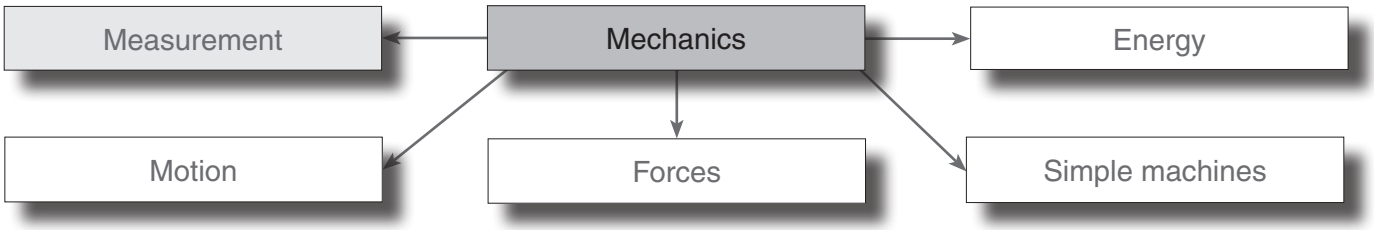
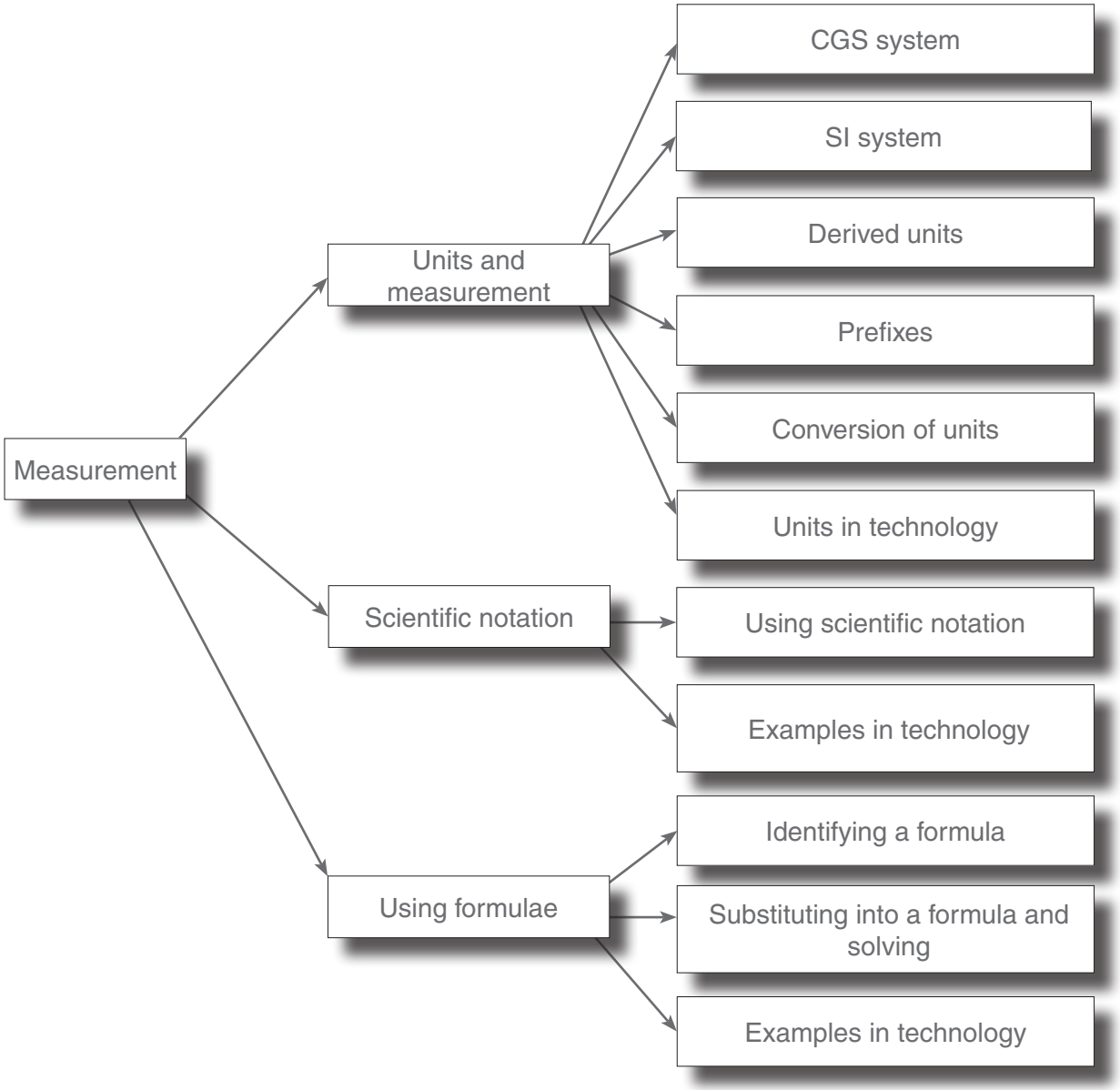
Masters for transparencies

5.1
Term 1

TERM 1: MECHANICS



UNIT 1 MEASUREMENT



1.1 Units and measurement

A physical quantity is a basic property of a phenomenon, body or substance, that can be quantified by measurement.

Fundamental units are used to define all other units in the relevant system.

1.1.1 CGS system

1.1.2 SI system

1.1.3 Derived units

Derived units are units that are derived by combining fundamental units.

The derived units that we will require for mechanics are the following:

Quantity	Symbol	Formula	Unit in terms of SI system	Unit in terms of CGS system	Derived SI unit	Derived CGS unit
Velocity; speed	v	$v = \frac{\Delta x}{\Delta t}$	$m \cdot s^{-1}$	$cm \cdot s^{-1}$		
Acceleration	a	$a = \frac{\Delta v}{\Delta t}$	$m \cdot s^{-2}$	$cm \cdot s^{-2}$		
Force; weight	F	$F_{net} = ma$	$kg \cdot m \cdot s^{-2}$	$g \cdot cm \cdot s^{-2}$	newton (N)	dyne (dyn)
Work; energy	W; E	$W = F\Delta x \cos\theta$	$kg \cdot m^2 \cdot s^{-2}$	$g \cdot cm^2 \cdot s^{-2}$	joule (J)	erg (erg)
Power	P	$P = \frac{W}{\Delta t}$	$kg \cdot m^2 \cdot s^{-3}$	$g \cdot cm^2 \cdot s^{-3}$	watt (W)	erg per second ($erg \cdot s^{-1}$)
Pressure	p	$p = \frac{F}{A}$	$kg \cdot m^{-1} \cdot s^{-2}$ $N \cdot m^{-2}$	$g \cdot cm^{-1} \cdot s^{-2}$ $dyn \cdot cm^{-2}$	pascal (Pa)	barye (Ba)
Volume	V	$V = \ell \times b \times h$	m^3	cm^3	kilolitre (kℓ)	millilitre (mℓ)
Torque	τ	$\tau = F \cdot r_{\perp}$	$N \cdot m$	$g \cdot cm^2 \cdot s^{-2}$		dyne·cm (dyn·cm)

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1 Define the following quantities:

1.1 a physical quantity;

A physical quantity is a basic property of a phenomenon, body or substance, that can be quantified by measurement.

1.2 fundamental units.

A set of units used to define all other units in the relevant system.

2. What is meant by the "SI system" of measurement?

International system of measuring units.

3. What is meant by the "CGS system" of measurement?

It is the system of measuring that is based on the SI system, but that uses centimetre, gram and seconds as fundamental units.

4. What is meant by "fundamental" units?

A set of units used to define all other units in the relevant system.

5. Write down the seven fundamental units for the basic quantities in the SI system.

- **Distance, length, radius, etc.:** **metre**
- **Mass:** **kilogram**
- **Time:** **seconds**
- **Electrical current strength:** **ampere (A)**
- **Thermodynamic temperature:** **kelvin (K)**
- **Quantity of matter:** **mol (mol)**
- **Light intensity:** **candela (cd)**

6 Write down the fundamental units according to the CGS system for the following quantities:

6.1 length;

Centimetres (cm)

6.2 mass;

Grams (g)

6.3 time.

Seconds (s)

7. Explain what derived units are.

Derived units are units that are derived by combining fundamental units.
This combination of fundamental units is derived from the formula that is used to calculate the quantities.

8. Complete the following table:

Quantity	Symbol	Unit in terms of SI system	Unit in terms of CGS system	Derived SI unit	Derived CGS unit
Velocity; speed	**v**	$m \cdot s^{-1}$	$cm \cdot s^{-1}$		
Acceleration	**a**	$m \cdot s^{-2}$	$cm \cdot s^{-2}$		
Pressure	**p**	$kg \cdot m^{-1} \cdot s^{-2}$ $N \cdot m^{-2}$	$g \cdot cm^{-1} \cdot s^{-2}$ $dyn \cdot cm^{-2}$	**pascal (Pa)**	**barye (Ba)**
Volume	**V**	m^3	cm^3	**kilolitre (kℓ)**	**millilitre (mℓ)**
Power	**P**	$kg \cdot m^2 \cdot s^{-3}$	$g \cdot cm^2 \cdot s^{-3}$	**watt (W)**	**erg per second ($erg \cdot s^{-1}$)**
Force; weight	**F**	$kg \cdot m \cdot s^{-2}$	$g \cdot cm \cdot s^{-2}$	**newton (N)**	**dyne (dyn)**
Work; energy	**W; E**	$kg \cdot m^2 \cdot s^{-2}$	$g \cdot cm^2 \cdot s^{-2}$	**joule (J)**	**erg (erg)**

1.1.4 Prefixes to standard units

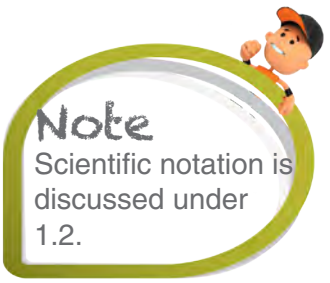
Prefixes to standard units indicate decimal multiples or sub multiples of the standard unit.

Factor with which is multiplied	SI prefix	Power of ten	
1 000 000 000 000 000 000 000 000	yotta (Y)	10^{24}	
1 000 000 000 000 000 000 000	zetta (Z)	10^{21}	
1 000 000 000 000 000 000	exa (E)	10^{18}	
1 000 000 000 000 000	peta (P)	10^{15}	
1 000 000 000 000	tera (T)	10^{12}	**
1 000 000 000	giga (G)	10^{9}	**
1 000 000	mega (M)	10^{6}	**
1 000	kilo (k)	10^{3}	**
0,001	milli (m)	10^{-3}	**
0,000 001	micro (μ)	10^{-6}	**
0,000 000 001	nano (n)	10^{-9}	**
0,000 000 000 001	pico (p)	10^{-12}	**
0,000 000 000 000 001	femto (f)	10^{-15}	
0,000 000 000 000 000 001	atto (a)	10^{-18}	
0,000 000 000 000 000 000 001	zepto (z)	10^{-21}	
0,000 000 000 000 000 000 000 001	yocto (y)	10^{-24}	

Examples

The average volume of water in an Olympic size swimming pool is 2 500 000 m^3. Write this number as a simpler number in the SI system by using prefixes.

- First, write the number in scientific notation: $2{,}5 \times 10^6$ m^3.
- Rewrite it so that the power of ten is a multiple of 3.
- Now find a prefix that corresponds: mega (M) represents 10^6.
- Then 2 500 000 m^3 = 2,5 Mm^3 or 2,5 Gℓ since 1 kilolitre = 1 m^3 in the SI system.



Examples

The sandpaper that is used to do the final polish on surfaces, has a grit (how rough it is) of P1500. The glass particles that are used to manufacture the sandpaper have an average diameter of 0,000 012 6 m.

1.1.5 Conversion of units

Quantity	Symbol	SI unit	Conversion factor	CGS unit
Length	ℓ ; x	m	$\xrightarrow{\times 10^2}$ $\xleftarrow{\times 10^{-2}}$	cm
Mass	m	kg	$\xrightarrow{\times 10^3}$ $\xleftarrow{\times 10^{-3}}$	g
Time	t	s		s
Velocity	v	$m \cdot s^{-1}$	$\xrightarrow{\times 10^2}$ $\xleftarrow{\times 10^{-2}}$	$cm \cdot s^{-1}$
Acceleration	a	$m \cdot s^{-2}$	$\xrightarrow{\times 10^2}$ $\xleftarrow{\times 10^{-2}}$	$cm \cdot s^{-2}$
Force; weight	F ; w	$kg \cdot m \cdot s^{-2}$ N	$\xrightarrow{\times 10^5}$ $\xleftarrow{\times 10^{-5}}$	$g \cdot cm \cdot s^{-2}$ dyn
Work; energy	W ; E	$kg \cdot m^2 \cdot s^{-2}$ J	$\xrightarrow{\times 10^7}$ $\xleftarrow{\times 10^{-7}}$	$g \cdot cm^2 \cdot s^{-2}$ erg
Power	P	$kg \cdot m^2 \cdot s^{-3}$ W	$\xrightarrow{\times 10^7}$ $\xleftarrow{\times 10^{-7}}$	$g \cdot cm^2 \cdot s^{-3}$ $erg \cdot s^{-1}$
Pressure	p	$kg \cdot m^{-1} \cdot s^{-2}$ $N \cdot m^{-2}$ Pa	$\xrightarrow{\times 10}$ $\xleftarrow{\times 10^{-1}}$	$g \cdot cm^{-1} \cdot s^{-2}$ Ba