Physics II
Bungee Problems

Formulas:

- W=Fd
- Energy and work can often be thought of as interchangeable
- F=ma

1. A 10kg weight was lifted 20meters, straight up.

   a. What was the minimum force that must have been applied?

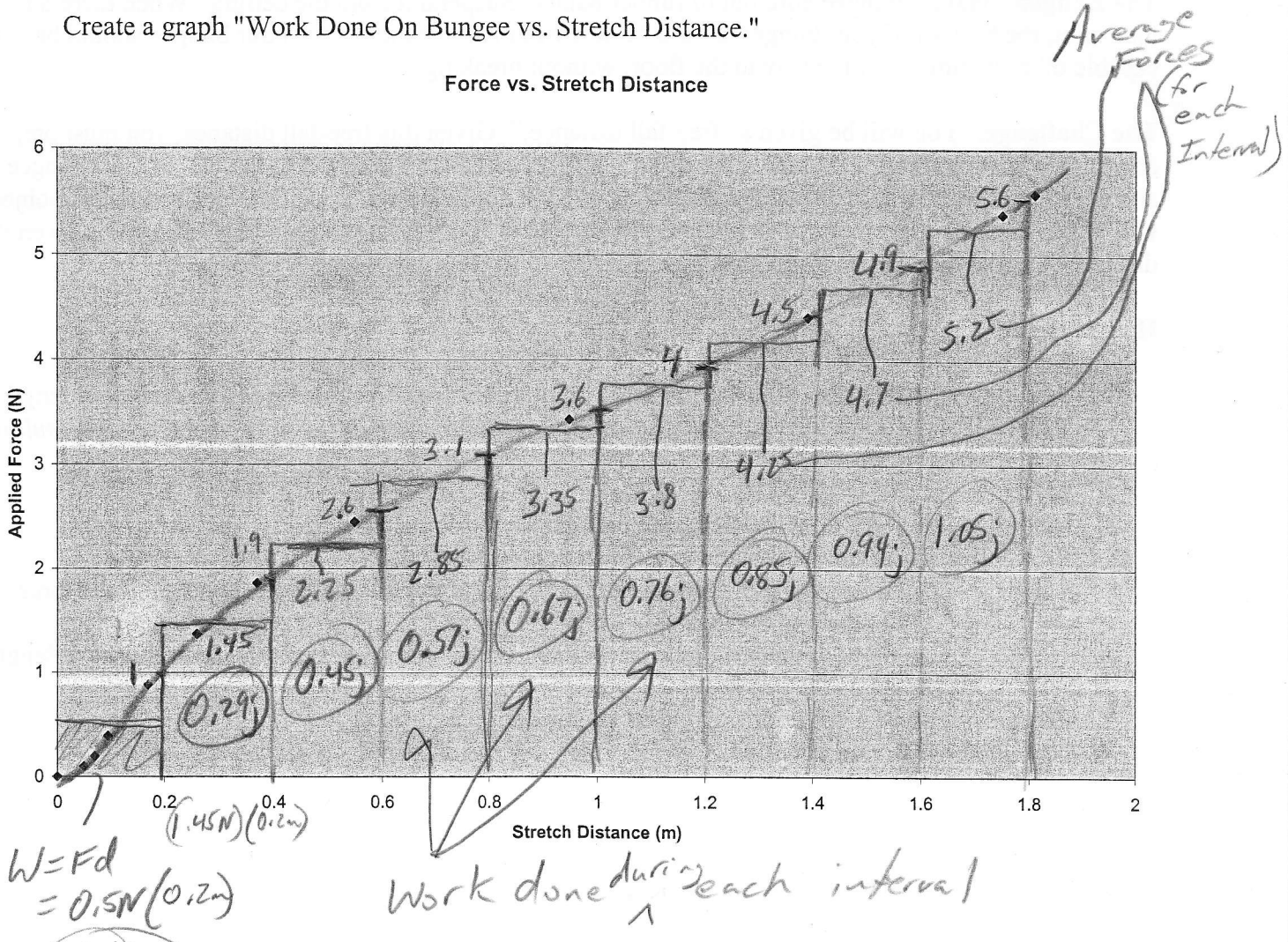
   b. How much work was done?

2. The graph below shows the force applied to a bungee in order to stretch the bungee to a variety of distances.

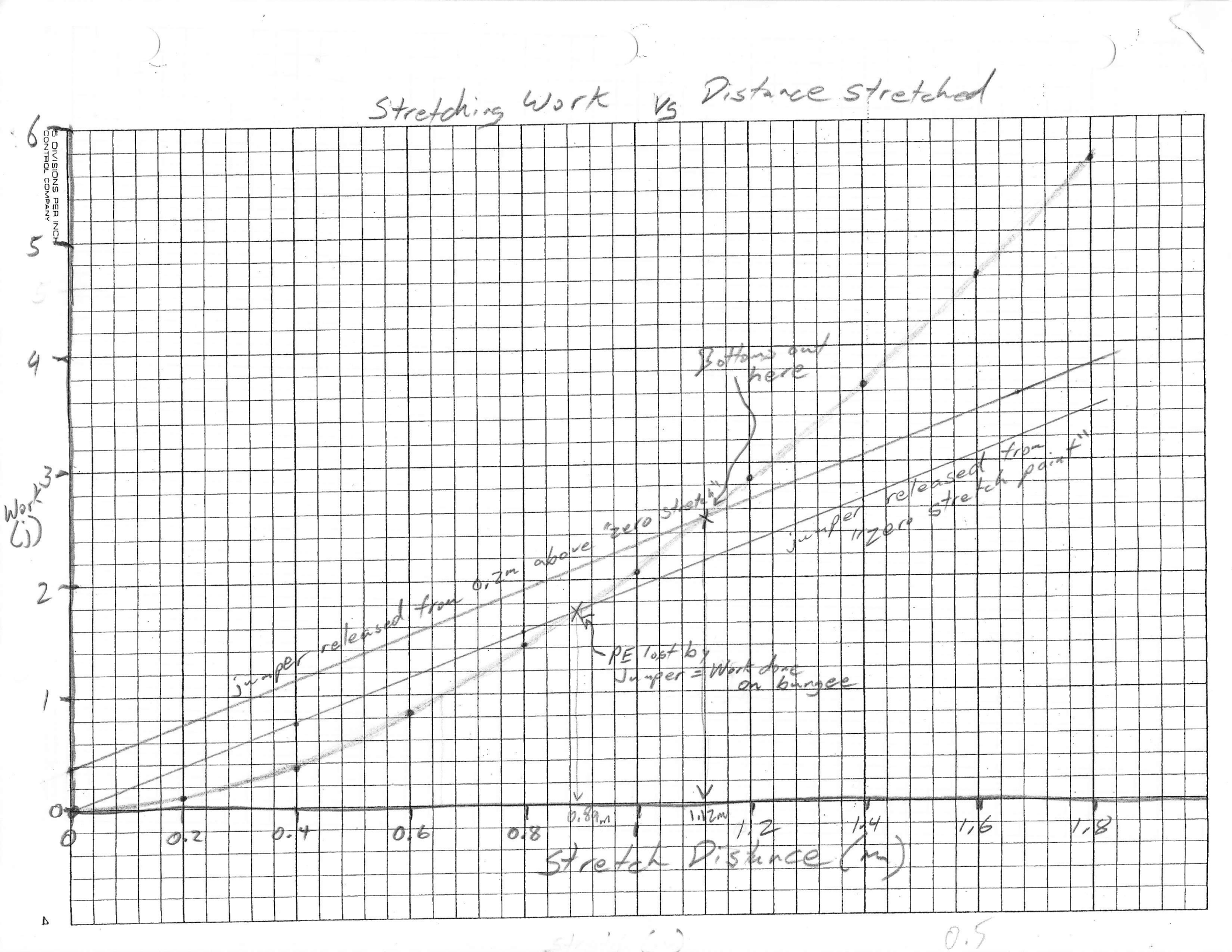
   a. What was the average applied force between stretch distances of 0.2m and 0.4m?

   b. How much work must have been done in the process of stretching the bungee between those distances?

3. Create a graph "Work Done On Bungee vs. Stretch Distance."



Stretch Interval	Ave Force (N)	Interval Stretch Dist (m)	Interval work (j)	Total Stretch (m)	Total work (j)
0-0.2m	0.5N	0.2m	0.1j	0.2m	0.1j
0.2m-0.4m	1.45N	0.2m	0.29j	0.4m	0.39j
0.4m-0.6m	2.25N	0.2m	0.45j	0.6m	0.84j
0.6m-0.8m	2.85N	0.2m	0.57j	0.8m	1.41j
0.8m-1m	3.35N	0.2m	0.67j	1m	2.08j
1m-1.2m	3.8N	0.2m	0.76j	1.2m	2.84j
1.2m-1.4m	4.25N	0.2m	0.85j	1.4m	3.69j
1.4m-1.6m	4.7N	0.2m	0.94j	1.6m	4.63j
1.6m-1.8m	5.25N	0.2m	1.05j	1.8m	5.68j


Stretching Work vs Distance stretched
Work (J)
Stretch Distance (m)
Bottom out here
jumper released from "zero stretch"
jumper released from 0.2m above "zero stretch"
PE lost by Jumper = Work done on bungee
0.89m
1.12m
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
1
2
3
4
5
6
5 DIVISIONS PER INCH
CONTROL COMPANY

4. How far would you have to stretch this bungee in order to have done 1j of work on the bungee?

0.065m

5. Suppose your bungee is hanging from the ceiling. Suppose that a 0.2kg "bungee jumper" is attached to the end of the bungee and released. On your graph of work vs stretch distance, add-in the PE lost by the "jumper." Assuming that the jumper begins its jump from a stretch distance of zero, graph the PE lost by the jumper at each stretch distance along the X axis.

$\Delta PE = mg\Delta h = 0.2kg(9.8m/s^2)(0.4m) = 0.784j$

$0.2kg(9.8m/s^2)(0.8m) = 1.57j$

6. At what stretch distance does the PE released by the jumper equal the work done on the bungee? What is special about this stretch distance?

$PE_1 + KE_1 = PE_2 + KE_2$ (KE_1 = zero)

KE_2 = zero when PE_1 (jumper initial PE) = PE_2 (Bungee PE)

d = 0.89m this is where the jumper "bottoms out"

7. Now plot the PE lost by a jumper that was released from a point 0.2m above the zero stretch distance point. How far will the bungee stretch before this jumper stops falling?

PE lost @ zero stretch = $mgh = (0.2kg)(9.8m/s^2)(0.2m) = 0.392j$

Plot parallels previous slope (other jumper)

Bottoms out @ d = 1.12m

Bungee Challenge:

The Bungee: Make a bungee cord out of rubber bands. Suspend it from the ceiling. When there's no load on it, the bottom of your bungee should be at least 2m above the floor. Your bungee should be capable of stretching all of the way to the floor, without breaking.

The Challenge: You will be given a "free-fall distance." Given this free-fall distance, you must prepare an object with an appropriate mass, such that… When you attach the object to the end of your bungee and drop the object from 1 "free-fall distance" above the normal bottom point of your bungee, the object will reach its nadir at a point that is as close as possible to X cm from the ground. You will be given the distance X at the time of the competition.

How to do it:

1. Calibrate your bungee. Measure the force required to stretch your bungee to a variety of lengths. Make a table of force versus stretch distance. *Remember, F=ma. If you're using weights, multiply their masses, in kg, by 9.8m/s^2.*
2. Re-create your table in Excel.
3. Determine the work done in stretching the bungee to each length.
    a. Determine the work done in each stretching interval.
        i. Assume that the force at the midpoint of the interval is the average of the forces at the ends of the interval.
        ii. Work done during the interval → W=Fd. Or W = (average force)(interval length)
    b. Add up all of the intervals to get total work.
4. Create a graph of work done on bungee vs. total stretch distance.
5. From here, you're on your own. :-)