

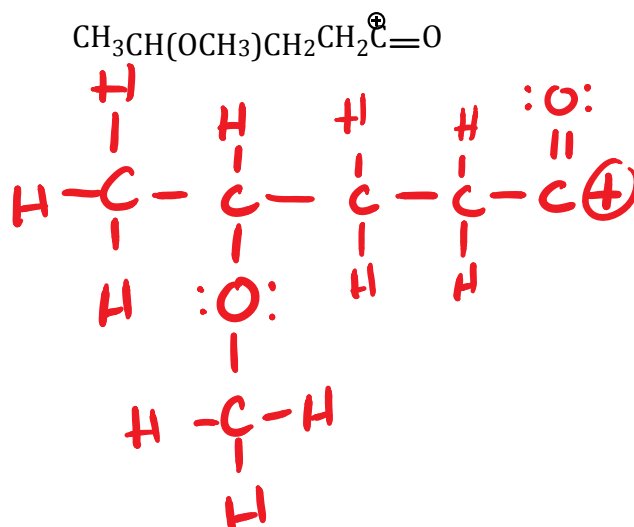
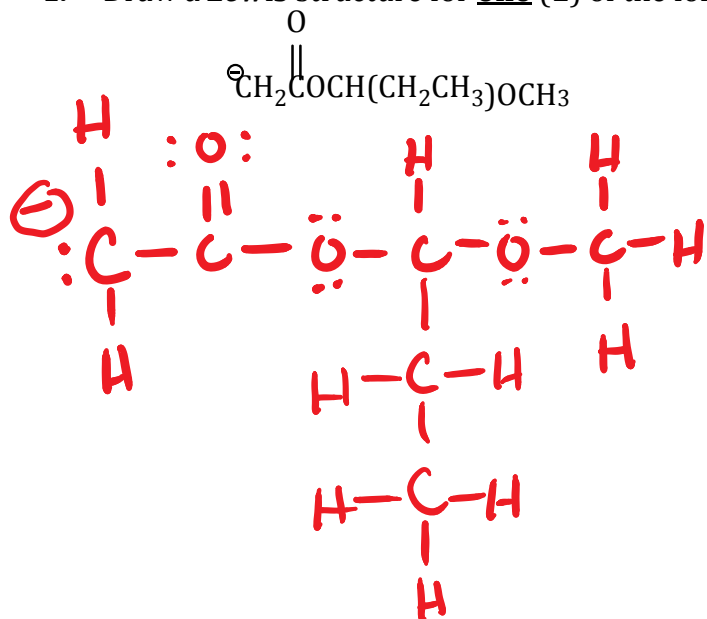
Dr. Richter

PRINT NAME \_\_\_\_\_.

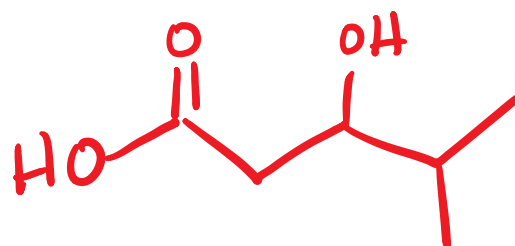
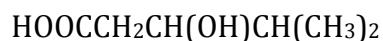
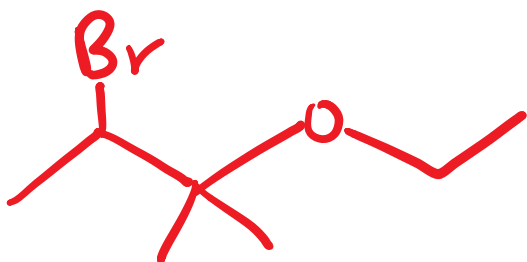
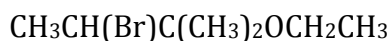
SIGN NAME \_\_\_\_\_.

You are required to answer all question sets. Please note that some of the question sets offer you a choice of questions - do only the number of questions asked for. Please write legibly and draw clearly. Points will be deducted for illegible and unclear answers. The point total for this exam is 100 and the value of each question set is shown in parenthesis beside that set. **READ ALL QUESTIONS CAREFULLY AND APPORTION YOUR TIME ACCORDINGLY.**

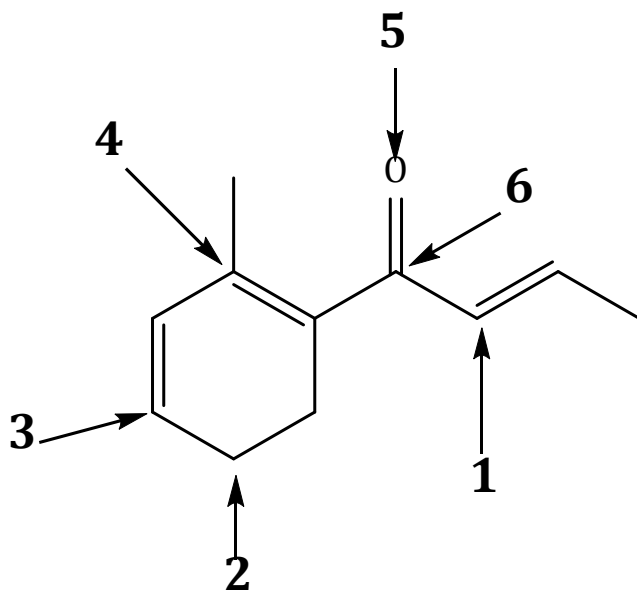
1. Draw a **Lewis** structure for **one** (1) of the following ions: (6)



2. Draw a **skeletal** structure for **one** (1) of the following molecules: (6)



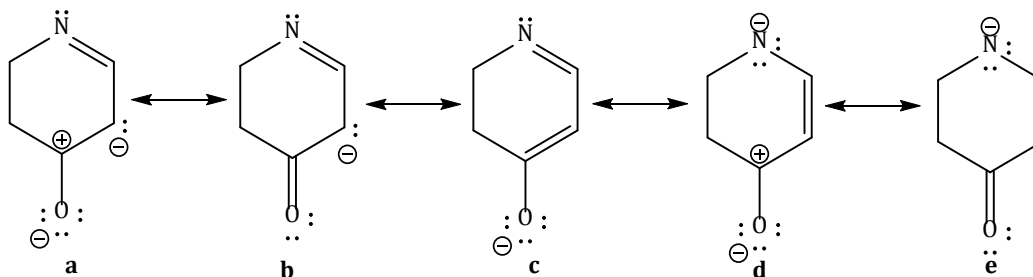
3. The structure below belongs to a family of compounds called the "damascenones." These compounds are responsible for the fragrance of roses. Indicate the hybridization of each of the numbered atoms in the provided list on the right. Remember, use the resonance **hybrid** as your guide. If an atom is "in between," label it as such. (12)



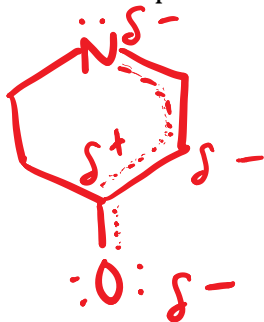
ANSWERS:

1.  $sp^2$
2.  $sp^3$
3.  $sp^2$
4.  $sp^2$
5.  $sp^2/sp^3$
6.  $sp^2$

4. Consider the five structures below (a-e).



- A. Draw the resonance hybrid of the ion represented by structures a-e. (4)

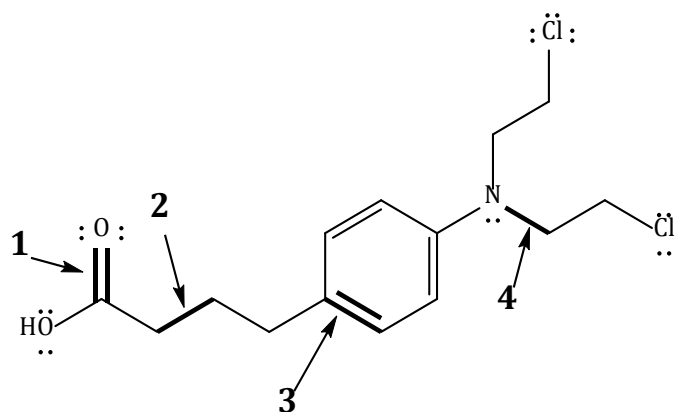


- B. Rank resonance structures a-e according to contribution to the resonance hybrid. (5)

Answers: c e b d a  
 greatest contribution  $\longrightarrow$  least contribution

5. Consider the molecule (chlorambucil, a chemotherapeutic agent) shown below.

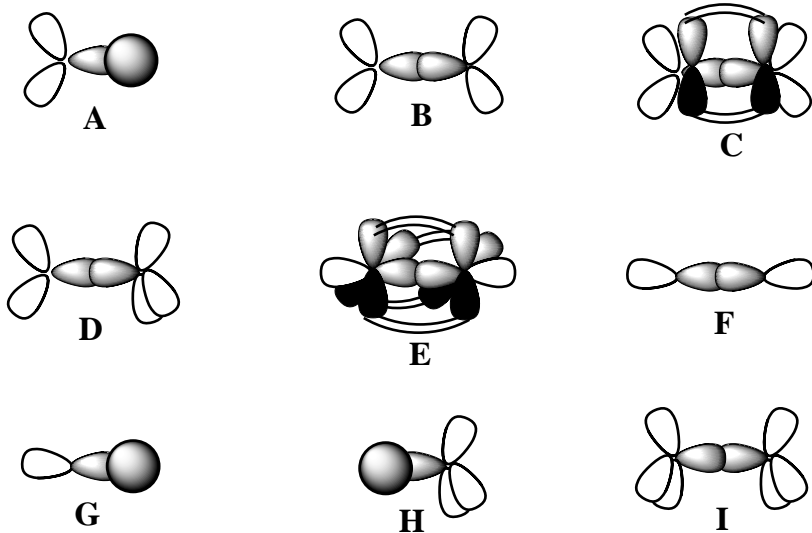
(16)



For each of the highlighted bonds **1-4**, match the bond with a 3-D orbital picture AND the description of the orbital overlap forming the  $\sigma$  and/or  $\pi$  bond(s). Write your answers in the table below. **Notes:** **1.** Do NOT consider the resonance hybrid for this exercise, **2.** You may need to use more than one description per bond, **3.** Not all choices will be used.

**Orbital Picture Choices**

**Description Choices**



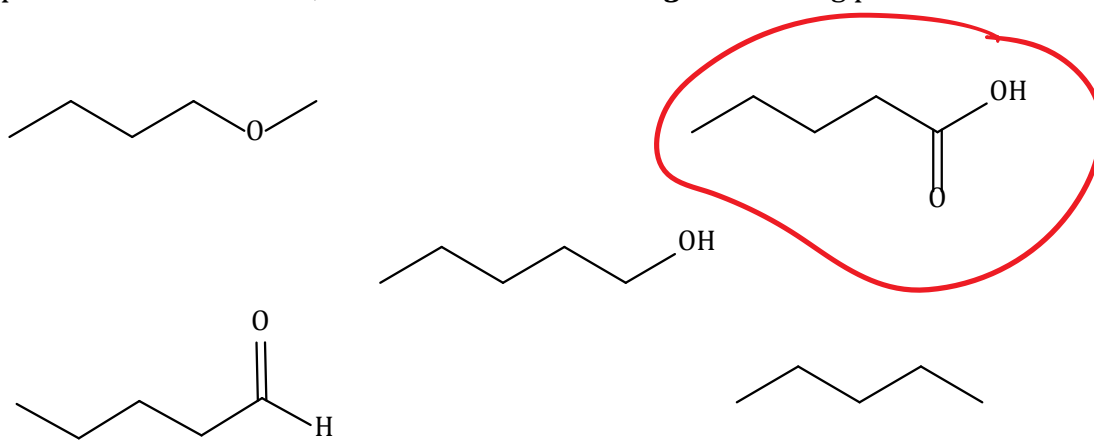
- 1:  $\sigma$  Csp<sup>3</sup>-H<sub>1s</sub>
- 2:  $\sigma$  Csp<sup>3</sup>-Osp<sup>2</sup>
- 3:  $\sigma$  Csp<sup>2</sup>-Osp<sup>2</sup>
- 4:  $\sigma$  Csp<sup>2</sup>-Nsp<sup>2</sup>
- 5:  $\sigma$  Csp<sup>2</sup>-Nsp<sup>3</sup>
- 6:  $\sigma$  Nsp-Nsp<sup>2</sup>
- 7:  $\sigma$  Nsp<sup>2</sup>-Nsp<sup>2</sup>
- 8:  $\sigma$  Nsp<sup>3</sup>-Csp<sup>3</sup>
- 9:  $\sigma$  Csp<sup>2</sup>-Csp<sup>2</sup>
- 10:  $\sigma$  Csp<sup>3</sup>-Csp<sup>3</sup>
- 11:  $\sigma$  Csp<sup>2</sup>-Csp<sup>3</sup>
- 12:  $\pi$  Op-Cp
- 13:  $\pi$  Cp-Np
- 14:  $\pi$  Cp-Cp

**Answers:**

Bond	Orbital Picture	Description(s)	Bond	Orbital Picture	Description(s)
1	C	3 + 12	3	C	9 + 14
2	I	10	4	I	8

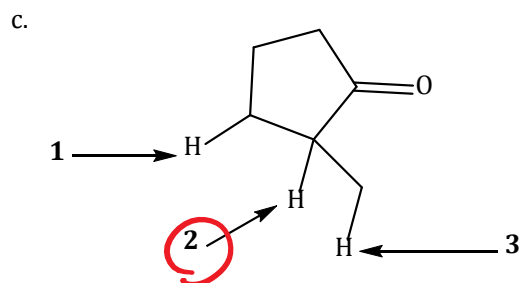
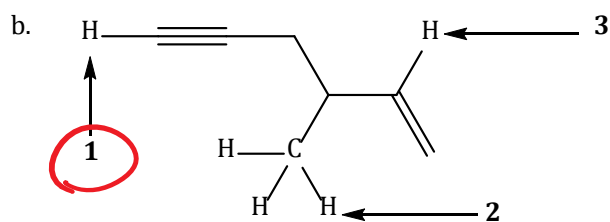
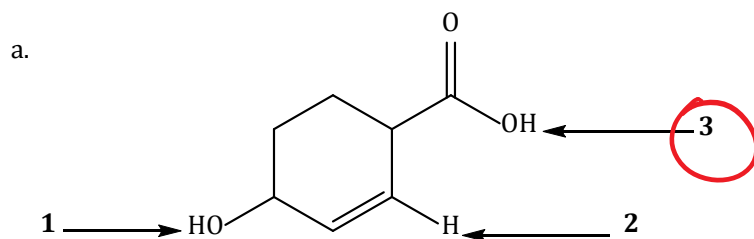
7. Of the 5 pure substances below, circle the one with the **highest** boiling point.

(5)



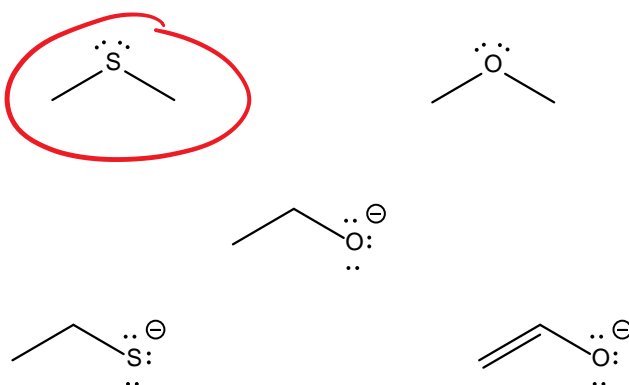
8. For **each** compound below (a-c), circle which proton (1, 2, or 3) has the lowest pKa.

(6)



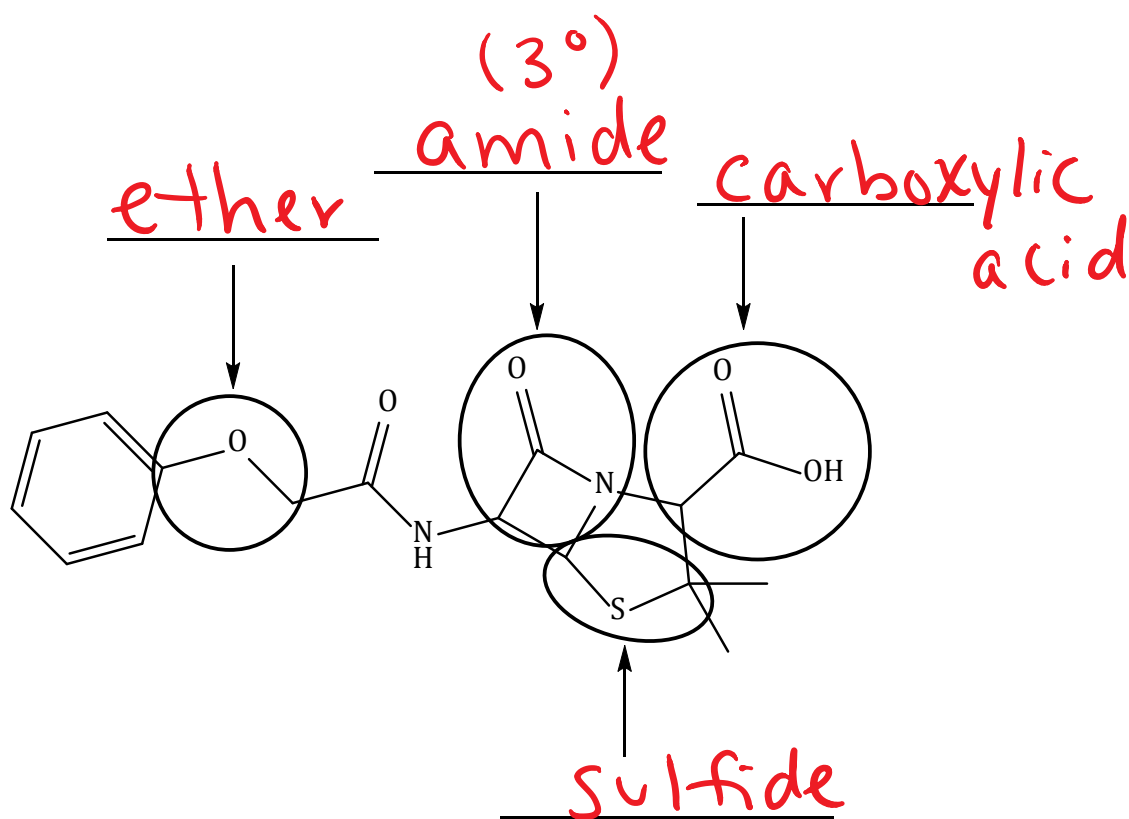
9. Of the 5 bases below, circle the *weakest* (i.e. *least reactive*).

(5)

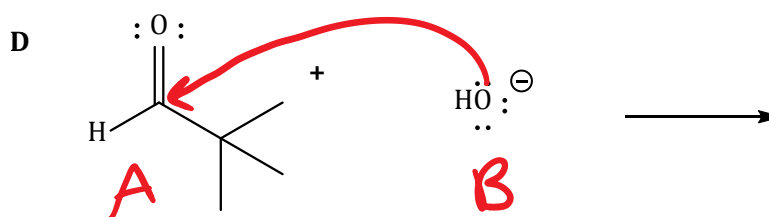
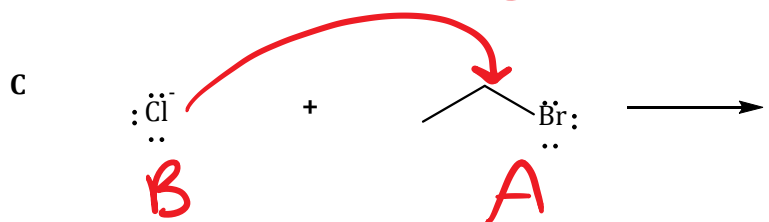
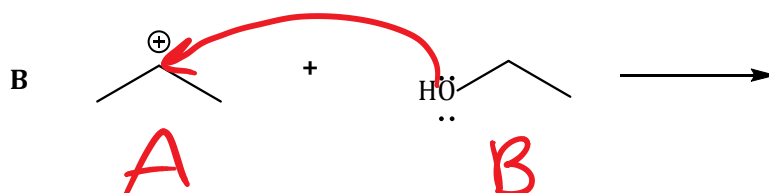
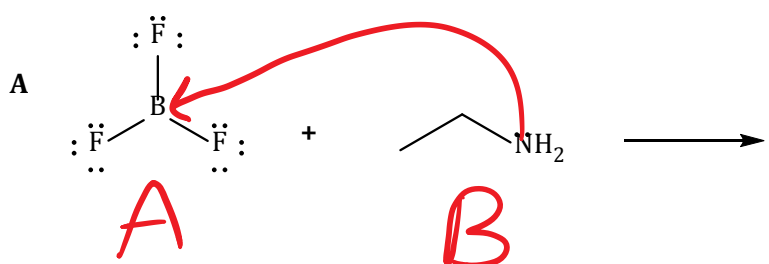


10. Identify the circled functional groups in the structure below. Reminder: use the term that Smith calls the "Type of Compound." For example, use "ether," not "alkoxy." Write your answer in the blanks provided.

(8)



11. For each of the following reactions (A-D) **a. label** the Lewis base (nucleophile) and the Lewis acid (electrophile) and **b. draw** reaction arrows to show the appropriate *electron movement* between the nucleophile and electrophile. **You do not need to show the products.** (8)



12. Indicate whether each statement a-e is **true (T)** or **false (F)**. (10)

T a. IR spectroscopy can be used to obtain functional group information about a compound.

T b. When matter absorbs infrared radiation, it causes vibrational excitations to take place within the matter.

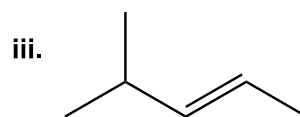
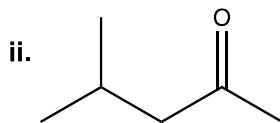
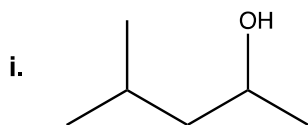
F c. IR spectral data is reported in parts per million or "ppm."

T d. In general, bonds between lighter atoms will absorb a higher frequency of IR radiation than will bonds between heavier atoms.

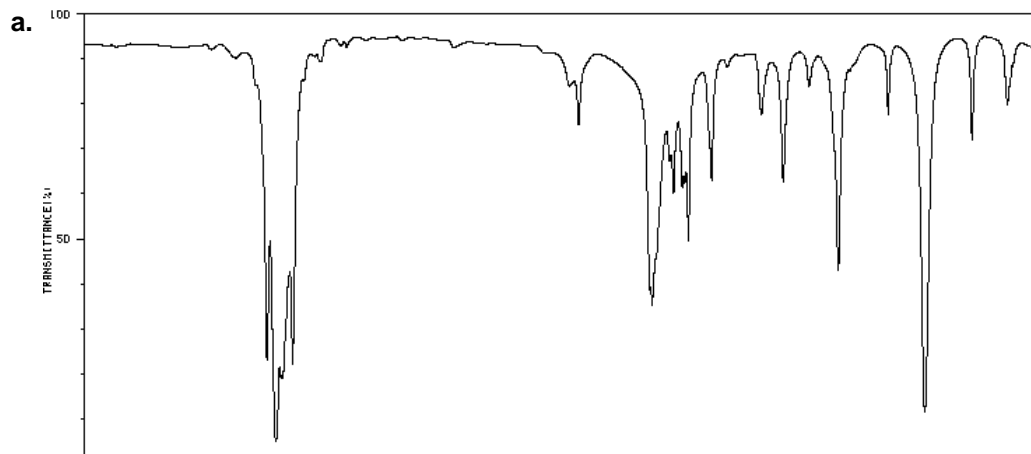
T e. Bonds between  $\text{sp}^3$  atoms tend to vibrate at lower frequencies than do bonds between  $\text{sp}^2$ - or  $\text{sp}$ -hybridized atoms.

13. Match each IR spectrum a-c below to one of the structures i-iii.

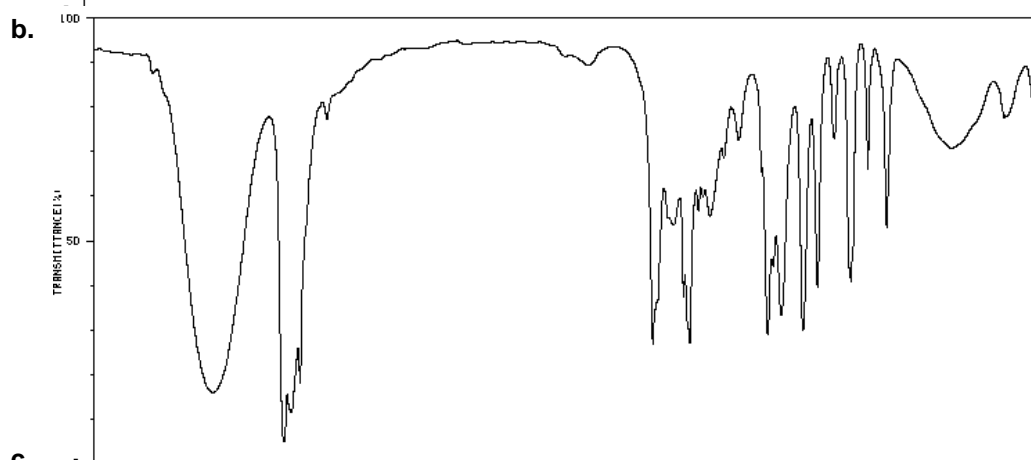
(9)



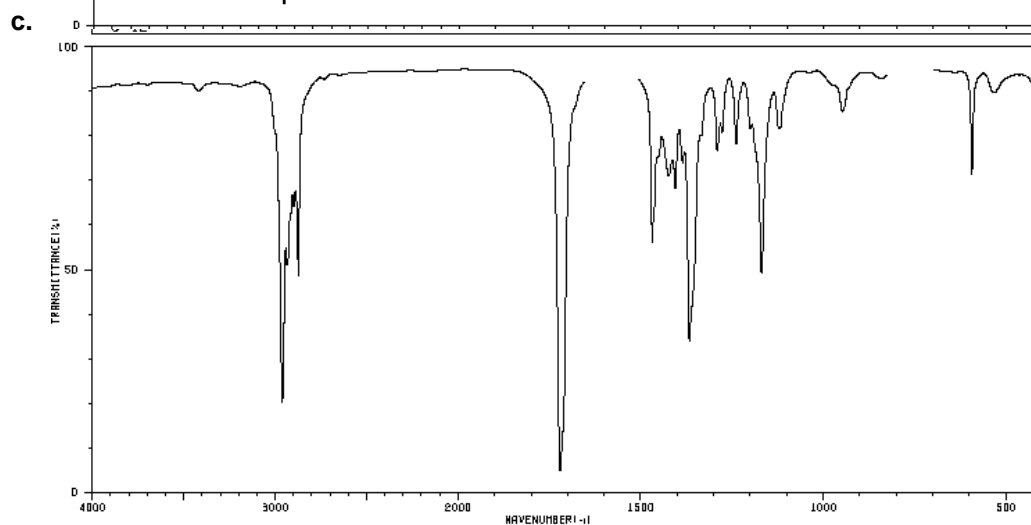
ANSWERS



iii



i



ii