HEAT MEASURES

Physics Notes • Secondary School Level

1. Meaning of heat and temperature

Heat is energy transferred from a hotter body to a colder body because of a temperature difference. Heat is measured in joules (J). **Temperature** tells us how hot or cold a body is. It is commonly measured in degrees Celsius (°C) or kelvin (K).

Important difference: heat is energy being transferred, while temperature measures how hot or cold something is. A large bucket of warm water can contain more thermal energy than a small cup of hotter water.

2. Measuring temperature

A **thermometer** is an instrument used to measure temperature. Common types include liquid-in-glass thermometers, digital thermometers and laboratory thermometers.

How to read a liquid-in-glass thermometer

• Keep the thermometer upright where possible.

• Place its bulb in contact with the substance whose temperature is being measured.

• Wait until the liquid level becomes steady.

• Read the scale at eye level to avoid parallax error.

• Do not let the bulb touch the sides or bottom of a container unless the procedure requires it.

3. Temperature scales

The main temperature scales are Celsius, Kelvin and Fahrenheit. In most school physics work, Celsius and Kelvin are especially important.

Scale	Water freezes	Water boils at standard atmospheric pressure
Celsius (°C)	0 °C	100 °C
Kelvin (K)	273 K (approximately)	373 K (approximately)
Fahrenheit (°F)	32 °F	212 °F

Conversion formulas

Temperature in kelvin = temperature in °C + 273 (school-level approximation)

Temperature in °C = temperature in kelvin − 273

°F = (9/5 × °C) + 32

°C = 5/9 × (°F − 32)

4. Measuring heat energy

Heat energy can be measured using a **calorimeter** in suitable experiments. The amount of heat needed to change a substance's temperature depends on its mass, the material and the temperature change.

Formula: $Q = mc\Delta T$

Where:
Q = heat energy transferred, measured in joules (J)
m = mass, measured in kilograms (kg)
c = specific heat capacity, measured in J kg■¹ °C■¹
ΔT = change in temperature = final temperature − initial temperature

Specific heat capacity is the heat energy required to raise the temperature of 1 kg of a substance by 1 °C (or 1 K), without a change of state.

5. Worked examples

Example 1: Convert 25 °C to kelvin.
K = °C + 273 = 25 + 273 = **298 K**.

Example 2: Calculate heat energy.
A 2 kg mass of water is heated from 20 °C to 30 °C. Take the specific heat capacity of water as 4,200 J kg■¹ °C■¹.
$Q = mc\Delta T = 2 \times 4{,}200 \times (30 - 20) = 84{,}000$ J.

Example 3: Convert 68 °F to Celsius.
°C = 5/9 × (68 − 32) = 5/9 × 36 = **20 °C**.

6. Changes of state and latent heat

When a substance melts or boils, it can absorb heat while its temperature remains constant during the change of state. The energy is used to change the arrangement of particles rather than increase their average kinetic energy.

Specific latent heat formula: $Q = mL$

Q = heat energy (J); m = mass (kg); L = specific latent heat (J kg■¹).
Specific latent heat of fusion: energy needed to change 1 kg of a solid into liquid at its melting point, without changing temperature.
Specific latent heat of vaporisation: energy needed to change 1 kg of liquid into gas at its boiling point, without changing temperature.

7. Common sources of error and safety

• Parallax error: reading a scale from above or below eye level.

• Heat loss: energy escapes to the surroundings during an experiment.

• Poor contact: the thermometer bulb does not properly contact the substance.

• Use suitable equipment and handle hot water, flames and hot containers carefully.

• Never use a thermometer outside its stated temperature range.

8. Quick revision questions

1. Define heat and temperature.

2. Name the instrument used to measure temperature.

3. Convert 40 °C to kelvin.

4. State two differences between heat and temperature.

5. Write the formula used to calculate heat energy and explain each symbol.

6. What is specific heat capacity?

7. Explain why temperature may remain constant while ice melts.

Answers for self-check

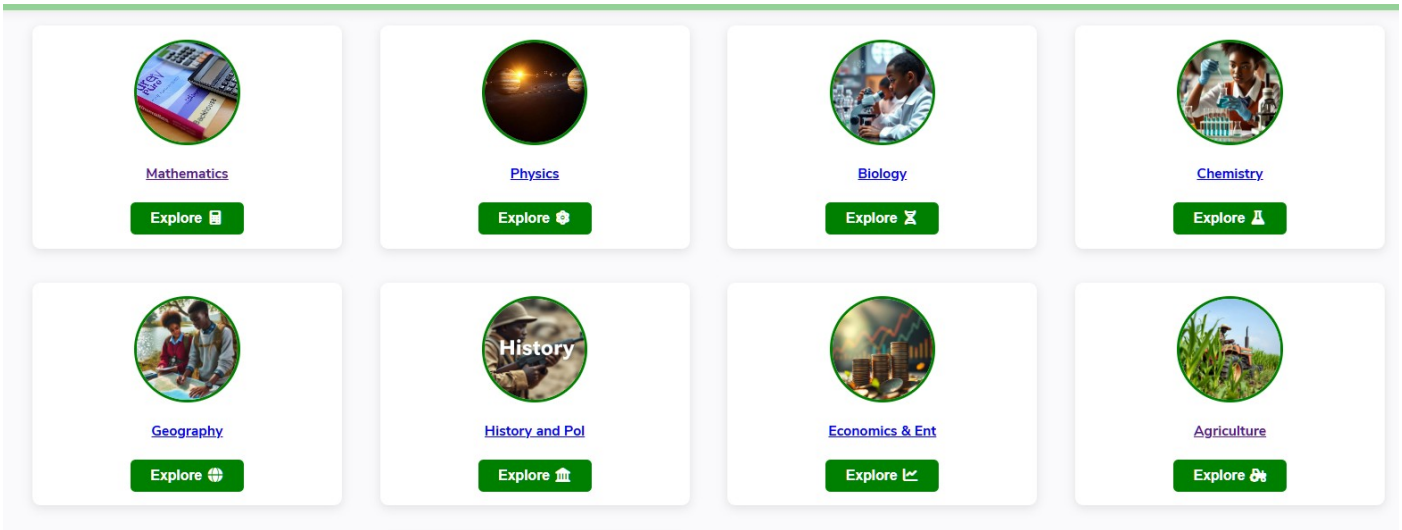
• 3. 40 + 273 = 313 K.

• 5. $Q = mc\Delta T$; Q is heat energy, m is mass, c is specific heat capacity and ΔT is temperature change.

• 6. Heat energy required to raise the temperature of 1 kg of a substance by 1 °C (or 1 K).

• 7. The energy is used for the change of state rather than raising the temperature.

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