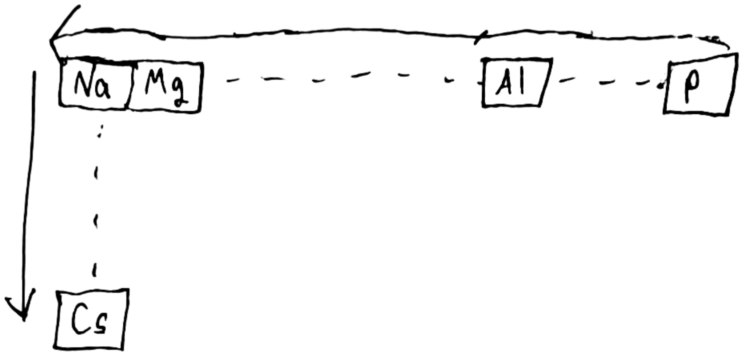
1. 1
2. 3
3. 2
4. 3
5. 1
6. 5
7. 3
8. 1
9. 3
10. 3
11. 5
12. 3
13. 5
14. 2
15. 4
16. 3

1. Periodic Table:



Electronegativity: increases up and to the right
decreases downwards to the left

Decreasing electronegativity: P > Al > Mg > Na > Cs

2. Ionization energies:

IE_1	IE_2	IE_3	IE_4	IE_5	IE_6	IE_7	IE_8
1000	2000	3000	5000	6000	22000	25000	29000

+1000 +2000 +2000 +1000 +16000 +3000 +4000

5 valence e^-

This is the greatest jump, so it is the cutoff between energy levels

Element in Period 3 with 5 valence e^-: Phosphorous

3. Acidity vs. Basicity of Oxides: Up and to the right: acidic
Down and to the left: basic

N is above P so it should be more acidic ✗
Cl is to right of P so it should be more acidic ✓ → **Cl_2O_7 is more acidic than P_4O_{10}**
Al is to right of Mg so it should be more acidic ✗
Bi is below As so it should be more basic ✗
Be is above Ca so it should be more acidic ✗

4.

all paired = diamagnetic

~~(1) Zn = [Ar] 4s~~

(1) Zn = [Ar] $4s^2 3d^{10}$ = 4s [↑↓] 3d [↑↓|↑↓|↑↓|↑↓|↑↓]

Zn^{2+}: Zn = [Ar] $4s^2 3d^{10}$
↓
Zn^{2+} = [Ar] $3d^{10}$ = 4s [ ] [↑↓|↑↓|↑↓|↑↓|↑↓]

all paired = diamagnetic

(1) is true

(2) Br = [Ar] $4s^2 3d^{10} 4p^5$ =
4s [↑↓]
3d [↑↓|↑↓|↑↓|↑↓|↑↓]
4p [↑↓|↑↓|↑]

2 filled p-orbitals

(2) is true

(3) Valence = how many bonding (valence) electrons/how many bonds can it make

[Ne] $3s^2 3p^3$ = Phosphorous: can make 3 bonds like Nitrogen to get full octet: valence = 3
because it is in period 3 and beyond, it can also expand its octet and form 5 bonds: valence = 5

[Ne] $3s^2 3p^3$ can have a valence of <u>3 or 5</u>

(3) is false

(4) C = [He] $2s^2 2p^2$ = 2s [↑↓] 2p [↑|↑|]

2 unpaired electrons

(4) is true

(5) Ti^{2+}: Ti = [Ar] $4s^2 3d^2$
↓
Ti^{2+} = [Ar] $3d^2$ = 4s [ ] 3d [↑|↑| | |]

at least one unpaired e^- = paramagnetic

(5) is true

5. Primary Factor for Lattice Energy: Product of Ion charges (more charge = greater LE)
Secondary factor: size of ions (smaller ions = greater LE)

First, compare product of charges:

Li_2O	$MgCl_2$	Na_2S	$NaCl$	LiF
$1 \times 2 = 2$	$2 \times 1 = 2$	$1 \times 2 = 2$	$1 \times 1 = 1$	$1 \times 1 = 1$

Li_2O, $MgCl_2$, and Na_2S all
have product of 2

Now, we compare one by one for size: (trend for atomic size)

<u>$MgCl_2$ vs. Na_2S:</u>
$Mg < Na$ and $Cl < S$, so $MgCl_2$ must be smaller than Na_2S; so, $MgCl_2$ has a greater lattice energy than Na_2S

~~$MgCl_2$ vs. Na_2S:~~

<u>$MgCl_2$ vs. Li_2O:</u>
$Li < Mg$ (there is a bigger jump in size going up and down vs. going left and right)
$O < Cl$

So, Li_2O is smaller than both $MgCl_2$ and Na_2S

So, Li_2O has the greatest lattice energy

6. Two factors for bond strength/bond length:

1. Size of atoms: smaller atoms = stronger bond = shorter bond length
   (use trend for periodic table)

2. Bond order: higher bond order = stronger bond = shorter bond length
   (single vs. double vs. triple)

I: H-F vs H-Cl vs H-Br:

all are single bonds (bond order=1), so we will look at size of atoms: all 3 have Hydrogen in common, so we will compare the other one

F vs. Cl vs. Br: ~~F is smallest, so H-F is sm~~

Atom size: F < Cl < Br

Bond strength: H-F > H-Cl > H-Br

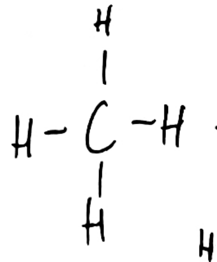
II: C-O vs. C=O vs. C≡O:

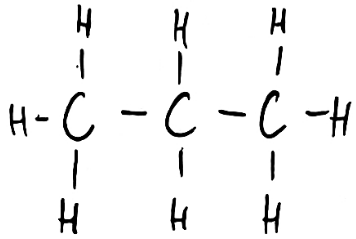
All three have same atoms but different bonds, so we will look at bond order

C-O: single bond → bond order = 1
C=O: double bond → bond order = 2
C≡O: triple bond → bond order = 3

Bond order: C≡O > C=O > C-O

Bond strength: C≡O > C=O > C-O

7. CH_4 →  → $4 \times (C\text{-}H) = 1656\,kJ$ → $C\text{-}H = 414\,kJ$

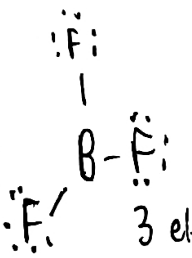
$CH_3CH_2CH_3$ →  → $8 \times (C\text{-}H) + 2(C\text{-}C) = 4006\,kJ$

$8 \times (414\,kJ) + 2(C\text{-}C) = 4006\,kJ$

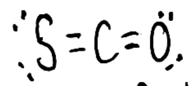
$3312\,kJ + 2(C\text{-}C) = 4006\,kJ$

$2(C\text{-}C) = 694$

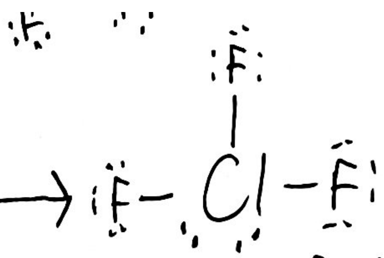
$C\text{-}C = 347\,kJ$

8. BF_3 → 

3 electron groups, no lone pairs = AX_3 = trigonal planar

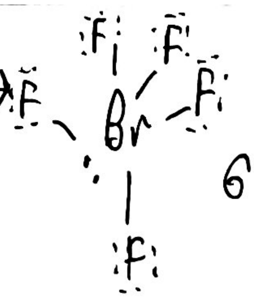
SCO → 

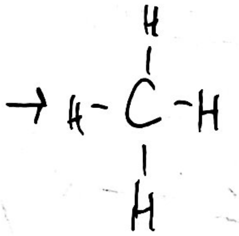
2 electron groups, no lone pairs = AX_2 = linear

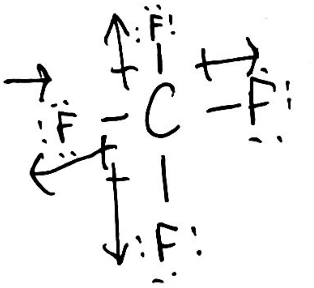
ClF_3 ⟶ 

5 electron groups, 2 lone pairs

$= AX_3E_2 =$ **T-shape**

BrF_5 →  6 electron groups, one lone pair = AX_5E = square pyramidal

9. CH_4 →  = tetrahedral geometry

CF_4 →  = tetrahedral geometry

(1) Both have 4 electron groups → both are sp^3 ✓

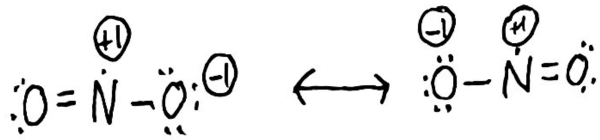
(2) Both molecules are completely symmetric → all dipoles cancel out
↓
both are non-polar ✓

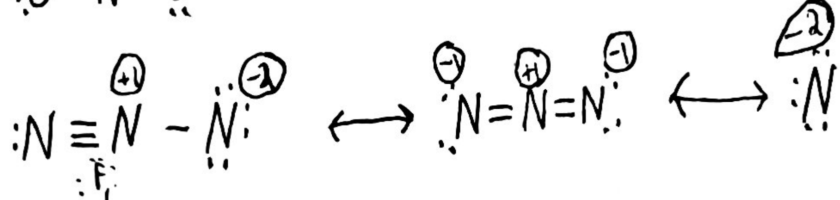
(3) Both are tetrahedral with no lone pairs → both have bond angles of 109.5° ✗

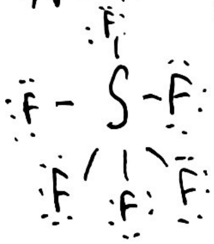
(4) C-F: $\Delta EN = 4 - 2.5 = 1.5$ $1.5 > .4$ ✓
C-H: $\Delta EN = 2.5 - 2.1 = .4$

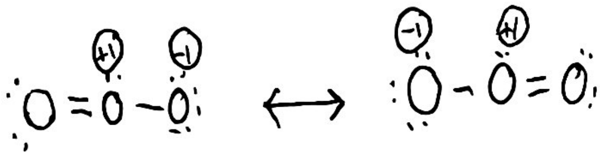
(5) C-F: $2.5 < 4$ → dipole towards F ✓
C-H: $2.5 > 2.1$ → dipole towards C

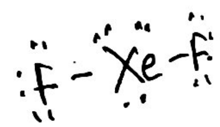
10.

NO_2 →  resonance ✓

N_3^- →  resonance ✓

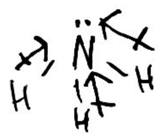
SF_6 →  No formal charge = no resonance

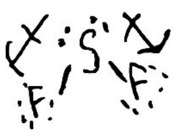
O_3 →  resonance ✓

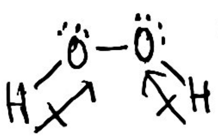
XeF_2 →  no formal charge = no resonance

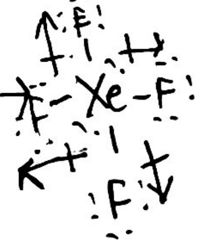
11.

(1) H_2O →  O-H bond is polar
Molecular geometry is bent → dipoles don't cancel → H_2O is polar

(2) NH_3 →  N-H bond is polar
molecular geometry is trigonal pyramidal → dipoles don't cancel → NH_3 is polar

(3) SF_2 →  S-F bond is polar
molecular geometry is bent → dipoles don't cancel → SF_2 is polar

(4) H_2O_2 →  O-H bond is polar
geometry is bent at each oxygen → dipoles don't cancel → H_2O_2 is polar

(5) XeF_4 →  Xe-F bond is polar
molecular geometry is square planar (symmetric) → dipoles cancel

The lone pairs on Xe are opposite each other so they also cancel

XeF_4 is nonpolar with polar bonds

12.

(1) This is true ✓

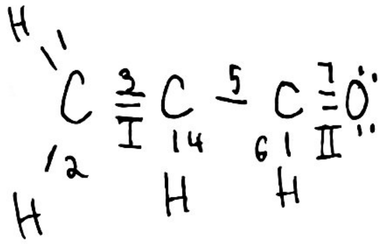
(2) 4 single bonds + 0 lone pairs = 4 regions of electron density = 4 hybridized orbitals $= sp^3$ ✓

(3) More than 8 electrons = more than 4 sharing (hybridized) orbitals $= sp^3d$ or greater ✓

(4) Incomplete octet = less than 8 electrons = less than 4 orbitals = sp^2 or smaller ✗

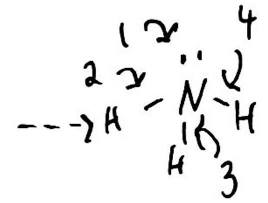
(5) Trigonal planar $= AX_3 =$ 3 regions of e^- density = 3 hybridized orbitals $= sp^2$

13.

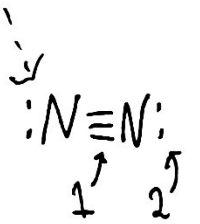


7σ
2π

14. $N_2 + H_2 \rightarrow NH_3$



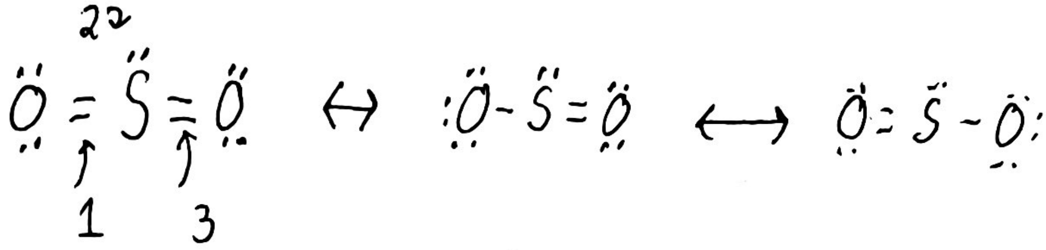
4 regions of e^- density $= sp^3$



2 regions of e^- density $= sp$

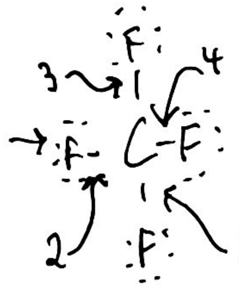
15.

(1) SO_2 →



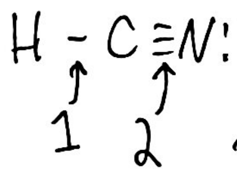
3 e^- regions = sp^2 ✓

(2) CF_4 →



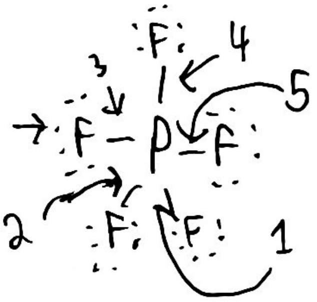
4e^- regions = sp^3 ✓

(3) HCN →



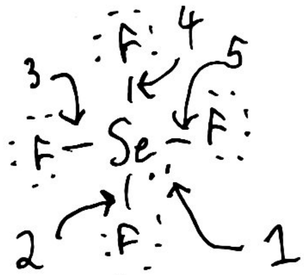
2 e^- regions = sp ✓

(4) PF_5 →



5e^- regions = sp^3d x

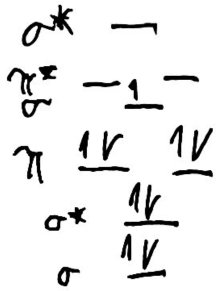
(5) SeF_4 →



5e^- regions = sp^3d ✓

16.

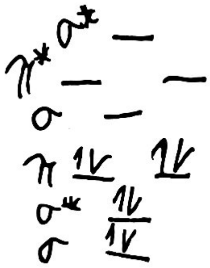
C_2^- ; # e^- = 4+4+1 = 9



Bond order = $\frac{(2+4+1)-(2)}{2}$

= 2.5

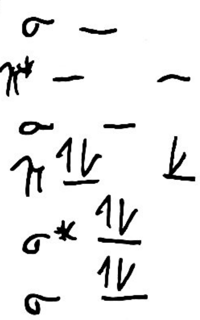
C_2 ; # e^- = 4+4 = 8



Bond order = $\frac{(2+4)-(2)}{2}$

= 2

C_2^+ ; # e^- = 4+4-1 = 7



Bond Order: $\frac{(2+3)-(2)}{2}$

= 1.5

Bond order: $C_2^+ < C_2 < C_2^-$

Bond Strength: $C_2^+ < C_2 < C_2^-$