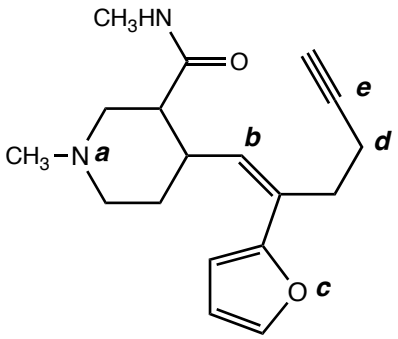
Section 1: Multiple choice. Questions 1-29 must be answered on the Scantron form by shading the appropriate circle with blue or black pen or pencil. Although responses on your Scantron sheet will be used to calculate your midterm grade, you can ensure that you receive all earned credit by indicating your answers on ***both*** the Scantron sheet and this examination paper. Note that ***more than one letter*** could be entered as an answer to a multiple choice question.

questions 1 to 5:

Consider the molecule to the right. Take note of the fact that specific atoms in this structure have been labelled ***a*** through ***e***.



1) Indicate the hybridization of the nitrogen atom labelled ***a***:

(a) s (b) p (c) sp (d) sp^2 (e) sp^3 (f) σ (sigma) (g) π (pi)

2) Indicate the hybridization of the carbon atom labelled ***b***:

(a) s (b) p (c) sp (d) sp^2 (e) sp^3 (f) σ (sigma) (g) π (pi)

3) Indicate the hybridization of the oxygen atom labelled ***c***:

(a) s (b) p (c) sp (d) sp^2 (e) sp^3 (f) σ (sigma) (g) π (pi)

4) Indicate the hybridization of the carbon atom labelled ***d***:

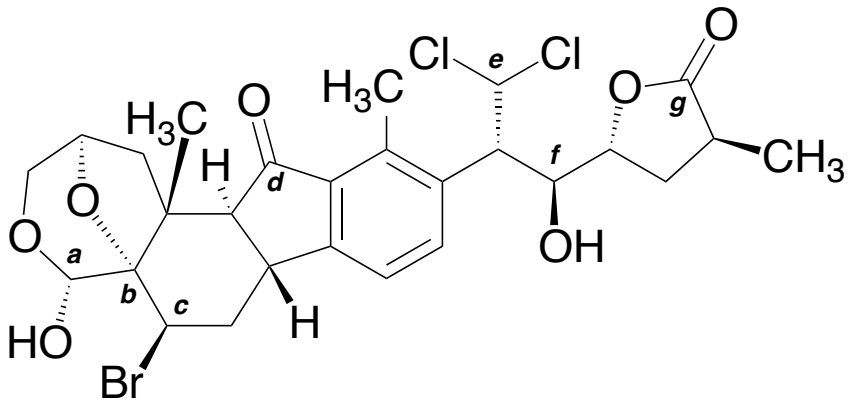
(a) s (b) p (c) sp (d) sp^2 (e) sp^3 (f) σ (sigma) (g) π (pi)

5) Indicate the hybridization of the carbon atom labelled ***e***:

(a) s (b) p (c) sp (d) sp^2 (e) sp^3 (f) σ (sigma) (g) π (pi)

questions 6 to 9:

(-)-Nakiterpiosin (structure to the right) is a compound that has been the subject of recent intense scientific interest. Take note of the fact that specific carbon atoms in this structure have been labelled ***a*** through ***g***.



6) The *name* of the functional group in which carbon ***d*** is incorporated:

(a) aromaticone (b) aldehyde (c) carboxylic ester (d) hemiacetal (e) none of these

7) The *name* of the functional group in which carbon ***g*** is incorporated:

(a) hemiketal (b) carboxylic ester (c) carboxylic anhydride (d) hemiacetal (e) carbonyl (e) none of these

8) The alcohol attached at carbon ***f*** can be classified as:

(a) primary (1°) (b) secondary (2°) (c) tertiary (3°) (d) quaternary (4°) (e) 100 °C (f) 180 ° (g) none of these

9) list all carbon atoms ***a*** through ***g*** that have the same *oxidation level* as an aldehyde. A DE
(be sure to record your answers on the Scantron also)

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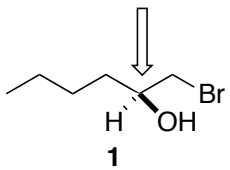
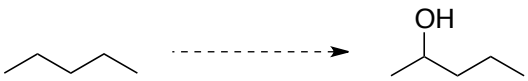
10) The configuration of the indicated carbon atom in **1** is:



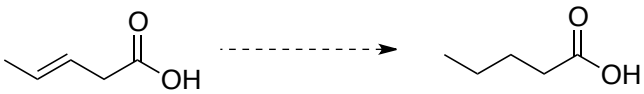
1

(a) *R* configuration
(b) *S* configuration
(c) *E* configuration
(d) *Z* configuration
(e) D configuration

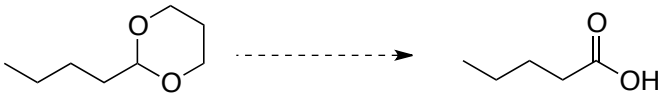
• For questions 11-14, indicate whether the hypothetical transformation is a *formal oxidation, formal reduction,* or *no change in oxidation level*:

11) 

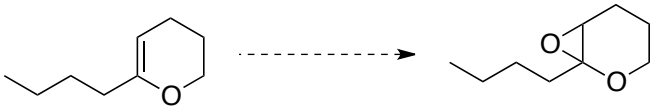
(a) formal oxidation
(b) formal reduction
(c) no change

12) 

(a) formal oxidation
(b) formal reduction
(c) no change

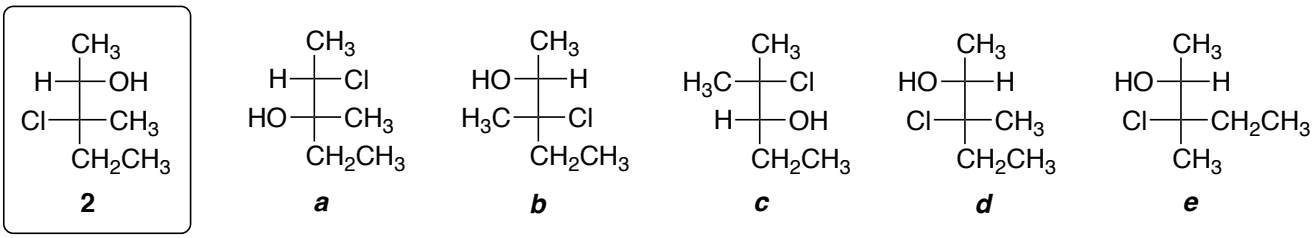
13) 

(a) formal oxidation
(b) formal reduction
(c) no change

14) 

(a) formal oxidation
(b) formal reduction
(c) no change

• Consider the compounds **2**, and ***a***-***e*** (below) when answering questions 15 to 17. In questions 15-17, more than one letter *may* be indicated in your answers. Take note that incorrect answers will be subtracted from correct answers.



15) what compound(s) ***a***-***e*** is/are *enantiomers* of compound **2**? BE

16) what compound(s) ***a***-***e*** is/are *constitutional isomers* of compound **2**? AC

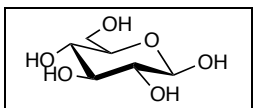
17) what compound(s) ***a***-***e*** is/are *diastereomers* of compound **2**? D

• Questions 18 to 22. Consider that you have two solvents, *n-octane* and *water*, available to dissolve each of the following substances. Predict the superior solvent in each case.

18) ethanol — (a) n-octane (b) water

19) ethylbenzene — (a) n-octane (b) water

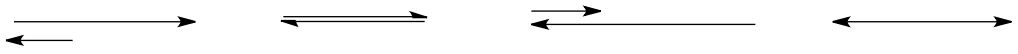
20) (±)-2-bromobutane — (a) n-octane (b) water

21) 
glucose

(a) n-octane (b) water

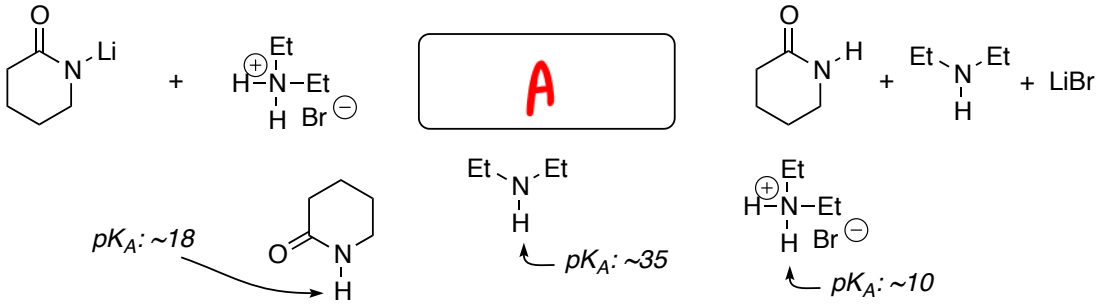
22) sodium ethanoate — (a) n-octane (b) water

• For questions 23)-29), select the letter (**A**, **B**, **C**, **D**) that corresponds to the arrows that *best* describes the relationship between the 'reactants' and 'products':



A **B** **C** **D**

23)



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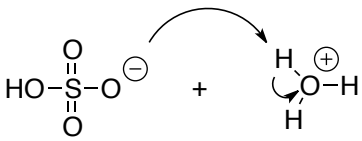
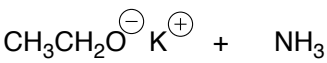
24)



C

products of proton transfer

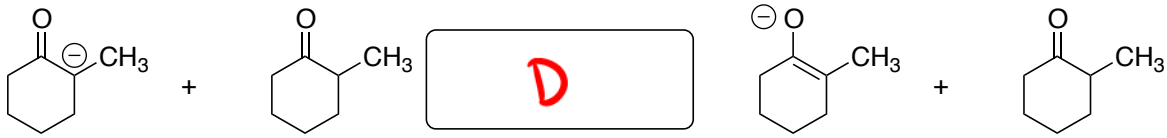
25)



C

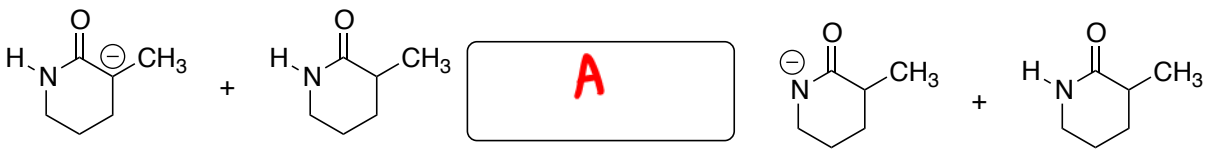
products of proton transfer

26)



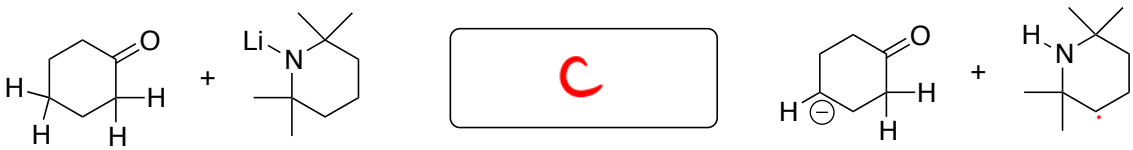
D

27)



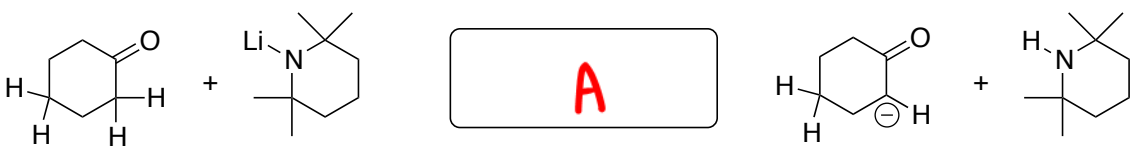
A

28)



C

29)

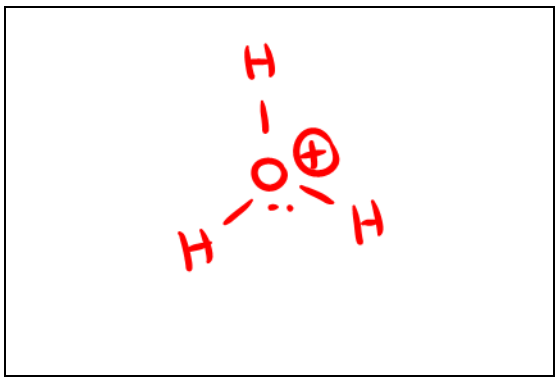


A

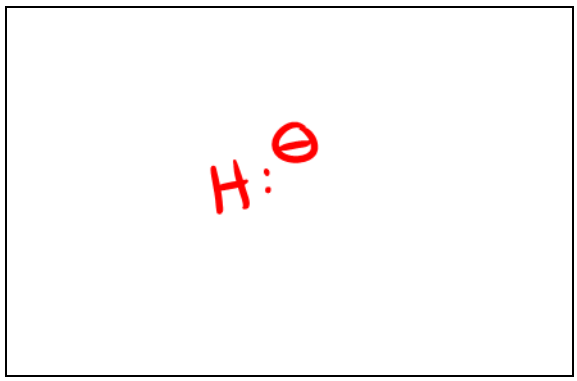
Section 2. Short answer questions. Please write your answers in the designated space. Please note that in some cases it is better for you to work out your answer on practice paper and copy a neat version to the examination paper.

*****Messy and/or incoherent answers that are difficult to read or interpret may receive reduced or zero credit.*****

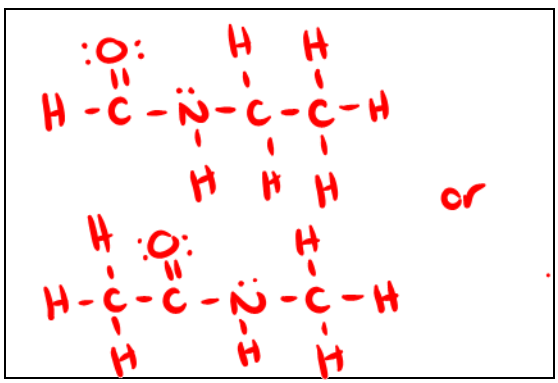
30) (8 marks) Draw formal Lewis structures with all lone pairs and formal charges clearly shown:



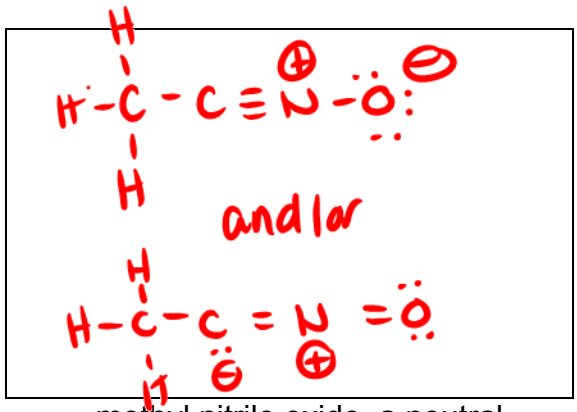
• hydronium ion (protonated water)



• hydride ion (H-)

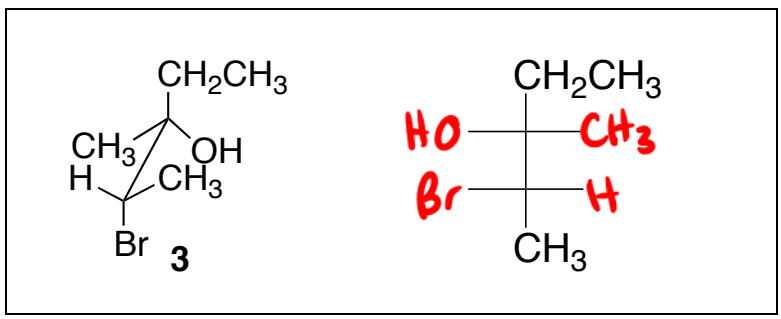


• a secondary (2°) amide with molecular formula C_3H_7NO

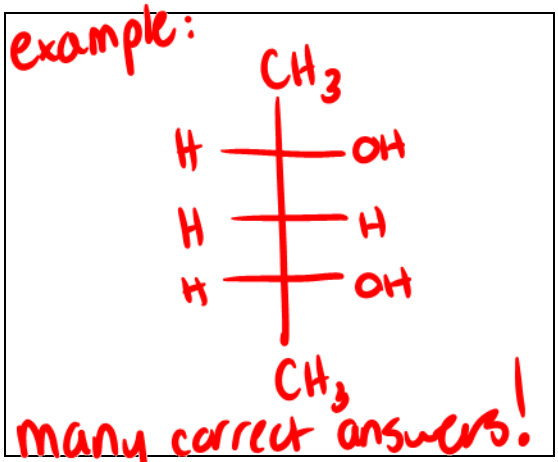


• methyl nitrile oxide, a neutral compound, H_3CCNO

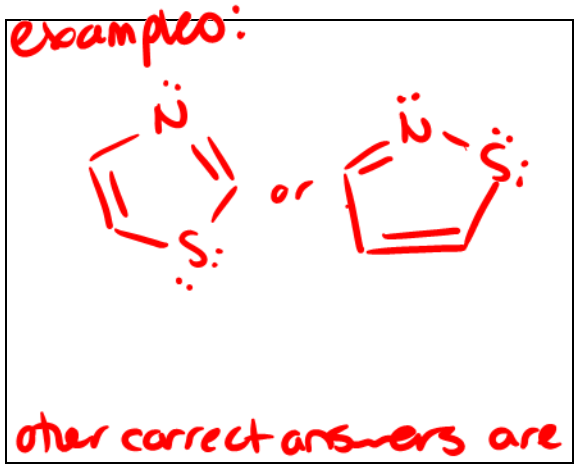
31) (2 marks) Using the supplied template, provide a *Fischer projection* for compound **3**:



32) (6 marks) Provide the following:

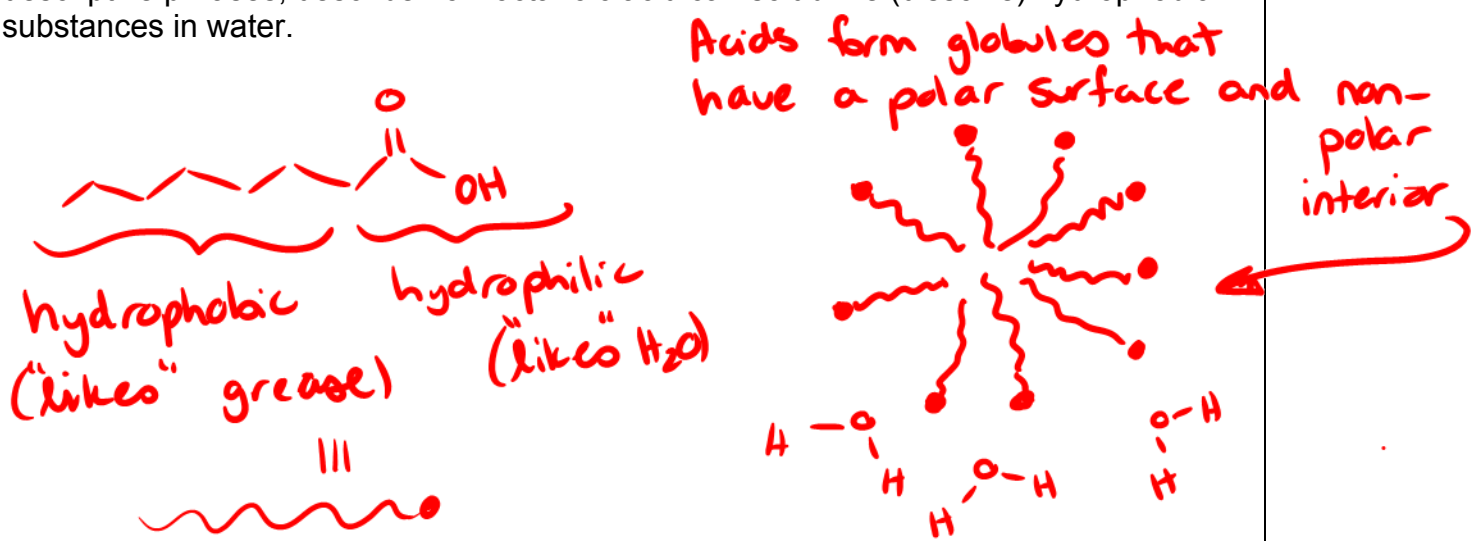


• the structure of a *MESO* compound having five carbon atoms

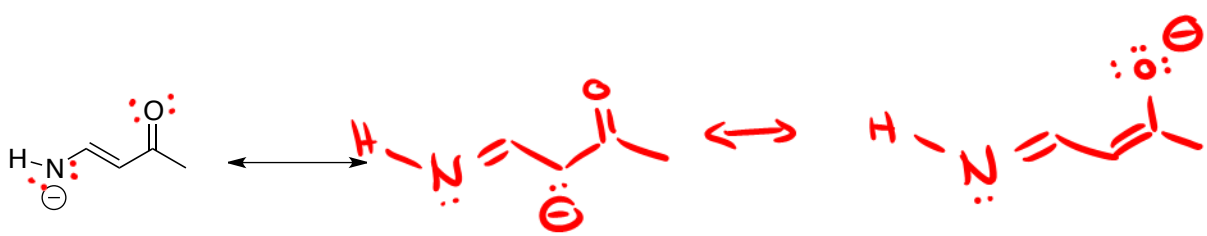


• the structure of an aromatic molecule that contains a N and S atom in a ring

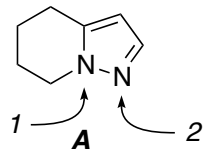
33) (3 marks) Octanoic acid can act as a detergent. Using ***pictures*** with some descriptive phrases, describe how octanoic acid can solubilize (dissolve) hydrophobic substances in water.



34) (4 marks) Draw the *major contributing resonance structures* for the following anion:

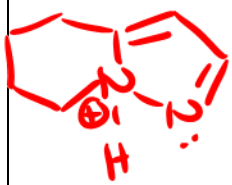


35) (6 marks) Consider molecule ***A*** (below). What is the hybridization of *N-1* and *N-2*? One of these nitrogen atoms is *much more reactive* to treatment with acids than the other. Which nitrogen atom has higher reactivity, and justify your answer with brief comments and drawings.



lone pair in a sp^2 orbital so it can be protonated

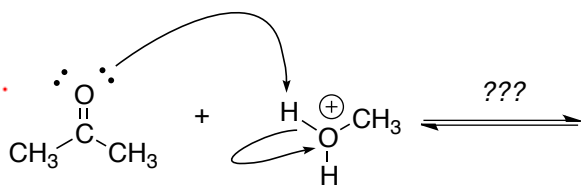
lone pair in the π aromatic system, so cannot be protonated without breaking the aromaticity

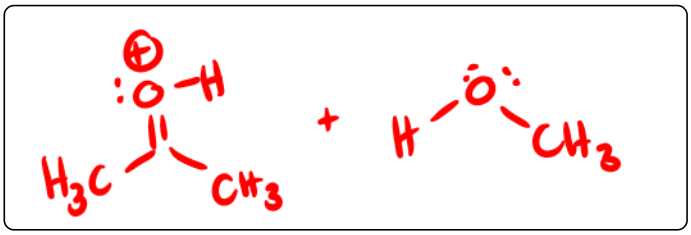


aromatic

not aromatic → Thus, N2 is more reactive than N1

36) (6 marks) a) Provide the products of the following process described in equation 1:

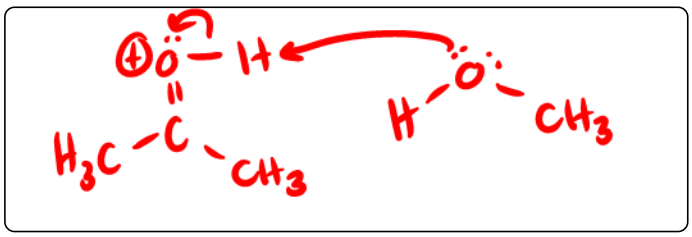




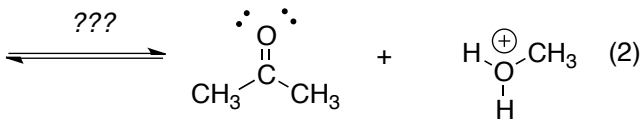
(1)

products of these transformation

b) Using arrows that represent electron-movement, provide a mechanistic description of the process to convert the products in equations 1 back to starting materials:



mechanistic description



(2)

c) Circle the set of arrows that **best** describes the relationship between starting materials and products in equation 2.