# 9 The laws of thermodynamics – Part 2

Name: _____ Class: _____ Date: _____

## Vocabulary

*Write each word three times.*

| **English** | **Write it 3 times** (English) | | |
|---|---|---|---|
| internal energy | | | |
| first law of thermodynamics | | | |
| Entropy | | | |
| second law of thermodynamics | | | |

## Recall

In Part A you met temperature, gases, and heat. Now connect heat to energy:

- Energy is never lost – it only moves or changes form (you saw this with work and kinetic energy).
- Heating a gas can warm it **or** make it push out and do work.
- Heat only ever flows hot → cold on its own. This sheet says why.

Each idea has a worked example before the Practice.

## New ideas

### ■ 1 Internal energy

The **internal energy** $U$ of a gas is the total energy of its particles' motion. More internal energy means a higher temperature.

### 2 The first law of thermodynamics

The **first law of thermodynamics** is just energy conservation for a gas:

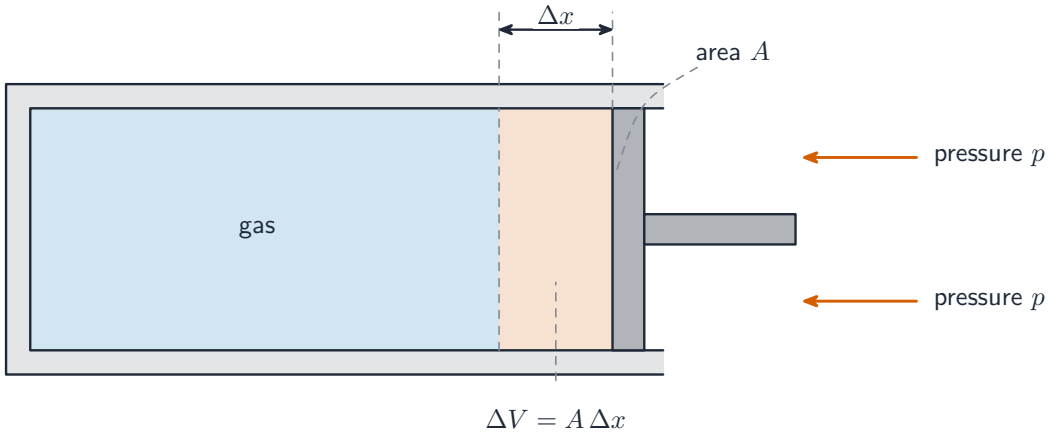
$$\Delta U = Q + W,$$

where $Q$ is the heat added **to** the gas and $W$ is the work done **on** the gas. Add heat and the gas warms up or does work (or both).

*Worked example.* A gas absorbs 500 J of heat and does 200 J of work on its surroundings (so work done **on** the gas is $W = -200$ J): $\Delta U = Q + W = 500 + (-200) = 300$ J. Its internal energy rises by 300 J, so it ends up hotter.

### 3 Work when a gas expands

When a gas expands and pushes a piston, it does work on the outside world.




Compressing a gas does **positive** work on it (raising its energy); letting it expand does **negative** work on it (it gives energy away).

### 4 Entropy and the second law

**Entropy** measures how spread-out or disordered energy is. The **second law of thermodynamics** says the total entropy of an isolated system never decreases – energy naturally spreads out. This is why heat flows hot → cold by itself, and never cold → hot.

**Watch out:** in $\Delta U = Q + W$, the sign of $W$ matters most. Work done **on** the gas is positive; when the gas does work on its surroundings, $W$ is **negative**. Get the sign right and these problems are easy.

## Practice

Try these in order. The methods are all above.

**2.1** State what the internal energy of a gas depends on. [1]

**2.2** A gas gains 400 J of heat and 100 J of work is done **on** it. Find the change in internal energy. [2]

**2.3** A gas absorbs 600 J of heat and does 250 J of work on its surroundings. Find the change in its internal energy. [3]

**2.4** State the direction heat naturally flows between a hot and a cold object, and name the law that sets this direction. [2]

**2.5** Explain why energy naturally spreads out rather than gathering into one place, using the idea of entropy. [2]