Question 1
MC19d

What is the IUPAC name for the following molecule?

A 2,2-dimethyl-6-ethylheptane
B 6,6-dimethyl-2-ethylheptane
C 2,2,6-trimethyloctane
D 2,2,2-trimethyl-6-ethylhexane

the octane backbone is chosen to have the longest chain
The actual structure for this cannot be properly drawn using a single Lewis structure. The following are all resonance contributors that when mixed together describe the actual ion. Which is the MAJOR resonance contributor to the mixture?

Each has the same number of bonding electrons, so in this case the decision is based on the location of the formal negative charge. Oxygen is more electronegative than nitrogen or carbon, thus, having a formal negative charge on oxygen results in lower energy electrons, thus D is the major contributor.

In other words, IF each of these Lewis structures existed separately (they do NOT), the energy of the electrons would be lowest in D, which is why D contributes most to the formal mixture in the resonance model.

The resonance model attempts to describe the locations of energies in the actual structure by combining (mixing) formal Lewis structures, an actual structure would rarely be correctly represented by mixing these equally, as is the case here.
Question 3
MC11b

Which is the most important (major) resonance contributor for N₂O?

\[
\begin{array}{c}
\text{A} \\
:\text{N} \equiv \text{N} \equiv \text{O} \quad \text{B} \\
\text{N} \equiv \text{N} \equiv \text{O} \quad \text{C} \\
\text{N} \equiv \text{N} \equiv \text{O} \quad \text{D} \\
\end{array}
\]

A has the maximum number of possible bonds, and has a formal negative charge on oxygen (which is more electronegative) and a single positive charge on nitrogen, this is the lowest energy FORMAL arrangement of the electrons for a Lewis description of N₂O.

B does not have the maximum number of bonds, it only has one π-bond, this is NOT the lowest energy FORMAL arrangement of the electrons for a Lewis description of N₂O.

C does not have the maximum number of bonds, it only has one π-bond, this is NOT the lowest energy FORMAL arrangement of the electrons for a Lewis description of N₂O.

D has the maximum number of possible bonds, but it has a formal negative charge on nitrogen compared to oxygen in A, nitrogen is less electronegative than oxygen, and so this FORMAL arrangement of the electrons for a Lewis description of N₂O does not have quite as low an energy for the electrons as A.
**Question 4**

MC11c

The electron distribution in the following ion cannot be properly described using a single Lewis structure.

Additional Lewis structures should be mixed together with the one shown to generate the actual ion according to the resonance model.

What is the TOTAL number of reasonable resonance contributors that should be mixed together to describe the ion, INCLUDING the one that is shown?

A = 2
B = 3
C = 4
D = 5

![Resonance contributors](image)
Question 5
MC11f

Use resonance arguments to determine which of the following cations would you expect to be LEAST reactive (more resonance = more stability)

A

four resonance contributors

B

three resonance contributors

C

three resonance contributors

D

two resonance contributors

only "reasonable" resonance contributors are considered here, which in this context means no structures with more than one formal charge, e.g.
Question 6

Use resonance arguments to determine which of the indicated C-H bonds would have the SMALLEST bond dissociation energy (BDE) (hint, resonance stabilizes, i.e. lowers the energy of, the non-bonding electron in a radical).

the bond dissociation energy (B.D.E.) is the energy required to homolytically break a bond (homolytic means giving 1 electron to each atom). For these C-H bonds, this process will generate a hydrogen atom and a radical. The lower the energy of the electrons in the radical, the more stable the radical, the less energy is required to break the bond.

the radical formed by homolytic cleavage of this C-H bond is stabilized by resonance (it is properly described by TWO resonance contributors), the non-bonding electron is thus lower in energy, it thus takes less energy to break this bond to make this radical, thus a lower bond dissociation energy.

some hydrogen atoms added to the line-angle structure for this radical to show that no resonance stabilization is possible here.

some hydrogen atoms added to the line-angle structure for this radical to show that no resonance stabilization is possible here.

some hydrogen atoms added to the line-angle structure for this radical to show that no resonance stabilization is possible here.
What is the total number of REASONABLE resonance contributors (including the one provided below) that can be drawn for ozone? Reasonable resonance contributors will generally not have more than one formal charge per atom and will not violate the "octet" rule for any atom.

\[ \text{A} = 1 \]
\[ \text{B} = 2 \]
\[ \text{C} = 3 \]
\[ \text{D} = 4 \]

Ozone

Two TOTAL

Unreasonable

Unreasonable

NOTE that the two resonance contributors are not the same thing, the second is not the first "flipped over" horizontally.

This is NOT what happened here!!!!!

the negative charge is delocalized onto the TWO END oxygen atoms and NOT on the central oxygen atom, the first shows the negative charge on the "left" oxygen and the second shows the charge localized on the "right" oxygen.
Question 8

MCresonance5

Which best represents the order of the bond dissociation energies for the indicated C-H bonds? (hint, non-bonding electrons are more stabilized by more resonance contributors)

A  Ha < Hc < Hd < Hb
B  Hb < Hc < Hd < Ha
C  Hc < Hd < Hb < Ha
D  Hb < Hd < Hc < Ha

strongest bond
C is sp2 hybridized

three resonance contributors, most stable radical, takes least energy to form, lowest BDE

radical not resonance stabilized, therefore higher BDE than either Hb or Hd, but C is sp3 hybridized, so a weaker bond (lower BDE) than to Ha

two resonance contributors, radical more stable than that from Ha and Hc, but not as stable as that from Hb, BDE higher than for Hb, lower than for Ha and Hc

no reasonable resonance contributors possible that involve this C=C bond