

Answer on the question #63409, Chemistry / General Chemistry

Question:

Use average bond energies (table in the hint) to compare the stabilities of ethanol, C₂H₅OH, and dimethyl ether, (CH₃)₂O, which have the same empirical formula, C₂H₆O (all the bonds are single bonds).

Based on average bond energies, ___ is more stable by ___ kJ/mol.

Solution:

If we check the structure of ethanol and dimethyl ether, we will see that ethanol has 5 bonds carbon-hydrogen, 1 bond carbon-carbon, 1 bond carbon-oxygen and 1 bond oxygen-hydrogen:

$$E_{EtOH} = 5 \cdot E_{C-H} + 1 \cdot E_{C-C} + 1 \cdot E_{C-O} + 1 \cdot E_{O-H}$$

Then, we do the same with the structure of dimethyl ether: it has 6 bonds carbon-hydrogen and 2 bonds carbon-oxygen.

$$E_{DME} = 6 \cdot E_{C-H} + 2 \cdot E_{C-O}$$

Then, the difference between the two is:

$$\Delta = E_{EtOH} - E_{DME} = E_{C-C} + E_{O-H} - E_{C-H} - E_{C-O}$$

Now, let's check the table of average bond energies:

bond	E – kJ/mol
E_{C-C}	347
E_{O-H}	467
E_{C-H}	413
E_{C-O}	358

Bond energies were taken from:

<http://butane.chem.uiuc.edu/cyerk/Chem104ACSpring2009/Genchemref/bondenergies.html>

$$\Delta = 347 + 467 - 413 - 358 = 43 \text{ kJ/mol}$$

Answer: Based on average bond energies, ethanol is more stable by 43 kJ/mol.

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