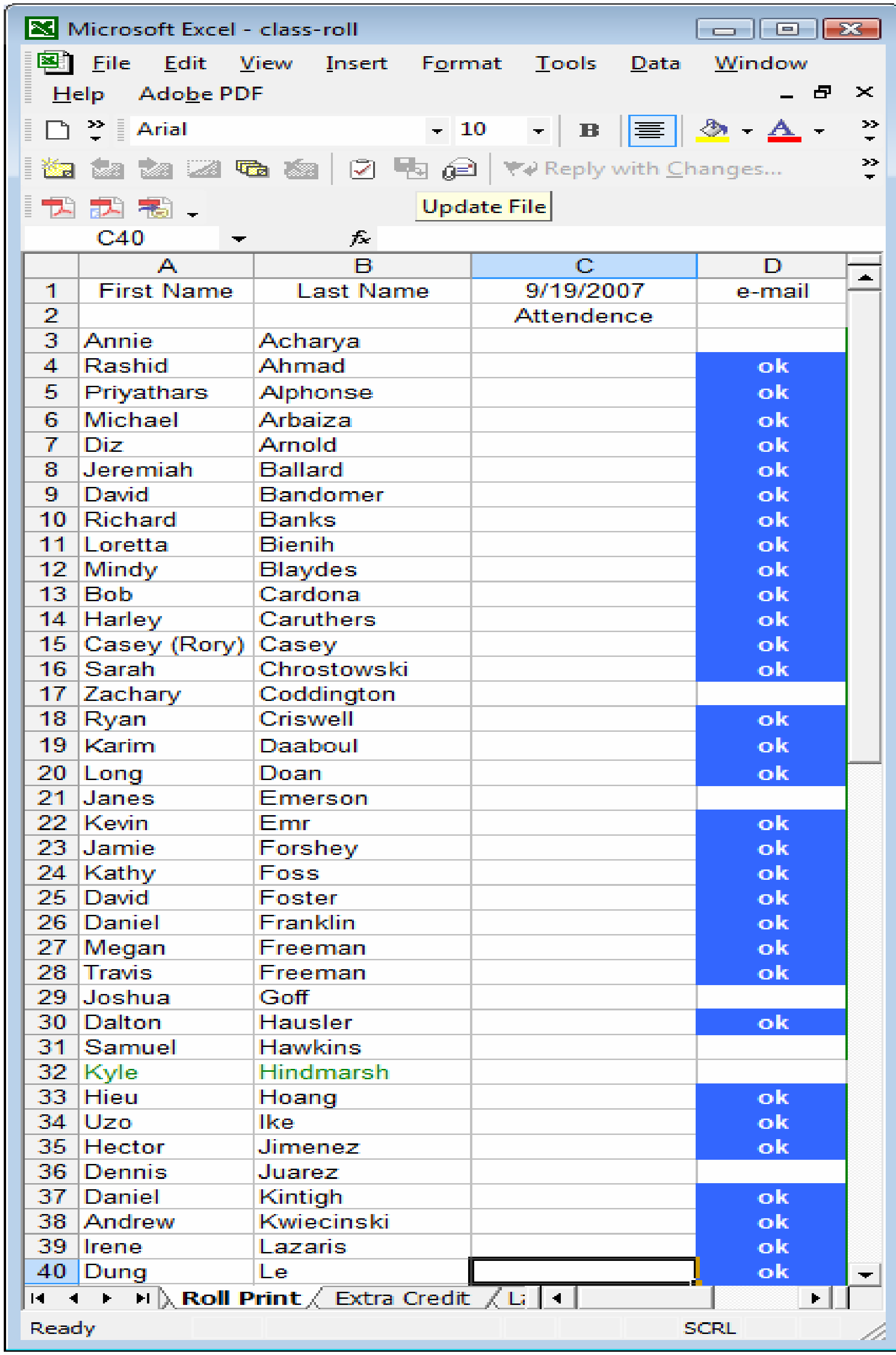
PHYS 1443 – Section 002
Lecture #7

Wednesday, Sept. 19, 2007
Dr. Jaehoon Yu

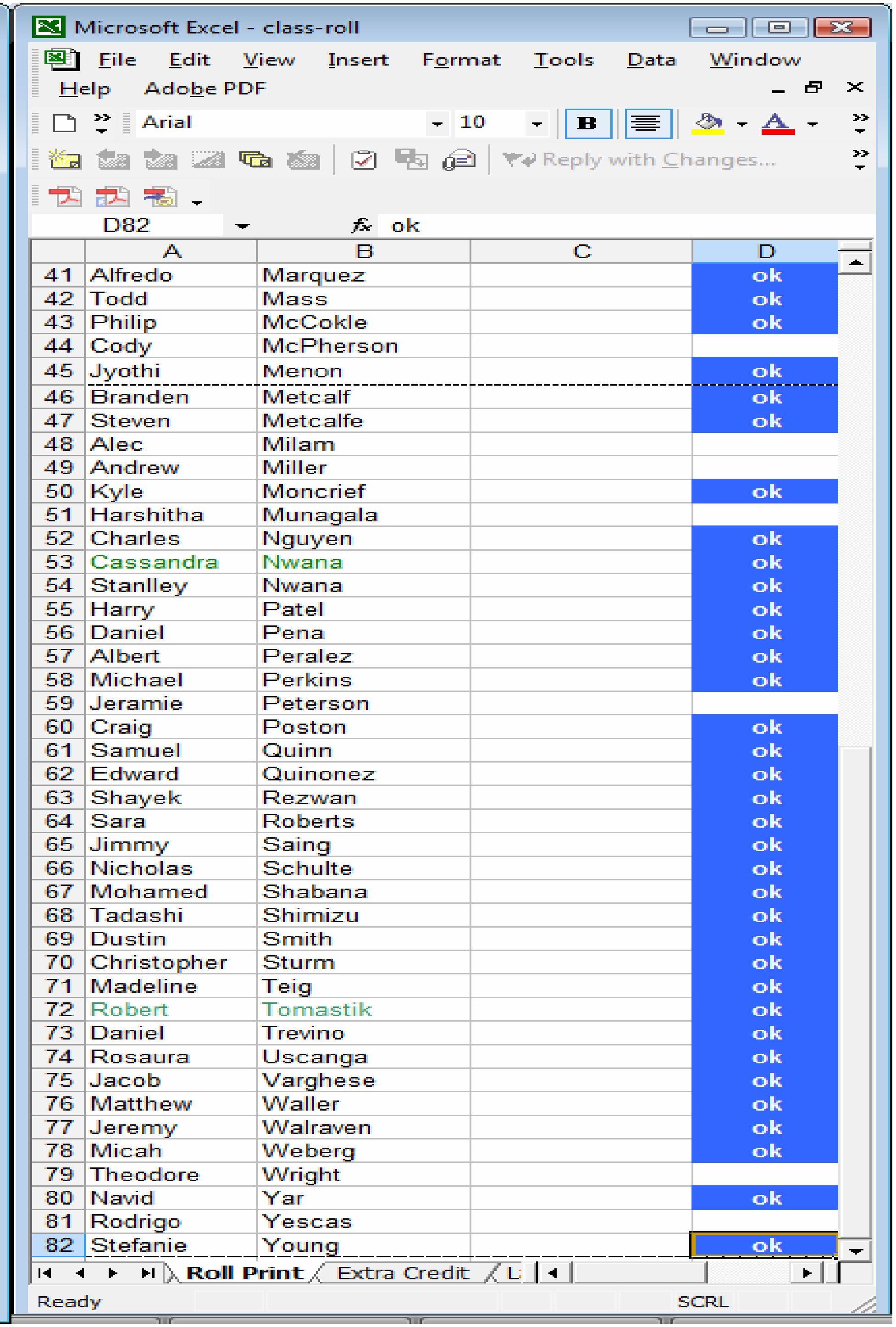
- Motion in Two Dimensions
  - Maximum ranges and heights
- Reference Frame and Relative Velocity
- Newton's Laws of Motion
  - Force
  - Newton's Law of Inertia & Mass
  - Newton's second law of motion
  - Gravitational Force and Weight
  - Newton's third law of motion

Announcements

- E-mail distribution list: 67 of you subscribed to the list so far
  - Will issue -3 extra credit points if not done by midnight Friday, Sept. 21



	A	B	C	D
1	First Name	Last Name	9/19/2007	e-mail
2			Attendence	
3	Annie	Acharya		
4	Rashid	Ahmad		ok
5	Priyathars	Alphonse		ok
6	Michael	Arbaiza		ok
7	Diz	Arnold		ok
8	Jeremiah	Ballard		ok
9	David	Bandomer		ok
10	Richard	Banks		ok
11	Loretta	Bienih		ok
12	Mindy	Blaydes		ok
13	Bob	Cardona		ok
14	Harley	Caruthers		ok
15	Casey (Rory)	Casey		ok
16	Sarah	Chrostowski		ok
17	Zachary	Coddington		
18	Ryan	Criswell		ok
19	Karim	Daaboul		ok
20	Long	Doan		ok
21	Janes	Emerson		
22	Kevin	Emr		ok
23	Jamie	Forshey		ok
24	Kathy	Foss		ok
25	David	Foster		ok
26	Daniel	Franklin		ok
27	Megan	Freeman		ok
28	Travis	Freeman		ok
29	Joshua	Goff		
30	Dalton	Hausler		ok
31	Samuel	Hawkins		
32	Kyle	Hindmarsh		
33	Hieu	Hoang		ok
34	Uzo	Ike		ok
35	Hector	Jimenez		ok
36	Dennis	Juarez		
37	Daniel	Kintigh		ok
38	Andrew	Kwiecinski		ok
39	Irene	Lazaris		ok
40	Dung	Le		ok



	A	B	C	D
41	Alfredo	Marquez		ok
42	Todd	Mass		ok
43	Philip	McCokle		ok
44	Cody	McPherson		
45	Jyothi	Menon		ok
46	Branden	Metcalf		ok
47	Steven	Metcalfe		ok
48	Alec	Milam		
49	Andrew	Miller		
50	Kyle	Moncrief		ok
51	Harshitha	Munagala		
52	Charles	Nguyen		ok
53	Cassandra	Nwana		ok
54	Stanlley	Nwana		ok
55	Harry	Patel		ok
56	Daniel	Pena		ok
57	Albert	Peralez		ok
58	Michael	Perkins		ok
59	Jeramie	Peterson		
60	Craig	Poston		ok
61	Samuel	Quinn		ok
62	Edward	Quinonez		ok
63	Shayek	Rezwan		ok
64	Sara	Roberts		ok
65	Jimmy	Saing		ok
66	Nicholas	Schulte		ok
67	Mohamed	Shabana		ok
68	Tadashi	Shimizu		ok
69	Dustin	Smith		ok
70	Christopher	Sturm		ok
71	Madeline	Teig		ok
72	Robert	Tomastik		ok
73	Daniel	Trevino		ok
74	Rosaura	Uscanga		ok
75	Jacob	Varghese		ok
76	Matthew	Waller		ok
77	Jeremy	Walraven		ok
78	Micah	Weberg		ok
79	Theodore	Wright		
80	Navid	Yar		ok
81	Rodrigo	Yescas		
82	Stefanie	Young		ok

Announcements

- E-mail distribution list: 67 of you subscribed to the list so far
  - Will issue -3 extra credit points if not done by midnight Friday, Sept. 21
- Homework site had massive failure about the time HW3 was due!
  - Many many of you communicated to me about the problem! Thanks!
  - Some of you submitted the homework despite the problems
  - But I extended the due till 7pm tonight!
  - Please submit ASAP. Let me know if you have any further problems!
- First term exam next Wednesday, Sept. 26
  - 1-2:20pm, SH103
  - Covers Ch 1 to what we cover next Monday (~Ch4)
- There will be a quiz next Monday in the beginning of the class

Physics Department
The University of Texas at Arlington

COLLOQUIUM

Prof. Dr. Yin Guo
Prof. Dr. X.c. Xie

Oklahoma State University

4:00 pm Wednesday, September 19, 2007
Room 101 SH

Abstract: Dr. Guo: Methods for Large-Scale Simulations

There is an increasing interest in modeling large systems such as nanoparticles, condensed-phase materials and biological systems. However, despite the rapid advances in computational capability, modeling and simulation of large, complex systems at the atomic level remain a challenge. Developing efficient and accurate computational methods is a central focus in order to push the current computational capability to larger systems and longer time scales. The main focus of our research is on the development and application of computational methods for studying physical and chemical processes in large systems. In this talk, I will first describe the basic idea of multi-scale approach in large-scale simulations. I will then present our work on two topics: (1) Incorporating quantum tunneling calculations into classical molecular dynamics simulation; (2) constructing potential energy functions using an interpolative approach for studying dynamic and static properties.

Abstract: Dr. X.C. Xie: Spin Transport and Spin-related Transport

We find that in order to completely describe the spin transport, apart from the spin current (or the linear spin current), one has to introduce the angular spin current. The two spin currents respectively describe the translational and rotational motion of a spin. Both spin current densities appear naturally in the spin continuity equation. Moreover we predict that the angular spin current, just like the linear spin current, can also induce an electric field.

In the second topic, the spin-orbit coupling systems with a zero magnetic field is studied under the equilibrium situation, i.e., without a voltage bias. A persistent spin current is predicted to exist under most circumstances, although the persistent charge current and the spin accumulation are identically zero.

In addition, various semiconductor spin devices using spin-orbit interaction are proposed.

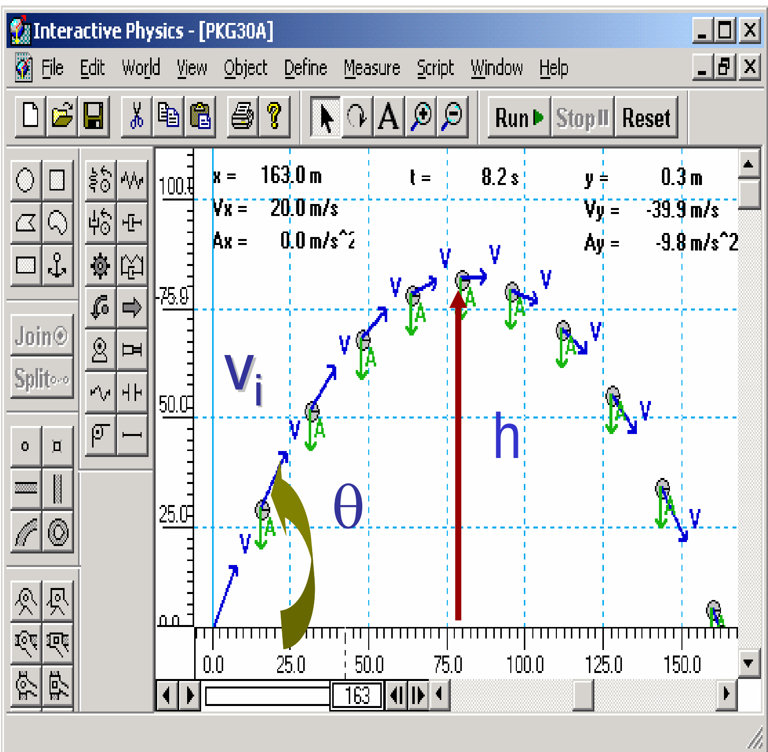
Refreshments will be served in the Physics Library at 3:30 pm

Horizontal Range and Max Height

- Based on what we have learned in the previous lecture, one can analyze a projectile motion in more detail
  – Maximum height an object can reach
  – Maximum range

What happens at the maximum height?

At the maximum height the object's vertical motion stops to turn around!!



$$v_{yf} = v_{yi} + a_y t$$

$$= v_i \sin\theta_i - g t_A = 0$$

Solve for t_A

$$\therefore t_A = \frac{v_i \sin\theta_i}{g}$$

Horizontal Range and Max Height

Since no acceleration is in x direction, it still flies even if v_y=0.

$$R = v_{xi}t = v_{xi}\left(2t_A\right) = 2v_i\cos\theta_i\left(\frac{v_i\sin\theta_i}{g}\right)$$

Range

$$R = \left(\frac{v_i^2\sin 2\theta_i}{g}\right)$$

$$y_f = h = v_{yi}t + \frac{1}{2}(-g)t^2 = v_i\sin\theta_i\left(\frac{v_i\sin\theta_i}{g}\right) - \frac{1}{2}g\left(\frac{v_i\sin\theta_i}{g}\right)^2$$

Height

$$y_f = h = \left(\frac{v_i^2\sin^2\theta_i}{2g}\right)$$

Maximum Range and Height

- What are the conditions that give maximum height and range of a projectile motion?

$$h = \left(\frac{v_i^2 \sin^2 \theta_i}{2g} \right)$$

This formula tells us that the maximum height can be achieved when $\theta_i = 90^o$!!!

$$R = \left(\frac{v_i^2 \sin 2\theta_i}{g} \right)$$

This formula tells us that the maximum range can be achieved when $2\theta_i = 90^o$, i.e., $\theta_i = 45^o$!!!

Example for a Projectile Motion

- A stone was thrown upward from the top of a cliff at an angle of 37° to horizontal with initial speed of 65.0m/s. If the height of the cliff is 125.0m, how long is it before the stone hits the ground?

$$v_{xi} = v_i \cos\theta_i = 65.0 \times \cos 37^{o} = 51.9 m/s$$

$$v_{yi} = v_i \sin\theta_i = 65.0 \times \sin 37^{o} = 39.1 m/s$$

$$y_f = -125.0 = v_{yi} t - \frac{1}{2} g t^2$$

Becomes

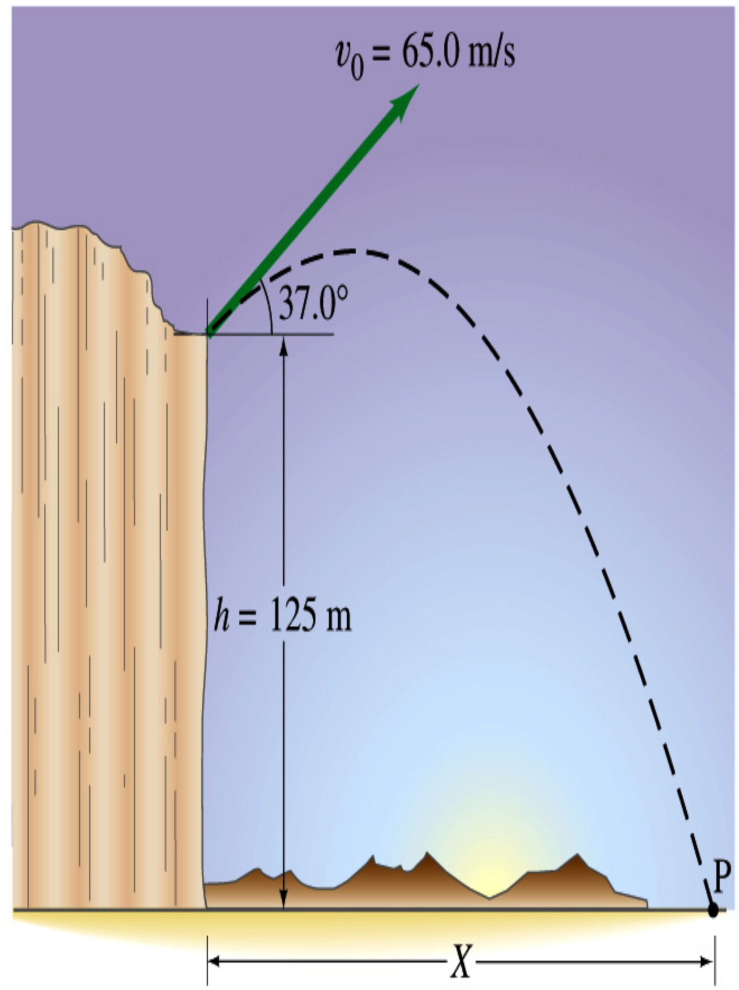
$$g t^2 - 78.2 t - 250 = 9.80 t^2 - 78.2 t - 250 = 0$$

$$t = \frac{78.2 \pm \sqrt{(-78.2)^2 - 4 \times 9.80 \times (-250)}}{2 \times 9.80}$$

$$t = -2.43 s \quad \text{or} \quad t = 10.4 s$$

$$t = 10.4 s$$

Since negative time does not exist.



Example cont'd

- What is the speed of the stone just before it hits the ground?

$$v_{xf} = v_{xi} = v_i \cos\theta_\iota = 65.0 \times \cos 37^o = 51.9 m/s$$

$$v_{yf} = v_{yi} - gt = v_i \sin\theta_i - gt = 39.1 - 9.80 \times 10.4 = -62.8 m/s$$

$$|v| = \sqrt{v_{xf}^{\ 2} + v_{yf}^{\ 2}} = \sqrt{51.9^2 + (-62.8)^2} = 81.5 m/s$$

- What are the maximum height and the maximum range of the stone?

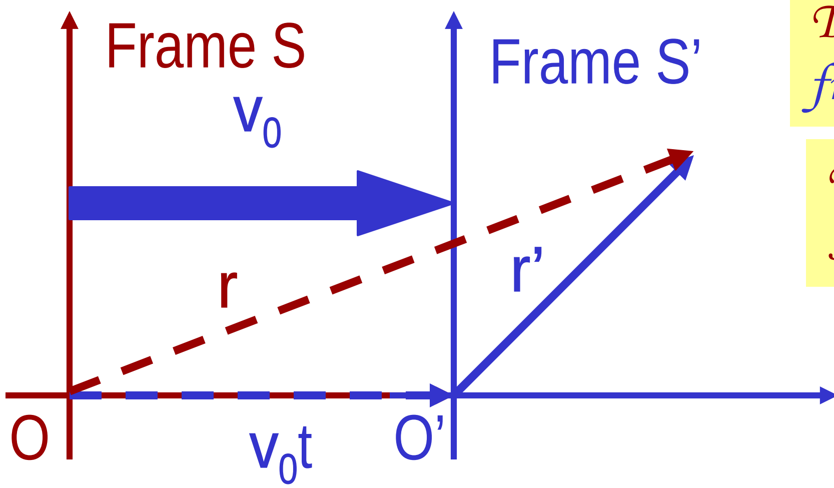
Do these yourselves at home for fun!!!

Observations in Different Reference Frames

Results of physical measurements in different reference frames could be different

Observations of the same motion in a stationary frame would be different than the ones made in the frame moving together with the moving object.

Consider that you are driving a car. To you, the objects in the car do not move while to the person outside the car they are moving in the same speed and direction as your car is.



The position vector r' *is still* r' *in the moving frame S' no matter how much time has passed!!*

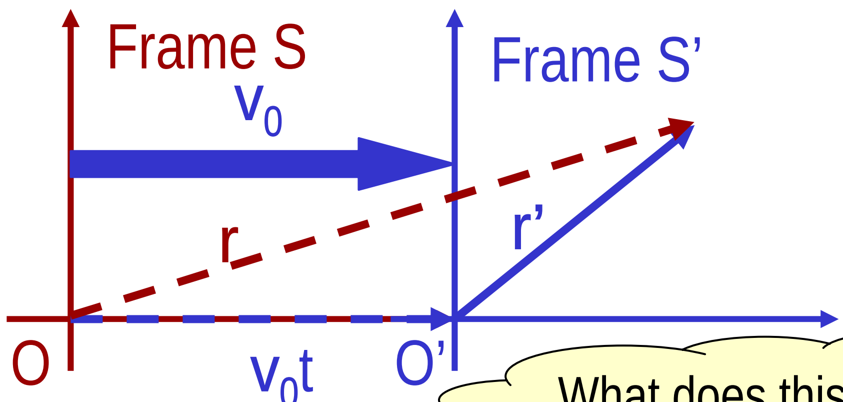
The position vector r *is no longer* r *in the stationary frame S when time t has passed.*

How are these position vectors related to each other?

$$\vec{r}(t) = \vec{r}_0 + \vec{v}_0 t$$

Relative Velocity and Acceleration

The velocity and acceleration in two different frames of references can be denoted, using the formula in the previous slide:



Galilean transformation equation

$$\vec{r}' = \vec{r} - \vec{v}_0 t$$

$$\frac{d\vec{r}'}{dt} = \frac{d\vec{r}}{dt} - \vec{v}_0$$

$$\vec{v}' = \vec{v} - \vec{v}_0$$

What does this tell you?

$$\frac{d\vec{v}'}{dt} = \frac{d\vec{v}}{dt} - \frac{d\vec{v}_0}{dt}$$

$\vec{a}' = \vec{a}$, when $\vec{v}_0$ is constant

The accelerations measured in two frames are the same when the frames move at a constant velocity with respect to each other!!!

The earth's gravitational acceleration is the same in a frame moving at a constant velocity wrt the earth.

Force

We've been learning kinematics; describing motion without understanding what the cause of the motion is. Now we are going to learn dynamics!!

Can someone tell me what FORCE is?

FORCE is what causes an object to move.

The above statement is not entirely correct. Why?

Because when an object is moving with a constant velocity no force is exerted on the object!!!

FORCEs are what cause any changes to the velocity of an object!!

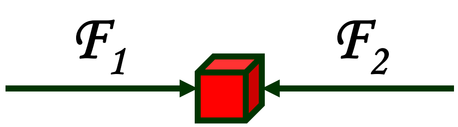
What does this statement mean?

When there is force, there is change of velocity!!

What does force cause? It causes an acceleration.!!

What happens if there are several forces being exerted on an object?

Forces are vector quantities, so vector sum of all forces, the NET FORCE, determines the direction of the acceleration of the object.



NET FORCE, $F = F_1 + F_2$

When the net force on an object is **0**, *it has constant velocity and is at its equilibrium!!*

More Force

There are various classes of forces

Contact Forces: Forces exerted by physical contact of objects

Examples of Contact Forces: Baseball hit by a bat, Car collisions

Field Forces: Forces exerted without physical contact of objects

Examples of Field Forces: Gravitational Force, Electro-magnetic force

What are possible ways to measure strength of Force?

A calibrated spring whose length changes linearly with the force exerted .

Forces are vector quantities, so addition of multiple forces must be done following the rules of vector additions.