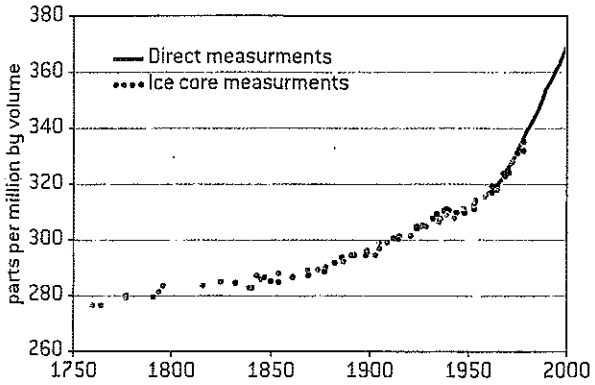
Data-based questions: CO_2 concentrations and global temperatures

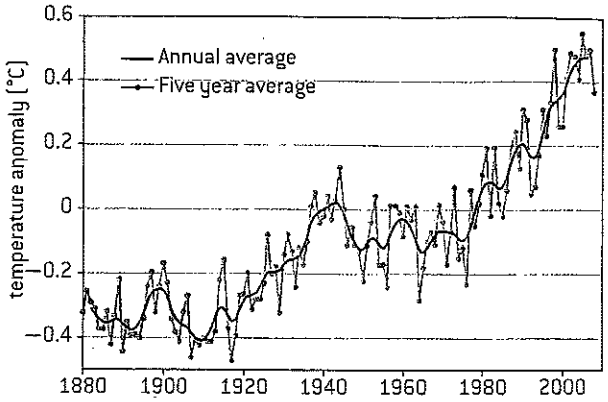
Figure 6 shows atmospheric carbon dioxide concentrations. The red line shows direct measurements at Mauna Loa Observatory. The points show carbon dioxide concentrations measured from trapped air in polar ice cores.



▲ Figure 6

Figure 7 shows a record of global average temperatures compiled by the NASA Goddard Institute for Space Studies. The green points are annual averages and the red curve is a rolling five-year average. The values are given as the deviation from the mean temperature between 1961 and 1990.

1 Discuss whether the measurements of carbon dioxide concentration from ice cores are consistent with direct measurements at Mauna Loa. [2]



▲ Figure 7

2 Compare the trends in carbon dioxide concentration and global temperatures between 1880 and 2008. [2

3 Estimate the change in global average temperature between

a) 1900 and 2000 [1

b) 1905 and 2005 [1

4 a) Suggest reasons for global average temperatures falling for a few years during a period with an overall trend of rising temperatures. [2

b) Discuss whether these falls indicate that carbon dioxide concentration does not influence global temperatures. [2

Data-based questions: Phenology

Phenologists are biologists who study the timing of seasonal activities in animals and plants, such as the opening of tree leaves and the laying of eggs by birds. Data such as these can provide evidence of climate changes, including global warming.

The date in the spring when new leaves open on horse chestnut trees (*Aesculus hippocastaneum*) has been recorded in Germany every year since 1951. Figure 8 shows the difference between each year's date of leaf opening and the mean date of leaf opening between 1970 and 2000. Negative values indicate that the date of leaf opening was earlier than the mean. The graph also shows the difference between each year's mean temperature during March and April and the overall mean temperature for these two months. The data for temperature was obtained from the records of 35 German climate stations.

1 Identify the year in which:

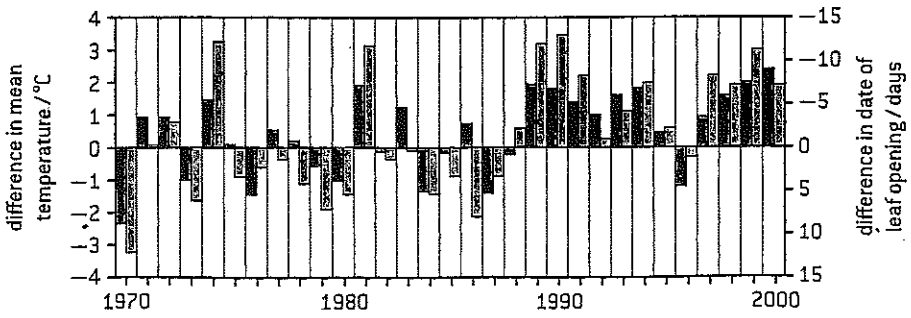
a) the leaves opened earliest [1

b) mean temperatures in March and April were at their lowest. [1

2 Use the data in the graph to deduce the following:

a) the relationship between temperatures in March and April and the date of opening of leaves on horse chestnut trees. [1

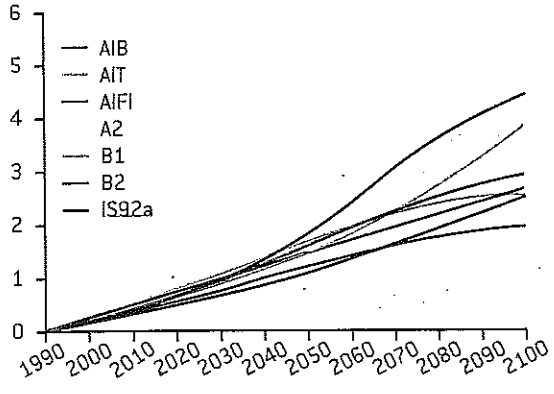
b) whether there is evidence of global warming towards the end of the 20th century. [2



◀ Figure 8 The relationship between temperature and horse chestnut leaf opening in Germany since 1951

Data-based questions: Uncertainty in temperature rise projections

Figure 11 shows computer-generated forecasts for average global temperatures, based on eight different scenarios for the changes in the emissions of greenhouse gases. The light green band includes the full range of forecasts from research centres around the world, and the dark green band shows the range of most of the forecasts. Figure 12 shows forecasts for arctic temperatures, based on two of the emissions scenarios.



▲ Figure 11 Forecast global average temperatures

1 Identify the code for the least optimistic emissions scenario. [1]

2 State the minimum and maximum forecasts for average global temperature change. [2]

3 Calculate the difference between the A2 and B2 forecasts of global average temperature rise. [2]

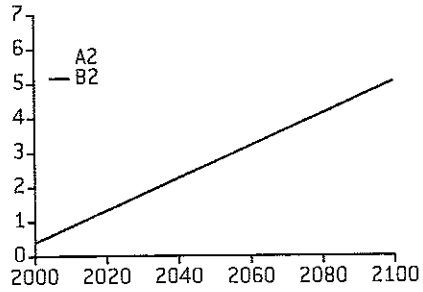
4 Compare the forecasts for arctic temperatures with those for global average temperatures. [2]

5 Suggest uncertainties, apart from greenhouse gas emissions, which affect forecasts for average global temperatures over the next 100 years. [2]

6 Discuss how much more confident we can be in forecasts based on data from a number of different research centres, rather than one. [3]

7 Discuss whether the uncertainty in temperature forecasts justifies action or inaction. [4

8 Discuss whether it is possible to balance environmental risks with socio-economic and livelihood risks or whether priorities nee to be established. [4



▲ Figure 12 Forecast arctic temperature

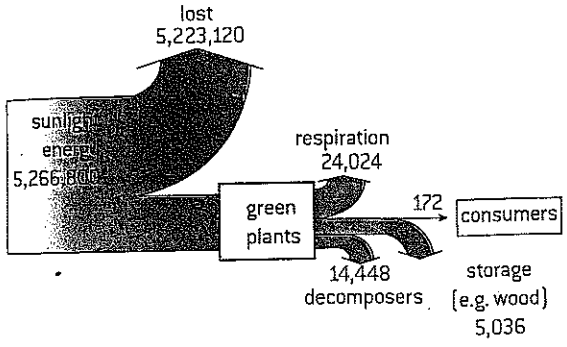
Questions

1 The total solar energy received by a grassland is 5×10^5 kJ m^{-2} yr^{-1}. The net production of the grassland is 5×10^2 kJ m^{-2} yr^{-1} and its gross production is 6×10^2 kJ m^{-2} yr^{-1}. The total energy passed on to primary consumers is 60 kJ m^{-2} yr^{-1}. Only 10 per cent of this energy is passed on to the secondary consumers.

a) Calculate the energy lost by plant respiration. [2]

b) Construct a pyramid of energy for this grassland. [3]

2 Figure 14 shows the energy flow through a temperate forest. The energy flow is shown per square metre per year (kJ m^{-2} yr^{-1}).

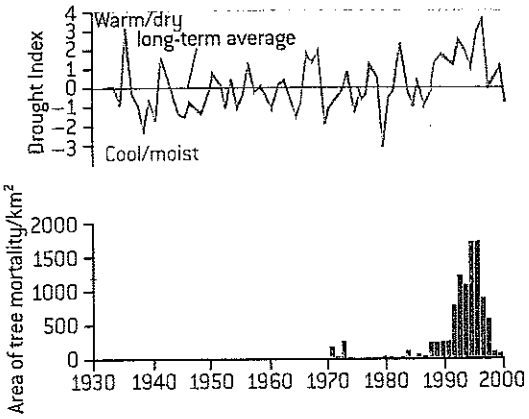


a) The chart shows that 99.17 per cent of the sunlight energy in the temperate forest is lost. Predict with a reason whether a greate or lesser percentage of sunlight energy would be lost in desert. [2

b) Only a small part of the net production of plants in the temperate forest passes to herbivores. Explain the reasons for this. [2

3 Warmer temperatures favour some species of pest, for example the spruce beetle. Since the first major outbreak in 1992, it has killed approximately 400,000 hectares of trees in Alaska and the Canadian Yukon. The beetle normally needs two years to complete its life cycle, but it has recently been able to do it in one year. The graphs in figure 15 show the drought index, a combination of temperatures and precipitation, and the area of spruce trees destroyed annually.

3 cont.



▲ Figure 15 Tree mortality and drought index

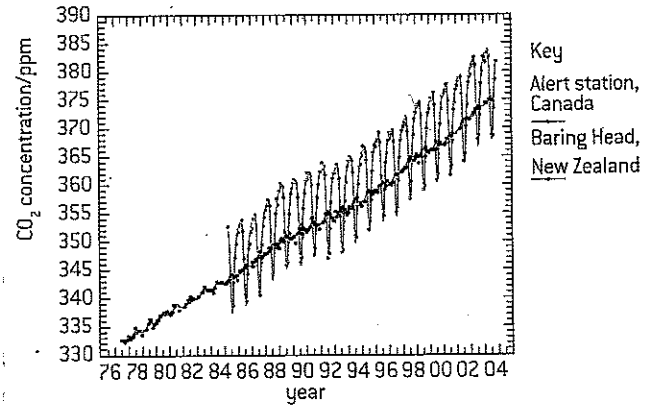
a) Identify the two periods when the drought index remained high for three or more years. [2]

b) (i) Compare the beetle outbreaks in the 1970s and 1990s. [2]

(ii) Suggest reasons for the differences between the outbreaks. [2]

c) Predict rates of destruction of spruce trees in the future, with reasons for your answer. [4]

4 Figure 16 shows monthly average carbon dioxide concentrations for Baring Head, New Zealand and Alert, Canada.



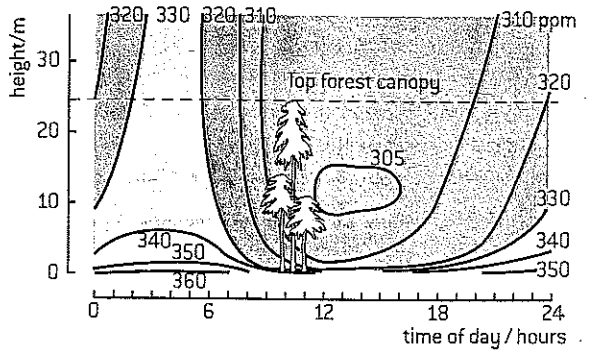
▲ Figure 16

a) Suggest why scientists have chosen such areas as Mauna Loa, Baring Head and Alert as the locations for monitoring stations. [1]

b) Compare the trends illustrated in both graphs. [2]

c) Explain why the graphs show different patterns. [3]

5 Figure 17 shows the concentration of CO_2 in the atmosphere, measured in parts per million (ppm). In a forest, concentrations of CO_2 change over the course of the day and change with height. The top of the forest is referred to as the canopy.



▲ Figure 17

a) (i) State the highest concentration of CO_2 reached in the canopy. [1]

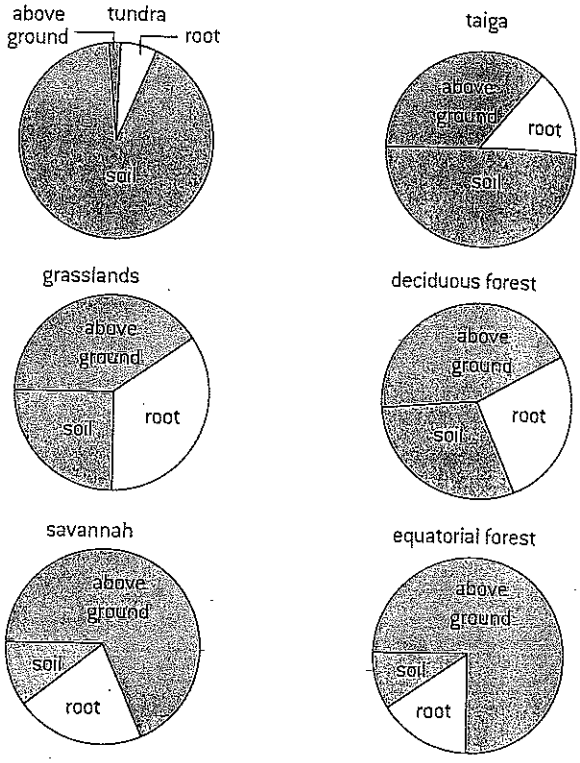
(ii) Determine the range of concentration found in the canopy. [2]

b) (i) State the time of day (or night) when the highest levels of CO_2 are detected. [1]

(ii) The highest levels of CO_2 are detected just above the ground. Deduce two reasons why this is the case. [2]

c) Give an example of an hour when CO_2 concentrations are reasonably uniform over the full range of heights. [1]

6 Within an ecosystem, nitrogen can be stored in one of three organic matter compartments: above ground, in roots and in the soil. Figure 18 shows the distribution of nitrogen in the three organic matter compartments for each of six major biomes.



▲ Figure 18 The distribution of nitrogen in the three organic matters compartments for each of six major biomes

a) Deduce what the "above ground" compartment consists of in an ecosystem. [1]

b) State which biome has the largest "above ground" compartment. [1]

c) Explain why it is difficult to grow crops in an area where equatorial forest has been cleared of its vegetation. [2]

d) State the name of the process carried out by decomposers and detritus feeders that releases CO_2 into the atmosphere. [1]

e) Suggest why most of the nitrogen in a tundra ecosystem is in the soil. [1]

f) Explain why warming due to climate change might cause a release of CO_2 from tundra soil. [2]