

SL HL Paper 3 Section A Data Response (8)

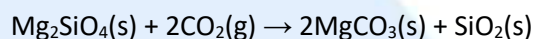
Coal is an abundant fossil fuel. The different grades of coal can be classified according to the percentage of carbon they contain.

Grade of coal	% by mass carbon	% by mass hydrogen	% by mass oxygen	% by mass sulfur	Heat content / kJ kg ⁻¹
Lignite	60-75	6.0-5.8	34-17	0.5-3	< 28470
Flame coal	75-82	6.0-5.8	>9.8	~ 1	< 32870
Gas flame coal	82-85	5.8-5.6	9.8-7.3	~ 1	< 33910
Gas coal	85-87.5	5.6-5.0	7.3-4.5	~ 1	< 34960
Fat coal	87.5-89.5	5.0-4.5	4.5-3.2	~ 1	< 35380
Forge coal	89.5-90.5	4.5-4.0	3.2-2.8	~ 1	< 35380
Nonbaking coal	90.5-91.5	4.0-3.75	2.8-2.5	~ 1	< 35380
Anthracite	> 91.5	< 3.75	< 2.5	~ 1	< 35300

- (a) Analysis of a sample of coal shows that it contains 90.5% carbon, 4.2% hydrogen and 0.8% sulfur by mass. Identify the name of the grade of coal this sample belongs to. **[1]**
- (b) (i) Assuming no other elements in the sample of coal combust, use Section 13 of the data booklet to determine the theoretical heat content of 1.00 kg of this particular sample of coal. **[2]**
- (ii) Suggest one reason why the value obtained for ii. (a) is higher than the value given in the table above for this particular grade of coal. **[1]**
- (c) The combustion of coal is one of the main causes of carbon dioxide pollution in the atmosphere. In 2011 it is estimated that the total amount of coal combusted worldwide was 7.695×10^9 tonnes, which added 1.442×10^{10} tonnes of carbon dioxide into the atmosphere. Assuming that coal contains on average 87% by mass of carbon and that all the carbon burned to form carbon dioxide, calculate the percentage of coal that did not release carbon dioxide into the atmosphere when it was combusted in 2011. **[2]**

(d) "Carbon capture" describes different methods in which carbon dioxide produced by coal combustion is prevented from entering the atmosphere. One such method is called "mineral sequestration" and involves reacting the carbon dioxide with naturally occurring metal silicates such as forsterite, Mg_2SiO_4 .

The equation for the reaction is:



Explain why carbon dioxide is a gas at STP whereas silicon dioxide is a solid with a high melting point ($1600\text{ }^\circ\text{C}$). **[2]**

(e) The products of coal combustion can also cause acid deposition.

(i) State one equation to show how the products from the combustion of coal can lead to acid rain. **[1]**

(ii) Outline why rainwater needs to have a pH below 5.6 before it is classified as "acid rain". **[1]**