Physics 2311 – Physics I, Week 4

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Outline for Day W4,D1

2D kinematics (Ch. 3)

- Vector problems (P. 10)
- 2D kinematics with vectors
- Projectile Motion

Homework

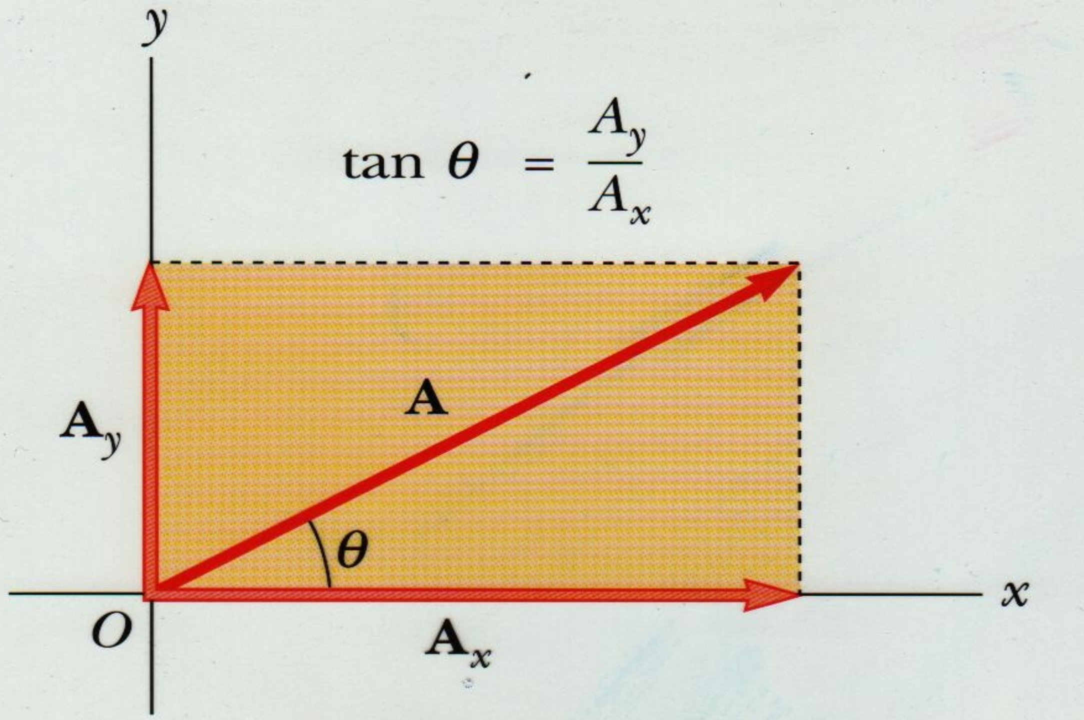
Ch. 3 P. 1,3,6,7,10,11,19,20,23,24,
32,33,37,38,39 Due by 3 pm.

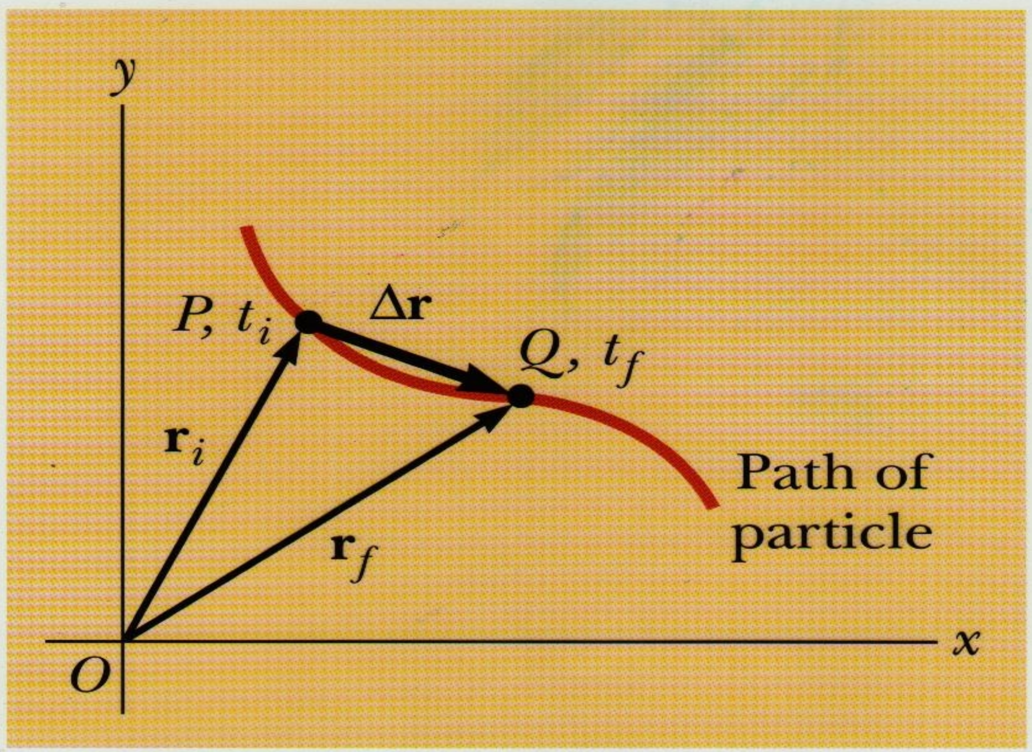
Notes: Lab this week: “Acceleration of Gravity”

Motion in 2D.

Top: position vector in 2-D.

Bottom: change of a position vector **r** gives a displacement Δ**r**.





Motion in 2-D
Definitions

Definitions ... (Most of these are very similar to the Ch. 2 equations)

Position vector: $\vec{r} = x\,\hat{i} + y\,\hat{j} + z\,\hat{k}$

Displacement: $\Delta\vec{r} = \vec{r}_f - \vec{r}_i$

Average velocity: $\vec{v}_{avg} = \dfrac{\Delta\vec{r}}{\Delta t}$. Instantaneous velocity: $\vec{v}_{inst} = \dfrac{d\vec{r}}{dt}$

Average acceleration: $\vec{a}_{avg} = \dfrac{\Delta\vec{v}}{\Delta t}$. Instantaneous acceleration: $\vec{a}_{inst} = \dfrac{d\vec{v}}{dt}$

Equations of Uniform acceleration

Final velocity $\vec{v}_f = \vec{v}_i + \vec{a}\,t$

Average Velocity $\vec{v}_{avg} = \dfrac{\vec{v}_i + \vec{v}_f}{2}$

Position as function of time: $\vec{r}_f = \vec{r}_i + \vec{v}_{avg}\,t$

Position as function of time: $\vec{r}_f = \vec{r}_i + \vec{v}_i t + \dfrac{1}{2}\vec{a}\,t^2$

Velocity change related to position change: $\vec{v}_f \cdot \vec{v}_f - \vec{v}_i \cdot \vec{v}_i = 2\,\vec{a} \cdot (\vec{r}_f - \vec{r}_i)$

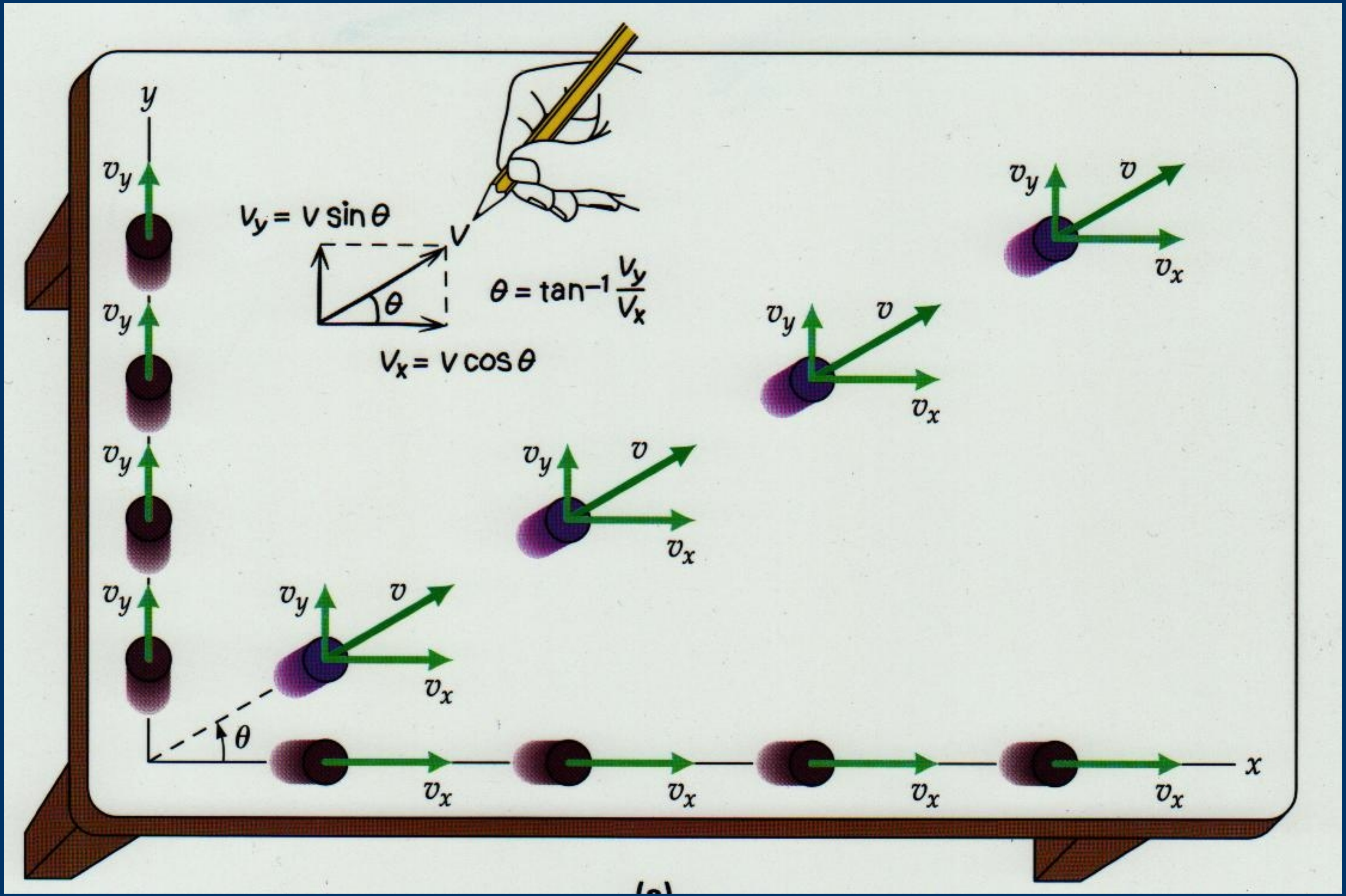
Motion in 2-D
Projectile Motion formulas

Time to reach max height: $t_{max} = \frac{v_i \sin\theta_i}{g}$ (v_i is the magnitude of the initial velocity)

Maximum height: $h_{max} = \frac{v_i^2 \sin^2\theta}{2g}$

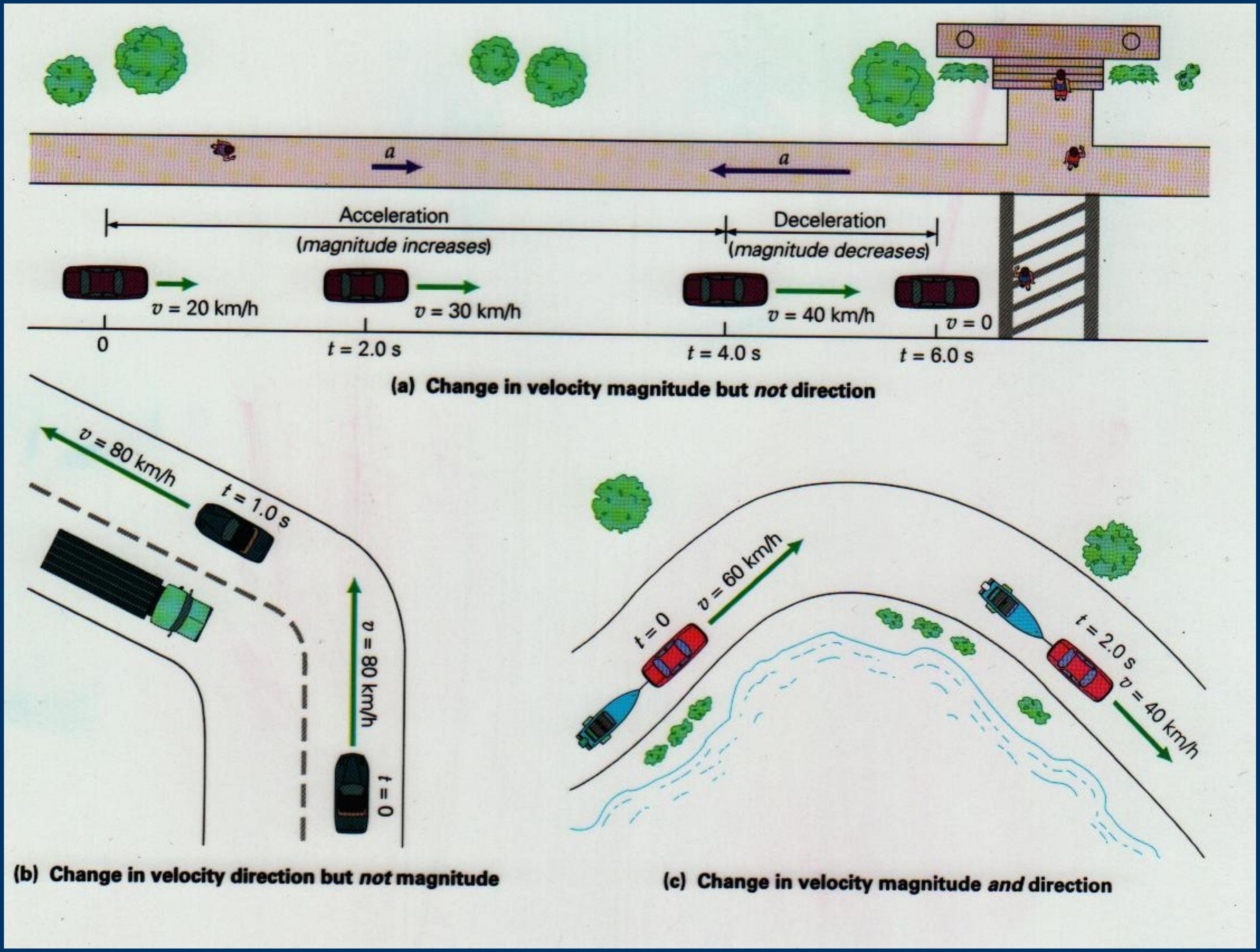
Range: $R = \frac{v_i^2 \sin 2\theta}{g}$

Velocity components in 2-D.

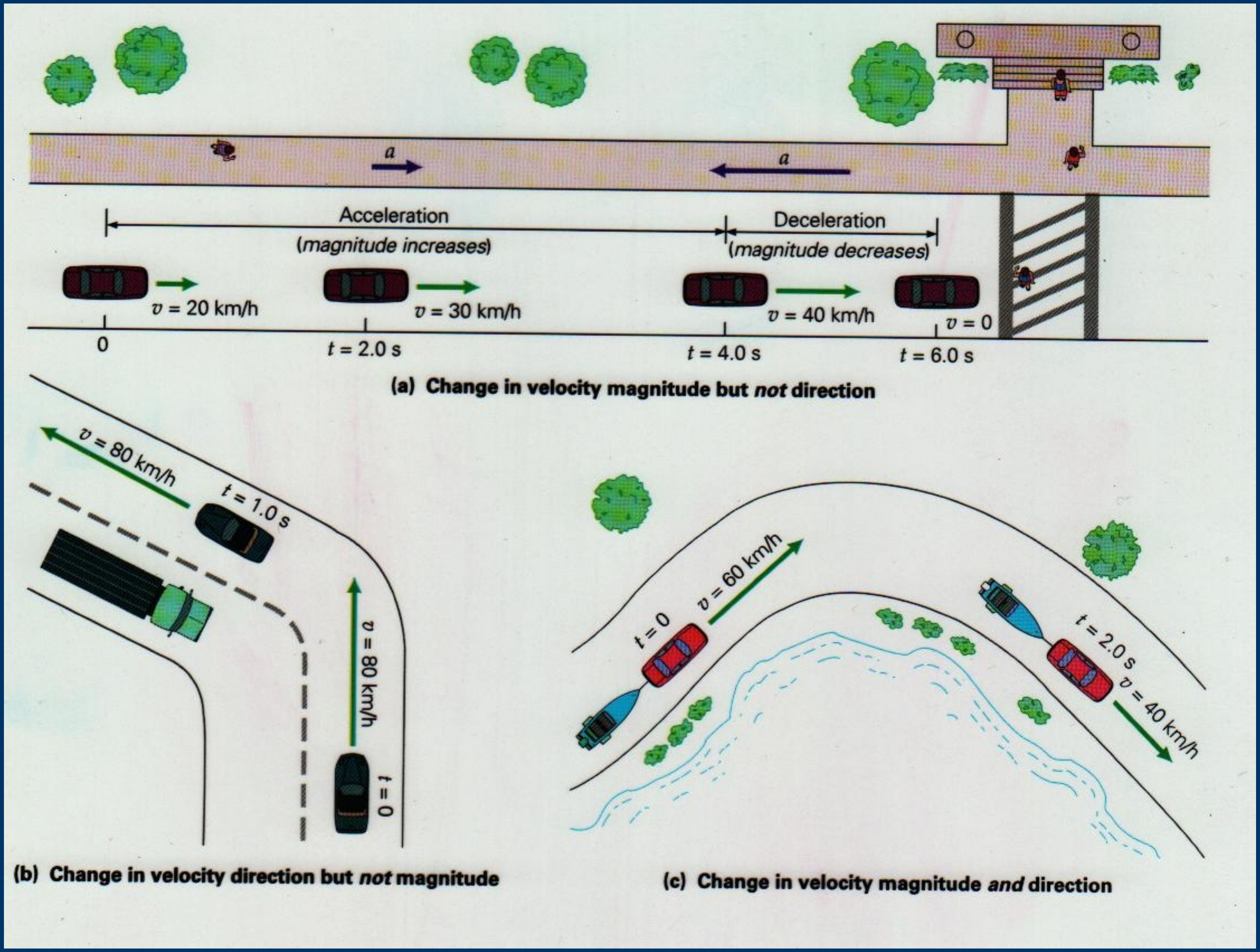


Notice that this motion is all in a straight line and so could be expressed with 1 dimension (using a rotated axis).

PHYS 2311 Week 3 - Motion in 1, 2, and 3 dimensions.

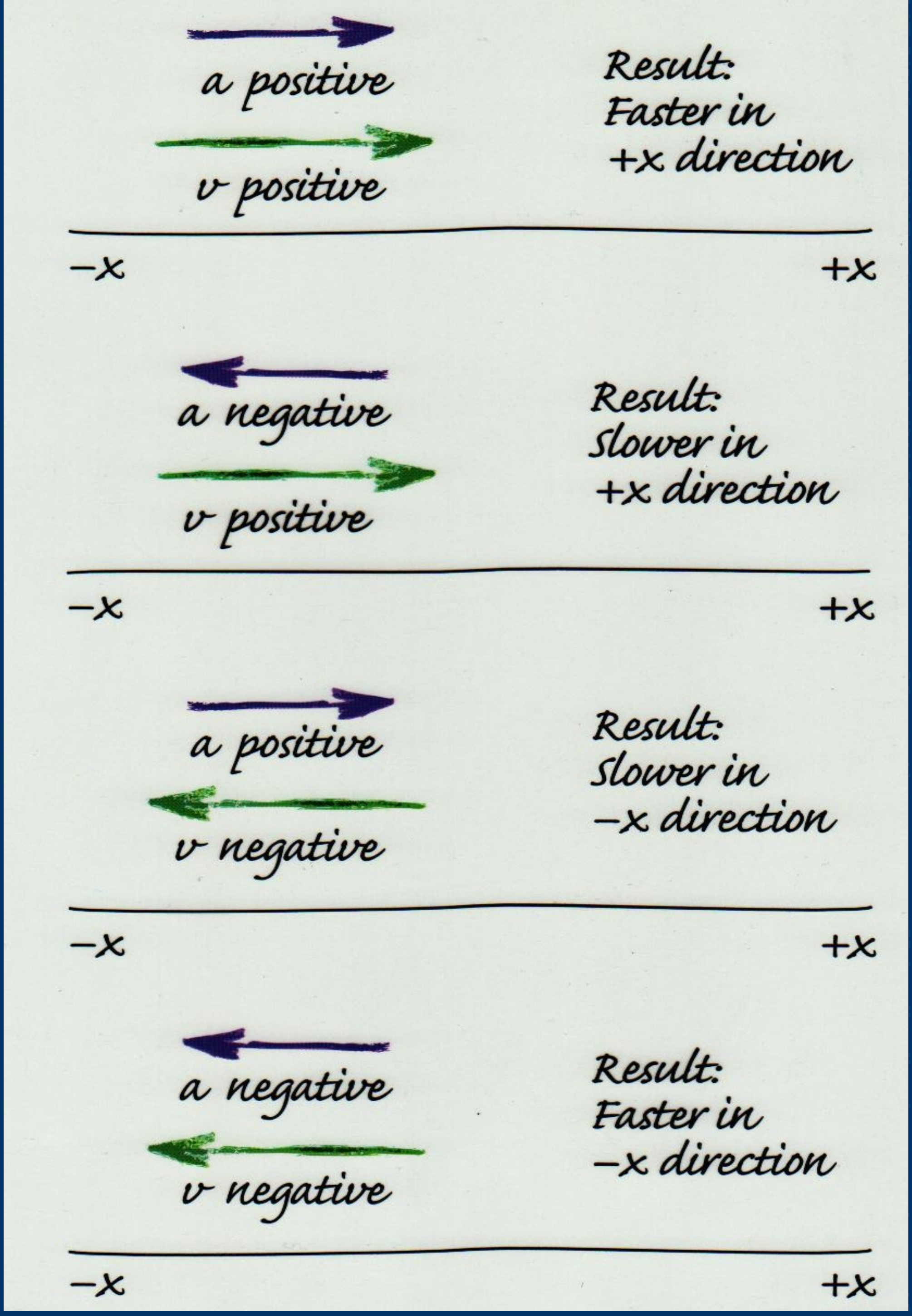


Top: Motion in 1D
Bottom: Motion in 2D.



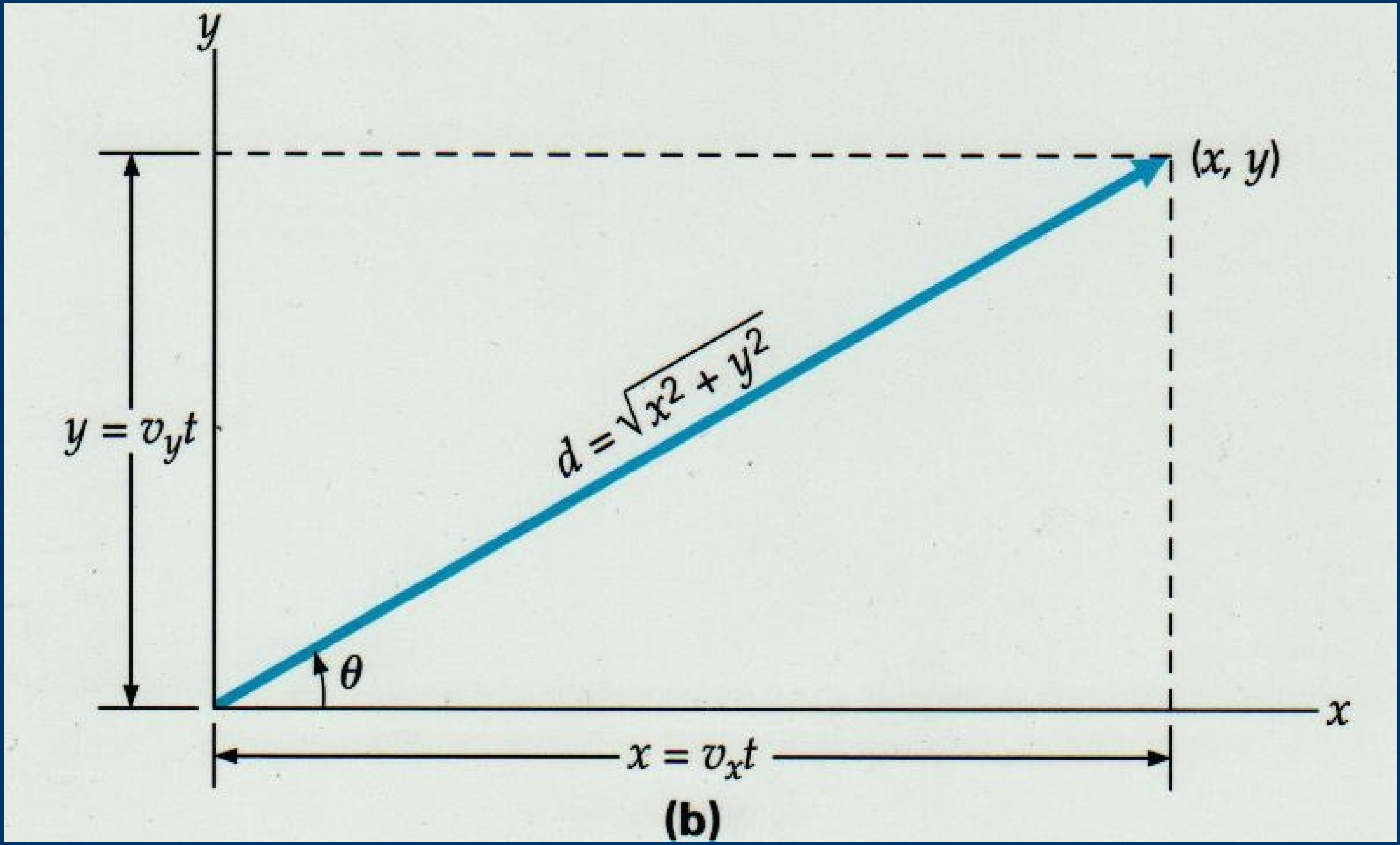
Motion in 1D.

The sign of acceleration and velocity is used to indicate the direction of these vectors.



Motion in 2D.

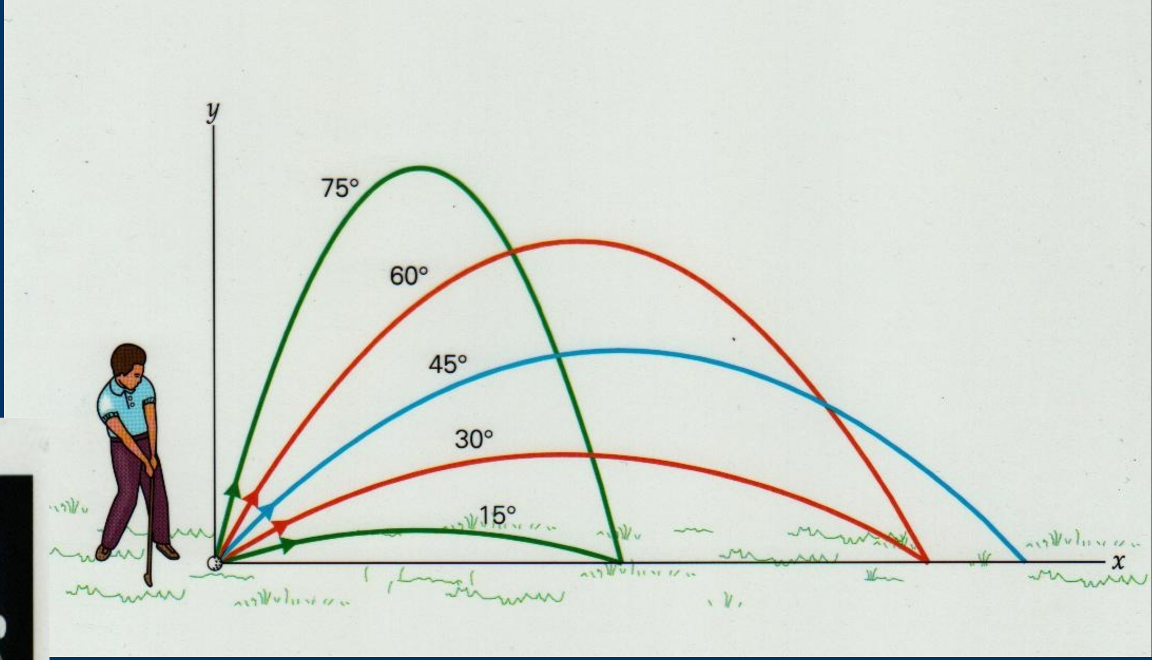
Relation between displacement components and velocity components.

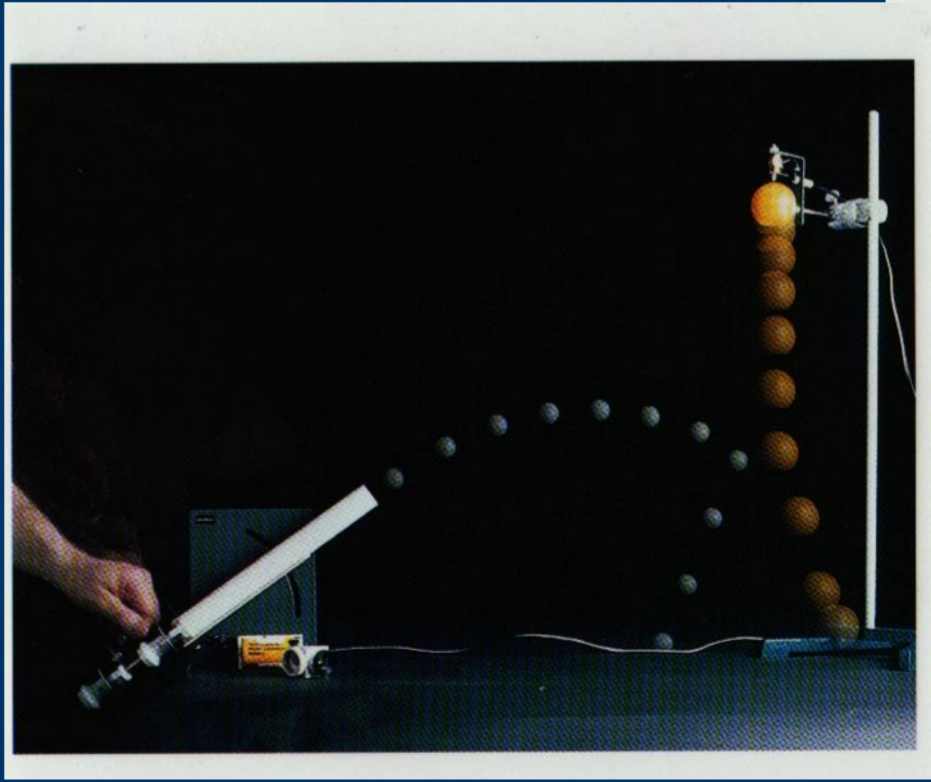


Motion in 2 dimensions.

Uniform downward acceleration leads to parabolic trajectories …

“Projectile Motion”.



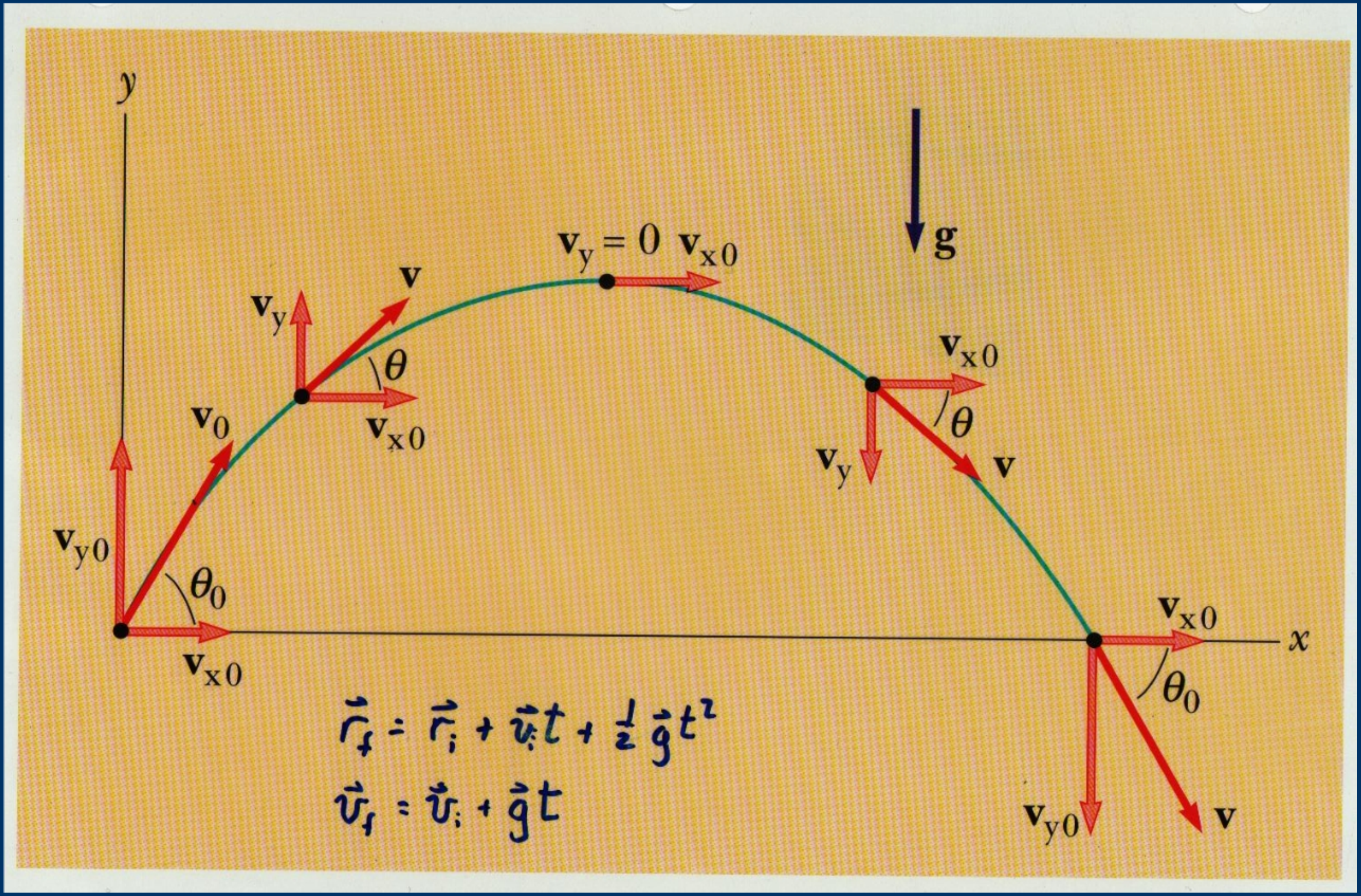


Notice that 2 initial angles lead to the same final range, except 45 degrees.

$$R = \frac{v_0^{\,2} \sin 2\theta}{g}$$

Motion in 2 dimensions.

Trajectories: position vector is a sum of 3 vectors.
(Velocity vector is a sum of 2 vectors.)



PHYS 2311 Motion in 2 dimensions.

Trajectories: parabolas distorted by air resistance.