AL AMAL LEARNING CENTER

PHYSICS KEY BOOK

Class 9 | Unit 1

PHYSICAL QUANTITIES AND MEASUREMENT

EXERCISE: SHORT AND LONG QUESTIONS

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About this part

Solved exercise short response questions (Q2) and long response questions (Q3) for Class 9 Physics Unit 1.

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PART EXERCISE: SHORT AND LONG QUESTIONS

Q2. Short Response Questions

1. How does physics play an important role in our life?

Physics is behind every technology we use: computers, phones, the internet, airplanes, medical scans (PET), rockets and trains. It also supports other sciences, for example the physics of fluid flow explains blood circulation in biology and subatomic particles explain chemical reactions. So physics improves communication, transport, medicine and daily comfort.

2. Estimate your age in minutes and seconds.

Take an age of 15 years (use your own age in the same steps).

- Minutes = 15 × 365 × 24 × 60 = 7,884,000 min ≈ 7.88×10^{6} min.
- Seconds = 7,884,000 × 60 = 473,040,000 s ≈ 4.73×10^{8} s.

3. Which base quantities are involved in force, pressure, power and charge?

Quantity	Unit in base units	Base quantities involved
Force	$\mathrm{kg\,m\,s^{-2}}$	mass, length, time
Pressure	$\mathrm{kg\,m^{-1}s^{-2}}$	mass, length, time
Power	$\mathrm{kg\,m^{2}s^{-3}}$	mass, length, time
Charge	A s	electric current and time

4. Show that the prefix micro is 1000 times smaller than milli.

micro = 10^{-6} and milli = 10^{-3}. Ratio milli ÷ micro = $10^{-3} \div 10^{-6} = 10^{3} = 1000$. So micro is a thousand times smaller than milli.

5. Justify that displacement is a vector while energy is a scalar.

Displacement needs a direction as well as a size (e.g. 5 km north), so it is a vector. Energy is fully given by a number and a unit (e.g. 50 J) and has no direction, so it is a scalar.

6. Why can a screw gauge give more precise length than a vernier calliper?

Its least count is 0.01 mm against 0.1 mm of a vernier calliper. The small pitch (0.5 mm) is divided into 50 circular-scale divisions, so very small fractions of a millimetre can be read.

7. Differentiate between a mechanical and a digital stopwatch.

A mechanical stopwatch has two dials and hands, one knob to start, stop and reset, and least count 1 s. A digital stopwatch shows time as numbers, uses two buttons (start/stop and reset/lap), and has least count 0.1 s.

8. How is a measuring cylinder used to measure the volume of an irregular stone?

Pour water in and read V_1. Lower the stone (tied to a thread) fully into the water and read V_2. Volume of the stone = $V_2 - V_1$.

9. What precaution should be kept while using a measuring cylinder?

Keep the cylinder on a flat surface and your eye level with the liquid surface, reading at the bottom of the meniscus, to avoid reading error. Also lower solids gently and make sure they are fully immersed.

10. Why do we need significant digits in measurements?

They show how reliable a measurement is: the certain digits and one doubtful digit. They stop us from reporting more accuracy than the instrument can give.

11. How can random error be reduced?

By taking the same reading many times and finding the mean, and by using statistical analysis. Example: measure the time of 10 oscillations of a pendulum and divide by 10.

12. Differentiate between precision and accuracy.

Precision is how close repeated readings are to each other (consistency). Accuracy is how close a reading is to the true value. A thermometer that is always 2 °C too high is precise but not accurate.

Q3. Long Response Questions

1. Define physics. Describe its revolutionary role in technology.

Physics is the branch of science that studies matter, energy and their interaction. Nearly every modern technology comes from physics principles: computers, smartphones, airplanes, rockets and space shuttles, magnetically levitating trains, PET scans and micro-robots in medicine, and nuclear energy. Physics also keeps developing these technologies further.

2. List with brief description the different branches of physics.

Branch	Brief description
Mechanics	Motion of bodies and forces
Optics	Light and its behaviour
Oscillations and waves	Vibrations, sound and waves
Thermodynamics	Heat and temperature
Electromagnetism	Electricity and magnetism
Astrophysics	Stars, planets and the universe
Quantum physics	Very small particles and energy packets
Atomic and nuclear physics	Atom, nucleus and radioactivity

Branch	Brief description
Relativity	Space, time and gravity at high speeds

3. What are physical quantities? Distinguish between base and derived quantities, with three examples of derived quantities.

Physical quantities are quantities that can be measured, such as length, mass, time and temperature. **Base quantities** are the simplest ones, chosen so that all others can be obtained from them (length, mass, time and so on). **Derived quantities** are obtained by multiplying or dividing base quantities.

Examples of derived quantities:

- **Area** = length × length, unit m^2.
- **Speed** = length ÷ time, unit $\mathrm{m\,s^{-1}}$.
- **Density** = mass ÷ volume = mass ÷ length³, unit $\mathrm{kg\,m^{-3}}$.
- (Also: force = mass × length ÷ time², unit $\mathrm{kg\,m\,s^{-2}}$ = newton.)

4. What do you mean by unit of a physical quantity? Define base units and derived units.

A **unit** is the standard with which a physical quantity is compared in measurement. **Base units** are the units of the seven base quantities in SI (m, kg, s, A, K, mol, cd). **Derived units** are formed by multiplying or dividing base units (m^2, $\mathrm{m\,s^{-1}}$, N = $\mathrm{kg\,m\,s^{-2}}$, Pa, J).

5. What are prefixes? What is their use in measurements?

A **prefix** is a name given to a power of ten (kilo = 10^3, milli = 10^{-3}, micro = 10^{-6} and so on). Prefixes let us write very large or very small values in convenient units without long strings of zeros, for example 40 µm for a page thickness or 5 km for a distance, and they make scientific notation easier to use.

6. What is scientific notation? Give at least five examples.

It is a way of writing a number as **mantissa × 10^exponent**, where the mantissa is from 1 up to 10. Examples:

Ordinary number	Scientific notation
149,530,000,000 m (Earth–Sun)	1.4953×10^{11} m
0.0008 g (human hair)	8×10^{-4} g
86,400 s (one day)	8.64×10^{4} s
5,980,000,… (21 zeros) kg (Earth's mass)	5.98×10^{24} kg
0.0000000000000017 m (nucleus)	1.7×10^{-15} m

7. Describe the construction and working of the vernier calliper in detail.

Construction: it has a fixed **main scale** (divisions of 1 mm) with a fixed jaw at its left end, and a sliding **vernier scale** carrying a movable jaw. It also has outside jaws, inside jaws, a depth probe and

a retainer (locking screw).

Working: the vernier scale divisions are slightly shorter than main-scale divisions, so a small fraction of a millimetre can be read.

$$\text{Least count} = \frac{\text{smallest main-scale division}}{\text{number of vernier divisions}} = \frac{1\ \text{mm}}{10} = 0.1\ \text{mm}$$

Taking a reading: check zero error; fix the object between the jaws; read the main scale reading (MSR) just before the vernier zero; find the vernier division coinciding with a main-scale division (VSR); total = MSR + VSR × LC (corrected for zero error). It can measure thickness, diameter, width, and inner and outer diameter of hollow cylinders.

8. What is a screw gauge? What is its pitch and least count? How is it used to measure the thickness of a thin copper wire?

A **screw gauge** is a length-measuring device used for lengths smaller than a vernier calliper can measure; it reads a fraction of the smallest main-scale division by rotating a circular scale. **Pitch** is the distance the circular scale moves on the linear scale in one rotation (e.g. 0.5 mm).

$$\text{Least count} = \frac{\text{pitch}}{\text{number of circular divisions}} = \frac{0.5}{50} = 0.01\ \text{mm}$$

To measure a copper wire:

1. Note the pitch, least count and zero error.
2. Place the wire between the anvil and the spindle.
3. Close the gap with the ratchet until it clicks.
4. Read the main (linear) scale.
5. Multiply the circular-scale line at the datum line by 0.01 mm.
6. Add the two readings and correct for zero error. Repeat a few times and take the mean.

9. Define error. Differentiate between random and systematic error. How can these errors be reduced?

Error is the uncertainty that arises during measurement; no measurement is perfectly exact.

Point	Systematic error	Random error
Nature	Same direction every time	Unpredictable, irregular
Causes	Faulty instrument or zero error, poor technique, personal bias	Changing conditions, reaction time, instrument limits
Reduced by	Better instruments and methods, calibration, less bias	Repeating readings and taking the mean

10. Differentiate between scalars and vectors. Justify that distance, speed, mass and energy are scalars while displacement, velocity, acceleration and force are vectors.

Point	Scalar	Vector
Description	Magnitude and unit only	Magnitude, unit and direction

Point	Scalar	Vector
Algebra	Ordinary	Vector algebra
Examples	Distance, speed, time, mass, energy, temperature	Displacement, velocity, acceleration, force, weight, momentum

Justification: distance (4.5 km), speed (20 m/s), mass (5 kg) and energy (50 J) are fully stated by a number and a unit, so they are scalars. Displacement (5 km north), velocity (20 m/s east), acceleration (2 m/s² downward) and force (10 N upward) are incomplete unless the direction is stated, so they are vectors.

11. Justify and illustrate the use of a measuring cylinder to measure the volume of a liquid.

A measuring cylinder is a transparent tube with a vertical scale in mL (cm^3), so the height of the liquid directly gives its volume. Pour the liquid in, place the cylinder on a flat surface, keep the eye level with the liquid surface, and read the scale at the bottom of the meniscus. Example: if the liquid surface is at the 60 mL mark, the volume is 60 mL (60 cm^3). Its least count is about 1 cm^3, so changes smaller than this cannot be measured. Choose a cylinder whose size suits the volume of liquid.

12. Differentiate between precision and accuracy.

Point	Precision	Accuracy
Meaning	Closeness of repeated readings	Closeness to the true value
Related to	Random errors / scatter	Systematic errors / bias
Example	Darts tightly grouped away from the centre	Darts around the bullseye

Exam tip

In long questions, answer in the order the question asks (define, differentiate, example), and write one point per mark. A two-column table is the quickest way to score full marks in "differentiate between" questions.