Teresa Choe
September 24, 2008

Title: Newton's 2nd Law

Purpose: To study the application of Newton's Law (F=ma)

Background:

1. F=ma
2. Multiple forces on an object with net force accelerate the object.
3. Acceleration is proportional to the net force on an object
4. Acceleration is inversely proportional to mass (a=F/m)

Materials:

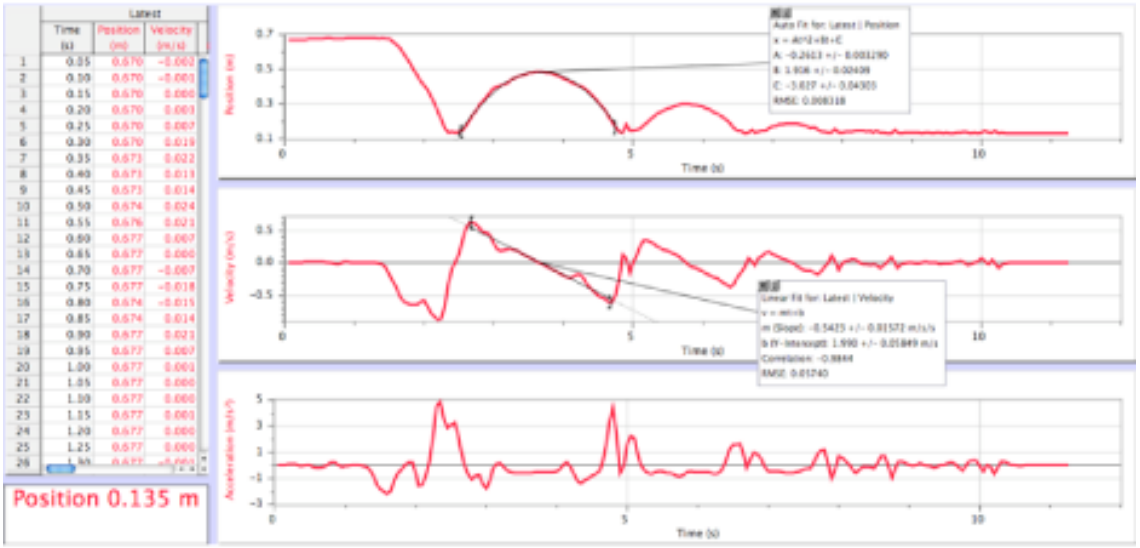
1. Fan cart (586 g)
2. Weight (240 g)
3. Vernier Motion Detector
4. Metal sail
5. Books (for height)
6. Meter Stick
7. Logger Pro
8. Computer
9. Cart (489 g)
10. Track

Procedures:

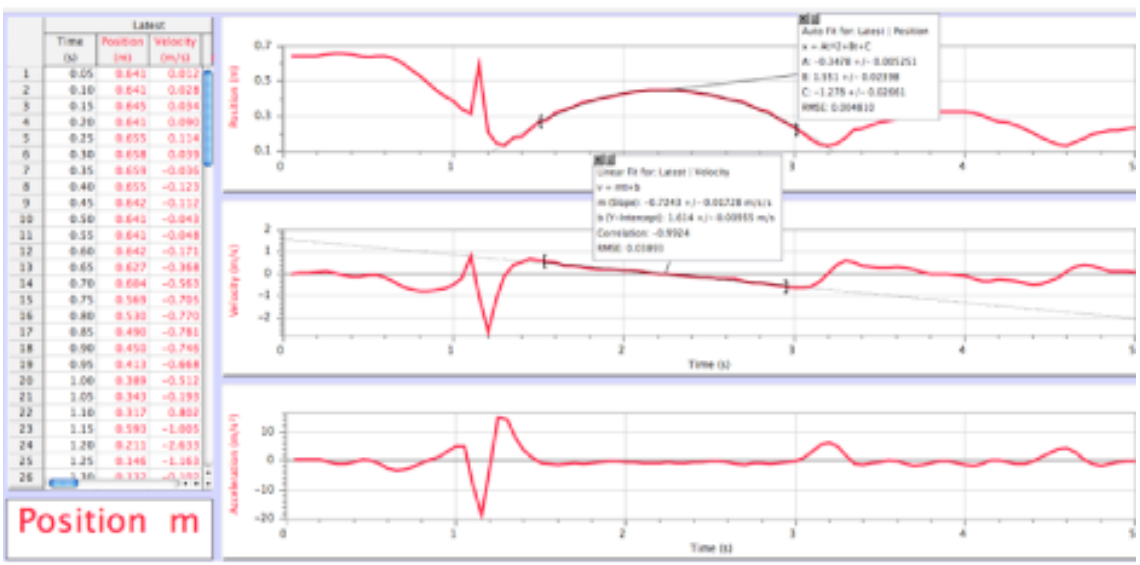
1. Connect the Vernier Motion Detector to a computer and turn on Logger Pro
2. Place the track on top of the books to create a 5° angle
3. Place the Vernier Motion Detector so that it faces the front end of the track
4. Place the cart at the top end of the track and release it as you record the movement on the Logger Pro. Stop recording when the cart stops moving
5. Use the "curve fit" function on Logger Pro to analyze the graph
6. Place more books under the track to create a 7° angle
7. Repeat steps 3-5
8. Set the sail on top of the fan cart on the opposite end of the fan
9. Set the fan cart on Low speed, moving toward the Vernier Motion Detector, as you record it on Logger Pro.
10. Stop the fan cart just before it reaches the Vernier Motion Detector by turning off the switch.
11. Use the "curve fit" function on Logger Pro to analyze the graph.
12. Set the fan cart on High Speed and release it toward the Vernier Motion Detector as you record it on Logger Pro
13. Repeat steps 10-11.
14. Place the weight (240 g) on the fan cart
15. Repeat steps 9-13

Data:

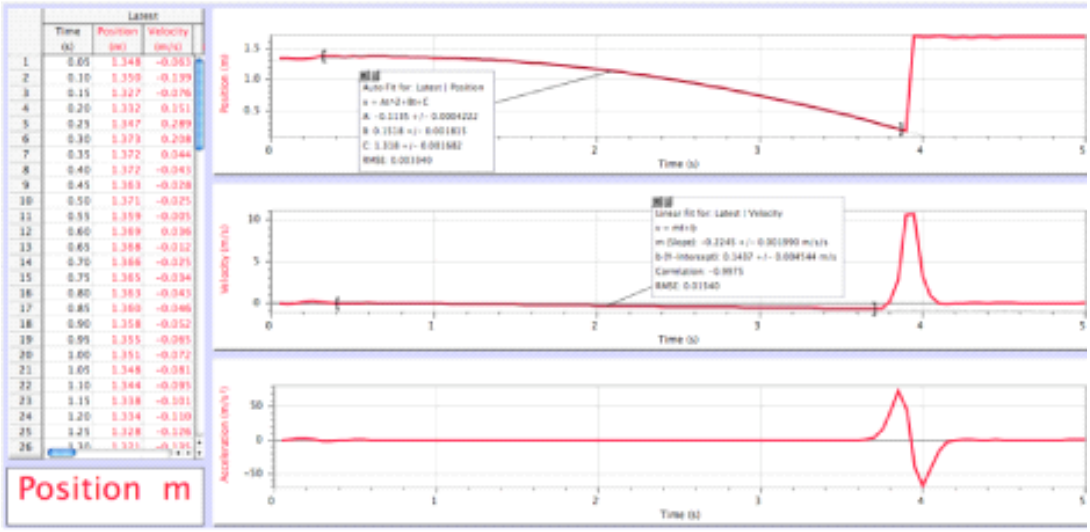
1.1Cart at 5° angle



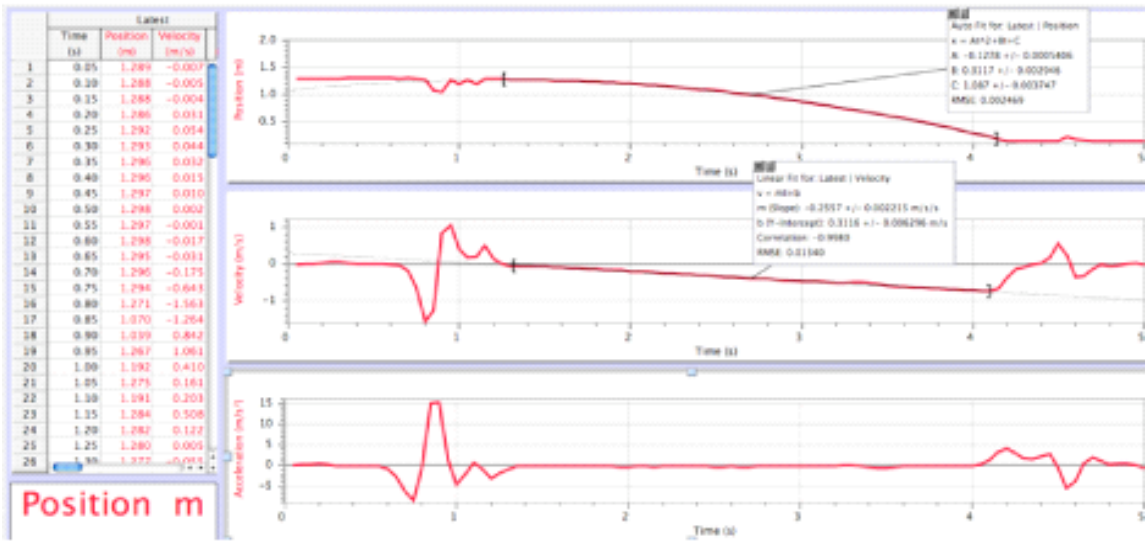
1.2Cart at 7° angle

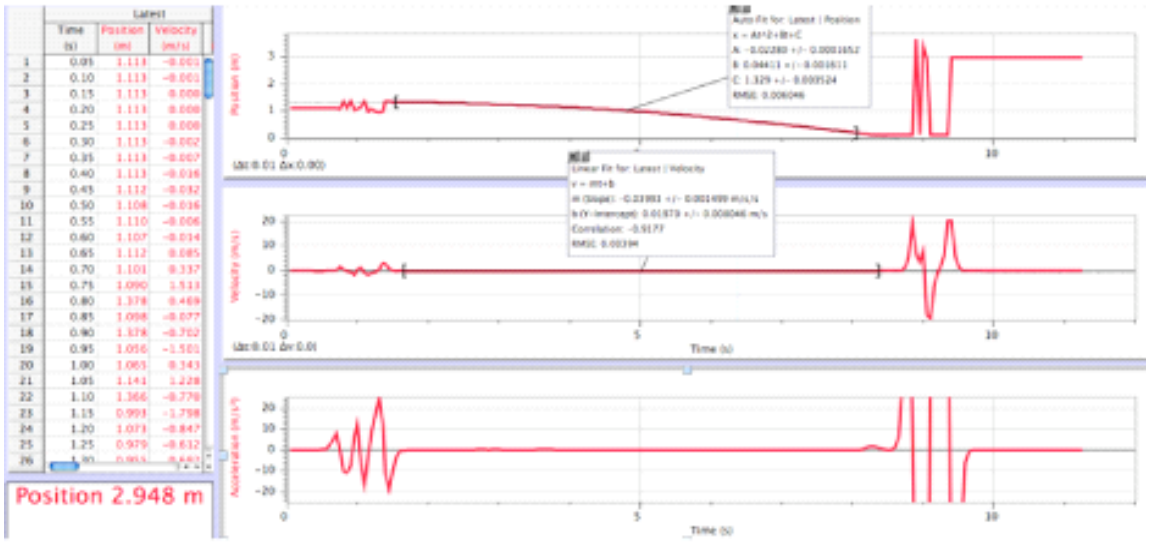


1.3Empty fan car at Low Speed



1.4Empty fan cart a

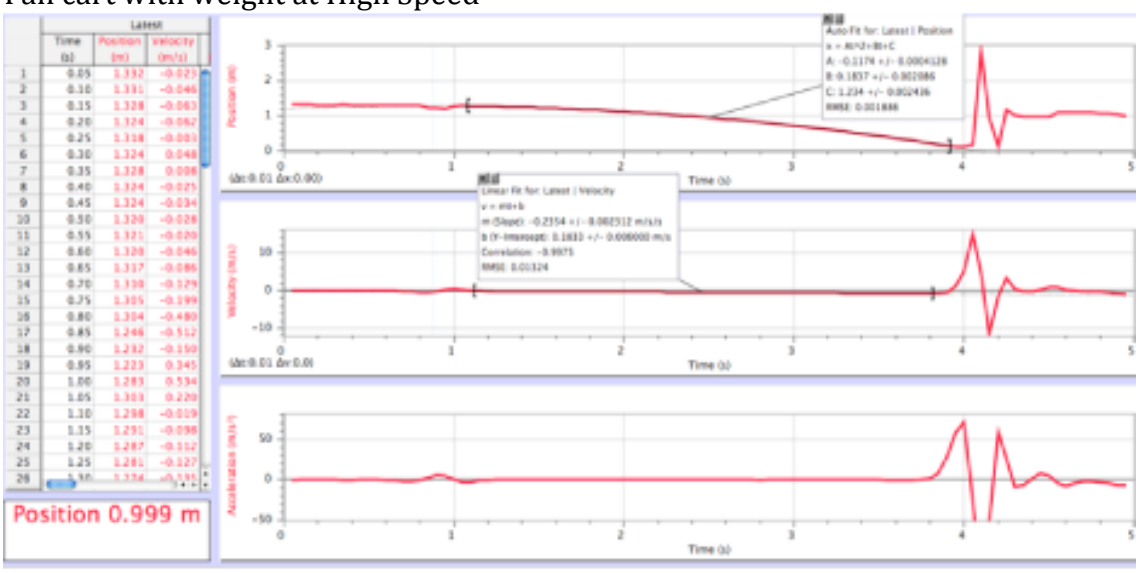




t High speed

1.5 Fan cart with weight at Low Speed

1.6 Fan cart with weight at High Speed



Observations:

As the cart moved down the track, it accelerated and hit the end of the track. It bounced off the end of the track several times, each time rebounding less and less until the cart stopped. The empty fan cart accelerated in a straight line at both speeds, though it moved faster at high speed than low speed. The loaded fan cart also accelerated in a straight line, but it moved slower than the empty fan cart.

Analysis:

1.The gravity of the cart (at 5°) and the normal force from the track were the 2 forces acting on the cart as it moved down the track. There is a net force of the

x component of the cart's weight parallel to the track because the sum of the y component of the cart's weight and the normal from the track equals zero. The cart was at its highest speed when it hit the end of the track, and it bounced off several times, each rebound decreasing in magnitude. Its acceleration decreased each time. The equation of the s/t curve from Graph 1.1 is $y=-0.2613t^2+1.916t-3.027$ and the equation of the v/t curve is $y=-0.5423t+1.990$. The acceleration is about 0.54 m/s^2 in both graphs. If you plug in F=ma, then $F=489g * 0.54m/s^2= 264.04$ N.

2. For the cart at 7° (Graph 1.2), the s/t equation is $y=-0.3478t^2+1.551t-1.278$ and the v/t equation is $y=-0.7243t+1.614$. The magnitude of the acceleration is about 0.72 m/s^2. The net force $F=489g*0.72m/s^2= 352.08$ N.

3. Three forces acted on the empty fan cart at Low speed: the gravity of the fan cart, the normal force of the ground (equal to gravity), and the net force from the fan. Its velocity and acceleration were constant throughout. The equation of the s/t curve from Graph 1.3 is $y=-0.1135t^2+0.1518+1.318$ and the v/t equation is $y=-0.2245t+0.1437$. The acceleration is about 0.22 m/s^2. The net force $F=586g*0.22m/s^2= 128.92$ N.

4. When set on High speed, the empty fan cart's velocity and acceleration increased. The s/t equation from Graph 1.4 is $y=-0.1278t^2+0.3117t+1.087$and the v/t equation is $y=-0.2557t+0.3116$. The acceleration is about 0.26 m/s^2. The net force $F=586g*0.26m/s^2=152.36$ N.

5. The same three forces acted on the loaded fan cart at Low speed, but its heavier mass decreased the acceleration. Its velocity and acceleration were constant again. The acceleration from Graph 1.5 is about $0.04m/s^2$. The force $F=(586g+240g)*0.04m/s^2= 33.04$ N.

6. The loaded fan cart at High speed had the same three forces and mass and constant velocity/acceleration, but its fan was stronger so its acceleration was greater. The acceleration from Graph 1.6 is about 0.23 m/s^2. Therefore, the net force $F=(568g+240g)*0.23m/s^2= 189.98$ N.

Conclusion:

The acceleration of an object can be determined by finding the curve fit of the graphs and by applying Newton's 2nd law F=ma. The greater the angle that an object falls with gravity, the greater its acceleration will be. If the acceleration increases, the net force increases as well because acceleration and net force are directly proportional. Also, the higher the velocity (speed), the higher the acceleration. Contrarily, the greater the mass, the smaller the acceleration. However, mass is directly proportional to net force, so the net force increases if mass increases. Possible sources of error may be that the fan cart ran out of battery during the third trial, and we had to use a different fan cart. Next time, you should make sure the batteries are fresh and stick with the same fan cart. Also, we could increase the displacement (but keep it constant for all trials of the fan cart) to acquire more data points and get a more correct acceleration value.