Organic Chemistry 9th edition McMurry Test Bank

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Chapter 02 - Polar Covalent Bonds; Acids and Bases

Exhibit 2-1
Give the corresponding letter of the term that best matches the given definition.

a. Brønsted-Lowry Acid
b. Brønsted-Lowry Base
c. Lewis Acid
d. Lewis Base
e. Electronegativity
f. Ionic Bond
g. Covalent Bond
h. Polar-Covalent Bond
i. Hydrophobic
j. Hydrophilic

1. _____ Any species that accepts electrons.
ANSWER: c
POINTS: 1

2. _____ A bond between two atoms differing in electronegativity by 0.5 − 2.
ANSWER: h
POINTS: 1

3. _____ A term used to describe a "water loving" species.
ANSWER: j
POINTS: 1

4. _____ A compound that can donate a proton.
ANSWER: a
POINTS: 1

5. _____ The ability of an atom to attract the shared electrons in a covalent bond.
ANSWER: e
POINTS: 1

6. _____ A term used to describe a "water fearing" species.
ANSWER: i
POINTS: 1

7. _____ Any species that donates electrons.
ANSWER: d
POINTS: 1

8. _____ A bond between two atoms differing in electronegativity by < 0.5.
ANSWER: g
POINTS: 1

9. _____ A compound that can accept a proton.
ANSWER: b
POINTS: 1

10. _____ A bond between two atoms differing in electronegativity by > 2.
ANSWER: f
POINTS: 1

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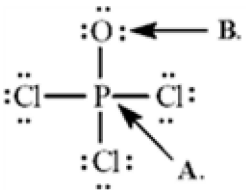
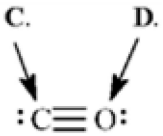
Exhibit 2-2
Calculate the formal charges on the indicated atoms in each compound below.





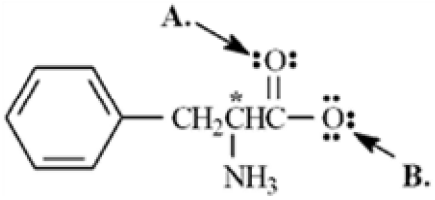
11. Refer to Exhibit 2-2. The formal charge on phosphorous (**A**) is _____.
ANSWER: +1
POINTS: 1

12. Refer to Exhibit 2-2. The formal charge on oxygen (**B**) is _____.
ANSWER: −1
POINTS: 1

13. Refer to Exhibit 2-2. The formal charge on carbon (**C**) is _____.
ANSWER: −1
POINTS: 1

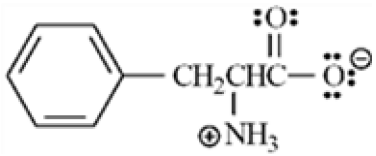
14. Refer to Exhibit 2-2. The formal charge on oxygen (**D**) is _____.
ANSWER: +1
POINTS: 1

Exhibit 2-3
Phenylalanine is an amino acid that is essential to human nutrition. The representation below shows the structure of phenylalanine at physiological pH. Consider this structure to answer the following question(s).



phenylalanine

15. Refer to Exhibit 2-3. Assign any formal charges to atoms in this representation of phenylalanine.
ANSWER:



POINTS: 1

16. Refer to Exhibit 2-3. The oxygen atom labeled **A**. has _____ non-bonding electrons.
ANSWER: four
POINTS: 1

17. Refer to Exhibit 2-3. The oxygen atom labeled **B**. has _____ bonding electrons.
ANSWER: two

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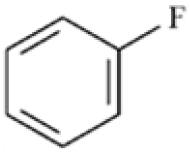
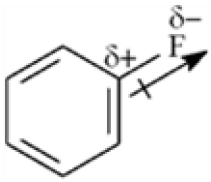
POINTS: 1

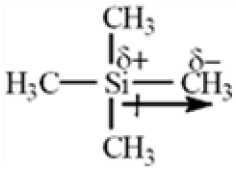
Exhibit 2-4
Use the $\delta-/\delta+$ convention and the crossed arrow (+→) to show the direction of the expected polarity of the indicated bonds in the following compounds.

18. Refer to Exhibit 2-4. The C−F bond in fluorobenzene, 

ANSWER: 

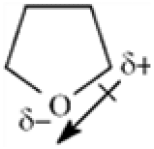
POINTS: 1

19. Refer to Exhibit 2-4. The C−Si bond in tetramethylsilane, $(CH_3)_4Si$

ANSWER: 

POINTS: 1

20. Refer to Exhibit 2-4. The C−O bond in furan,

ANSWER: 

POINTS: 1

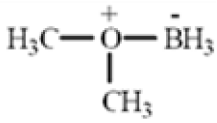
Exhibit 2-5
Label the acid, conjugate acid, base, and conjugate base in each reaction below.

21. $CH_3OH + NaH \longrightarrow CH_3O^- Na^+ + H_2$

ANSWER: $CH_3OH + NaH \longrightarrow CH_3O^- Na^+ + H_2$

acid *base* *conjugate base* *conjugate acid*

POINTS: 1

22. $CH_3OCH_3 + BH_3 \longrightarrow$ 

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ANSWER:

POINTS: 1

Exhibit 2-6
Refer to the following equation to answer the question(s) below. Place the letter corresponding to the correct answer in the blank.

23. Refer to Exhibit 2-6. The strongest Brønsted-Lowry acid in the equation is _____.
ANSWER: D
POINTS: 1

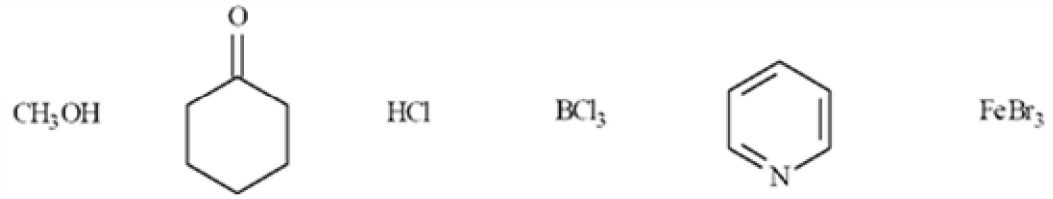
24. Refer to Exhibit 2-6. The strongest Brønsted-Lowry base in the equation is _____.
ANSWER: C
POINTS: 1

25. Refer to Exhibit 2-6. Will this reaction take place as written? Explain.
ANSWER: No, the reaction will not take place as written because the strongest acid reacts with the strongest base to give the weakest conjugate acid and the weakest conjugate base. **D** (pK_a = 15.7) is a stronger acid than **A** (pK_a = 18).
POINTS: 1

26. An acid with a low pK_a:

a. is a weak acid
b. is a strong acid
c. has a weak conjugate base
d. both b and c
ANSWER: d
POINTS: 1

27. Circle all the Lewis bases in the group of compounds below.



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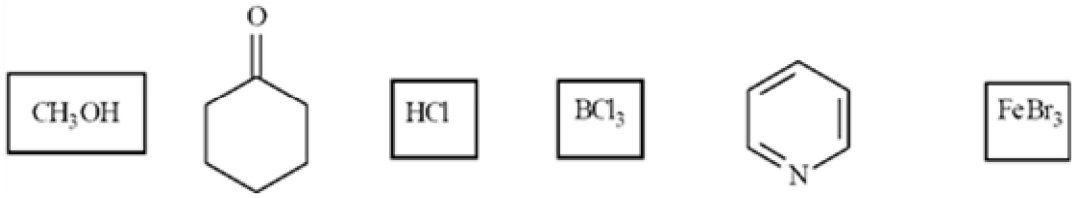
ANSWER:

POINTS: 1

28. Put a box around all the Lewis acids in the group of compounds below.

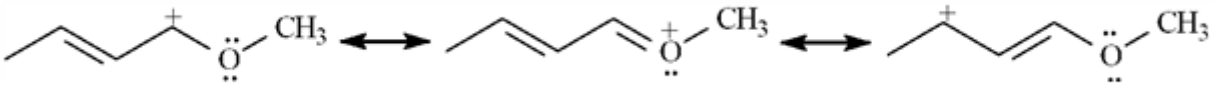
ANSWER:



POINTS: 1

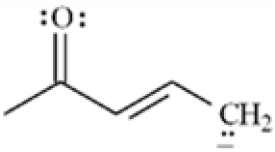
29. Draw *two* resonance structures for the species below.

ANSWER:

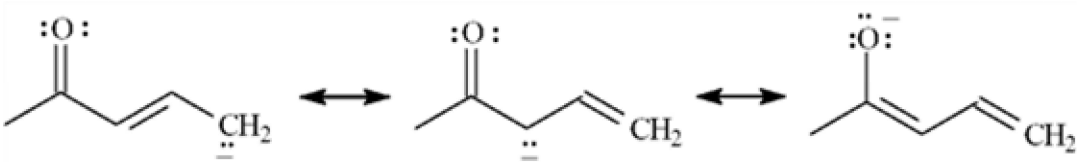


POINTS: 1

30. Draw *two* resonance structures for the species below.



ANSWER:



POINTS: 1

31. Draw *two* resonance structures for the species below.

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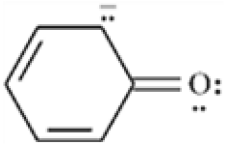
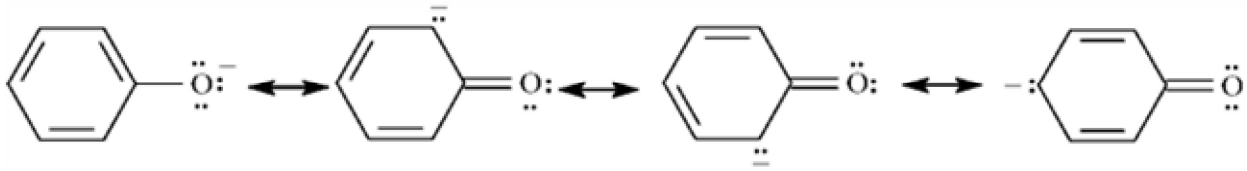
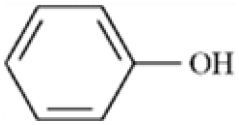


ANSWER:



POINTS: 1

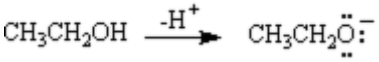
Exhibit 2-7
Consider the acidity constants below to answer the following question(s).

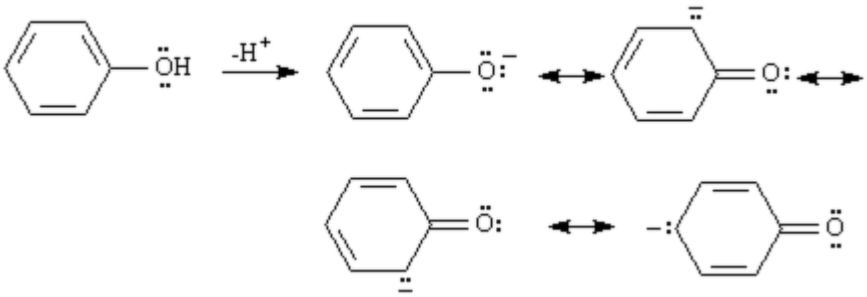
ACID	STRUCTURE	pK_a
phenol		10.00
ethanol	CH_3CH_2OH	16.00
water	HOH	15.74

32. Refer to Exhibit 2-7. Which acid will be almost completely deprotonated by NaOH?
ANSWER: phenol
POINTS: 1

33. Refer to Exhibit 2-7. Which acid has the *strongest* conjugate base?
ANSWER: Ethanol is the weakest acid (largest pK_a) so its conjugate base, ethoxide, $CH_3CH_2O^-$, will be the strongest base.
POINTS: 1

34. Refer to Exhibit 2-7. Explain why phenol has a much lower pK_a than ethanol.
ANSWER: Phenol is more acidic (has a lower pK_a) than ethanol because the phenoxide anion is resonance stabilized by the pi electrons in the ring.
Ethoxide anion has no resonance stabilization. The negative charge is borne fully by oxygen.





POINTS: 1

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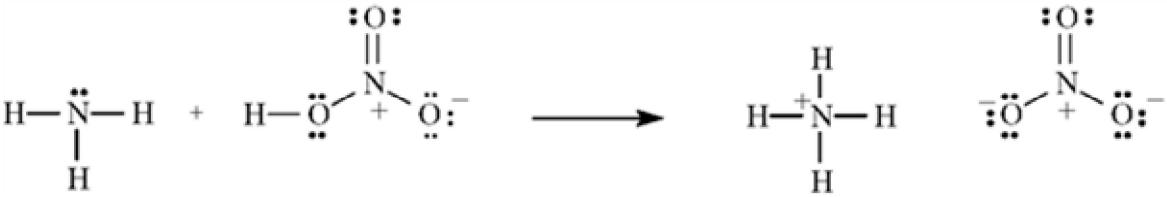
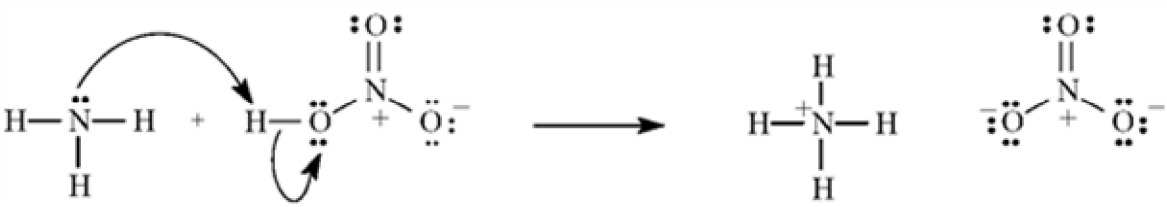
Exhibit 2-8
Consider the reaction below to answer the following question(s).

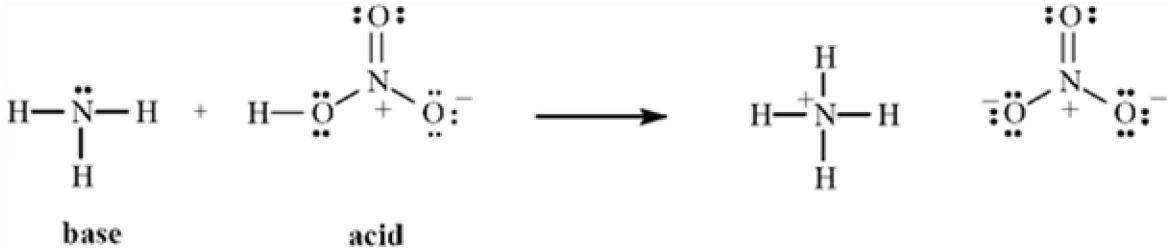


35. Refer to Exhibit 2-8. Using the curved arrow formalism, show the flow of electrons for this reaction.
ANSWER:



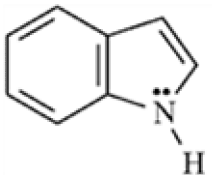
POINTS: 1

36. Refer to Exhibit 2-8. Label the acid and the base in the reaction.
ANSWER:



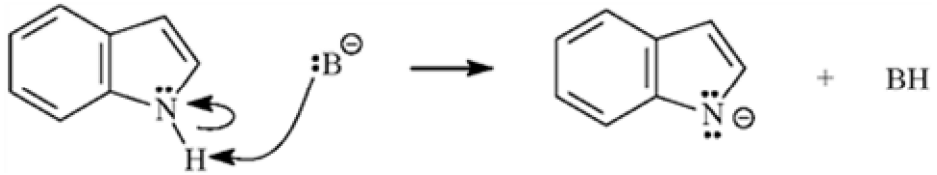
POINTS: 1

Exhibit 2-9
Indole is pleasant smelling in highly dilute solutions and has been used in perfumery. Use the structure of indole, below, to answer the following question(s).



indole

37. Refer to Exhibit 2-9. Indole can function as a Brønsted-Lowry acid in the presence of strong bases. Formulate a reaction, showing electron flow with arrows, that demonstrates this reactivity of indole.
ANSWER:



POINTS: 1

38. Refer to Exhibit 2-9. Indole can function as a Lewis base in the presence of strong acid. Formulate a reaction, showing electron flow with arrows, that demonstrates this reactivity of indole.

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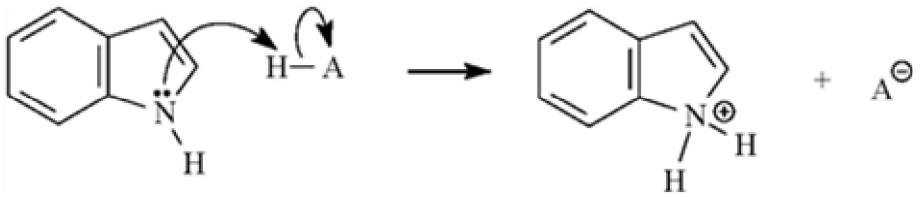
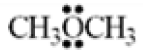
ANSWER:



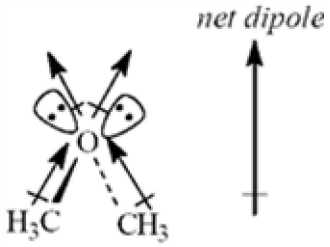
POINTS: 1

39. The condensed structure for dimethyl ether looks symmetrical. However, dimethyl ether has a dipole moment. Draw a structure that explains this and indicate the expected direction of the molecular dipole moment.



dimethyl ether

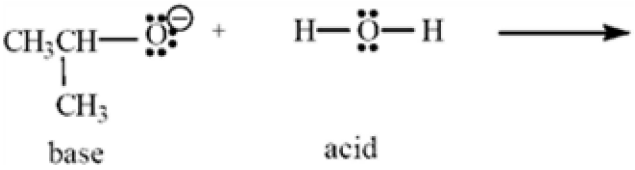
ANSWER:



POINTS: 1

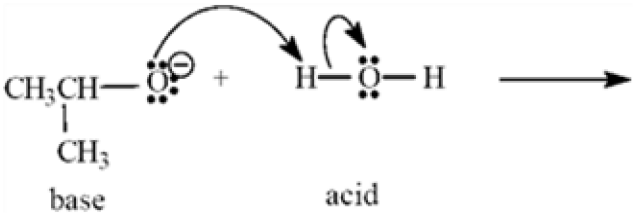
Exhibit 2-10

Consider the acid-base reaction below to answer the following question(s).



40. Refer to Exhibit 2-10. Using the curved arrow formalism, show the flow of electrons for this reaction.

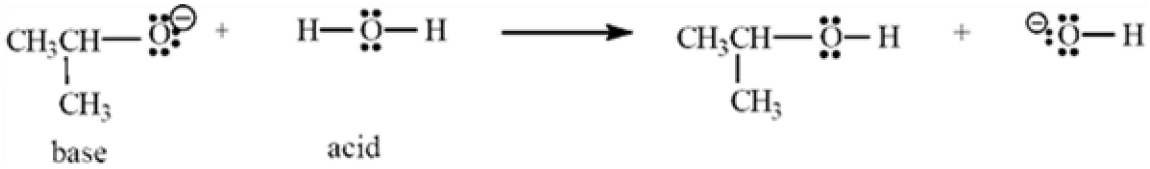
ANSWER:



POINTS: 1

41. Refer to Exhibit 2-10. Write the products of this Lewis acid - base reaction.

ANSWER:



POINTS: 1

42. The following is a representation of the pain reliever, acetaminophen, the active ingredient in Tylenol®. Indicate the positions of any multiple bonds. Atoms other than carbon and hydrogen are labeled.

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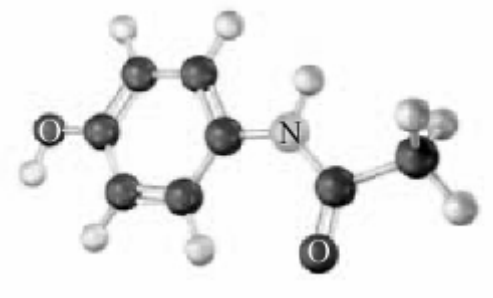
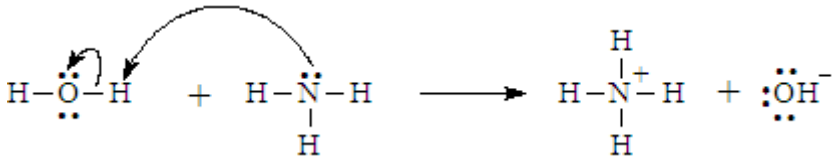
ANSWER:



POINTS: 1

43. Use the curved arrow formalism to show the electron flow in the reaction of ammonia with water.

ANSWER:



POINTS: 1

44. In which series are the elements listed in order of increasing electronegativity?

a. P < S < Cl b. Ge < C < P

c. As < S < F d. P < Br < N

ANSWER: c

POINTS: 1

45. Based on electronegativity values, in which of the following is the bond, represented by —, the most polar?

a. H_3C—I b. H_3C—Na

c. H_3C—Cl d. H_3C—OH

ANSWER: b

POINTS: 1

46. Which of the following substances has a zero dipole moment?

a. CO_2

b. $Cl_2C{=}CCl_2$

c. $HOCH_2CH_2OH$

d. HCl_2CCHCl_2

e. All have zero dipole moments.

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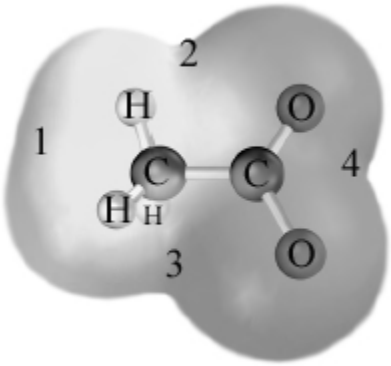
ANSWER: e
POINTS: 1

47. The following shows a gray-scale image of an electrostatic potential map with the atoms labeled. Which of the numbered regions would appear reddest in a color image?



a. 1
b. 2
c. 3
d. 4
e. 1, 2, and 3 would be the same shade of red.
f. 2, 3, and 4 would be the same shade of red.

ANSWER: d
POINTS: 1

48. How many resonance forms can be drawn for the NO_3^- ion?
a. 1
b. 2
c. 3
d. 4
e. None, the nitrate ion does not exhibit resonance.

ANSWER: c
POINTS: 1

49. Which of the following would represent the strongest acid?
a. $K_a = 2.5 \times 10^{-5}$
b. $pK_a = 14.5$
c. $pK_a = 4.60$
d. $K_a = 2.5 \times 10^{-1}$

ANSWER: d
POINTS: 1

50. Which of the following substances would be expected to have the largest pK_a?
a. $CH_3-CH_2-NH_2$
b. CH_3-CH_2-OH
c.
d.

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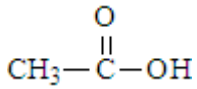
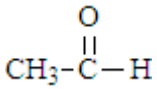
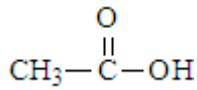
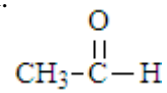




ANSWER: a
POINTS: 1

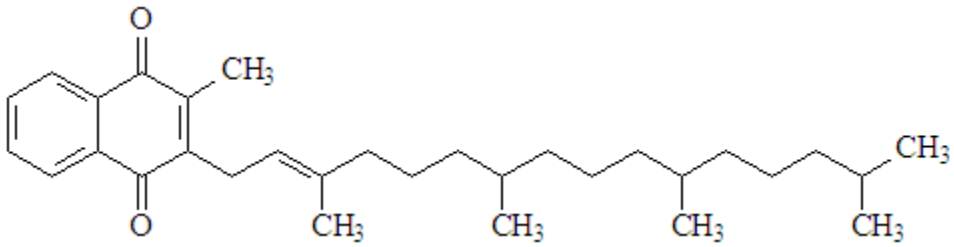
51. Which of the following does **not** characterize the curved arrow formalism?
    a. The arrow shows the movement of electrons not atoms.
    b. The atom at the head of the arrow is the electron pair acceptor.
    c. The atom at the tail of the arrow is a Lewis acid.
    d. The species containing the atom at the head of the arrow will have the smaller pK_a.
    e. All of these correctly describe the curved arrow formalism.

ANSWER: c
POINTS: 1

52. Which of the following substances would exhibit hydrogen bonding
    a. $CH_3-CH_2-NH_2$
    b. CH_3-CH_2-OH
    c. 
    d. 
    e. a, b, and c
    f. All would exhibit hydrogen bonding.

ANSWER: e
POINTS: 1

53. The structure for Vitamin K which is involved in blood clotting is shown below.



This vitamin would be:
    a. classified as hydrophilic.
    b. water-soluble.
    c. fat-soluble.
    d. both hydrophilic and hydrophobic.

ANSWER: c
POINTS: 1

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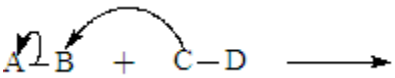
54. The following is generic depiction of a reaction using the curve arrow formalism.



Which of these statements is **not** correct for this reaction?

a. Electrons move from C to B.

b. Electrons move from B to A.

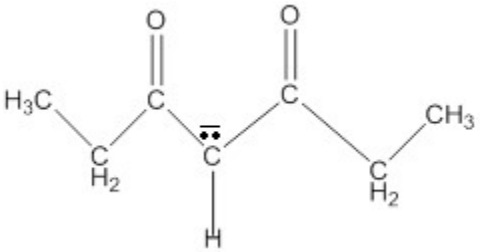
c. In the products, a bond forms between C and B.

d. In the products, A would have a positive charge.

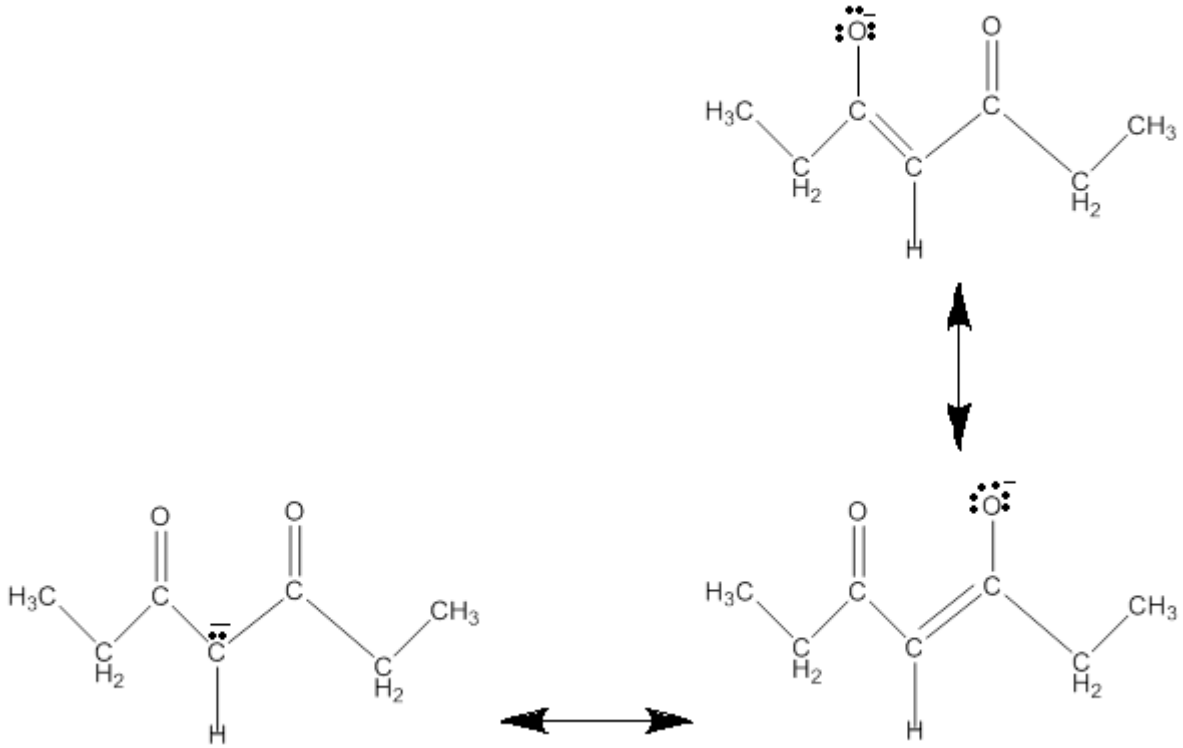
ANSWER: d

POINTS: 1

55. Draw the resonance forms of 3,5-heptanedione anion.



ANSWER:



POINTS: 1

56. Draw the resonance forms of methyl acetate anion formed during the protonation of methyl acetate in the presence of sulfuric acid.

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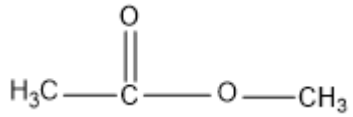
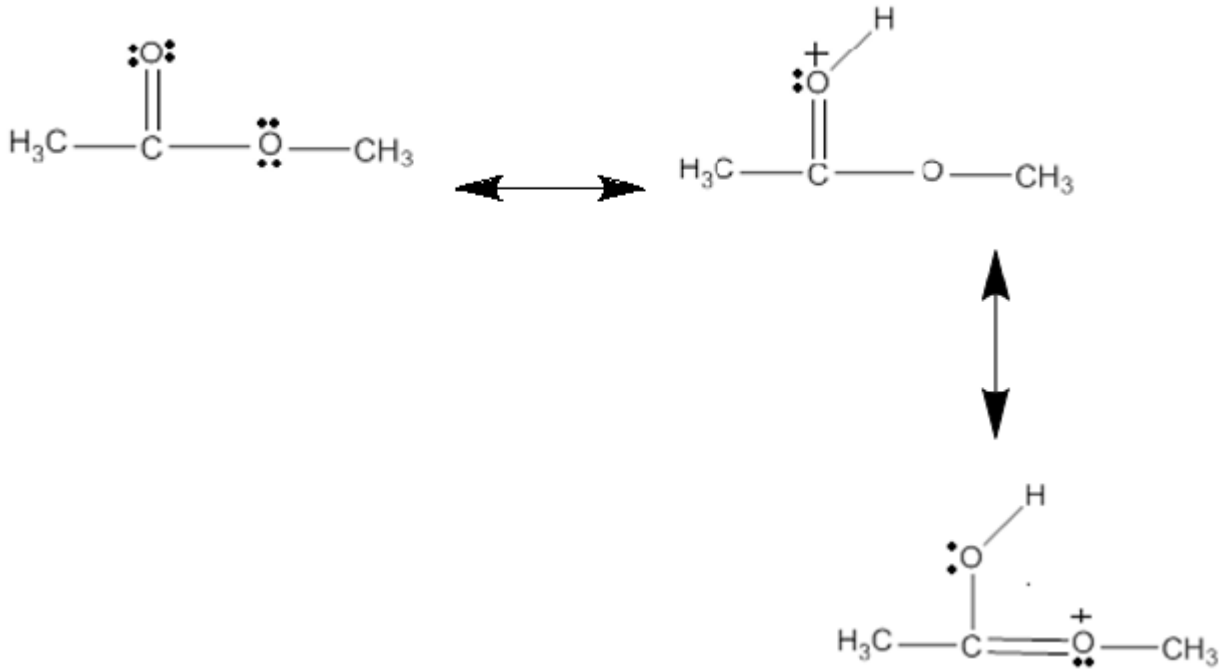


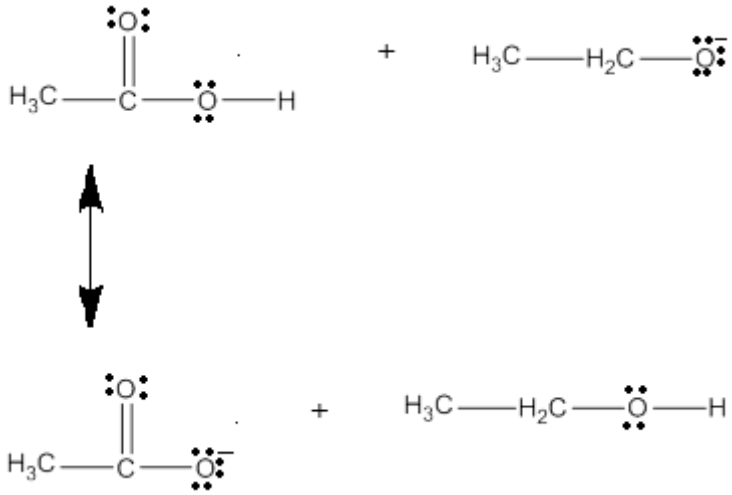
ANSWER:



POINTS: 1

57. What are the products of the following reaction?

ANSWER:



POINTS: 1

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