

# 16 Work and the first law – Part 2

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

## Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

| English                     | 中文      | Write it 3 times (English) |
|-----------------------------|---------|----------------------------|
| work                        | 功       | _____                      |
| first law of thermodynamics | 热力学第一定律 | _____                      |

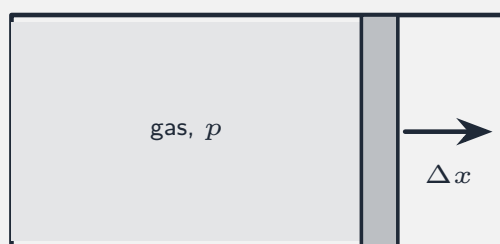
## Recall

Internal energy can change when heat is added, or when **work** 功 is done on or by the gas.

## New ideas

Read these first. Each idea has a short worked example. Then do the Practice.

### ■ 1 Work done by a gas

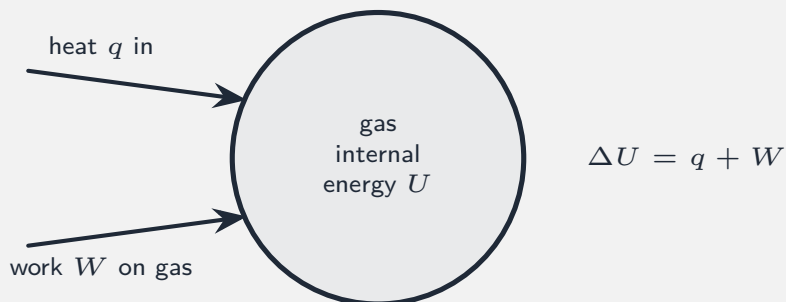


$$W = p \Delta V$$

When a gas expands against an outside pressure  $p$  by a small volume  $\Delta V$ , it does work  $W = p \Delta V$  on the surroundings.

*Worked example.* A gas at  $p = 1.0 \times 10^5$  Pa expands by  $\Delta V = 2.0 \times 10^{-3}$  m<sup>3</sup>:  
 $W = p \Delta V = (1.0 \times 10^5)(2.0 \times 10^{-3}) = 200$  J of work done on the surroundings.

## ■ 2 The first law



The **first law of thermodynamics** 热力学第一定律:  $\Delta U = q + W$  —the change in internal energy equals the heat added plus the work done *on* the gas.

*Worked example.* 100 J of heat is added to a gas while it pushes a piston out, doing 30 J of work on the surroundings. Work done *on* the gas is  $W = -30$  J, so  $\Delta U = q + W = 100 + (-30) = 70$  J.

**Watch out:** in  $\Delta U = q + W$ , the symbol  $W$  is the work done *on* the gas. If the gas expands (doing work on the surroundings),  $W$  is *negative*.

## Practice

Try these in order.

**16.1** Write the work done when a gas changes volume at constant pressure. [1]

**16.2** When a gas *expands*, does it do work on the surroundings or have work done on it? [1]

**16.3** Write the *first law of thermodynamics*. [1]

**16.4** Heat  $q = 50$  J is added and  $W = 20$  J of work is done on a gas. Find  $\Delta U$ . [1]

**16.5** A gas at  $2.0 \times 10^5$  Pa expands by  $1.5 \times 10^{-3}$  m<sup>3</sup>. Find the work it does on the

surroundings ( $W = p \Delta V$ ).

[2]

**16.6** 80 J of heat is added to a gas while it does 50 J of work on the surroundings. Find the change in internal energy, and explain the signs. [2]

**16.7 Challenge.** A gas is compressed quickly, so fast that no heat escapes ( $q = 0$ ). Explain what happens to its internal energy and temperature. [2]