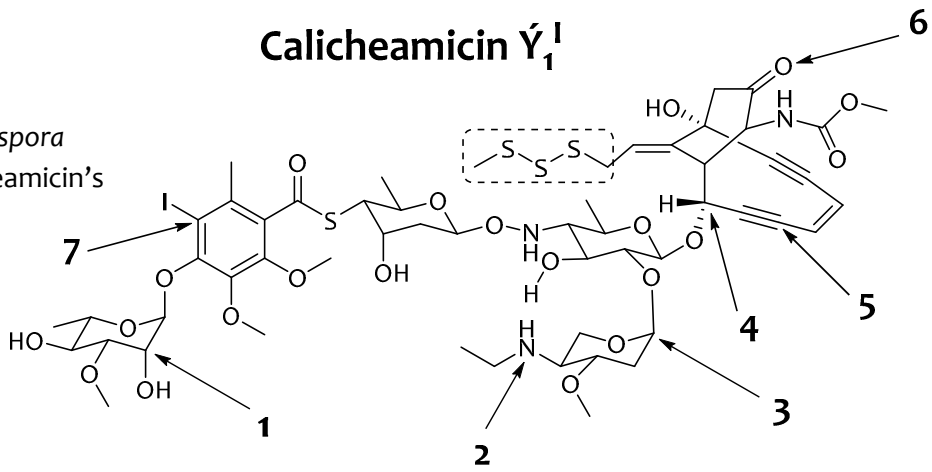
# ANSWER KEY

**Part 1: Multiple Choice.** Questions 1 - 28 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. In the case of a discrepancy between your examination paper and your Scantron, the Scantron shall be graded as the intended answer. *While most correct answers are worth 1 point each, some may be worth less than 1 point.*

**Questions 1 - 8.** Calicheamicin $\gamma_1^I$ is a member of a family of naturally occurring compounds which were isolated from the bacteria *Micromonospora echinospora SSP*. The family of Calicheamicin's have led to the development of new, cancer fighting drugs. Take note that specific atoms/sites have been labelled **1** - **7**.




**1)** What is the name of the functional group in which carbon **1** is incorporated?

**(A)** ether **(B)** acetal **(C)** hemiacetal **(D)** ketal **(E)** hemiketal **(F)** 2° alcohol **(G)** carboxylic ester

**2)** What is the hybridization of the nitrogen labelled **2**?

**(A)** sp **(B)** $sp^2$ **(C)** $sp^3$ **(D)** $sp^3d^2$ **(E)** σ (sigma) **(F)** π (pi) **(G)** s **(H)** p

**3)** What is the name of the functional group in which carbon **3** is incorporated?

**(A)** ether **(B)** acetal **(C)** hemiacetal **(D)** ketal **(E)** hemiketal **(F)** 2° alcohol **(G)** carboxylic ester

**4)** What is the stereochemical configuration of the carbon atom labelled **4**?

**(A)** R **(B)** S **(C)** E **(D)** Z **(E)** cis **(F)** trans **(G)** α (alpha) **(H)** β (beta)

**5)** What is the hybridization of the carbon atom labelled **5**?

**(A)** sp **(B)** $sp^2$ **(C)** $sp^3$ **(D)** $sp^3d^2$ **(E)** σ (sigma) **(F)** π (pi) **(G)** s **(H)** p

**6)** What is the hybridization of the oxygen atom labelled **6**?

**(A)** sp **(B)** $sp^2$ **(C)** $sp^3$ **(D)** $sp^3d^2$ **(E)** σ (sigma) **(F)** π (pi) **(G)** s **(H)** p

**7)** What is the total number of lone pairs of electrons in the trisulfide (three consecutive sulfur atoms) located in the dashed box?

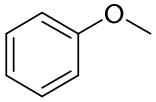
**(A)** 8 **(B)** 6 **(C)** 12 **(D)** 16 **(E)** 5 **(F)** 9 **(G)** 10 **(H)** 28

**8)** What is the name of the functional group in which carbon **7** is incorporated?

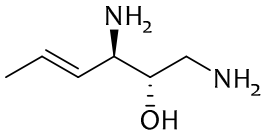
**(A)** alkene **(B)** alkyne **(C)** alkyl iodide **(D)** benzene **(E)** iodene **(F)** arene

For **questions 9 - 12,** consider that you have two solvents, heptane and water, available to dissolve each of the following compounds. Predict the *superior* solvent to accomplish this task in each question.

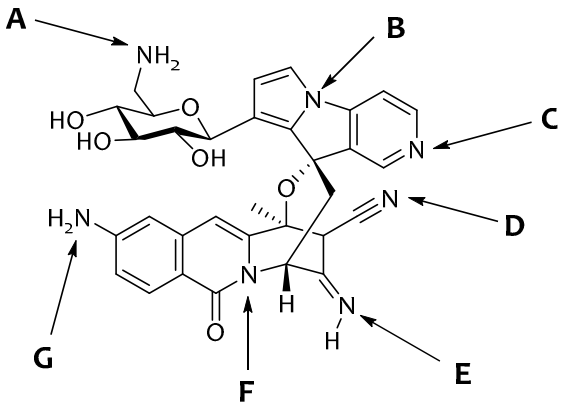
**9)** Methyl propoanoate **(A)** heptane **(B)** $H_2O$

**10)**  **(A)** heptane **(B)** $H_2O$

**11)** (*R*)-2-bromopentane **(A)** heptane **(B)** $H_2O$

**12)**  **(A)** heptane **(B)** $H_2O$

Consider the structure below when answering **questions 13 - 15.** Take note that the nitrogen atoms in this structure have been labelled (**A** – **G**). Incorrect answers will be subtracted from correct answers to a minimum grade of zero for this section.

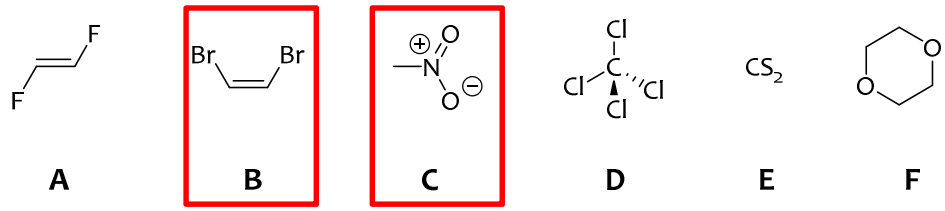



**13)** Which nitrogen(s) (**A** – **G**) is/are the most basic? **A (worth 0.5 marks)**

**14)** Which nitrogen(s) (**A** – **G**) have a lone pair in a $sp^2$ hybridized orbital? **C E (each worth 0.5 marks)**

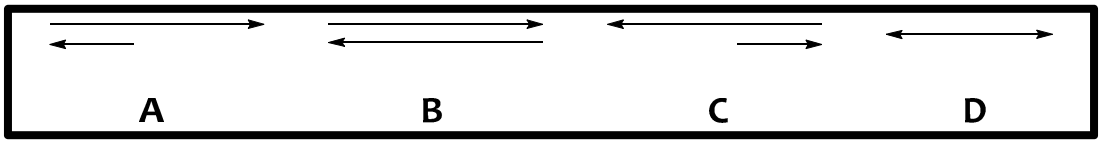
**15)** Which nitrogen(s) (**A** – **G**) is/are the least basic? **B (worth 0.5 marks)**

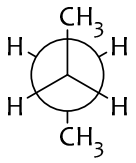
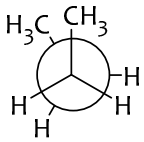
**16)** Which of the following compounds (**A** - **F**) would have a dipole moment (μ) greater than zero? Incorrect answers will be subtracted from correct answers to a minimum grade of zero for this section. **(0.5 marks each)**

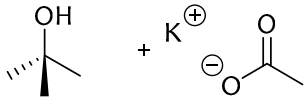
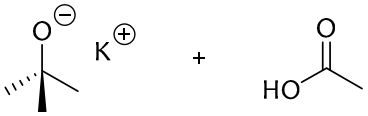


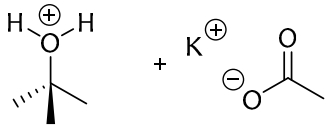
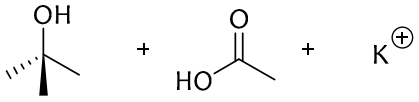

**A** **B** **C** **D** **E** **F**

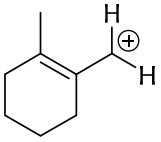
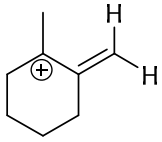
For **questions 17 - 23,** select the letter (**A, B, C** or **D**) that corresponds to the arrow that ***best*** describes the relationship between 'reactants' and 'products'.

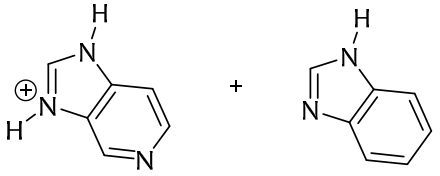
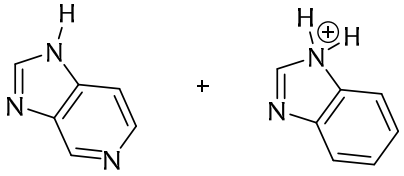


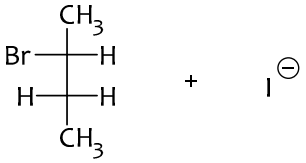
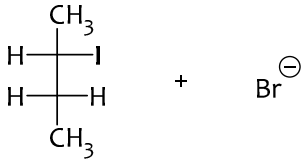

**17)**  *answer on scantron* **C** 

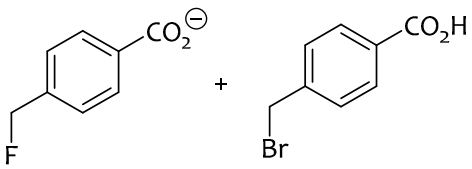
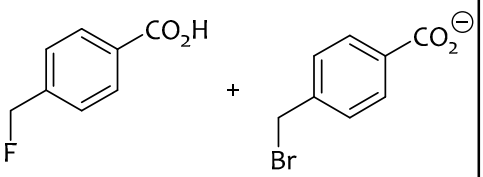
**18)**  *answer on scantron* **C** 

**19)**  *answer on scantron* **A** 

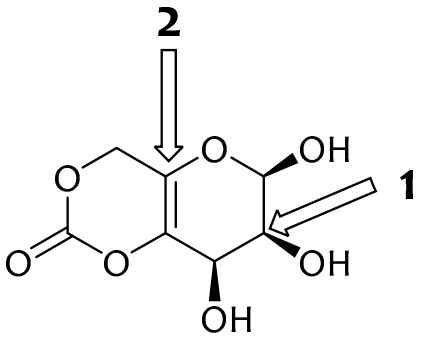
**20)**  *answer on scantron* **D** 

**21)**  *answer on scantron* **C** 

**22)**  *answer on scantron* **C** 

**23)**  *answer on scantron* **C** 

Consider the structure to the right when answering **questions 24 – 25.**




**24)** What is the stereochemical configuration of the carbon labelled **1**?

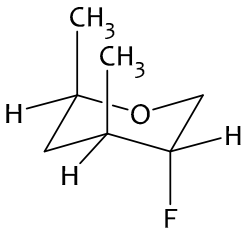
**(A)** R **(B)** S **(C)** E **(D)** Z **(E)** *meso* **(F)** Carbon is not asymmetric

**25)** What is the stereochemical configuration of the alkene in which the carbon labelled **2** is incorporated?

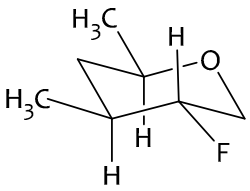
**(A)** R **(B)** S **(C)** E **(D)** Z **(E)** *meso* **(F)** Not a stereoisomer

For **questions 26 - 27,** select the letter (**A** – **E**) which ***best*** describes the relationship between the noted compounds.

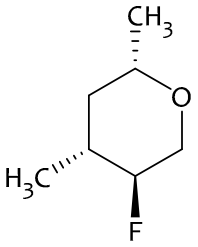
**(A)** Conformers
**(B)** Constitutional Isomers
**(C)** Diastereomers
**(D)** Enantiomers
**(E)** Identical (not conformers)




**1**




**2**

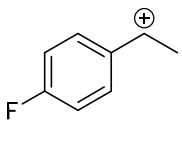



**3**

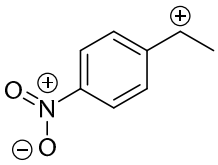
**26)** What is the relationship between compounds **1** and **2**? **A**

**27)** What is the relationship between compounds **2** and **3**? **D**

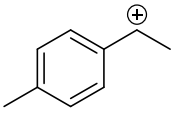
**28)** Which of the carbocations (**A** – **E**) is/are considered the MOST stable?



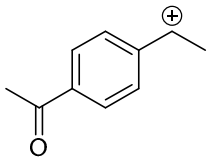

**A**



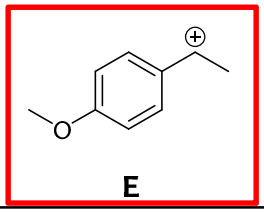

**B**



**C**




**D**




**E**

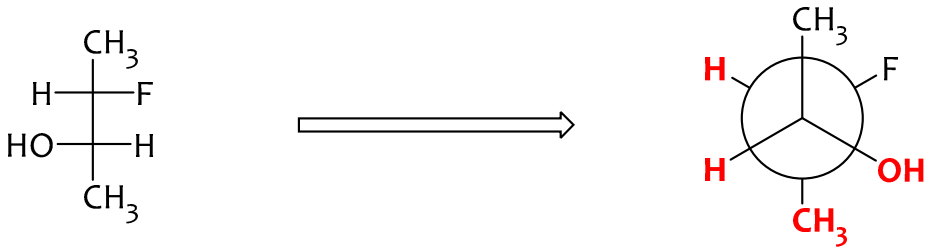
**This is the end of the multiple choice portion of this examination!!**

**Be sure you have correctly "bubbled-in" your name and student number (I.D. number).**

**Part 2: Short Answer Questions.** Write your answers in the designated space. Please note that in some cases it may be 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****

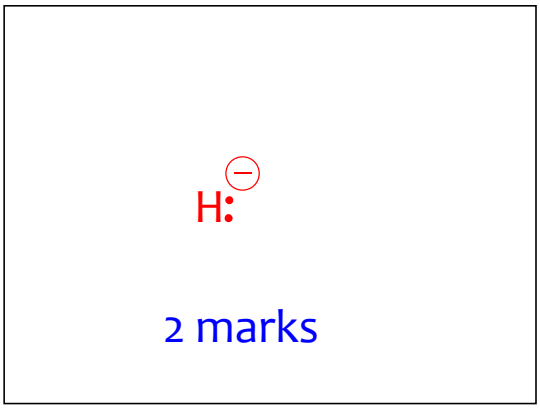
**Question 29** (2 marks). Using the supplied template, provide a Newman projection of the following compound.



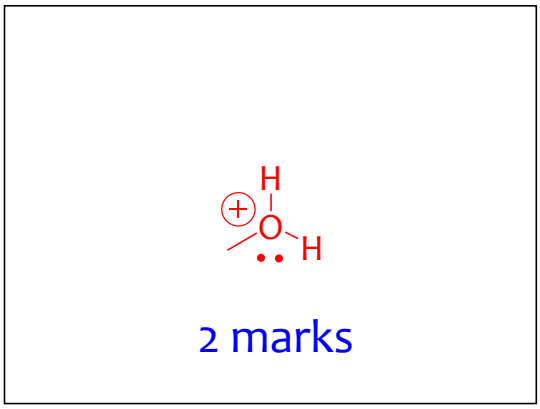

***Each atom worth 0.5 each***

*Complete this template using the structure to the left*

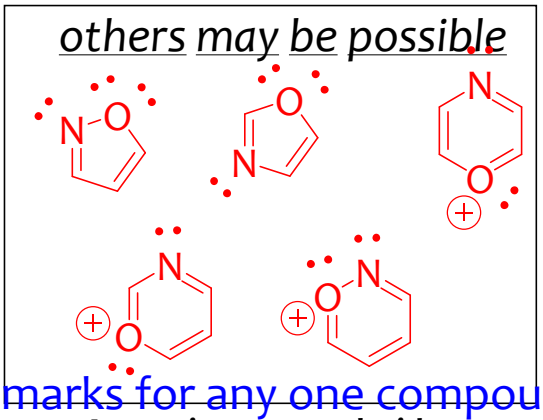
**Question 30** (6 marks). Provide line-bond structures with ***all*** lone pairs and formal charges clearly shown.




**Hydride ion ($H^-$)**

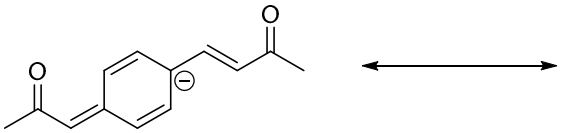


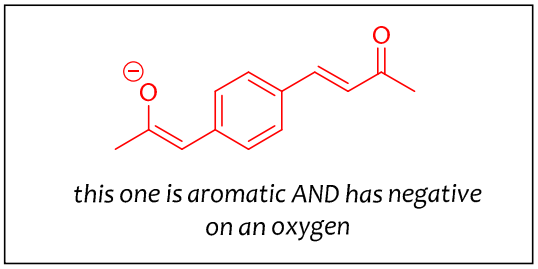

**Conjugate acid of methanol**




**Aromatic compound with a nitrogen and oxygen atom in the ring**

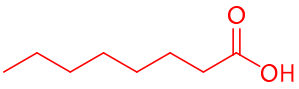
**Question 31** (2 marks). Using the provided space, draw the single most contributing resonance structure of the compound below to the resonance hybrid.



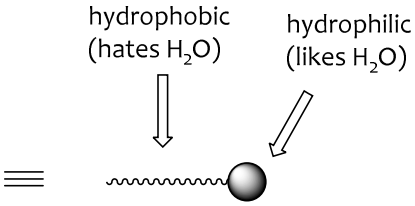



***Single greatest contributor to the resonance hybrid***

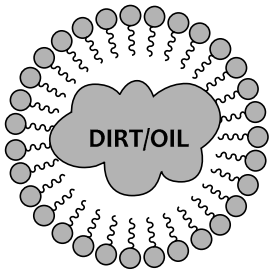
**Question 32** (3 marks). Octanoic acid can act as a detergent. Using pictures and ***BRIEF*** descriptions explain how octanoic acid can solubilize (dissolve) hydrophobic substances.



*octanoic acid*
***1 mark for structure***



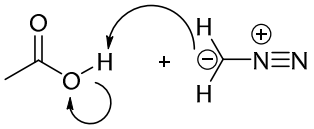

*Some indication of a hydrophobic part and a hydrophilic part. This diagram isn't required though it is being used to illustrate the point*
***1 mark***



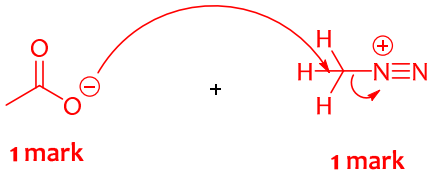

*Molecules organize to form a miscelle (or sphere/globule/force field is fine).*
*It has a polar outer shell which allows it to be H2O soluble*
*It has a non-polar interior which dissolves dirt/oil*
***1 mark***

Diazomethane is a powerful method for the formation of methyl esters. For **question 33 - 34**, provide the required information. Note that **question 34** is written beside the arrow below (3 marks).

**33)**



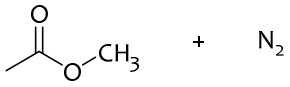
***NO WORKUP STEP***



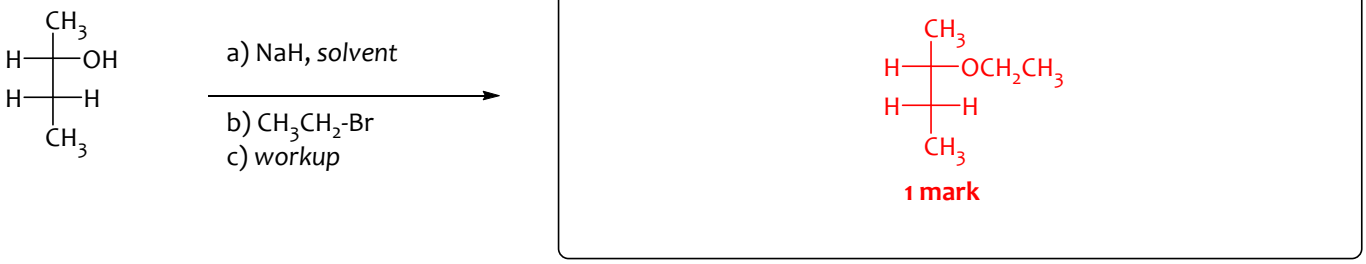
**1 mark** **1 mark**

***Provide the major organic product(s)***

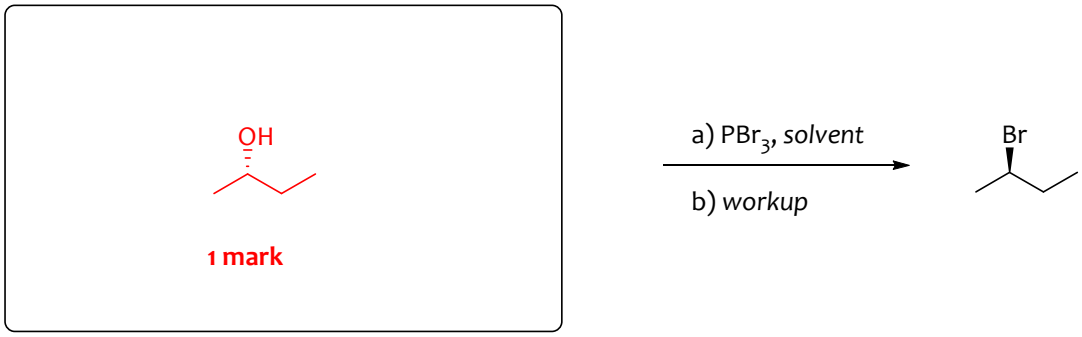
**Question 34**
On your compounds above, provide the arrows that would be required to produce the products below.
***1 mark for arrows***



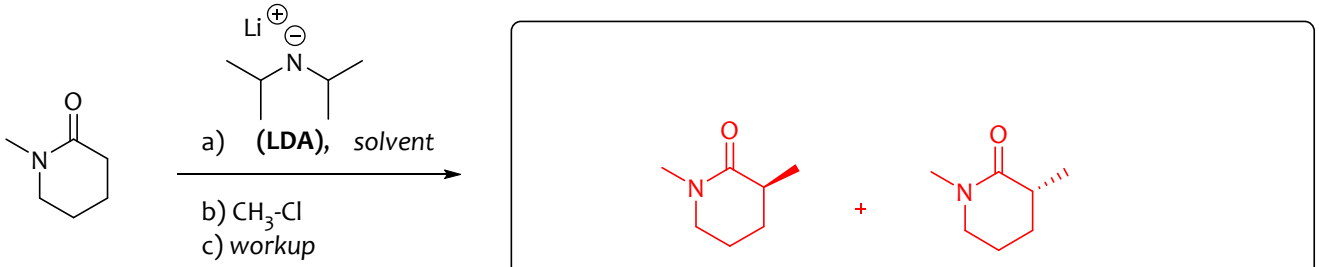
**Question 35** (4 marks). Predict the major organic product(s) for each of the following transformations. Include stereoisomers if appropriate. You do not need to include by-products or a mechanistic rationale for these reactions.



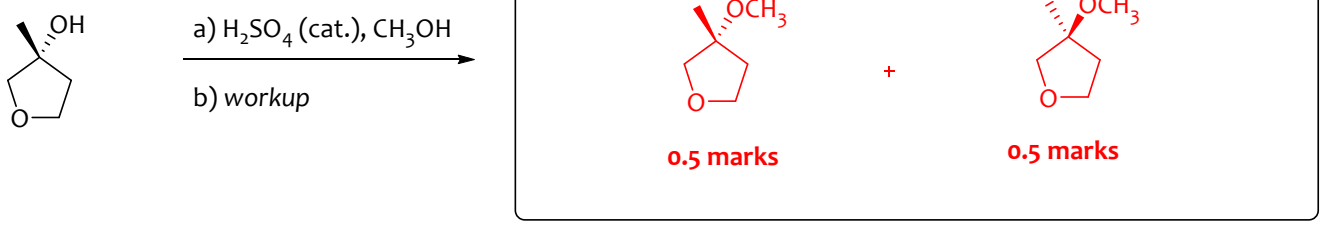

**1 mark**




**1 mark**

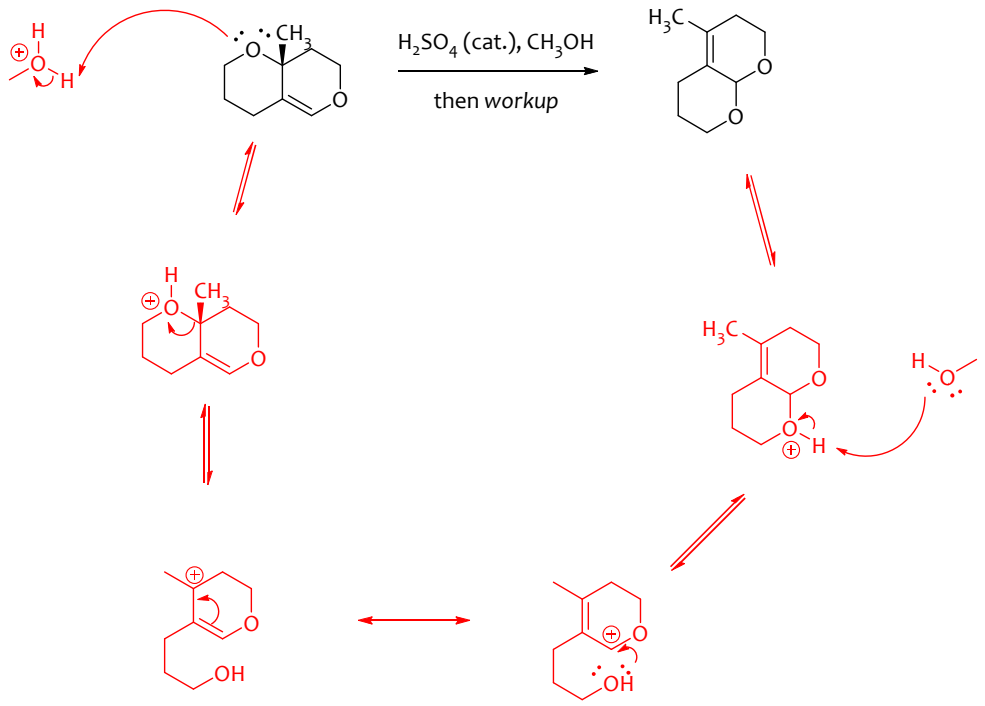



**0.5 marks** **0.5 marks**




**0.5 marks** **0.5 marks**

**Question 36** (5 marks). Using arrows to represent electron movement, draw a mechanistic rationale for the following transformation.




FAQ

I didn't use methanol to protonate and or deprotonate! Did I lose marks?
- No, within reason.

I protonated the other oxygen! Is that wrong?
- No, acid base reactions happen all the time at various locations. ***However, this would not have led you to the product that I asked for.***

How do you know its $S_N1$? Why not $S_N2$?
- We have a tertiary ether a weak nucleophile and an acid. In this case, $CH_3OH$ is our solvent and our weak nucleophile. This should lead you to $S_N1$.

I didn't use the resonance arrows to relate the structures! Did I lose marks?
- Yes, I mentioned in class several time that the only arrow you need to use correctly in this course are resonance arrows. If you misused this arrow, it was -0.5 total.

I didn't show both stereoisomers in my answer! Did I lose marks?
- No. I am more interested in the mechanism in this case. Knowing that it should have stereoisomers is good enough for me.