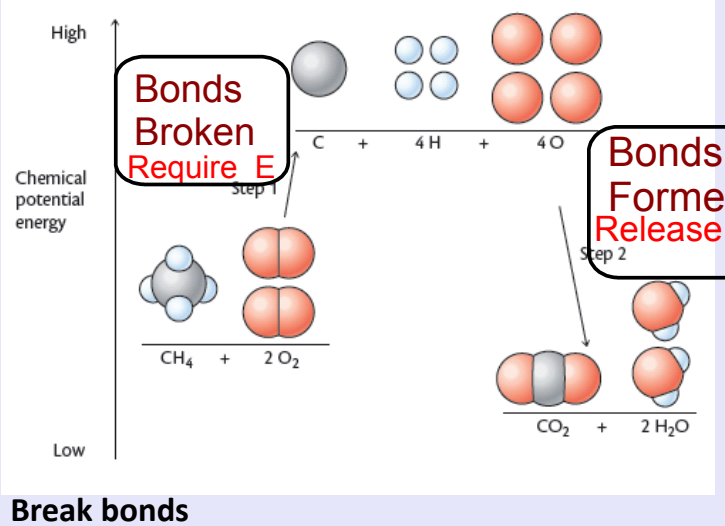
Bond Energy

$$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$$



Break bonds

Energy --always required to break bonds (endothermic)

Form bonds

Energy --always given off to form bonds (exothermic)

The net difference between these is the E released or absorbed (Enthalpy change, ΔH)

Two ways to determine ΔH

Bond Energies: ΔH = Bonds Broken - Bonds Formed

Reactants - Products

Enthalpy change (formation) data tables (last week)

ΔH_f

$$\Delta H = \Sigma \Delta H_{f\ (products)} - \Sigma \Delta H_{f\ (reactants)}$$

Products - Reactants

Bond Energy and Enthalpy

ΔH = Bonds Broken - Bonds Formed
Reactants - Products

Balance

Reactants - Products

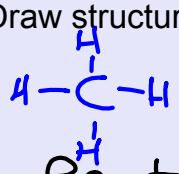
$$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$$

4 C-H 2 O=O 2 C=O 4 O-H

4(99) 2(119) 2(192) 4(111)

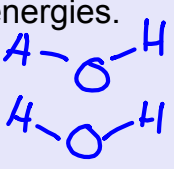
396 238 384 444

Draw structures. Count bonds, find bond energies.



O=O

O=O



Reactant - Products

$\Delta H = (376 + 238) - (384 + 444) = -194$ kJ

Standard Bond Energies					
Single Bonds	$\Delta H°$	Single Bonds	$\Delta H°$	Multiple Bonds	$\Delta H°$
H–H	104.2	B–F	150	C=C	146
C–C	83	B–O	125	N=N	109
N–N	38.4	C–N	73	O=O	119
O–O	35	N–CO	86	C=N	147
F–F	36.6	C–O	85.5	C=O (CO_2)	192
Si–Si	52	O–CO	110	C=O (aldehyde)	177
P–P	50	C–S	65	C=O (ketone)	178
S–S	54	C–F	116	C=O (ester)	179
Cl–Cl	58	C–Cl	81	C=O (amide)	179
Br–Br	46	C–Br	68	C=O (halide)	177
I–I	36.	C–I	51	C=S (CS_2)	138
H–C	99	C–B	90	N=O (HONO)	143
H–N	93	C–Si	76	P=O ($POCl_3$)	110
H–O	111	C–P	70	P=S ($PSCl_3$)	70
H–F	135	N–O	55	S=O (SO_2)	128
H–Cl	103	S–O	87	S=O (DMSO)	93
H–Br	87.5	Si–F	135	P=P	84
H–I	71	Si–Cl	90	P≡P	117
H–B	90	Si–O	110	C≡O	258
H–S	81	P–Cl	79	C≡C	200
H–Si	75	P–Br	65	N≡N	226
H–P	77	P–O	90	C≡N	213