

PH504M Lab1: Basic Python Coding to Solve Physics Problems

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Example 1: Kinetic Energy of Objects

Problem:

Write a Python program to calculate the kinetic energy of several objects. The kinetic energy is given by:

$$KE = \frac{1}{2}mv^2$$

You are provided with two lists:

- **masses**: containing the masses (in kg) of objects.
- **velocities**: containing their corresponding velocities (in m/s).

1. Write a function `calculate_ke(m, v)` to calculate the kinetic energy of a single object.
2. Use a `for` loop to compute the kinetic energy of each object in the lists and store the results in a new list.
3. Print the final list of kinetic energies.

Example 2: Gravitational Force Between Two Objects

Problem:

The gravitational force between two objects is given by:

$$F = G \frac{m_1 m_2}{r^2}$$

Where:

- $G = 6.674 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$ (gravitational constant),
- m_1 and m_2 are the masses of the two objects (in kg),
- r is the distance between their centers (in meters).

1. Write a function `gravitational_force(m1, m2, r)` to calculate the force.

2. Given lists of masses `m1_list`, `m2_list`, and distances `r_list`, compute the gravitational forces between each pair of masses using a `for` loop.
3. Use an `if` statement inside the loop to ensure $r > 0$. If $r \leq 0$, print a warning message.

Example 3: Average Velocity in Free Fall

Problem:

An object in free fall experiences constant acceleration due to gravity $g = 9.8 \text{ m/s}^2$. The velocity after t seconds is:

$$v = g \cdot t$$

1. Create a list of time intervals (e.g., [1, 2, 3, 4, 5] in seconds).
2. Write a function `velocity(t)` that calculates the velocity at a given time.
3. Use a `for` loop to calculate velocities for each time in the list and store them in a new list.
4. Calculate and print the average velocity over the time interval using basic operations.

Example 4: Filtering Light Wavelengths

Problem:

The wavelength of light determines its type:

- $\lambda < 380 \text{ nm}$: Ultraviolet
- $380 \text{ nm} \leq \lambda \leq 750 \text{ nm}$: Visible
- $\lambda > 750 \text{ nm}$: Infrared

1. Create a list of wavelengths (in nm), e.g., [300, 450, 700, 800, 250].
2. Write a function `classify_wavelength(wavelength)` that takes a wavelength and returns whether it is "Ultraviolet", "Visible", or "Infrared".
3. Use a `for` loop to classify all wavelengths in the list and print the results.

Example 5: Temperature Conversion

Problem:

Convert a list of temperatures from Celsius to Fahrenheit using the formula:

$$F = \frac{9}{5}C + 32$$

1. Write a function `c_to_f(celsius)` to perform the conversion.

2. Use a list of temperatures in Celsius (e.g., [-20, 0, 20, 37, 100]) and a `for` loop to convert each value to Fahrenheit.
3. Store the Fahrenheit values in a new list and print both lists (Celsius and Fahrenheit).

Example 6: Sum of Forces in a System

Problem:

Given a system of forces acting along a straight line, calculate the net force. A positive value indicates a force to the right, and a negative value indicates a force to the left.

1. Create a list of forces (e.g., [10, -5, 15, -20, 5] in N).
2. Use a `for` loop to calculate the sum of all forces.
3. Use an `if` statement to determine whether the system is in equilibrium (net force = 0) and print the result.