

teacher pre-visit packet

# motion



## Exhibit Description

The University of Montana spectrUM Discovery Area has been traveling its wildly popular **Motion** exhibition across Big Sky Country. Bring **Motion** to your school and inspire the next generation of engineers, pilots, physicists, and visionaries.

**Motion** explores the sciences of movement from flight to spin through eight interactive exhibits including a bigger than life Turn Table from the San Francisco Exploratorium, an iconic Gravity Well from the Franklin Institute and spectrUM's very own Flight Simulator.

Through inquiry and hands-on learning, visitors to Motion explore first hand the Bernoulli Principle, the Conservation of Angular Momentum, Newton's Three Laws of Motion, and more, all while they laugh, play and learn.

Many engaging and educational experiences await you at spectrUM's popular traveling exhibit, **Motion**.

**“We love Motion! My students were captivated by the inquiry based exhibits – it is very engaging, as science should be!”**

-Darrell VanDusen, 1st grade teacher

To bring Motion to your school,  
**call 728-STEM.**



## Overview of Montana OPI Content Standards and Next Generation Science Standards applied in Motion

### OPI Content Standards

#### Science Standard 2

Students, through the inquiry process, demonstrate knowledge of properties, forms, changes and interactions of physical and chemical systems.

- **End of Grade 4:**

- Benchmark 3: Identify the basic characteristics of light, heat, motion, magnetism, electricity and sound.
- Benchmark 5: Identify that the position of an object can be described by its location relative to another object and its motions described, and measured by external forces action upon it.
- Benchmark 6: Identify, build, and describe mechanical systems and the forces acting within those systems.

- **End of Grade 8:**

- Benchmark 3: Describe energy and compare and contrast the energy transformations and the characteristics of light, heat, motion, magnetism, electricity, sounds, and mechanical waves.
- Benchmark 5: Describe and explain the motion of an object in terms of its position, direction, and speed as well as the forces acting upon it.
- Benchmark 6: Identify, build, describe, measure, and analyze mechanical systems (e.g., simple and complex machines) and describe the forces acting within those systems.

- **Upon Graduation:**

- Benchmark 5: Explain the interactions between motions and forces, including (a) the laws of motion and (b) an understanding of the gravitational and electromagnetic forces.
- Benchmark 6: Explain how energy is stored, transferred, and transformed, including (a) the conservation of energy, (b) kinetic and potential energy and energy contained by a field, (c) heat energy and atomic and molecular motion, and (d) energy tends to change from concentrated to diffuse.



## Next Generation Science Standards

### PS2: Motion and Stability: Forces and Interactions

- **K-PS2-1.** Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
- **K-PS2-2.** Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.
- **3-PS2-1.** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- **3-PS2-2.** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- **3-PS2-3.** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
- **5-PS2-1.** Support an argument that the gravitational force exerted by Earth on objects is directed down.
- **MS-PS2-1.** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
- **MS-PS2-2.** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- **MS-PS2-4.** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of the interacting objects.
- **MS-PS2-5.** Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
- **HS-PS2-1.** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- **HS-PS2-2.** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the systems.

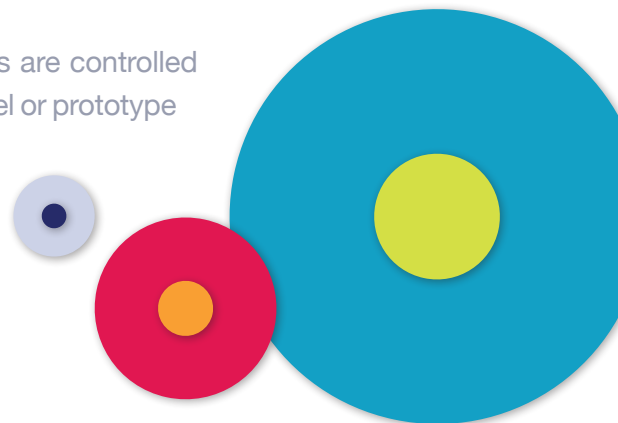


## PS3: Energy

- **4-PS3-1.** Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- **4-PS3-2.** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- **4-PS3-3.** Ask questions and predict outcomes about the changes in energy that occur when objects collide.
- **MS-PS3-1.** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- **MS-PS3-2.** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- **MS-PS3-5.** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.
- **MS-HS3-2.** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

## ETS1: Engineering Design

- **3-5-ETS1-3.** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.





## Key Concepts Explored in Motion

Some basic themes explored during a field trip at Motion include:

- Forces
- Newton's Three Laws of Motion
- Flight and Flight Design
- Air Pressure and Bernoulli's Principle

## Pre-Visit Discussion

We invite you to have a discussion with your class before visiting Motion to explore what they already know about physics.

These topics will be explored at your field trip.

- What are Newton's Three Laws of Motion?
- How does an airplane fly in the air?
- What is potential energy and kinetic energy?

## Post-Visit Discussion

After visiting Motion, we invite you to review the pre-visit discussion items.

- What did students learn from their visit to Motion?
- What was their favorite part of the exhibition?
- Are they interested in pursuing a career in physics or flight?

## Resources

Check out these great websites to get more information about physics and motion to use in your classroom!

- [edheads.org/activities/odd\\_machine](http://edheads.org/activities/odd_machine)
- [edheads.org/activities/simple-machines](http://edheads.org/activities/simple-machines)
- [physics4kids.com](http://physics4kids.com)
- [thephysicsofflight.homestead.com](http://thephysicsofflight.homestead.com)