**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period:\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trial Time:** | **Calculation:** | **Average Time/Oscillation:** | **Distance *X1*** | **Distance *X2*** |
| seconds | / 10 = | seconds | in. | in. |

**Data Table:**

**Description:**

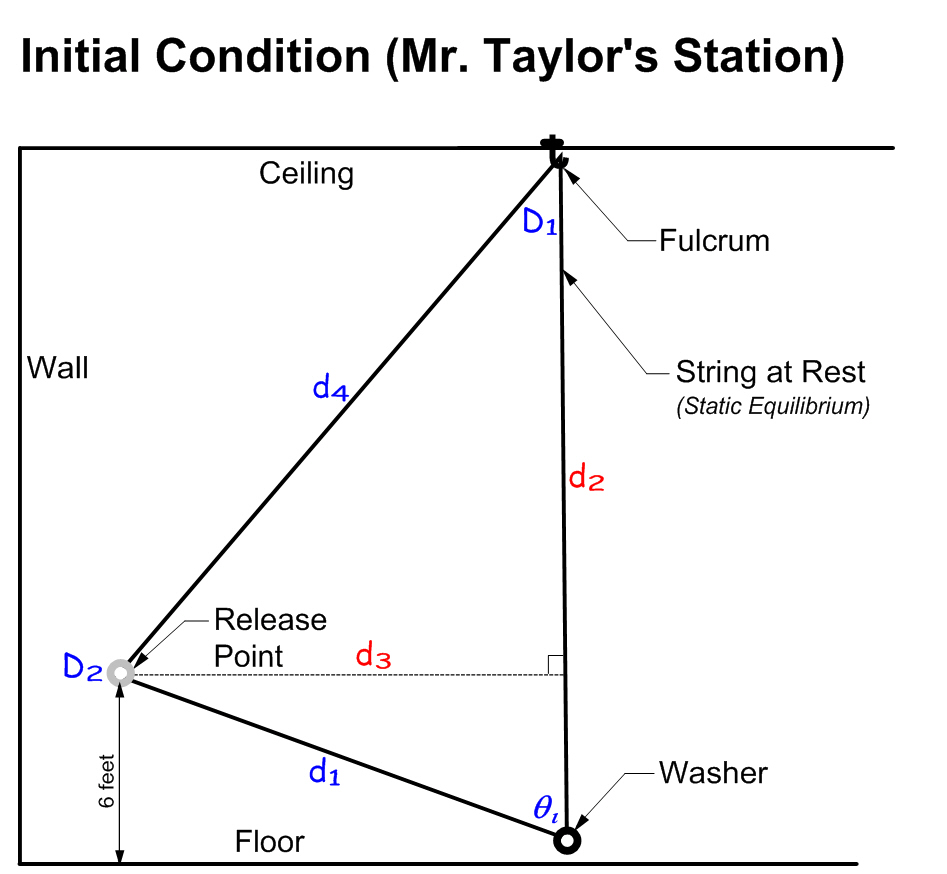
Step 1 -

Observe Mr. Taylor’s pendulum station as he, from a fixed release point which is accurately located on the floor exactly ***8 feet*** (***X1***) from the point of rest (static equilibrium), swings the pendulum weight 10 times (back and forth counts as one swing) and times it with a stopwatch. Afterward you divide the recorded time: **\_\_\_\_\_\_\_\_\_\_** by 10, thereby acquiring an **\_\_\_\_\_\_\_\_\_\_\_\_** time per swing, then input that average time you calculated: **\_\_\_\_\_\_\_\_\_\_\_** into the matrix above, along with any other pertinent information you can glean from this process.

Step 2 -

Repeat previous activity (swinging pendulum 10 full oscillations as before) but catch the pendulum at the end of the last oscillation and record the distance the pendulum arrived at by dropping a plumb bob, perpendicular to the floor, and recording that point on floor. Accurately measure (using a tape measure) the distance from this newly located point and the static equilibrium point previously discussed. ***X2* = \_\_\_\_\_\_\_\_\_\_\_**

**Diagram 1:**



**Measured Attributes:**

**d2 = \_\_\_\_\_\_\_ inches**

**d3 = \_\_\_\_\_\_\_ Inches**

**Calculated Attributes:**

**d1 = \_\_\_\_\_\_\_ inches**

**d4 = \_\_\_\_\_\_\_ inches**

**** = \_\_\_\_\_\_\_ degrees**

**D1 = \_\_\_\_\_\_\_ degrees** *(at fulcrum)*

**D2 = \_\_\_\_\_\_\_ degrees** *(at release point)*

**Diagram 1 Calculations:**

***Law of Cosine: Law of Cosine:***

*(****d1****)****2 =*** *(****d2****)****2 +*** *(****d4****)****2 – 2****(****d2****)(****d4****)****cosD1***



*(**)****2 =*** *(**)****2 +*** *(**)****2 – 2****(**)(**)****cosD1***



*(**)* ***=*** *(**)* ***+*** *(**)* ***– 2****(**)(**)****cosD1***

*(**)* ***=*** *(* *)* ***– 2****(**)****cosD1***



*(**)* ***=*** *(* *)* ***–*** *(**)****cosD1***

*(**)* ***= –*** *(**)****cosD1***



*(****0.*** *)* ***= cosD1***



***cos-1*** *(****0.*** *)* ***= cos-1****(* ***cosD1****)*



\_\_\_\_\_\_\_\_\_\_\_***o = D1***



***Sum Interior Angles of Triangle:***



***D1 + D2  + i = 180o***

Therefore: ***Pythagorean Theorem:***

***D2 =*****\_\_\_\_\_\_*o*  *(d3)2 + (****see diagram 1****)2 = (d1)2***

***Pythagorean Theorem:*** ***( )2 + ( )2*** = ***(d1)2***

**What right triangle could you use to find *d4*? *( ) + ( )*** = ***(d1)2***

***(d3)2 + (****see diagram 1****)2 = (d4)2*** ***( )*** = ***(d1)2***

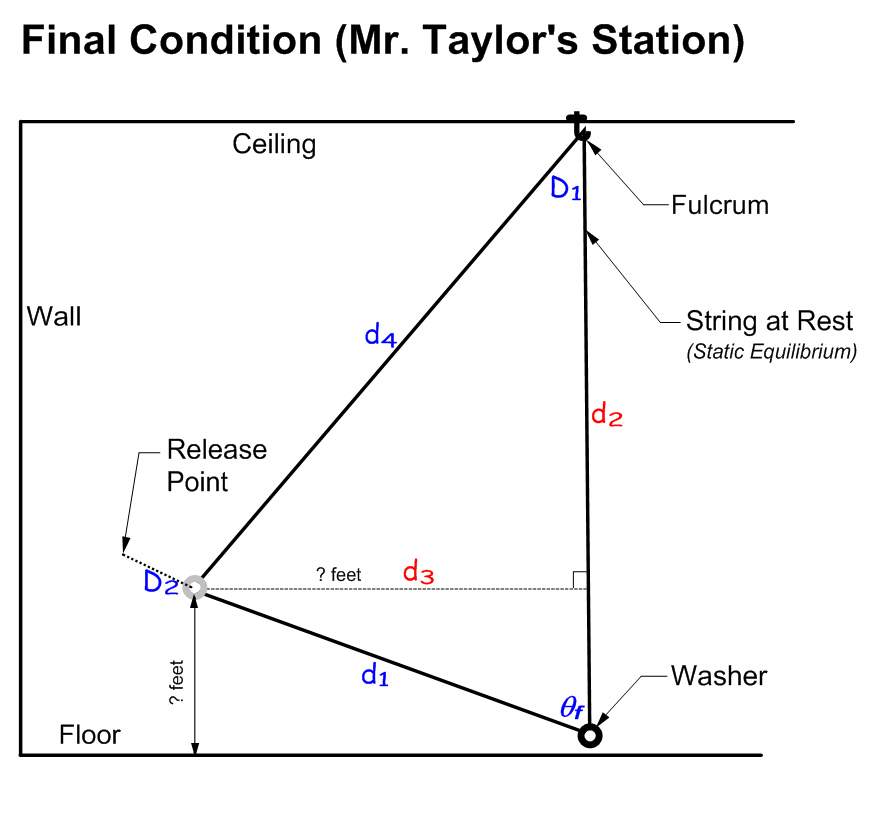


***( )***  = ***(d1)2***

**\_\_\_\_\_\_\_\_\_\_\_\_** = ***d1***

**\_\_\_\_\_\_\_\_\_\_\_\_ = *d4***

**Diagram 1F:**



**Diagram 1f Calculations:**

*Find the following -* **Calculated:**

D1=

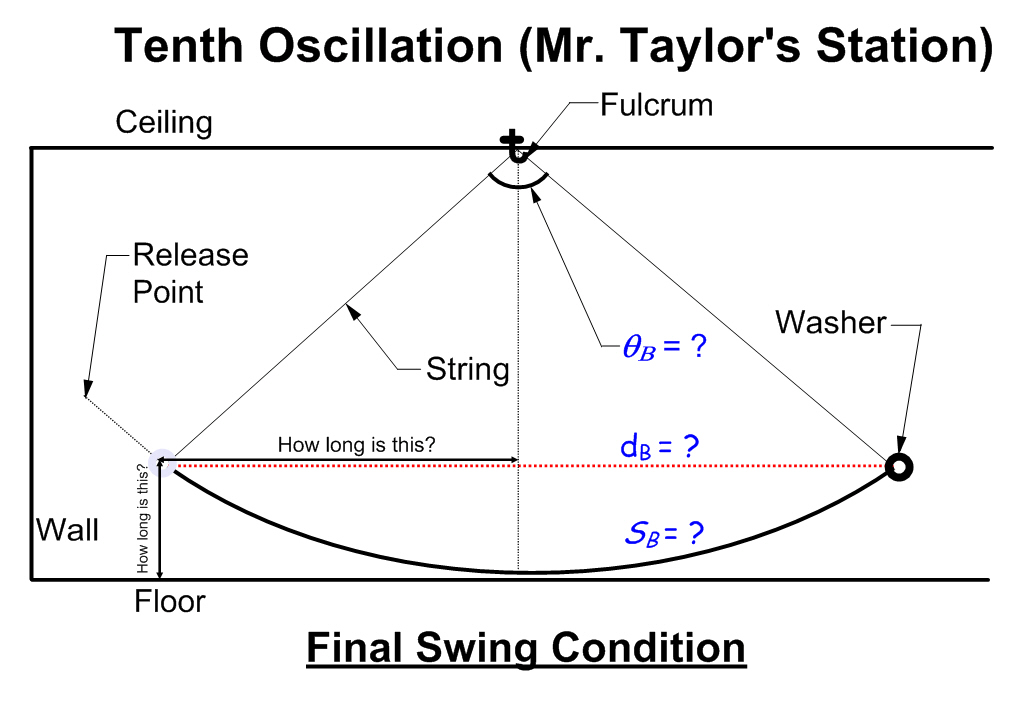
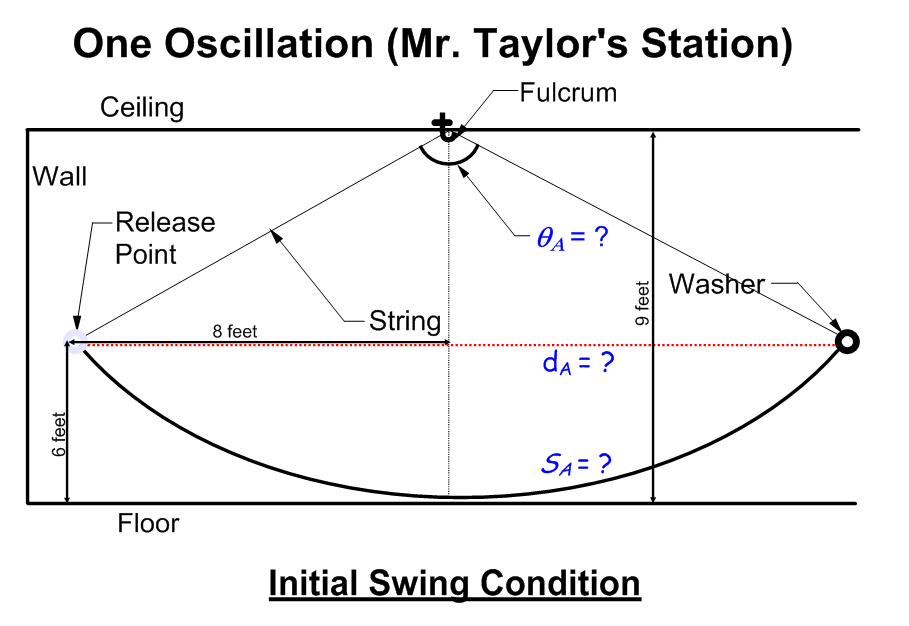
d4 =

**Measured:**

d3 =

D2 from floor=

**Diagram 2:**



**Diagram 2 Calculations:** *(Refer to diagram* ***1*** *calculations as necessary)*

***- Analyzing the One Oscillation Diagram***

Calculate the chord length ***dA***

***dA*** = 2(*measured-see diagram 2*) = 2( ) = **­­­\_\_\_\_\_\_ inches**

Compare your calculated dimension ***d4*** to your recorded tape measurement ***d1***

Percent Error (P.E.) = **|** (***d4*** *-****d1***)**/*d1*|**(100)

**P.E.** = **|** ( - )/( ) **|** (100) = **\_\_\_\_\_\_\_\_%**

Using triangle data calculate the Central Angle (***A***) or “angular displacement”

***A*** = 2(**D1**) = 2( o) = **\_\_\_\_\_\_\_o**

Using ***A*** calculate what percentage of the entire circle the sector you have described in this illustration might be?

***A*** /360o = ( o/360o)(100) = **\_\_\_\_\_\_\_\_\_\_\_%**

Using the above information, and the circumference of a circle formula, how might you calculate the distance as captured by ***A*** as an “arc length” (***A.L.***) which represents the true distance the pendulum actually travels from release point to its other extreme?

***A.L***. = ( %)(******)(2)(***d4***) = (0. )(3.14)(2)( )

Arc Length***A*** (***SA***) = **\_\_\_\_\_\_ Inches**

Using the above information, and the area of a circle formula, how might you calculate the “area of the sector” (***A.S.***) the pendulum motion describes as it moves through the angular displacement as shown by ***A***?

***A.S***. = ( %)(******)(***d4***)2 = (0. )(3.14)( )2

A.S. = (0. )(3.14)( ) = (0. )( )

Area of Sector***A*** (***ASA***) = **\_\_\_\_\_\_ Square Inches**

*(Refer to diagram* ***1f*** *calculations as necessary)*

***- Analyzing the Tenth Oscillation Diagram***

Calculate the chord length ***dB***

***dB*** = 2(*see diagram 2*) = 2( ) = **­­­\_\_\_\_\_\_ inches**

Compare distance ***dA*** to distance ***dB…***what is the difference between the two?

**| *dA – dB*** **|** = \_\_\_\_\_\_\_\_ **inches**

Using triangle data calculate the Central Angle (***B***) or “angular displacement”

***B*** = 2(**D1**) = 2( o) = **\_\_\_\_\_\_\_o**

Using ***B*** calculate what percentage of the entire circle the sector you have described in this illustration might be?

***B*** /360o = ( o/360o)(100) = **\_\_\_\_\_\_\_\_\_\_\_%**

Using the above information, and the circumference of a circle formula, how might you calculate the distance as captured by ***B*** as an “arc length” (***A.L.***) which represents the true distance the pendulum actually travels from release point to its other extreme?

***A.L***. = ( %)(******)(2)(***d4***) = (0. )(3.14)(2)( )

Arc Length***B*** (***SB***) = **\_\_\_\_\_\_ Inches**

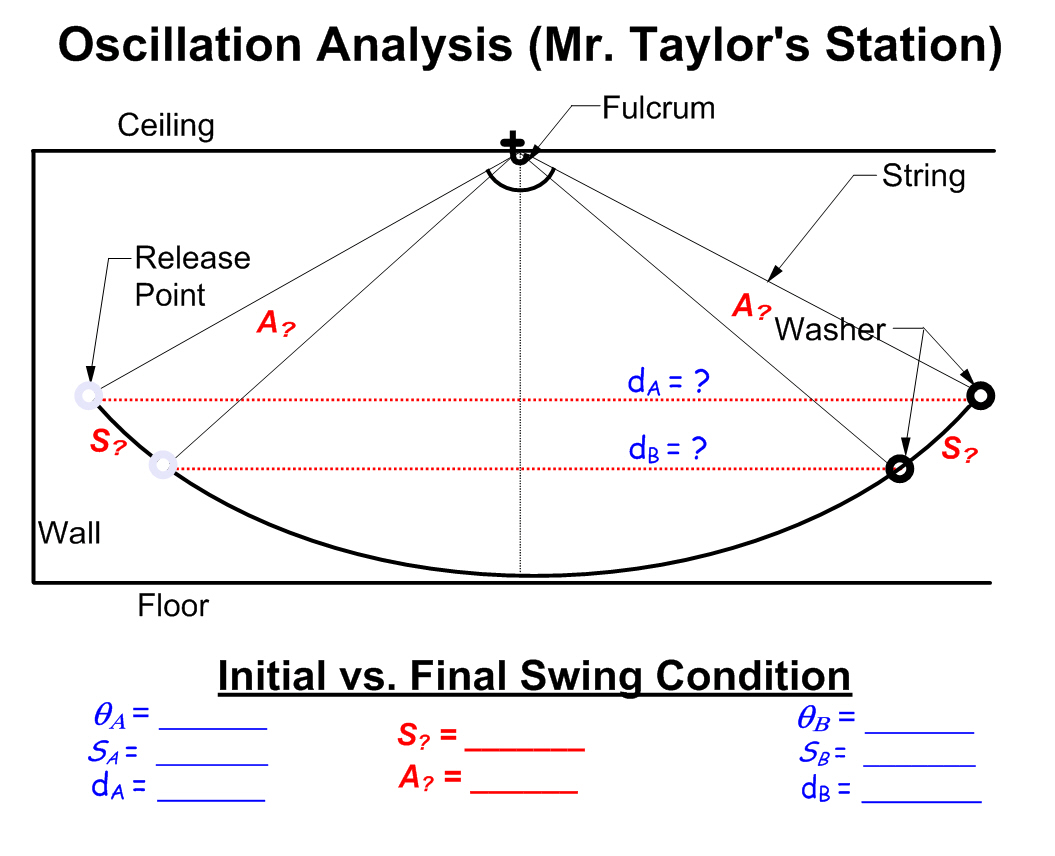
Using the above information, and the area of a circle formula, how might you calculate the “area of the sector” (***A.S.***) the pendulum motion describes as it moves through the angular displacement as shown by ***B***?

***A.S***. = ( %)(******)(***d4***)2 = (0. )(3.14)( )2

A.S. = (0. )(3.14)( ) = (0. )( )

Area of Sector***B*** (***ASB***) = **\_\_\_\_\_\_ Square Inches**

**Diagram 3:**



Fill in the values above from your previous calculations. Then find ***S?***and ***A?*** using the following Trigonometric formulas: (*Remember* ****** *must be in radians to use these formulas*)

***ASA*** = **\_\_\_\_\_\_ *ASB*** = **\_\_\_\_\_\_**

If ****** is in radians already:

***S = r AS = (0.5)r2***

If ****** is in degrees and needs to be converted:



Think about what ***S?***and ***A?*** are. What am I asking for? Create your calculation to find these values. Show all work on the following page. Original equations used, input values, steps, etc… Box your answers on calc sheet below then show answers in the spaces provided above.**Calculations Diagram 3:**

Based upon your findings…Estimate how many oscillations from the original release point would be required for the pendulum to come to rest? *(Return to static equilibrium)*

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ full oscillations**

**Extension Bonus***:*

***Create a graph*** *as described below representing the values from* ***Diagram 1*** *and using the* ***initial swing condition in Diagram 2.*** *Label all necessary values and attributes completely.*

**Graphical Representation:**

In the above graph we see the horizontal axis as time ***(t)*** is centered in the vertical axis such that if the pendulum is **at rest** it is represented as distance ***(d)*** **zero**, the full retraction of the weight to the release point is **\_\_\_\_\_\_ inches** positive ***(d)*** and when released it swings past the rest point, fully over to the other extreme position, that is represented by **\_\_\_\_\_\_ inches** negative ***(d).***

