General Physics

Lecture 2

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What is Physics?

Physics tries to explain processes we observe in terms of a set of 'laws' or rules

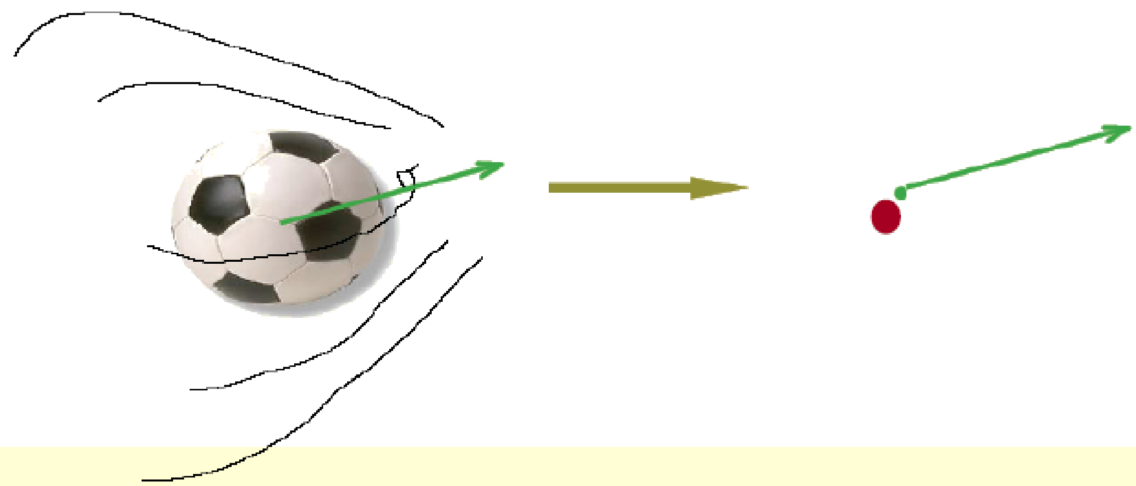
These laws are normally expressed in terms of mathematical equations with which we can predict things

These predictions can be compared to what we see

"Theory & Experiment"

Idealized Models

- A physical system is often too complicated to analyze all at once
- A **model** is a simplified version of a physical system
- Example: We neglect the size and shape of a *ball* and represent it as a *particle* (completely localized at a single point in space)



Physics and Measurements

- Physics is based on experimental observations and quantitative measurements. These observations have described by numbers and units.
- Numbers give us how large our measurement was, and the units tell us the nature of this measurement.

Height = 2.29 m

Number + Unit

Physical quantity is a physical property of a phenomenon, body, or substance

Fundamental Physical Quantity

- Are expressed in terms of standard units.
- There are seven (7) basic physical quantities.
- Examples- mass, length, time, electric current, temperature, luminous intensity and amount of substance.
- All other quantities are expressed in terms of these quantities.

Derived Physical Quantities

- When a physical quantity expresses itself in terms of two or more fundamental physical quantities.
- It is derived by multiplying or dividing one basic physical quantity with another basic physical quantity.
- Examples- density, volume, force, power, velocity, acceleration etc.

- Derived quantities: area, speed, volume, density ……
  - Area = Length × Length — unit for area = m^2
  - Volume = Length × Length × Length — unit for volume = m^3
  - Speed = Length / time — unit for speed = m/s
  - Density = Mass / Volume — unit for density = kg/m^3

Unit systems

Two systems of units are widely used in the world, the metric and the British systems.

The metric system measures the length in meters whereas the British system makes use of the foot, inch, …..

The metric system is the most widely used. Therefore the metric system will be used in this course.

By international agreement the metric system was formalized in 1971 into the *International System of Units* (SI). There are seven basic units in the SI as shown in table Below.

Basic units in the SI

Quantity	Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Number of particles	mole	mol
Luminous intensity	candela	cd

Dimensional Analysis

The word dimension in physics indicates the physical nature of the quantity. For example the distance has a dimension of *length*, and the *speed* has a dimension of *length*/*time*.

The dimensional analysis is used to check the formula, since the dimension of the left hand side and the right hand side of the formula must be the same.

Example

Using the dimensional analysis check that this equation $x = \frac{1}{2} at^2$ is correct, where x is the distance, a is the acceleration and t is the time.

Solution

$$x = \frac{1}{2} at^2$$

The right hand side $[x] = L$

The left hand side $[at^2] = \frac{L}{T^2} \times T^2 = L$

This equation is correct because the dimension of the left and right side of the equation have the same dimensions.

Example

Show that the expression $v = v_o + at$ is dimensionally correct, where v and v_o are the velocities and a is the acceleration, and t is the time.

Solutions:

The right hand side $[v] = \frac{L}{T}$

The left hand side $[at] = \frac{L}{T^2} \times T = \frac{L}{T}$

Therefore, the expression is dimensionally correct

VECTOR AND SCALAR

Scalars: One that can be described by a single number (along with the unit)

- Water freezes at a temperature of 0° C or 32° F
- The mass of a book is 198.2 g
- The length of room is 5 m
- The car kinetic energy was 0.345 J

Vectors: A quantity that deals with magnitude and direction is called a vector quantity

- The wind had a velocity of 25 km/h from the North
- The momentum was 1.234 kg m/s to the left

Vector and scalar quantities

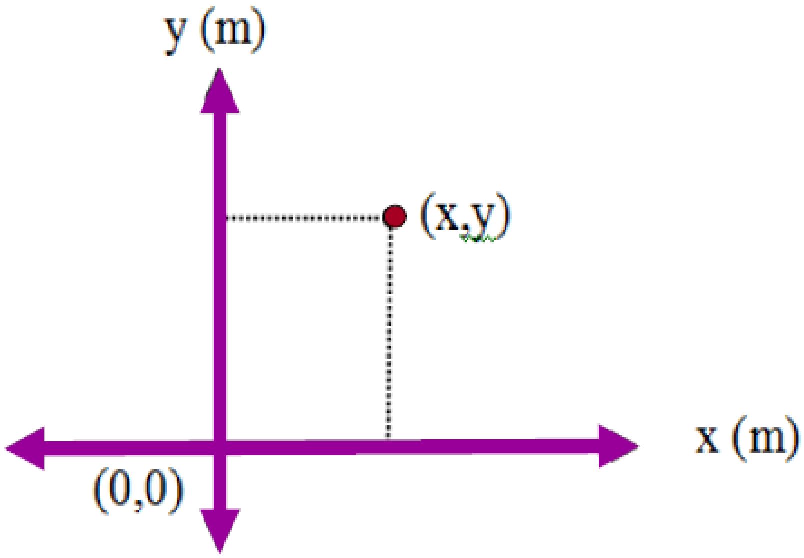
Vector Quantity	Scalar Quantity
Displacement	Length
Velocity	Mass
Force	Speed
Acceleration	Power
Field	Energy
Momentum	Work

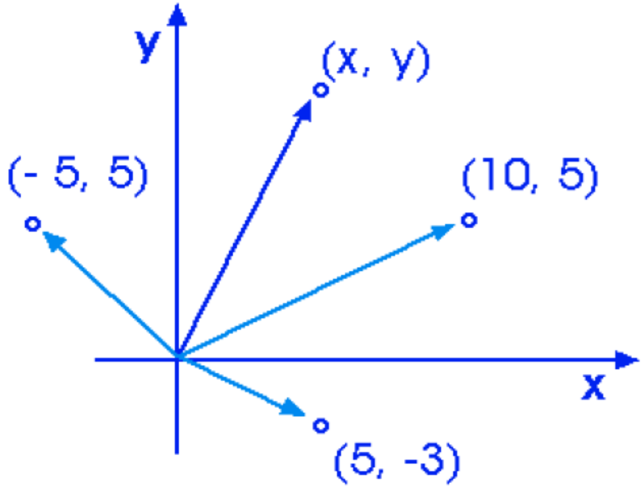
COORDINATE SYSTEM (1)

(1) The rectangular coordinates

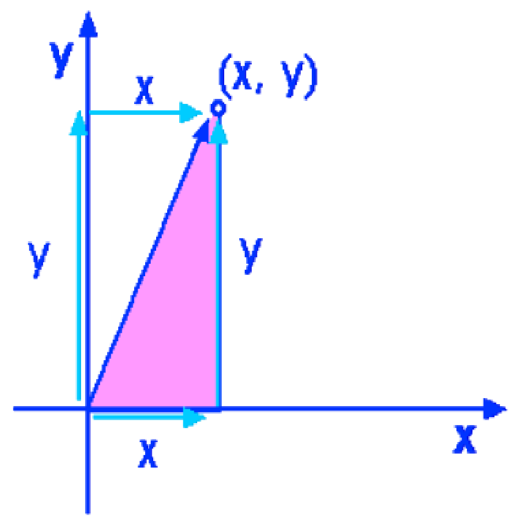
This coordinate system is consist of a fixed reference point (0,0) which called the origin.

A set of axis with appropriate scale and label.





The x- and y-coordinates may be either positive or negative



We can call this x-component, a vector along the x-direction of length x, and indicate that it is a vector by x.

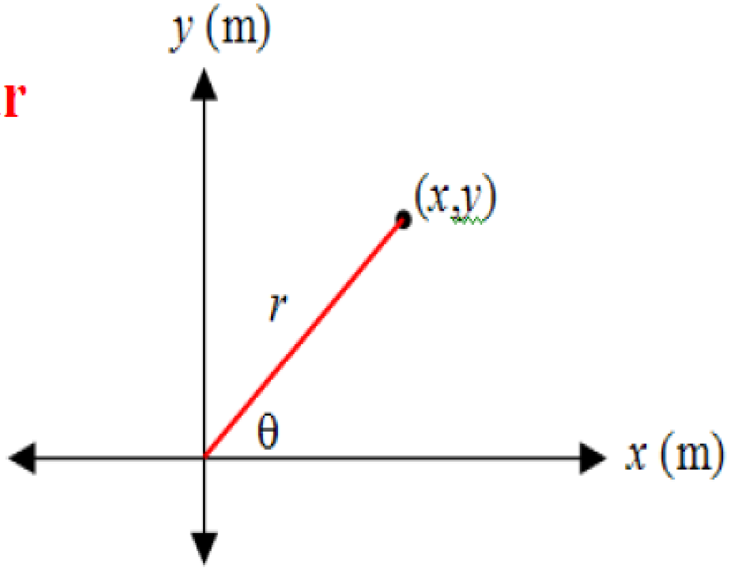
Likewise, we can call this y-component, a vector along the y-direction of length y, and indicate that it is a vector by y .

r = x + y

Coordinate system (2)

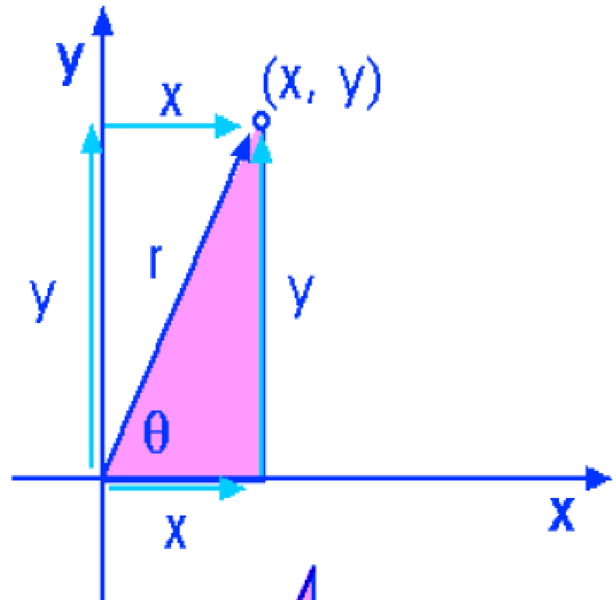
(2) The polar coordinates

Sometimes it is more convenient to use the polar coordinate system (r,θ), where r is the distance from the origin to the point of rectangular coordinate (x,y), and θ is the angle between r and the x axis.



THE RELATION BETWEEN COORDINATES

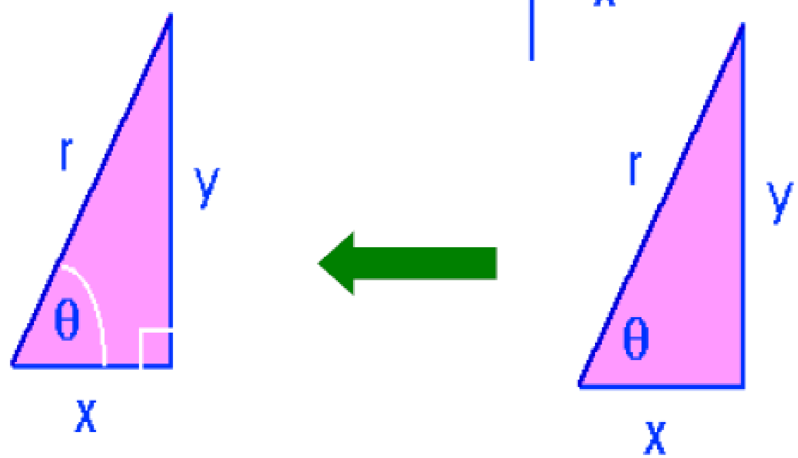
The relation between the rectangular coordinates (x,y) and the polar coordinates (r,θ) is shown in Figure,

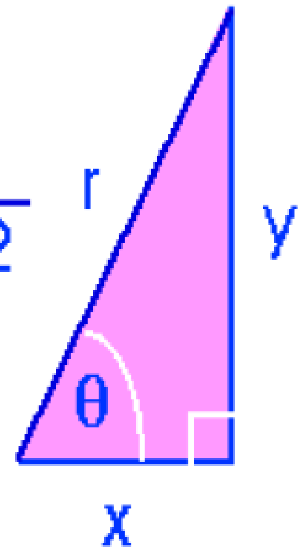


$$\sin\theta = y/r$$

$$\cos\theta = x/r$$

$$\tan\theta = y/x$$





$$r = \sqrt{x^2 + y^2}$$

$$y = r \sin \theta$$

$$x = r \cos \theta$$

It is common practice to measure the angle from the positive x-axis and to measure it positive for a counterclockwise direction.