AS | Physics - 9702 - 1.1 Physical Quantities

INTRODUCTION

A physical quantity is one that can be measured or calculated from other measurements. Scientists often make measurements. These need to be stated with the units of the quantity being measured, and how accurate the measurements are. We will explore the different physical quantities and their SI units in this unit.

LEARNING OBJECTIVES

By the end of this unit you should be able to:

1. Understand that all physical quantities consist of a numerical magnitude and a unit.
2. Make reasonable estimates of physical quantities included within the syllabus.
3. Recall the following SI base quantities and their units: mass (kg), length (m), time (s), current (A) and temperature (K).

Physical Quantities and SI Units

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Introduction

In this section we look at what physical quantities are, and the SI units we use to measure them.

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TERMS AND DEFINITIONS

SI unit - Internationally agreed upon system of units - Système Internationale d'Unités

Estimate - An approximate value of a quantity

Physical quantity - Any measurable quantity

Unit - The scale to which a measurement is compared

1. Physical Quantities

Making measurements is very important in physics. Without numerical measurements, we would have to rely on descriptions, and this could lead to inaccurate comparisons. We would not be able to build a building if the instructions were just 'big' or 'small'.

When making these measurements, physicists use different instruments for different physical quantities and take special care to make these measurements as accurate as possible. For any measurement, the unit being used must be stated to give an understanding of the scale of the measurement.

A ***physical quantity*** is one that can be measured: for example, mass.

All physical quantities consist of:

- a numerical magnitude (**size**)
- the ***unit*** in which it was measured.

Letters are used to represent these physical quantities. For example, the letter *'m'* is used to represent mass. The units provide the context of how much of *'m'* is being referred to: for example, 60 g and 60 kg are two very different quantities. The flashcard below is an example of how to express a physical quantity in terms of both the numerical size and unit.

Mass of an adult woman

m= 65 kg

A physical quantity is measurable. Units are the **scale of measurement**. Having units is essential in our everyday life.

There is a seemingly endless number of units in physics, but the ***SI system*** called the *Système Internationale d'Unités* brings some order to units. It is an internationally agreed-upon system of units which consists of base units that are carefully defined and allow us to compare other measurements against them.

What is a physical quantity?

VIDEO

2. SI Units

Physical quantity	Unit	Typical symbol
mass	kilogram	kg
length	metre	m
time	second	s
temperature	kelvin	K
electric current	ampere	A
amount of substance	mole	mol
luminous intensity	candela	cd

[Note, you are not required to use the candela in this section.]

All other units can be **derived** from the seven base units. For example:

- Volume is measured in cubic metres (m^3)
- Density is measured in kilograms per cubic metre ($kg\ m^{-3}$)
- Velocity is measured in metres per second ($m\ s^{-1}$)

Please remember to leave a small space between them when writing units. Leaving out the space might lead to using an incorrect unit. For example, you need to write the unit for speed as 3 m s^{-1}. If you write it as 3 ms^{-1}, it would mean 3 $millisecond^{-1}$.

EXAM - STYLE QUESTIONS

Consider these EXAM-STYLE QUESTIONS below. After reflecting on these questions, click the FEEDBACK and EXPLANATION tabs to reveal the suggested answers.

QUESTION	FEEDBACK	EXPLANATION

1. In the following list, underline all the units that are SI base units.

ampere coulomb metre newton [1]

2. State the SI base units of volume. [1]

QUESTION	FEEDBACK	EXPLANATION

1. Ampere and metre

2. m^3

QUESTION	FEEDBACK	EXPLANATION

1. Coulomb and newton are derived units which are made up of one or more of the S.I. base units.

2. $V = L \times W \times H$
$= m \times m \times m$
$= m^3$

As a follow up to the exam-style questions, you can gain more practice here ▶ Physical Quantities & Units MCQ. ◀

3. Estimating Physical Quantities

When you carry out an experiment or a calculation, it is sensible to look at the answer to see if it seems **reasonable**. For example, you might want to recheck your answer if you find that the speed of a car is 900 km/s! To do this, you need to be aware of some **basic benchmarks**. The following tables give some real quantities in everyday life and knowledge of these will help you to make reasonable ***estimates***.

Mass of sun	2×10^{30} kg
Mass of Earth	6×10^{24} kg
Mass of moon	7×10^{22} kg
Mass of an elephant	2×10^{6} kg
Mass of a football	4×10^{-1} m
Length of a car	2 m
Distance from Earth to sun	1.52×10^{8} m
Diameter of an atom	3×10^{-10} m
Human life expectancy	2×10^{9} s
Orbit period of the moon	2×10^{6} s

KEY TAKEAWAYS

- A physical quantity is something that can be measured: for example, time.
- Units are used to give an understanding of the scale of the measurement.
- Scientists use standardised units called SI units.
- A scientist is expected to be able to make reasonable estimates of quantities.

TEST YOUR KNOWLEDGE

1. Let's start by seeing whether you can estimate some quantities with their most relevant size. Match the object with the most applicable estimation:

1	The wavelength of UV light	10 n m
2	Height of an adult human	2 m

3	Distance between the Earth and the sun	1.5×10^8 m
4	Mass of a hydrogen atom	10^{-27} kg
5	Mass of an adult human	70 kg
6	Power of a lightbulb	60 W
7	Atmospheric pressure	1×10^5 Pa
8	Seconds in a day	90 000 s
9	Speed of sound in air	3×10^7 m s^{-1}

SUBMIT

2. Which of the following is an SI base unit?

- current
- gram
- Kelvin
- volt

SUBMIT

3. Five energies are listed below.

- 5 kJ
- 5 mJ
- 5 MJ
- 5 nJ

Starting with the smallest first, what is the order of increasing magnitude of these energies?

- 5 kJ → 5 mJ → 5 MJ → 5 nJ
- k nJ → 5 kJ → 5 MJ → 5 mJ
- 5 nJ → 5 mJ → 5 kJ → 5 MJ
- 5 mJ → 5 nJ → 5 kJ → 5 MJ

SUBMIT

4. What is a reasonable estimate of the average gravitational force acting on a fully grown woman standing on the Earth?

- 60 N
- 250 N

- 350 N
- 650 N

SUBMIT

5. Which statement includes a correct unit?

- energy = 7.8 N s
- force = 3.8 N s
- momentum = 6.2 N s
- torque = 4.7 N s

SUBMIT

6. For which quantity is the magnitude a reasonable estimate?

- frequency of a radio wave 500 pHz
- mass of an atom 500 µg
- the Young's modulus of a metal 500 kPa
- wavelength of green light 500 nm

SUBMIT

REFERENCES

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END OF UNIT