Lab 4 - Centripetal acceleration

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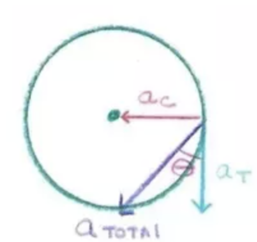
Spreadsheet: lab4 spreadsheet

Learning Outcomes

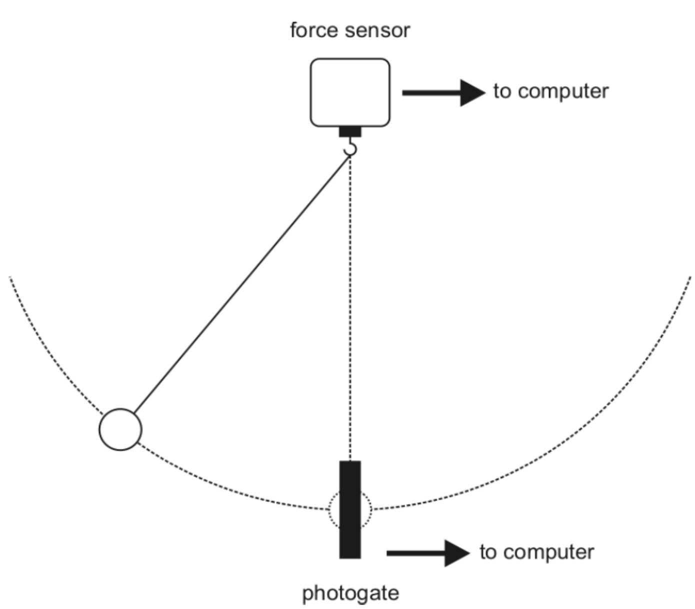
- State the dependence of centripetal acceleration on the radius
- State the dependence of centripetal acceleration on tangential speed

Background



A simple pendulum is a mass attached to a string, which is set into motion by releasing the mass from rest from a height h above the bottom of the swing. Throughout the swing, the mass experiences tangential and centripetal acceleration, which adds up to the total acceleration, as shown in the figure.

You will use a pendulum to investigate the dependence of *centripetal acceleration* on the radius of rotation and on speed. You will do this by measuring the speed of a pendulum at the bottom of its swing and the force it then exerts on the string. The force can then be used to calculate the acceleration (using a=F/m, which we will cover in class soon). We carry out this measurement at the bottom of the swing because the total acceleration is then equal to the centripetal acceleration (we will cover this in class soon, as well



Materials

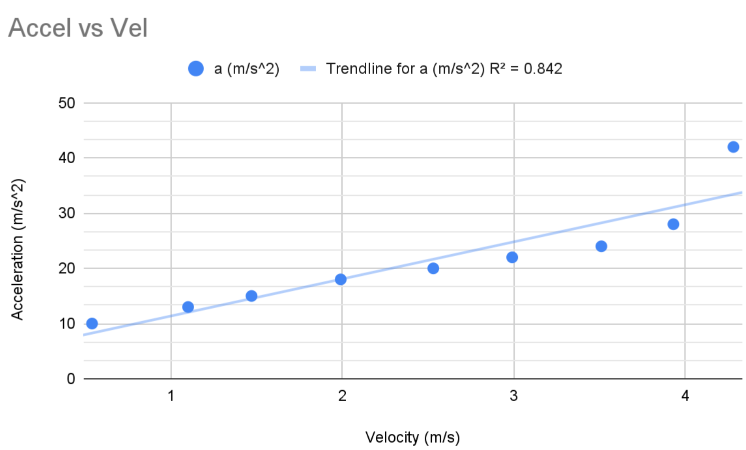
- PC with DataStudio
- One Pasco force sensor
- One Pasco photo gate
- A 100 g hooked mas
- A ~1 m long string
- Two base stands, rod, and clamps
- Protractor
- A 1 m stick

Set up

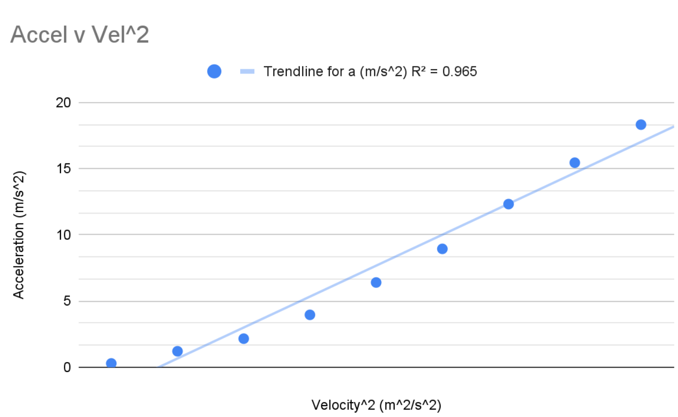
- Set up the force sensor to take 100 measurements per second by setting its frequency to 100 Hz.
- Before each run, zero the sensor *while holding the mass in your hand* so that not force is applied on the sensor.

Dependence on speed

1. Keeping the string taught, lift the mass in a circular arc until it makes an angle of 10 degrees with the vertical. Carefully align the arc so that it will pass through the photo gate. Release the mass from rest, allow it to swing through the photo gate, and catch the mass of the opposite side of the arc. **In a spreadsheet, record the starting angle, and the force and speed at the bottom of the swing.**
2. Release the pendulum with the same length and mass *from* a different angle (by increments of 10 degrees) all the way to 90 degrees. **In your spreadsheet, record the starting angle, and the force and speed (v) at the bottom of the swing for each trial.**
3. Use the fact that a=F/m to **calculate the acceleration (a) for each trial.**
4. **In your spreadsheet, plot a as a function of v. Display the best-fit equation and the value of R^2 (aka quality of the fit).**



5. **Plot a as a function of v^2. Display the best-fit equation and the value of R^2 (aka quality of the fit)?**



6. A fit is better when R^2 is closer to 1. **Which of your fit is better? What kind of relationship do you observe between a and v?**

   The R^2 for the Acceleration v Velocity^2 graph is the better fit, and the relationship between a & v^2 is near linear.

7. **How does your relation compare with the relation given during lecture? If you find a different relation, can you pinpoint the source of the discrepancy?**

   The relation we got during the lab checks out with what we were given during lecture.

θ (degrees)	F(N)	mass (kg)	v(m/s)	a (m/s^2)	v^2 (m^2/s^2)
10	1	0.1	0.54	10	0.2916
20	1.3	0.1	1.1	13	1.21
30	1.5	0.1	1.47	15	2.1609
40	1.8	0.1	1.99	18	3.9601
50	2	0.1	2.53	20	6.4009
60	2.2	0.1	2.99	22	8.9401
70	2.4	0.1	3.51	24	12.3201
80	2.8	0.1	3.93	28	15.4449
90	4.2	0.1	4.28	42	18.3184