Dynamics Track Set 1.2m ESD50241

The Dynamics system consists of a 1.2m track, two carts, and related accessories. The system is designed for use in physics and physical scientific experiments. Dynamics system enables more accurate and precise experiment by minimizing friction. Some typical experiments done with the system include

- Newton's Law
- Conservation of Energy
- Uniform Motion
- Spring Constant
- Motion under constant acceleration
- Inelastic collisions & Elastic collisions
- The dynamics system is designed for use with many sensors, such as the motion sensor, photogate, accelerometer and the interface Pro.

1. Composition

1.2m Track – 1ea

Single foot end stop – 1ea

Double foot end stop – 1ea

Adjustable end stop – 1ea

Plunger cart with two magnets and foam plugs for included end caps – 1ea

Standard cart with two magnets and foam plugs for included end caps – 1ea

Photogate bracket – 2ea

Pulley bracket – 1ea

500g mass – 1ea

Rod clamp – 1ea

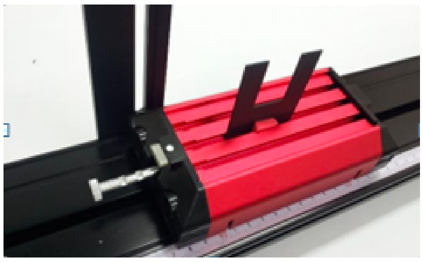
Fastener – 1set

Mini Wrench – 1ea

1-1. Carts

Dynamics carts are supplied with magnets. You may choose to install either or both on your carts.

The magnets are useful in studying collisions with the magnets positioned so that they are the same polarity on both sides and on both carts. This way the carts will repel one another, and you can arrange a collision in which the carts never actually touch. The collision will be very nearly elastic, unlike a collision using a spring or any kind of contract.



To study totally inelastic collisions, change polarity of one cart to be opposite each other. This way any cart will stick to any other. Carts with magnets will stick together, creating a totally inelastic collision.

To use the plunger, simultaneously press the horizontal button above the plunger and press the plunger in until it locks. To release, press on the pin from the top of the carts. The plunger force can be adjusted. To adjust the plunger release force, rotate the plunger while it is extended.

Note: Polarity in same cart should be equal. If they are different each other, the cart could leave the track.

1-2. Photogate Bracket

Photogate bracket is attached to the side of the track. With the nut loosely on the T-handled bolt, slide the nut into the side channel of the track. Attach the photogate using the supplied wing bolt in the long slot. Adjust the gate height so the beam intercepts the desired portion of the target.

1-3. Pulley Bracket

Pulley Bracket is attached to the end of the track. Attach the pulley using the supplied bolt. Adjust the height so can do experiment with pulley.

1-4. Single foot end stop

The single foot end stop slides into the end of the track, with the nut in the center slot of the track underside.

1-5. Double foot stand

The double foot stand slides into the end of the track, with the nut in the center slot of the track underside. Adjust the position as desired.

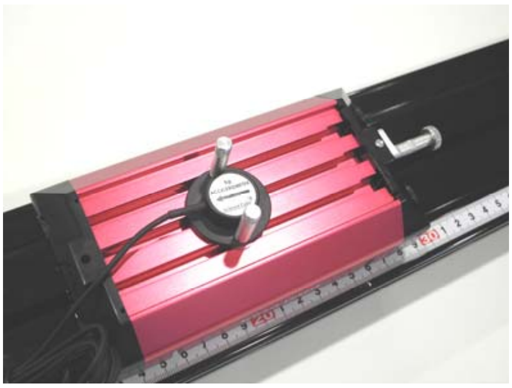
1-6. Rod Clamp

The rod clamp is used to support the track with a user-supplied ring stand. Insert the rod clamp nut into the side of the track. Adjust the height as desired.

1-7. Mass

The 500g mass is used to double the mass of the cart. Attach the mass by removing the wing nut and bolt, and placing the bolt head in one of the off-center slots on top of the cart. Slide the mass over the bolt, and tighten the wing nut.

1-8. Fasteners



The supplied fasteners are used to attach devices to the cart. For example, you may want to attach a force sensor, accelerometer to the cart. The fasteners may be inserted any point along the slot length. To use, loosen but do not remove the nut from the shaft, and insert the nut parallel to the slot. Turn the shaft clockwise to tighten.

1-9. Mini Wrench

This mini wrench is designed to use to adopt magnets in foam plugs of end cap.

2. Sample Experiment

Uniform motion

Uniform Acceleration

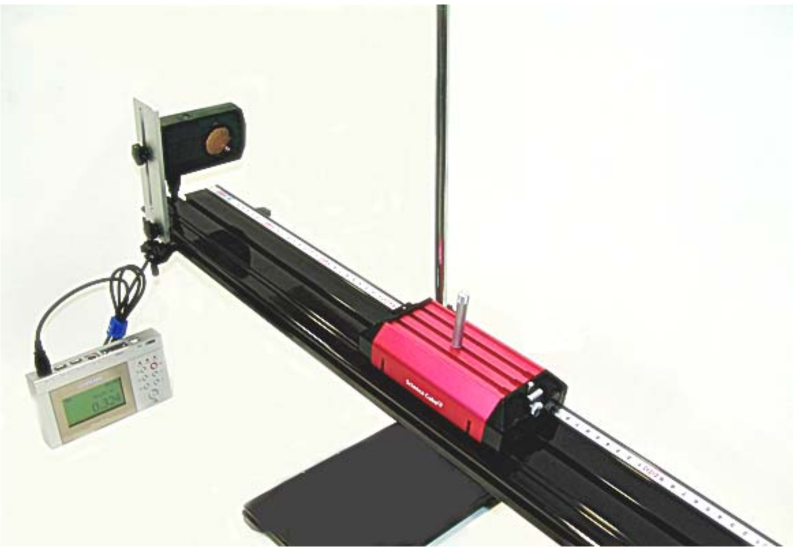
Atwood's machine

Gravitational Acceleration

Determining g on an incline

Newton's law

2-1. Determining 'g' on an Incline



A. OBJECTIVES

· Use a motion Sensor to measure the speed and acceleration of a ball and a cart rolling down an incline.

· Determine the mathematical relationship between the angle of an incline and the acceleration of ball rolling down the ramp.

· Determine the value of free fall acceleration, g, by extrapolating the acceleration vs. sine of track angle graph.

· Compare the results for a ball with the results for a low-friction dynamics cart.

· Determine if an extrapolation of the acceleration vs. sine of track angle is valid.

B. MATERIALS

Computer

EduScience Data Logger

Motion Sensor

Dynamics rail

Dynamics cart

Hard ball

Steel Rod

C. PRECEDURE

1. Connect the Motion Sensor to the channel [A] of the interface.
2. Place the Motion Sensor at the top of an incline. Place it so the ball will never be closer than 0.5m.
3. Open [EduScience]-[experiment sheet]-[velocity, acceleration-Motion] from Excel file.
4. Hold the hard ball on the incline about 0.5m from the Motion Sensor.
5. Click 'collect' button to begin collecting data; release the ball after the Motion Sensor starts to click. Get your hand out of the Motion Sensor path quickly. You may have to adjust the position and aim of the Motion Sensor several times before you get it right. Adjust and repeat this step until you get a good run showing approximately constant slope on the velocity vs. time graph during the rolling of the ball.
6. Graph shows acceleration automatically.
7. Repeat Steps 5 - 7 two more times.
8. Measure the length of the incline, x, which is the distance between the two contact points of the ramp. See figure 1.
9. Measure the height, h, the height of the rod(s). These last two measurements will be used to determine the angle of the incline.
10. Raise the incline by using rod clamp.
11. Repeat Steps 5 - 10 for the new incline.
12. Repeat Steps 5 - 11 with different height of rod.
13. Repeat Steps 5 - 13 using a low-friction dynamics cart instead of the ball.

Data using ball						
Height of rod (m)	Length of incline, x (m)	Sin(Θ)	Acceleration			Average acceleration (m/s^2)
			Trial 1 (m/s^2)	Trial 2 (m/s^2)	Trial 3 (m/s^2)	

Data using cart						
Height of rod (m)	Length of incline, x (m)	Sin(Θ)	Acceleration			Average acceleration (m/s^2)
			Trial 1 (m/s^2)	Trial 2 (m/s^2)	Trial 3 (m/s^2)	

D. ANALYSIS

1. Calculate the average acceleration for each height.
2. Using trigonometry and your values of x and h in the data table, calculate the sine of the incline angle for each height. Note that x is the hypotenuse of a right triangle.
3. Plot a graph of the average acceleration (y axis) vs. sin(Θ).
4. Draw a best-fit line by hand or use the linear fit feature of Excel, and determine the slope. The slope can be used to determine the acceleration of the ball on an incline of any angle.
5. How well does the extrapolated value agree with the accepted value of free-fall acceleration ($g = 9.8 m/s^2$)?
6. Repeat the analysis, including the extrapolation, dynamics cart.
7. Why do you think the data for the dynamics cart resulted in an extrapolated value of g that was closer to the accepted value than the rolling ball data?
8. Discuss the validity of extrapolating the acceleration value to an angle of 90°.

2-2. Newton's Second Law

How does a cart change its motion when you push and pull on it? You might think that the harder you push on a cart, the faster it goes. Is the cart's velocity related to the force you apply? Or does the force just change the velocity? Also, what does the mass of the cart have to do with how the motion changes? We know that it takes a much harder push to get a heavy cart moving than a lighter one.

A Force Sensor and an Accelerometer will let you measure the force on a cart simultaneously with the cart acceleration. The total mass of the cart is easy to vary by adding masses. Using these tools, you can determine how the net force on the cart, its mass, and its acceleration are related. This relationship is Newton's second law of motion.

A. OBJECTIVES

·Collect force and acceleration data for a cart as it is moved back and force.

·Compare force vs. time and acceleration vs. time graphs.

·Analyze a graph of force vs. acceleration.

·Determine the relationship between force, mass, and acceleration.

B. MATERIALS

Computer

Interface ce Pro

Force Sensor

D ynamics cart

5 -g Accelerometer

500g mass

C. PROCEDURE

1. Connect a Force Sensor to Channel [A] on Interface Pro.
   Connect the low-g Accelerometer to Channel [B] on the interface.
2. Open [Excel] – [EduScience] to collect data from your computer.
3. Attach the Force Sensor to a dynamics cart so you can apply a horizontal force to the hook, directed along the sensitive axis of your particular Force Sensor. Nest, attach the Accelerometer so the arrow is horizontal and parallel to the direction that the cart will roll. Orient the arrow so that if you pull on the Force Sensor the cart will move in the direction of the arrow. Find the mass of the cart with the Force Sensor and Accelerometer attached. Record the mass in data table.
4. Place the cart on a level surface. Make sure the cart is not moving and click “zero”. Check to make sure both sensors are highlighted and click “ok”.
5. You are now ready to collect force and acceleration data. Grasp the Force Sensor hook. Click “collect” and take several seconds to move the cart back and forth on the table. Vary the motion so that both small and large forces are applied. Make sure that your hand is only touching the hook on the Force Sensor and not the Force Sensor of cart body.
6. Note the shape of the force vs. time and acceleration vs. time graphs. The graph of force vs. acceleration should appear to be a straight line.
7. Using the graphs, estimate the acceleration of the cart when a force of 1.0 N has acted upon it. Record the force and acceleration in the data table.
8. Attach the 500g mass to the cart. Record the mass of the cart, sensors, and additional mass in the data table.
9. Repeat Steps 5-8.

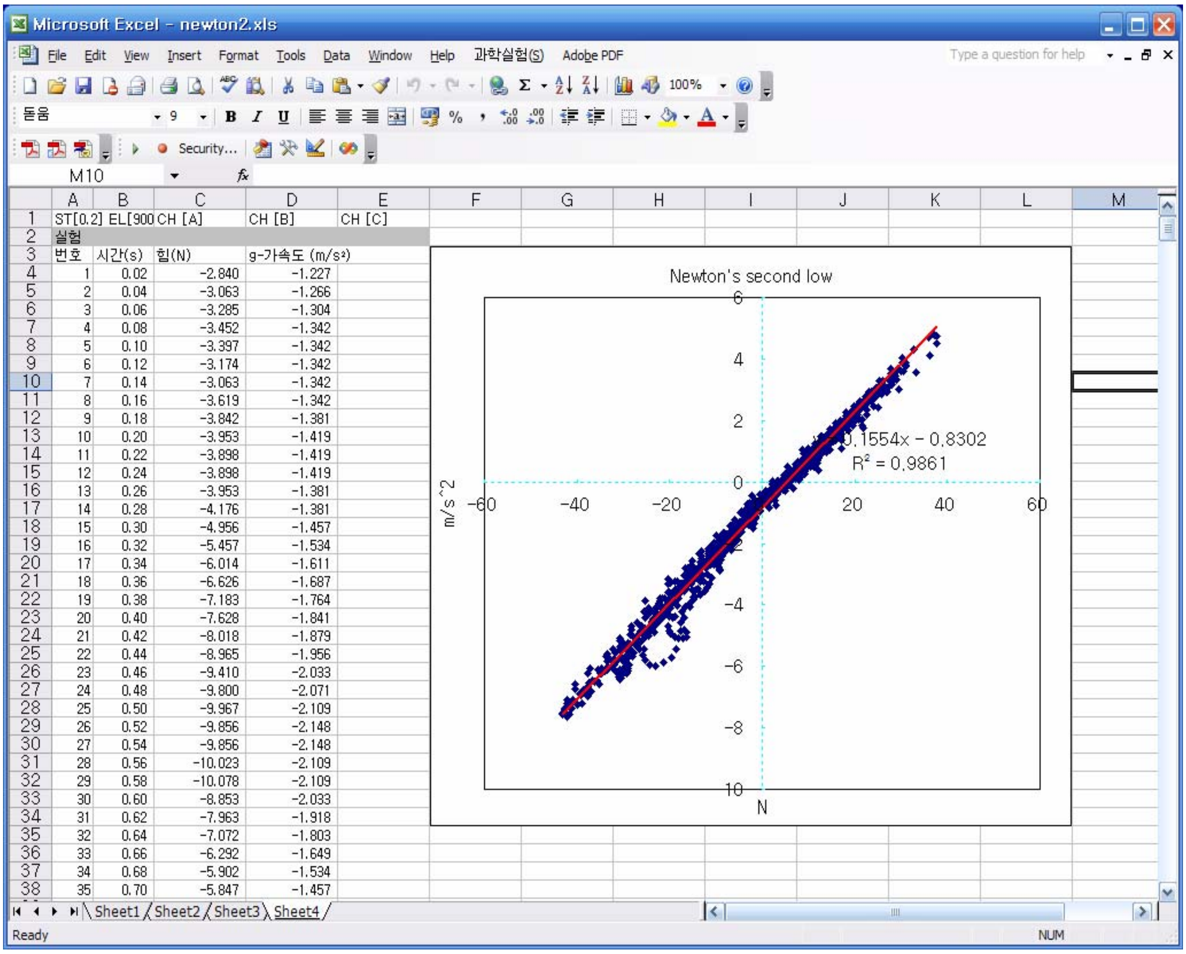
D. DATA TABLE

Mass of cart with sensors (kg)		Mass of cart with sensors and additional mass (kg)	
Force(N)	Acceleration(m/s^2)	Force(N)	Acceleration(m/s^2)
1.0N		1.0N	

E. ANALYSIS

1. Compare the graphs of force vs. time and acceleration vs. time for a particular trial. How are they different? How are they the same?
2. Are the net force on an object and the acceleration of the object directly proportional?
3. What are the units of the slope of the force vs. acceleration graph? Simplify the units of the slope to fundamental units (m, kg, s).
4. For each trial compare the slope of the regression line to the mass being accelerated. What does the slope represent?
5. What a general equation that relates all three variables: Force, mass, and acceleration.

F. SAMPLE RESULTS



	A	B	C	D	E
1	ST[0.2]	EL[900	CH [A]	CH [B]	CH [C]
2	실험				
3	번호	시간(s)	힘(N)	g-가속도 (m/s²)	
4	1	0.02	-2.840	-1.227	
5	2	0.04	-3.063	-1.266	
6	3	0.06	-3.285	-1.304	
7	4	0.08	-3.452	-1.342	
8	5	0.10	-3.397	-1.342	
9	6	0.12	-3.174	-1.342	
10	7	0.14	-3.063	-1.342	
11	8	0.16	-3.619	-1.342	
12	9	0.18	-3.842	-1.381	
13	10	0.20	-3.953	-1.419	
14	11	0.22	-3.898	-1.419	
15	12	0.24	-3.898	-1.419	
16	13	0.26	-3.953	-1.381	
17	14	0.28	-4.176	-1.381	
18	15	0.30	-4.956	-1.457	
19	16	0.32	-5.457	-1.534	
20	17	0.34	-6.014	-1.611	
21	18	0.36	-6.626	-1.687	
22	19	0.38	-7.183	-1.764	
23	20	0.40	-7.628	-1.841	
24	21	0.42	-8.018	-1.879	
25	22	0.44	-8.965	-1.956	
26	23	0.46	-9.410	-2.033	
27	24	0.48	-9.800	-2.071	
28	25	0.50	-9.967	-2.109	
29	26	0.52	-9.856	-2.148	
30	27	0.54	-9.856	-2.148	
31	28	0.56	-10.023	-2.109	
32	29	0.58	-10.078	-2.109	
33	30	0.60	-8.853	-2.033	
34	31	0.62	-7.963	-1.918	
35	32	0.64	-7.072	-1.803	
36	33	0.66	-6.292	-1.649	
37	34	0.68	-5.902	-1.534	
38	35	0.70	-5.847	-1.457	