

### Exercise 4.43 – Limitations of bond enthalpy

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**Q443-01** Enthalpies of reaction, for example, combustion can be calculated using average bond enthalpies or enthalpies of formation. The two methods give closer results for cyclohexane than they do for benzene. Explain this difference.

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**Q443-02** The enthalpies of hydrogenation of but-2-ene and benzene are shown below:

compound	$\Delta H^\circ$ (hydrogenation) /kJmol <sup>-1</sup>
but-2-ene	-120
benzene	-208

Predict the value of  $\Delta H^\circ$ (hydrogenation) that benzene would have if it contained the same type of bonding as but-2-ene. State what can be deduced from the difference in these two values for benzene.

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**Q443-03** Using the following bond enthalpy data calculate the standard enthalpy of formation of buta-1,3-diene, CH<sub>2</sub>=CH-CH=CH<sub>2</sub>.

type of bond	C - C	C = C	C - H
bond enthalpy /kJ mol <sup>-1</sup>	348	612	412

- The enthalpy of atomisation of graphite = +715 kJ mol<sup>-1</sup>
- Bond enthalpy of hydrogen = +436 kJ mol<sup>-1</sup>

The formation enthalpy of buta-1,3-diene, calculated using experimental combustion enthalpy data is -243 kJ . Explain the reasons for this difference.

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**Q443-04** The average C-C bond enthalpy in cyclobutane is 320 kJ mol<sup>-1</sup>, whereas the average C-C bond enthalpy in butane is 348 kJ mol<sup>-1</sup>. Account for this difference?

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**Q443-05** The cyclic unsaturated hydrocarbon naphthalene, C<sub>10</sub>H<sub>8</sub>, reacts with 5 moles of hydrogen per mole of naphthalene with an standard enthalpy change of -284 kJ. The average enthalpy of hydrogenation of a C=C double bond in a ring is -120 kJ mol<sup>-1</sup>. Use these values to calculate the delocalisation stabilisation energy of naphthalene.

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