Dynamics problem solving procedure

(for unknown motion given ICs and/or BCs)

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Approaches (in order of complexity):

A. Use conservation principles if possible (energy, linear momentum, angular momentum). If the problem involves more than one body (or particle), try to apply conservation principles to the entire system. If that doesn't work, try to apply the principles to individual bodies (or particles) within the system. Use the list of questions below.

B. Use work and energy principles ($T_A + V_A = T_B + V_B + W_{AB}$) if all non-conservative forces and torques (e.g., friction, damping, air resistance, applied loads from actuators, etc.) are known or can be easily characterized.

C. Write the general equations of motion and solve the DEs for the complete motion.
   a. Newton's method: draw FBDs, do kinematics, set F = ma.
   b. Lagrange's method: express the kinetic and potential energy functions for the system, express the generalized forces for non-conservative forces, and write the Lagrange Equations for the system.

Questions you should ask yourself for Approach "A":

1. Are any external forces acting on the system or body?

   If not, the linear momentum of the system is conserved and the velocity of the CM of the system is constant.

2. Are any external torques or moments acting on the system or body about a fixed point or its CM?

   If not, the angular momentum of the system is conserved about that point.

3. Are any non-conservative forces acting in or on the system or a body?

   If not, energy is not conserved

4. Is a central force field acting on a particle (i.e., does the force always go through an inertial [fixed or constant velocity] center point)?

   If so, the angular momentum of the particle about the center point is constant.