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SOLUTIONS BOOK

CLASS 9

Science · Exploration

CHAPTER 1

Exploration: Entering the World of Secondary Science

Complete In-text Questions and Activities Solutions

In-text Questions

Contents

Class 9 Science · Exploration · Chapter 1 — Exploration: Entering the World of Secondary Science

1.1 **In-text Questions** 3

13 questions · Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13

Every question is followed by its answer. Question numbers above are clickable and the PDF bookmarks panel lets you jump to any exercise set or question. Figures are reproduced from the NCERT textbook (© NCERT) for educational use.

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1.1

CLASS 9 SCIENCE · CHAPTER 1

In-text Questions

Solutions · 13 questions

Directions (Questions 1–13): These are the questions, examples and activities that appear inside the chapter (Example, Activity, Threads of Curiosity, Pause and Ponder and Ready to Go Beyond), numbered in the order in which they appear. Many are open-ended; model answers based on the chapter are given, and you may add examples from your own surroundings.

QUESTION 1 *Example 1.1 · p. 2*

Think of a cricket ball being hit for a six. You want to make a simple model. What details would you include? What would you ignore?

ANSWER

A model keeps only the details that matter for the question being asked. Here the question is: “Will the ball cross the boundary without hitting the ground first?”

a Details to include and ignore

Detail	In the simple model?	Why
Mass of the ball	**Include**	Very important for how the ball moves
Speed and direction of the hit	**Include**	Very important for where the ball lands
Air resistance, spin of the ball, stitching of the seam	Ignore (for now)	Smaller effects that can be ignored in a simple model
Brand of the bat, colour of the ball, amount of grass on the field	**Ignore**	Make no difference to whether the ball crosses the boundary

b Adding more detail later

As we build more and more complex models, we add extra details (such as air resistance and spin) for greater accuracy.

Therefore, include the mass of the ball and the speed and direction of the hit; ignore details that make no difference or have only small effects.

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QUESTION 2 *Activity 1.1 · p. 2*

Suppose you ride a bicycle from your school to your home. You want to model the time it takes to go home from school. What details would you keep? What details could you ignore? Suggest why ignoring some details may actually be useful.

ANSWER

The question the model must answer is: "How long does the ride from school to home take?" Only the details that affect this time are kept.

a Details to keep

- **Distance** of the route from school to home.
- **Average speed** of the ride (time = distance ÷ speed).
- Long **stops** on the way (for example at a railway crossing), if they add noticeable time.

b Details to ignore

- Colour, make and decoration of the bicycle, and the colour of your bag or clothes.
- Small changes of speed along the road – use one average speed instead.

c Simple example

Distance = 3 km, average speed = 12 km/h

Time = distance ÷ speed = 3 ÷ 12 h = 0.25 h = 15 minutes

d Why ignoring some details is useful

- A model with only the important details is simple enough to work with, yet still answers the question.
- Ignoring details is done on purpose; it is not a mistake. Details that make no difference only complicate the model.
- If we need a more accurate answer, extra details (traffic, slopes) can be added later.

Therefore, keep the distance and the average speed, ignore details such as colour, and remember that leaving out unimportant details keeps the model simple.

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QUESTION 3 *Threads of Curiosity · p. 3*

Why is the speed of light denoted by ‘c’?

ANSWER

Scientific symbols often come from history and international agreements; they are not necessarily abbreviations chosen for convenience.

a Reason for the symbol c

- The symbol **c** comes from the Latin word *celeritas*, meaning **speed**.
- So the speed of light is usually written as c, even though the word “speed” does not start with c in English.

b Its value today

The speed of light is one of the physical constants and is defined to be exactly **299 792 458 m/s** (about 3×10^8 m/s when rounded).

Therefore, c stands for the Latin word celeritas (speed), and its symbol was fixed by history and international agreement.

QUESTION 4 *Threads of Curiosity · p. 3*

Why is a kilogram used everywhere?

ANSWER

We expect 1 kg of rice or vegetables to mean the same amount everywhere (Fig. 1.1). This is possible because measurements are based on agreed international standards.

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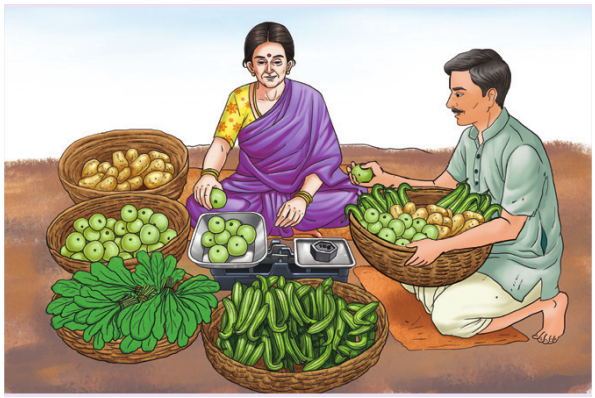

Fig. 1.1: A vegetable seller using a pan balance

a Reasons

- Measurements are based on agreed international standards, **not** on local objects or opinions.
- Standard units allow scientific results to be compared.
- They ensure fairness in daily life and trade; imagine the confusion if different weights were used everywhere.

b Example of what can go wrong

A passenger aircraft ran out of fuel mid-flight because of a mix-up of units: the ground crew used the density of fuel in pounds (lb) per litre instead of kilograms (kg) per litre. Using standard (SI) units everywhere avoids conversions and errors.

Therefore, a kilogram is used everywhere because it is an agreed international standard that makes measurements comparable, fair and free of unit errors.

QUESTION 5 *Pause and Ponder 1 · p. 4*

Think of a prediction you or your family made recently (for example, the outcome of a cricket match). Was it based on evidence and reasoning, or mainly on guesswork? How can scientific thinking improve such predictions?

ANSWER

Model answer using the cricket-match example. Your own prediction may differ, but the same questions can be asked of it.

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a Was the prediction a guess?

A family member says, “Our team will win today because it is my favourite team.” This is mainly **guesswork**, because it rests on liking and not on evidence.

b How scientific thinking improves it

Guesswork	Evidence and reasoning
“Our team always wins.”	Check the recent results and the head-to-head record of the two teams.
“I feel they will win.”	Look at the form of the main players and the condition of the pitch and weather.
Forget the prediction once the match is over.	Compare the prediction with the result; if it was wrong, re-examine the assumptions.

Therefore, a prediction based on evidence and careful thinking is a reasoned expectation, not a guess, and it can be tested and improved.

QUESTION 6 *Example 1.2 · p. 4*

Varsha told her friend Meghna, “It will rain this afternoon because the clouds look dark”. Think of some questions Meghna could ask Varsha to make this prediction scientifically testable.

ANSWER

Good scientific questions look for measurable evidence and past patterns. Questions with simple yes/no answers are usually not so useful.

a Questions Meghna could ask (examples)

Question	What it checks
What was the condition of the sky when it rained the last time?	Past pattern
What is the humidity today?	Measurable data
Was the humidity above 80 per cent the last time it rained?	Measurable data compared with a past pattern
What is today’s wind speed and direction?	Measurable data
Is the temperature dropping like it did before the recent rains?	Past pattern

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Therefore, questions about measurable data and past patterns go beyond "clouds look dark" and make the prediction scientifically testable.

QUESTION 7 *Ready to Go Beyond · p. 4*

Why do weather forecasts sometimes go wrong?

ANSWER

Weather depends on many changing factors, so it is difficult to predict exactly.

a Reasons

- Weather depends on many factors such as temperature, pressure, humidity and wind.
- Forecasts use measurements and models, but very tiny differences in conditions can grow over time and lead to something completely different.
- So forecasts are usually reliable for a few hours or even a few days, but less certain further into the future.

b What scientists do when a forecast fails

When predictions do not match observations, scientists re-examine their assumptions, models or measurements. This drives further exploration.

Therefore, forecasts sometimes go wrong because tiny differences in many changing conditions grow over time.

QUESTION 8 *Threads of Curiosity · p. 5*

Checking 'viral' claims on social media: Is eating food harmful during an eclipse? The claim: "Food should not be eaten during an eclipse because it becomes harmful". What physical change occurs during an eclipse? Does temperature change significantly? Does food go bad if it is left in a shadow?

ANSWER

A claim is tested by asking simple scientific questions. An eclipse is just a play of shadows (Fig. 1.2).

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Fig. 1.2: A total solar eclipse

a Answering the three questions

Question	Answer
What physical change occurs during an eclipse?	Only a shadow: for a short time the Sun’s light is blocked, so a place is shaded. Nothing in the food itself changes.
Does temperature change significantly?	No significant change that could affect food; any change is small and temporary.
Does food go bad if it is left in a shadow?	No. Food kept in shade or indoors every day does not go bad because of the shadow.

Therefore, no physical, chemical or biological mechanism supports the claim that food becomes harmful during an eclipse.

QUESTION 9 *Ready to Go Beyond · p. 5*

How much rice would feed a family of four for a month? To make a rough estimate, assume that all their calorie needs come from rice alone (Fig. 1.3). An average adult needs about 2000 – 2500 kilocalories (kcal) per day. Find out how many calories 100 g of uncooked rice provides when cooked and use this to estimate the daily requirement for the family. The aim is not to get an exact number, but to check whether the answer makes sense.

ANSWER

This is a rough estimate. We assume every member needs as much as an average adult and that rice is the only food.

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Fig. 1.3: Rice being cooked on a gas stove

a Step-by-step estimate

Step 1: Energy from rice ≈ 350 kcal per 100 g of uncooked rice
Step 2: Family needs ≈ 4 × 2000 = 8000 kcal to 4 × 2500 = 10 000 kcal per day
Step 3: Rice per day (lower) ≈ 8000 ÷ 350 × 100 g ≈ 2286 g ≈ 2.3 kg
Step 3: Rice per day (upper) ≈ 10 000 ÷ 350 × 100 g ≈ 2857 g ≈ 2.9 kg
Step 4: Rice per month (lower) ≈ 2.286 × 30 ≈ 69 kg
Step 4: Rice per month (upper) ≈ 2.857 × 30 ≈ 86 kg

The value of about 350 kcal per 100 g is the usual figure for uncooked rice (check the packet of rice at home). Cooked rice has absorbed water, so 100 g of cooked rice gives much less energy.

b Does the answer make sense?

- 100 g for a month would be clearly too little, and a few tonnes would be far too much.
- About 70 – 85 kg lies between these two limits, so the estimate is reasonable.
- In real life families also eat other foods and children need less, so the actual amount of rice would be smaller.

Therefore, a family of four would need roughly 70 – 85 kg of rice for a month if rice were their only food.

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QUESTION 10 *Example 1.3 · p. 6*

Estimate how many litres of air you breathe in one day. Start by estimating how many breaths you take per minute, and the volume of one breath. Your aim is not to find an exact answer, but a reasonable estimate.

ANSWER

We multiply the number of breaths in a day by the volume of one breath. Both numbers are estimated.

a Number of breaths in a day

At rest we take about 12 – 15 breaths per minute

Minutes in a day = 60 × 24 = 1440

Breaths per day ≈ 12 × 1440 = 17 280 to 15 × 1440 = 21 600

≈ 18 – 22 thousand, say about 20 thousand breaths a day

b Volume of one breath

About 4 – 5 breaths fill a rubber party balloon of about 2 litres

One breath ≈ 2 ÷ 4 = 0.5 litre to 2 ÷ 5 = 0.4 litre ≈ 0.5 litre

c Air breathed in a day

Air per day ≈ 20 000 × 0.5 litre = 10 000 litres

d Checking the estimate a second way

A balloon can be blown up in about 20 s, so about 3 balloons a minute can be filled.

3 balloons/minute × 2 litres/balloon × 1440 minutes/day

= 8640 litres per day

8640 litres is reasonably close to 10 000 litres, so the estimate is sensible. (Blowing balloons non-stop would tire us quickly, unlike normal restful breathing.)

Therefore, we breathe in roughly 10 000 litres of air a day (about 8000 – 10 000 litres).

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QUESTION 11 *Pause and Ponder 2 · p. 6*

Describe one situation where an approximate answer is good enough, and one where you would need a very exact value.

ANSWER

An approximate answer is enough when we only need to know whether a result is reasonable; an exact value is needed when a small error can cause harm.

a Two situations

Situation	Approximate or exact?	Reason
Estimating how much rice a family needs for a month, or how many litres of air we breathe in a day	**Approximate** is enough	We only need to check that the answer is reasonable, not impossible
Working out the fuel needed for an aircraft flight (22 300 kg in the chapter's example)	**Exact** value needed	A small error or a mix-up of units can leave the aircraft short of fuel

Therefore, a rough estimate is good for checking reasonableness, but an exact value is needed where safety depends on it.

QUESTION 12 *Pause and Ponder 3 · p. 6*

Choose a real-life object (maybe a pressure cooker or a mobile phone) or a problem (maybe a traffic jam near your school). Make a sketch listing what kind of ideas from physics, chemistry, biology, earth science, or mathematics are involved. Show how at least two branches of science connect with your example.

ANSWER

Model answer for a **pressure cooker**. You may choose another object, such as a mobile phone.

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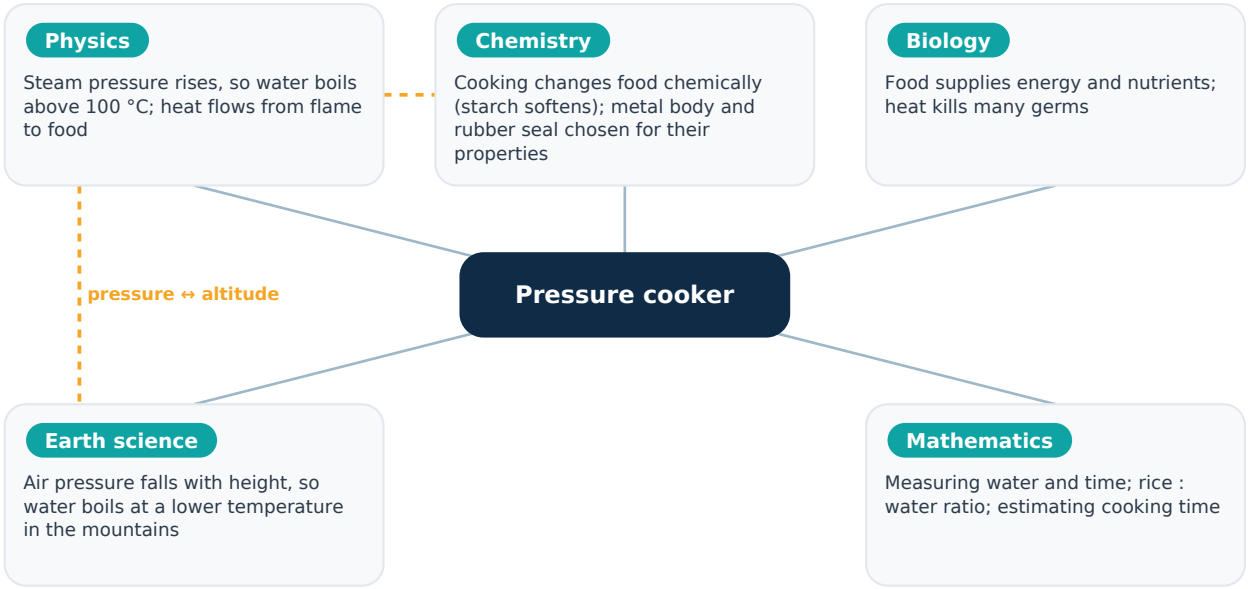
a Sketch: ideas from different branches



b How the branches connect

- **Physics and chemistry:** higher steam pressure raises the boiling point of water, so the chemical changes of cooking (for example, starch in rice softening) happen faster.
- **Physics and earth science:** air pressure is lower at greater heights, so water boils at a lower temperature in the mountains; a pressure cooker makes up for this by trapping steam.
- **Chemistry and biology:** cooking changes food chemically and heat kills many germs, so the food is easier to digest and safer to eat.

Therefore, even one everyday object such as a pressure cooker uses ideas from physics, chemistry, biology, earth science and mathematics together.

QUESTION 13 *Ready to Go Beyond · p. 7*

How does a mask really work?

ANSWER

Solving real problems requires knowledge from several branches of science. During the COVID-19 pandemic we all used masks for safety (Fig. 1.4).

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Fig. 1.4: A collection of surgical masks

a Ideas from different branches

Branch	Concept needed
Physics	Particle motion and electrostatic attraction
Chemistry	Properties of polymer fibres
Biology	Size and behaviour of viruses
Mathematics	Modelling airflow and filtration efficiency

Therefore, understanding how a mask works needs physics, chemistry, biology and mathematics together.

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