The First Law of Thermodynamics (SwiftStudy Printable)

Key Formulas

$$Q = \Delta U + W$$

Q	heat added to system	joules (J)
ΔU	change in internal energy	joules (J)
W	work done by system	joules (J)

$$W = P\Delta V$$

W	work done by gas	joules (J)
P	pressure	pascals (Pa)
ΔV	change in volume	m^3

Tips to Remember

- Know your signs. Q is positive when heat is added to the system, and negative when heat is removed. ΔU is positive when the internal energy increases and negative when it decreases. Finally, W is the one that seems to trip the most people up. W is positive when the gas is expanding and doing work on its surroundings. W is negative when the gas is getting compressed, so that work is being done **on the system**.
- In isometric systems, the gas in is a rigid container whose dimensions can't change. Since the volume does not change, W = 0, and the first law simplifies to $Q = \Delta U$.
- In an adiabatic process, no heat enters or leaves the system, usually because the process happens so rapidly that there is little time to do so. (This isn't technically **no** heat entering or leaving, but the approximation is usually good enough.) Words such as "a gas is rapidly compressed" should tip you off that a process is adiabatic. When no heat is transfered, Q = 0, and the first law simplifies to $0 = \Delta U + W$.
- To calculate the work done using the pressure and change in volume, you won't be able to use a simple multiplication unless the pressure is constant. If the pressure changes noticeably as the gas expands (as it usually does unless the volume change is small), you will need to use calculus or graphical methods to calculate the work done.