Winter 2024 **Chemistry 2500 Midterm #1X** ____/65 marks

Confidentiality Agreement:
I agree not to discuss (or in any other way divulge) the contents of this exam with (or in the presence of) any CHEM 2500 student who has yet to write it. I understand that breaking this agreement would constitute academic misconduct. The minimum penalty would be a mark of 0/65 on this exam.

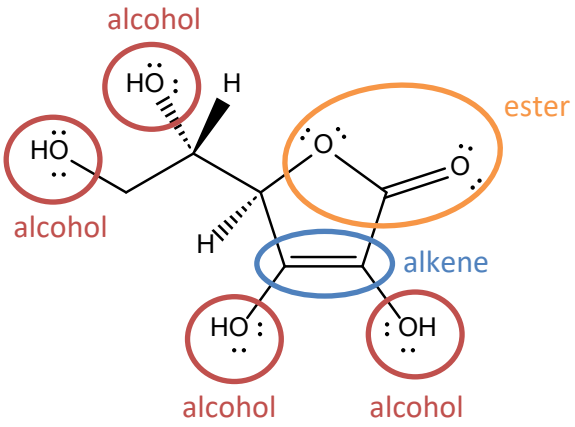
Signature: _____ Date: _____

1) Please read the test carefully before starting. It has 7 pages of questions and a periodic table.
2) You have also been given a data sheet. It does not have a QR code, so nothing written on it will be graded. If you need scrap paper, use the back of any page of the test.
3) **DO NOT WRITE ON ANY QR CODE!!!** Work on pages without a QR code will not be graded.
4) You may use a molecular model kit. You may not have written materials in your model kit.
5) No electronic devices are allowed. This test does not require a calculator.
6) ALL structures must be drawn showing lone pairs, non-zero formal charges and reasonable bond angles – regardless of whether you are using line-bond notation. Marks will be deducted for poorly drawn structures.
7) If your work is not legible, it will be given a mark of zero. For full credit, explanations must be complete. In many cases, complete explanations include drawing relevant structures. If delocalization of electrons is invoked, the relevant resonance structures must be drawn.
8) Marks will be deducted for incorrect information added to an otherwise correct answer.
9) You have 2 hours to complete this test.

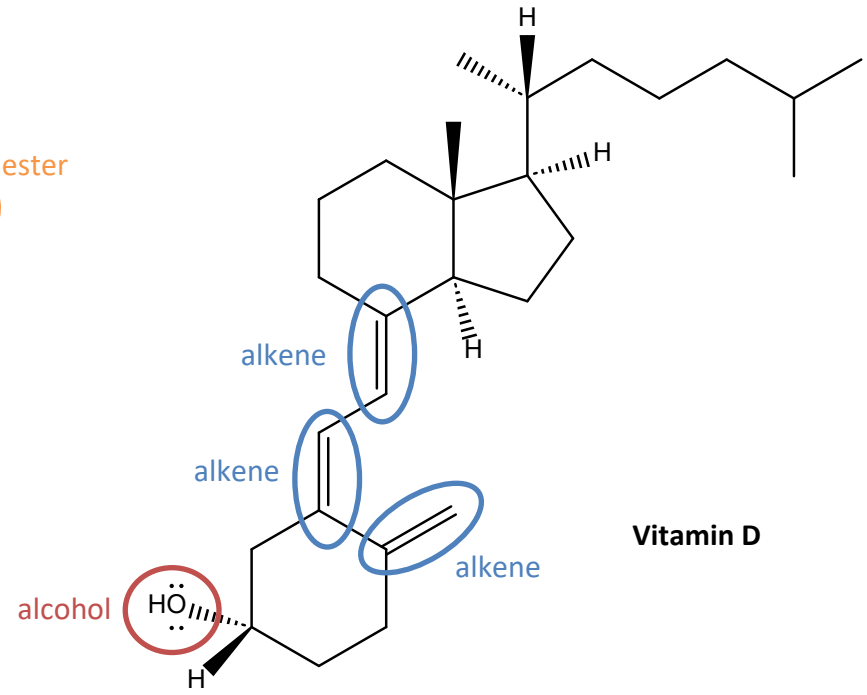
Question Breakdown

Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**					**Total**
/ 9	/ 6	/ 4	/ 4	/ 5	/ 4	/ 6	/ 12	/ 12	/ 3					/ 65

1. The structures of Vitamin C and Vitamin D are shown below. **[9 marks]**



Vitamin C



Vitamin D

(a) Circle (or highlight) and clearly label all functional groups in each of these two vitamins. If a particular kind of functional group appears multiple times in the same vitamin, all instances must be labeled.

Answer directly on the structures above. *[5 marks]*

(b) One of these two vitamins is classified as water-soluble while the other is fat-soluble (or "not water-soluble"). Which is which? Justify your answer. Your justification must reference relevant intermolecular forces for BOTH vitamins. *[4 marks]*

Vitamin C is water-soluble. Vitamin D is fat-soluble.

Vitamin C contains many hydroxy groups which are all capable of hydrogen bonding with water.

While Vitamin also D contains one hydroxy group, the vast majority of the molecule consists of carbon and hydrogen atoms, making that part nonpolar. The nonpolar portions of a Vitamin D molecule will be attracted to the nonpolar parts of other molecules of Vitamin D via London dispersion forces (*aka* induced dipole-induced dipole forces).

Meanwhile, the water molecules will be more strongly attracted to each other than they will be to the mostly-nonpolar Vitamin D molecules. As such, Vitamin D will not dissolve well in water.

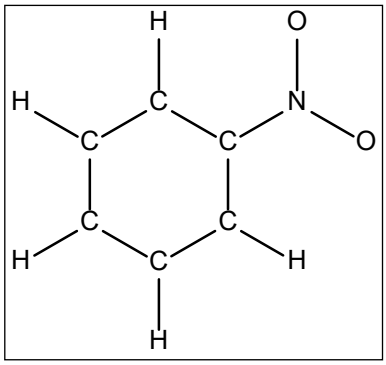
2. The connectivity of the atoms in nitrobenzene ($C_6H_5NO_2$) is shown in the box below. **[6 marks]**

In all your resonance structures, clearly show any non-zero formal charges on the appropriate atoms.

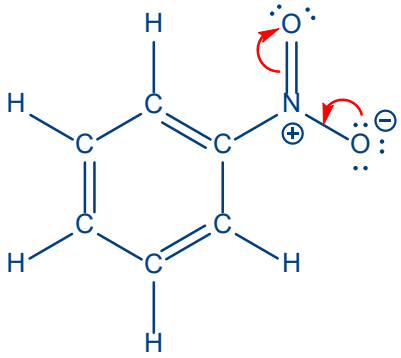
(a) Draw one valid Lewis diagram for nitrobenzene. *Minimize formal charge but do not allow any atoms to violate the octet rule.*

(b) Draw another valid Lewis diagram for nitrobenzene that is degenerate with (equally good as) your answer to part (a). *One of the non-zero formal charges should now be on a different atom.*

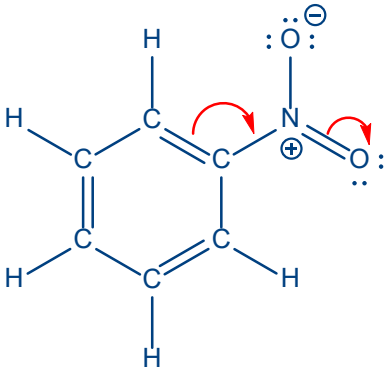
(c) Draw three more resonance structures for nitrobenzene. *These resonance structures should show that nitro is an electron withdrawing group and that the <u>averaged</u> structure therefore has partial positive charges on three of the carbon atoms in the benzene ring.*



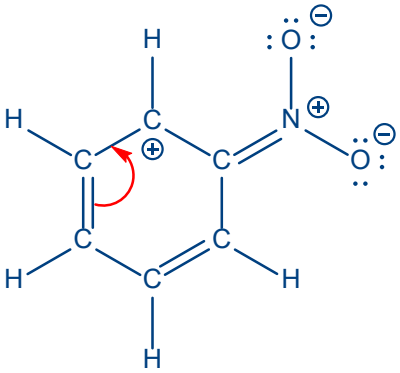
(a)

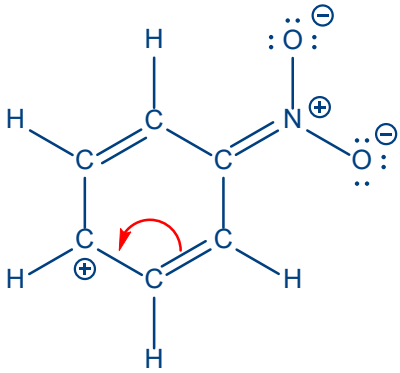


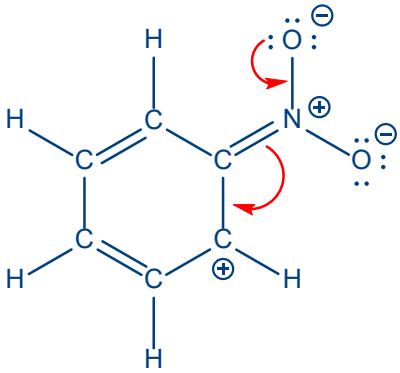
(b)



(c)





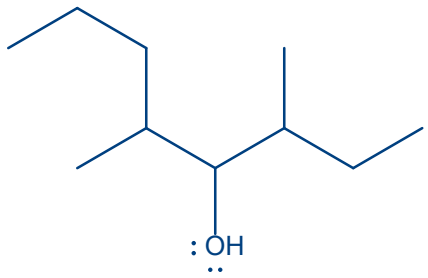


Each set of curved arrows shows how to get to the next resonance structure. Since they were not asked for by the question, they were not required for full credit.

3. **[4 marks]**

(a) Draw the compound described by the name 2-*n*-propyl-3-hydroxy-4-methylhexane.

If you prefer, start with the name 2-propyl-3-hydroxy-4-methylhexane.

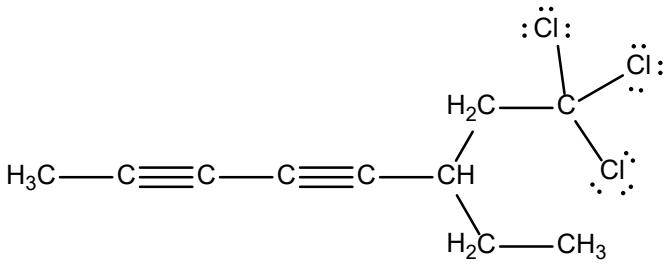


(b) The name in part (a) does not follow the IUPAC naming conventions. Give the correct name for the structure you drew in part (a).

3,5-dimethyloctan-4-ol *or* 3,5-dimethyl-4-octanol

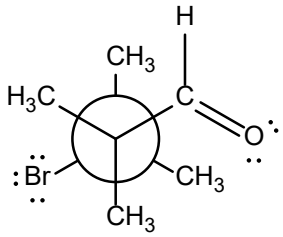
4. Name each of the following compounds according to IUPAC naming conventions. **[4 marks]**

(a)



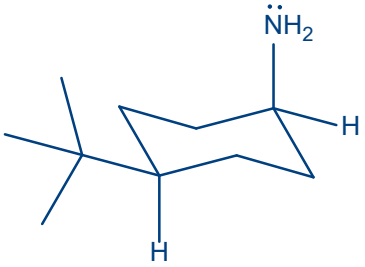
8,8,8-trichloro-6-ethylocta-2,4-diyne *or* 8,8,8-trichloro-6-ethyl-2,4-octadiyne

(b)

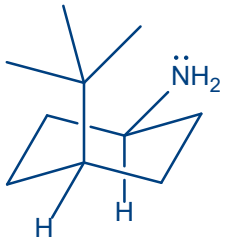


3-bromo-2,2,3-trimethylbutanal

5. Draw both chair conformers of *cis*-4-*tert*-butylcyclohexanamine. Write "more stable" under the more stable of the two conformers. **[5 marks]**



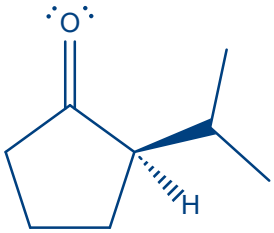
more stable



6. **[4 marks]**

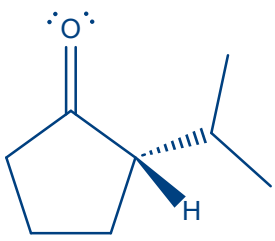
(a) Draw *(R)*-2-isopropylcyclopentanone using line-bond notation.

For full marks, your diagram must clearly communicate the configuration at the chirality center.

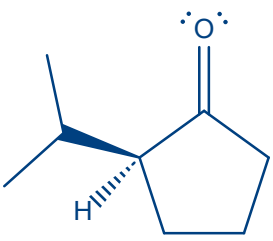


(b) Draw *(S)*-2-isopropylcyclopentanone using line-bond notation.

For full marks, your diagram must clearly communicate the configuration at the chirality center.



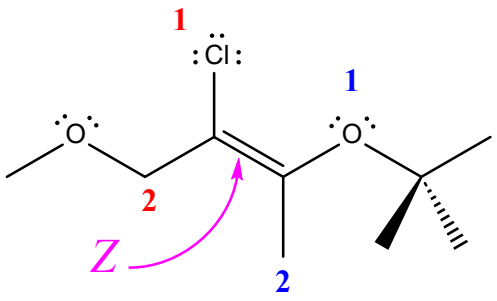
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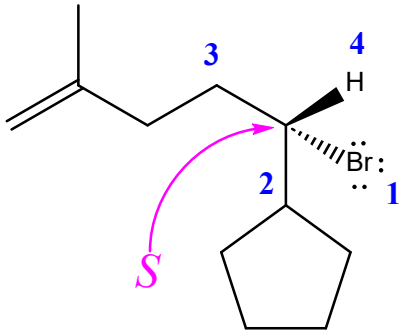
7. For each of the molecules below, assign the stereochemical configuration(s) as *E*, *Z*, *R* or *S*. **[6 marks]**

For full marks, you must show the priority numbers you used to assign each configuration and it must be clear what part of the molecule is being described as E, Z, R or S.

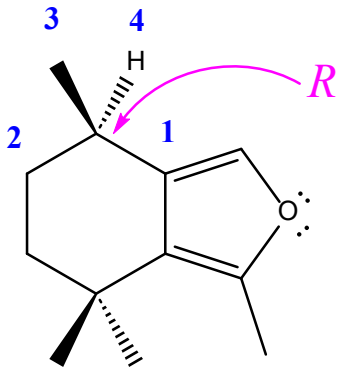
(a)



(b)



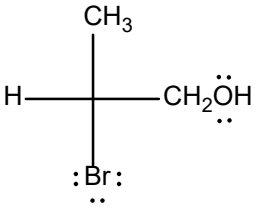
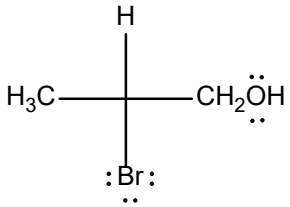
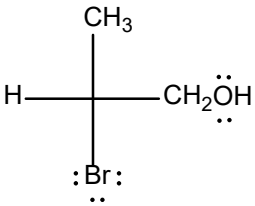
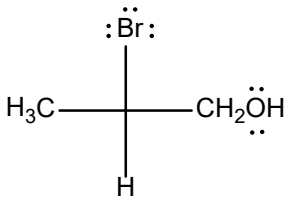
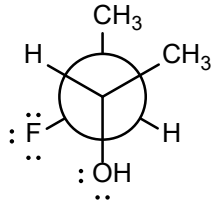
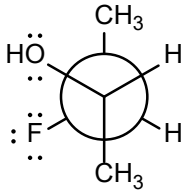
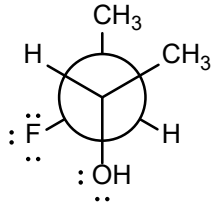
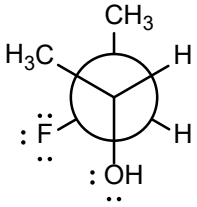
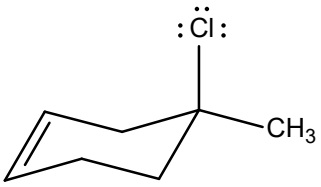
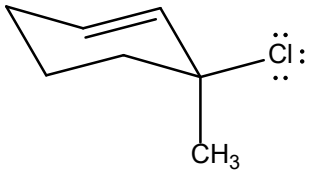
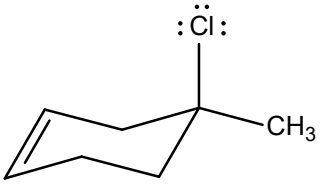
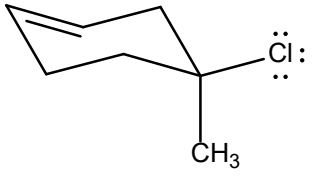
(c)



8. Using the appropriate letter or letters, identify the relationship between each of the following pairs of molecules. If more than one term applies, list all the corresponding letters. **[12 marks]**

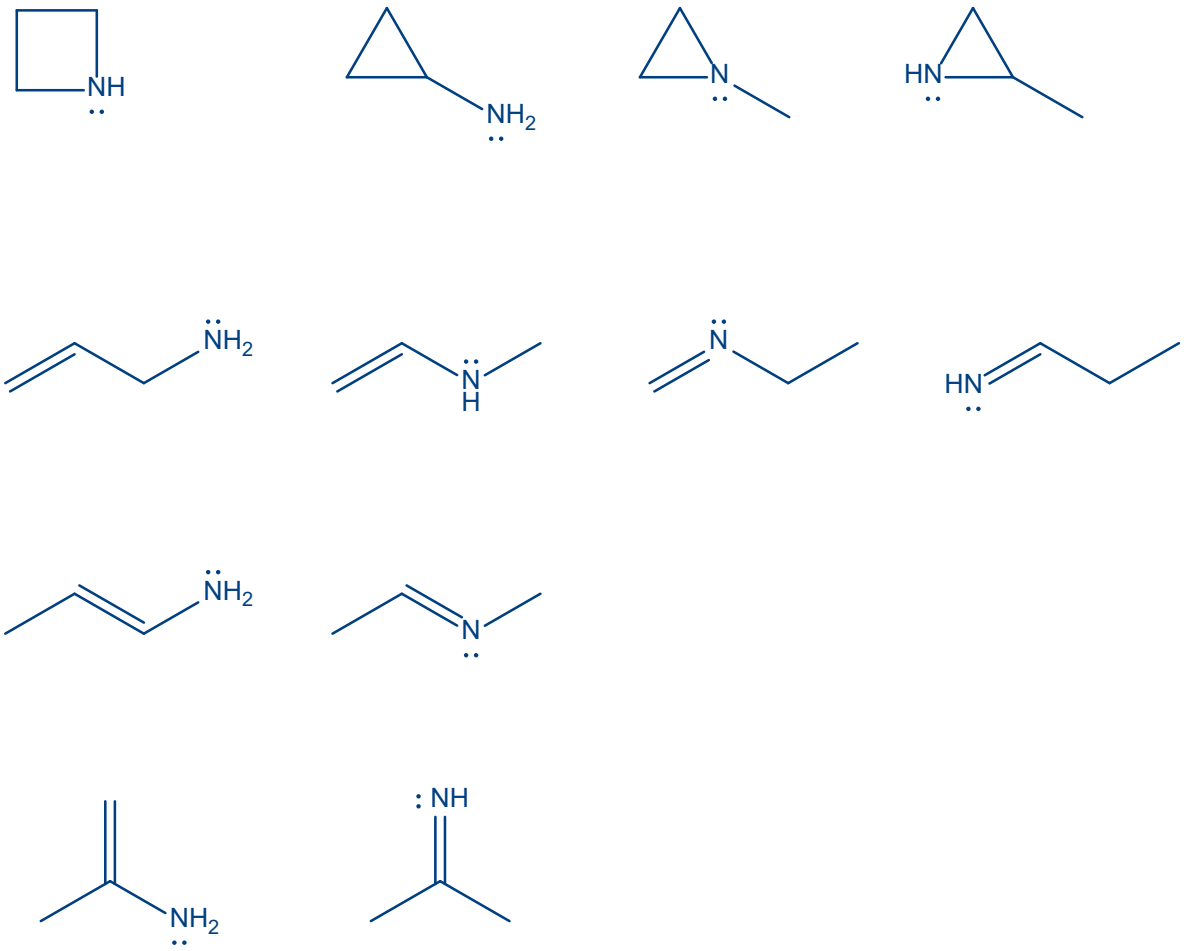
No explanation is necessary.

A = stereoisomers
B = constitutional isomers
C = conformers
D = diastereomers
E = enantiomers
F = identical molecules
G = none of the above

			relationship
	and		A and E
	and		F
	and		C
	and		A and D
	and		B
	and		C

9. Draw all twelve **constitutional isomers** with the molecular formula C_3H_7N. **[12 marks]**

All atoms should have formal charges of zero in all isomers. Marks may be deducted if the same isomer is drawn multiple times.



10. Choose one of your answers to the previous question for which *cis/trans* isomerism is possible. Draw both the *cis* isomer and the *trans* isomer **and** label which is which. **[3 marks]**



cis *trans*