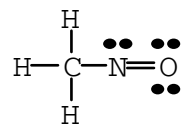
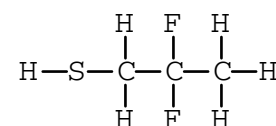
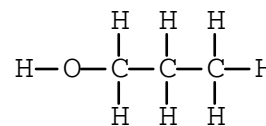
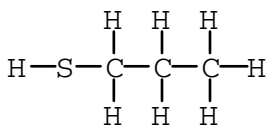
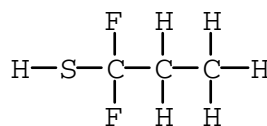
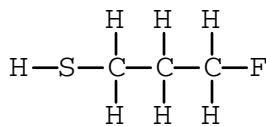
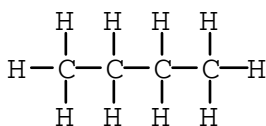


- 1** For each of the following species
- draw a Lewis structure, writing non-zero formal charges on the atoms that require them
 - indicate the hybridization state of all atoms other than hydrogen
 - characterize the shape of the molecule using the terms *linear*, *bent*, *planar*, *tetrahedral* or *pyramidal*
 - if appropriate, draw a resonance structure of the molecule
- a** NO_2^+ (N is the central atom)
- b** BH_3 (B is the central atom)
- c** N_3^- (three N atoms in a row)
- d** CH_2NH (two H's bonded to C, C bonded to N, one H bonded to N)
- 2** (i) Draw a three-dimensionally accurate picture of the molecular orbitals in nitrosomethane; (ii) label each molecular orbital as a sigma (σ), pi (π) or non-bonding (n) orbital.

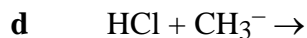
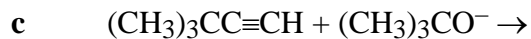
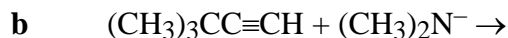


nitrosomethane

3 Rank these compounds in order of acidity (1 = most acidic).



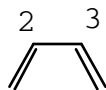
4 Given the pK_a s in the table at right,
(i) complete the following acid–base reactions; (ii) indicate whether the equilibrium lies to the left or to the right.



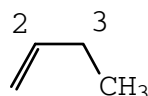
Acid	pK_a^*
HCl	-7
CH₃SH	10
HOH	16
(CH₃)₃COH	19
(CH₃)₃CC≡CH	25
(CH₃)₂NH	35
H₃CH	50

* pK_a s refer to the proton *in bold type*.

5 Explain why the C2–C3 bond in 1,3-butadiene is shorter than the C2–C3 bond in 1-butene.

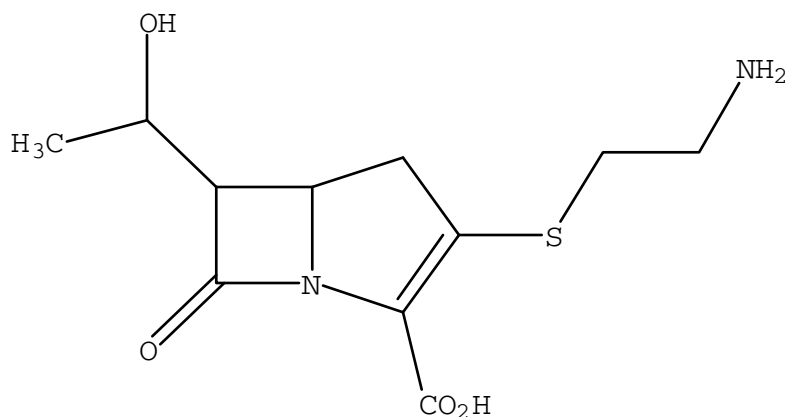


1,3-butadiene

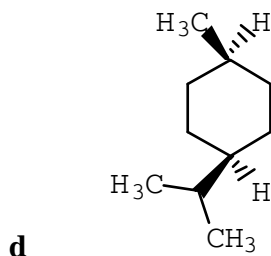
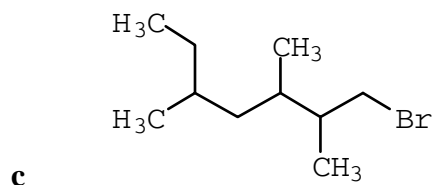
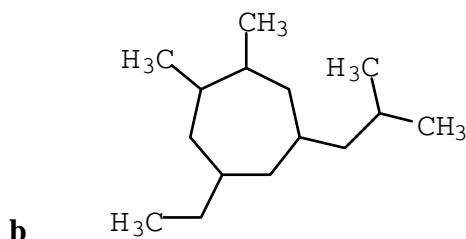
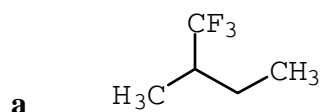


1-butene

- 6 Circle and identify the functional groups in the antibiotic thienamycin (shown below).



- 7 Name these compounds.



- 8 Draw in Newman projection (i) the most stable and (ii) the least stable conformation of 2,2,5,5-tetramethylhexane with respect to rotation about the C3–C4 bond.

- 9 Draw in Newman projection (i) the most stable conformation of 2,2,3-trimethylbutane with respect to rotation about the C2–C3 bond, (ii) the least stable conformation of 2,2,3-trimethylbutane with respect to rotation about the C2–C3 bond, and (iii) calculate the strain energy of each conformation using the values in the table.

Interaction	Strain energy [kcal/mol]
H,H eclipse	1.0
CH ₃ ,H eclipse	1.4
CH ₃ ,CH ₃ eclipse	2.6
CH ₃ ,CH ₃ <i>gauche</i>	0.9
CH ₃ ,H 1,3-diaxial	0.9

- 10 Draw two additional, reasonable resonance structures of the ions shown below; indicate the movement of electron pairs using the curved-arrow convention.

