Chapter 2

Measurement

A TIME

For thousands of years people measured time by observing the passage of day and night, the stars, and the changes of season. This was necessary to help them with farming and other aspects of daily life.

The earliest inventions for measuring time included the sundial, the hourglass, and the waterclock or *clepsydra*.

Over the centuries many different devices were made to measure time more accurately, eventually leading to the watches and clocks we use today. The most accurate clock in the world, the cesium fountain atomic clock, is inaccurate by only one second every 20 million years.

UNITS OF TIME

The units of time we use are based on the sun, the moon, and the Earth's rotation.

The most common units are related as follows:

1 minute = 60 seconds
1 hour = 60 minutes = 3600 seconds
1 day = 24 hours
1 week = 7 days
1 year = 12 months = $365\frac{1}{4}$ days

For times which are longer or shorter we either multiply or divide by powers of 10:

1 millisecond = $\frac{1}{1000}$ second

1 microsecond = $\frac{1}{1\,000\,000}$ second

1 decade = 10 years
1 century = 100 years
1 millennium = 1000 years

Convert into seconds: 2 hours 5 minutes 28 seconds

2 h 5m 28 s

120m = 7200s

300

28

7528 s

2h x 60 x 60 = 7200

5min x 60 = 300

+ 28

Convert into minutes: 3 days 1 hour 48 minutes

3d 1h 48m

60x24x3

48+60+4320

4428 min

3:42 → 4:00 18

4pm → 6am = 14

6:00 - 6:08 8

Find the time difference between: 3:42 pm and 6:08 am the next day.

3:42pm - 6:08am

18min

14hrs

8min

14 hrs 26 mins

B TEMPERATURE

There are two units which are commonly used to measure temperature:

degrees Celsius (°C) and degrees Fahrenheit (°F).

	water freezes	water boils
°F	32	212
°C	0	100

If C is in degrees Celsius and F is in degrees Fahrenheit then:

- to convert °C to °F, use $F = \frac{9}{5}C + 32$
- to convert °F to °C, use $C = \frac{5}{9}(F - 32)$

Rearrange $F = \frac{9}{5}C + 32$ to show that $C = \frac{5}{9}(F - 32)$.

$F = \frac{9}{5}C + 32$

$-32 \quad -32$

$\frac{5}{9}(F-32) = \left(\frac{9}{5}C\right)\frac{5}{9}$

$\frac{5}{9}(F-32) = C$

$\frac{9}{5} \cdot \frac{5}{9} = \frac{45}{45}$

Convert into °C:

a 0°F b 100°F

Convert into °F:

a 70°C

C SCIENTIFIC NOTATION (STANDARD FORM)

https://youtu.be/AWof6knvQwE

Write as a decimal number:

a The estimated population of the world in the year 2020 is 7.4×10^9 people.

b The pressure at the edge of the Earth's thermosphere is about 1.0×10^{-7} Pa.

Express the following in scientific notation:

a The Jurassic period lasted about 54 400 000 years.

b The ball bearing in a pen nib has diameter 0.003 m.

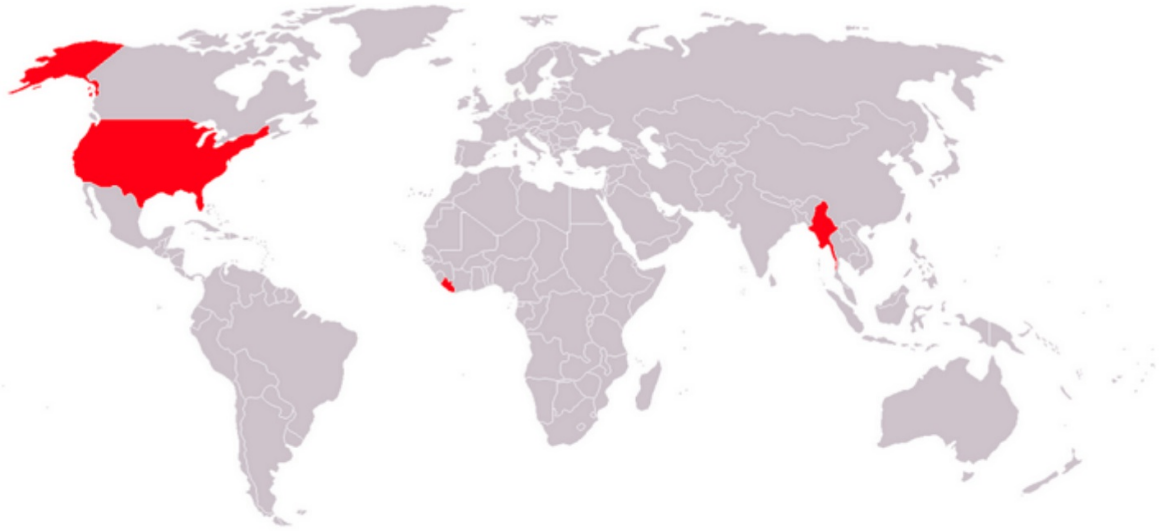
D INTERNATIONAL SYSTEM (SI) UNITS

The **International system of Units** is the world's most widely used system of measurement.

It is founded on seven base units:

Quantity	*Name*	*Symbol*
Distance	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Intensity of light	candela	cd
Amount of substance	mole	mol

Map of countries officially not using the metric system



http://www.zmescience.com/other/map-of-countries-officially-not-using-the-metric-system/

Other SI units, called **derived units**, are defined in terms of the base units.

Some of the common SI derived units are:

Quantity	*Name*	*Symbol*
Area	square metre	m^2
Volume	cubic metre	m^3
Mass	gram	g
Velocity	metres per second	$m\,s^{-1}$
Angle	radian	rad

Quantity	*Name*	*Symbol*
Force	newton	N
Pressure	pascal	Pa
Energy	joule	J
Power	watt	W
Frequency	hertz	Hz

Quantity	*Name*	*Symbol*	*SI equivalent*
Time	minute hour	min h	60 s 3600 s
Mass	tonne	t	1000 kg
Capacity	litre	L	0.001 m^3
Area	hectare	ha	10 000 m^2
Angle	degree	°	$\frac{\pi}{180}$ rad
Temperature	degree Celsius	°C	$K - 273.15$
Pressure	millibar	mb	100 Pa
Distance at sea	Nautical mile	Nm	1.852 km
Speed at sea	Knot	kn	1.852 km h^{-1}
Energy	Kilowatt hour	kWh	3.6 MJ

Smaller or larger multiples of these units are obtained by combining the base unit with a prefix

nano	n	$10^{-9} = \frac{1}{1\,000\,000\,000}$
micro	μ	$10^{-6} = \frac{1}{1\,000\,000}$
milli	m	$10^{-3} = \frac{1}{1000}$

kilo	k	$10^{3} = 1000$
mega	M	$10^{6} = 1\,000\,000$
giga	G	$10^{9} = 1\,000\,000\,000$

Assignment: