LAB01: Introduction to VPython

SCI-103 Physics I
K. Kanjanasit
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Goals

In this lab, you will learn the fundamentals of programming and 3D visualization using **VPython**. By the end of the lab, you should be able to:

- Use the GlowScript IDE to create and run VPython programs.
- Write basic Python code for arithmetic and vector operations.
- Implement loops and conditional structures.
- Create and manipulate 3D geometric objects.
- Combine 3D graphics with simple animations.

I. Getting Started

For reference, see the official VPython documentation: `https://www.glowscript.org/docs/VPythonDocs/index.html`

A. GlowScript IDE

1. Sign in at `https://www.glowscript.org/`.
2. Create or open a folder under "My Programs".
3. Create a new program and give it a file name.

By default, the VPython module is preloaded, so you do not need to type `from vpython import *`. This environment allows you to perform 3D animations easily, while also supporting mathematical functions from Python.

B. Basic Python Programming

Type and execute the following commands in the editor. Python is case-sensitive. The results will appear in the output area. Record and interpret the outputs.

```
print(6 + 5)
print(2**3)
a = 3
b = 5
print(a - b)
print("Hello World!")
print("a + b")
print((a + b) * (a - b))

c = vector(0,1,0)
d = vector(1,0,0)
print(c + d)
print(dot(c, d))
print(cross(c, d))
print(mag(c + d))
print(pi)
print(sin(pi/3))
print(cos(0))
print(sin(pi))
print(cos(pi/2))
print(4.0/3.0)
print(4/3)
```

Question: What is the distinction between `4` and `4.0`?

C. Loops

Loops allow repeated execution while a condition is true. Indentation is essential.

```
i = 1
while i < 11:
    print(i)
    i = i + 1
```

Task: Explain the output and your understanding of how the loop executes.

D. 3D Geometric Objects

Start a new program and enter:

```
ball = sphere(pos=vec(0,0,0), radius=0.5, color=color.red)
wall1 = box(pos=vec(-10,0,0), length=0.1, height=10, width=5, color=color.blue)
wall2 = box(pos=vec(10,0,0), length=0.1, height=10, width=5, color=color.blue)
```

This produces a 3D display of a red ball between two blue walls. You can rotate or zoom using your mouse. Try modifying object attributes, for example:

```
ball.pos.x = ball.pos.x + 5
```

Task: Explain the changes in output and their meaning.

E. Animation: Combining 3D Objects and Loops

Enhance the program by adding motion:

```
v = 1.0    # initial velocity
dt = 0.1
while True:
    rate(100)
    ball.pos.x = ball.pos.x + v*dt
```

Task: Describe the animation and explain how the ball's position is updated frame by frame. Try changing `x` to `y` to move the ball vertically.

II. Additional Resources

You are using only a small subset of Python and VPython. For further study:

- VPython Web Documentation: `http://vpython.org/webdoc/visual/index.html`
- Python Official Tutorial: `https://docs.python.org/3/tutorial/`
- Mark Lutz, *Learning Python*
- John Zelle, *Python Programming: An Introduction to Computer Science*