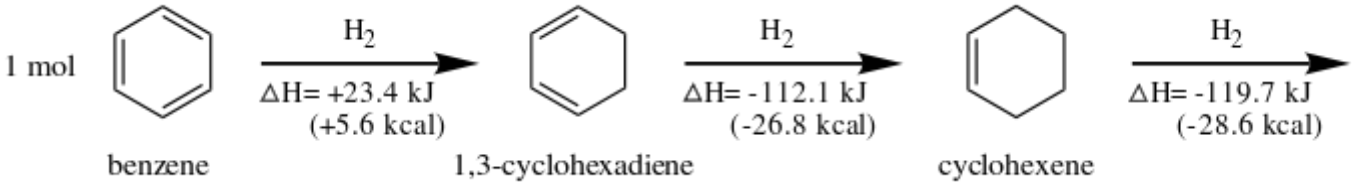
Question: What is resonance energy? Explain by taking the example of benzene

Answer: Resonance (or delocalization) energy is the amount of energy needed to convert the true delocalized structure into that of the most stable contributing structure. The *empirical resonance energy* can be estimated by comparing the enthalpy change of hydrogenation of the real substance with that estimated for the contributing structure.

The complete hydrogenation of benzene to cyclohexane via 1,3-cyclohexadiene and cyclohexene is exothermic; 1 mole of benzene delivers 208.4 kJ (49.8 kcal).



Hydrogenation of one mole of double bonds delivers 119.7 kJ (28.6 kcal), as can be deduced from the last step, the hydrogenation of cyclohexene. In benzene, however, 23.4 kJ (5.6 kcal) are needed to hydrogenate one mole of double bonds. The difference, being 143.1 kJ (34.2 kcal), is the empirical resonance energy of benzene. Because 1,3-cyclohexadiene also has a small delocalization energy (7.6 kJ or 1.8 kcal/mol) the net resonance energy, relative to the localized cyclohexatriene, is a bit higher: 151 kJ or 36 kcal/mol. [22]

This measured resonance energy is also the difference between the hydrogenation energy of three 'non-resonance' double bonds and the measured hydrogenation energy:

$$(3 \times 119.7) - 208.4 = 150.7 \text{ kJ/mol (36 kcal)}$$

https://en.wikipedia.org/wiki/Resonance_(chemistry)