P3

1: Protons, neutrons

2. carbon dioxide and methane

3. 15^{th}, 4^{th}

P4

4. It reacted with oxygen produced by newly evolved photosynthetic organisms

5. One that absorbs infra-red, thus trapping heat

6. O_2, in sufficient quantities to react with things or be useful. For hundreds of millions of years the concentration couldn't rise past a few percent because it reacted with 'reducing' agents in the natural environment, such as Fe^{2+} ions in seawater and lakes etc.

7. Once there was free oxygen in the atmosphere, some of it formed ozone in the stratosphere. This ozone protects against UV light which would otherwise be too strong for land based life.

P6

8. The Carboniferous is a period of time dominated by plant growth in huge swamps; it got its name from the vast coal deposits these formed.

9. There was too little carbon dioxide in the atmosphere to provide an adequate greenhouse effect.

10. Once the Earth froze, there was nothing to absorb the carbon dioxide produced by volcanoes (no photosynthesis, no liquid water to dissolve in)

P7

1. A bond where electrons are shared (in pairs)
2. It has four electrons, to share with one other each as part of a pair.
3. A double bond is where two electrons from each atom are shared i.e. four altogether
4. There are so many ways of arranging the bonds, including in long and complex chains
5. Diamond – arranged in tetrahedral; graphite – arranged in layers; amorphous carbon – random arrangement
6. Sugars, fats, proteins, lignin
7. Lignin is not easily broken down therefore can be transferred to long term storage in the geological cycle

P10

1. The conversion of carbon dioxide and water into glucose using light energy
2. The glucose is used to synthesise other carbon compounds, which in various biological processes is eventually converted into the form in your skin

P15

1. By reacting carbon dioxide and water with rock and forming soluble, neutral carbonate compounds which can be washed into the sea.
2. Into the sea, as neutral carbonates and bicarbonates
3. Two ways: one – photosynthesis (same as for plants except for balancing); second – formation of calcium carbonate for shells (and bones, a bit)
4. Shell and bone material can easily accumulate in sediments and become part of sedimentary rocks
5. The pH of the ocean is decreasing; this makes it harder for organisms such as corals to build their structure up of calcium carbonate
6. Peat is dead plant matter preserved in swamps or former swamps
7. It requires wet, acid and fairly oxygen poor conditions to preserve the lignin; otherwise it tends to oxidise and return carbon to the atmosphere
8. Keragen is oily stuff formed from the cooked remains of plants and animals which have been buried in sedimentary rocks; it forms from the breakdown of living tissue (particularly fats and oils) under heat and pressure
9. It can migrate through pore space and often undergoes further 'cooking' to modify its makeup
10. Fracking is breaking up the rock using liquids under pressure; this helps release trapped gas and some keragen. It is controversial because it can pollute aquifers in near surface situations. NZ deposits are mostly not of this sort; we have some low grade coal that could potentially yield gas under fracking. Our normal gas deposits are too deep for the environmental problems to be as much of a concern as in the US.