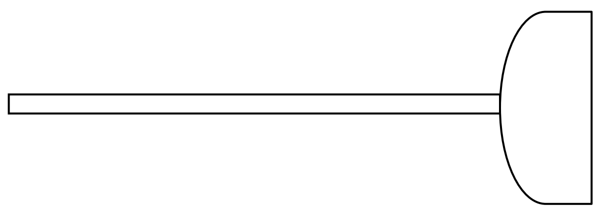
Review of Bond Energies, Partial Pressures and Other Goodies

1. a) A gas mixture consists of 20. g of H_2 and 8.0 g of He. What is the partial pressure of hydrogen at STP?
   b) What volume will it occupy at STP?

2. Why does a suction cup stick to the wall after it's been fired?



3. a) Use the table of bond energies to estimate the ΔH/mole Cl_2 in the following reaction:

$$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$$

All values in kJ/mole

H---H	436	Cl---Cl	243
H---C	410.	C---C	350.
H---Cl	432	C---Cl	330.

   b) Graph an energy diagram of ΔH_{bb}, $\Delta H_{bf,}$ and overall ΔH for the above reaction.

   c) Calculate ΔH if we produce 3.65 g of HCl from the above reaction.

   d) What will happen to the temperature of the air surrounding the above reaction?

4. Use your knowledge of potential and kinetic energy to classify as exothermic or endothermic.

a) $Na_{(s)} \rightarrow Na_{(g)}$

b) $Cl_{2(g)} \rightarrow 2Cl_{(g)}$

c) $Na_{(g)} \rightarrow Na_{(g)}^{+} + 1\ e^{-}$

d) $Cl_{(g)}\ + 1\ e^{-} \rightarrow Cl_{(g)}^{-}$

e) $Na_{(g)}^{+} + Cl_{(g)}^{-} \rightarrow NaCl_{(s)}$

5. If the ΔH's associated with the above 5 reactions are:
   a) 107.3 kJ
   b) 244 kJ
   c) 495.8 kJ
   d) -348.6 kJ
   e) -787 kJ

   find the ΔH/mole Cl_2 for the following reaction using Hess Law:

   $2\ Na_{(s)} + Cl_{2(g)} \rightarrow 2\ NaCl_{(s)}$

Solutions

1. a) First convert to moles:
   20. g of H_2(mole/2.0 g) = 10 moles H_2;
   8.0 g of He (mole/4.0 g) = 2.0 moles He;
   n_T= 10 +2.0 = 12 moles

   P_T = 101.3 kPa at STP
   $P_{H2} = (n_{H2}/n_T)\ P_T$
   =(10/12)(101.3)= 84 kPa

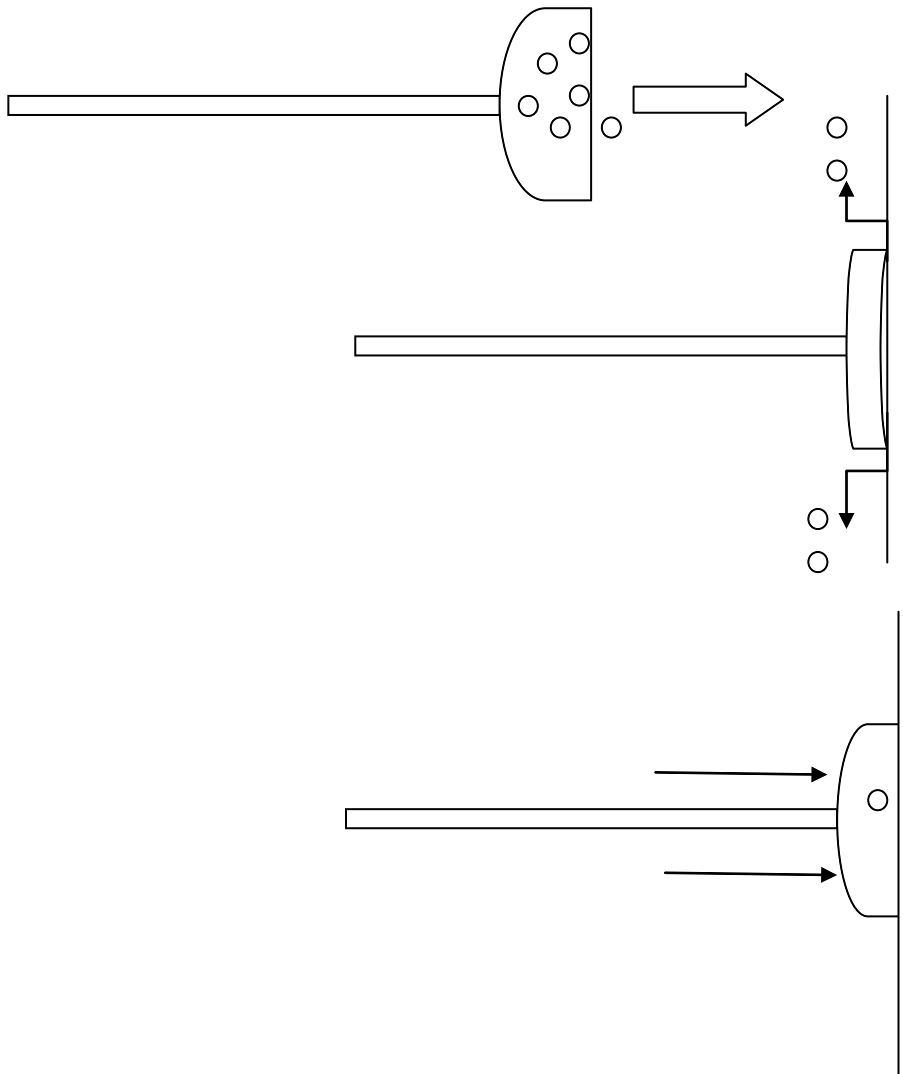
b) $P_TV=n_TRT$
$V= n_TRT/P_T$=12(8.31)(273)/101.3 = 270 Lor 22.4L/mole*12moles=270 L
Rounded to 2 SF because of 20.0 and 8.0 and 2.0g/mole and 4.0 g/mole, all of which have 2 SF

2. The act of firing it gives it energy (figure A) . Then on impact, it squeezes a lot air out of the cup, lowering the pressure inside.(figure B). Meanwhile atmospheric pressure squeezes the outside of the sup against the wall, preventing gravity from pulling it down.(figure C).

A

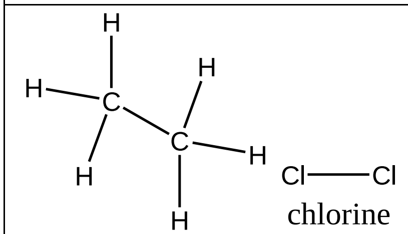
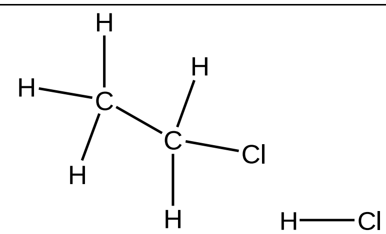
B

C



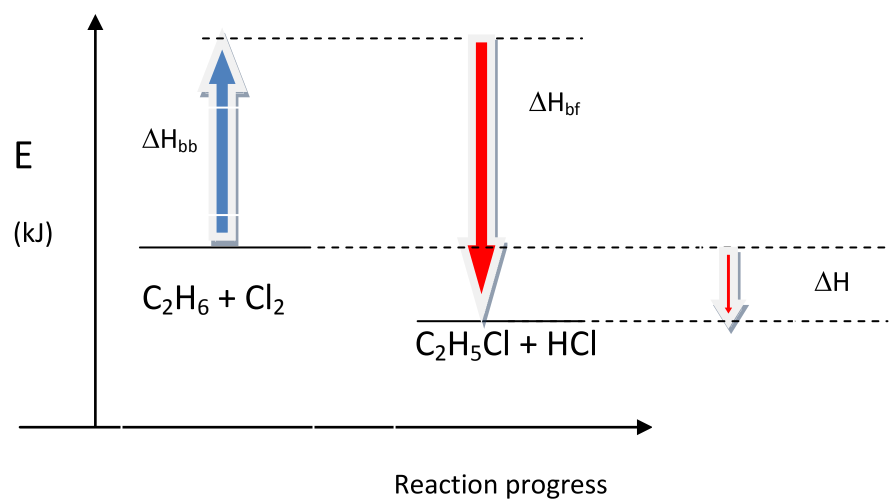
3. a) <u>All values in kJ/mole</u>

H---H	436	Cl---Cl	243
H---C	410.	C---C	350.
H---Cl	432	C---Cl	330.

ΔH_{bb}	ΔH_{bf}	ΔH
 chlorine		$\Delta H_{bb}+\Delta H_{bf}$
6(C--H)+1(C---C) +1(Cl---Cl) =6(410)+1(350)+(243) =3053 kJ	-5(C--H)-1(C---C) -1(Cl---C)-1(H—Cl) =-5*410-350-330-432 =-3162 kJ	3053 kJ +-3162 kJ = -109 kJ

There's only one mole of Cl2 in the balanced equation,
so ΔH = -109 kJ/mol Cl_2.

b)



c) 3.65 g HCl(mole/36.5 g) = 0.100 mole HCl
see equation:
(-109 kJ/mol of HCl) (0.100 mole HCl) = -10.9 kJ

d) It will increase(reaction is releasing heat)

4.

a) $Na_{(s)} \rightarrow Na_{(g)}$ sublimation is endothermic. Energy must be absorbed to overcome attraction between solid molecules and to move them apart.

b) $Cl_{2(g)} \rightarrow 2Cl_{(g)}$ Endothermic. Bond has to be broken. Atoms are now separated. There is now a greater separation between what was a shared valence electron and other Cl nucleus.

c) $Na_{(g)} \rightarrow Na_{(g)}^{+} + 1\ e^{-}$ Endothermic. Although the electron was loose, it is now at a greater distance from the Na nucleus.

d) $Cl_{(g)}\ +1\ e^{-} \rightarrow Cl_{(g)}^{-}$ Exothermic. Free electron has now been pulled closer to the Cl nucleus.

e) $Na_{(g)}^{+} + Cl_{(g)}^{-} \rightarrow NaCl_{(s)}$ Big time exothermic. Two opposite charges far away from each other (they were gaseous ions) are now closely bonded in a solid form. Potential energy has decreased dramatically.

5. Given:

(1) $Na_{(s)} \rightarrow Na_{(g)}$ $\Delta H = 107.3$ kJ

(2) $Cl_{2(g)} \rightarrow 2Cl_{(g)}$ $\Delta H = 244$ kJ

(3) $Na_{(g)} \rightarrow Na_{(g)}^{+} + 1\ e^{-}$ $\Delta H = 495.8$ kJ

(4) $Cl_{(g)}\ +1\ e^{-} \rightarrow Cl_{(g)}^{-}$ $\Delta H = -348.6$ kJ

(5) $Na_{(g)}^{+} + Cl_{(g)}^{-} \rightarrow NaCl_{(s)}$ $\Delta H = -787$ kJ

Double(1): $2Na_{(s)} \rightarrow 2Na_{(g)}$ $\Delta H = 2*107.3$ kJ

$Cl_{2(g)} \rightarrow 2Cl_{(g)}$ $\Delta H = 244$ kJ

Double(3): $2Na_{(g)} \rightarrow 2\ Na_{(g)}^{+} + 2\ e^{-}$ $\Delta H = 2*495.8$ kJ

Double(4): $2Cl_{(g)}\ + 2e^{-} \rightarrow 2Cl_{(g)}^{-}$ $\Delta H = 2*-348.6$ kJ

Double (5): $2Na_{(g)}^{+} + 2Cl_{(g)}^{-} \rightarrow 2NaCl_{(s)}$ $\Delta H = 2* -787$ kJ

Now add them all up:

$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$ $\Delta H = -821$ kJ

(faster way: just take half of (2) and then double the final sum)