1. FUNDAMENTALS OF HEAT & TEMPERATURE (ऊष्मा और तापमान) — Section 1

1.1 What is Temperature? (तापमान क्या है?): Temperature is a physical quantity that expresses the degree of **hotness or coldness** of an object or environment. When heat is added to a substance, its temperature rises; when heat is removed, its temperature falls. Unlike heat (a form of energy measured in Joules/Calories), temperature determines the **direction of heat flow**—heat always flows from a hotter body to a colder body.

तापमान वह भौतिक राशि है जो किसी वस्तु की गर्माहट या ठंडक की मात्रा बताती है। ऊष्मा सदैव अधिक तापमान वाली वस्तु से कम तापमान वाली वस्तु की ओर प्रवाहित होती है।

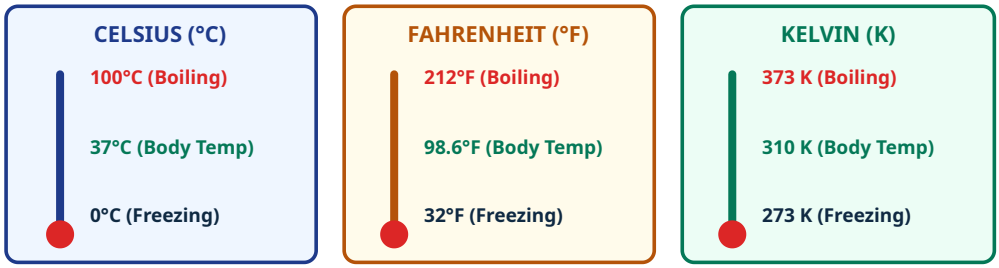

Figure 1: Comparison of Celsius (°C), Fahrenheit (°F) & Kelvin (K) Temperature Scales

1.2 Three Major Temperature Scales (तीन प्रमुख तापमान पैमाने):

- **Celsius Scale (°C):** Invented by Anders Celsius (1742). Ice melts at **0°C** and water boils at **100°C** (100 equal divisions).
- **Fahrenheit Scale (°F):** Invented by Daniel Gabriel Fahrenheit (1714). Ice melts at **32°F** and water boils at **212°F** (180 equal divisions).
- **Kelvin Scale (K):** Invented by Lord Kelvin. SI unit of temperature! Ice melts at **273 K** and water boils at **373 K**. Note: We never write a degree symbol (°) with Kelvin!

सेल्सियस (0°C से 100°C, 100 भाग), फारेनहाइट (32°F से 212°F, 180 भाग) और केल्विन (273 K से 373 K, SI मात्रक) तीन प्रमुख पैमाने हैं।

2. CELSIUS TO FAHRENHEIT CONVERSION (°C → °F) — Section 2

2.1 Exact Formula & Derivation: Since 100 divisions on Celsius equal 180 divisions on Fahrenheit (ratio 100 : 180 = **5 : 9**), we have **C / 100 = (F − 32) / 180 ⇒ C / 5 = (F − 32) / 9**. Rearranging for F gives:
F = (9 / 5) × C + 32 (or **F = 1.8 × C + 32**).

सूत्र: F = (9/5) × C + 32। पहले सेल्सियस मान को 9/5 (या 1.8) से गुणा करें और फिर उसमें 32 जोड़ दें।

Solved Example 1: Convert 35°C into degrees Fahrenheit (°F).
Solution: F = (9/5) × 35 + 32 = 9 × 7 + 32 = 63 + 32 = **95°F**.

हल: F = (9/5) × 35 + 32 = 63 + 32 = 95°F।

Solved Example 2: Convert 45°C into degrees Fahrenheit (°F).
Solution: F = (9/5) × 45 + 32 = 9 × 9 + 32 = 81 + 32 = **113°F**.

हल: F = (9/5) × 45 + 32 = 81 + 32 = 113°F।

Solved Example 3: Convert 37°C (normal human body temperature) into Fahrenheit.
Solution: F = (9/5) × 37 + 32 = 333/5 + 32 = 66.6 + 32 = **98.6°F**.

हल: F = (9/5) × 37 + 32 = 66.6 + 32 = 98.6°F।

Solved Example 4 (Negative Temp): Convert −15°C into degrees Fahrenheit.
Solution: F = (9/5) × (−15) + 32 = −27 + 32 = **5°F**.

हल: F = (9/5) × (−15) + 32 = −27 + 32 = 5°F।

3. FAHRENHEIT TO CELSIUS CONVERSION (°F → °C) Section 3

3.1 Exact Formula: Starting from C / 5 = (F − 32) / 9, multiplying both sides by 5 gives:
C = (5 / 9) × (F − 32). Always subtract 32 FIRST inside the brackets before multiplying by 5/9!

सूत्र: C = (5/9) × (F − 32)। ध्यान रखें: पहले F में से 32 घटाएँ, उसके बाद ही 5/9 से गुणा करें!

Solved Example 5: Convert 104°F into degrees Celsius (°C).
Solution: C = (5/9) × (104 − 32) = (5/9) × 72 = 5 × 8 = **40°C**.

हल: C = (5/9) × (104 − 32) = (5/9) × 72 = 40°C।

Solved Example 6: Convert 122°F into degrees Celsius (°C).
Solution: C = (5/9) × (122 − 32) = (5/9) × 90 = 5 × 10 = **50°C**.

हल: C = (5/9) × (122 − 32) = (5/9) × 90 = 50°C।

Solved Example 7: Convert 14°F into degrees Celsius (°C).
Solution: C = (5/9) × (14 − 32) = (5/9) × (−18) = 5 × (−2) = **−10°C**.

हल: C = (5/9) × (14 − 32) = (5/9) × (−18) = −10°C।

4. KELVIN SCALE & INTER-CONVERSIONS (केल्विन पैमाना) Section 4

4.1 Celsius ↔ Kelvin Relationship: Kelvin (K) is the **absolute temperature scale** where 0 K (−273°C) is called **Absolute Zero** (the lowest possible temperature in the universe).
• **K = C + 273** | **C = K − 273**.
• Note: A temperature difference of 1°C equals a temperature difference of 1 K!

केल्विन परम तापमान पैमाना है। 0 K (−273°C) को परम शून्य ताप कहते हैं। सूत्र: K = C + 273 तथा C = K − 273।

Solved Example 8: Convert 27°C into Kelvin (K) and 300 K into °C.
Solution: (i) K = 27 + 273 = **300 K**. (ii) C = 300 − 273 = **27°C**.

हल: (i) 27 + 273 = 300 K; (ii) 300 − 273 = 27°C।

Solved Example 9 (Two-Step °F → K): Convert 77°F into Kelvin (K).
Solution: Step 1 (°F → °C): C = (5/9)(77 − 32) = (5/9)(45) = 25°C. Step 2 (°C → K): K = 25 + 273 = **298 K**.

हल: पहले C = (5/9)(77−32) = 25°C, फिर K = 25 + 273 = 298 K।

5. THERMOMETERS, METALS & SCIENTIFIC FACTS — Section 5

5.1 Types of Thermometers (थर्मामीटर के प्रकार):
• **Clinical Thermometer:** Used to measure human body temperature. Range: **35°C to 42°C** (or **94°F to 108°F**). It has a small bend called a **kink** near the bulb that stops mercury from falling back before reading.
• **Laboratory Thermometer:** Used in science labs to measure liquids/chemicals. Range: **−10°C to 110°C** (no kink!).
• **Maximum–Minimum Thermometer:** Used by meteorologists to record daily highest and lowest weather temperatures.

डॉक्टरी थर्मामीटर (35°C–42°C) में पारे को गिरने से रोकने के लिए किंक (गाँठ) होता है; प्रयोगशाला थर्मामीटर (−10°C–110°C) में किंक नहीं होता।

5.2 Why Mercury is Used in Thermometers? (पारे का उपयोग क्यों?): Mercury (Hg) is the only metal that is **liquid at room temperature**. It is shiny (easy to see), expands uniformly with heat, does not stick to glass, and has a high boiling point (357°C). For very cold regions (below −39°C, where mercury freezes), **Alcohol Thermometers** are used (alcohol freezes at −115°C).

पारा (Mercury) कमरे के तापमान पर द्रव रहता है, चमकदार है और काँच से नहीं चिपकता। अत्यंत ठंडे स्थानों (−39°C से नीचे) के लिए अल्कोहल थर्मामीटर प्रयोग होता है।

Thermometer Type	Temperature Range (°C)	Range (°F)	Special Feature
Clinical Thermometer	35°C to 42°C	94°F to 108°F	Has a **kink**; measures body temp
Laboratory Thermometer	−10°C to 110°C	14°F to 230°F	No kink; read while dipped in liquid
Digital Thermometer	32°C to 43°C	90°F to 109.4°F	Mercury-free; safe electronic sensor

6. RISE/FALL IN TEMPERATURE & WORD PROBLEMS — Section 6

Solved Example 10 (Difference in Temperature): The morning temperature in Ajmer was 18°C and by afternoon it rose to 34°C. Find the rise in temperature in both °C and °F.
Solution: Rise in °C = 34 − 18 = **16°C**. Since 1°C rise = 9/5 °F rise, Rise in °F = 16 × (9/5) = **28.8°F**. (Check: 34°C=93.2°F, 18°C=64.4°F; 93.2−64.4 = 28.8°F!)

हल: °C में वृद्धि = 34 − 18 = 16°C। °F में वृद्धि = 16 × 9/5 = 28.8°F।

Solved Example 11 (Negative Temp Gap): The temperature of Shimla is −4°C and that of Jaipur is 22°C. What is the temperature difference between the two cities?
Solution: Difference = Higher − Lower = 22 − (−4) = 22 + 4 = **26°C**.

हल: अंतर = 22 − (−4) = 22 + 4 = 26°C।

Solved Example 12 (Body Fever Check): A child's temperature is 102.2°F. How many degrees °C above normal body temperature (37°C) is the fever?
Solution: C = (5/9)(102.2 − 32) = (5/9)(70.2) = 5 × 7.8 = 39°C. Fever above normal = 39 − 37 = **2°C**.

हल: 102.2°F = 39°C। सामान्य (37°C) से अधिक = 39 − 37 = 2°C।

Solved Example 13 (Proof of −40°): Find the temperature at which Celsius and Fahrenheit readings are numerically equal.
Solution: Let C = F = x. Then x = (9/5)x + 32 ⇒ x − (9/5)x = 32 ⇒ (−4/5)x = 32 ⇒ x = 32 × (−5/4) = **−40°**.

हल: माना C = F = x, तो x = (9/5)x + 32 ⇒ −4x/5 = 32 ⇒ x = −40°।

7. QUICK REFERENCE CONVERSION TABLE & EXAM CHECKLIST — Section 7

Celsius (°C)	0°C	10°C	20°C	25°C	30°C	37°C	50°C	100°C
Fahrenheit (°F)	32°F	50°F	68°F	77°F	86°F	98.6°F	122°F	212°F
Kelvin (K)	273 K	283 K	293 K	298 K	303 K	310 K	323 K	373 K

Solved Example 14 (Average Temperature): The temperatures of a city for 5 days were 28°C, 30°C, 32°C, 29°C, and 31°C. Find the average temperature.
Solution: Sum = 28 + 30 + 32 + 29 + 31 = 150°C. Average = 150 / 5 = **30°C**.

हल: कुल योग = 150°C; औसत तापमान = 150 / 5 = 30°C।

Solved Example 15 (Drop in Temperature): At midnight the temperature was 5°C. It dropped by 8°C by 4 AM. What is the temperature at 4 AM?
Solution: 5°C − 8°C = **−3°C**.

हल: 5°C − 8°C = −3°C।

8. RMS CET ADVANCED WORD PROBLEMS & MENTAL SHORTCUTS — Section 8

8.1 Mental Math Shortcut for °C ↔ °F: Notice that every **5°C** change equals exactly a **9°F** change! Starting from 0°C = 32°F: 5°C = 41°F, 10°C = 50°F, 15°C = 59°F, 20°C = 68°F, 25°C = 77°F, 30°C = 86°F, 35°C = 95°F, 40°C = 104°F!

मानसिक गणित ट्रिक: प्रत्येक 5°C की वृद्धि पर फारेनहाइट में ठीक 9°F की वृद्धि होती है (0°C=32°F, 10°C=50°F, 20°C=68°F, 30°C=86°F, 40°C=104°F)।

Solved Example 16 (Two-City Comparison): At 6 AM, Srinagar recorded −3°C while Ajmer recorded 14°C. By 2 PM, Srinagar rose by 7°C and Ajmer rose by 11°C. Find the afternoon temperature difference between Ajmer and Srinagar.
Solution: Srinagar at 2 PM = −3 + 7 = 4°C. Ajmer at 2 PM = 14 + 11 = 25°C. Difference = 25 − 4 = **21°C**.

हल: दोपहर 2 बजे श्रीनगर = −3 + 7 = 4°C; अजमेर = 14 + 11 = 25°C। अंतर = 25 − 4 = 21°C।

Solved Example 17 (Freezing Mixture): Ice is at −8°C and boiling water is at 100°C. What is the temperature gap between them in both °C and K?
Solution: Gap in °C = 100 − (−8) = **108°C**. Since 1°C change = 1 K change, Gap in Kelvin = **108 K**.

हल: °C में अंतर = 100 − (−8) = 108°C। केल्विन में अंतर भी ठीक 108 K होगा!

Solved Example 18 (Boiling Point at High Altitude): On Mount Abu, water boils at 96°C instead of 100°C. Express 96°C in Fahrenheit.
Solution: F = (9/5) × 96 + 32 = 864/5 + 32 = 172.8 + 32 = **204.8°F**.

हल: F = (9/5) × 96 + 32 = 172.8 + 32 = 204.8°F।

Solved Example 19 (Converting 410 K to °F): Convert 410 K into degrees Fahrenheit.
Solution: Step 1: C = 410 − 273 = 137°C. Step 2: F = (9/5) × 137 + 32 = 246.6 + 32 = **278.6°F**.

हल: C = 410 − 273 = 137°C; F = (9/5) × 137 + 32 = 278.6°F।

9. COMMON EXAM TRAPS & FORMULA REVISION TABLE — Section 9

Common RMS Exam Mistake (सामान्य गलती)	Correct Rule (सही नियम)
Writing 373°K with a degree symbol	Kelvin NEVER uses a degree symbol — write **373 K**
Multiplying F by 5/9 before subtracting 32	Always subtract 32 FIRST: **(F − 32) × 5/9**
Adding 32 before multiplying C by 9/5	Always multiply C by 9/5 FIRST, then add 32
Reading clinical thermometer as −10°C to 110°C	Clinical is **35°C–42°C**; Lab thermometer is **−10°C–110°C**

10. HIGH-YIELD RMS CET ONE-LINER REVISION BANK — Section 10

10.1 Key Exam Facts (परीक्षा के महत्वपूर्ण तथ्य):

• **Galileo Galilei** invented the first thermoscope (early thermometer); **Anders Celsius** gave the 0–100°C scale.

• **Clinical Thermometer Kink:** Prevents mercury from dropping back into the bulb automatically.

• **Maximum–Minimum Thermometer:** Used in weather stations to record highest day and lowest night temperatures.

• **1°C change = 1 K change = 1.8°F change** (always remember this for temperature difference problems!).

गैलीलियो ने थर्मामीटर का आविष्कार किया; डॉक्टरी थर्मामीटर में किंक पारे को गिरने से रोकता है; 1°C अंतर = 1 K अंतर = 1.8°F अंतर।

Narayan Sir's 100% Score Checklist: (1) Memorise Boiling (100°C / 212°F / 373 K), Freezing (0°C / 32°F / 273 K), and Body Temp (37°C / 98.6°F / 310 K). (2) Remember −40°C = −40°F. (3) Never write a degree symbol (°) before Kelvin (K). (4) Subtract 32 first when converting °F to °C!

100% अंक मंत्र: (1) हिमांक, क्वथनांक व शरीर ताप याद रखें। (2) −40°C = −40°F। (3) K के साथ ° नहीं लगता। (4) °F से °C में पहले 32 घटाएँ!