Dylan's PHYS211 Notes

Week 1

Lecture 1: *Syllabus Day*

Vector review

$$v, |\vec{v}| \text{ Magnitude}$$

$$\theta \text{ above } \hat{i}, \text{ Direction}$$

The primary method to add or subtract

$$\vec{A} + \vec{B} = \vec{C} = (\vec{A}_i + \vec{B}_i) + (\vec{A}_j + \vec{B}_j)$$

$$\vec{C}_i = \vec{A}_i + \vec{B}_i$$

$$\vec{C}_j = \vec{A}_j + \vec{B}_j$$

Multiplying vectors

Scalar / Dot Product

$$\vec{A} = c\hat{i} + c\hat{j} + c\hat{k}$$

$$\vec{B} = b\hat{i} + b\hat{j} + b\hat{k}$$

$$\vec{A} \cdot \vec{B} = (\vec{A}_{\hat{i}} + \vec{B}_{\hat{i}}) + (\vec{A}_{\hat{j}} + \vec{B}_{\hat{j}}) + (\vec{A}_{\hat{k}} + \vec{B}_{\hat{k}})$$

Cross Product

$$\vec{A} = c\hat{i} + c\hat{j} + c\hat{k}$$

$$\vec{B} = b\hat{i} + b\hat{j} + b\hat{k}$$

$$\vec{A} \times \vec{B} = A_j B_k - A_z B_j \hat{i} + A_k B_i - A_i B_k \hat{j} + A_i B_j - A_j B_i \hat{k}$$

Lecture 2: *Learning*

$$\vec{r}(t) = ct\hat{i} + (ct - gt^2/2)\hat{j} + 0\hat{k}$$

$$\vec{v}(t) = \frac{d\vec{r}}{dt} = \frac{dr_x}{dt}\hat{i} + \frac{dr_y}{dt}\hat{j} + 0$$

$$c\hat{i} + (c - gt)\hat{j}$$

$$\vec{a} = (-g)\hat{j}$$

Kinematics Review

Figure 1: Display of vectors

Position : $\vec{r}(t)$
Length / distance : $r = |\vec{r}(t)|$
Displacement : $\Delta\vec{r}$
Velocity :

$$\vec{v}_{avg} = \frac{\vec{r}(t+\delta t) - \vec{r}(t)}{\Delta t}$$

Instantaneous Velocity :

$$\vec{v}(t) = \lim_{\Delta t \to 0} \frac{\vec{r}(t+\Delta t) - \vec{r}(t)}{\Delta t} = \frac{d}{dt}\vec{r}(t)$$

Acceleration :

$$\vec{a}(t) = \frac{d}{dt}\vec{v}(t) = \frac{d}{dt^2}\vec{r}(t)$$

Example problem : Find velocity (Accelerations) from position (velocity)
Example : Suppose that the position of a particle if given by $\vec{r} = A(e^{\alpha t}\hat{i} + e^{-\alpha t}\hat{j})$, where A and $a\alpha$ are constants. Find the velocity and sketch the trajectory.

$$\vec{r} = A(e^{\alpha t}\hat{i} + e^{-\alpha t}\hat{j})$$

Velocity would follow from a simple derivative :

$$\frac{d}{dt}\vec{r} = A(\alpha e^{\alpha t}\hat{i} + -\alpha e^{\alpha t}\hat{j})$$

We can factor out :

$$\vec{v} = A\alpha(e^{\alpha t}\hat{i} - \alpha e^{\alpha t}\hat{j})$$

we can sketch this graph by just looking at the behaviors of the graph at it's extremes.

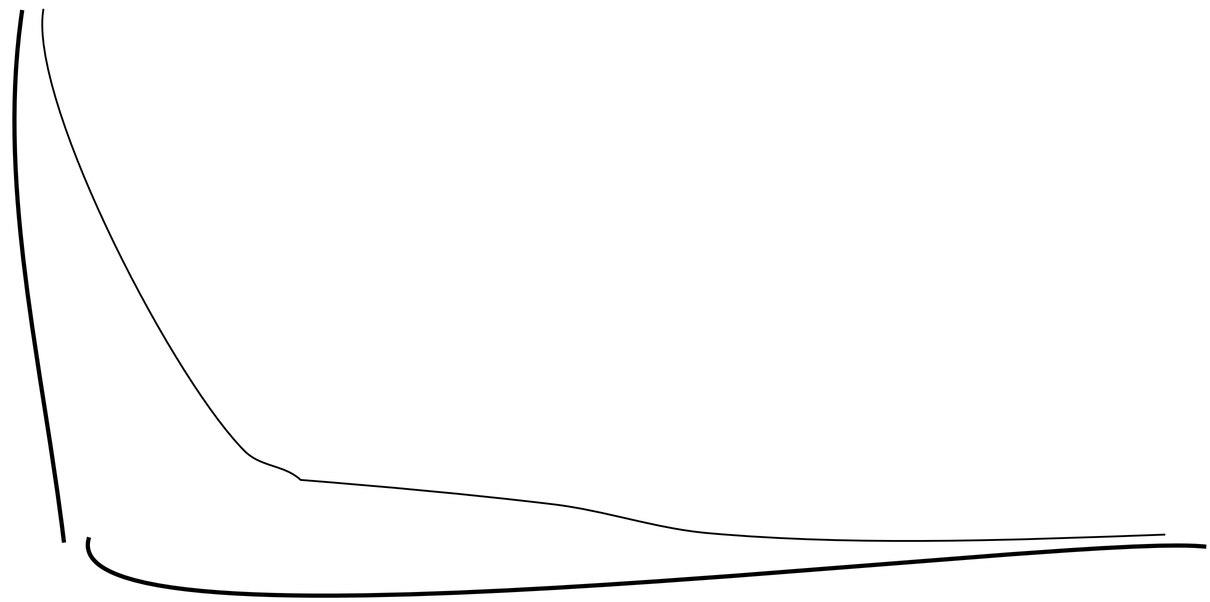

Figure 2: Sample decay graph

A table-tennis ball is released near the surface of the moon with initial velocity $\vec{v}_0 = (0, 5, 3)$ m/s . It accelerates downward with acceleration $\vec{a} = (0, 0, -1.6)$ m/s^2. Find its velocity at $t = 5$s

This is just a simple function of units :

$$5s\left(-1.6 \text{ m/s}^2\hat{k}\right)$$

$$25 \cdot -1.6 = -40$$

Simple addition then :

$$3 - 40 = -37$$

The balls velocity at 5 seconds is :

$$\vec{v}(5) = (0, 5, -37)$$

This can also be done more formally, aka the "correct" way :

$$\vec{v}(t) = \int \vec{a}(t)\,dt, \int_{t_0}^{t_f} \frac{d\vec{v}}{dt}\,dt = \vec{v}_f - \vec{v}_0$$

$$\int_{t_0}^{t_f} \vec{a}(t)\,dt = \int_{t_0}^{t_f} (0, 0, a_z)\,dt = (0, 0, a_z)t\big|_{t_0}^{t_f}$$

$$(0, 0, a_z(t_f - t_i)) =$$