

9.6 Entropy and the Second Law of Thermodynamics

Name: _____ Class: _____ Date: _____

Total: 9 marks

Objective

Build the skills to answer exam questions on **entropy and the second law of thermodynamics**.

You must be able to:

- describe **entropy** 熵 as a measure of disorder (the number of microstates)
- state the **second law of thermodynamics** 热力学第二定律: total entropy tends to increase
- explain why thermal energy flows spontaneously from hot to cold

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ Entropy

Entropy measures **disorder** —the number of ways (microstates) the particles can be arranged. More disorder means higher entropy.

■ The second law

The **total** entropy of an isolated system tends to **increase** over time.

■ Direction of heat flow

Heat flows from hot to cold on its own because that **raises** the total entropy. The reverse (cold to hot) needs external work —that is what a refrigerator does.

2 Practice

2.1 State what entropy measures. [1]

2.2 State the second law of thermodynamics. [1]

2.3 Explain why heat does not flow from a cold object to a hot one on its own. [2]

3 Exam-style questions

3.1 Entropy is a measure of a system's [1]

- **A** temperature
 - **B** energy
 - **C** disorder
 - **D** pressure
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3.2 In an isolated system, the total entropy tends to [1]

- **A** decrease
 - **B** increase
 - **C** stay exactly constant
 - **D** fall to zero
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3.3 A block of ice melts in a warm room.

(a) State whether the entropy of the water increases or decreases. [1]

(b) Explain your answer in terms of disorder. [2]

4 Go further

- work through the **9.6 Entropy and the Second Law of Thermodynamics** lesson on the **Learn** page;
- read the **Thermodynamics** section of the AP Physics 2 handout on the **Know** page.

Solutions

2.1 the disorder of a system (the number of microstates).

2.2 the total entropy of an isolated system tends to increase.

2.3 that would **decrease** the total entropy, which the second law forbids without external work being done.

3.1 C.

3.2 B.

3.3 (a) increases. (b) liquid water is more disordered than solid ice —its particles move more freely, so there are more microstates and higher entropy.