DAY 7

Applications: Graphing and Base Conversion — Includes Problem Set 3 Due Sept. 20

Where are We?

We have finished (with the exception of only a few topics — notably the statistical functions) the entire *Owner's Handbook*, we have keyed in several programs, including, most recently, Moon Lander, and we have written a program that finds the direction of Mecca. The HP-25 *Applications Programs* book is what we will draw from next for a rich variety of subjects and programs. The first chapter of applications is on Algebra and Number Theory.

Graphing

Read pp. 4–8 of the *Applications Programs* book. Then do Problems 1 to 3 on the Problem Set. These will take a while. Budget extra time to get Problem 2 right. You will have to significantly modify the graphing program and document your new program.

Base Conversion

Take a look at pp. 22–25 of the *Applications Programs* book. Then do Problems 4 and 5 on the Problem Set. These will be pretty quick, except for keying in the programs. Leave the last program (the one on pp. 24-25) keyed in when we start the next class so that we can try to understand how it works.

History

We have pp. 180-189 from *Bill & Dave* to read. It is fun, but straightforward. I'm not expecting it to provoke a lot of discussion. Perhaps I am wrong. Come with your comments.

Problem Set 3

The problems are on the following 3 pages.

Looking Ahead

If anyone has studied complex numbers and would like to discuss some of the other programs that we are skipping, come see me.

The material on cross products, dot products, and simultaneous equations in two unknowns is all worthy and not too advanced, so we will cover that next.

Numerical Analysis — Problem Set 3 — Starting Applications Programs

Due Tuesday, Sep. 20 (beginning of class)

We are leaving the HP-25 Owner's Handbook *behind and launching into Chapter 1 of the* HP-25 Applications Programs *book*. These problems relate to the Plotting/Graphing program and the Base Conversion programs.

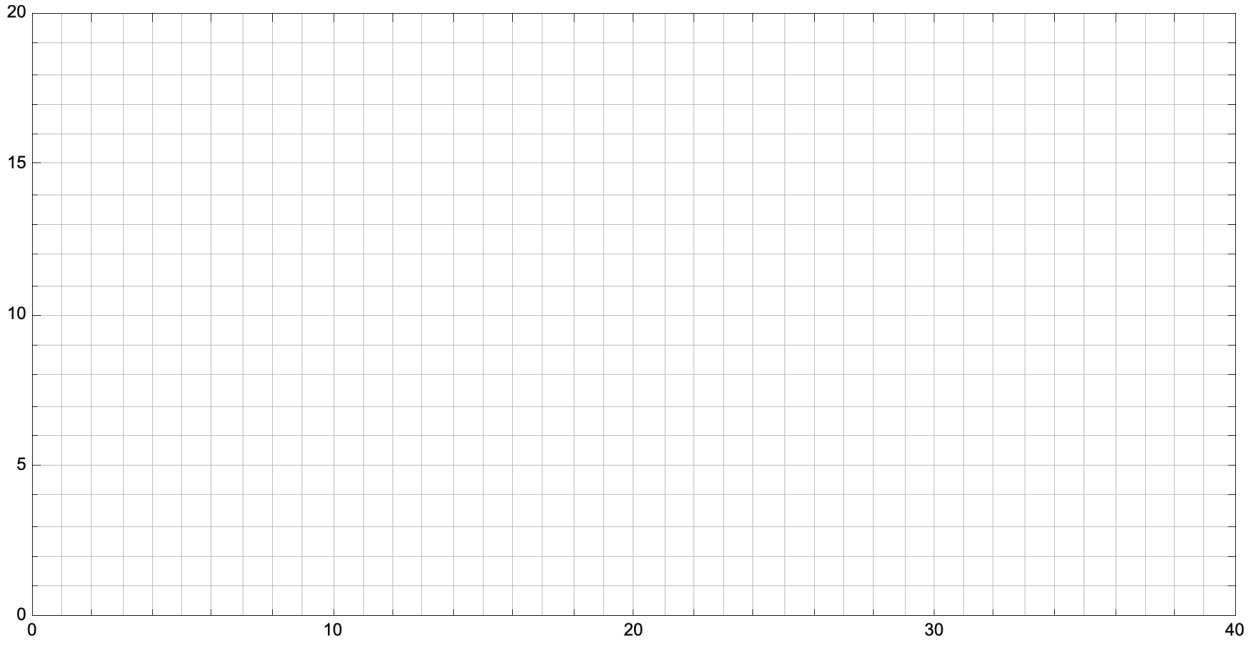
1. Plotting/Graphing

After you have keyed in the Plotting/Graphing program on p. 7 of the *Applications Programs* book, use it to plot three trajectories:

(a) 0.25 time interval in seconds (abbreviated s), 9.8 acceleration of gravity in meters per second per second, (abbreviated m/s^2), 30° initial angle, 20 initial speed in meters/second (abbreviated m/s)
(b) 0.25 s, 9.8 m/s^2, 45°, 20 m/s
(c) 0.25 s, 9.8 m/s^2, 60°, 20 m/s

In[24]:=
```
Plot[{}, {x, 0, 40}, PlotRange → {{0, 40}, {0, 20}},
 GridLines → {Range[0, 40, 1], Range[0, 20, 1]}, AxesLabel → {x, y},
 Ticks → {Range[0, 40, 5], Range[0, 20, 5]}, AspectRatio → 1 / 2, Frame → True]
```

Out[24]=



2. Including Air Resistance

Examine the program and find the lines where this equation was incorporated:

$$x = v_x\, t$$

Change the lines to this new formula for x:

$$x = \frac{v_x\, v_{\text{terminal}}}{g}\left(1 - e^{-g t / v_{\text{terminal}}}\right)$$

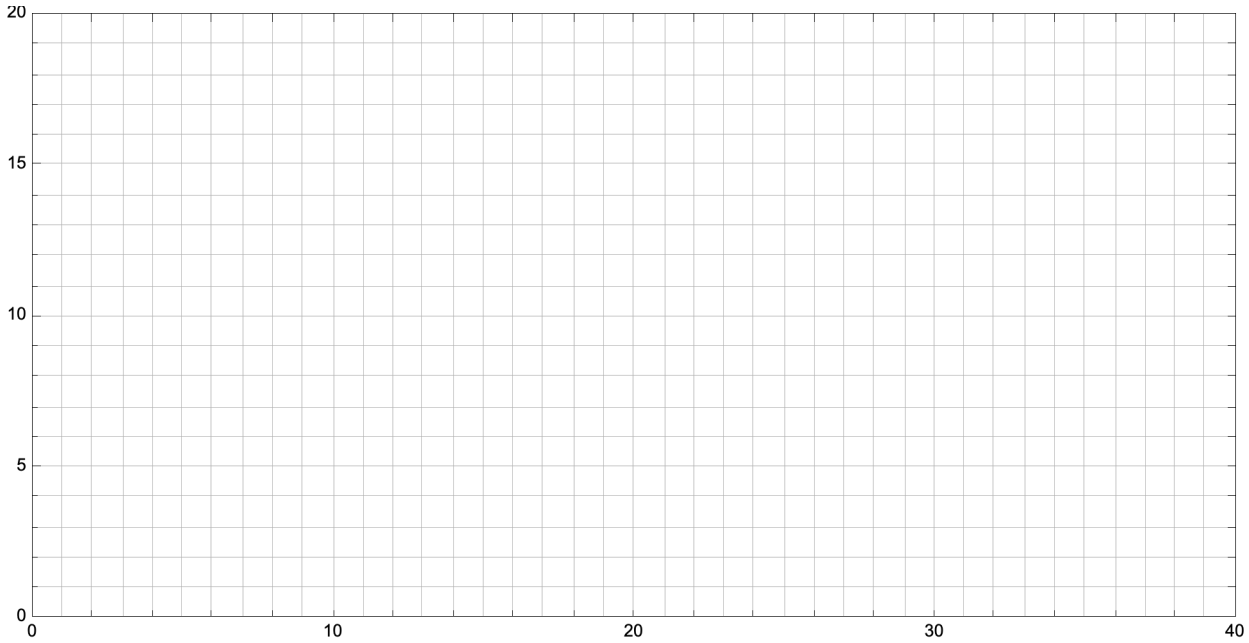
v_{terminal} is a new parameter that accounts for air resistance (it is known as the terminal velocity). You are going to need to store that new parameter in another register. Since R_0 to R_4 are already assigned, R_5 would be a good choice. Document your program in the usual format (a program form is attached).

3. Plot with Air Resistance

Re-do your plot of trajectory (a) with your new program and $v_{\text{terminal}} = 30\ \text{m}/s$. (All other parameters should be the same as trajectory (a) above.)

In[•]:=
```
Plot[{}, {x, 0, 40}, PlotRange → {{0, 40}, {0, 20}},
 GridLines → {Range[0, 40, 1], Range[0, 20, 1]}, AxesLabel → {x, y},
 Ticks → {Range[0, 40, 5], Range[0, 20, 5]}, AspectRatio → 1 / 2, Frame → True]
```

Out[•]=



To be fair, I have to admit that the formula for y which was $y = v_y\, t - \frac{1}{2}\, g t^2$ really should to be modified to include air resistance too. But if you fire at low angles, that modification doesn't matter much.

4. Converting from Base 2 to Base 10

Convert 1000000000 in base 2 (there are 9 zeros in that number) to a number in base 10.

5. Converting from Base 10 to Base 16 and Base 2

(a) Convert 48879 in base 10 to base 16.

(b) In base 16, we could really use more numerals to choose from, because each digit goes from 00 to 15. Here is how the digits are usually represented in base 16:

Instead of 00 just write 0.
Instead of 01 just write 1.
Instead of 02 just write 2.
...
Instead of 07 just write 7.
Instead of 08 just write 8.
Instead of 09 just write 9.
Instead of 10 just write A.
Instead of 11 just write B.
Instead of 12 just write C.
Instead of 13 just write D.
Instead of 14 just write E.
Instead of 15 just write F.

Convert whatever you got in Part (a) using these conventions.

(c) It is common to prefix base sixteen numbers with 0x to emphasize that they are base 16. Here is how the khaki color on the Deep Springs website is stuffed into three bytes on a video card: 0xFBFCE0. 0xFB represents the red value. 0xFC represents the green value, and 0xE0 represents the blue value.

What are the red, green, and blue values in base 10?

NB: You don't need any program to do parts (b) and (c). For example, for the red in part (c), you just need to know that F is in the 16's place and F represents 15, so to 15x16 you need to add what B represents, which is 11.

(d) Convert 0.2 in base 10 to base 2. This one is amusing: such an easy number in base 10 (and such an easy fraction, it is just 1/5) has no easy representation in base 2!

HP-25 Program Form

Title_____ Page____ of____

Switch to PRGM mode, press [f] [PRGM], then key in the program.

DISPLAY LINE	DISPLAY CODE	KEY ENTRY	X	Y	Z	T	COMMENTS
00							
01							
02							
03							
04							
05							
06							
07							
08							
09							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							

REGISTERS
R_0
R_1
R_2
R_3
R_4
R_5
R_6
R_7

HEWLETT hp PACKARD

HP-25 Program Form

Title _____ Page _____ of _____

Programmer _____

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS