AS-Level Physics

Notes

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Title	AS-LEVEL PHYSICS NOTES
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Published by	MS Books (042-35774780)
Legal Advisor	Ashir Najeeb Khan (Advocate) **AKBAR LAW CHAMBERS** 39-40, 1st Floor, Sadiq Plaza, The Mall, Lahore. 0307-4299886, 042-36314839
For Complaints/Order	**MS Books** 83-B Ghalib Market, Gulberg III Lahore (042-35774780),(03334504507),(03334548651)

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Physical Quantities

Quantitative versus qualitative

- Most observation in physics are quantitative
- Descriptive observations (or qualitative) are usually imprecise

Qualitative Observations	Quantitative Observations
How do you measure artistic beauty?	What can be measured with the instruments on an aeroplane?
	

Physical Quantities

☞ SI units are used in Scientific works

A physical quantity is one that can be measured and consists of a magnitude and unit.

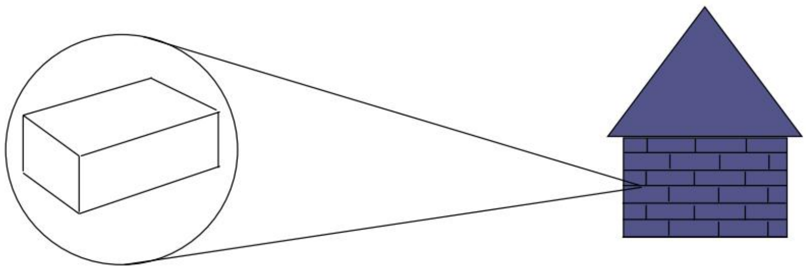
Physical quantities are classified into two types:

1. Base quantities

2. Derived quantities

Base quantity

Base are the quantities on the basis of which other quantities are expressed. For example the brick the basic building block of a house



Derived quantity

The quantities that are expressed in terms of base quantities are called derived quantities. For example is like the house that was build up from a collection of bricks (basic quantity)

SI Units for Base Quantity

SI Units – International System of Units

Base Quantities	Name of Unit	Symbol of Unit
Length	Metre	m
Mass	Kilogram	kg
Time	Second	s
Electrical current	Ampere	A
Temperature	Kelvin	K
Amount of Substances	Mole	Mol

Derived quantity & equations

A derived quantity has an equation which links to other quantities. It enables us to express a derived unit in terms of base-unit equivalent.

Example: $F = ma$; Newton = kg m s^{-2}

$P = F/A$; Pascal = kg m s^{-2}/m^2 = kg m^{-1} s^{-2}

Some derived units

Derived quantity	Base equivalent units	Symbol
Area	Square meter	m^2
volume	Cubic meter	m^3
Speed, velocity	Meter per second	m/s or ms^{-1}
Acceleration	Meter per second squared	m/s/s or ms^{-2}
Density	Kilogram per cubic meter	kg m^{-3}
Amount concentration	Mole per cubic meter	Mol m^{-3}
Force	kg ms^{-2}	Newton
Work/ Energy	kg m^2s^{-2}	Joule
Power	kg m^2s^{-3}	Watt
Pressure	kg $m^{-1}s^{-2}$	Pascal
Frequency	s^{-1}	Hertz

SI Units

1. Equation: area = length × width

In terms of base units: Units of area = m × m = m^2

2. Equation: volume = length × width × height

In terms of base units: Units of volume = m × m × m = m^3

3. Equation: density = mass ÷ volume

In terms of base units: Units of density = kg m^{-3}

Work out the derived quantities for:

1. Equation: $\text{Speed} = \dfrac{\text{distance}}{\text{time}}$

In terms of base units: Units of speed = ms^{-1}

2. Equation: $\text{Acceleration} = \dfrac{\text{Velocity}}{\text{time}}$

In terms of base units: Units of acceleration = ms^{-2}

3. Equation: force = mass × acceleration

In terms of base units: Units of force = kg ms^{-2}

4. Equation: $\text{Pressure} = \dfrac{\text{Force}}{\text{Area}}$

In terms of base units: Units of pressure = $Kgm^{-1}\ s^{-2}$

5. Equation: Work = Force × Displacement

In terms of base units: Units of work = Kgm^2s^{-2}

6. Equation: $\text{Power} = \dfrac{\text{Work done}}{\text{Time}}$

SI Units – Fill in…

Derived Quantities	Relation with Base and Derived Quantities	Unit	Special Name
Momentum			
Electric Charge			
Potential Difference			
Resistance			

For you to know…

Physical Quantity	Defined as	Unit	Special
Density	Mass (kg) ÷ volume (m^3)	kg m^{-3}	
Momentum	Mass (kg) × velocity (ms^{-1})	kg m^{-1}	
Force	Mass (kg) × acceleration (ms^{-2})	kg m^{-2}	Newton (N)
Pressure	Force (kg ms^{-2} or N) ÷ area (m^2)	kg^{-1} m^{-2} (Nm^{-2})	Pascal (Pa)
Work (energy)	Force (kg ms^{-2} or N) × distance (m)	kg^2 m^{-3} (Js^{-1})	Joule (J)
Power	Wok (kg m^2 s^{-2} or J) ÷ time (s)	Kg m^2 s^{-3} (Js^{-1})	Watt (W)
Electrical charge	Current (A) × time (s)	A s	Coulomb (C)
Potential difference	Energy (kgm^2s^{-2} or J) ÷ charge (A s or C)	kg m^{-2} A s^{-3} (J C^{-1})	Volt (V)
Resistance	Potential Difference (kg^2 A^{-1} s^{-3} or V)	kg m^2 A^{-2} s^{-3} (V A^{-1})	Ohm (Ω)

Reference Link – Physical quantities

http://thinkzone.wlonk.com/Units/PhysQuantities.htm

Key Concepts

1. A physical quantity is a quantity that can be measured and consists of a numerical magnitude and a unit.
2. The physical quantities can be classified into base quantities and derived quantities.
3. There are seven base quantities: length, mass, time, current, temperature, amount of substance and luminous intensity.
4. The SI units for length, mass, time, temperature and amount of substance, electric current are metre, kilogram, second, kelvin, mole and ampere respectively.

Homogeneity of an equation

An equation is homogeneous if quantities on both sides of the equation has the same unit.

- E.g. s = ut + ½ at^2
- LHS : unit of s = m
- RHS : unit of ut = ms-1xs = m
- Unit of at2 = ms^{-2} x s^2 = m
- Unit on LHS = unit on RHS
- Hence equation is homogeneous

Non-homogeneous

- $P = \rho g h^2$
- LHS ; unit of P = $Nm^{-2} = kgm^{-1}s^{-2}$
- RHS : unit of $\rho g h^2 = kgm^{-3}(ms^{-2})(m^2) = kgs^{-2}$
- Unit on LHS $\neq$ unit on RHS
- Hence equation is not homogeneous

Homogeneity of an equation

- Note: numbers has no unit
- Some constants have no unit.
- e.g. π,
- A homogeneous eqn may not be physically correct but a physically correct eqn is definitely homogeneous
- E.g. $s = 2ut + at^2$ (homogenous but not correct)
- F = ma (homogeneous and correct)

Magnitude

- Prefix: magnitudes of physical quantity range from very large to very small.
- E.g. mass of sun is 10^{30} kg and mass of electron is 10^{-31} kg.
- Hence, prefix is used to describe these magnitudes.

Significant number

- Magnitudes of physical quantities are often quoted in terms of significant number.
- Can you tell how many sig. fig. in these numbers?
- 103, 100.0, 0.030, 0.4004, 200
- If you multiply 2.3 and 1.45, how many of should you quote?
- 3.19, 3.335, 3.48
- 3.312, 3.335, 3.358

The rules for identifying significant figures

- The rules for identifying significant figures when writing or interpreting numbers are as follows:-
- All non-zero digits are considered significant. For example, 91 has two significant figures (9 and 1), while 123.45 has five significant figures (1, 2, 3, 4 and 5).
- Zeros appearing anywhere between two non-zero digits are significant. Example: 101.1203 has seven significant figures: 1, 0, 1, 1, 2, 0 and 3.
- Leading zeros are not significant. For example, 0.00052 has two significant figures: 5 and 2.

Trailing zeros in a number containing a decimal point are significant. For example, 12.2300 has

six significant figures: 1, 2, 2, 3, 0 and 0. The number 0.000122300 still has only six significant figures (the zeros before the 1 are not significant). In addition, 120.00 has five significant figures since it has three trailing zeros.