Problem-solving Example 13

Write the Lewis structure for (a) $TeBr_4$ (tellurium tetrabromide), (b) ICl_2^- (dichloroiodide ion) (c) $SClF_5$ (d) H_3PO_4 (e) $BFCl_2$

SOLUTION

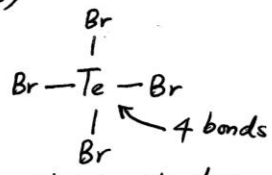
Solution : Problem-solving Example 13

a) $TeBr_4$.

*Valence electrons (total) = [1 × Te (6e⁻)] + [4 × Br (7e⁻)]

= 6e⁻ + 28e⁻ = 34e⁻

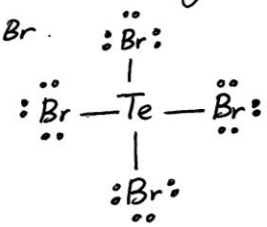
Te
(Group 16)



Skeleton structure

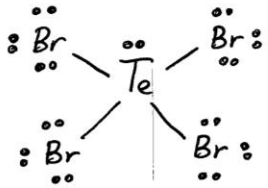
*Remaining e's = 34 − 4(2e⁻) = (34 − 8)e⁻
(4(2e⁻): bonding e's)
= 26 e⁻

* 26e⁻ should be assign to the terminal atom, Br.



* 24e⁻ already assign to 4 Br atoms
Now the remaining e's = (26−24) = 2e's

* The 2e⁻ assign to the central atom, Te.
Now the structure will be:



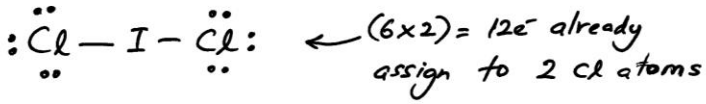
The central-atom Te now has a total of 10e⁻ (5 pairs : 4 shared bonding electrons + 1 lone pair, unshared) around it, acceptable for a Period-5 element.

(b) ICl_2^-

* Total valence electrons $= [1 \times I(7e^-)] + [2 \times Cl(7e^-)] + 1e^-$
$= (7 + 14 + 1)e^- = 22e^-$

Cl — I — Cl : Bonding e's = (2 bonds x $2e^-$) = $4e^-$
skeleton structure Remaining e's = $(22-4)e^-$ = $18e^-$

* 18e's should assign to the terminal atoms, Cl



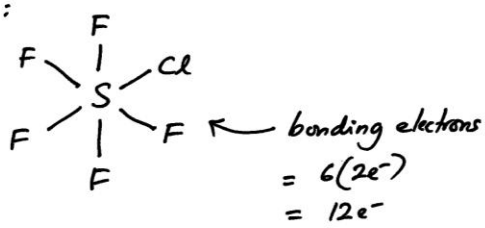
* Remaining e's = (18 − 12)
These remaining 6e's (3 electron pairs) are placed on the central atom, I which can accommodate more than eight electrons because I is from Period-5.

(c) $SClF_5$

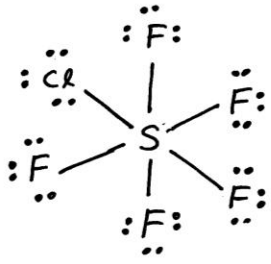
* Total valence electrons $= [1 \times S(6e^-)] + [1 \times Cl(7e^-)] + [5 \times F(7e^-)]$
$= (6 + 7 + 35)e^- = 48e^-$

S (2.8.6)
Cl (2.8.7)
F (2.7)

Skeleton structure:



Remaing e's = $48e^- - 6(2e^-) = (48-12)e^- = 36e^-$
Assign these $36e^-$ to the 6 terminal atoms.



6 atom x $6e^-$
= $36e^-$ (all e's already used up by 6 terminal atoms)

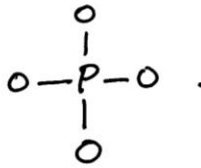
(d) $H_3PO_4 \equiv PO_4^{3-} + 3H^+$ or $PO(OH)_3$

PO_4^{3-}

* Total no. of valence electrons $= [1 \times P(5e^-)] + [4 \times O(6e^-)] + 3e^-$

$= (5 + 24 + 3)e^- = 32e^-$

* Skeleton structure:

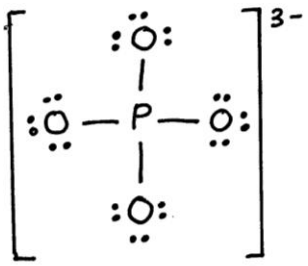


← 4 single bond

∴ Bonding e's $= (4 \times 2e^-) = 8e^-$

* Remaining e's $= (32 - 8) = 24e^-$.

These $24e^-$s assign to the 4 O atoms (terminal atoms)



* Check the Formal Charge of each atom.

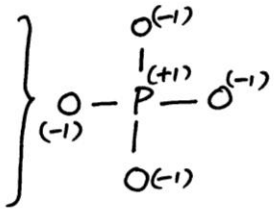
FC of O = 6 − 7 = −1 (6 dots + 1 line)

(all 4 atom are similar)

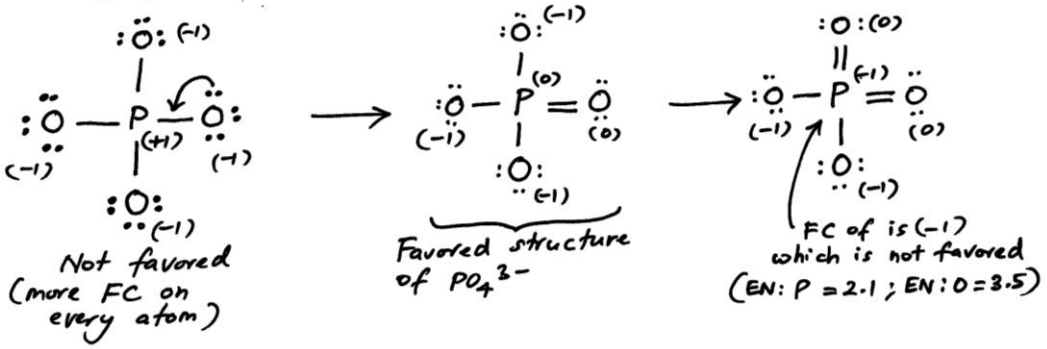
O = 2.6

P = 2.8.5

FC of P = 5 − 4 = +1 (0 dot + 4 lines)



* All atoms have formal charge, therefore this structure is not favored.

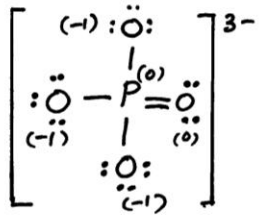


Not favored (more FC on every atom)

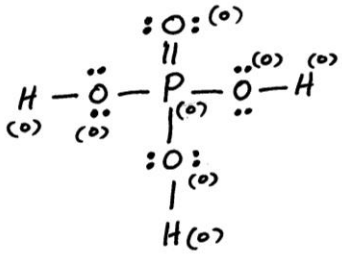
Favored structure of PO_4^{3-}

FC of is (−1) which is not favored (EN: P = 2.1 ; EN: O = 3.5)

The favored Lewis struct of PO_4^{3-}



So the structure for H_3PO_4 will be



← This structure has an expanded valence shell with all formal charges equal to zero.

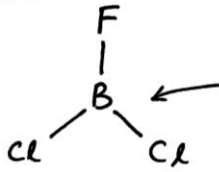
(e) $BFCl_2$

* Total no. of valence e's $= [1 \times B(3e^-)] + [1 \times F(7e^-)] + [2 \times Cl(7e^-)]$

$= 3e^- + 7e^- + 14e^-$

$= 24e^-$

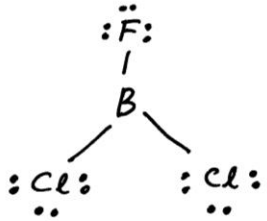
* The skeleton structure:



← 3 bonds (bonding e's $= 3 \times 2e^- = 6e^-$)

* Remaining e's $= 24e^- - 6e^- = 18e^-$

Place the $18e^-$ at the terminal atoms



Fc of B $= 3 - 3 = 0$

Fc of F $= 7 - 7 = 0$

Fc of Cl $= 7 - 7 = 0$

∴ It is the favored structure.

B has 6 e's surrounding it. So $BFCl_2$ is an electron-deficient molecule.

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