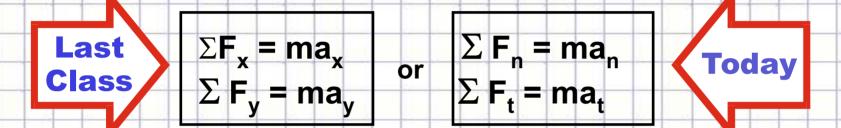
## Particle F=ma: Curved Paths and n-t Coordinates

Last Class, Particle Straight Line Motion: We solved F=ma problems in which particles moved along straight line paths. We wrote particle F=ma equations in x and/or y directions (or along rotated x-y coordinates).



Today, Particles moving along curved paths: We'll work with circular and non-circular paths, in vertical and horizontal planes. Lots of interesting, practical problems!

We'll use normal and tangential (n-t) coordinates.

## Various n-t coordinate problems...

We will investigate a number of basic F=ma problems, using n-t coordinates, in which particles move in curves.

## A. Problems where the curve is in a vertical plane.

- 1. Pendulum
- 2. Car cresting hill or in dip
- 3. Airplane or space shuttle
- **B.** Problems where the curve is in the horizontal plane.
  - 4. Weight swung in circle (tetherball problem).
  - 5. Car in banked curve on track.
- C. Additional n-t problem(s)
  - 6. Non-constant radius of radius of curvature.

## **Procedure for solving F = ma particle problems:**

- 1. Draw a complete Free Body Diagram (FBD) showing all forces acting on the body.
- 2. Draw a complete Kinetic Diagram (KD) which shows the ma (kinetic) terms and their assumed directions.
- 3. Write the equations of motion, using coordinates appropriate to the problem:

- 4. You may need to write an additional equation, such as a pulley kinematics relationship, a friction equation
  - (  $F = \mu N$  ), and/or others.
- 5. Solve the equations.