

Exercise walk-through

9.6

Entropy and the Second Law of Thermodynamics

AP Physics 2

Entropy and the second law

Entropy S measures **disorder**. The **second law** : total entropy of an **isolated system** never decreases.

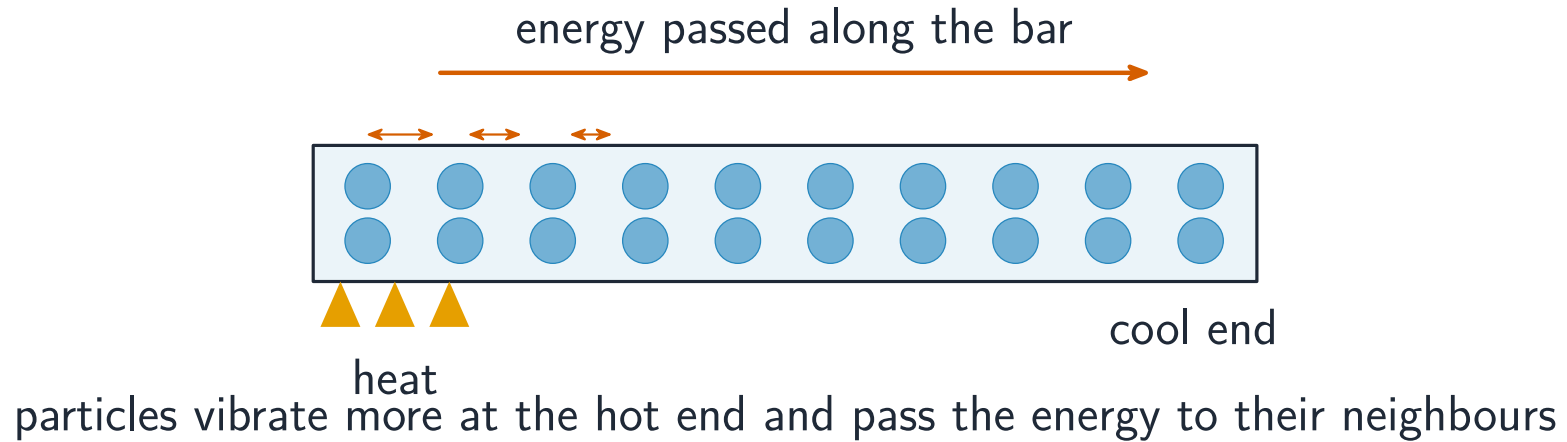
The arrow of time

$$\Delta S_{\text{total}} \geq 0$$

- heat flows hot $\rightarrow$ cold on its own
- ink spreads, glass shatters – never reverse

No heat engine is 100% efficient – some heat is always dumped as waste.

Specific Heat and Thermal Conductivity



Conduction: vibrating particles pass energy along a metal bar

Exam tips

- Always convert temperatures to **kelvin** ($T_K = T_C + 273$) before using any gas law.
- In the first law $\Delta U = Q + W$, get the **sign of W right**: **work done on** the gas is positive; when the gas expands and does work on its surroundings, W is negative.
- **Temperature** measures the average kinetic energy of particles, so at the same T lighter molecules move faster.
- On a **PV diagram** the work done by the gas is the **area** under the process curve.
- Use $Q = mc\Delta T$ for temperature change; the **second law** fixes the direction – heat flows hot→cold and total entropy never decreases.

Exercises 2.1-2.3

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]

Exercises 2.1-2.3

2.1 State what entropy measures.

[1]

2.1

- the disorder of a system (the number of microstates)

2.2 State the second law of thermodynamics.

[1]

2.2

- the total entropy of an isolated system tends to increase

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

[2]

2.3

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

Exercises 3.1-3.2

3.1 Entropy is a measure of a system's

[1]

☐

A temperature

B energy

C disorder

D pressure

3.2 In an isolated system, the total entropy tends to

[1]

☐

A decrease

B increase

C stay exactly constant

D fall to zero

Exercises 3.1-3.2

3.1 Entropy is a measure of a system's

[1]

☐

A temperature

B energy

C disorder

D pressure

3.1 C

- disorder.

3.2 In an isolated system, the total entropy tends to

[1]

☐

A decrease

B increase

C stay exactly constant

D fall to zero

3.2 B

- increase.

Exercise 3.3 (a)

3.3 A block of ice melts in a warm room.

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

[1]

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[1]

(a)

- increases

Exercise 3.3 (b)

3.3 A block of ice melts in a warm room.

(b) Explain your answer in terms of disorder.

[2]

Exercise 3.3 (b)

3.3 A block of ice melts in a warm room.

(b) Explain your answer in terms of disorder.

[2]

(b)

- liquid water is more disordered than solid ice – its particles move more freely, so there are more microstates and higher entropy