Chapter 1. Making measurements

Contents:

New word list:

1.1 Physical quantities and measurement techniques

Core

1 Describe the use of rulers and measuring cylinders to find a length or a volume

2 Describe how to measure a variety of time intervals using clocks and digital timers

3 Determine an average value for a small distance and for a short interval of time by measuring multiples (including the period of oscillation of a pendulum)

Supplement

4 Understand that a scalar quantity has magnitude (size) only and that a vector quantity has magnitude and direction

5 Know that the following quantities are scalars: distance, speed, time, mass, energy and temperature

6 Know that the following quantities are vectors: force, weight, velocity, acceleration, momentum, electric field strength and gravitational field strength

7 Determine, by calculation or graphically, the resultant of two vectors at right angles, limited to forces or velocities only

1.1Physical Quantities

Why do we need physics quantities? What is a physical quantity? Name **three** common physical quantities.

Classification of physical quantities:

How do we express physical quantities? e.g. the height of your desk.

1.2 Measurements

1.2.1 Unit

- **SI Unit** (French: Système International d'Unités, English: International System of Units)

7 Basic quantities and their SI Units:

7 Base Quantity	SI Unit	
	Name	Symbol
Mass		
Length		
Time		
Electric current		
Temperature		
Luminous intensity		
Amount of substance		

Exercise:

1.a Guess the mass of an apple, an adult, an airplane, the Earth, express them in SI unit. Guess the size of an atom, the height of an adult, a school building, the circumference of the Earth, express them in SI unit.

- Powers of ten shorthand — **standard notation**

Example:

$$9000 = 9 \times 10 \times 10 \times 10 = 9 \times 10^3$$
$$900 = 9 \times 10 \times 10 = 9 \times (\quad)$$
$$90 = 9 \times 10 = 9 \times 10^1$$
$$9 = 9 \times 1 = 9 \times (\quad)$$
$$0.9 = 9/10 = 9 \times 10^{-1}$$
$$0.09 = 9/100 = 9 \times (\quad)$$
$$0.009 = 9/1000 = 9 \times 10^{-3}$$

Exercise:1.b:

1000 = ;10= ;1 = ;0.000005 =

- **Prefix** (take meter as an example)

Definition of meter:

Submultiples:

1 nanometer(nm) = m

1 micrometer( ) = m

1 millimeter( ) = m

1 centimeter( ) = m

1 decimeter( ) = m

Multiples:

1 kilometer( ) = m

1 megameter( ) = m

1 gigameter( ) = m

Generally,

kilo(k) corresponds to:

mega(M) corresponds to:

giga(G) corresponds to:

milli(m) corresponds to:

micro(μ) corresponds to:

Exercise: 1.c

1 kg = g

1 mA = A

1 ms = s

1.2.2 Significant figures

General rules for determining significant figures:

Exercise 1.d

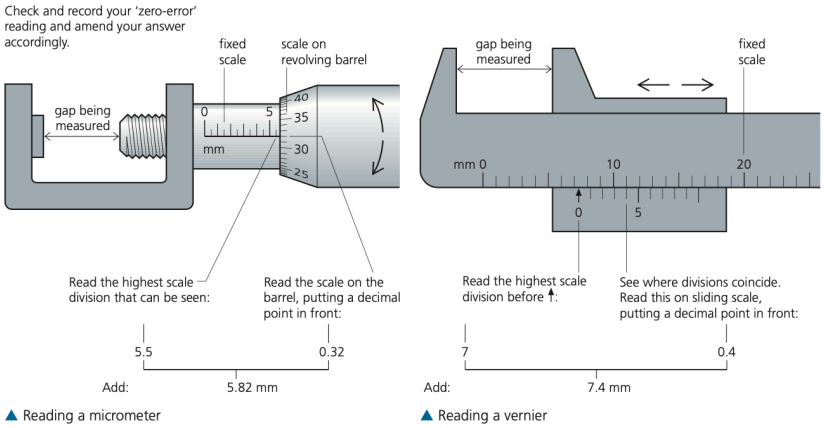
1.200 has __ significant figures.
1200 has __ significant figures.
1200. has __ significant figures.
1200.0 has __ sf.
1.2 has__ sf.
0.012 has __ sf.

1.2.3 Measuring length

Try to measure the length of a wire yourself, answer following questions.
What do you have to consider before measuring? How do you do the measurement? How do you read the result? How about measuring the thickness of a sheet of paper? How do you measure curved lines?

Measurement techniques:

More precise measurement: micrometer & vernier



▲ Reading a micrometer ▲ Reading a vernier

1.2.4 Measuring area

Exercise: 1.f

$1\ dm^2 =$ m^2

$1\ cm^2 =$ m^2

Exercise: 1.g Measure the area of the front page of your textbook.

1.2.5 Measuring volumes

Exercise: 1.h

$1\ dm^3 =$ m^3

$1\ cm^3 =$ m^3

$1\ liter(l) = 1(\quad)$

$1\ milliliter(ml) = 1(\quad) =$ m^3

I. Liquid:
   tool:
   how to read:
   choice of cylinder:

Exercise: 1.i

II. Solid: Regularly shaped:
   Volume of a cuboid =

   Volume to be measure is around 300ml, which of following cylinder's capacity is most suitable?

   A. 100 cm^3 B. 250 cm^3 C. 500 cm^3 D.1000 cm^3

   Volume of a cube =
   Volume of a sphere =
   Volume of a cylinder =

III. Solid: Irregularly shaped:

technique: *displacement*.

Explain in your own words, how to use displacement to measure a rock. What is the **key** step?

1.2.6 Measuring time

tool: *analogue* clock; *digital* clock/stopwatch (When to use which?)

Measuring short intervals of time

e.g. measure the *period* of a pendulum.

Mass is not weight.

Weight:

1.3 Density

1.3.1 Mass:

Def of mass:

Unit of mass:

Tool to measure mass:

1.3.2 Density:

Def of density:

Unit of density:

Density of water:

Values of density:

	Material	Density/kg/m³
Gases	air	1.29
	hydrogen	0.09
	helium	0.18
	carbon dioxide	1.98
Liquids	water	1000
	alcohol (ethanol)	790
	mercury	13 600
Solids	ice	920
	wood	400–1200
	polyethene	910–970
	glass	2500–4200
	steel	7500–8100
	lead	11 340
	silver	10 500
	gold	19 300

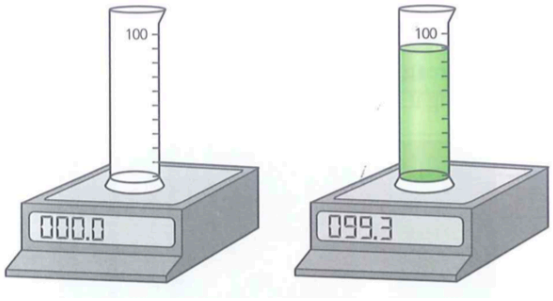
Table 1.3: Densities of some substances. For gases, these are given at a temperature of 0 °C and a pressure of 1.0×10^5 Pa.

Calculating density — density of earth:

The Earth has a mass of $6 \times 10^{24}\ kg$ and a radius of about $6400\ km$.

1.3.3 Finding the density of a liquid

How to use balance to measure the mass of liquid?



1.3.4 Liquids with different densities

Miscible:

Immiscible: