Grade Level Content Expectations (GLCE's) that are covered by Dr. Zeemo's "Science of Spinning" School Assembly.

For over 20 years Dr. Zeemo (Paul Kyprie) has been performing a school assembly program called "The Science of Spinning". This program was specifically designed and written to follow the Michigan Dept. of Education curriculum guidelines for K-8 physical science. The goal has always been to use demonstrations that teach concepts and that students can then apply the knowledge to novel situations. Specifically, the demonstrations involve the use of toys and objects with which children are familiar making them easier to recall and the novel application is answering questions on standardized tests. Children that see this program should therefore score higher on the physical science portion of the MEAP test.

What follows is a list of over 90 GLCE's broken down by grades that focus on physical science as well as understanding how to use the scientific method to conduct experiments in this area. Dr. Zeemo reinforces this by perfoming experiments in this area with students participating as well.

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Grade Level Content Expectations

Kindergarten

Prior to entering kindergarten, many students have developed an understanding of the motion of objects. For example, the young learner has discovered that solid objects cannot move through each other, changes in motion and position of objects are the result of a force outside them, and that objects tend to endure over space and time. They learn even though the ball has rolled out of sight, it still exists behind the wall, under the couch, or behind someone's back. They can also make inferences about reasonable causes of motion of inanimate objects. Pre-kindergarteners have their own concept of force that they use to explain what happens in the motion of objects. They think of forces as active pushes and pulls that are needed to explain an object's motion. The kindergarten content expectations for physical science are meant to build on and use the early learners' ability to correctly sense some of the behaviors of simple mechanical objects and the motion of objects. The central idea is for the young learner to be able to attach appropriate language that describes motion, compares motion, and begin to develop an understanding of forces and their relationship to changes in motion. Finally the students are introduced to the concept that objects fall toward the Earth and that the force that pulls objects toward Earth affects the motion of all objects.

Kindergarten

Physical Science: Force and Motion
Prior to entering kindergarten, many students have developed an understanding of the motion of objects. For example, the young learner has

discovered that solid objects cannot move through each other, changes in motion and position of objects are the result of a force outside them, and that objects tend to endure over space and time. They learn even though the ball has rolled out of sight, it still exists behind the wall, under the couch, or behind someone's back. They can also make inferences about reasonable causes of motion of inanimate objects. Pre-kindergarteners have their own concept of force that they use to explain what happens in the motion of objects. They think of forces as active pushes and pulls that are needed to explain an object's motion.

The kindergarten content expectations for physical science are meant to build on and use the early learners' ability to correctly sense some of the behaviors of simple mechanical objects and the motion of objects. The central idea is for the young learner to be able to attach appropriate language that describes motion, compares motion, and begin to develop an understanding of forces and their relationship to changes in motion. Finally the students are introduced to the concept that objects fall toward the Earth and that the force that pulls objects toward Earth affects the motion of all objects.

1st Grade

P.FM.E.3 Force- A force is either a push or a pull. The motion of objects can be changed by forces. The size of the change is related to the size of the force. The change is also related to the weight (mass) of the object on which the force is being exerted. When an object does not move in response to a force, it is because another force is being applied by the environment.
P.FM.00.31 Demonstrate pushes and pulls on objects that can move. *

P.FM.00.32 Observe that objects initially at rest will move in the
direction of the push or pull.
P.FM.00.33 Observe how pushes and pulls can change the speed or direction of moving objects.

P.FM.00.34 Observe how shape (for example: cone, cylinder, sphere) and mass of an object can affect motion.
*** * Revised expectations marked by an asterisk.**

P.FM.E.2 Gravity- Earth pulls down on all objects with a force called gravity. With very few exceptions, objects fall to the ground no matter where the object is on the Earth.
P.FM.00.21 Observe how objects fall toward the earth.

K-7 Standard P.FM: Develop an understanding that the position and/or motion of an object is relative to a point of reference.
Understand forces affect the motion and speed of an object and that the net force on an object is the total of all of the forces acting on it. Understand the Earth pulls down on objects with a force called gravity. Develop an understanding that some forces are in direct contact with objects, while other forces are not in direct contact with objects.

P.FM.E.1 Position- A position of an object can be described by locating the object relative to other objects or a background. *

P.FM.00.11 Describe the position of an object (for example: above, below, in front of, behind, on) in relation to other objects around it. *

P.FM.00.12 Describe the direction of a moving object (for example: away from or closer to) from different observers' views. *

P.FM.E.2 Gravity- Earth pulls down on all objects with a force called gravity. With very few exceptions, objects fall to the ground no matter where the object is on the Earth.

P.FM.00.21 Observe how objects fall toward the earth.

P.FM.E.3 Force- A force is either a push or a pull. The motion of objects can be changed by forces. The size of the change is related to the size of the force. The change is also related to the weight (mass) of the object on which the force is being exerted. When an object does not move in response to a force, it is because another force is being applied by the environment.

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P.FM.00.34 Observe how shape (for example: cone,

cylinder, sphere) and mass of an object can affect motion. *

2nd Grade

K-7 Standard P.PM: Develop an understanding that all matter has observable attributes with physical and chemical properties that are described, measured, and compared. Understand that states of matter exist as solid, liquid, or gas; and have physical and chemical properties. Understand all matter is composed of combinations of elements, which are organized by common attributes and characteristics on the Periodic Table. Understand that substances can be classified as mixtures or compounds and according to their physical and chemical properties.

P.PM.E.1 Physical Properties- All objects and substances have physical properties that can be measured.

P.PM.02.12 Describe objects and substances according to their properties (color, size, shape, texture, hardness, liquid or solid, sinking or floating).

P.PM.02.13 Measure the length of objects using rulers (centimeters) and meter sticks (meters).

P.PM.02.14 Measure the volume of liquids using common measuring tools (graduated measuring cups, measuring spoons, graduated cylinders, andbeakers).*

P.PM.02.15 Compare the weight of objects using balances.

3rd Grade

General

Physical Science: Motion of Objects, Energy, and Properties of Matter The previous grades have provided the students with an introduction to the understanding of motion (kindergarten), and properties of matter (first grade and second grade). The study of motion asks for students to compare and contrast motion in terms of direction and speed of an object. Using force as a push or a pull from the kindergarten expectations now builds toward the idea that when an object does not move in response to a force, it is because another force is acting on it. The force of gravity as the force that pulls objects towards the Earth is the foundation of this learning.

The third grade science content expectations introduce the concept of energy through the study of light and sound. Students explore light and how light travels in a straight path, how shadows are made, and the behavior of light through water. Students discover that different objects interact differently with light; objects can reflect, absorb, or refract light. Objects can also absorb heat energy when exposed to light.

Properties of sound are also introduced in the third grade curriculum. Students are given the opportunity to explore how different pitches are produced and sound as a result of vibrations.

Energy

K-7 Standard P.EN: Develop an understanding that there aremany forms of energy (such as heat, light, sound, and electrical)and that energy is transferable by convection,

conduction, orradiation. Understand energy can be in motion, called kinetic; or it can be stored, called potential. Develop an understanding that astemperature increases, more energy is added to asystem.Understand nuclear reactions in the sun produce light and heat forthe Earth.

P.EN.E.1 Forms of Energy- Heat, electricity, light, and sound are forms of energy.

P.EN.03.11 Identify light and sound as forms of energy.

P.EN.E.2 Light Properties- Light travels in a straight path. Shadows result from light not being able to pass through an object. When light travels at an angle from one substance to another (air and water), it changes direction.*

P.EN.03.21 Demonstrate that light travels in a straight path and that shadows are made by placing an object in a path of light. *

P.EN.03.22 Observe what happens to light when it travels from air to water (a straw half in the water and half in the air looks bent). *

P.EN.E.3 Sound- Vibrating objects produce sound. The pitch of sound varies by changing the rate of vibration.

P.EN.03.31 Relate sounds to their sources of vibrations (for example: a musical note produced by a vibrating guitar string, the sounds of a drum made by the vibrating drum head).

P.EN.03.32 Distinguish the effect of fast or slow vibrations as pitch.

PHYSICAL SCIENCE

Force and Motion

K-7 Standard P.FM: Develop an understanding that the position and/or motion of an object is relative to a point of reference. Understand forces affect the motion and speed of an object and that the net force on an object is the total of all of the forces acting on it. Understand the Earth pulls down on objects with a force called gravity. Develop an understanding that some forces are in direct contact with objects, while other forces are not in direct contact with objects.

P.FM.E.2 Gravity- Earth pulls down on all objects with a force called gravity. With very few exceptions, objects fall to the ground no matter where the object is on the Earth.

P.FM.03.22 Identify the force that pulls objects towards the Earth.

Energy

K-7 Standard P.EN: Develop an understanding that there are many forms of energy (such as heat, light, sound, and electrical) and that energy is transferable by convection, conduction, or radiation. Understand energy can be in motion, called kinetic; or it can be stored, called potential. Develop an understanding that as temperature increases, more energy is added to a system. Understand nuclear reactions in the sun produce light and heat for the Earth.

P.EN.E.1 Forms of Energy- Heat, electricity, light, and sound are forms of energy.

P.EN.03.11 Identify light and sound as forms of energy.

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P.EN.03.32 Distinguish the effect of fast or slow vibrations as pitch.

4th Grade

Physical Science: Energy, Properties of Matter, Changes in Matter
Students enter the fourth grade with prior knowledge regarding energy in the context of sound and light as examples of energy. Heat and electricity are introduced as additional forms of energy, as well as describing energy in terms of evidence of change or transfer. Students have intuitive notions that energy is necessary to get things done and that humans get energy from food. Children are not expected to understand the complex concept of energy at this level. By experimenting with light and sound (third grade) and heat, electricity and magnetism in fourth grade, students begin to recognize evidence of energy through observation and measurement of change. Through multiple experiences with simple electrical circuits, heat transfer, and magnetism, students make simple correlations and describe how heat is produced through electricity, identify conductors of heat and electricity, and explain the conditions necessary to make an electromagnet.

4 0 FOUTH GRADE SCIENCE v.1 . 0 9 MDE
The content expectations for physical science conclude with the study of properties ofmatter that can be measured and observed, states of matter, and changes in states of matter through heating and cooling.

Energy
K-7 Standard P.EN: Develop an understanding that there are many forms of energy (such as heat, light, sound, and electrical) and that energy is transferable by convection, conduction, or radiation. Understand energy can be in

motion, called kinetic; or it can be stored, called potential. Develop an understanding that as temperature increases, more energy is added to a system. Understand nuclear reactions in the sun produce light and heat for the Earth.

P.EN.E.1 Forms of Energy- Heat, electricity, light, and sound are forms of energy.

P.EN.04.12 Identify heat and electricity as forms of energy.

P.EN.E.4 Energy and Temperature- Increasing the temperature of any substance requires the addition of energy.

P.EN.04.41 Demonstrate how temperature can be increased in a substance by adding energy.

P.EN.04.42 Describe heat as the energy produced when substances burn, certain kinds of materials rub against each other, and when electricity flows through wire.

P.EN.04.43 Describe how heat is produced through electricity, rubbing, and burning.

5th Grade

Physical Science: Forces and Motion

Students participate in an in-depth study of motion as related to a point of reference, distance, time, and direction. Their exploration into motion also presents high interest content for students to hone their skills in metric measurement and the use of tools and equipment appropriate to scientific investigations. The middle school experience of investigating balanced and unbalanced forces, and their relationship to the size of change in motion, provide concrete experiences on which a more comprehensive understanding of force can be based at the high school level. Students can move from qualitative descriptions of moving objects in the elementary grades to quantitative descriptions of moving objects and the identification of the forces acting on the objects. The completion of the study in motion involves the exploration and identification of contact and non-contact forces and how they change the motion of objects. Students' everyday experiences in motion lead them to believe that friction causes all moving objects to slow down and stop. In-depth explorations into reducing the force of friction can help the students understand and demonstrate that a moving object requires friction to keep it moving. The understanding of objects at rest requires the students recognize that there are balanced forces in equilibrium, such as a book on a table or chair on the floor.

Forces and Motion

K-7 Standard P.FM: Develop an understanding that the position and/or motion of an object is relative to a point of reference. Understand forces affect the motion and speed of an object and that the net force on an object is the total

of all of the forces acting on it. Understand the Earth pulls down on objects with a force called gravity. Develop an understanding that some forces are in direct contact with objects, while other forces are not in direct contact with objects.

P.FM.M.2 Force Interactions- Some forces between objects act when the objects are in direct contact (touching), such as friction and air resistance, or when they are not in direct contact (not touching), such as magnetic force, electrical force, and gravitational force.

P.FM.05.21 Distinguish between contact forces and non-contact forces.

P.FM.05.22 Demonstrate contact and non-contact forces to change the motion of an object.

P.FM.M.3 Force- Forces have a magnitude and direction. Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The speed and/or direction of motion of an object changes when a non-zero net force is applied to it. A balanced force on an object does not change the motion of the object (the object either remains at rest or continues to move at a constant speed in a straight line).

P.FM.05.31 Describe what happens when two forces act on an object in the same or opposing directions.

P.FM.05.32 Describe how constant motion is the result of balanced (zero net) forces.

P.FM.05.33 Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

P.FM.05.34 Relate the size of change in motion to the strength of unbalanced forces and the mass of the object.

P.FM.M.4 Speed- Motion can be described by a change in position relative to a point of reference. The motion of an object can be described by its speed and the direction it is moving. The position and speed of an object can be measured and graphed as a function of time.

P.FM.05.41 Explain the motion of an object relative to its point of reference.

P.FM.05.42 Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.

P.FM.05.43 Illustrate how motion can be measured and represented on a graph.

Earth Science
P.FM.M.3 Force- Forces have a magnitude and direction. Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The speed and/or direction of motion of an object changes when a non-zero net force is applied to it. A balanced force on an object does not change the motion of the object (the object either remains at rest or continues to move at a constant speed in a straight line).

P.FM.05.31 Describe what happens when two forces act on an object in the same or opposing directions.
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P.FM.05.42 Describe the motion of an object in terms of distance,
time and direction, as the object moves, and in relationship to other objects.

P.FM.05.43 Illustrate how motion can be measured and represented on a graph.

6th Grade

P.FM.M.3 Force- Forces have a magnitude and direction. Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The speed and/or direction of motion of an object changes when a non-zero net force is applied to it. A balanced force on an object does not change the motion of the object (the object either remains at rest or continues to move at a constant speed in a straight line).

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P.FM.05.32 Describe how constant motion is the result of balanced (zero net) forces.

P.FM.05.33 Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

P.FM.05.34 Relate the size of change in motion to the strength of unbalanced forces and the mass of the object.

P.FM.M.4 Speed- Motion can be described by a change in position relative to a point of reference. The motion of an object can be described by its speed and the direction it is moving. The position and speed of an object can be measured and graphed as a function of time.

P.FM.05.41 Explain the motion of an object relative to its point of reference.

P.FM.05.42 Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.

P.FM.05.43 Illustrate how motion can be measured and represented on a graph.

S.IP.M.1 Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.

S.IP.06.11 Generate scientific questions based on observations, investigations, and research.

S.IP.06.12 Design and conduct scientific investigations.

S.IP.06.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes) appropriate to scientific investigations.

S.IP.06.14 Use metric measurement devices in an investigation.

S.IP.06.15 Construct charts and graphs from data and observations.

S.IP.06.16 Identify patterns in data.

K-7 Standard P.EN: Develop an understanding that there are many forms of energy (such as heat, light, sound, and electrical) and that energy is transferable by convection, conduction, or radiation. Understand energy can be in motion, called kinetic; or it can be stored, called potential. Develop an understanding that as temperature increases, more energy is added to a system. Understand nuclear reactions in the sun produce light and heat for the Earth.

P.EN.M.1 Kinetic and Potential Energy- Objects and substances in motion have kinetic energy. Objects and substances may have potential energy due to their relative positions in a system. Gravitational, elastic, and chemical

energy are all forms of potential energy.

P.EN.06.11 Identify kinetic or potential energy in everyday situations (for example: stretched rubber band, objects in motion, ball on a hill, food energy).

P.EN.06.12 Demonstrate the transformation between potentialand kinetic energy in simple mechanical systems (forexample: roller coasters, pendulums).

7th Grade

K-7 Standard P.EN: Develop an understanding that there are many forms of energy (such as heat, light, sound, and electrical) and that energy is transferable by convection, conduction, or radiation. Understand energy can be in motion, called kinetic; or it can be stored, called potential. Develop an understanding that as temperatu Understand nuclear reactions in the sun produce light and heat for the Earth.

P.EN.M.3 Waves and Energy-Waves have energy and transfer energy when they interact with matter. Examples of waves include sound waves, seismic waves, waves on water, and light waves.

P.EN.07.31 Identify examples of waves, including sound waves, seismic waves, and waves on water.
P.EN.07.32 Describe how waves are produced by vibrations in matter.

P.EN.07.33 Demonstrate how waves transfer energy when they interact with matter (for example: tuning fork in water, waves hitting a beach, earthquake knocking over buildings).

P.EN.M.4 Energy Transfer- Energy is transferred from a source to a receiver by radiation, conduction, and convection. When energy is transferred from one system to another, the quantity of energy before the transfer is equal to the quantity of energy after the transfer. *re increases, more energy is added to a system.