**CHE-2060 Lecture 5: HW Problems**

Problems must be solved, or written out, in their entirety with all work shown on engineering graph paper. You must label each set in the upper left hand corner with your name, the date and the chapter. Problems must be identified by number and all work must be shown with answers boxed. Be sure your handwriting is legible. An example is posted in the ‘course basics’ section of our Moodle page.

**5.1: Acids & bases: overview & basics**

Identifying Lewis acids & Lewis bases

1. Which proton(s) is/are the most acidic in this molecule, and *why*?

H

|

H - C – N:

|

H

H

H

2. Draw the structure of the conjugate base of the acid shown in the previous problem.

3. Which proton(s) is/are the most acidic in this molecule, and *why*?

HS

OH

4. Which proton(s) is/are the most acidic in this molecule, and *why*?

H

H

5. Draw the structure of the conjugate base of the acid shown in the previous problem.

Identifying nucleophiles and electrophiles

6. Label each as a Lewis acid or a Lewis base and as an electrophile or nucleophile.

a. Zn+2

b. CH3OCH3

c. (CH3)3C+1

Simple acid-base reactions

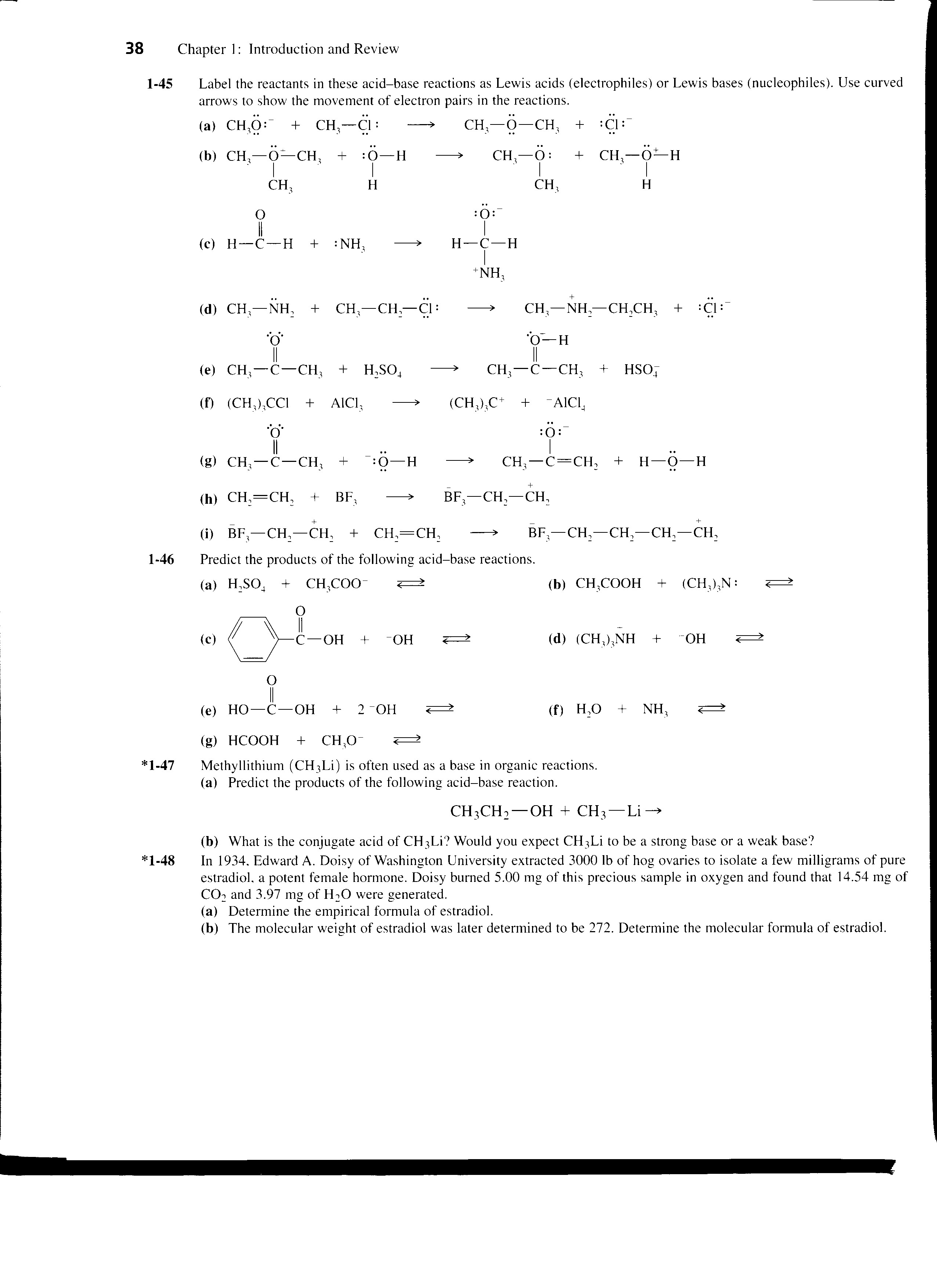
7. For the reaction shown below:

a. Label each reactant as either a Lewis acid or a Lewis base.

b. Label each reactant as a Nu: or E+.

c. Draw arrows to show movement of electrons in the reactions.

d. Is the Nu: acting as a base?



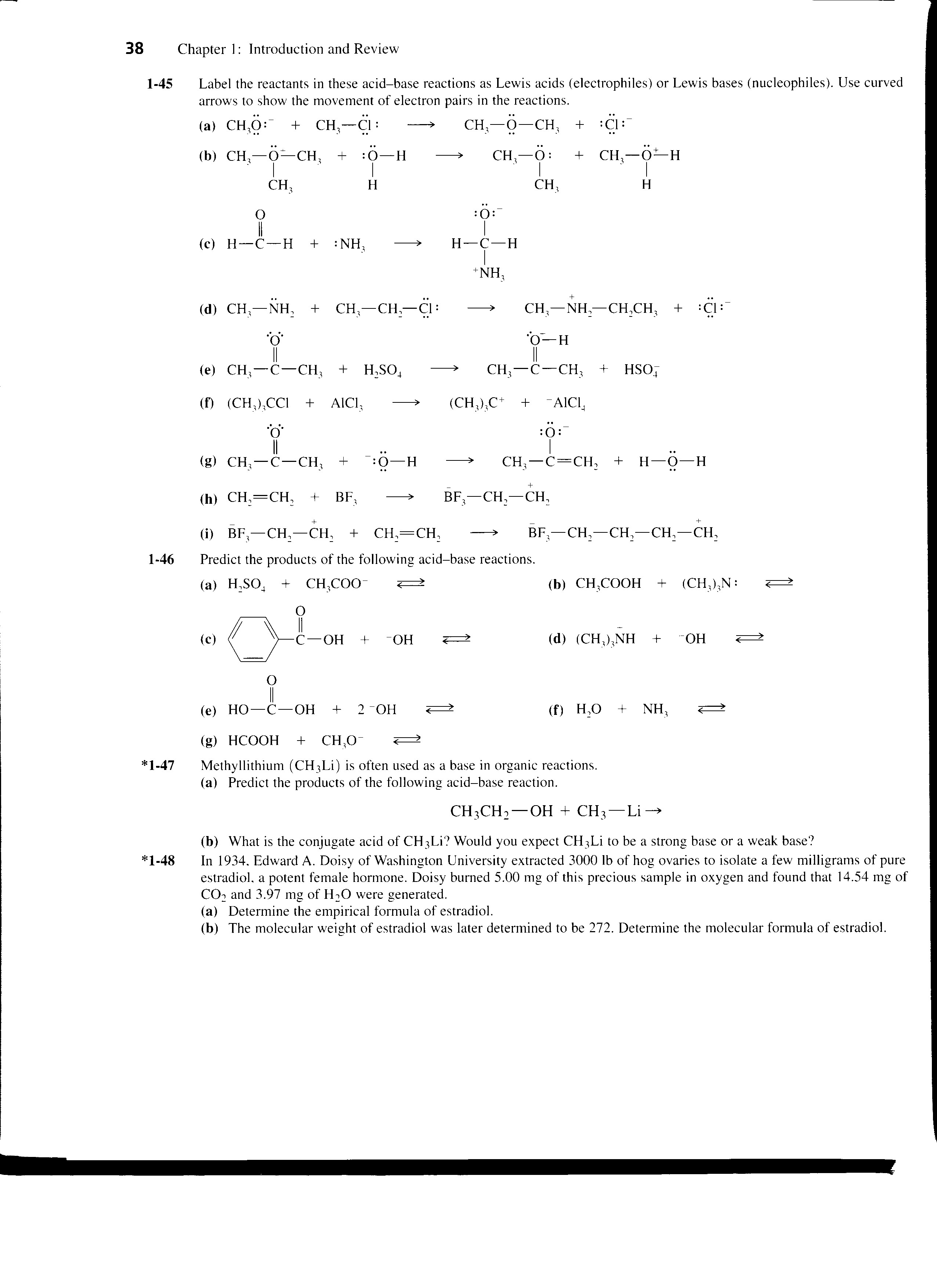
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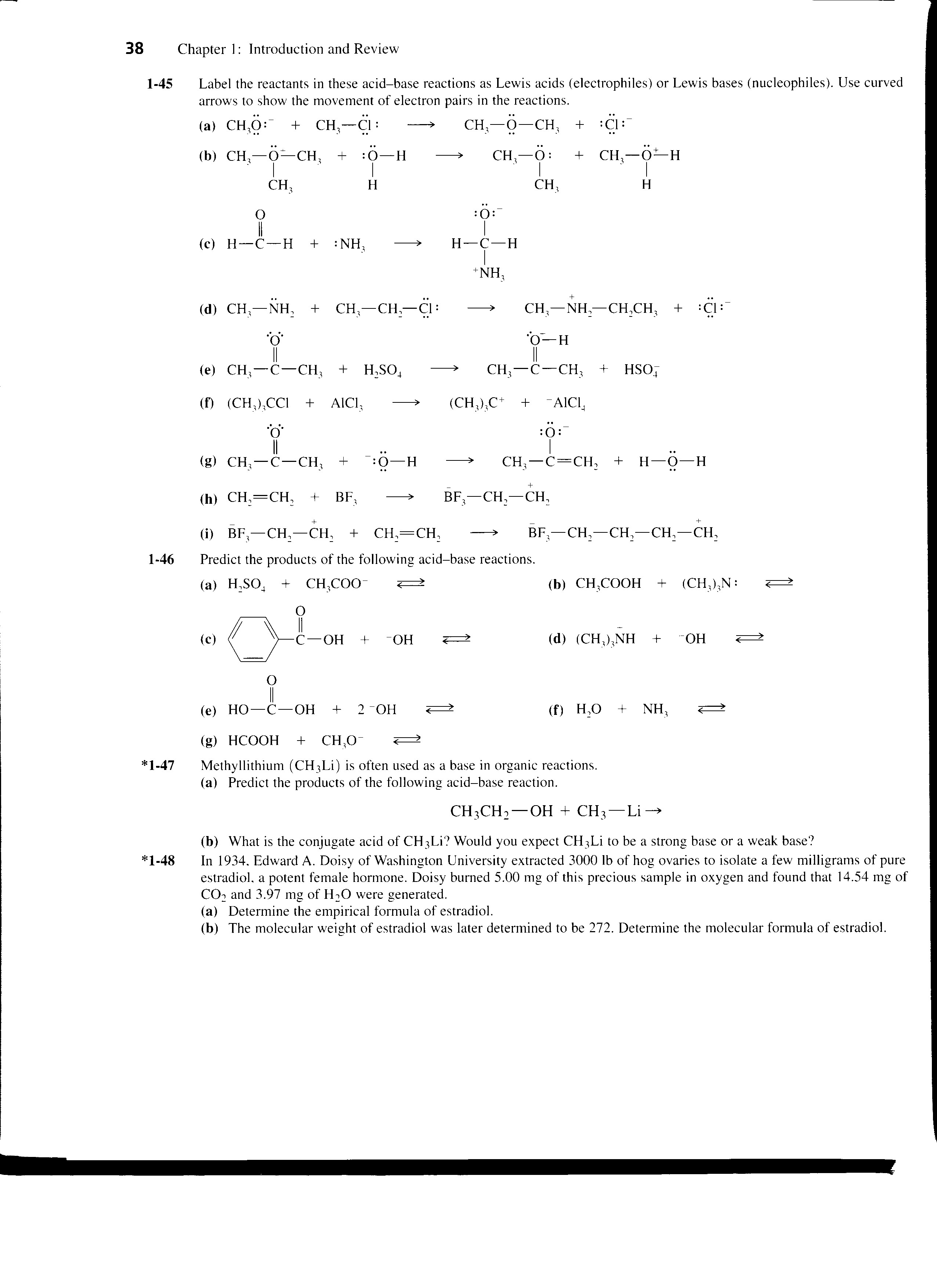
9. For the reaction shown below:

a. Label each reactant as either a Lewis acid or a Lewis base.

b. Label each reactant as a Nu: or E+.

c. Draw arrows to show movement of electrons in the reactions.

d. Is the Nu: acting as a base?



Acidity of alkanes vs. alkenes vs. alkynes

10. Rank these hydrocarbons in order of pKa values or acidity.

a. pentane

b. pentene

c. pentyne

**5.2: Acid & base strength**

11. The Ka for ethanol is 1.0 x 10-16. What is ethanol’s pKa?

12. The pKas of hydrogen cyanide and acetic acid are 9.2 and 4.7, respectively. Which is the stronger acid?

13. Use the periodic table to predict the relative strengths of HBr v. HI and explain your answer.

14. Compare the pKa values of water and its conjugate acid, the hydronium ion. Which is a stronger acid? How much stronger?

**5.3: Equilibirum acid-base reactions (with prediction of product)**

15. Acid-base equations:

a. Create Lewis dot structures for each ion or molecule.

b. Write a balanced chemical equation for each reaction of acid & base.

c. Use pKa tables to determine whether reactants or products are favored.

CH3COO-1 + CH3OH 🡪

16. Acid-base equations:

a. Create Lewis dot structures for each ion or molecule.

b. Write a balanced chemical equation for each reaction of acid & base.

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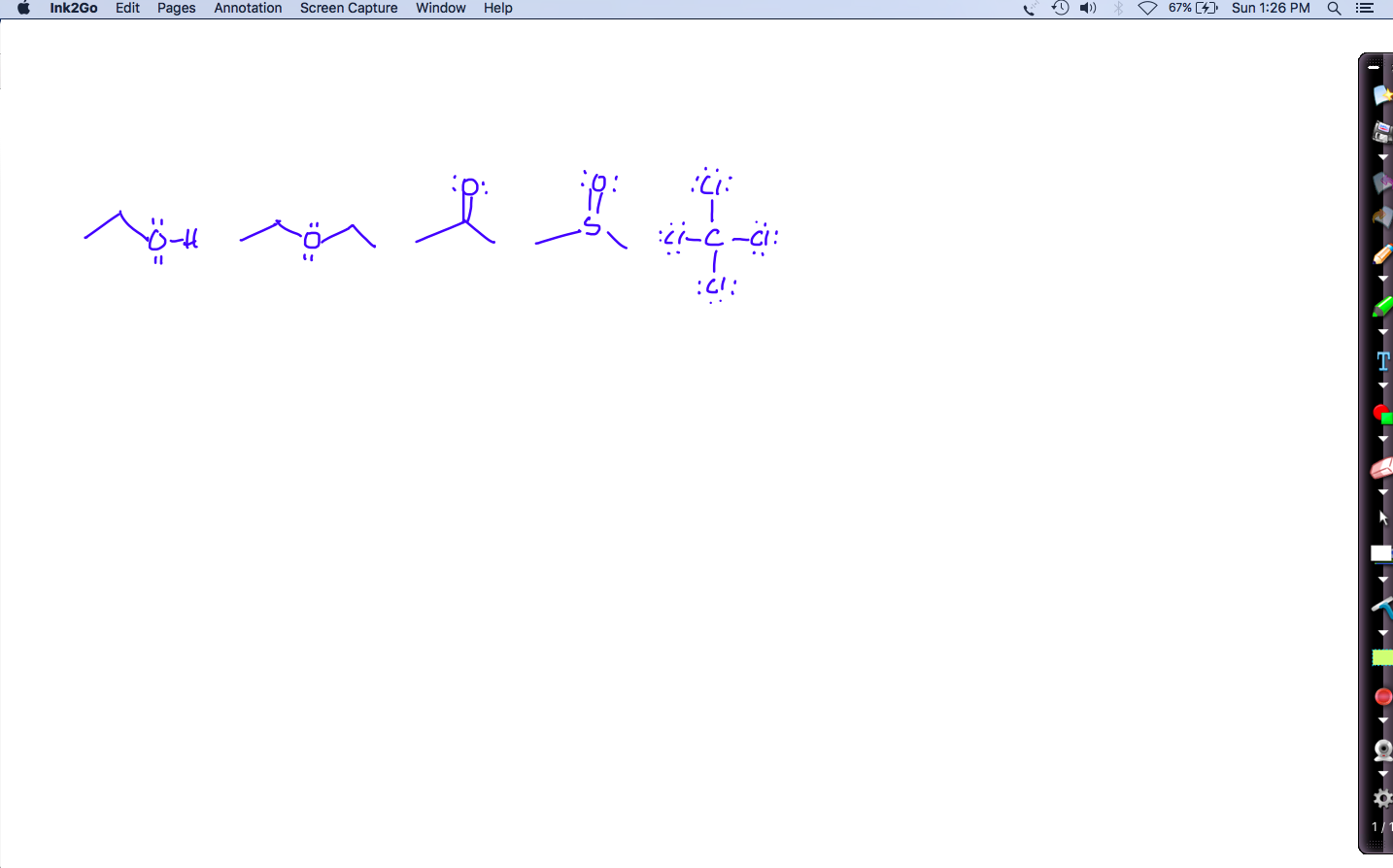
CH3OH + NaNH2 🡪

**5.4: The leveling effect of solvents**

17. Some farmers use formic acid to acidify milk fed to calves; acidification prevents the milk from spoiling. If concentrated formic acid is diluted in water does ‘leveling’ affect the acid’s strength?

If so, is the effect greater than the effects expected from simple dilution?

18. In which of these solvents is CH3NH2 the weakest base?



**5.6: Classes of organic acids & bases**

19. Why are carboxylic acids like acetic acid more acidic than phenol?

20. How does the electronegativity of N contribute to the fact that amines are strong bases?

21. What orbitals do the charges on these ions occupy?

1. carbocations
2. carbanions

**5.7: Functional groups: their acid-base nature**

22. Which functional group is the stronger acid and why?

a. a sulfhydryl (or thiol) group

b. a hydroxide (or alcohol) group

24. Why are carboxylic acids stronger acids than alcohols?

25. Ammonia (pka 36) is considered a base rather than an acid, but ethanamide (CH3CHONH2) is a decent acid (pKa 17). Why?