

Classify the following bonds as ionic, polar covalent, or covalent.

A) the CC bond in H_3CCH_3 •

$\Delta\text{EN} = 0$ **non-polar covalent bond**

B) the K-Cl bond in KCl •

$\Delta\text{EN} = 3 - 0.8 = 2.2$ **Ionic bond**

C) the NB bond in H_3NBCl_3 •

$\Delta\text{EN} = 3 - 2 = 1$ **polar covalent bond**

D) the CF bond in CF_4

$\Delta\text{EN} = 4 - 2.5 = 1.5$ **polar covalent bond**

Q- What is the type of the chemical bond in O-H?

$$\text{O-H} = 3.5 - 2.1 = 1.4$$

∴ Polar covalent bond

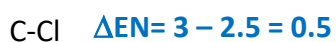
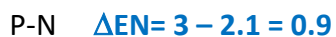
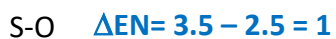
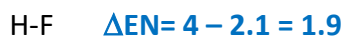
Q- What is the type of the chemical bond in MgO? (EN: Mg=1.2 ,O=3.5)

$$\text{Mg-O} = 3.5 - 1.2 = 2.3 > 2$$

∴ Ionic bond

(note: the bond between metal and non metal is ionic bond)

Based on relative electronegativities, which of these is the MOST polar bond?



Most polar bond is H-F

1A																				8A
H	2A																			
Li	Be																			
Na	Mg	3B	4B	5B	6B	7B	8B				1B	2B	3A	4A	5A	6A	7A			
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr			
0.9	1.0	1.2	1.3	1.5	1.6	1.6	1.5	1.8	1.9	1.9	1.9	1.6	1.5	1.8	2.1	2.5	3.0			
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe			
0.8	1.0	1.2	1.4	1.6	1.8	1.9	2.2	2.2	2.2	2.2	1.7	1.7	1.8	1.9	2.1	2.5	2.6			
Cs	Ba	La-Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At				
0.7	0.9	1.0-1.2	1.3	1.5	1.7	1.9	2.2	2.2	2.2	2.4	1.9	1.8	1.9	1.9	2.0	2.2				
Fr	Ra																			
0.7	0.9																			

Which of the following molecules contains a nonpolar covalent bond?

- A. H₂O
- B. HF
- C. F₂
- D. NH₃

Which of the following molecules contains a polar covalent bond?

- A. H₂
- B. PH₃
- C. F₂
- D. NH₃

When an atom of H and an atom of F bond together:

- The H will be partially positive, because it has higher electronegativity than F.
- The H will be partially negative, because it has higher electronegativity than F.
- The F will be partially positive, because it has higher electronegativity than H.
- The F will be partially negative, because it has higher electronegativity than H.**

Q- What is the type of the chemical bond in Na_2Ca ?

Both elements are metal

\therefore not allowed to bond

Lewis Dot Symbols

Valence electrons of an atom are represented by dots.

Remember: In the representation elements (s + p elements) number of Valence electrons equal to the group number

1	2											13	14	15	16	17	18
1A	2A	3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A	8A
·H·	·Be·										·B·	·C·	·N·	·O·	·F·	·Ne·	
·Li·	·Mg·										·Al·	·Si·	·P·	·S·	·Cl·	·Ar·	
·Na·	·Ca·										·Ga·	·Ge·	·As·	·Se·	·Br·	·Kr·	
·K·	·Sr·										·In·	·Sn·	·Sb·	·Te·	·I·	·Xe·	
·Rb·	·Ba·										·Tl·	·Pb·	·Bi·	·Po·	·At·	·Rn·	
·Cs·	·Ra·																
·Fr·																	

Draw Electron Dot Diagrams for the following species?

OR Draw Lewis Dot symbol for the following species?

- S

S in group 6A. It has 6 valence electrons



- Br⁻

Br in group 7A. It has 7 valence electrons

Br gains one electron to become a negatively charged bromine ion



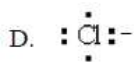
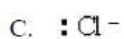
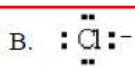
- K⁺

K in group 1A. It has 1 valence electrons

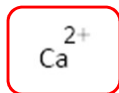
K loses this valence electron to become a positively charged potassium ion



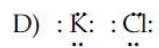
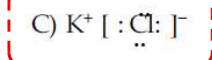
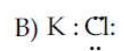
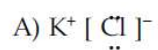
The Lewis dot symbol for the chloride ion is



Which of the following is the correct Lewis dot symbol for the Calcium ion?



Which Lewis structure below correctly represents KCl?



Writing Lewis structure

1- Write the Lewis structure : follow the steps

2- Calculate the formal charge: please remember formal charge should be calculated for each atom

$$\text{formal charge on an atom in a Lewis structure} = \text{total number of valence electrons in the free atom} - \left[\frac{1}{2} (\text{total number of bonding electrons}) + \text{total number of nonbonding electrons} \right]$$

3- Exceptions to the Octet Rule:

1. **Incomplete octet: Be, B, & Al**

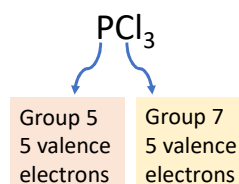
2. **Odd-electrons: NO, NO₂** (or when the valence electrons is odd number)

3. **Expanded octet: elements of 3rd, 4th, & so on, may form expanded octet**

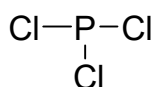
Draw Lewis Structures for the following molecules.

PCl₃

1- Valence electron (**A**) = $5 + (3 \times 7) = 26$ valence e⁻

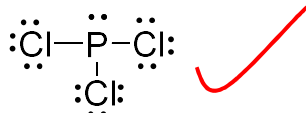


2- draw the skeleton



3- Count remaining electrons = $26 - 6 = 20$ e⁻

4- Use remaining electrons to complete an octets for atoms except H



5- **Check:**

A (valence e⁻) = 26 e

B (Octet e⁻) = $8 + (3 \times 8) = 32$ e

C (bonding e⁻) = **B** - **A** = $32 - 26 = 6$ e → number of bonds $6/2 = 3$ bonds

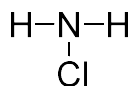
D (nonbonding e⁻) = **A** - **C** = $26 - 6 = 20$ e → number of lone pair $D/2 = 20/2 = 10$ lone pairs

Draw Lewis Structures for the following molecules.

NH₂Cl

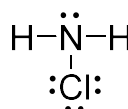
1- Valence electron (**A**) = $5 + (2 \times 1) + 7 = 14$ valence e⁻

2- draw the skeleton



3- Count remaining electrons = $14 - 6 = 8$ e⁻

4- Use remaining electrons to complete an octets for atoms except H



5- Check:

A (valence e⁻) = 14 e

B (Octet e⁻) = $8 + 8 + (2 \times 2) = 20$ e

C (bonding e⁻) = **B** - **A** = $20 - 14 = 6$ e → number of bonds $6/2 = 3$ bonds

D (nonbonding e⁻) = **A** - **C** = $14 - 6 = 8$ e → number of lone pair $D/2 = 8/2 = 4$ lone pairs

The number of bonds and lone electron pairs in the CNS⁻ molecule is

A (valence e⁻) = $4 + 5 + 6 = 15 + 1 = 16$ e

B (Octet e⁻) = $3 \times 8 = 24$ e

C (bonding e⁻) = **B** - **A** = $24 - 16 = 8$ e → number of bonds $8/2 = 4$ bonds

D (nonbonding e⁻) = **A** - **C** = $16 - 8 = 8$ e → number of lone pair $D/2 = 8/2 = 4$ lone pairs

Number of bonds = 4 bonds

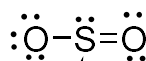
Number of lone electron pairs = 4 lone pairs

The formal charge on the sulfur atom in the resonance structure of sulfur dioxide which has one single bond and one double bond is

- A. -2
- B. -1
- C. 0
- D. +1



1- Valence electron (A) = $(3 \times 6) = 18$ valence e⁻

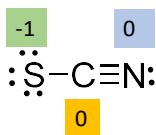
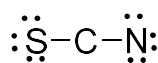


$$\text{Formal charge} = 6 - 2 - (\frac{1}{2} \times 6) = +1$$

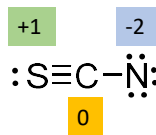
What is the formal charge on sulfur in the most favourable Lewis structure for the SCN⁻ (thiocyanate) ion based on minimizing formal charge

- A. -2
- B. -1
- C. 0
- D. +1

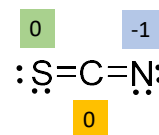
Valence electron (A) = $6 + 4 + 5 = 15 + 1 = 16$ valence e⁻



(a)



(b)



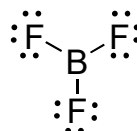
(c)

By calculating the formal charges (c) is the most favourable structure

The correct Lewis structure for BF_3 would have exactly:

- A. 1 double bond
- B. 2 double bonds
- C. no double bonds
- D. 1 triple bond

Valence electron (**A**) = $3 + (3 \times 7) = 24$ valence e⁻

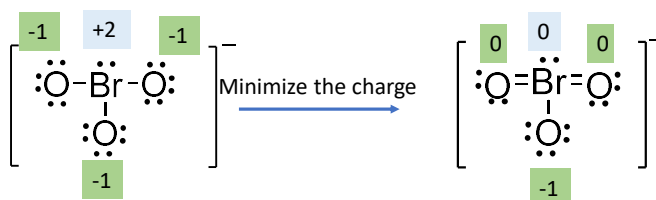


Exception!!!!
Incomplete octet

How many covalent bonds will be drawn to bromine in BrO_3^- for the dot structure that expands the octet to minimize formal charge:

- A. 3
- B. 4
- C. 5
- D. 6

Valence electron (**A**) = $7 + (3 \times 6) = 25 + 1 = 26$ valence e⁻



The Lewis structure reveals a triple bond in which of the following molecules?

- A. Br_2
- B. O_2
- C. N_2
- D. H_2

The Lewis structure reveals an unpaired electron (free radical) in which of the following species?

- A. NO_3^-
- B. N_2O
- C. NO_2
- D. NO_2^-

When two atoms of nitrogen bond, how many pairs of electrons will be shared between them?

- A. 1
- B. 2
- C. 3
- D. 4

When two atoms of fluorine bond, how many electrons will be shared between them?

- A. 1
- B. 2
- C. 3
- D. 4

Group	1A	2A	3A	4A	5A	6A	7A	8A
Lewis Dot	x•	•x•	•x•	•x•	•x•	•x•	•x•	•x•
Bonding electrons	1	2	3	4	3	2	1	0
nonbonding electrons (pair of nonbonding electrons)	0	0	0	0	2e 1pair	4e 2pairs	6e 3pairs	8e 4pairs

The number of lone electron pairs in the NH_4^+ ion is ____.

- A. 0
B. 1
C. 2
D. 3

A (valence e-) = $4 + 5 - 1 = 8$ e

B (Octet e-) = $8 \times (4 \times 2) = 16$ e

C (bonding e-) = **B** - **A** = $16 - 8 = 8$ e → number of bonds $8/2 = 4$ bonds

D (nonbonding e-) = **A** - **C** = $8 - 8 = 0$ e → number of lone pair $D/2 =$ zero lone pairs

The number of lone electron pairs in the ClO_4^- ion is ____.

A. 3

B. 4

C. 6

D. 12

A (valence e-) = $7 + (6 \times 4) = 31 + 1 = 32 \text{ e}$

B (Octet e-) = $8 \times (4 \times 8) = 40 \text{ e}$

C (bonding e-) = $\text{B} - \text{A} = 40 - 32 = 8 \text{ e} \rightarrow$ number of bonds $8/2 = 4$ bonds

D (nonbonding e-) = $\text{A} - \text{C} = 32 - 8 = 24 \text{ e} \rightarrow$ number of lone pair $24/2 = 12$ lone pairs

• How many resonance structure that satisfy the octet rule does SO_2 Have?

2 resonance structure

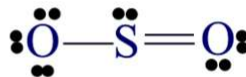
Because:



Then to complete octet for S atom:



or



Which of the following stable molecules is an exception for the octet rule of Lewis structure?

- AlCl_3
- NO
- BeF_2
- PCl_5
- SO_2
- SF_4

To find the answer:

First: Look firstly if there is Be, Al or B (incomplete octet)

If it is not

Second: Calculate the valance electron for each compound and see if there is odd number (Odd electron)

if it's not

Third: See if the central atom in the 3rd period and beyond, check by draw the molecule

AlCl_3 (incomplete octet rule Be-Al-B)

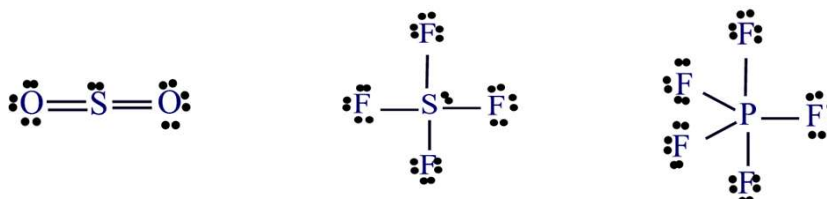
NO (odd electrons $5+7=11$)

BeF_2 (incomplete octet rule Be-Al-B)

PCl_5 (Expanded the Octet rule Period 3 and beyond)

SO_2 (Expanded the Octet rule Period 3 and beyond)

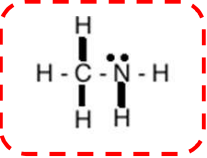
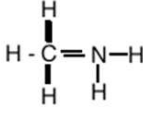
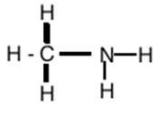
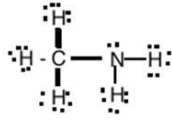
SF_4 (Expanded the Octet rule Period 3 and beyond)



A valid Lewis structure of _____ cannot be drawn without violating the octet rule.

- A) NH_3
- B) IF_3
- C) PF_3
- D) SbCl_3
- E) NO_3^{1-}

Which of the following would be the correct Lewis structure for methyl amine (CH_3NH_2)?

- A) 
- B) 
- C) 
- D) 

Which of these neutral atoms has an INCORRECT Lewis symbol?

- A $\cdot\ddot{\text{S}}\cdot$ B $\cdot\ddot{\text{Sb}}\cdot$ C $:\ddot{\text{Se}}:$ D $:\ddot{\text{Si}}$ E $:\ddot{\text{Sn}}\cdot$