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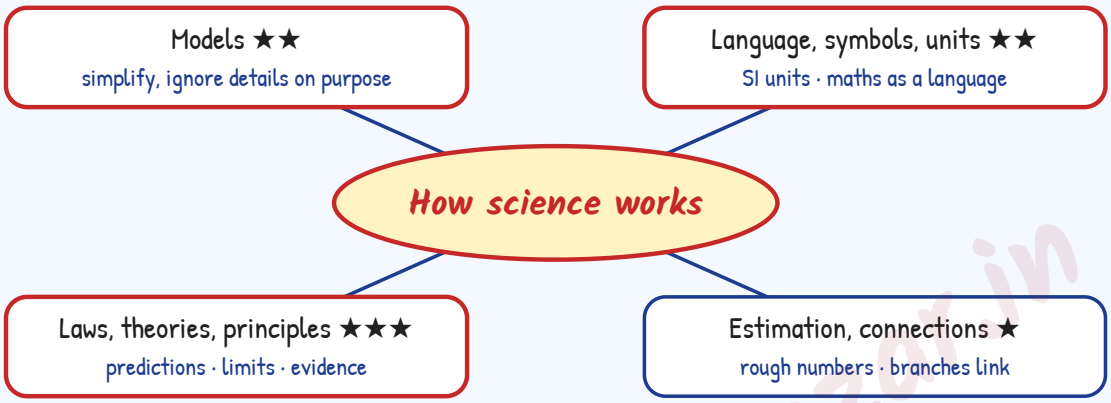
Class 9 · Science (Exploration) · Chapter 1

Entering the World of Secondary Science



NCERT Exploration, Grade 9 · 2026-27 edition

Chapter map (★ = important for tests)



What is inside

1. Concept notes with NCERT examples
2. Pause and Ponder, Activity and estimation answers
3. Exam-style questions, MCQs, A–R and summary

★ **Exam tip:** This is the **opening chapter** of the new book. It has no end exercises, but school tests ask about: the **difference between a law, a theory and a principle**; what a **scientific model** is and why we ignore details; why **SI units** matter; how to **check a claim** with evidence; and simple **estimation** sums. Every idea here comes back in later chapters.

Based on NCERT "Exploration" Grade 9 (2026-27), Chapter 1. Answers and estimates are our own. Questions are Exam-style.

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1.1 From wonder to deep exploration

In the middle stage, science made us **curious**: observe closely, ask questions, find out how things work. The secondary stage continues with **deep exploration**: science is not only **what we know** but **how we know it**: how observations lead to **measurements**, how patterns are written with **symbols and equations**, how **models** represent complex systems, and how ideas are **tested, revised and sometimes discarded**. The book's page numbers are framed by a **magnifying glass** (careful observation, noticing patterns) and a **compass** (direction: choosing the right models and questions, knowing where ideas apply).

1.2 Models: simplified pictures of reality ★★

Definition ✎ **Scientific model**: a simplified way of looking at a real system that focuses only on **what is most important for a given question**. Building a model means making **assumptions** and **deliberately ignoring** certain details. These choices are **not mistakes**; they keep things simple enough while still letting us find the answer we want. For more accuracy we add more details later.

Branch	Model used	What is ignored
Physics	a moving car shown as a **single point**; a falling object with gravity only	the car's shape and size; **air resistance**
Chemistry	atoms and molecules drawn as **spheres and bonds**	the fine inner structure of atoms
Biology	cells as diagrams highlighting key parts; the heart as a pumping **organ**	the many individual cells of the heart
Earth science	the Earth as a **smooth sphere** with distinct layers	mountains, valleys, uneven shape

Example 1.1: a cricket shot for six. Question: will the ball cross the boundary without hitting the ground? **Keep**: the mass of the ball, the speed and direction of the hit. **Ignore**: brand of the bat, colour of the ball, grass on the field. **Smaller effects** that a simple model ignores: air resistance, spin, stitching on the seam.

Meet a scientist: Meghnad Saha. Studying starlight, he did not model every atom, reaction or movement inside a star. He treated the star's matter as a **hot gas**, ignored many complex processes and focused on **temperature, pressure** and how atoms formed **ions**. This simplification explained how the **colour of a star is connected to its temperature**.

1.3 The careful language of science ★★

Everyday words such as **force, work, cell, reaction** have **specific meanings** in science, so ideas are communicated clearly and unambiguously. Scientists across the world share a language of **terms, symbols and units**. Quantities like **mass, velocity, force, electric current** have symbols **m, v, F, I**, each with a defined unit.

Word	Everyday meaning	Scientific meaning (you will meet later)
Work	any effort or job	done only when a force moves an object (Ch 7)
Force	strength, pressure on someone	a push or pull that can change motion (Ch 6)

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Cell	a battery or a small room	the basic unit of life (Ch 2)
Reaction	a response to something	a change that forms new substances

★ **Exam tip: Why is the speed of light written c?** Symbols often come from history and international agreement, not from short forms: **c** comes from the Latin **celeritas**, meaning speed. The speed of light is a physical constant, defined to be exactly **299792458 m/s**.

1.4 Mathematics: a language for thinking

Mathematics is **not a hurdle**; it lets relationships between quantities be expressed clearly and tested. An **equation** is not just a calculation tool; it is a **compact statement** of how things are related (distance, time and velocity tell where an object will be later; equations also describe rates of reactions, population growth, energy changes). Using maths in science does **not** mean memorising equations: **understand the situation first, identify the relevant quantities, then reason with the relationships.**

1.5 Standard (SI) units ★★

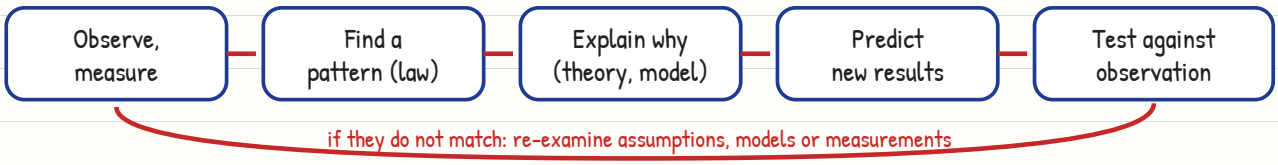
Why a kilogram everywhere? When we buy rice or vegetables (on a pan balance), a kilogram must mean the same everywhere. Measurements are based on **agreed international standards**, not local objects or opinions. Standard units let scientific results be **compared** and ensure **fairness in trade**.

Airplane fuel mix-up (NCERT): a flight needed **22,300 kg** of fuel, but the ground crew used the density of fuel in **pounds per litre** instead of **kilograms per litre**. The aircraft was about **15,000 litres short**, ran out of fuel mid-flight and glided to an emergency landing (aircraft damaged, no casualties). Since 1 kg ≈ 2.2 lb, mixing them up is a huge error. **Using SI units everywhere avoids conversions and errors.**

1.6 Laws, theories and principles ★★★

Term	Meaning (NCERT)	Example
Law	describes a **regular pattern observed in nature**, often in words or mathematical relationships	**Newton's laws of motion** explain the jerk felt when a bus stops suddenly
Theory	goes a step further: **explains why** those patterns occur, based on evidence gathered over time and available at that time	the **atomic theory** explains how molecules are formed
Principle	a **broad idea** that helps us make sense of a given situation	**conservation of energy** applied when climbing stairs

✗ **Don't do this: A theory is NOT a guess.** In science a theory is an explanation based on **careful testing and critical examination**. These ideas are always open to improvement and change as new evidence becomes available; this is a key feature that makes science **reliable**.



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1.7 The power of prediction ★★

Well-established laws, theories and models let us **anticipate** what will happen under new conditions, before an experiment, and even when we cannot do one: how far a kicked football will travel (motion); how much carbon dioxide will be produced or how soft bread will be (chemical reactions); how breathing changes while running (biology). Predictions are **reasoned expectations based on evidence**, not guesses. When they match observations, confidence grows; when they do not, scientists **re-examine** assumptions, models or measurements.

Example 1.2: Varsha says "It will rain this afternoon because the clouds look dark." Questions that make it testable ask about **measurable data and past patterns**: What was the sky like the last time it rained? What is the humidity today; was it above 80 per cent last time? What are today's wind speed and direction? Is the temperature dropping as before the recent rains? (Yes/no questions are less useful.)

Why do weather forecasts go wrong? Weather depends on many changing factors (temperature, pressure, humidity, wind). Forecasts use measurements and models, but **tiny differences in conditions can grow over time**, so forecasts are reliable for a few hours or days but less certain further ahead.

1.8 Limits of theories and evidence ★★

Even the most successful theories have **limits** and may fail under new conditions or more precise measurements. Such failures are science's **greatest strength**, not its weakness: scientists reject ideas **only on evidence**, not opinion or belief. **No scientific theory is ever final and none is beyond question**; this openness to correction by nature is what makes science useful.

Checking a viral claim: "Food should not be eaten during an eclipse because it becomes harmful." Ask simple scientific questions: an eclipse is just a **play of shadows**. What physical change occurs? Does the temperature change significantly? Does food go bad if left in a shadow? **No physical, chemical or biological mechanism** supports the claim, so it is false.

1.9 Estimation: does the answer make sense? ★★

A good habit: (1) **understand the situation**, (2) **identify the quantities** that matter, (3) make a **rough estimate** to check whether an answer is reasonable or impossible. Exact values are not always needed early on. Estimation builds intuition, catches errors and gives confidence. **"Science values careful reasoning perhaps much more than accurate calculations!"**

Example 1.3: Litres of air breathed in a day

Breaths: 12–15 a minute × 1,440 minutes a day ≈ 18,000–22,000, about **20,000 breaths**.

Volume: 4–5 breaths fill a party balloon of about 2 L, so one breath ≈ **0.5 L**.

Air a day ≈ 20,000 × 0.5 = **10,000 litres**.

Check: a balloon in about 20 s ⟶ 3 balloons a minute × 2 L × 1,440 min ≈ **8,640 L**, close to 10,000 L.

Our estimate: rice for a family of four for a month

Assume all calories from rice. Adults need 2,000–2,500 kcal a day; children less; take about **8,800 kcal** a day for

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the family.
100 g of uncooked rice gives about **350 kcal** (check the pack; values are 340–360).
Rice a day ≈ 8,800 ÷ 350 × 100 g ≈ **2.5 kg**.
Rice a month ≈ 2.5 × 30 ≈ **75 kg**. Sensible: far more than 100 g, far less than a few tonnes.

1.10 The branches are connected ★

After Grade 10, science is divided into **physics, chemistry, biology and earth science**, but the natural world has **no such boundaries**; the divisions only help organise knowledge. Real problems (climate change, medicines, sustainable technology) need several disciplines together, plus mathematics, technology, arts and social sciences. **How a mask works**: physics (particle motion, electrostatic attraction), chemistry (polymer fibres), biology (size and behaviour of viruses), mathematics (modelling airflow and filtration efficiency).

Activity 1.1: let us model (bicycle ride home)

Ans. **Keep**: the distance from school to home, your average cycling speed, the number of traffic signals or crossings and the usual waiting time there, any steep slope on the way. **Ignore**: the colour of the bicycle, the brand of tyres, what you are wearing, small changes in wind on most days. **Why ignoring helps**: the model stays simple (time ≈ distance ÷ average speed + waiting time), easy to calculate, and still gives an answer close enough to plan when to leave; we can add details (rain, traffic) only if we need more accuracy.

Pause and Ponder answers

1. Think of a prediction your family made recently (e.g. a cricket match). Was it based on evidence or guesswork? How can scientific thinking improve it?

Ans. Example: "India will win because our captain is lucky." This is guesswork. Scientific thinking would use evidence: recent results of both teams, each player's form, pitch and weather reports, the toss and past results at that ground. The prediction becomes a reasoned expectation and can be checked after the match; if it fails, we ask which factor we misjudged.

2. One situation where an approximate answer is good enough, and one where you need an exact value.

Ans. Approximate: how much rice to buy for a month, or how long the bus ride will take. Exact: a medicine dose for a child, the fuel needed for an aircraft (as the fuel mix-up shows), or the amount of a chemical in a laboratory test.

3. Choose a real-life object or problem and show ideas from at least two branches of science.

Ans. **Pressure cooker**: **physics** (higher pressure raises the boiling point of water, the safety valve and whistle); **chemistry** (cooking breaks down starch and proteins; the steel and rubber gasket materials); **biology** (soft food is easier to digest; heat kills germs); **mathematics** (how many whistles for how much rice). **Traffic jam near school**: mathematics (vehicle counts, timing of signals), physics (speed and braking distance), earth science and biology (air pollution, its effect on breathing).

Threads of Curiosity answered

Ans. **Why is a kilogram used everywhere?** So that every buyer and seller, and every scientist, means the same amount; results can be compared and trade is fair. **Why is the speed of light c?** From the Latin *celeritas* (speed); it is fixed at exactly 299792458 m/s. **Is food harmful in an eclipse?** No: an eclipse only creates a shadow; nothing physical, chemical or biological changes the food.

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Exam-style questions Exam-style

1. What is a scientific model? Why do scientists ignore some details while making it? [2]

> **Ans.** A model is a simplified way of looking at a real system that keeps only what is important for a given question. Details are ignored on purpose to keep the problem simple enough to solve while still giving a useful answer; e.g. a falling stone studied without air resistance.

2. Distinguish between a law and a theory with one example each. [3]

> **Ans.** A law describes a regular pattern in nature, often as a mathematical relation (Newton's laws of motion: the jerk in a stopping bus). A theory explains why the pattern happens, based on evidence (atomic theory explains how molecules form). A theory is not a guess; it is tested carefully and can be improved with new evidence.

3. "Failures of theories are science's greatest strength." Explain. [3]

> **Ans.** When predictions do not match observations, scientists re-examine their assumptions, models or measurements and improve the theory. Ideas are accepted or rejected only on evidence, not opinion. Since no theory is final, science keeps correcting itself and becomes more reliable over time.

4. Why should SI units be used everywhere? Give one real example of the danger of mixing units. [3]

> **Ans.** Standard units mean the same everywhere, so results can be compared and trade is fair, and no conversion errors occur. Example: a flight needing 22,300 kg of fuel was loaded wrongly because density was taken in pounds per litre instead of kilograms per litre; it was about 15,000 litres short and had to glide to an emergency landing.

5. Estimate how many times your heart beats in a day. Show your reasoning. [3]

> **Ans.** At rest the heart beats about 70 times a minute (60–100). Minutes in a day = 60 × 24 = 1,440. Beats ≈ 70 × 1,440 ≈ 1,00,800, about **1 lakh beats a day**. Check: 1 beat per second gives 86,400, the same order, so the estimate is reasonable.

6. A message says "Drinking water kept under a pyramid shape cures diseases." How would you test it scientifically? [3]

> **Ans.** Ask what mechanism could change the water; take two similar groups (or samples) and give one pyramid water and the other ordinary water without telling them which (fair test); measure a clear outcome; repeat; compare. Without evidence from such tests and a mechanism, the claim should not be accepted.

7. How does a mask show that branches of science are connected? [2]

> **Ans.** Physics (motion of particles, electrostatic attraction), chemistry (polymer fibres), biology (size and behaviour of viruses) and mathematics (modelling airflow and filtration) are all needed to understand it.

10 MCQs

1. The magnifying glass on the page numbers stands for
   (a) direction (b) careful observation (c) speed (d) mathematics

2. In a simple model of a falling object we usually ignore
   (a) gravity (b) mass (c) air resistance (d) time

3. Meghnad Saha treated the matter in a star as
   (a) a liquid (b) a hot gas (c) a solid (d) plasma of cells

4. The symbol c for the speed of light comes from the Latin word
   (a) celeritas (b) centum (c) calor (d) constans

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5. An explanation of why a pattern occurs, based on evidence, is a
   (a) law (b) theory (c) guess (d) unit

6. Conservation of energy is an example of a
   (a) law of motion (b) principle (c) model (d) unit

7. We take about ___ breaths a minute at rest.
   (a) 2–3 (b) 12–15 (c) 50–60 (d) 100

8. Air we breathe in a day is about
   (a) 100 L (b) 1,000 L (c) 10,000 L (d) 1,00,000 L

9. Scientists reject an idea on the basis of
   (a) opinion (b) belief (c) evidence (d) popularity

10. Weather forecasts are less certain far ahead because
    (a) instruments fail (b) tiny differences grow over time (c) clouds hide data (d) models are banned

1 (b) · 2 (c) · 3 (b) · 4 (a) · 5 (b) · 6 (b) · 7 (b) · 8 (c) · 9 (c) · 10 (b)

Assertion–Reason (4)

(a) Both true, R explains A. (b) Both true, R does not explain A. (c) A true, R false. (d) A false, R true.

1. A: Ignoring details in a model is not a mistake. R: It keeps the model simple while still answering the question.
2. A: A scientific theory is just a guess. R: Theories can change with new evidence.
3. A: Using SI units avoids errors. R: No conversion between different unit systems is needed.
4. A: Eating food during an eclipse is harmful. R: An eclipse is a play of shadows.

Key: 1 (a) · 2 (d) · 3 (a) · 4 (d)

Last-night summary

- Science = what we know + how we know it; magnifying glass (observation) and compass (direction).
- Models simplify on purpose (point car, spheres for atoms, smooth Earth; Saha's hot-gas star; cricket shot).
- Precise language, symbols (m, v, F, I, c from celeritas) and SI units (fuel mix-up); maths is a language for thinking.
- Law = pattern; theory = explanation (not a guess); principle = broad idea. Predictions are reasoned; failures lead to improvement; no theory is final.
- Check claims with evidence (eclipse food). Estimate: understand, identify quantities, rough numbers (20,000 breaths, 10,000 L a day).
- Branches are connected (mask example).

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