South Slave Divisional Education Council

Physics 20

Curriculum Package

February 2012

Creating Futures

2012

Unit A: Kinematics

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Focusing Questions: How do changes in position, velocity and acceleration allow us to predict the paths of moving objects and systems? How do the principles of kinematics influence the development of new mechanical technologies?	
1 GENERAL OUTCOMES: STUDENTS WILL DESCRIBE MOTION IN TERMS OF DISPLACEMENT, VELOCITY, ACCELERATION AND TIME.	
Knowledge: describe motion in terms of displacement, velocity, acceleration and time.	• Define, qualitatively and quantitatively, displacement, velocity and acceleration • Define, operationally, and compare and contrast scalar and vector quantities • Explain, qualitatively and quantitatively, uniform and uniformly accelerated motion when • Provided with written descriptions and numerical and graphical data • Interpret, quantitatively, the motion of one object relative to another, using displacement and velocity vectors • Explain, quantitatively, two-dimensional motion in a horizontal or vertical plane, using vector components.
Explain that the goal of science is knowledge about the natural world **Science, Technology and Society (STS),** (Nature of Science Emphasis)	• Identify common applications of kinematics, such as determining the average speed of a run, bike ride or car trip, or the acceleration required to launch an aircraft from a carrier
Explain that scientific knowledge is subject to change as new evidence becomes apparent and as laws and theories are tested and subsequently revised, reinforced or rejected	• Analyze lunar free fall as illustrated in a video
Explain that the process for technological development includes testing and evaluating designs and prototypes on the basis of established criteria	• Investigate the application of kinematics principles, such as determining the appropriate length of airport runways, the design of merging lanes or the timing of traffic lights.
• **SKILLS OUTCOMES**: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Identify, define and delimit questions to investigate; e.g., What are the relationships among displacement, velocity, acceleration and time? • Explain why distances are measured in different units (as the crow flies, days of travel, mileage from city centre to city centre, light years).
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Perform an experiment to demonstrate the relationships among displacement, velocity, acceleration and time, using available technologies; e.g., interval timers, photo gates • Collect information from various print and electronic sources to explain the use of kinematics concepts; e.g., the synchronization of traffic lights
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Construct graphs to demonstrate the relationships among displacement, velocity, acceleration and time for uniform and uniformly accelerated motion • Analyze a graph of empirical data to infer the mathematical relationships among displacement, velocity, acceleration and time for uniform and uniformly accelerated motion • Solve, quantitatively, projectile motion problems near Earth's surface, ignoring air resistance • Relate acceleration to the slope of, and displacement to the area under, a velocity-time graph • Analyze uniform motion examples, using computer simulations

Unit A: Kinematics

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Use appropriate International System of Units (SI) notation, fundamental and derived units and significant digits • Use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate ideas, plans and results • Use delta notation correctly when describing changes in quantities

Unit B: Dynamics

Focusing Questions:
How does the understanding of forces help humans improve or change their environment?
How do the principles of dynamics influence the development of new mechanical technologies?
What role do gravitational effects play in the universe?

1 GENERAL OUTCOMES: STUDENTS WILL EXPLAIN THE EFFECTS OF BALANCED AND UNBALANCED FORCES ON VELOCITY.

Knowledge: effects of balanced and unbalanced forces on velocity.	• Explain that a nonzero net force causes a change in velocity • Apply Newton's first law of motion to explain, qualitatively, an object's state of rest or uniform motion • Apply Newton's second law of motion to explain, qualitatively, the relationships among net force, mass and acceleration • Apply Newton's third law of motion to explain, qualitatively, the interaction between two objects, recognizing that the two forces, equal in magnitude and opposite in direction, do not act on the same object • Explain, qualitatively and quantitatively, static and kinetic forces of friction acting on an object • Calculate the resultant force, or its constituents, acting on an object by adding vector components graphically and algebraically • Apply Newton's laws of motion to solve, algebraically, linear motion problems in horizontal, vertical and inclined planes near the surface of Earth, ignoring air resistance.
Explain that the goal of technology is to provide solutions to practical problems, that technological development includes testing and evaluating designs and prototypes on the basis of established criteria, and that the products of technology cannot solve all problems **Specific Outcomes for Science, Technology and Society (STS)** (Social and Environmental Contexts Emphasis)	• Assess the design and use of injury-prevention devices in cars and sports in terms of Newton's laws of motion • Explain how buffalo jumps represented a technological solution to food supply problems and describe the advantages and limitations of such a technique
Explain that science and technology are developed to meet societal needs and that society provides direction for scientific and technological development	• Discuss the use of seat belts in school buses
Explain that scientific knowledge and theories develop through hypotheses, the collection of evidence, investigation and the ability to provide explanations	• Analyze the trajectory of lunar dust particles as illustrated in a video

Unit B: Dynamics

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Identify questions to investigate arising from practical problems; e.g., What are the relationships among acceleration, mass and force acting on a moving object?
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Conduct experiments to determine relationships among force, mass and acceleration, using available technologies; e.g., using interval timers or motion sensors to gather data • Research the use of kinematics and dynamics principles in everyday life; e.g., research traffic accident investigation methods, using the Internet and/or interviews
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Analyze a graph of empirical data to infer the mathematical relationships among force, mass and acceleration • Use free-body diagrams to describe the forces acting on an object
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Select and use appropriate numeric, symbolic, graphical or linguistic modes of representation to communicate findings and conclusions
2 GENERAL OUTCOMES: STUDENTS WILL EXPLAIN THAT GRAVITATIONAL EFFECTS EXTEND THROUGHOUT THE UNIVERSE	
Knowledge: explain that gravitational effects extend throughout the universe	• Identify the gravitational force as one of the fundamental forces in nature • Describe, qualitatively and quantitatively, Newton's law of universal gravitation • Explain, qualitatively, the principles pertinent to the Cavendish experiment used to determine the universal gravitational constant, G • Define the term "field" as a concept that replaces "action at a distance" and apply the concept to describe gravitational effects • Relate, qualitatively and quantitatively, using Newton's law of universal gravitation, the gravitational constant to the local value of the acceleration due to gravity • Predict, quantitatively, differences in the weight of objects on different planets
Explain that concepts, models and theories are often used in interpreting and explaining observations and in predicting future observations **Science, Technology and Society (STS),** (Nature of Science Emphasis)	• Compare apparent weightlessness and zero net gravity • Investigate the existence and shape of globular star clusters • Explain tidal forces on Earth • Describe the forces required to accelerate the Mars rover on Earth and on Mars • Explore the evolution of theories of gravity, using different worldviews.
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Identify, define and delimit questions to investigate; e.g., What is the relationship between the local value of the acceleration due to gravity and the gravitational field strength?

Unit B: Dynamics

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Determine, empirically, the local value of the acceleration due to gravity • Explore the relationship between the local value of the acceleration due to gravity and the gravitational field strength
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• List the limitations of mass-weight determinations at different points on Earth's surface • Treat acceleration due to gravity as uniform near Earth's surface
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Select and use appropriate numeric, symbolic, graphical or linguistic modes of representation to communicate findings and conclusions

Unit C: Circular Motion, Work and Energy

Focusing Questions:
What conditions are necessary to maintain circular motion?
How does an understanding of conservation laws contribute to an understanding of the universe?
How can mechanical energy be transferred and transformed?

1 GENERAL OUTCOMES: STUDENTS WILL EXPLAIN CIRCULAR MOTION, USING NEWTON'S LAWS OF MOTION

Knowledge explain circular motion, using Newton's laws of motion	• Describe uniform circular motion as a special case of two-dimensional motion • Explain, qualitatively and quantitatively, that the acceleration in uniform circular motion is directed toward the centre of a circle • Explain, quantitatively, the relationships among speed, frequency, period and radius for circular motion • Explain, qualitatively, uniform circular motion in terms of Newton's laws of motion • Explain, quantitatively, planetary and natural and artificial satellite motion, using circular motion to approximate elliptical orbits • Predict the mass of a celestial body from the orbital data of a satellite in uniform circular motion around the celestial body • Explain, qualitatively, how Kepler's laws were used in the development of Newton's law of universal gravitation.
Explain that the process of scientific investigation includes analyzing the evidence and providing explanations based upon scientific theories and concepts **Specific Outcomes for Science, Technology and Society (STS)** (Nature of Science Emphasis)	• Examine the role of orbital perturbations in the discovery of outer planets • Examine the evidence for extra-solar planets
Explain how science and technology are developed to meet societal needs and expand human capability	• Explain the functions, applications and societal impacts of geosynchronous satellites

Unit C: Circular Motion, Work and Energy

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Explain that the goal of technology is to provide solutions to practical problems; analyze the principles and applications of circular motion in daily situations	• Analyze the principles and applications of circular motion in daily situations • Explain the use of a centrifuge in industry or research • Explain the motion of a car moving with constant speed through a curve • Explain the motion of carnival or playground rides moving in a horizontal plane and/or a vertical plane • Explain the operation of a potter's wheel.
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Design an experiment to investigate the relationships among orbital speed, orbital radius, acceleration and force in uniform circular motion (IP–NS2) • Explore design characteristics of structures that facilitate circular motion; e.g., How is banking used on a racetrack to make high-speed turns safer?
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Perform an experiment to investigate the relationships among net force acting on an object in uniform circular motion and the object's frequency, mass, speed and path radius
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Organize and interpret experimental data, using prepared graphs or charts • Construct graphs to show relationships among frequency, mass, speed and Path radius • Summarize an analysis of the relationships among frequency, mass, speed and path radius • Solve, quantitatively, circular motion problems in both horizontal and vertical planes, using algebraic and/or graphical vector analysis
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Select and use appropriate numeric, symbolic, graphical or linguistic modes of representation to communicate findings and conclusions
2 GENERAL OUTCOMES: STUDENTS WILL EXPLAIN THAT WORK IS A TRANSFER OF ENERGY AND THAT CONSERVATION OF ENERGY IN AN ISOLATED SYSTEM IS A FUNDAMENTAL PHYSICAL CONCEPT	
Knowledge: Explain that work is a transfer of energy and that conservation of energy in an isolated system is a fundamental physical concept	• Define mechanical energy as the sum of kinetic and potential energy • Determine, quantitatively, the relationships among the kinetic, gravitational potential and total mechanical energies of a mass at any point between maximum potential energy and maximum kinetic energy • Analyze, quantitatively, kinematics and dynamics problems that relate to the conservation of mechanical energy in an isolated system • Recall work as a measure of the mechanical energy transferred and power as the rate of doing work • Describe power qualitatively and quantitatively • Describe, qualitatively, the change in mechanical energy in a system that is not isolated

Unit C: Circular Motion, Work and Energy

<table>
<tr><th>Specific Outcomes</th><th>Achievement Indicators – Measurable outcomes</th></tr>
<tr><td>It is expected that students will:</td><td>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</td></tr>
<tr><td>Explain that concepts, models and theories are often used in interpreting and explaining observations and in predicting future observations
Specific Outcomes for Science, Technology and Society (STS) (Nature of Science Emphasis)</td><td>• Estimate the energy released during a meteoritic impact with Earth's surface
• Analyze the gravitational collapse of a star
• Examine how a planet can provide a gravity assist to a space probe
• Analyze the transformation of kinetic and potential energy of an orbiting object at perihelion and aphelion</td></tr>
<tr><td>Explain that the products of technology are devices, systems and processes that meet given needs; however, these products cannot solve all problems</td><td>• Evaluate the design and efficiency of energy transfer devices in terms of the relationships among mechanical energy, work and power
• Analyze the use of irrigation systems and water wheels used by different cultures, such as the Incas</td></tr>
<tr><td>Evaluate whether Canadian society supports scientific research and technological development to facilitate a sustainable society, economy and environment</td><td>• Investigate and report on a technology developed to improve the efficiency of energy transfer as a means of reconciling the energy needs of society with its responsibility to protect the environment and to use energy judiciously.</td></tr>
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Unit D: Oscillatory Motion and Mechanical Waves

Focusing Questions:
What are examples of oscillatory motion in the world around us?
How do mechanical waves transmit energy?
How is structural design and the development of technologies influenced by our understanding of wave properties?

1 GENERAL OUTCOMES: STUDENTS WILL DESCRIBE THE CONDITIONS THAT PRODUCE OSCILLATORY MOTION.

<table>
<tr><td>Knowledge: Describe the conditions that produce oscillatory motion.</td><td>• Describe oscillatory motion in terms of period and frequency
• Define simple harmonic motion as a motion due to a restoring force that is directly proportional and opposite to the displacement from an equilibrium position
• Explain, quantitatively, the relationships among displacement, acceleration, velocity and time for simple harmonic motion, as illustrated by a frictionless, horizontal mass-spring system or a pendulum, using the small-angle approximation
• Determine, quantitatively, the relationships among kinetic, gravitational potential and total mechanical energies of a mass executing simple harmonic motion
• Define mechanical resonance</td></tr>
<tr><td>Explain that the goal of science is knowledge about the natural world
Specific Outcomes for Science, Technology and Society (STS) (Nature of Science Emphasis)</td><td>• Analyze, qualitatively, the forces in real-life examples of simple harmonic motion:
o Action of springs in vehicle suspensions
o Mechanical resonance in cars, bridges and buildings
o Seismic waves in Earth's crust
• Relate the fundamental frequency and amplitude of a vibrating drum membrane to its properties.</td></tr>
<tr><td colspan="2">SKILLS OUTCOMES: (embed throughout the unit)</td></tr>
<tr><td>Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues</td><td>• Design an experiment to demonstrate that simple harmonic motion can be observed within certain limits, relating the frequency and period of the motion to the physical characteristics of the system; e.g., a frictionless horizontal mass-spring system or a pendulum
• Predict the conditions required for mechanical resonance</td></tr>
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Unit D: Oscillatory Motion and Mechanical Waves

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Perform an experiment to determine the relationship between the length of a pendulum and its period of oscillation • Perform an experiment to illustrate the phenomenon of mechanical resonance • Perform an experiment to determine the spring constant of a spring
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Relate the length of a pendulum to its period of oscillation • Ask if the mass of the pendulum bob is a factor in the pendulum's period of oscillation
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Select and use appropriate numeric, symbolic, graphical or linguistic modes of representation to communicate findings and conclusions
2 GENERAL OUTCOME: STUDENTS WILL DESCRIBE THE PROPERTIES OF MECHANICAL WAVES AND EXPLAIN HOW MECHANICAL WAVES TRANSMIT ENERGY.	
Knowledge: describe the properties of mechanical waves and explain how mechanical waves transmit energy.	• Describe mechanical waves as particles of a medium that are moving in simple harmonic motion • Compare and contrast energy transport by matter and by waves • Define longitudinal and transverse waves in terms of the direction of motion of the medium particles in relation to the direction of propagation of the wave • Define the terms wavelength, wave velocity, period, frequency, amplitude, wave front and ray as they apply to describing transverse and longitudinal waves • Describe how the speed of a wave depends on the characteristics of the medium • Predict, quantitatively, and verify the effects of changing one or a combination of variables in the universal wave equation ($v = f\lambda$) • Explain, qualitatively, the phenomenon of reflection as exhibited by mechanical waves • Explain, qualitatively, the conditions for constructive and destructive interference of waves and for acoustic resonance • Explain, qualitatively and quantitatively, the doppler effect on a stationary observer of a moving source.
Explain that the goal of technology is to provide solutions to practical problems **Specific Outcomes for Science, Technology and Society (STS)** (Science & Technology Emphasis)	• Investigate the application of acoustic phenomena in recreation, medicine, industry and technology (sonography, ultrasound, sonar, pipe organs, wind and brass instruments, noise-reduction devices, noise-measurement devices) • Describe the properties of waves that can be used to manipulate direction and speed when travelling (surfing, canoeing or kayaking) in rivers or oceans.
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Predict the conditions required for constructive and destructive interference to occur

Unit D: Oscillatory Motion and Mechanical Waves

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Draw wave-front and ray diagrams • Draw a wave-front diagram of a two-point source interference pattern • Perform an experiment to illustrate the phenomenon of acoustic resonance
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Determine the speed of a mechanical wave; e.g., water waves and sound waves • Relate apparent changes in wavelength and frequency to the speed of the source relative to the observer
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Select and use appropriate numeric, symbolic, graphical or linguistic modes of representation to communicate findings and conclusions