CODERS and You: Force, Motion and Friction

STEM CONTENT

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Goals

CODERS CONNECTION

- Learn STEM Content
- Acquire related vocabulary
- Experiment
- Incorporate writing elements into prediction and analysis
- Use Coding to simulate and predict

Force and Motion

YEAR 2 CONTENT

- Specific vocabulary for the classroom
- Definitions and examples
- The approach to experimentation and measurement
- Practice acquiring data through experimentation
- Computing/Coding Integration

Vocabulary for the Classroom

- Force – a force can be felt, it can be a push or a pull on an object. It can result in that object moving
- Push – an applied force that feels repulsive
- Pull – an applied force which feels attractive
- Newton – one unit of force
- Rest – not moving. An object at rest will stay at rest unless acted upon by a force
- Motion – the opposite of rest, motion means to move. Motion can occur when a force acts on an object

Vocabulary for the Classroom

- Friction – the "sticky" force felt between two surfaces. Friction nearly always opposes motion
- Kinetic friction – friction that an object experiences *while* it is moving. This friction is lower than static friction for the same surface
- Static friction – friction that an object experiences while trying to *begin* moving. This friction is higher, but once it has been overcome, it can experience kinetic friction which is lower.
- System – the agreed upon bubble of things we are concerned with. The system is the "world" that we work in for example, the ramp and the block could be our system

Vocabulary for the Classroom

- Speed – distance / time. How fast something is moving. We measure this in meters per second, m/s
- Velocity – velocity is a speed **and** a direction. 10 m/s at 90°. we measure this in meters per second, m/s
- Acceleration – (change in speed) / (change in time) how much the speed of an object changes over time. Acceleration includes all types of changes, speeding up, slowing down, even changing direction is a type of acceleration. We measure this in meters per second squared, m/s^2

Force

THE BASICS

- We all have an idea of force. Forces typically come in two flavors: push and pull
- Where do these forces originate? We can point to objects that produce force and label them the "cause"
- a spring can create both a push and pull, the earth can pull me, or the ground can push me

Motion

THE BASICS

- We define motion in opposition to rest
- Position, speed (velocity), and acceleration.
- We pick an agreed upon reference point. Meaning we *choose* our 0 point, our origin from which everything is measured.
  - 10 meters away – from where?

Speed

THE BASICS

- Speed is defined as distance/time.
- Velocity is nearly the same as speed, but not quite.
- Velocity includes direction, speed has no direction
- Example

Acceleration

THE BASICS

- What if our speed changes?
- Acceleration is defined as (the change in speed) / (the change in time)
  - You can speed up or slow down, both are types of acceleration

Measurements

- You can measure motion directly, like timing a runner down a track or a car down a road
  - Motion is a response to force
- Force is measured indirectly. We can see motion, and infer a force but measuring it is trickier
- A scale, for example, has more nuance than you would suspect

Measurements

- Friction typically works against your motion. If you are sliding, friction seeks to stop you
  - There are two types of friction: Static and kinetic
- Static friction is often bigger than kinetic friction, meaning it is harder to *start* moving than it is to *continue* moving

How do we measure?

- Measure the force an object provides by using a scale.
- Measure the friction felt by using an angle and some geometry. Let's define it more quantitatively
  - The angle at which the block *just* begins to move on an elevated ramp can be very small or very large. The larger the angle, the greater the static friction
- You could also measure how far an object slides. The farther the distance, the smaller the kinetic friction

How do we measure?

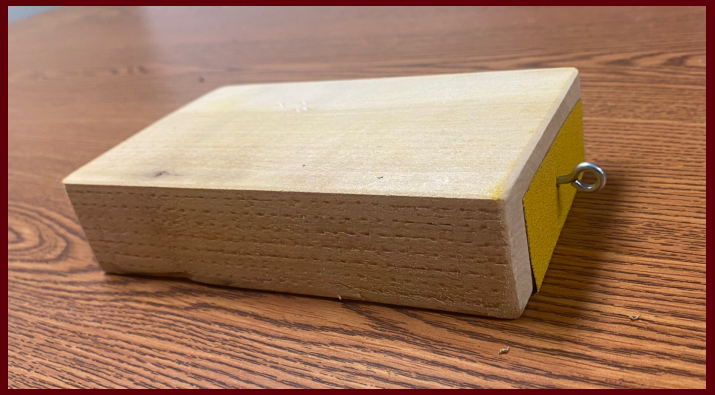
- We measure the speed by measuring both the distance using a meter stick and the time using a stopwatch and our equation.
- Measuring acceleration is much harder, but we can qualitatively observe it

Describe your systems

DEFINE YOUR EXPERIMENT WORLD

- Examine your gear and write a short description of each piece.
- Writing can be applied in a multitude of ways, such as straight description, prediction, analysis, coding development.
- In Year 2, we will specify to some degree how writing will be incorporated.

Describe your systems



Measurement Tools

Cutebot and Microbit

MicroBit and Cutebot's capabilities for F&M

- The Microbit is equipped with several sensors, including three accelerometers
- An accelerometer uses internal displacements to measure gravity and/or acceleration

example

- Two things cause a non-zero reading: gravity and acceleration.

Let's measure some speeds

THROUGH EXPERIMENTATION

- Walk with constant speed and have a partner measure the time it takes you to walk 5 meter
- Now let's measure Cutebot's ability
  - Write a brief program to have your Cutebot move with a constant speed at least 5 meters, just as you did.
  - Measure the time it takes
- Determine the speeds of yourself and your Cutebot

Let's measure some forces

THROUGH EXPERIMENTATION

- Hanging the wooden block from the spring scale and record and reading in Newtons
- Attach Cutebot to the spring scale and set the speed to 100%. Record the results in Newtons.

Let's measure some friction

THROUGH EXPERIMENTATION

- Using the block, the board, and your spring scale we will measure friction
- Attach the spring scale to the hook on the block.
- Set the block, sandpaper side down, on top of the sandpaper track.
- Pull gently with a slowly increasing force until the block begins to move, measure in that moment
- Continue pulling now with a constant force and measure again. You may see a slight difference between the two readings. This is static and kinetic friction.
- You can test the different surface combinations, but use extreme caution for sandpaper on felt as the friction may break the scale if the force is too high

More Static Friction

- Use the board and block combination for 6 frictional possibilities
- Tip the board until the block begins to move. The angle is related to the coefficient of static friction

Microbit and Kinetic Friction

THINGS TO DO FOR THE YEAR

- Write a program to read the accelerometers on the microbit
- Strap the microbit to the block and slide it on frictional surfaces
- Use the data to analyze the friction
- Read the accelerometer as the cutebot moves
- Use the data to assess the acceleration

Scratch

- By now, you should have a Scratch account
- Log in to your account
- Start a new project
- We will be writing a program to see how friction affects the speed of a block sliding down a ramp

Friction Program

- Plan your Sprites (write out a set of Sprites for the world). What do they represent?
  - Ramp
  - Block
  - A way to change the ramp material (sprites that we will use as buttons)
  - A way to calculate speed (variables)

Friction Program

- https://scratch.mit.edu/projects/699215377/

Writing and STEM/Coding

- Use a combination of writing strategies, including KWL, 3-2-1, Sticky Notes, Exit Ticket, Journaling
- Link the writing to important pieces of Coding and STEM experimentation such as: algorithm development, experimental procedures, etc.
- Share writing to improve communication