01. One Dimensional Motions

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1 Purpose

We want to analyze the one dimensional motion and understand displacement, velocity, acceleration. And we will recognize the patterns of displacement and time, velocity and time, acceleration and time. We also learn how to analyze the experimental data.

2 Theoretical Background

1. The distance is total length that object moved.
2. The displacement is change of position in vector.
3. The speed is change of distance.

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

4. The velocity is change of displacement.

$$\text{velocity} = \frac{\text{displacement}}{\text{time}}$$

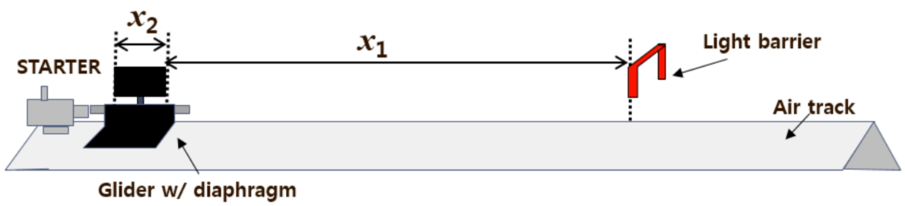
5. Acceleration is change of velocity.

6. If the body is on the tilted track with angle θ, acceleration of body is $\mathrm{g}\sin\theta$.

3 Procedure

3.1 Linear Uniform Motion

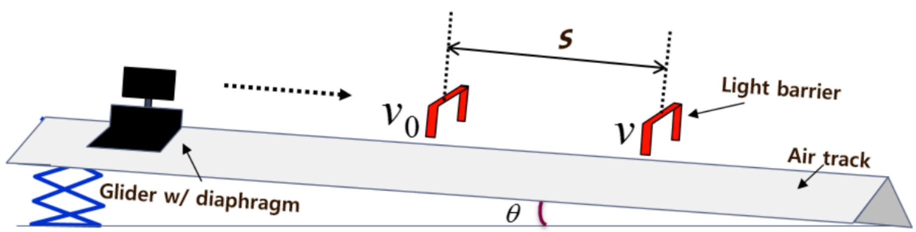
1. Set up the experiment as



2. Set value x_1 and x_2 in Cobra 3 program. x_1 implies average velocity of glider and x_2 implies instant velocity of glider
3. Compare measured values between timer 1 and timer 2.
4. Change weight and distance, and repeat the step 1 to 3.

3.2 Uniformly Accelerated Motion with on Inclined Track

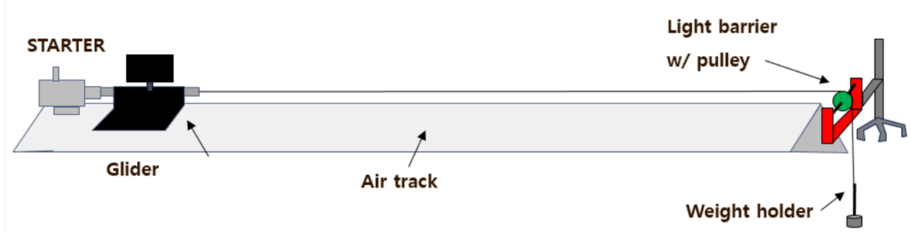
1. Set up the experiment as



2. Measure the distance between first and second light barrier.
3. In Cobra 3, measure the velocity at first and second light barrier.
4. Repeat steps again with different angle.

3.3 Uniformly Accelerated Motion with on Accelerating Mass

1. Sep up experiment as



2. Start the 'Translation/Rotation' program in Cobra 3, and set measurement s, v, a.
3. Release the glider then system starts recording.

4. Plot the data and compare with estimated value.

4 Data Analisys and Conclusion

4.1 Linear Uniform Motion

The data table of this experiment is:

mass of the glider (M)	mass of holding magnet (m_1)	mass of needle (m_2)	mass of hook (m_3)
190.2	9.4	9.7	9.7

Table 1: mass of the glider and parts

Distance	Average v_1	Average v_2
1.0	0.812	0.794
0.8	0.825	0.810
0.6	0.845	0.820

Table 2: The velocity measured from timer 1(v_1) and timer 2(v_2)

Put Slotted Weight	Average v_1	Average v_2
40	0.777	0.756
80	0.709	0.689
100	0.676	0.656

Table 3: The velocity of the glider which is slotted weight (with 0.8m)

v_1 is average velocity of whole distance and v_2 instantaneous velocity while the glider pass the light barrier.

We used air track to reduce friction between glider and track.

However there are small gap between v_1 and v_2 because there exists air resistance. Since there exists air flow and air resistance is proportion to square of velocity, it is hard to calculate value of air resistance.

In Table 3, kinetic energy of glider contains each slotted weight must be same. The kinetic energy is 71.24×10^{-3}J when weight is 40g, 68.67×10^{-3}J when it is 80g, 66.55×10^{-3} when it is 100g.

The gap between kinetic energy is occurred. Because air density between track and glider is increased by weight is increasing, hence air resistance increased.

4.2 Uniformly Accelerated Motion with an Inclined Track

θ (measurement)	v_0	v_1	a (measurement)	a(theoretic)
2	0.669	0.881	0.37	0.34
4	0.891	1.179	0.66	0.68
6	1.065	1.415	0.96	1.02

Table 4: The velocities of the accelerated glider on the inclined track

The distance between first and second light barrier is 0.8m. v_1 and v_2 are the instantaneous velocity of glider while it pass each light barrier.

We can calculate the acceleration with our measurement by the formula:

$$2as = v_1^2 - v_0^2$$

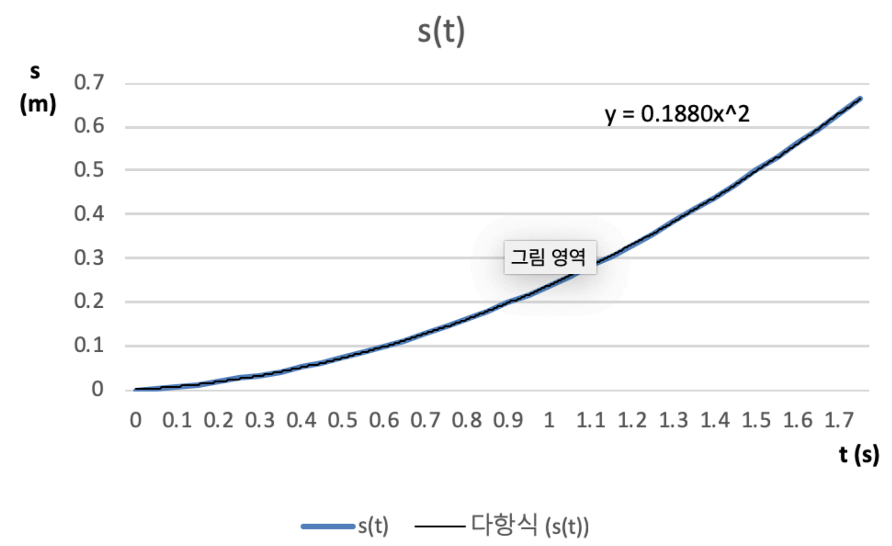
and can calculate the theoretic acceleration with the angle by the formula:

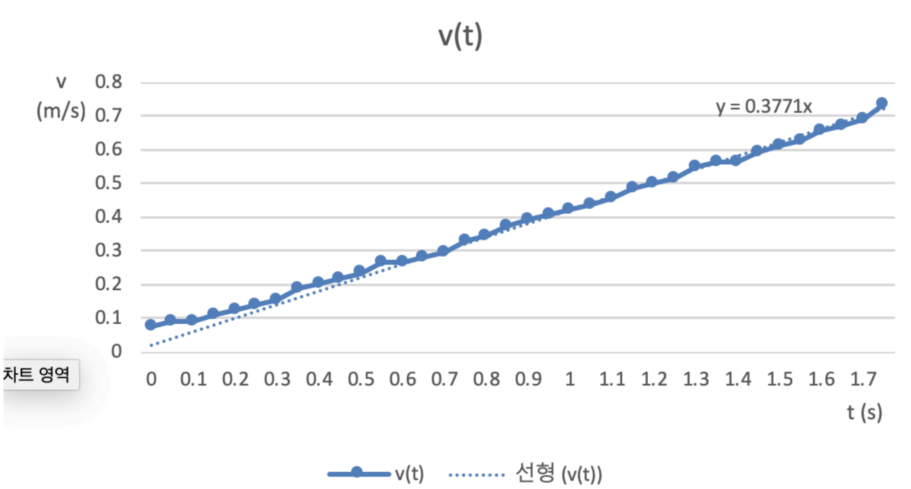
$$a = g\sin\theta$$

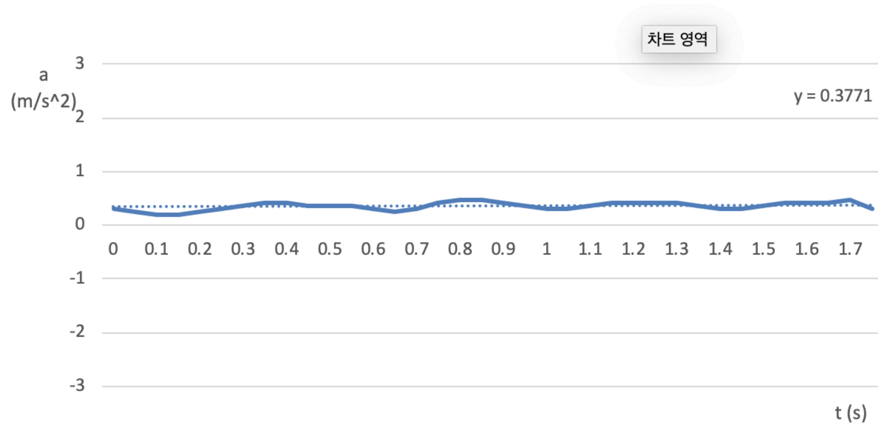
In Table 4, error between measurement a and theoretic a is occurred 8.8% when θ is 2, 2.9 % when θ is 4 and 5.9% when θ is 6.

We think the error occurred because of air resistance.

4.3 Uniformly Accelerated Motion with an Accelerating Mass







The mass of glider M is 209.3g and mass of the weight is m 10g. We can calculate the acceleration of glider a:

$$a = \frac{mg}{M+m} = 0.446\mathrm{m/s^2}$$

And we can estimate acceleration by regression of data:

$$a' = 0.3771\mathrm{m/s^2}$$

The error is 15.4%. We think the error occurred because rotation of pulley and friction between pulley and string and also air resistance.