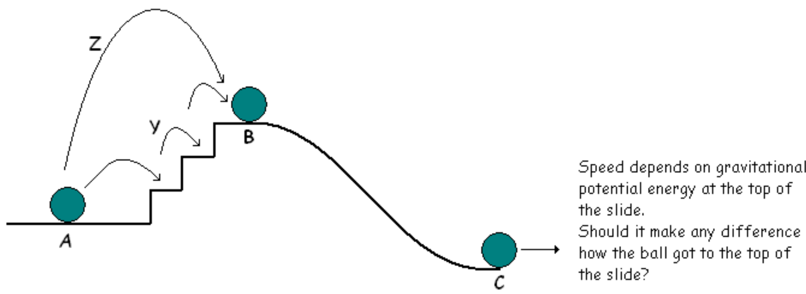
State Variables X

$\Delta X = X_f - X_i$ It does not matter how one gets from initial to final state.

For example, consider the following example concerning gravitational potential energy:



The speed that the ball achieves at the bottom of the slide depends on the potential energy that it has at the top.
The change in potential energy E_{gp} from point A to point B is $\Delta E_{gp} = E_{gpB} - E_{gpA}$.

$$E_{gpB} = \Delta E_{gp} + E_{gpA}$$

If ΔE_{gp} depends on how the ball gets from point A to B (route Y or Z, in this example), then the ball will achieve a different speed at the bottom of the slide depending on how it got to the top. Does this make any sense?

If not, then any route from point A to B must have the same ΔE_{gp}.
In other words: $\Delta E_{gp} = E_{gpF} - E_{gpI}$

It must also be the case for chemical reactions. If $\Delta H = H_f - H_i$, then it should not matter what sort of reaction path a reaction follows.

Both of the following processes must have the same overall ΔH, since they have the same intial and final states:

$8C + 9H_2 + 4O_2 \longrightarrow C_4H_{10} + C_4H_8 + 4O_2 \longrightarrow C_8H_{18} + 4O_2$ $\Delta H = -250.1$ kJ
$8C + 9H_2 + 4O_2 \longrightarrow C_8H_{16}O_8 + H_2 \longrightarrow C_8H_{18} + 4O_2$ $\Delta H = -250.1$ kJ

Why is this important? Because if any reaction of interest (target reaction) can be represented by the sum of a series of steps, then the ΔH for the target reaction must equal the sum of the ΔH values for each of the steps.

Example: target reaction is $8C + 9H_2 \longrightarrow C_8H_{18}$ $\Delta H = ?$

Known Reactions

$C + 2H_2 \longrightarrow CH_4$	$\Delta H = a$	$8C + 16H_2 \longrightarrow 8CH_4$	$\Delta H = 8a$
$2CH_4 \longrightarrow C_2H_6 + H_2$	$\Delta H = b$	$8CH_4 \longrightarrow 4C_2H_6 + 4H_2$	$\Delta H = 4b$
$2C_2H_6 \longrightarrow C_4H_{10} + H_2$	$\Delta H = c$	$4C_2H_6 \longrightarrow 2C_4H_{10} + 2H_2$	$\Delta H = 2c$
$2C_4H_{10} \longrightarrow$ C8H18 + H_2	$\Delta H = d$	$2C_4H_{10} \longrightarrow C_8H_{18} + H_2$	$\Delta H = d$
		$8C + 9H_2 \longrightarrow C_8H_{18}$	$\Delta H = 8a+4b+2c+d$

Hess' Law: $\Delta H_{target} = \Sigma \Delta H_{known}$

Why is Hess' Law important.

a) any reaction can be represented by a series of other reactions
b) many target reactions cannot be measured using calorimetry because:
- they are too slow
- they are too dangerous
- they are too difficult (other products are made instead)