Dynamics Summary

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Kinematics of Particles

The 7 Holy Steps

Here are Hazim's 7 holy steps for kinematics of particles:

1. Identify provided information and what is required
2. Sketch the motion and identify points of interest on the path
3. Choose coordinate system
4. Construct the kinematic conditions table
5. For each interval, identify the type of acceleration and choose the appropriate equations to solve
6. Solve equations for required information
7. Check that your answers make sense

Ensure that when you integrate it is definite integration (with limits) because we will almost always know the limits and it's preferred over indefinite integration. Additionally, ALWAYS draw a FBD for a question (or maybe a sketch of the motion) and note that you might want to draw a kinematics condition table for every part of a question as the conditions change.

Rectilinear Motion

Also called linear motion, rectilinear motion is motion in 1 dimension i.e a straight line. These kinematic equations form the basis of rectilinear motion:

$$v = \frac{ds}{dt},\ a = \frac{dv}{dt},\ s = v\frac{ds}{dt}$$

If acceleration is constant, we can derive these equations by integration:

$$v - v_0 = a(t - t_0) \tag{1}$$
$$v^2 - v_0^2 = 2a(s - s_0) \tag{2}$$
$$s - s_0 = v_0(t - t_0) + \frac{1}{2}a(t - t_0)^2 \tag{3}$$

The general approach for a rectilinear motion question is detailed in the 7 holy steps but for the solution steps we will use any of the equations above (and maybe others, depending on the question). Acceleration (a) will be one of four things: constant, a function of time, a function of velocity or a function of displacement. Each of these have different methods.

1. Const.: use the above equations for constant velocity to solve
2. a(t): solve $a = \frac{dv}{dt}$
3. a(v): solve $a = \frac{dv}{dt}$ or $vdv = ads$ depending on what you are solving for
4. a(s): solve $vdv = ads$

Plane Curvilinear Motion