More Physics Simulations:
A Mass on a Linear Spring and Beyond

I. FINISHING YOUR MASS-ON-A-SPRING PROGRAM

- Make your mass oscillate under the influence of a linear restoring force. If you have a working bouncing ball program with a force function, you should only need to modify a few things:

    1. You should change your force function (your ball is moving under the influence of a linear restoring force, not the constant force of gravity).
    2. You should remove the `if` statement that causes the ball to bounce.

- After you have your ball oscillating, move the "floor" out of the way. I suggest moving it down at least 6 units.

- Add a helix object. To see how these objects work, do the following:

    – Follow the pull-down menu path `Help` ⟶ `Visual` ⟶ `Reference Manual` ⟶ `helix`.

    – Cut and past the example of a helix command into your program; put it near the line where you define the `ball` object.

    – Run your program and see what the command produces.

    – Modify the parameters in the `helix` statement one at a time, and see what they do to the displayed helix.

    – Modify your `helix` parameters so that one end of your "spring" is attached to the "floor" and the other end is attached to your moving ball.

II. THINGS TO TRY

Once you have a working program with a force function, you should be able to change the function and start investigating physics questions.

- Make two side-by-side masses on springs. Make it so that it is easy to adjust the individual masses and spring constants. You can keep one of your systems unchanged as a reference system, and investigate questions like:
  - **How does the period depend on the value of the spring constant?**
    For example, what do you have to do to the spring constant to cut the period in half? to double the period?
  - **How does the period depend on the value of the mass?**
    For example, what do you have to do to the mass to cut the period in half? to double the period?
  - **How does the period depend on the amplitude of the oscillation?**
- Extend your investigations of springs by making one of the springs *non-linear*. One version of a non-linear restoring force is

  $$F = -k_3 x^3,$$

  where k_3 is a constant.
  - Compare two side-by-side springs, one linear and one non-linear. Adjust the magnitude of k_3 so that the two masses start with the same initial force, and see if the period of the non-linear system is the same as the period of the linear system.
  - Investigate how the period of the non-linear oscillation depends on the amplitude of the oscillation.
  - Is mechanical energy conserved in your linear oscillator? Is mechanical energy conserved in your non-linear oscillator?
- Start thinking about how to include a realistic drag force on your oscillator.

III. FUTURE PROJECTS

- **Orbits**
  You can start by trying to model the motion of the earth around the Sun.
- **Deterministic Chaos**