Chapters 1-10

Physics Terms

Be able to define or discuss the following terms and ideas, with their SI units if appropriate.

1. coordinate
2. coordinate system
3. computer convention for a coordinate system in pixels
4. vector, vector tail, and vector head
5. vector components
6. magnitude of a vector
7. direction of a vector
8. unit vectors in the $+x$, $-x$, $+y$, $-y$, $+z$, and $-z$ directions, respectively
9. position
10. displacement
11. position update equation
12. time interval (when this is relatively small, we call it a time step), Δt
13. clock reading, t
14. velocity
15. uniform motion
16. slope of a x-position vs. t graph (or y-position vs. t graph or z-position vs. t graph)

VPython Programming Terms

Be able to define or discuss the following programming statements, terms, and VPython functions. Know the syntax and study example uses of each term, statement or function.

1. `sphere()`
2. `box()`
3. name of an object
4. property of an object
5. the value of a property of an object
6. variable
7. list
8. loop, including the `for` loop and `while` loop
9. conditional statement (`if-elif-else` statement)
10. updating a variable (`t=t+dt` and `points=points+1` are two examples)
11. function (including `def` and `return` statements)
12. `mag()`

Equations

Understand the meaning and know the SI units of all symbols in these equations; know how to perform each mathematical operation; know how to solve for any unknown quantity; understand how changing one quantity affects another quantity (if all other quantities remain constant); be able to apply one or more equations to solve a problem.

- Vectors

$$\begin{aligned}
\text{(head)} &= \text{(tail)} + \text{(vector components)} \\
\text{(vector components)} &= \text{(head)} - \text{(tail)} \\
\text{magnitude: } |\vec{A}| &= \sqrt{A_x^2 + A_y^2} \\
\text{direction: } \hat{r} &= \frac{\vec{r}}{|\vec{r}|} \\
\text{multiplying a scalar and vector: } a\vec{r} &= < ar_x, ar_y, ar_z >
\end{aligned}$$

- A few specially defined unit vectors are $\hat{i}$, $\hat{j}$, and $\hat{k}$ which point along the x, y and z axes, respectively. They are written as

$$\begin{aligned}
\hat{i} &=< 1, 0, 0 > \\
\hat{j} &=< 0, 1, 0 > \\
\hat{k} &=< 0, 0, 1 >
\end{aligned}$$

  Suppose that a vector points in the $-x$ direction, then its unit vector is $< -1, 0, 0 >$. Likewise $< 0, -1, 0 >$ points in the –y direction, and $< 0, 0, -1 >$ points in the –z direction.

- displacement

$$\text{displacement} = \text{final position coordinates} - \text{initial position coordinates}$$

- velocity

$$\begin{aligned}
\text{velocity} &= \frac{\text{displacement}}{\text{time interval}} \\
\text{displacement} &= \text{velocity} \times \text{time interval}
\end{aligned}$$

- position update

$$\begin{aligned}
\text{final position coordinates} &= \text{initial position coordinates} + \text{displacement} \\
\text{final position coordinates} &= \text{initial position coordinates} + \text{velocity} \times \text{time interval}
\end{aligned}$$

Skills

1. You should be able to read a given VPython program and know the purpose of a given line of code and its result when executed.

   Example: When line 5 is executed in the program below, what will be printed?

```
1 tennisball=sphere(pos=(0,6,0), radius=1, color=color.orange)
2 box(pos=(0,0,0), length=78, height=4, width=36, color=color.green)
3 print(tennisball.pos)
4 tennisball.pos=vector(32,7,-12)
5 print(tennisball.pos)
```

Answer: (32,7,-12)

2. You should be able to modify a given VPython program by adding a single line of code to perform a necessary task.

   Example: A function called `collisionSpheres` is written to calculate the distance between two spheres and compare it to the radii of the spheres. If the distance is is less than the sum of the radii, it returns true. Otherwise, it returns false. Write line 2 so that the function will execute correctly.

```
1 def collisionSpheres(sphere1, sphere2):
2
3     if(dist<sphere1.radius+sphere2.radius):
4         return True
5     else:
6         return False
```

   Answer: `dist=mag(sphere1.pos-sphere2.pos)`

3. You should be able to measure the slope of a x-position vs. t graph and know what it means.

4. You should be able to solve problems similar to those on homework.

   (See the solutions for examples. Note that the questions will not be copied. Numbers, directions, etc. will be different.)