1 Summary

1.1 Esimates

- Distances

$$1\,m \sim \text{The distance from me to you} \quad (1)$$
$$100\,km \sim \text{Here to memphis} \quad (2)$$
$$5000\,km \sim \text{Size of the continental U.S.} \quad (3)$$

- Times

$$1s \sim \text{Human Heart} \quad (4)$$
$$1ms \sim \text{Human reaction times} \quad (5)$$
$$1 \underbrace{\mu s}_{\text{microsecond}=10^{-6}\text{second}} \sim \text{chemical reaction rates} \quad (6)$$

- Velocity

$$5m/s \sim \text{Run} \quad (7)$$
$$20m/s \sim \text{50 mph} \quad (8)$$
$$40m/s \sim \text{80 mph fast ball} \quad (9)$$
$$70m/s \sim \text{Airplane} \quad (10)$$
$$300m/s \sim \text{Mach 1 = Sound Speed, velocity of Air Molecules} \quad (11)$$
$$600m/s \sim \text{Bullet} \quad (12)$$

- Acceleration $g \sim 9.8m/s^2$

$$\frac{1}{2}g \sim \text{Car} \quad (13)$$
$$3-4\,g \sim \text{Rocket} \quad (14)$$
$$30\,g \sim \text{Max a Human can withstand} \quad (15)$$

1.2 Constant Velocity

- x vs. t. Acceleration=0.

$$\Delta x = v\Delta t$$

1.3 Constant Acceleration

- v vs. t

$$\Delta v = a\Delta t$$

- x vs. t

$$\Delta x = v_0\Delta t + \frac{1}{2}a(\Delta t)^2$$

- v vs. x

$$v^2 = v_0^2 + 2a\Delta x$$

1.4 Graphical Analysis

Picture the situation in your mind and translate that into graphs.

1. The slope of position vs. time is

$$\text{“rise over run”} = \Delta x/\Delta t = \text{The velocity}$$

2. The slope of velocity vs. time is

$$\text{“rise over run”} = \Delta v/\Delta t = \text{The acceleration}$$

Here we have used derivatives = slopes, next we use integrals

1. The change position Δx over a time interval Δt is the area under the velocity vs. time curve

2. The change in velocity Δv over a time interval Δt is the area under the acceleration vs. time curve

The acceleration reflects the curvature of the x vs. t curve. u

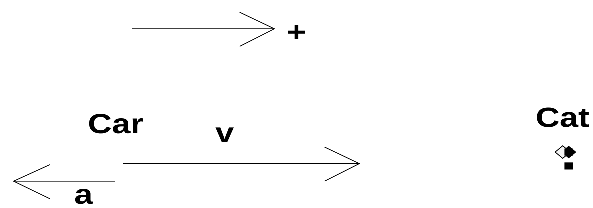
- For constant acceleration x vs. t is parabolic

- For constant velocity x vs. t is linear

1.5 Problem Solving Hints

Example. A car sees a cat in the road $50m$ ahead. Given that the car can have at most $1g$ deceleration What is the fastest the car can go without hitting the cat?

- **Sketch**. Show the velocity and acceleration vector and agree on a coordinate system to get the signs.



- **Boil down** the question as done in class. Here we want

$$v(x = 50m) = 0$$

. The velocity should be zero when the position is $50m$. This suggests the equation to use – the v vs. x equation in this case because the boiled down question is $v(x \dots)$.

$$v^2 = v_0^2 + 2a\Delta x \quad (16)$$

$$0 = v_0^2 + 2(-g)(50m) \quad (17)$$

You can now solve for the initial velocity v_0

- In such a problem I would usually have you **Plot** the position velocity and acceleration and as a function of time