Chapter 1. Newton's Laws of Motion
Section 1.1. Classical Mechanics
Section 1.2. Space and Time

Read Sections 1.1 and 1.2.

Section 1.1 contains *a short history of classical mechanics*, which mentions four names:

Galileo Galilei (1564 - 1642)

Isaac Newton (1642 - 1727)

Joseph-Louis Lagrange (1736 - 1813)

William Hamilton (1805 - 1865)

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All four of them were professors of mathematics.

PHY 321 is really a course about mathematics.

It won't help you fix your car.
(See the picture on the front of the textbook, *Classical Mechanics* by John Taylor. The picture is meant to be a joke.)

You already know a lot about mechanics, from PHY 183. There will be some repetition in PHY 321.

But the emphasis in PHY 321 is on using ***calculus*** as much as possible.

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Section 1.2

SPACE AND TIME

What is "space"?

Space is what we measure with rulers and protractors. I.e., the fundamental measurements of space are distances and angles.

In mechanics we're interested in the motion of objects. We'll need to define the *location* of an object (think of a small point-like particle).

We use a position vector $\boldsymbol{r}$ to specify the location.

Handwritten = $\vec{r}$

Vectors and scalars

You need to be careful to distinguish between vectors and scalars.

A vector is a mathematical quantity with both a direction and a magnitude.

Recall these vectors from PHY 183:

position $\boldsymbol{r}$; velocity $\boldsymbol{v} = d\boldsymbol{r}/dt$;
acceleration $\boldsymbol{a} = d\boldsymbol{v}/dt$;
force $\boldsymbol{F}$; momentum $\boldsymbol{p} = m\boldsymbol{v}$;
angular momentum $\boldsymbol{l} = \boldsymbol{r} \times \boldsymbol{p}$;
etc.

A scalar has magnitude but not direction.

time t ; mass m ; Kin. energy T ; ***etc.***

In your homework solutions, always put an arrow over any symbol that denotes a 2d or 3d vector. If you leave out the arrow, I'll take off points.

Position vector of a particle P.

[By particle, I mean a "small" object.

How small is "small"?

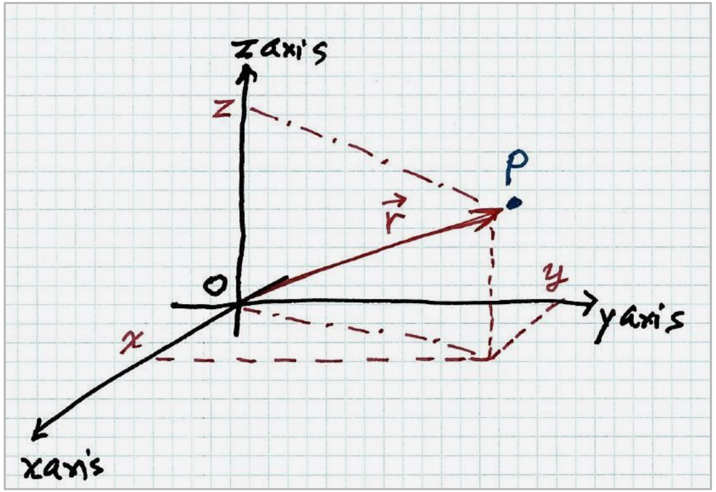
It means that the size of the object is much smaller than the distances involved in the motion.

For example, the Earth is a particle when we calculate its orbit, because the radius of the Earth is 6,400 km and the radius of the orbit is 150,000,000 km.]

The position vector $\boldsymbol{r}$ is the vector from a fixed point O called the "origin" to the particle.

The *magnitude* of $\boldsymbol{r}$ is the distance from O to P (a scalar); the *direction* is from O to P.

Figure 1.1. The Cartesian coordinates of P are {x,y,z}



Cartesian coordinates and unit direction vectors:

$$\boldsymbol{r} = x\,\boldsymbol{e}_x + y\,\boldsymbol{e}_y + z\,\boldsymbol{e}_z$$

where $\{x, y, z\}$ are displacements from O; a *displacement* is a *signed distance*.

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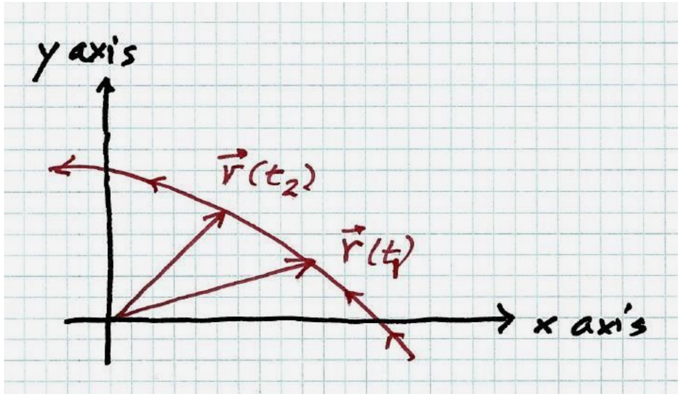
What is "time"?

Time is what we measure with clocks. I. e., the fundamental measurement of time is an interval of time—the number of clock ticks that occur between two events or two observations.

In mechanics we're interested in the motion of objects. We'll need to define the location of an object *as a function of time.*

We use a position vector $\boldsymbol{r}$(t) to specify the location. The vector varies with time (unless the particle is at rest).

Motion: The *trajectory* is the curve traced out by the position vector $\boldsymbol{r}$(t).



<u>*Units*</u>

Measurements require units.
Recall from PHY 183, the SI system of units.
Two of the base units are meters (m) for distance and seconds (s) for time.

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What is a meter?

In the old days, a meter was defined as the length of a standard meter stick. Any distance was determined by comparison to the standard.

Since 1983, a meter is defined as the distance that light travels in a time of 1/299792458 second.

What is a second?

In the old days, a second was defined as the time interval equal to 1/(24*3600) of a sidereal day.

Clocks were invented to register one second intervals. Any time interval was determined by comparison to that standard.

Since 1967, a second is defined as the time interval of 9192631770 periods of the radiation produced in the transition between the two hyperfine levels of the ground state of the Cesium-133 atom.

Homework Assignment #1

Instructions

The due date is Friday, September 9.

Homework solutions must be handed in in class.

Homework solutions submitted by e-mail will be deleted.

Homework solutions that are handed in late are not eligible for full credit, unless you have a valid reason for being late (you must document the reason for being late).

Staple the cover sheet, with answers where indicated, in front of your solutions.

Homework Assignment #1

due in class, Friday Sept. 9

[1] Problem 1.3 *

[2] Problem 1.5 *

[3] Problem 1.18 **

[4] Problem 1.24 *

[5] Problem 1.30 *

Use the cover sheet !

Be sure to get the two handouts:

1. ***Course description***
2. ***Cover sheet for H. assignment #1***

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