Physics 5a: Homework 1

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Newtons Laws

K.K. Ch. 2

Known properties

We know:

Objects have **mass**

Four fundamental forces: **Gravity, Electromagnetic Force, Strong Force, Weak Force**

First Law

In English: An object at rest stays at rest, an object in motion stays in motion.

More mathematical rigorous: If $\overrightarrow{F}_i = 0$, then $\overrightarrow{v}_i$ is constant ($\overrightarrow{a}_i = 0$). (True only in an "inertial frame")

Inertial Frames

Graph outlining R(t) to a point that extends another vector r-prime, which has the combined vector of r.

R is location of plane.

$$\vec{r}(t) = \vec{R}(t) + \vec{r'}(t)$$
$$\vec{v}(t) = d/dt\,\vec{R}(t) + d/dt\,\vec{r'}(t) = V(t) + v'(t)$$
$$\vec{a}(t) = d/dt\,\vec{V}(t) + \vec{a'}(t)$$

Case 1) $R(t) = R_0 + tV \Rightarrow a(t) = a'(t)$

Case 2) $R(t) = R_0 + 1/2t^2\vec{A} \Rightarrow a(t) \neq a'(t)$

In english: People can disagree whether or not things are moving, i.e. frames of reference, and a frame of reference is inertial if it doesn't start accelerating in the frame without forces from the frame.

Second Law

$$\vec{F}_i = m_i\vec{a}_i$$

$$\vec{F}_i = F_{2->1}(r_1, r_2, v_1, v_2) + F_{3->1}(r_1, r_3, v_1, v_3) = \sum_i F_{i->1}$$

Example based elaborations

Gravity:

$$F_{E->1} = -m_i g\hat{j}$$

Diagram of tree and earth. Force $a = F_{earth->apple}$ pulling down on the apple, a little algebra later you have $a = -g\hat{j}$.

Contact force:

Ball on slope diagram. Force is pushing on ball, then another diagram showing a ball on a vertical wall showing how the contact isn't pushing in that case. The contact force of $\vec{F}_{1->2} = \hat{n} \cdot f$.

More examples of normal force.

Tension

You can only ever pull with a rope. Tension can be worked out with normal forces and seeing what things aren't falling, i.e. if gravity is pulling down on a hanging block, the rope must be pulling up.

$F_{s->1} = T\hat{t}$.