SCIENCE FOUNDATIONS

Basic thermodynamics

Difficulty level: Intermediate

Science Foundations

This document was made by AI and there may be mistakes. If a question or answer looks wrong, use the Flag a mistake button to let Brett know so he can fix it.

Overview of the concept

This is how you explain why a hot drink cools down, why a fridge needs power to stay cold, and why no engine can ever be perfectly efficient. A hot drink cools because heat flows from hot to cold on its own, and a fridge has to spend electricity to push heat the other way. A car engine turns some of its fuel into motion and the rest into waste heat, and no engine can ever turn it all into motion. Heat always spreads out unless you spend energy to hold it back, and that one idea explains a cooling coffee, a running fridge, and a car engine.



© 2026 Brett Robbins. All Rights Reserved.

Rule

Basic thermodynamics: heat flows from hot to cold on its own.

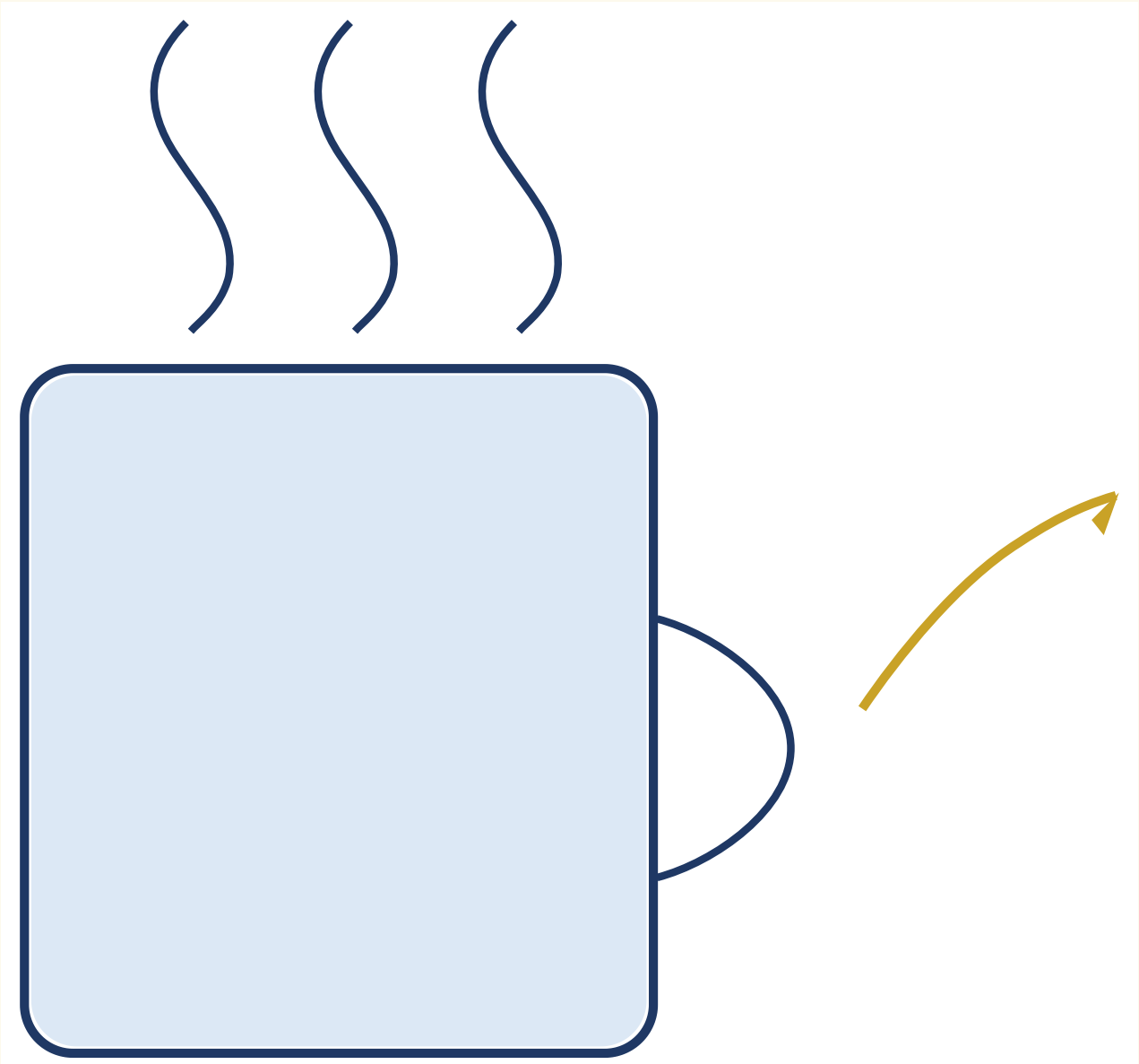
First law: energy is conserved, never created or destroyed, only changed from one form to another. Second law: heat will not flow from cold to hot by itself, so some energy is always wasted as heat and no engine can ever be 100 percent efficient.

© 2026 Brett Robbins. All Rights Reserved.

Worked examples

EXAMPLE 1

Q A hot drink cools in a cold room. Which way does heat flow?



SOLUTION

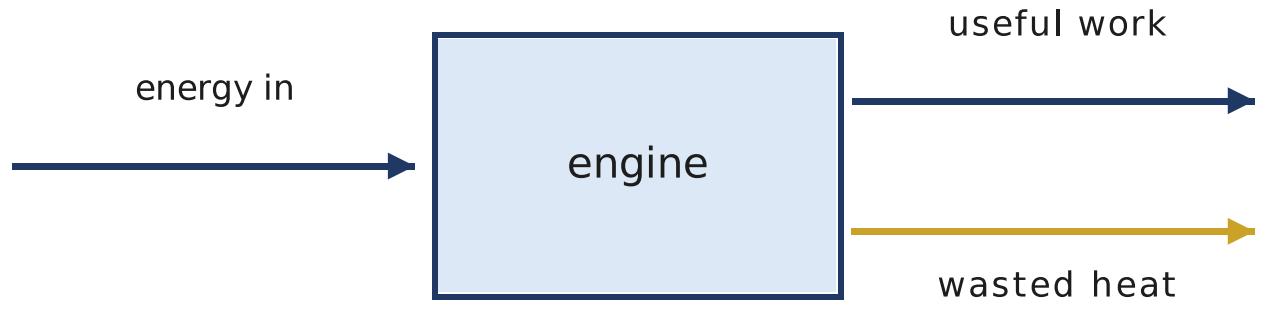
Left alone, heat moves from hot things to cold things. The drink is hot, the room is cold.

Heat flows out of the drink, into the room.

© 2026 Brett Robbins. All Rights Reserved.

EXAMPLE 2

Q Can an engine be 100 percent efficient?



SOLUTION

No. The second law says some energy is always wasted as heat, so no engine can ever turn it all into motion.

No, some energy is always wasted as heat.

Practice questions

1 Heat flows from where to where?

- A From hot to cold
- B From cold to hot
- C From hot to hot
- D It does not flow

Understand It with Pulse | Flag a mistake

© 2026 Brett Robbins. All Rights Reserved.

2

A warm laptop sits on a cool desk. Which way does heat flow?

- A From the desk to the laptop
- B From the laptop to the room
- C From the laptop to the desk
- D It does not flow

Understand It with Pulse | Flag a mistake

3

A cold can of drink is left in a warm room. Which way does heat flow?

- A From the can to the room
- B From the room to the can
- C From the can to the floor
- D It does not flow

Understand It with Pulse | Flag a mistake

© 2026 Brett Robbins. All Rights Reserved.

4 **A hot metal block is placed on a cold metal block. Which way does heat flow, and what happens to the temperatures?**

- **A** Heat flows from the hot block to the cold block; the hot block cools and the cold block warms
- **B** Heat flows from the cold block to the hot block; the cold block cools and the hot block warms
- **C** Heat flows from the hot block to the cold block; both blocks stay the same temperature
- **D** Heat flows from the cold block to the hot block; both blocks warm up

Understand It with Pulse | Flag a mistake

5 **A gas takes in 80 J of heat and does 30 J of work. What is the change in its internal energy?**

Understand It with Pulse | Flag a mistake

© 2026 Brett Robbins. All Rights Reserved.

6 **An engine takes in 100 J of heat and turns 40 J into useful work. How much energy is wasted as heat?**

Understand It with Pulse | Flag a mistake

7 **A heat engine works between 600 K and 300 K. What is its maximum efficiency?**

Understand It with Pulse | Flag a mistake

8 **Can heat flow from cold to hot by itself?**

A Yes

B No

Understand It with Pulse | Flag a mistake

© 2026 Brett Robbins. All Rights Reserved.

9 **Where does wasted energy go in an engine?**

- **A** Back into the fuel tank
- **B** Into the wheels as extra speed
- **C** It disappears
- **D** Out as waste heat

Understand It with Pulse | Flag a mistake

10 **A fridge moves heat from inside (cold) to outside (warm). Why does this not break the rule that heat flows from hot to cold by itself?**

- **A** The fridge uses electricity to do work that moves the heat
- **B** Heat flows from cold to hot by itself inside a fridge
- **C** The inside of a fridge is hotter than the room
- **D** A fridge does not move heat at all

Understand It with Pulse | Flag a mistake

© 2026 Brett Robbins. All Rights Reserved.

ANSWER KEY

1. From hot to cold

2. From the laptop to the desk

3. From the room to the can

4. Heat flows from the hot block to the cold block; the hot block cools and the cold block warms

5. 50 J

6. 60 J

7. 50%

8. No

9. Out as waste heat

10. The fridge uses electricity to do work that moves the heat

© 2026 Brett Robbins. All Rights Reserved.