1 THE BASICS: BONDING AND MOLECULAR STRUCTURE

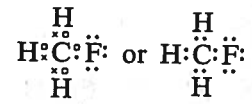
SOLUTIONS TO PROBLEMS

Another Approach to Writing Lewis Structures

When we write Lewis structures using this method, we assemble the molecule or ion from the constituent atoms showing only the valence electrons (i.e., the electrons of the outermost shell). By having the atoms share electrons, we try to give each atom the electronic structure of a noble gas. For example, we give hydrogen atoms two electrons because this gives them the structure of helium. We give carbon, nitrogen, oxygen, and fluorine atoms eight electrons because this gives them the electronic structure of neon. The number of valence electrons of an atom can be obtained from the periodic table because it is equal to the group number of the atom. Carbon, for example, is in Group IVA and has four valence electrons; fluorine, in Group VIIA, has seven; hydrogen, in Group 1A, has one. As an illustration, let us write the Lewis structure for CH_3F. In the example below, we will at first show a hydrogen's electron as x, carbon's electrons as o's, and fluorine's electrons as dots.

Example A

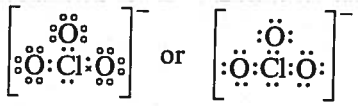
3 $H^{\times}$, $\cdot\overset{\circ}{\underset{\circ}{C}}\cdot$, and $\cdot\ddot{F}:$ are assembled as



If the structure is an ion, we add or subtract electrons to give it the proper charge. As an example, consider the chlorate ion, ClO_3^-.

Example B

$:\ddot{Cl}\cdot$, and $:\ddot{O}:$ and an extra electron × are assembled as



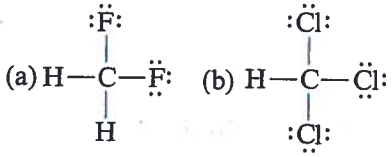
1.1 ^{14}N, 7 protons and 7 neutrons; ^{15}N, 7 protons and 8 neutrons

1.2 (a) one (b) seven (c) four (d) three (e) eight (f) five

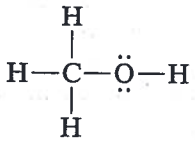
1.3 (a) O (b) N (c) Cl (d) S

1.4 (a) ionic (b) covalent (c) covalent (d) covalent

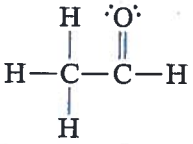
1.5



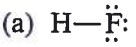
1.6



1.7

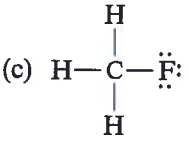


1.8 (a)

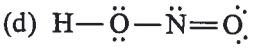


(b)

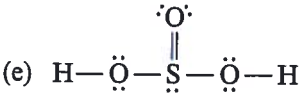
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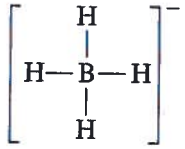
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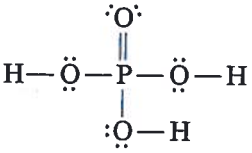
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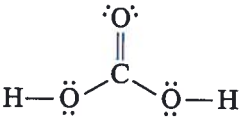
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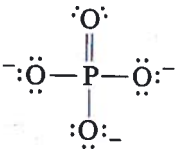
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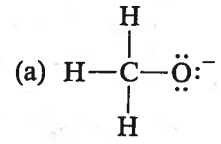


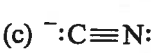
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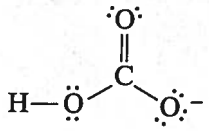


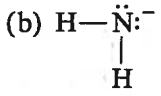
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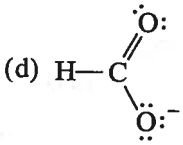


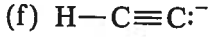
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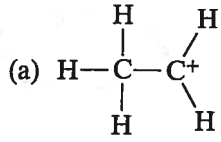
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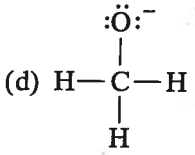
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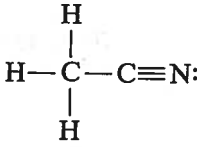
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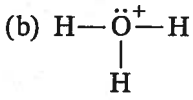
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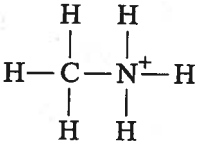
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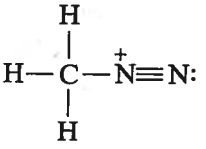
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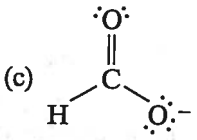
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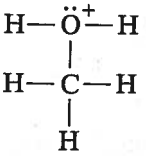
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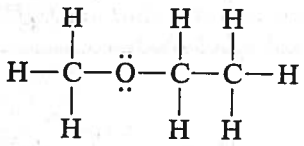
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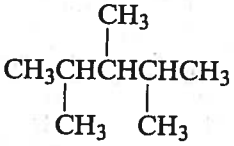
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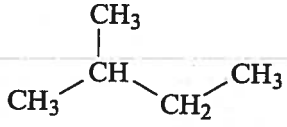
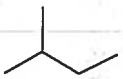
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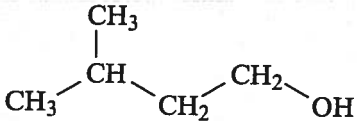
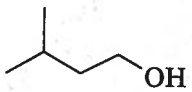
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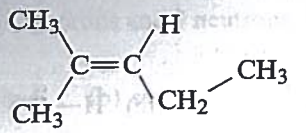
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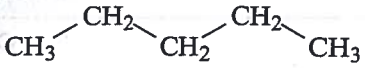
1.12 

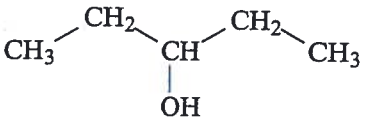
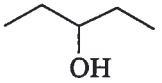
1.13  or $(CH_3)_2CHCH(CH_3)CH(CH_3)_2$

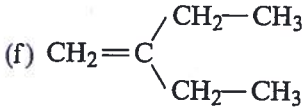
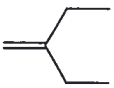
1.14 (a)  = 

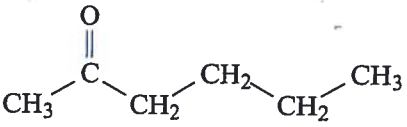
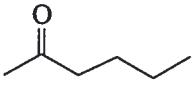
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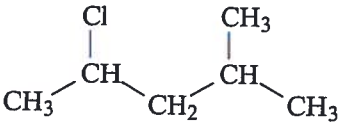
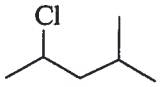
(c)  = 

(d)  = 

(e)  = 

(f)  = 

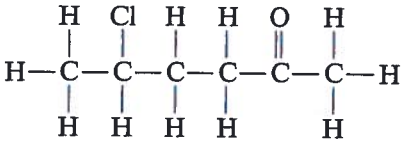
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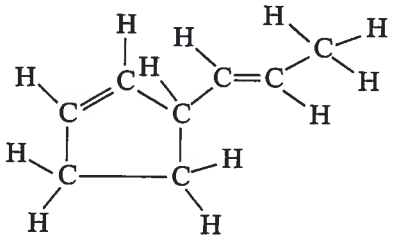
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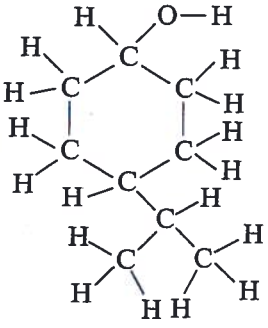
1.15 (a) and (d) are constitutional isomers with the molecular formula C_5H_{12}.

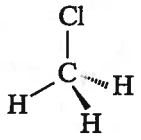
(b) and (e) are constitutional isomers with the molecular formula $C_5H_{12}O$.

(c) and (f) are constitutional isomers with the molecular formula C_6H_{12}.

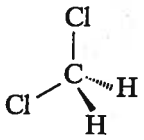
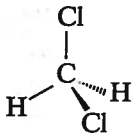
1.16 (a) 

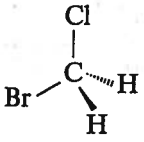
(c) 

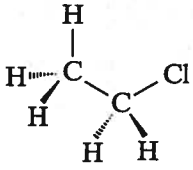
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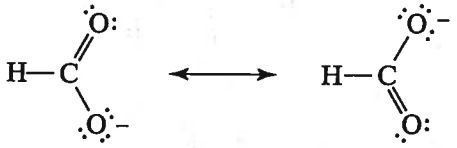
1.17 (a) 

(Note that the **Cl** atom and the three **H** atoms may be written at any of the four positions.)

(b)  or  and so on

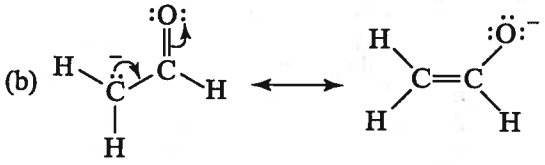
(c)  and others

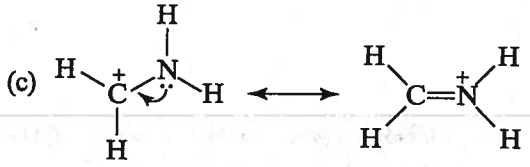
(d)  and others

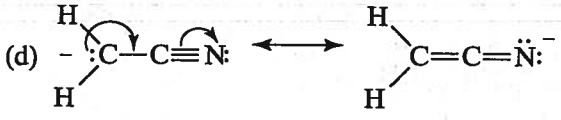
1.18 (a) 

(b) and (c). Since the two resonance structures are equivalent, each should make an equal contribution to the overall hybrid. The C—O bonds should therefore be of equal length (they should be of bond order 1.5), and each oxygen atom should bear a 0.5 negative charge.

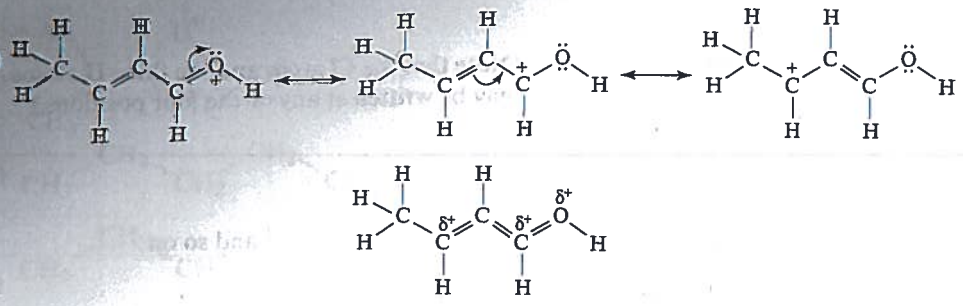
1.19 (a) 

(b) 

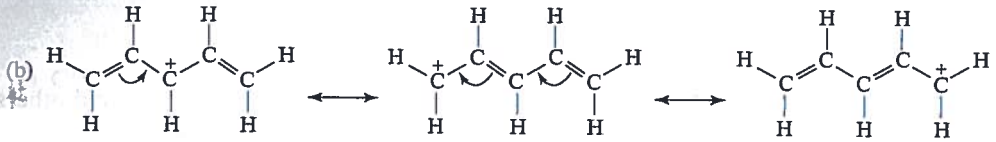
(c) 

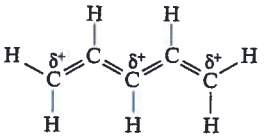
(d) 

1.20 (a)

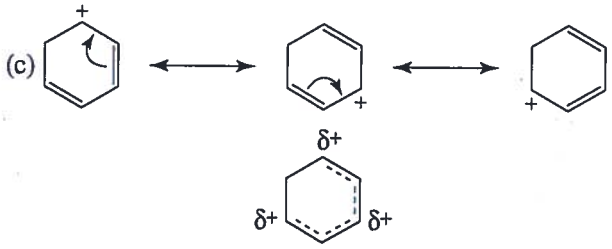


(b)

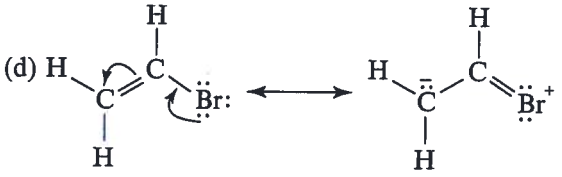


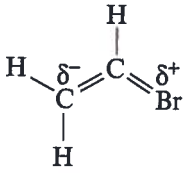


(c)

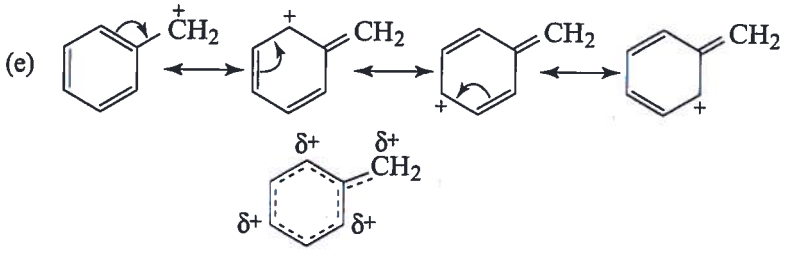


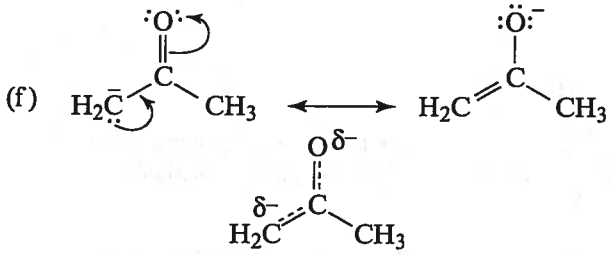
(d)

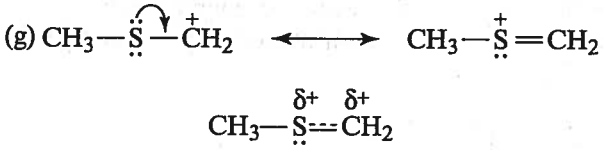


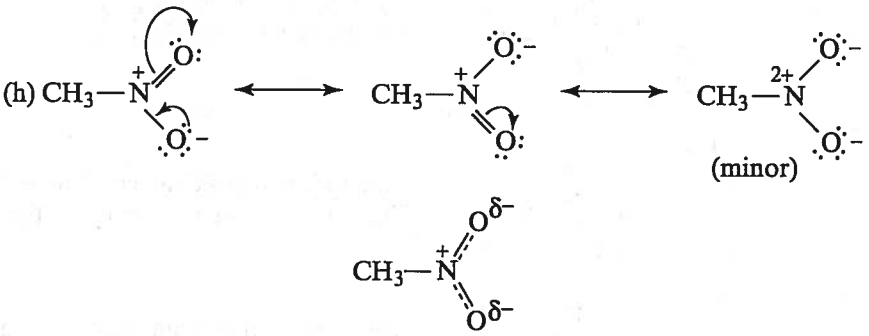


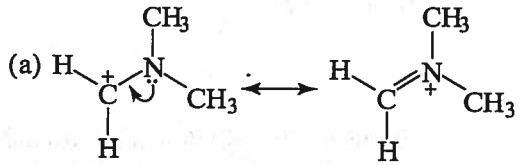
(e)

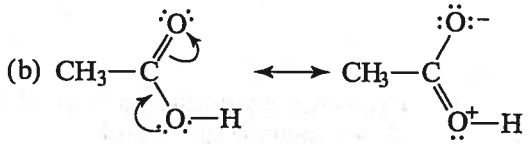
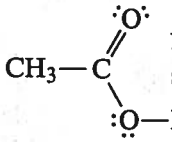


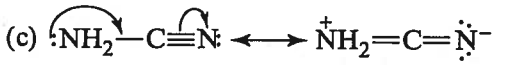
(f) 

(g) 

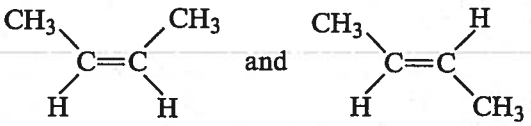
(h) 

1.21 (a)  $CH_2{=}\overset{+}{N}(CH_3)_2$ because all atoms have a complete octet (rule 3), and there are more covalent bonds (rule 1).

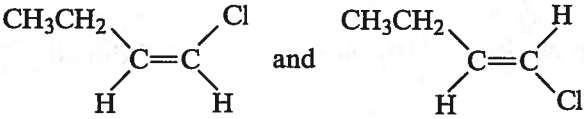
(b)   because it has no charge separation (rule 2).

(c)  $:NH_2{-}C{\equiv}N:$ because it has no charge separation (rule 2).

1.22 (a) Cis-trans isomers are not possible.

(b) 

(c) Cis-trans isomers are not possible.

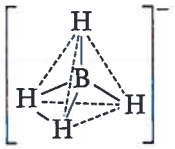
(d) 

1.23 sp^3

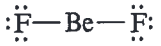
1.24 sp^3

1.25 sp^2

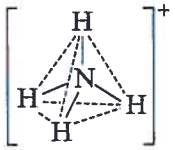
1.26 sp

1.27 (a) 

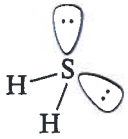
There are four bonding pairs. The geometry is tetrahedral.

(b) 

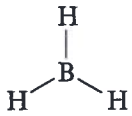
There are two bonding pairs about the central atom. The geometry is linear.

(c) 

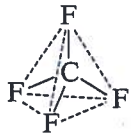
There are four bonding pairs. The geometry is tetrahedral.

(d) 

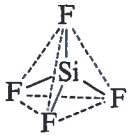
There are two bonding pairs and two nonbonding pairs. The geometry is tetrahedral and the shape is angular.

(e) 

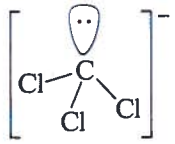
There are three bonding pairs. The geometry is trigonal planar.

(f) 

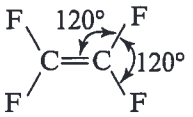
There are four bonding pairs around the central atom. The geometry is tetrahedral.

(g) 

There are four bonding pairs around the central atom. The geometry is tetrahedral.

(h) 

There are three bonding pairs and one nonbonding pair around the central atom. The geometry is tetrahedral and the shape is trigonal pyramidal.

1.28 (a)  trigonal planar at each carbon atom

(b)  linear

(c)  linear

Problems

Electron Configuration

1.29 (a) Na^+ has the electronic configuration, $1s^2 2s^2 2p^6$, of Ne.

(b) Cl^- has the electronic configuration, $1s^2 2s^2 2p^6 3s^2 3p^6$, of Ar.

(c) F^+ and (h) Br^+ do not have the electronic configuration of a noble gas.

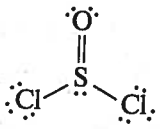
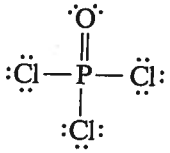
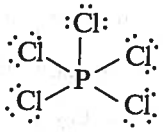
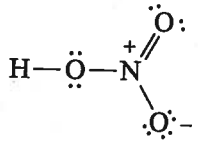
(d) H^- has the electronic configuration, $1s^2$, of He.

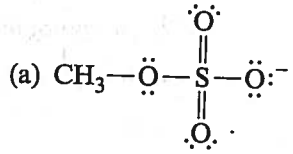
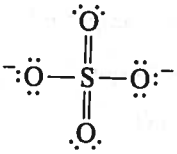
(e) Ca^{2+} has the electronic configuration, $1s^2 2s^2 2p^6 3s^2 3p^6$, of Ar.

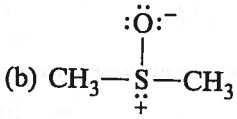
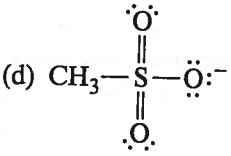
(f) S^{2-} has the electronic configuration, $1s^2 2s^2 2p^6 3s^2 3p^6$, of Ar.

(g) O^{2-} has the electronic configuration, $1s^2 2s^2 2p^6$, of Ne.

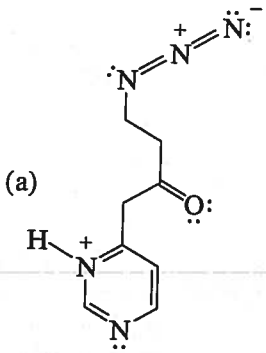
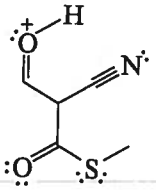
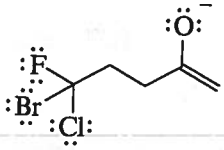
Lewis Structures

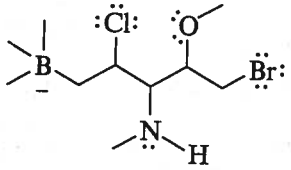
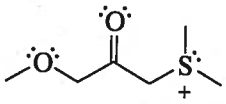
1.30 (a)  (b)  (c)  (d) 

1.31 (a)  (c) 

(b)  (d) 

1.32

(a)  (b)  (c) 

(d)  (e) 

Structural Formulas and Isomerism

1.33 (a) $(CH_3)_2CHCH_2\ddot{O}H$

(b) $(CH_3)_2CH\overset{\cdot\cdot}{\underset{\|}{C}}CH(CH_3)_2$

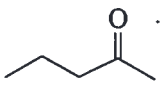
(c) $H_2C(-CH_2)-HC{=}CH$

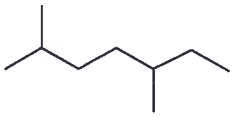
(d) $(CH_3)_2CHCH_2CH_2\ddot{O}H$

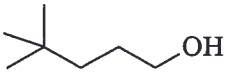
1.34 (a) $C_4H_{10}O$ (c) C_4H_6

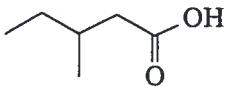
(b) $C_7H_{14}O$ (d) $C_5H_{12}O$

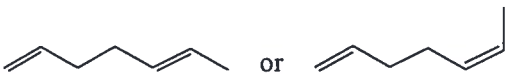
1.35 (a) Different compounds, not isomeric
(b) Same compound
(c) Same compound
(d) Same compound
(e) Same compound
(f) Constitutional isomers
(g) Different compounds, not isomeric
(h) Same compound
(i) Different compounds, not isomeric
(j) Same compound
(k) Constitutional isomers
(l) Different compounds, not isomeric
(m) Same compound
(n) Same compound
(o) Same compound
(p) Constitutional isomers

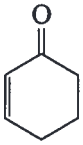
1.36 (a) 

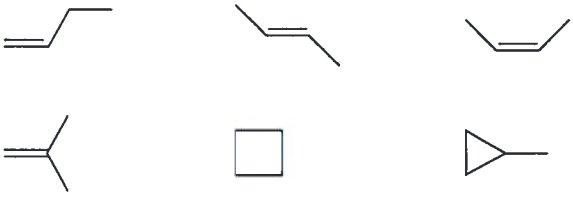
(b) 

(c) 

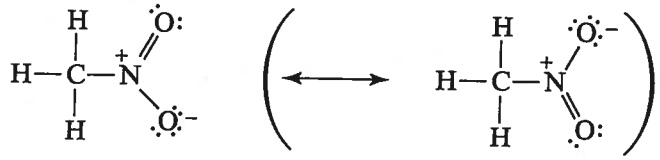
(d) 

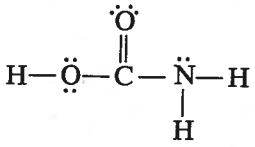
(e) 

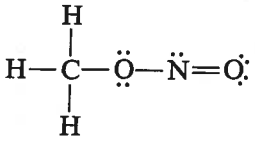
(f) 

1.37 

1.38



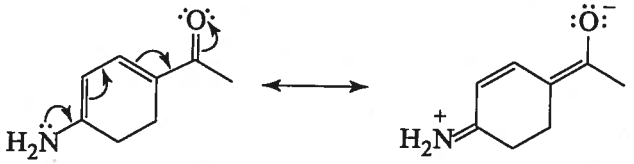




(Other structures are possible.)

Resonance Structures

1.39



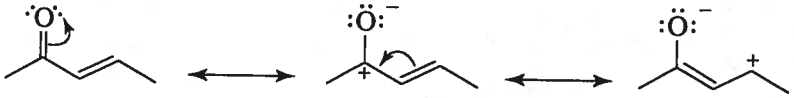
1.40



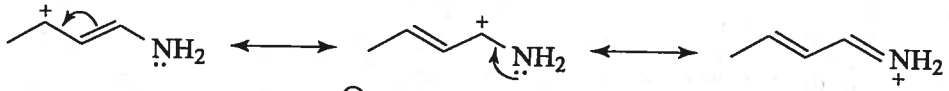
1.41 (a)



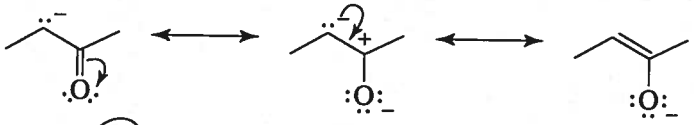
(b)



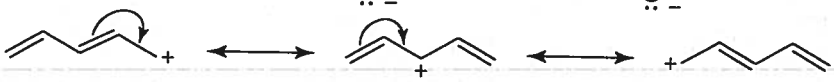
(c)



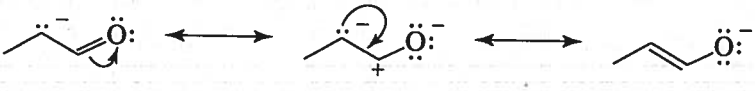
(d)



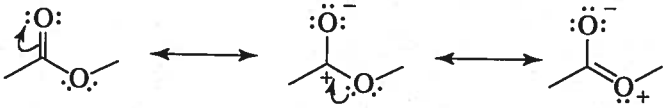
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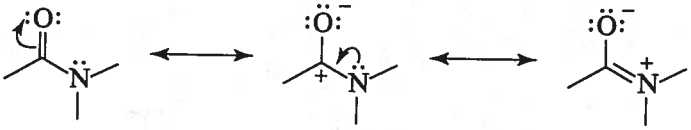
(f)



(g)



(h)



(i)

