Explain the physical and human factors that might have led to the changes in global air temperatures/ Global warming

Physical factors

• Solar activity: variations in solar energy and sun spot activity.
• Changes in the earth's orbit and tilt: Croll-Milankovitch Cycles, 'wobble and roll'.
• Volcanic eruptions: dust particles reduce temperatures by shielding the Earth from incoming insolation.
• Ice cap/sheet melting: reduction in albedo effect.
• Changing oceanic circulation – El Nino/La Nina.

Human factors

• Carbon dioxide: from burning fossil fuels – road transport, power stations, heating systems, cement production and from deforestation (particularly in the rainforests) and peat bog reclamation/development (particularly in Ireland and Scotland for wind farms).
• CFC's: from aerosols, air conditioning systems, refrigerators, polystyrene packaging etc
• Methane: from rice paddies, animal dung, belching cows – even flatulent termites!
• Nitrous oxides: from vehicle exhausts and power stations.
• Sulphate aerosol particles and aircraft contrails: global 'dimming' – increase in cloud formation increases reflection/absorption in the atmosphere and therefore cooling.
• Atomic bomb – linked to cooling.

Consequences of Global Warming

Melting of the ice sheets/glaciers

• A rise in sea level with subsequent migration as islands and coastal areas are submerged. Loss of plant and animal habitats in these areas eg impact on polar bears which could lead to a loss of tourism/more problems in settlements as the bears scavenge instead of hunting on the ice.
• New transportation routes across the Arctic Ocean ie the North West Passage with resulting benefits to trade/previously ice bound coastal settlements.
• Extension of mineral exploitation into the Arctic with positive and negative consequences.

Changing rainfall/temperature patterns

• Higher or lower rainfall/temperature and maybe more extreme weather depending on where you are with resulting increasing/decreasing crop yields, more floods/drought/hurricanes/tornadoes etc.
• Extension or retreat of vegetation (and associated wildlife) by altitude as well as latitude – growing vines/sunflowers in Scotland, spread of malaria, the loss of the Cairngorm Arctic habitat etc.
• Change in ocean currents (El Nino/La Nina).
• Change to the Atlantic Conveyor – disruption of the thermohaline circulati

Ocean Currents

• currents follow loops or gyres – clockwise in the North Atlantic. In the Northern Hemisphere the clockwise loop or gyre is formed with warm water from the Gulf of Mexico (Gulf Stream/North Atlantic Drift) travelling northwards and colder water moving southwards eg the Canaries Current.

• currents from the Poles to the Equator are cold currents whilst those from the Equator to the Poles are warm currents. Cold water moves southwards from Polar latitudes – the Labrador Current. This movement of warm and cold water thus helps to maintain the energy balance.

• ocean currents are greatly influenced by the prevailing winds, with energy being transferred by friction to the ocean currents and then affected by the Coriolis effect, and the configuration of land masses which deflect the ocean currents. Due to differential heating, density differences occur in water masses, resulting in chilled polar water sinking, spreading towards the Equator and displacing upwards the less dense warmer water.

Explain how circulation cells in the atmosphere and the associated surface winds assist in the transfer of energy between areas of surplus and deficit.

Candidates should be able to name and explain the mechanism of each of the three cells – Hadley, Ferrel and Polar – and should describe their role in the redistribution of energy.
Eg warm air rises at the Equator, travels in the upper atmosphere to c.30°N and S, cools and sinks. Some of this air returns as surface NE or SE trade winds to the Equator to form the Hadley Cell.

The remainder of the air travels north over the surface as Westerlies to converge at about 60°N and S with cold air sinking at the Poles and flowing outwards. This convergence causes the air to rise – some of this air flows in the upper atmosphere to the Poles where it sinks forming the Polar Cell. Candidates may note the Easterlies from the High Pressure area at the Pole.

The remainder of this air in the upper atmosphere travels south and sinks at 30°N and S to form the Ferrel Cell. Credit should be awarded to candidates who recognise that the eastward passage of depressions and associated jet streams deforms any Ferrel Cell out of recognition.

It is in this way that warm air from the Equator is distributed to higher (and cooler) latitudes and cold air from the Poles distributed to lower (and warmer) latitudes.

ITCZ and effect on Africa (Dependant on sources used in question)

Maritime Tropical (mT)

Origin – Atlantic ocean/Gulf of Guinea, in tropical latitudes
Weather characteristics – hot, high humidity, warm
Nature – unstable

Continental Tropical (cT)

Origin – Sahara Desert, in tropical latitudes
Weather characteristics – hot/very hot, dry, low humidity, warm
Nature – stable, poor visibility

(b) Description should highlight the marked contrast in precipitation totals, seasonal distribution and number of days between a very dry north (Gao with only 200 mm in a hot desert climate in Mali) and a much wetter south (Abidjan with 1700 mm in a tropical rainforest climate in the Ivory Coast).

Bobo-Dioulasso in Burkina Faso in central West Africa has an „in-between‟ amount of both rain days and total annual precipitation (1000 mm in a Savannah climate).

Candidates should also refer to the variation in rain days and seasonal distribution for each station. Gao with a limited amount of precipitation in summer, Bobo-Doiulasso with a clear wet season/dry season regime and Abidjan with a „twin-peak‟ regime with a major peak in June and a smaller peak in October/November.

Explanation should focus on the role of the ITCZ and the movement of the Maritime Tropical and Continental Tropical air masses over the course of the year. For example, Abidjan, on the Gulf of Guinea coast, is influenced by hot, humid mT air for most of the year, accounting for its higher total annual precipitation and greater number of rain days. The twin precipitation peaks can be attributed to the ITCZ moving northwards in the early part of the year and then southwards later in the year in line with the thermal equator/overhead sun.

Gao, on the other hand, is under the influence of hot, dry cT air for most of the year and therefore has far fewer rain days and a very low total annual precipitation figure as it lies well to the north of the ITCZ for most of the year. Bobo-Dioulasso again is in an „in-between‟ position, getting more rain days and heavy summer precipitation from June-August when the ITCZ is furthest north.

Explanation ought to concentrate on the role of the I.T.C.Z and its associated Tropical Maritime air mass (warm, moist and unstable) and Tropical Continental air mass (warm,

dry and stable). For example, Lagos – on the coast of the Gulf of Guinea – is influenced by warm moist Tm air for most of the year. This accounts for its much higher annual rainfall total. The twin rainfall peaks can be attributed to the I.T.C.Z migrating northwards and then southwards again later in the year, following the overhead sun or thermal equator. Tombouctou, in contrast, lies well
to the north of the I.T.C.Z in January and is under the influence of the hot, dry Tc air from the Sahara Desert. In May/June the I.T.C.Z. moves north bringing moist Tm air and rainfall to Jos and, to a much lesser extent, Tombouctou which lies closer to its point of maximum extent.