4 The oxides nitrogen monoxide (NO) and nitrogen dioxide (NO_2) both contribute to atmospheric pollution.

The table gives some data for these oxides and for oxygen.

	$S^{\ominus}$ / J K^{-1} mol^{-1}	$\Delta H_f^{\ominus}$ / kJ mol^{-1}
$O_2(g)$	211	0
NO(g)	205	+90
$NO_2(g)$	240	+34

Nitrogen monoxide is formed in internal combustion engines. When nitrogen monoxide comes into contact with air, it reacts with oxygen to form nitrogen dioxide.

$$NO(g) + \tfrac{1}{2}O_2(g) \longrightarrow NO_2(g)$$

4 (a) Calculate the enthalpy change for this reaction.

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(2 marks)

4 (b) Calculate the entropy change for this reaction.

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(2 marks)

4 (c) Calculate the temperature below which this reaction is spontaneous.

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(2 marks)

4 (d) Suggest **one** reason why nitrogen dioxide is **not** formed by this reaction in an internal combustion engine.

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(1 mark)

4 (e) Write an equation to show how nitrogen monoxide is formed in an internal combustion engine.

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(1 mark)

4 (f) Use your equation from part **(e)** to explain why the free-energy change for the reaction to form nitrogen monoxide stays approximately constant at different temperatures.

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(2 marks)

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