commercialisation of many products/species; appropriate examples (rhinoceros horn, ivory, tiger parts).

Weaknesses: enforcement is difficult; small fines; many countries have not signed; support by some countries has been lukewarm; favours large/conspicuous/attractive organisms; appropriate examples (poaching of ivory in Africa continues).

Evaluation: e.g. despite its limitations, overall the treaty has been successful in conserving many endangered species such as sea turtles. [4 max]

16 *Any five from the following points:*

Name of area, e.g. Uluru (Ayers Rock, Northern Territory, Australia).

Reasons for selection will depend on area selected. For example, with respect to Uluru: protected area has spectacular nature/aesthetic appeal of isolated monolith; geological importance; relatively undisturbed nature of surrounding habitats (e.g. by western influences); archaeological importance; variety of organisms (plants, reptiles); significance to indigenous peoples; possibility of taking large areas into management without disturbing long-established ownerships. [5 max]

Topic 5 Pollution management

Quick check questions

1 Point-source pollution

2 Non-point-source pollution

3 Lead and mercury, chemicals such as CO_2, SOx and NOx, and particulate matter, such as dust.

4 Healthy, clean water generally has >75% oxygen saturation, whereas polluted water has 10–50% oxygen saturation.

5 Vegetation gets trampled, broken and may die – especially those plants closest to the centre of the path. The soil becomes compacted – water flows over the surface rather than infiltrating the soil, thus accelerating erosion.

6 BOD is a measure of the amount of dissolved oxygen required to break down the organic material (in a given volume of water through aerobic biological activity).

7 The population of *Tubifex* worms increases. These feed on and break down the organic pollution. They respire and use up a lot of oxygen – BOD increases. Further downstream, the amount of organic matter has decreased. BOD is reduced. Even further downstream BOD is lower as all the organic matter has been broken down. The population of *Tubifex* has decreased, whereas that of mayfly nymphs has increased.

8 Thermal pollution lowers the dissolved oxygen content of water.

9 6

10 4

11 Regulating and reducing the pollutant at the point of emission.

12 Altering human activity through education, incentives and penalties to promote development of alternative technologies, adoption of alternative lifestyles, and reducing, reusing and recycling.

13 Zabbaleen

14 It may create jobs, pay taxes and create recycled resources.

15 The Stockholm Convention on POPs regulated the use of DDT – it was banned for use in farming but was permitted for disease control. The plan is to find alternatives for disease control by 2020. In 2006, WHO recommended the use of DDT for regular treatment in buildings in areas with a high incidence of malaria.

16 Indoor residual spraying (spraying DDT indoors but not outside).

17 Natural cycles of eutrophication include nutrients added from decomposing biomass, and upwelling ocean currents bringing nutrients to the surface.

18 Nitrates and phosphates

19 Macrophytes disappear because they are unable to photosynthesise as less sunlight penetrates the water.

20 The increased death of algae and underwater plants leads to an increase in BOD, as bacteria multiply to break down the dead organic matter.

21 Fertilisers should not be applied in winter as the soil is bare and runoff may wash fertilisers into rivers and streams.

22 It is a clean-up and restoration strategy.

23 There would be an increase in the amount of paper and packaging (card, paper, plastic). There may also be increased food waste.

24 We would expect Tokyo residents to have a much greater volume of waste, as they are generally wealthier than residents in Kabul.

25 Recycling involves transport of sometimes heavy, bulky goods, so requires lots of energy. It may also produce toxic waste.

26 Landfill is a cheap and easy way to dispose of waste. It is also a way of producing energy (in the form of methane) from waste.

27 The stratosphere

28 The troposphere

29 The thinning of the concentration of ozone in the stratosphere.

30 The effects include mutation and subsequent effects on health, damage to photosynthetic organisms, especially phytoplankton, as well as skin cancer and cataracts in humans.

31 Wear sunglasses, use sun block, wear T-shirts and stay inside during the hottest part of the day.

32 Fridges with ODS refrigeration can be replaced with 'green freeze' technology; pump-action sprays can be used instead of aerosols; alternatives to aerosols can be used; organic farming can be used instead of using methyl bromide.

33 A temperature inversion occurs when cold air is located above warm air, so the normal decrease of temperature with height is disrupted.

34 Rain cleans the air and winds disperse the smog – these are associated with low pressure conditions. Smog is more likely under high pressure (calm) conditions. The clear skies allow more sunlight to get through and the light winds are unable to disperse the smog.

35 Pedestrianisation of city centres or only allowing cars with certain number plates to enter on particular days of the week.

36 Reducing fossil fuel combustion through urban design: e.g. south-facing windows, triple-glazed windows, cavity- and loft-insulation. Design cities so that there is more open space and water courses to help reduce the temperature and allow evaporative cooling.

37 Sulfur dioxide and nitrogen dioxide

38 Crown 'die-back', shedding of leaves and needles, reduced intake of nutrients and water. Increased leaching of nutrients from soil.

39 Chalk and limestone

40 It neutralises the effects of acidification.

Exam practice

1 *Award up to 2 marks for the definition, and up to 3 marks for distinguishing between point-source and non-point-source pollution.*

Pollution is the addition of a substance produced by human activity to an environment. Alternatively, pollution is a substance added to the environment resulting in negative effects. It is added at a rate greater than that at which it can be rendered harmless and has a negative effect on the organisms within it.

Non-point-source pollution is the release of pollutants from numerous, widely dispersed origins such as coal power stations or vehicles. In contrast, point-source pollution is the release of pollutants from a single, clearly identifiable site such as a nuclear power station or a sewage outlet. Point-source pollution is easier to manage/clean up than non-point-source pollution.

2 *Award [1 mark] for the definition of BOD and award up to [4 marks max] for an explanation of how BOD can be used to assess pollution levels in water.*

BOD is a measure of the amount of dissolved oxygen required to break down the organic material (in a given volume of water through aerobic biological activity). The *Tubifex* worms feed on effluent; their populations increase rapidly immediately downstream of any effluent input, hence the demand for oxygen (BOD) increases and the availability of oxygen is decreased. A high population of *Tubifex* worms in any river could indicate that organic pollution has recently occurred. In contrast, the population of mayfly nymphs crashes as soon as the effluent enters. They need clean water (low BOD) and, at the point of entry, either die or move away. Thus, the absence of mayfly nymphs in a particular river might indicate that organic pollution has occurred and large populations might indicate clean, unpolluted water.

3 *Award up to 4 marks max if only benefits or costs are addressed. Award 1 mark for a clear attempt at evaluation.*

The benefits of using DDT were mostly in health and farming. For example, in health, DDT was used to control lice that spread typhus [1], and mosquitoes that spread malaria [1]; in farming, DDT was used to control pests [1].

However, DDT can build up in the food chain (bioaccumulation and biomagnification); consequently, top predators can accumulate very high concentrations of DDT – enough to have an impact on their survival chances [1]; similarly, among humans there is evidence that DDT can have a negative impact on health, such as increasing cancer, and reducing birth weight, causing prematurity, and impacting on mental development [1]. As the 2001 Stockholm Convention on POPs aims to phase out the use of DDT for disease control by 2020 (it has already been banned for use in farming), it would seem that the costs associated with DDT outweigh the benefits [1].

4 *Award up to 2 marks max for description of ecocentric response. Award up to 2 marks max for description of technocentric response. Award 4 marks for evaluation.*

Ecocentric responses will try to minimise the impact on the environment by encouraging people to be restrained, using methods that are more in harmony with natural systems [1]. These include the use of organic fertilisers, crop rotation, educational campaigns and use of buffer zones [1].

Technocentric responses will emphasise the use of technology/human ingenuity [1], such as developing an alternative to phosphates in detergents, applying fertilisers more carefully, pumping air through lakes and dredging sediments [1].

However, people are reluctant to adapt lifestyles, so ecocentric approaches can be hard to enforce [1]. Alternative approaches might not be so efficient and technocentric solutions can increase the costs, and so may not be an option for less-wealthy farmers [1].

5 Decomposition or composting of organic waste produces carbon dioxide and methane. Both are greenhouse gases [1]. Methane is a more powerful greenhouse gas [1]. Composting organic material produces methane [1]. Methane generates carbon dioxide when it is burnt. Incinerating solid domestic waste to produce heat (to generate electricity) produces carbon dioxide [1]. [4 max]

6 *Award up to 4 marks if only one viewpoint is given. Award 6 marks if both viewpoints are mentioned and each point is evaluated.*

A technocentric approach provides alternatives to individuals that don't inconvenience them. It substitutes materials and allows economic and social development to continue. [1]

A technocentric approach is very costly and technological solutions may give rise to further environmental problems [1]. It also promotes greater resource consumption [1]. In contrast, an ecocentric approach may be more sustainable. It does not rely on technological developments to occur and it raises general environmental awareness in the population [1]. A technocentric approach would replace CFCs with other chemicals that are not destructive to ozone [1]. It would develop products that do not require harmful chemicals [1]. However, some of the substitutes (e.g. HFCs) are harmful to the environment [1]. Moreover, substitution does not address the question of over-consumption [1]. In contrast, an ecocentric approach would favour the reduced use of refrigeration, air conditioning, aerosols and fossil fuels that release NOx [1]. It would also favour energy conservation, e.g. communal transport, but would be dependent on changes in individual attitudes and cannot easily be implemented [1]. An ecocentric approach requires individual change, which can be difficult to encourage and may hinder economic growth and development [1]. [6 max]

7 *Award up to 4 marks for human factors and award up to 3 marks for named examples/case studies.*

Pollution management strategies can aim to: alter human actions; reduce pollution at point of emission; or clean up after the pollutant has been emitted [1]. Cultural values will determine readiness of population to change lifestyle, e.g. Scandinavian countries have been relatively successful in developing alternative technologies [2]. Political systems will determine to what extent legislation is enforced, e.g. if standards for emissions for vehicles are enforced, or if recycling/reducing/reusing programmes are promoted [1]. The level of economic development can affect whether long-term sustainability/short-term opportunism is the prevailing approach, e.g. restoring degraded environments such as Cheong-Gye-Cheon in Seoul [2].

8 *Award up to 6 marks max if only strengths or weaknesses of reducing, reusing or recycling strategies are considered.*

The main cause of the release of many atmospheric pollutants is the burning of fossil fuels in transport, industry and energy generation. Reducing fossil fuel combustion can therefore be an effective way of limiting release of pollutants [1]. Reducing domestic demand for electricity by energy-saving methods, e.g. improved insulation, can lead to reduced emissions of greenhouse gases [1]. Reducing fossil fuel combustion by switching to renewable energy methods and/or reusing resources limits the amount that needs to be produced, meaning fewer pollutants released in industrial processes [1]. These strategies on their own are sometimes not enough to cope with the effects of atmospheric pollution [1]. Sometimes clean-up strategies are needed, e.g. application of lime to acidified lakes [1]. Sometimes the process of recycling can release atmospheric pollutants [1]. Reducing the use of resources is often the hardest solution due to resistance to changes in consumption [1]. Government intervention to set targets with legislation is most effective in affecting a reduction in emissions [1]. However, as global population increases, strategies to reduce per capita fossil fuel consumption may not necessarily lead to a reduction in absolute energy demand [1]. [9 max]

Topic 6 The issue of global warming

Quick check questions

1 The greenhouse effect is the way in which gases in the atmosphere allow incoming short-wave radiation to pass through the atmosphere and heat up the Earth's surface. However, they trap a proportion of the out-going long-wave radiation from the Earth – hence the atmosphere is heated from below rather than from above.

2 There appears to be a very close relationship between carbon dioxide levels and global temperature changes. For example, when CO_2 levels are low, for example at around 350 000 years before present (BP), 250 000 years BP and 150 000 years BP, temperatures were much cooler: 10°C cooler than today. In contrast, when CO_2 levels were higher, such as at 320 000 BP and 120 000 BP, temperatures were 2–3°C warmer.

3 Energy

4 Carbon dioxide, methane, oxides of nitrogen and CFCs/HFCs.

5 Less energy is needed for heating appliances; timber productivity increases.

6 As a result of increased temperatures, the range of mosquitoes may increase. As a result of coastal inundation, there may be more stagnant water, which is needed for mosquitoes to lay their eggs.

7 Negative feedback

8 Positive feedback

9 2012

10 Durban

11 Global dimming refers to a reduction in global temperatures as a result of pollution.

12 Milankovitch cycles – variations in the Earth's orbit around the Sun, in the length of seasons and in the orientation of the poles towards or away from the Sun.

Exam practice

1 *Award up to 2 marks, for ecocentric response. Award up to 2 marks for technocentric response. Award up to 4 marks for justification.*

Ecocentric responses stress the minimum disturbance of natural processes, so ecocentrics would advise reducing greenhouse gas emissions so as not to unbalance the natural greenhouse effect. They urge self-imposed restraint on resource use, e.g. individuals reducing their carbon footprint by walking to work. In contrast, technocentric responses stress that technology can provide solutions to environmental problems. They support investing in alternative technologies, e.g. nuclear power or carbon capture and storage to reduce atmospheric carbon. Technocentrism stresses the importance of market and economic growth, so it would support carbon trading and/or economic advantages of trading in low-carbon technologies. In some cases, the same action, e.g. constructing a low-energy house, can be seen as both ecocentric and technocentric.

Ecocentrics believe their approach is more effective because:

- □ we are not using resources sustainably and this cannot continue
- □ it puts sustainable living at the heart of the issue
- □ individuals changing their lifestyles will lead to real change
- □ it challenges the economic growth model
- □ it involves increased environmental education
- □ ecocentric responses can be cheaper and have a more immediate impact.

Technocentrics believe their approach is more effective because:

- □ people are reluctant to accept a reduction in standard of living
- □ technological solutions will reduce greenhouse gas emissions without necessarily changing lifestyles
- □ LEDCs have not developed yet, and a technocentric approach offers a means for them to develop without the negative effects
- □ technology already exists that can help us to reduce our carbon footprint
- □ it involves increased efficiency of technology.

Topic 7 Environmental value systems

Quick check questions

1 A particular worldview that shapes the way an individual or group of people perceives and evaluates environmental issues.

2 Both social systems and ecosystems exist at different scales and have common features, such as feedback and equilibrium; social systems have flows of information, ideas and people, whereas ecosystems have flows of energy and matter; social systems have storages of environmental value systems/philosophies, whereas ecosystems have storages of e.g. biomass, soils, the atmosphere, seas, lakes and rivers; social systems have social levels, whereas ecosystems have trophic/feeding levels; social systems have people responsible for new input as producers, whereas ecosystems have plants, algae

and some bacteria; consumers in social systems absorb new input, such as material possessions, whereas in ecosystems they consume other organisms.

3 They range from ecocentrism, through anthropocentrism, to technocentrism.

4 Believe that economic growth and resource exploitation can continue if carefully managed; believe that laws and regulation can manage natural resources; appreciate that preserving biodiversity can have economic and ecological advantages; believe in compensation for those who experience adverse environmental or social effects.

5 Deep ecologists see humans as subject to nature, not in control of it, whereas cornucopians believe that nature is there to be made use of by humanity; deep ecologists place more value on nature than on humanity, whereas cornucopians believe that humans have the ability to improve the conditions of the Earth's peoples and that they have the ingenuity to overcome any difficulties; deep ecologists believe in the inherent right to life and intrinsic value of species, whereas cornucopians see biodiversity as a resource to be exploited for economic gain; deep ecologists place most value on biorights, whereas cornucopians have less concern for intrinsic or ethical rights of biodiversity; deep ecologists believe that nature is more important than material gain for its own sake, whereas cornucopians believe that resources are there to be exploited and to generate income; deep ecologists distrust modern technology, whereas cornucopians see it as the solution to humanity's problems; deep ecologists believe that economic growth should not occur at the expense of natural resources and the environment, and should be geared to providing the needs of the poorest people, whereas cornucopians believe it should form the basis of all projects and policies; deep ecologists believe that environmental problems should be prevented in the first place, whereas cornucopians believe that humans can always find solutions to political, scientific or technological difficulties.

6 Any four from e.g. Minamata: raised awareness of threats posed by industrialisation; Rachel Carson's *Silent Spring* raised awareness of the threat of the pesticide DDT to organisms high up food chains; *Save the Whale* campaign – direct action to prevent whaling, and raised the profile of environmental issues; Bhopal – showed people how dangerous factories can be; Chernobyl – reinforced negative perceptions of nuclear power in society; UN Rio Earth Summit – led to the adoption of Agenda 21, a blueprint for action to achieve sustainable development worldwide; the film of Al Gore's book *An Inconvenient Truth* – made the arguments about global warming very accessible to a wider audience, and changed peoples' attitude and raised awareness about climate change.

7 Result in the creation of environmental pressure groups, both local and global; promote the concept of stewardship; increased media coverage, which raises public awareness.

8 When a new resource or product is first developed, people are more likely to see benefits than potential problems, which emerge later, e.g. the car; key events prompt change, such as the Rio Earth summit, which led to the adoption of Agenda 21; environmental pressure groups help to raise awareness by distributing leaflets and staging events, e.g. Greenpeace and the *Save the Whale* campaign; environmental attitudes can become politically mainstream when economic consequences of pollution are seen, e.g. Stern report on global warming; school curricula can reflect and promote changing attitudes, e.g. the IB Environmental Systems and Societies course; changing technologies can help to spread new attitudes, e.g. the internet; international organisations, e.g. United Nations Development Programme (UNDP), can raise the profile of global issues through conferences; these can set targets that take effect through national government strategies, e.g. Millennium Development Goals.

9 *For example, any two of the following:*

E.g. Judaeo-Christian and Buddhist societies: the view of the environment in Judaeo-Christian religions is one of stewardship, where humans have a role of responsibility towards the Earth; the Genesis story suggests that God gave

the planet to humans as a gift; this contrasts with the Buddhist approach to the environment, which sees the human being as an intrinsic part of nature, rather than a steward; Buddhism is sometimes seen as an ecological philosophy, which emphasises human interrelationships with all other parts of nature; belief in reincarnation emphasises humanity's interconnectedness with nature; recognising this principle of inter-dependence in Buddhist societies inspires an attitude of humility and responsibility towards the environment.

E.g. First Nation Americans and European pioneers: prior to the colonisation of North America by Europeans, the country was occupied solely by Native American Indian tribes (First Nation Americans); Native Americans saw their environment as communal, and had a subsistence economy based on barter; their low-impact technologies meant that they lived in harmony with the environment; the colonial European pioneers operated frontier economics, which involved the exploitation of what they saw as seemingly unlimited resources; this inevitably led to environmental degradation through over-population, lack of connection with the environment, heavy and technologically advanced industry, and unchecked exploitation of natural resources.

E.g. Communist and capitalist societies: communist societies have been criticised for their poor environmental record; e.g. the Buna chemical works in East Germany dumped ten times more mercury into its neighbouring river than counterparts in the West; the communist ideal of equal distribution of resources with no profit motive meant that energy, materials and natural resources could be squandered without care; in contrast, the capitalism model is seen as being environmentally friendly – the free market imposes checks and balances to ensure sound use of resources in order to maximise profits; however, many criticisms of the communist environmental record stem from the period of the Cold War, where such criticism was used by the West against the communist states; capitalism itself has a mixed record with regard to the environment: in Germany prior to reunification the communist state had protected the interests of farmers, foresters and fishermen, and thereby unintentionally benefited certain sectors of the environment; the rise of capitalism in the former communist state led to polluters organising into powerful lobbies to protect their own interests at the expense of the environment; in capitalist societies, civil liberties and the role of democracy may have played a more significant role in combating environmental problems than the economic basis of the system (i.e. the free market and profit motives).

10 The environmental philosophy of an individual will be shaped by cultural, economic and socio-political context; inputs that shape personal viewpoints include: social influences (e.g. parents, friends, culture, economic positions and politics), personal characteristics (class, age, gender, religion, optimist/pessimist), knowledge of environmental issues (education, exposure to books, films, TV), habits (either fixed or ones that can be changed); how the personal viewpoint is appraised and influenced by emotions will determine how an individual acts concerning environmental issues.

Exam practice

1 *5 marks for any five of the following points. For full marks, answers should show both similarities and differences.*

Systems are assemblages of parts and the relationships between those parts, which together constitute the entity or whole; both types of systems will have common features such as inputs, outputs, flows and storages; social systems are more general, however, in that there will be lots of different types, e.g. a transport system/economic system/farming system/class system; energy and matter will flow through ecosystems, whereas social systems will have flows of e.g. information/ideas/people; both types of system will exist at different scales; and have common features such as feedback and equilibrium;

trophic levels and levels in society; there are consumers and producers in both. [5 max]

2 *Any five from the following points. Answers must compare the view of a deep ecologist to that of a cornucopian for full marks.*

Deep ecologists and cornucopians are at opposite ends of the environmental values system continuum; deep ecologists would probably be opposed to the exploitation of oil reserves/cornucopians are likely to support it; deep ecologists would be concerned that nature will be damaged, and that it is more important than material gain for its own sake; cornucopians feel that resources are there to be exploited or to generate income; and that with sufficient technical expertise, potential environmental obstacles could be overcome, i.e. a technocentric approach; deep ecologists would favour the rights of species to remain unmolested over the rights of humans who wish to exploit resources for economic gain; deep ecologists distrust modern large-scale technology; and its associated demands on restricted expertise (which would be required for coal exploitation). [5 max]

3 *Answer needs at least one advantage and one disadvantage of each approach (technocentric and ecocentric), and an evaluation for full marks.*

Technocentric advantages *[at least one from the following]*: provides alternatives to individuals that don't inconvenience them; substitutes materials/inputs and so avoids costly manufacturing/industrial change; allows economic/social/technological development to continue.

Technocentric disadvantages *[at least one from the following]*: high cost; technological solutions may give rise to further environmental problems; allows for/promotes greater resource consumption.

Specific examples, technocentric approach *[1 mark for any of the following]*: would replace CFCs with other chemicals that are not destructive to ozone; would develop appliances/aerosols etc. that do not require harmful chemicals.

Ecocentric advantages *[at least one from the following]*: approaches may be more sustainable; does not have to wait for technological developments to occur; raises general environmental awareness in population/communities.

Ecocentric disadvantages *[at least one from the following]*: requires individual change, which can be difficult to encourage; may hinder economic growth and development.

Specific examples, ecocentric approach *[1 mark for any of the following]*: would recommend reduced use of refrigeration/air-conditioning/aerosols; would recommend reduced use of fossil fuels that release NOx; would recommend energy conservation, e.g. communal transport/low technology.

Evaluation *[at least one from the following]*: technocentric approach – the substitutes can also be harmful to the environment; substituting does not solve the problem of consumerism.

Ecocentric approach: solutions are dependent on changes in individual attitude/lifestyle and cannot easily be centrally managed; so the extent of solution is likely to be limited/localised. [6 max]

4 *2 marks available max for each environmental philosophy.*

Deep ecologist [2 max]:

Biorights/the rights of living things to exist unmolested; intrinsic value of biodiversity; all species have an inherent right to life.

Environmental manager [2 max]:

Believes that economic growth and resource exploitation can continue if carefully managed; believes that legislation and laws/regulation can manage biodiversity; appreciates that preserving biodiversity can have economic/ecological advantages; those who experience adversity from loss of biodiversity can be compensated.

Answers such as 'because it is our duty' will not be credited, and receive 0 marks.

5 *Up to 3 marks for each of three valid landmarks:*

E.g. publication of *The Limits to Growth*

Justification [3 max]: The Club of Rome – a global think-tank of academics, civil servants, diplomats and industrialists that first met in Rome – published *The Limits to Growth* in 1972; the report examined the consequences of a rapidly growing world population on finite natural resources; the report claimed that, within a century, a mixture of man-made pollution and resource depletion would cause widespread population decline; it has sold 30 million copies in more than 30 translations and has become the best-selling environmental book in history.

E.g. publication of *Our Common Future*

Justification [3 max]: *Our Common Future* was a report published in 1987; it developed the ideas from the Stockholm Declaration; it was produced by the UN World Commission on Environment and Development (WCED), linked environmental concerns to development and sought to promote sustainable development through international collaboration; it also placed environmental issues firmly on the political agenda; *Our Common Future* is also known as The Brundtland Report after the Chair of the WCED, former Norwegian Prime Minister Gro Harlem Brundtland; the publication of *Our Common Future* and the work of the WCED provided the groundwork for the UN's Earth Summit at Rio in 1992.

E.g. the film *An Inconvenient Truth* based on the book by Al Gore

Justification [3 max]: big publicity meant that many people heard about global warming; the message was spread widely and rapidly through modern media, e.g. the internet; marked a sea-change in public opinion in the USA; for the first time a mainstream political figure championed environmental issues; the film made the arguments about global warming very accessible to a wider audience; the film was supported by hard scientific evidence recorded in the book.

Other possible landmarks could include: publication of *Gaia* by James Lovelock, publication of IPCC findings on climate change, Rachel Carson's *Silent Spring*, Minamata disaster, Bhopal disaster, sinking of *Rainbow Warrior* (Greenpeace's *Save the Whale* campaign), etc. [any 3 examples for 9 marks]

6 *Any personal value system is valid as long as it is appropriately justified. Viewpoints can be expected to be, for example, either broadly ecocentric or broadly techocentric, although a mix of opinions may be given. 6 marks for any of the following points:*

E.g. broadly ecocentric approach: rainforests have an economic value to humans; may contain food/medicines/materials for human use; intrinsic value of the rainforest; life support function for water cycles/carbon sink/oxygen provider; contains high biodiversity; aesthetic value; tourism function can bring income; indigenous peoples' home; regeneration rate is slow; spiritual/cultural/religious value to local communities; stewardship value of having rainforests for future generations.

E.g. broadly technocentric approach: rainforests contain valuable timber, which can provide valuable income; forests can use technologies such as reduced-impact logging, which can minimise adverse effects on the remaining forest, so it can regenerate quickly; forest can be replanted, so that it can be sustainably managed; MEDCs have used their forests to provide income and to become fully developed, so LEDCs should have the right to follow the same path; indigenous people who live in the forest can be relocated and enjoy an improved way of life (e.g. better health care) in towns and cities; as long as around 10% of the natural forest of a country is preserved, the rest can be utilised for humanity's benefit; logging forest is better than clear-cutting and replacement with monocultures, e.g. oil palm.