# Lecture 12

# Newtonian Mechanics

**We know how to solve numerically → ODEs in MATLAB**

**Comparison with cases where analytical solution is available.**

**Investigating a system.**

# Steps to Follow always

1. Sketch the Problem, Define a coordinate system.
2. Draw all the forces as vectors.
3. Find the net force along each coordinate axis (force components) (Newton's second law. component by component.
4. Apply the constraints.
5. Solve the equations to find the acceleration along each coordinate. (known forces).

➢one can integrate them to find the velocity and position as a function of time. (with initial conditions.)
➢If so desired, apply initial conditions to obtain the full solution.

# Problem



A particle undergoing vertical motion in the presence of gravity. Retarding force proportional to the velocity. Find the displacement and velocity.

Phenomena of terminal velocity.

# Problem 1

**If a block slides without friction down a fixed inclined plane with $\theta$=30, what's the block's acceleration.**

# Problem 1 continuation



Now allow for static friction to hold the block in place, with coefficient of static friction μs = 0.4. At what angle does it become possible for the block to slide?

# Problem



Projectile motion in 2D.
Air resistance=0.
Velocity of the projectile v0; angle of elevation “theta”.
Calculate displacement, velocity  and range.

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Projectile motion in 2D.
Air resistance=0.
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Now put finite air resistance

What we learned:

Force function can be very simple when it is constant.

Also it can be complicated when it is a function of (r,v,t).
Integration becomes complex!!

- **Till now we did** Motion analysis with ***forces***.
- **Now** An alternative analysis using the concepts of **Work & Energy**.
- **Conservation of Energy: Force Language** to **Energy Language (Newton's Law)**.

- Phase space, Phase trajectory (simple harmonic oscillator)

# from the book Thornton (page 84)