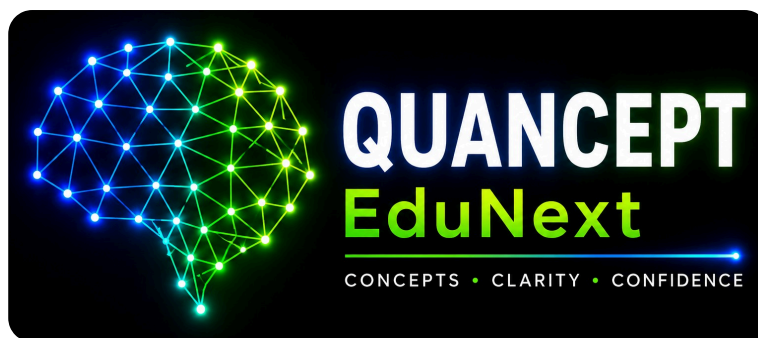




FREE SAMPLE CHAPTER • CLASS 7 • SCIENCE

QUANCEPT Science Quest

Class 7 | Olympiad & Foundation

Heat Transfer in Nature

CONDUCTION • CONVECTION • RADIATION

QUANCEPT Team of Experts

QUANCEPT EduNext • Concepts • Clarity • Confidence

7 Heat Transfer in Nature

how heat moves, and why it matters

NCERT Chapter 7 opening

Pema and Palden live in Gangtok. On a cold winter evening they sit by a fireplace. Palden has just visited Kerala, where winter was warm and humid. Why are some places so cold and others so warm? Their grandfather, a retired science teacher, explains that Kerala is closer to the equator and has a long coastline. Meanwhile their grandmother cooks thukpa in a large metal pan, and Pema wonders: why are cooking pots made of metal?

Every question in that story is about **heat moving from one place to another**: from the fire to the children, from the flame through the pan into the soup, from the Sun to Kerala, and from the sea to the land. This chapter explains how that movement happens.

Heat always flows from a hotter object to a colder one

The one rule behind the whole chapter

it stops when both reach the same temperature

Concept check. When you hold a cold glass of water, does “cold” flow into your hand, or does heat flow out of it? Use the rule in the box above.

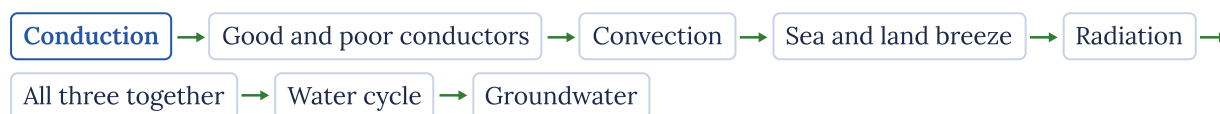
Three ways heat can travel

Conduction particle to particle solids needs a medium	Convection particles move liquids, gases needs a medium	Radiation no particles needed even through space no medium
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The three processes of heat transfer. Each is studied in its own section.

Process	How heat moves	Everyday example	Section
Conduction	passed from particle to particle; the particles stay in place	the handle of a metal spoon in hot tea gets hot	7.1
Convection	hot particles themselves move, carrying heat with them	smoke rising from an incense stick	7.2
Radiation	travels without needing any particles at all	warmth of the Sun on your face	7.3

The same ideas then explain two big processes in nature: the **sea and land breezes** that keep coastal places mild, and the **water cycle** that is driven by the Sun’s heat and refills our rivers and groundwater.



You bring: the Sun as Earth’s main source of heat and light, and the three states of water (Grade 6 Curiosity); metals as good conductors of heat (*The World of Metals and Non-metals*); using a laboratory thermometer.

7.1 Conduction of Heat

passing heat from particle to particle

NCERT §7.1, Activity 7.1, Fig. 7.1-7.2

Activity 7.1 Let us experiment

Caution: do this under the supervision of a teacher or an adult.

1. Take a metal strip (aluminium or iron) about 15 cm long.
2. Stick four pins to it with wax, about 2 cm apart, and label them I, II, III, IV (I is farthest from the stand).
3. Clamp the strip to a stand (or rest it between two bricks).
4. Heat the free end with a candle or spirit lamp. Predict, then record, the order in which the pins fall.

What you find. Pin I, nearest the flame, falls first, then II, III and IV, one after another. They do not all fall together.

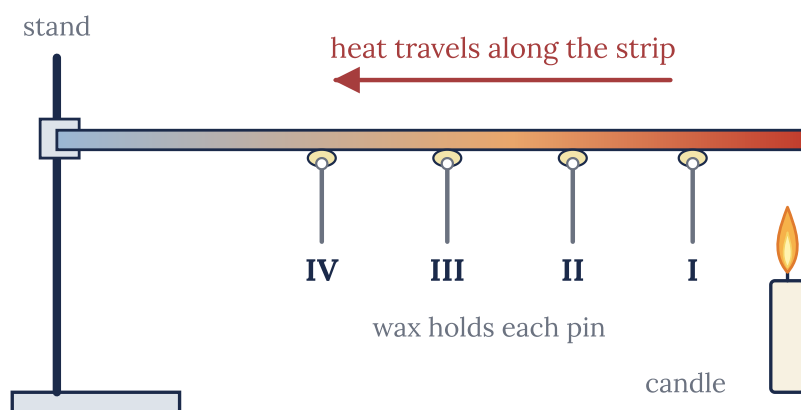


Fig. 7.1 (redrawn). Heat creeps along the strip from the heated end towards the stand, melting the wax under each pin in turn.

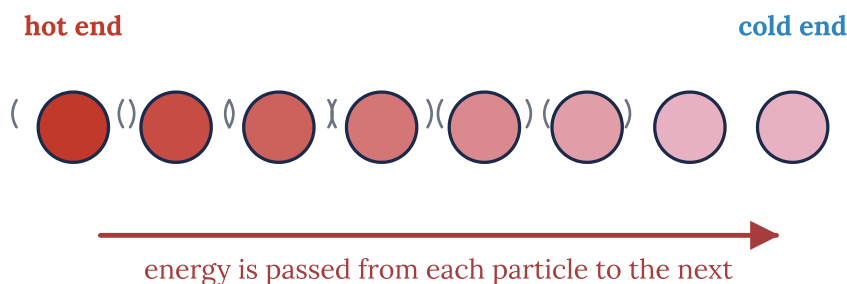
WHAT THE PINS TELL US

- 1 The end of the strip in the flame gets hot first.
- 2 That heat travels along the metal, towards the colder end.
heat flows from hot to cold
- 3 When enough heat reaches a pin, its wax melts and the pin drops.
the nearest pin drops first
- 4 The pins fall in order because heat takes time to travel along the strip.
order: I → II → III → IV

Conduction: heat passes from the hotter part of an object to its colder part, particle by particle

Definition

the particles pass heat on but do not leave their places



each particle vibrates about its own place; none travels along the strip

The particle picture of conduction. Hot particles vibrate more strongly and nudge their neighbours; the energy is handed along, like buckets passed along a line of people.

Why? Why did the pins not all fall at the same time?

Heat does not jump instantly to every part of the strip. Each particle has to warm up and pass the energy to the next one. So the part near the flame warms first, and a place farther along warms only later. The distance from the flame decides when each pin falls.

Good and poor conductors of heat

Materials that let heat pass through them easily are **good conductors**. Metals are good conductors, which is why cooking utensils are made of metal. Materials that do not let heat pass easily are **poor conductors**, also called **insulators**. In solids, heat travels mainly by conduction.

Good conductors	Poor conductors (insulators)
copper, aluminium, iron, steel, silver	wood, plastic, glass, rubber
a metal pan, a steel spoon	clay (<i>kulhad</i>), porcelain cup, cloth
—	air, wool, cotton wool, cork

If Activity 7.1 were repeated with a wooden or glass strip, the pins would not fall: those materials are poor conductors. That is also why tea stays hot longer in a clay or porcelain cup, and why a pan's handle is made of plastic or wood.

Misconception diagnostic

Student may think	A metal railing feels colder than a wooden bench on a winter morning, so the metal must be at a lower temperature.
Correct interpretation	Both are at the same temperature as the air. Metal is a good conductor, so it carries heat away from your hand much faster; your hand loses heat quickly and feels cold.
Why the confusion happens	Our skin senses how fast we lose heat, not the actual temperature of the object.

Air: the insulator all around us

Air is a **poor conductor** of heat. Woollen clothes keep us warm because wool traps air in its pores, and that trapped air slows the flow of heat from our warm body to the cold surroundings. Wool does not make heat; it holds on to the heat our body produces.

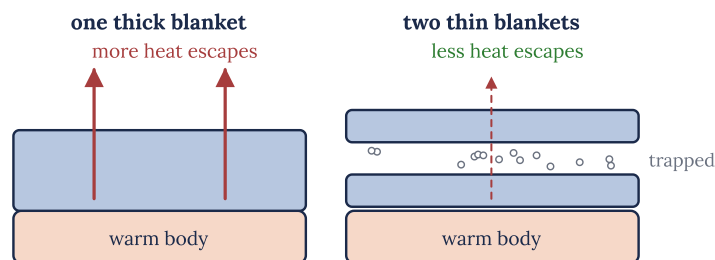
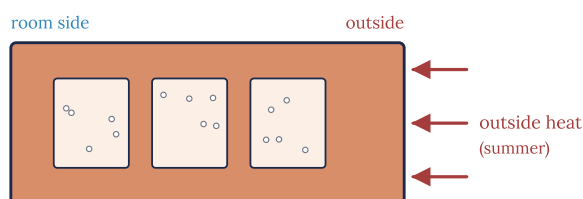


Fig. 7.2 idea. A layer of air trapped between two thin blankets acts as an insulator, so two thin blankets keep us warmer than one thick one.

Houses that use conduction



Hollow bricks: air in the gaps slows heat flow through the wall.

Hollow bricks in outer walls trap air, a poor conductor. The house stays cooler in summer and warmer in winter.

Fascinating fact. In the Mori block of Uttarkashi, Uttarakhand, winters are extremely cold. Houses are built with walls of two wooden layers filled with cow dung and mud. Wood and mud are poor conductors, so heat does not escape easily and the houses stay warm.

Worked example

Level B • applying the idea

A saucepan has a metal body and a plastic handle. Explain each choice in terms of conduction.

Body Metal is a good conductor, so heat from the flame passes quickly through the base into the food.

Handle Plastic is a poor conductor, so heat from the hot pan does not reach your hand.

Answer **body: good conductor; handle: poor conductor (insulator)**

Question types choose the correct option (order of pins falling; materials of a pan); true/false with reason (conduction in solids); explain everyday choices (woollens, blankets, hollow bricks, clay cups).

Concept check. Is air a good or a poor conductor of heat? Give two examples from this section where that fact is used.

7.2 Convection

heat carried by moving particles

NCERT §7.2, Activities 7.2–7.3, Fig. 7.3–7.5

Pema points at the smoke rising from the burning firewood. “Why is the smoke going up?”

Activity 7.2 Let us investigate

1. Hang two identical paper cups upside down from the two ends of a wooden stick, using threads of equal length.
2. Balance the stick so that it is horizontal.
3. Place a burning candle below one cup (well below it, so the cup cannot catch fire), and watch.

What you find. The cup above the candle **rises**, and the stick tilts.

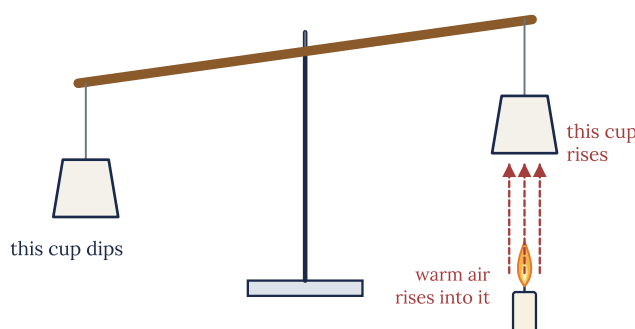


Fig. 7.3 (redrawn). Warm air from the candle collects inside the right-hand cup and lifts it.

WHY THE CUP RISES

- 1 The candle heats the air around its flame.
- 2 Warm air expands: the same air takes up more space.
it is now lighter for its size than the cooler air around it
- 3 Lighter air rises, like a cork rising in water, and collects in the cup.
the cup is pushed up

You can see air expand on heating by leaving a partly blown-up balloon in the Sun: as the air inside warms, the balloon swells (Fig. 7.4). Smoke from an incense stick (*agarbatti*) is a mixture of hot gases and tiny solid particles; because it is warmer than the surrounding air, it rises.

Misconception diagnostic

Student may think	Warm air rises because heating makes it lose weight.
Correct interpretation	The amount of air does not change. The same air spreads out into more space, so a cupful of warm air is lighter than a cupful of cool air. The cooler, heavier air around it pushes in below and lifts it.
Why the confusion happens	Everyday words like “light” and “heavy” mix up total weight with weight for a given size.

Heat transfer in liquids

Activity 7.3 Let us find out

Caution: do this under the supervision of a teacher or an adult.

1. Half-fill a 500 mL beaker with water.
2. Using a straw, place one grain of potassium permanganate at the centre of the base.
3. Heat the beaker gently with a candle placed right below the centre, and watch the coloured streak.

What you find. A purple streak rises up the middle, spreads out at the top and comes down along the sides. The pattern keeps going round.

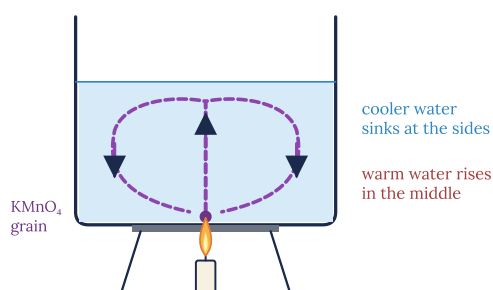


Fig. 7.5 (redrawn). The coloured streak shows the path of the moving water.

THE LOOP IN THE BEAKER

- 1 Water at the bottom, just above the flame, is heated first.
- 2 It expands, becomes lighter and rises up the middle.
- 3 Cooler, heavier water from the sides sinks to take its place.
- 4 This water is heated in turn and rises. The loop continues until all the water is hot.

a convection current

Convection: heat is carried by the actual movement of particles from one place to another

Definition

this is how liquids and gases are heated

	Conduction	Convection
Do particles move from place to place?	no, they vibrate in place	yes, they carry the heat with them
Main way heat travels in	solids	liquids and gases
Needs a medium (particles)?	yes	yes

Why? Why must a room heater be placed near the floor, and an air conditioner high on a wall?

Warm air rises and cool air sinks. A heater near the floor warms the air there; that air rises and cooler air comes down to be heated, so the whole room circulates and warms. An air conditioner cools air near the ceiling; the cool air sinks and pushes warm air up to be cooled. Both use convection to mix the whole room.

Worked example

Level A • smoke detector (NCERT Q1 iii)

Where should a smoke detector be fitted in a room: near the floor, in the middle of a wall, on the ceiling, or anywhere?

Idea Smoke from a fire is hot, so it rises by convection.

Answer **(c) on the ceiling**, where the rising smoke reaches it first

Question types explain an activity (cups, beaker); choose placement (smoke detector, heater); true/false (convection needs movement of particles).

Concept check. Water is heated in a pan from below, but a pot of milk on a stove is sometimes stirred. Why is stirring not needed for water to heat all through?

Stop and think • Level B/C (answers: Part B key, p. 32)

- | | | |
|-------------|---|---|
| B F1 | Why are ventilators fitted close to the ceiling of a room? | 2 |
| C F2 | Rewrite in your own words, correctly: "Warm air rises because it becomes lighter." What exactly is lighter than what? | 3 |
| B F3 | A hot-air balloon is lifted when its burner is on and slowly sinks when the burner is switched off. Explain both. | 3 |

Try them with the book closed. Then compare your reasoning with the key: the reason matters more than the answer.

Draw it • Level C (answer: Part B key, p. 32)



F6. The heater has been on for ten minutes. Draw arrows to show the **whole loop** of air in the room. Mark where air is warm, where it is cool and where it sinks.

Check: does your loop go up at the heater, across the ceiling, down at the window and back along the floor?

7.1 Conduction of Heat

ladder: from recall to reasoning

Part B • Level A–D

Think it through • wool, ice and a warm room

1. A student wraps a piece of ice in a woollen sweater; another leaves identical ice on the table. The room is warm. Which ice lasts longer?
2. **Direction.** Heat flows from the warm room towards the cold ice.
3. **What does wool do?** It traps air in its pores. Air is a poor conductor, so the flow of heat is slowed.
4. **So** the wrapped ice receives heat more slowly and lasts longer.
5. **Trap.** Wool does not “make” heat; it only slows heat down, in *either* direction. It keeps warmth in and warmth out.

Answer: the ice wrapped in wool lasts longer.

A Know recall from the section

A 7.1-A1 Name two good conductors and two poor conductors of heat. 2

A 7.1-A2 In Activity 7.1 which pin falls first? Why do the pins **not** all fall together? 2

B Apply the idea in a new everyday case

B 7.1-B1 The base of a pressure cooker is metal but its handle is plastic or wood. Explain both choices. 2

B 7.1-B2 Birds fluff up their feathers on a cold morning. Use the idea of trapped air to explain why. 2

B 7.1-B3 A steel spoon and a wooden spoon stand in the same cup of hot tea for a minute. Which handle end feels hotter? Why? 2

C Reason predict, design, evaluate

C 7.1-C1 Four equal rods (copper, iron, glass, wood) are coated with wax and one end of each is placed in hot water. Predict which rod’s far-end wax melts **first** and which **last**. Justify. 3

C 7.1-C2 Rahul says: “A metal chair feels colder than a wooden bench on a winter morning, so the metal must be at a lower temperature.” Design a quick test with a thermometer to check his claim and state the result you expect. 3

D Olympiad data and deduction

D 7.1-D1 Wax pins are fixed on a long strip at distances 2, 4, 6 and 8 cm from the heated end. They fall at the times shown.

distance from flame (cm)	2	4	6	8
time for pin to fall (s)	10	40	90	160

(a) Is heat travelling along the strip at a **constant** speed? Support your answer with numbers. (b) If the pattern continues, when will a pin at **10 cm** fall? (c) What does the pattern tell you about conduction over longer distances?
[5 marks]

Misconception diagnostic

Student may think Heat travels through a metal rod at a fixed speed, like a runner on a track.

Correct interpretation Heat takes **disproportionately longer** to reach farther points. Doubling the distance more than doubles the time.

Why the confusion happens We picture “flow” as steady motion. In conduction each particle must first warm up before it can pass energy on, so the delay grows with distance.

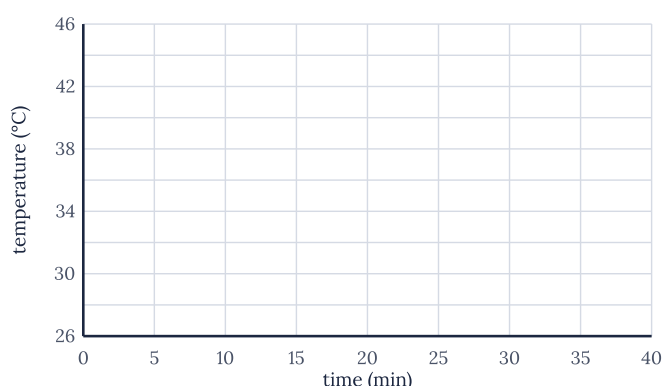
Skills Lab 1

graphs, predictions and writing with evidence

Part B • Skills

Skill 1 • Draw a graph from data

Plot **soil** and **water** from the table on page 20 (question 7.2.1.C1). Use a different mark for each line and label both lines. Check yourself: ☐ title ☐ both axes named with units ☐ scale even ☐ points marked ☐ smooth line ☐ lines labelled.



Grid for Skill 1: time (min) on the x-axis, temperature (°C) on the y-axis. Mark the moment the samples were brought indoors with a dotted vertical line.

Skill 2 • Predict – Observe – Explain

Task (safe, at home). Place one ice cube on a **metal** plate or steel lid and another, of the same size, on a **wooden** board at room temperature. Watch both for a few minutes.

Step	Your entry
Predict	Which ice cube melts faster? Why do you think so?
Observe	What did you see after 2 min, 5 min? (draw or write)
Explain	Use the words <i>conductor</i> , <i>heat flows from</i> and <i>room</i> .

Skill 3 • Claim – Evidence – Reasoning (CER)

Strong answers have three parts. Study the model, then write your own for question 7.3.C2 or 7.2.1.D2.

Model: Why is the climate of Kerala's coast milder than that of an inland desert?

Claim. Coastal places have smaller changes between day and night and between seasons.

Evidence. Water heats and cools slowly (the soil–water graph: soil rose 16 °C, water only 4 °C in the same time). The sea is a large body of water next to the coast.

Reasoning. The sea stays cooler by day and gives out its heat slowly at night, and the sea and land breezes bring this moderated air onto the land. An inland desert has dry soil that heats and cools quickly and no sea breeze to even it out.

Olympiad Bridge

ideas just beyond NCERT, explained from the ground up

Enrichment • not required for school exams

Everything on these two pages builds on Part A. It goes **beyond** the Grade 7 textbook and is marked as enrichment. Use it to see *why* the NCERT statements are true.

1 • Heat is not the same as temperature

Temperature tells you how hot something is. **Heat** is the energy that flows because of a temperature difference. A bathtub of warm water holds far more heat than a cupful of boiling water, even though the cup is hotter. A sparkler spark is extremely hot, but it carries so little energy that it hardly burns your skin.

2 • Why water is slow to change temperature

Different materials need different amounts of heat to raise the same mass by the same temperature. About **4200 J** warms 1 kg of water by 1 °C, whereas about **800–900 J** does the same for dry soil or sand. So the same sunshine warms soil about **five times** as fast as the same mass of water (this property is called *specific heat capacity*, met in later classes). Water also mixes by convection and lets sunlight go deeper, so its heat is shared through a large volume. That is the real reason behind the graph in Activity 7.4.

3 • What controls how fast heat conducts

If you change...	Heat flow	Why / example
material (metal → wood)	much slower	particles pass energy less easily
thickness (thin → thick wall)	slower	energy must travel further, as in the pins data
area (small → large)	more	more paths for heat; a big window loses more heat than a small one
temperature difference (small → large)	faster	a very hot pan heats a handle quickly; a warm one slowly

4 • Everything radiates, not only hot things

Every object gives out radiation, and the hotter it is, the more it emits. A **dark, rough** surface is a better absorber and a better emitter than a **shiny** one. So a hot black teapot cools faster than a hot shiny one, and a shiny flask keeps tea hot. The Sun's radiation is mostly visible light and infrared, with some ultraviolet.

- | | | |
|-------------|---|---|
| D O1 | A bucket of water at 30 °C and a cup of water at 80 °C are placed in cold air. Which has more heat? Which is hotter? Why are these different questions? | 3 |
| D O2 | The same sunshine falls on 1 kg of dry sand and 1 kg of water, both at 25 °C. Using the figures above, estimate how much hotter the sand is than the water after each has absorbed 8400 J. (Ignore losses.) | 4 |