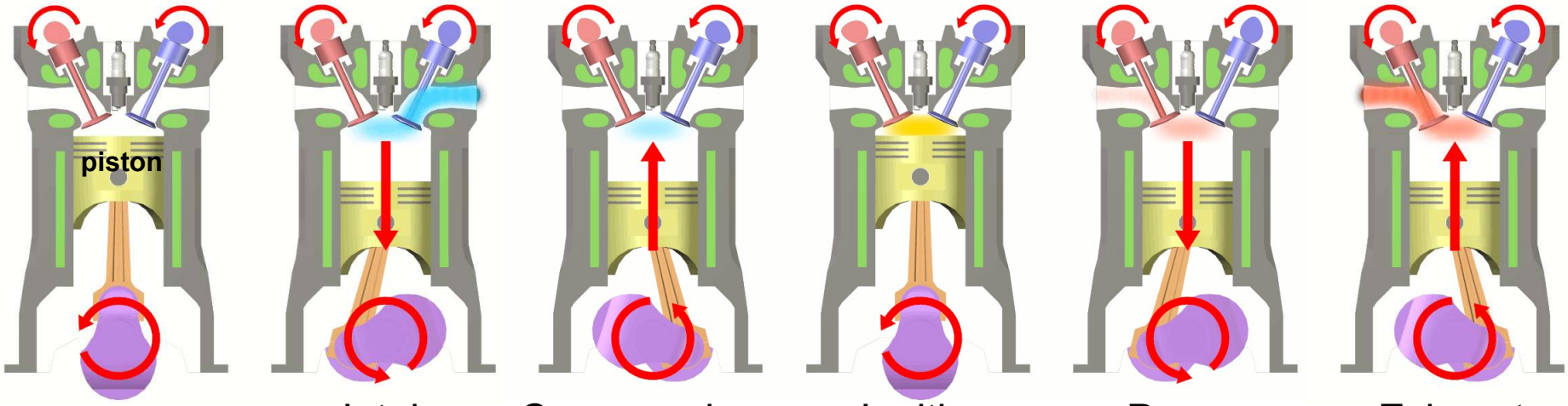
The 4-stroke Auto Engine



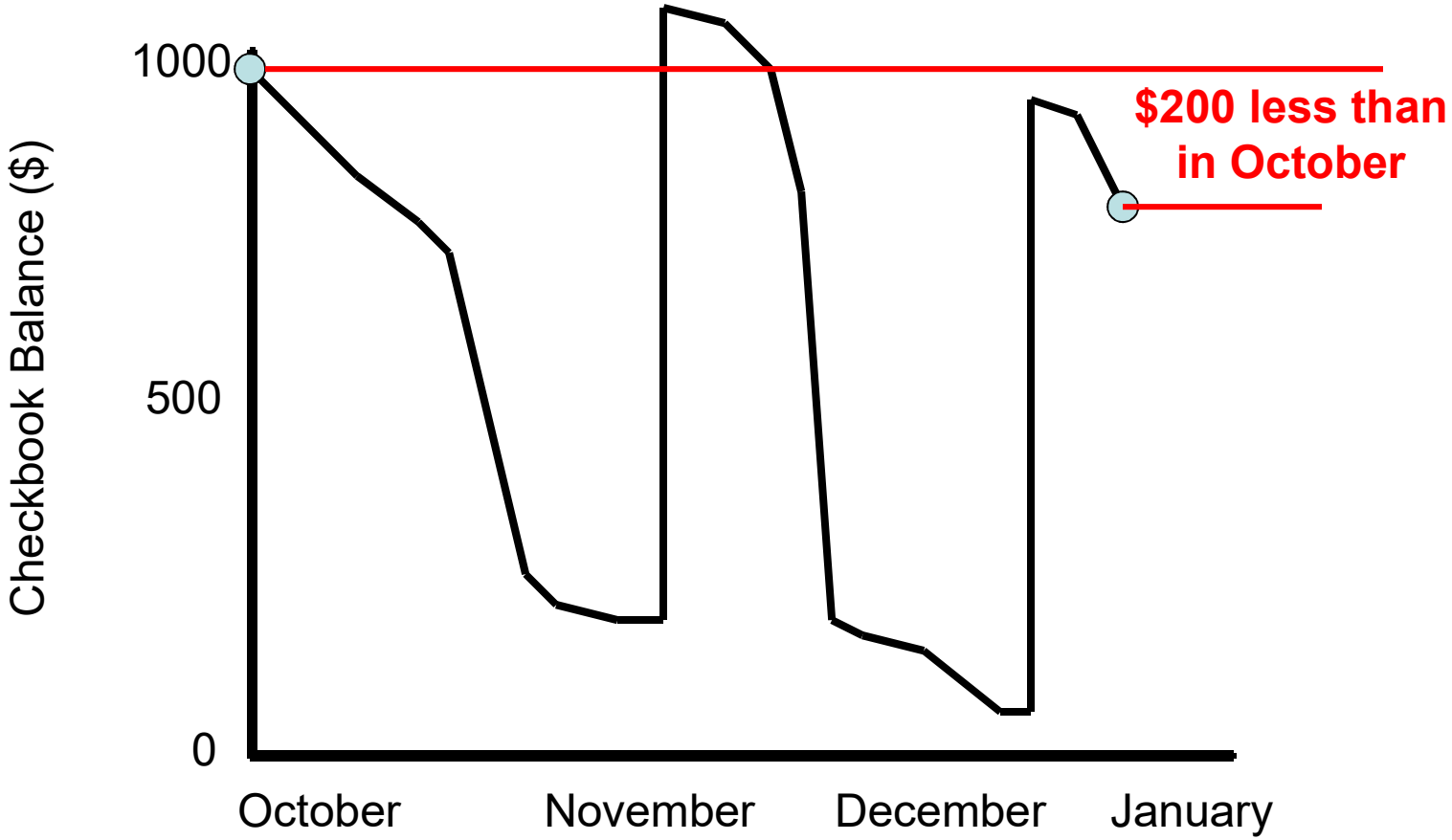
$\Delta E = q + w$

q (neg) heat released
...heat warms engine, passengers and surroundings on cold days

w (neg) work done on surroundings
....moves car against frictional forces and gravity

Automotive engineers design engines that release as little heat as possible. Why?

State Functions and Your Checkbook Balance.



Not saving any money!

What happens between October and January isn't important.

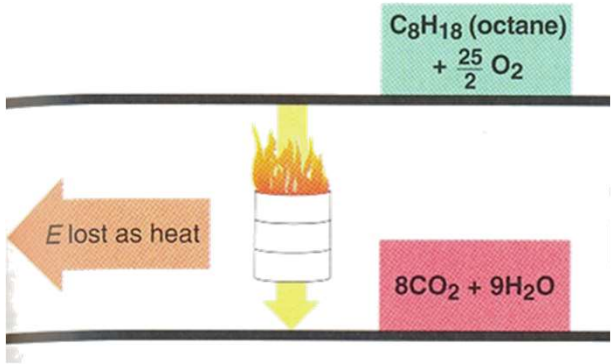
You are $200 behind in your savings and that is what matters.

State Functions: ΔE, ΔP, ΔV

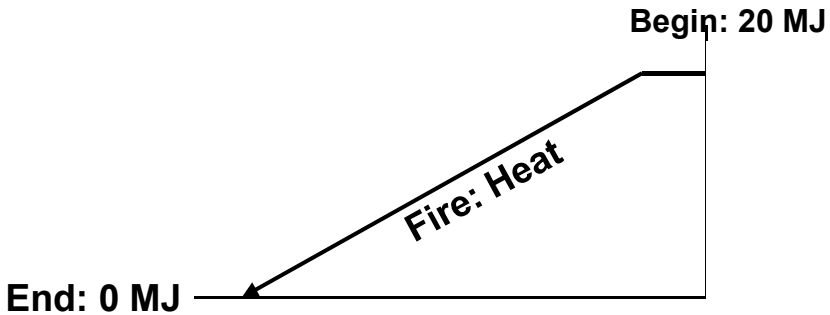
State functions: the path or prior history doesn't matter....

...What does matter is where the system begins and ends.

20.0 MJ
Chemical Energy



20.0 Mega Joules
(Heat)



Enthalpy:

How we measure energy changes in chemistry

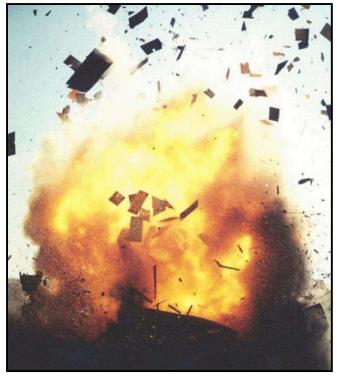
$$\Delta E = q + w$$

- **$\Delta E > 0$ (i.e. positive) system gains energy**
- **$\Delta E < 0$ (i.e. negative) system loses energy**

Work done by system

$w = - P\Delta V$

$$\Delta E = q - P\Delta V$$



Destructive $\Delta V > 0$

Explosive's $\Delta E < 0$

Constructive $\Delta V > 0$

Fuel's $\Delta E < 0$

e.g. Explosion (boom!)

... System volume increases...

... $\Delta V > 0$

... Lowers the system's energy.

... $\Delta E_{system} < 0$

Enthalpy:

How we measure energy changes in chemistry

Need to measure ΔE for chemical reactions...

...and this requires us to measure both q and $p\Delta V$

...measuring q is easy but...

... Measuring ΔV is difficult.

Reformulate... and assume P is constant...

heat at constant pressure

$$\Delta E_{system} = q_P - P\Delta V$$

$$q_P = \Delta E_{system} + P\Delta V$$

$$\Delta H = \Delta E_{system} + P\Delta V$$