Marks 5

- Carbon monoxide is commonly used in the reduction of iron ore to iron metal. Iron ore is mostly haematite, Fe_2O_3, in which case the complete reduction reaction is:

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g) \qquad \Delta H° = -25 \text{ kJ mol}^{-1}$$

Incomplete reduction, however, results in the formation of magnetite, Fe_3O_4:

$$3Fe_2O_3(s) + CO(g) \rightarrow 2Fe_3O_4(s) + CO_2(g) \qquad \Delta H° = -47 \text{ kJ mol}^{-1}$$

Use these heats of reaction to calculate the enthalpy change when one mole of magnetite is reduced to iron metal using carbon monoxide.

Answer:

Another iron oxide that can be formed as an intermediate during reduction is FeO. Use the following table of thermochemical data to show whether the formation of FeO from Fe_3O_4 is spontaneous or not at 25 °C.

	$\Delta_f H°$ (kJ mol^{-1})	$S°$ (J K^{-1} mol^{-1})
FeO	–272	61
Fe_3O_4	–1118	146
CO	–111	198
CO_2	–394	214