# PHYSICS LAB – ANSWER KEY
## The Pendulum - Computer Simulation

**Part 1** – Period versus Amplitude Partner 1 = _____

Find the period for each of the amplitudes listed below and fill in the data table. Note that the length and mass should remain constant.

| Amplitude, A (% of l) | 50 | 60 | 70 | 80 |
|---|---|---|---|---|
| Period, T (s) | 1.98 | 1.97 | 1.98 | 1.97 |
| Length = 1.0 m | | Mass = 6 kg | | |

Calculations

Find the equation that relates A (x-variable) and T (y-variable) by using graphical analysis. Show all work.

Questions

1) __No_____ Is there a relationship between A and T (yes or no).

2) __None____ If so, what is the equation between A and T.

3) Discuss what effect air resistance, if any, would have on the period of a pendulum. In your discussion, specifically answer whether air resistance would cause the period to increase or decrease.

Air resistance would resist or retard the motion of the bob as it moves though the air. It would tend to slow the pendulum down. In other words, the pendulum would take more time to move back and forth.

As the air resistance increases, the period should increase.

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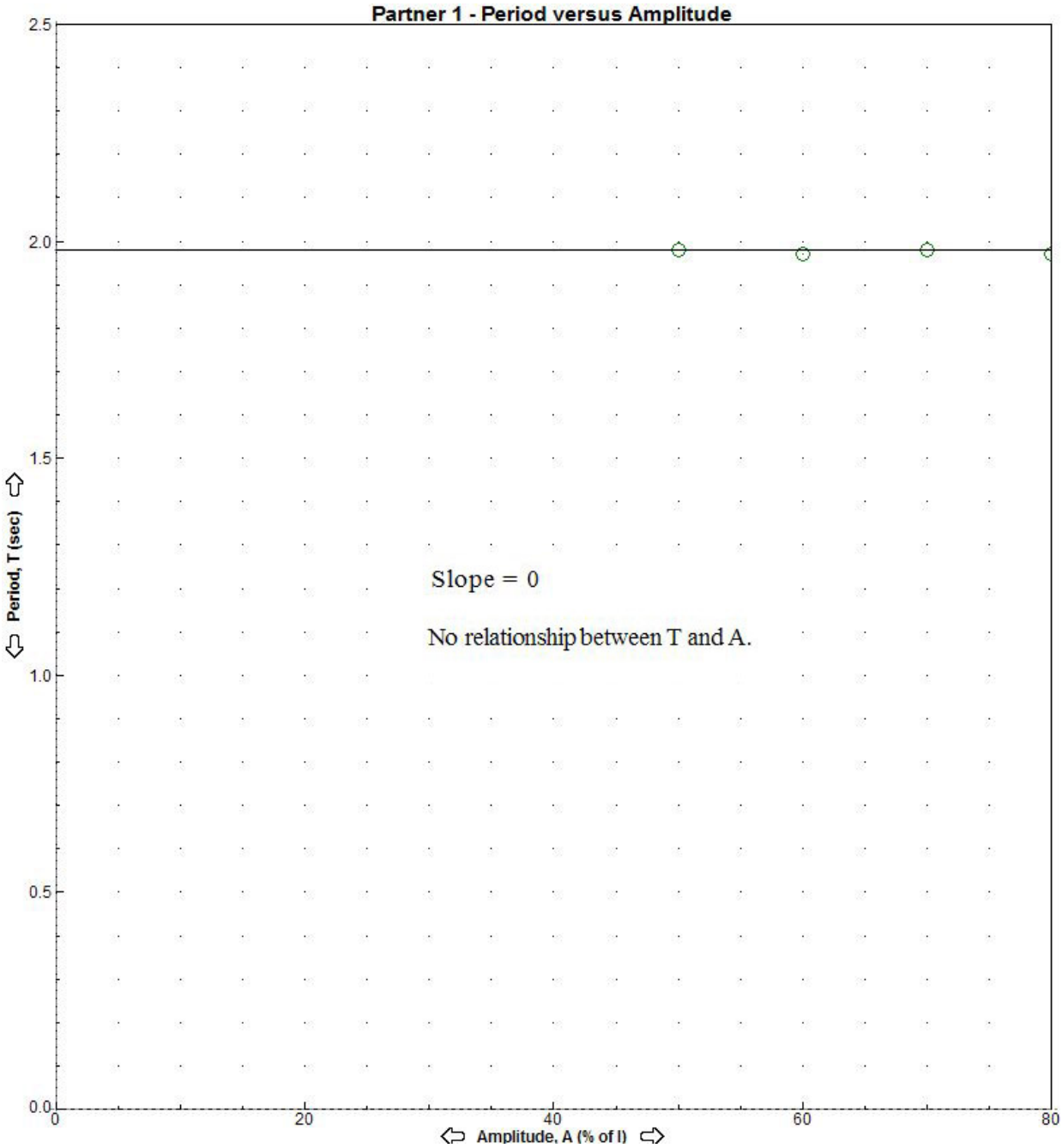

Partner 1 - Period versus Amplitude
2.5
2.0
1.5
1.0
0.5
0.0
Period, T (sec)
0
20
40
60
80
Amplitude, A (% of I)
Slope = 0
No relationship between T and A.

**Part 2** – Period versus Mass Partner 2 = _____

Find the period for each of the masses listed below and fill in the data table. Note that the amplitude and length should remain constant.

| Mass, m (kg) | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|
| Period, T (s) | 2.39 | 2.40 | 2.41 | 2.41 | 2.40 |
| Amplitude = 60 % of l | | | Length = 4 m | | |

Calculations

Find the equation that relates m (x-variable) and T (y-variable) by using graphical analysis. Show all work.

Questions

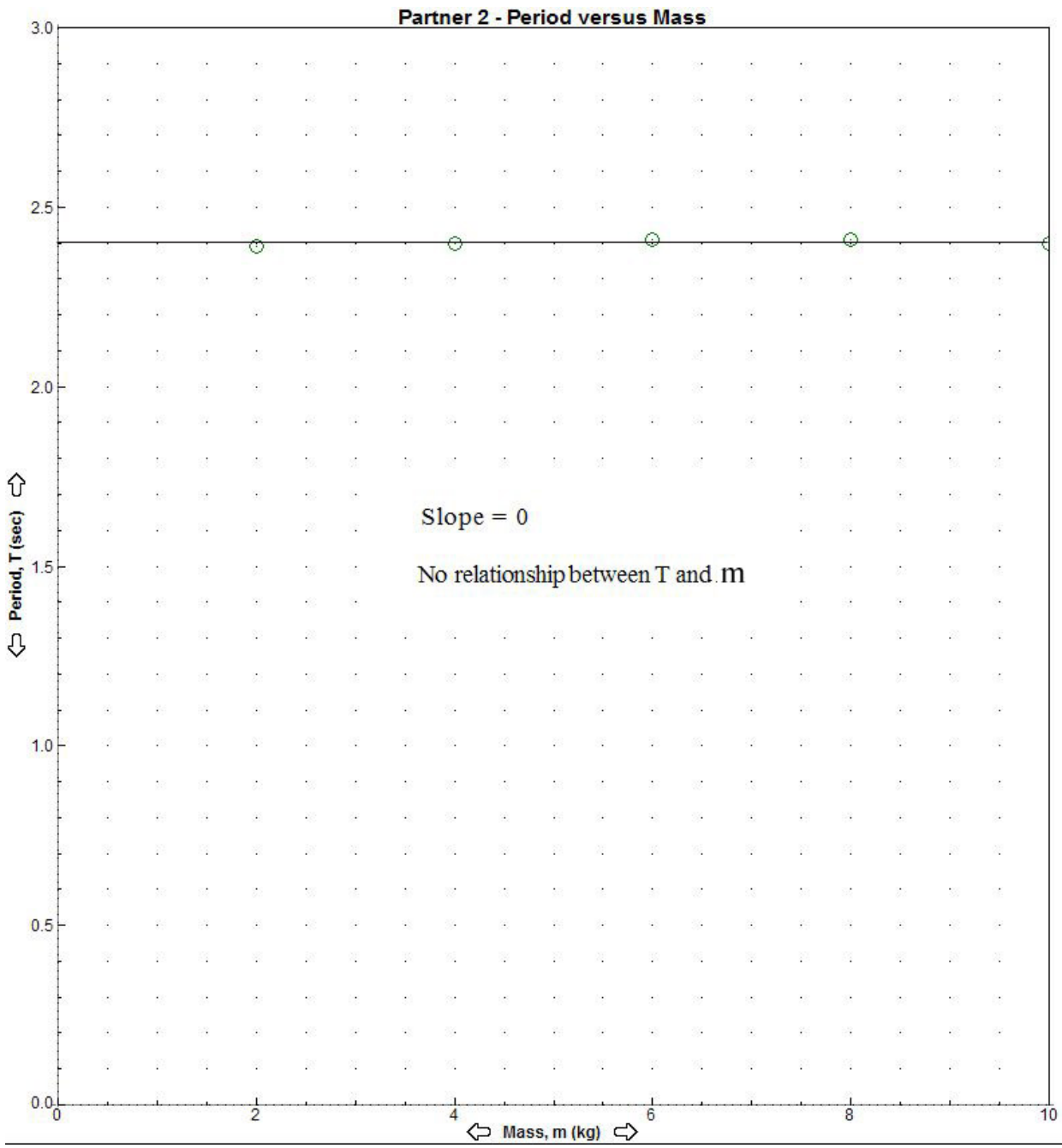
1) __No_____ Is there a relationship between m and T (yes or no).

2) __None_____ If so, what is the equation between m and T?

3) Discuss what effect an increase in gravity, if any, would have on the period of a pendulum. In your discussion, specifically answer whether an increase in gravity would cause the period to increase or decrease.

The force of gravity is the driving force of the pendulum. In other words, this force causes the pendulum to move back and forth. If the force of gravity is increased, the force driving the pendulum would increase. This would make the bob move faster and complete one period in less time.

As the force of gravity increases, the period should decrease.


Partner 2 - Period versus Mass
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
Period, T (sec)
Mass, m (kg)
Slope = 0
No relationship between T and m

**Part 3** – Period versus Length Partner 3 = _____

Find the period for each of the lengths listed below and fill in the data table. Note that the amplitude and mass should remain constant.

| Length, l (m) | 0.25 | 1 | 4 | 16 |
|---|---|---|---|---|
| Period, T (s) | 1.28 | 1.99 | 3.97 | 7.91 |
| Amplitude = 80 % of l | | | Mass = 6 kg | |

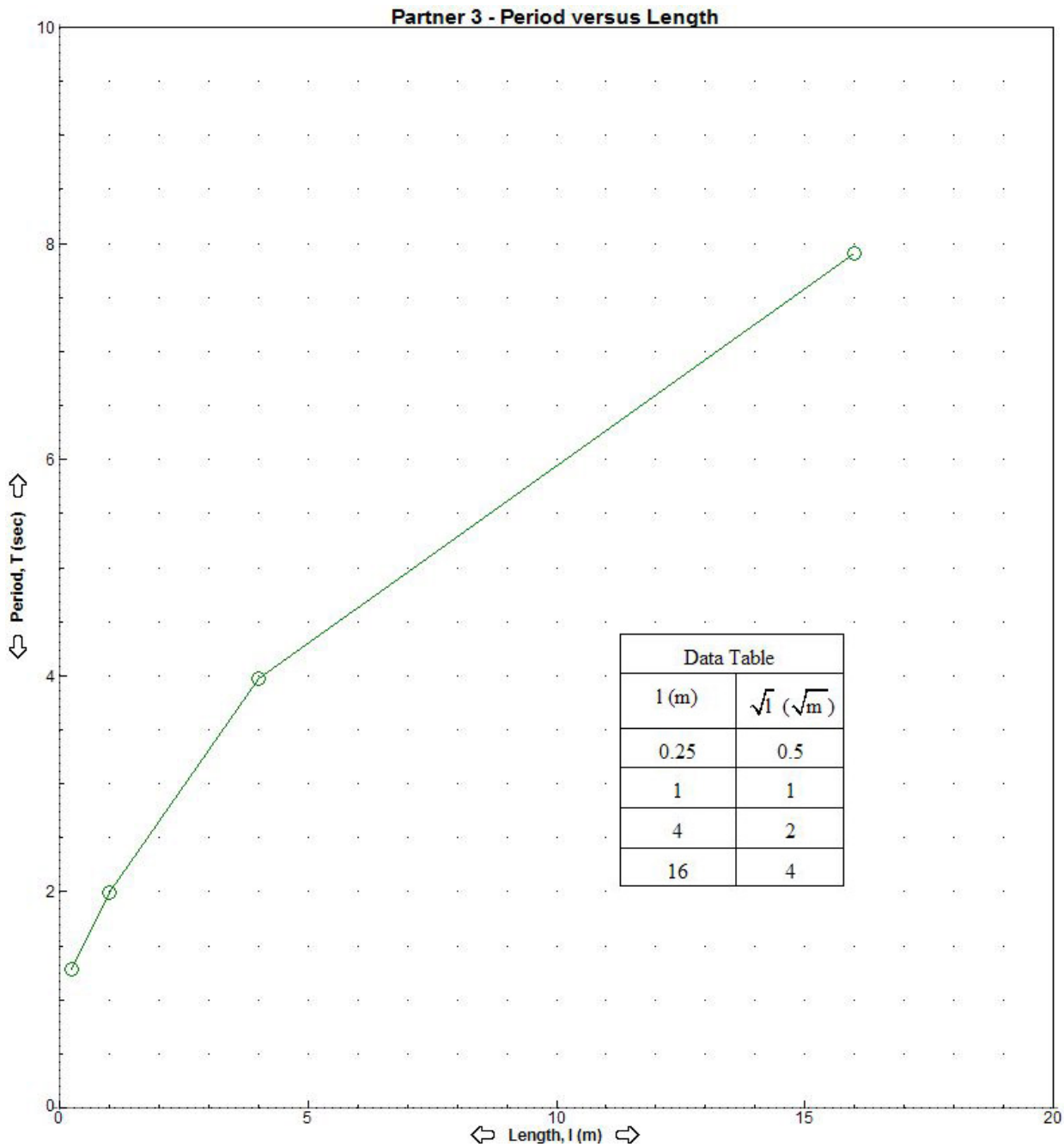
Calculations

Find the equation that relates l (x-variable) and T (y-variable) by using either graphical analysis. Show all work.

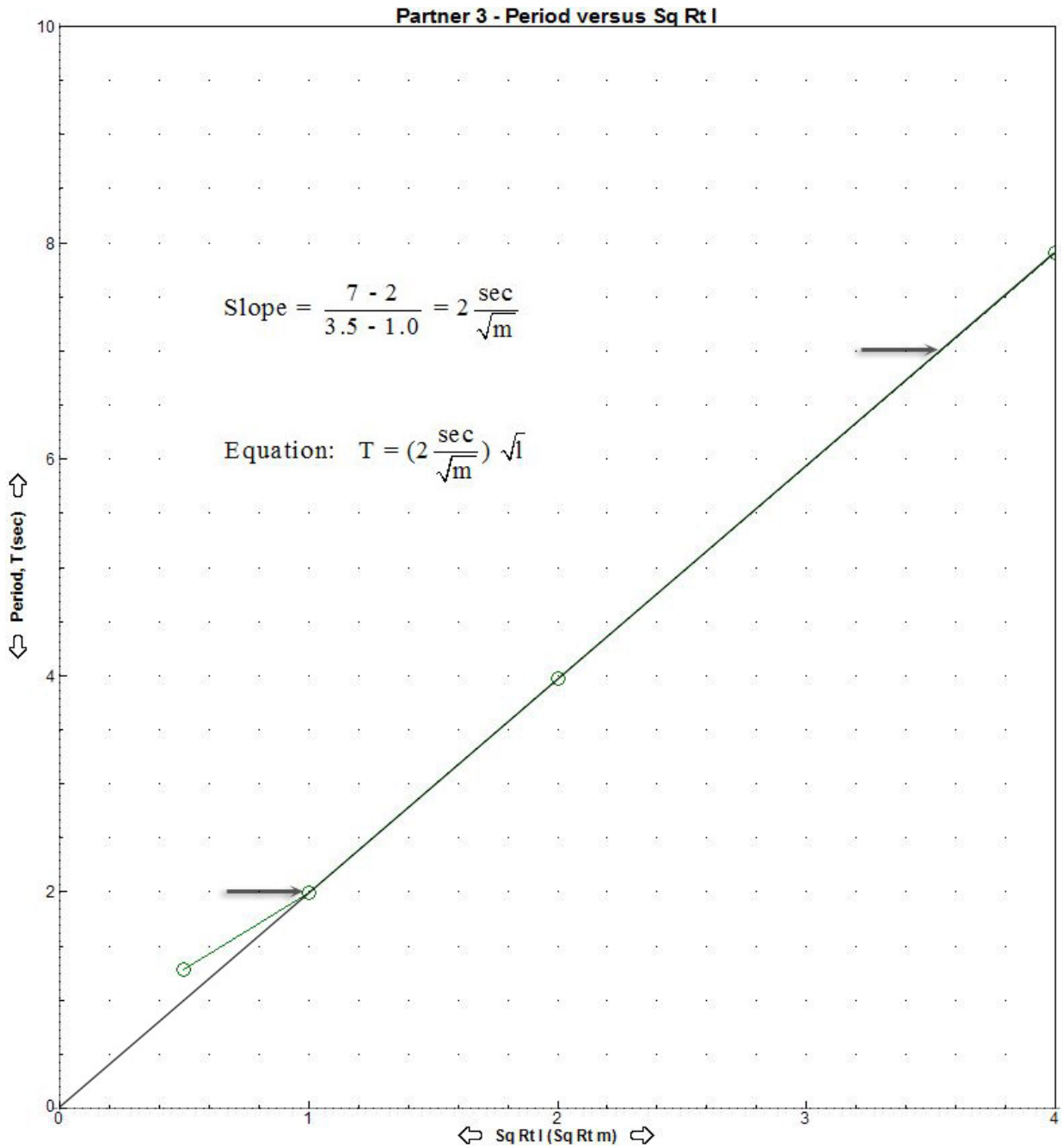
Questions

1) _____Yes_____ Is there a relationship between l and T (yes or no).

2) $T = (2\frac{\sec}{\sqrt{m}})\sqrt{l}$ If so, what is the equation between T and l?




| Data Table | |
|---|---|
| l (m) | $\sqrt{l}$ ($\sqrt{m}$) |
| 0.25 | 0.5 |
| 1 | 1 |
| 4 | 2 |
| 16 | 4 |


Partner 3 - Period versus Sq Rt l
Slope = $\frac{7 - 2}{3.5 - 1.0} = 2 \frac{\text{sec}}{\sqrt{\text{m}}}$
Equation: $T = (2 \frac{\text{sec}}{\sqrt{\text{m}}}) \sqrt{l}$
Period, T (sec)
Sq Rt l (Sq Rt m)
0
2
4
6
8
10
0
1
2
3
4

**Part 4** – Period versus A, m, and l. Partner 4 = _____

Calculations

1) Write one equation that relates all of the variables in the previous experiments - T, A, m, and l. Remember that T is the y variable. Any variable that has no effect should not be included. Show all work.

Final equation = $T = (2\frac{\sec}{\sqrt{m}})\sqrt{l}$ The only variable that effects the period is length, l.

2) 0.707 sec A pendulum has a period of 0.5 sec. If the length of the pendulum is doubled, what will the period be? Show work below.

Since $T \propto \sqrt{l}$ , if the length goes up by 2, the period will go up by $\sqrt{2}$ .

$T_{new}$ = (0.5 sec)( $\sqrt{2}$ ) = 0.707 sec

3) 1.5 sec A pendulum has a period of 1.5 sec. If the amplitude is doubled, what will the new period be? Show work below.

The period will still be 1.5 sec, since the amplitude has no effect on the period.

4) Discuss the changes in a pendulum's period if it were to be moved from the earth to the moon. Specifically predict whether the period would decrease or increase.

A pendulum on the moon would affect two variables, the force of gravity and the air resistance. The force of gravity would decrease, which should increase the period. The air resistance would decrease, which should decrease the period. The question is which of these two variables would have the biggest effect. We would guess that the effect of air resistance would be relatively small, since the air friction would be minimal at low speeds. The force of gravity would change significantly, decreasing by a factor of around six. Therefore, on the moon a pendulum's period should increase.