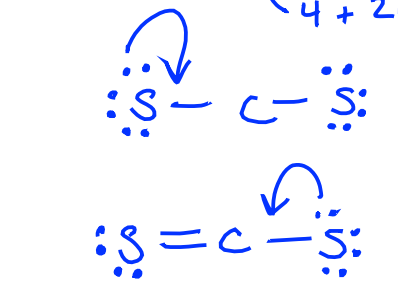
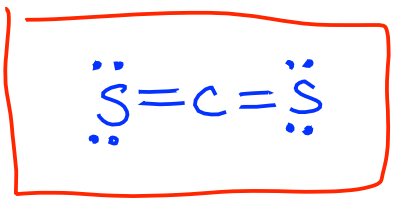
Chem E-1a
Friday Review Problems
Chapter 9: Chemical Bonding I

1. Draw Lewis Structures for the following molecules/ions. Include non-zero formal charges and show resonance if appropriate.

a) CS_2

$4 + 2(6) = 16e^-$





F.C.

LEFT S:

$6-4-2=0$

e^- IN NEUTRAL ATOM — DOTS — LINES

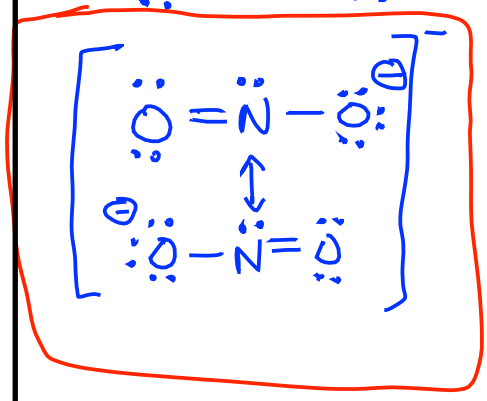
C:

$4-0-4=0$

R.S. $= 6-4-2=0$

b) NO_2^-

$5 + 2(6) + 1 = 18e^-$



F.C.:

LEFT O

$6-4-2=0$

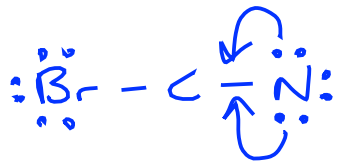
$N = 5-2-3=0$

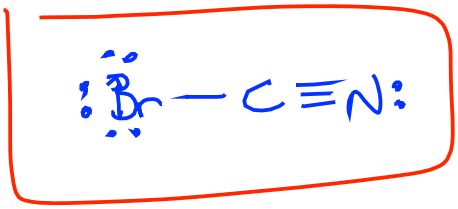
RIGHT O

$6-6-1=-1$

c) BrCN

$7 + 4 + 5 = 16e^-$



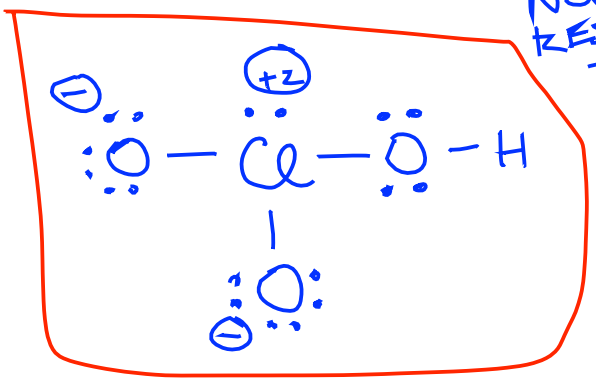


d) $HClO_3$

(Hint: This is an oxyacid!)

$1 + 7 + 3(6) = 26e^-$

NO RESONANCE



F.C.: L.O. $= 6-6-1 = -1$

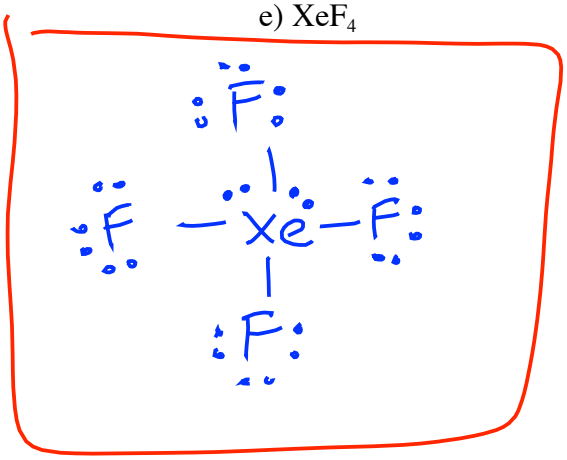
Cl $= 7-2-3 = +2$

BOTTOM O: $6-6-1=-1$

R.O. $= 6-4-2 = 0$

8 + 4(7) = 36 e⁻

e) XeF_4

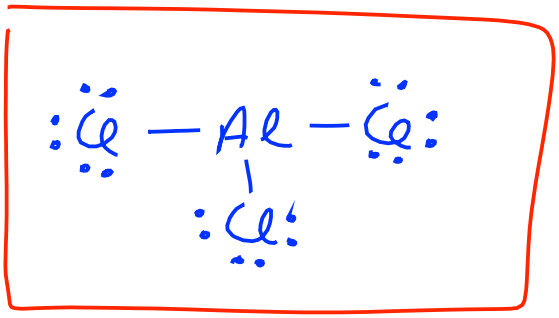


FC: F = 7 − 6 − 1 = 0

Xe = 8 − 4 − 4 = 0

3 + 3(7) = 24 e⁻

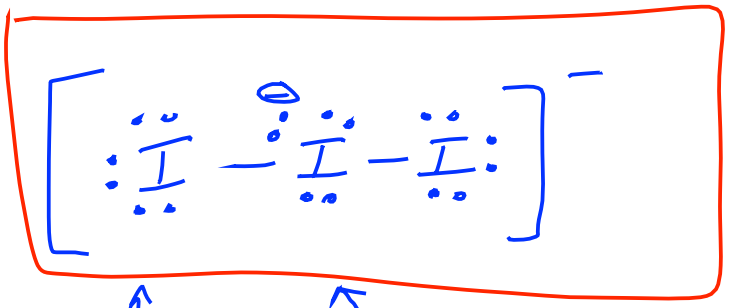
f) $AlCl_3$



Al ONLY "WANTS" 6 e⁻, NOT A FULL OCTET!

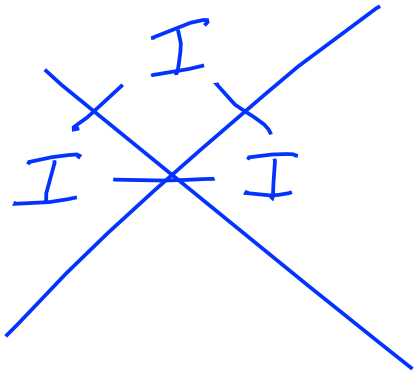
g) I_3^-

3(7) + 1 = 22e⁻



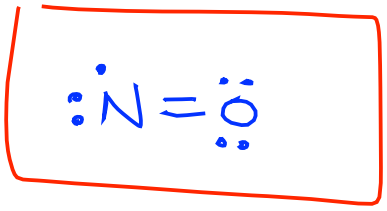
FC = 7 − 6 − 1 = 0

FC = 7 − 6 − 2 = −1



h) NO

5 + 6 = 11 e⁻



FC: N = 5 − 3 − 2 = 0

O = 6 − 4 − 2 = 0

2. Construct a Born-Haber cycle for $NaNO_2$ to determine the electron affinity of NO_2.

Useful information:

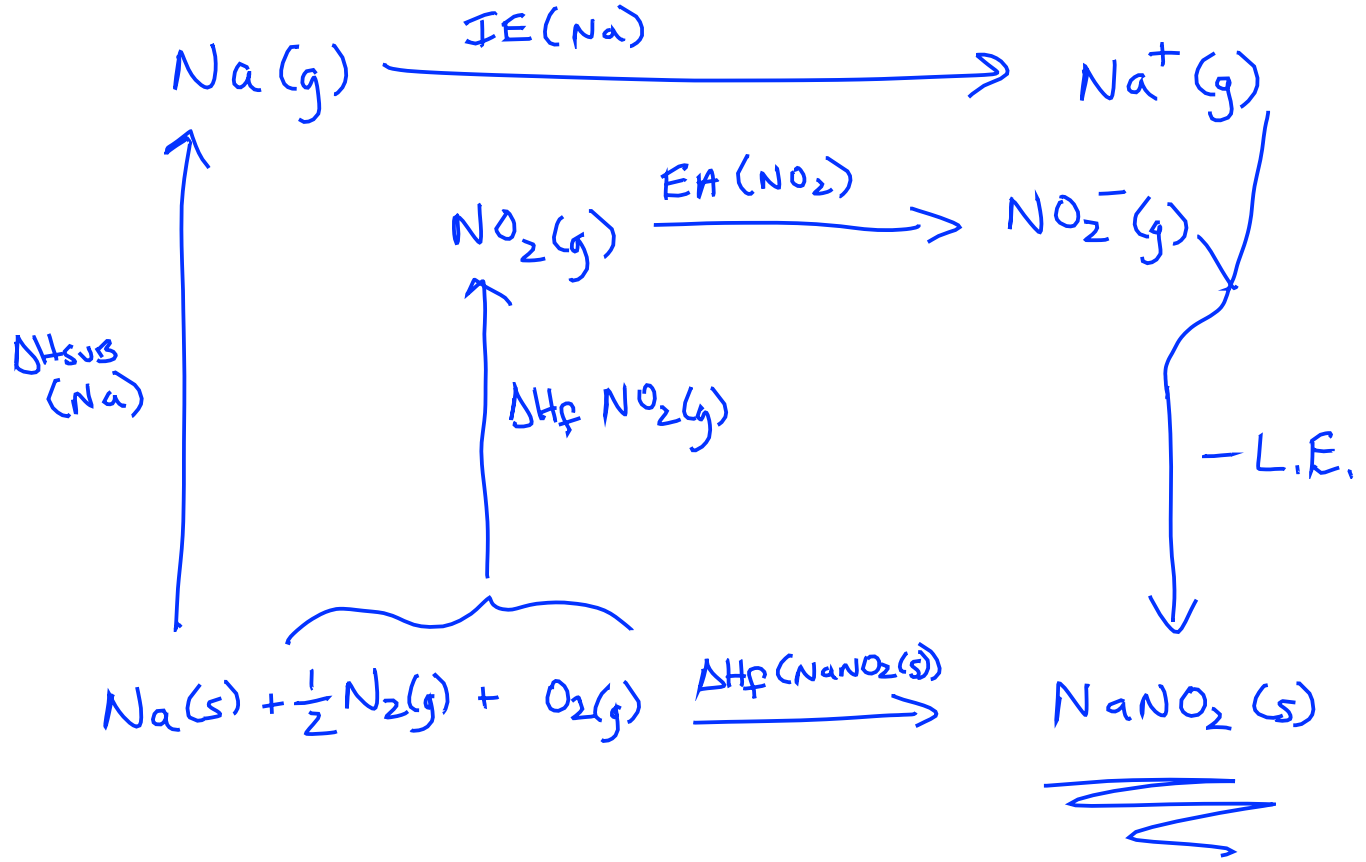
ΔH_f ($NaNO_2$(s)) = -359 kJ/mol

ΔH_{sub}(Na) = 108 kJ/mol

ΔH_f (NO_2(g)) = +33.2 kJ/mol

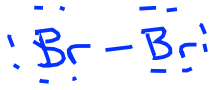
IE (Na) = 496 kJ/mol

L.E.($NaNO_2$) = 777 kJ/mol



$\Delta H_f(NaNO_{2(s)}) = \Delta H_{sub}(Na) + \Delta H_f(NO_{2(g)}) + IE(Na) + EA(NO_2) - LE(NaNO_{2(s)})$

PLUG IN NUMBERS AND CALC. $EA(NO_2) = -219.2$ kJ/mol



3. Draw the Lewis structure for BrF_3 and then use the following information to determine the enthalpy of formation ($\Delta H°_f$) for liquid BrF_3.

D_{Br-Br} = 193 kJ/mol
D_{Br-F} = 237 kJ/mol
$\Delta H_{vap}(BrF_3)$ = 47.6 kJ/mol
D_{F-F} = 155 kJ/mol
ΔH_{vap} (Br_2(l)) = 30.71 kJ/mol

ΔH_f° BrF_3 :

$\frac{1}{2} Br_2(l) + \frac{3}{2} F_2(g) \longrightarrow BrF_3(l)$ $\Delta H = ???$

BUT BOND ENTHALPIES ONLY WORK IN GAS PHASE!

SO....

$\frac{1}{2} Br_2(g) + \frac{3}{2} F_2(g) \longrightarrow BrF_3(g)$ NOW ALL GAS PHASE!

$\Delta H = \sum D_{\text{BONDS BROKEN (REACTANTS)}} - \sum D_{\text{BONDS FORMED (IN PRODUCTS)}}$

$= \frac{1}{2} D_{Br-Br} + \frac{3}{2} D_{F-F} - (3 D_{Br-F})$

$= \frac{1}{2}(193) + \frac{3}{2}(155) - 3(237) = -382$ kJ/mol

NOW HESS' LAW

	ΔH
$\frac{1}{2} Br_2(g) + \frac{3}{2} F_2(g) \longrightarrow BrF_3(g)$	-382
$\frac{1}{2} Br_2(l) \longrightarrow \frac{1}{2} Br_2(g)$	$+\frac{1}{2}\Delta H_{vap}(Br_2) = 1/2\ (30.71)$
$BrF_3(g) \longrightarrow BrF_3(l)$	$-\Delta H_{vap}(BrF_3) = -(47.6)$

$\frac{1}{2} Br_2(l) + \frac{3}{2} F_2(g) \longrightarrow BrF_3(l)$ $\Delta H = -414.2$ kJ/mol

3. (cont. – space for additional work)