Science

Science Grade 11

Curriculum Map

Topic B: Changes in Motion

Resources Included: *Academic One File, Canada in Context, Science in Context*

Betty-Lou Ayers
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User Guide

Curricular Topic

(taken from Alberta Education's Program of Studies)

"Title." (hyperlinked) *Publication:* Author, Publication Date/Info. pg. ORC Database. Date located.

If you have any questions regarding this guide or if you would like a guide for additional grades please contact Bethany Arsenault, ORC Coordinator at barsenault@thealbertalibrary.ab.ca

Topic A: Chemical Changes

Themes
Change, Energy and Systems

Overview
Motion is an important aspect of our lives, and the understanding of the effects of force on motion has many technological applications. Students learn that these applications can range from the design of safer roads and sports equipment to the investigation of traffic accidents. In this unit, students investigate the concepts of displacement, velocity, acceleration, force, momentum and mechanical energy and consider the relationships among them.

Focusing Questions
How does the design of safety equipment and systems take into account concepts of changes in motion and forces? What has been the influence of society on the development of safety technology, and what are the contextual constraints and limits of these technological solutions?

Students will:
- describe one-dimensional motion of objects in terms of displacement, time, velocity and acceleration
- describe and analyze the law of conservation of momentum for one-dimensional collisions and change in momentum (impulse) to explain how force affects motion.

Key Concepts
The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.
- displacement, time, velocity, acceleration
- conservation of momentum in one dimension
- impulse and force
- Newton's laws of motion
- application of laws of motion and principles of momentum in the design of sports and transportation safety devices

General Outcome 1

***Students will* describe one-dimensional motion of objects in terms of displacement, time, velocity and acceleration.**

Specific Outcomes for Knowledge
Students will:

- distinguish between scalar and vector quantities, including distance and displacement, speed and velocity
- define velocity and acceleration as $\vec{v} = \Delta\vec{d} / \Delta t$ and $\vec{a} = \Delta\vec{v} / \Delta t$ respectively
- compare and contrast displacement in uniform motion and uniformly accelerated motion, using the following relationships: $\Delta\vec{d} = \vec{v}_i \Delta t + \frac{1}{2}\vec{a}\Delta t$ and $\Delta\vec{d} = \frac{(\vec{v}_i + \vec{v}_f)}{2}\Delta t$.

Specific Outcomes for Science, Technology and Society (STS) (Science and Technology Emphasis)

Students will:

- explain that the goal of technology is to provide solutions to practical problems
  - *apply principles of one-dimensional uniform motion to relevant traffic safety design features, such as safe lengths of freeway entrance and exit ramps, traffic lights with advance warning flashers, types of intersections and length of time lights stay yellow*
  - *analyze the design of stop-and-go zones and propose improvements to the design of traffic lights and intersections*
- explain that science and technology have influenced, and been influenced by, historical development and societal needs
  - *describe the influence of societal perceptions of risk and the influence of scientific knowledge on the development of safety technologies designed to control changes in motion.*

Specific Outcomes for Skills (Science and Technology Emphasis)

Initiating and Planning
Students will:

- formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues
- *determine what needs to be measured and select the proper procedures, tools and technologies for investigating the relationships among displacement, velocity and acceleration* (IP-
- *design a study to assess the design of traffic lights and intersections*

Performing and Recording
Students will:

- conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
- conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
- use technologies effectively and accurately for collecting data on motion; *e.g., photogate, computer-based laboratories, stopwatches, weighing balances*
- *use library and electronic research tools to collect information in determining risks associated with sporting activities and transportation-related activities*

Analyzing and Interpreting
Students will:

- analyze data and apply mathematical and conceptual models to develop and assess possible solutions
- analyze position-time and velocity-time graphs to infer the relationships among displacement, velocity and acceleration
- solve, quantitatively, one-dimensional uniform motion and uniformly accelerated motion problems using $\Delta\vec{d}=\vec{v}_i\Delta t+\frac{1}{2}\vec{a}\Delta t$ and $\Delta\vec{d}=\frac{(\vec{v}_i+\vec{v}_f)}{2}\Delta t$

Communication and Teamwork
Students will:

- work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

- *use advanced menu features within a word processor to insert tables, graphs, text and graphics into a report*

General Outcome 2

***Students will* describe and analyze the law of conservation of momentum for one-dimensional collisions and change in momentum (impulse) to explain how force affects motion.**

Specific Outcomes for Knowledge
Students will:

- define momentum as a vector quantity equal to the product of the mass and velocity of an object $(\vec{p} = m\vec{v})$
- apply the law of conservation of momentum to one-dimensional collisions and explosions
- define change in momentum as impulse $(\Delta\vec{p} = m\Delta\vec{v} = \vec{F}_{ave}\Delta t)$, relate impulse to acceleration and Newton's second law of motion $(\Delta\vec{p}/\Delta t = m\vec{a} = \vec{F})$ and apply the concept of impulse to explain the functioning of a variety of safety devices; *e.g., air bags, collapsible frames, bumpers, seat belts in cars, restraining nets and crash barriers on highways, collapsible steering wheels, padded dashboards, padded helmets, padded goggles and padded gloves, all of which are designed to increase the stopping time or time of contact by reducing acceleration and, thereby, force*
- explain how an unbalanced force causes change in motion and apply Newton's first law of motion to explain an object's state of rest or uniform motion; *e.g., movement of passengers in a moving car that accelerates or is coming to a stop*
- apply Newton's second law of motion and use it to relate force, mass and motion; *e.g., as an explanation of a whiplash injury from a rear-end collision*
- apply Newton's third law of motion to explain the interaction between two objects; *e.g., collision between two cars*
- relate, quantitatively, potential and kinetic energy to work done.

Specific Outcomes for Science, Technology and Society (STS) (Science and Technology Emphasis)

Students will:

- explain that the goal of technology is to provide solutions to practical problems
- *explain the need for safety technologies and regulations for transportation and sporting situations*
- *trace the development of safety technologies in sports or transportation over the past 50 years, and compare the functioning of first- and current-generation safety technologies, such as sports safety equipment (helmets, shin guards, gloves) and automobile safety devices (lap belts, shoulder belts, air bags)*
- explain that decisions regarding the application of scientific and technological development involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations
- *analyze automobile and sports equipment safety features with a view to reducing risks within contextual constraints, such as costs, materials, weight, requirements for sustainability, rules and regulations*
- explain that the appropriateness, risks and benefits of technologies need to be assessed for each potential application from a variety of perspectives, including sustainability
- *list and assess the risks in a variety of day-to-day transportation and sporting situations, and describe the technologies designed to reduce the risk of injury.*

Specific Outcomes for Skills (Science and Technology Emphasis)

Initiating and Planning

Students will:

- formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues
- identify questions to investigate that arise from practical problems and issues; *e.g., "How can sports equipment be made to increase its protective capacity?", "Do you increase protection or change the rules to make sports such as soccer or hockey safer?"*
- *use spreadsheets to analyze the law of conservation of momentum*

Performing and Recording
Students will:

- conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
- compile and organize data on the risk of injury and death related to seat belt and air bag use
- *test materials for use as seat belts or as padding for sports equipment*

Analyzing and Interpreting
Students will:

- analyze data and apply mathematical and conceptual models to develop and assess possible solutions
- solve one-dimensional collision and explosion problems, using scale diagrams and numerical calculations; *e.g., apply* $m_1\vec{v}_1 + m_2\vec{v}_2 = m_1\vec{v}_1' + m_2\vec{v}_2'$ *to traffic accidents involving two vehicles*
- *delineate cause and effect or correlation among the use of seat belts or air bags, seat belt legislation and reduction of fatalities*
- *suggest a variety of alternatives to reduce whiplash injury caused by rear-end collisions and evaluate each alternative*
- *develop criteria and use them to assess a device for reducing whiplash injury*

Communication and Teamwork
Students will:

- work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
- *consult a wide variety of sources that reflect varied viewpoints on particular topics, such as legislation of seat belt use*
- *work cooperatively with team members, using library and electronic research tools to collect information in determining risks associated with sports- and transportation-related activities*

Section 1: General Topic Headings

Conservation Laws: *Science in Context*. Topic Page/Definition, with links to reference articles, news, magazines, academic journals, images, videos, audio and websites.

Energy (Physics): *Canada in Context*. Topic Page/Definition, with links to reference articles, news, magazines, academic journals, images, videos, audio and websites.

Force: *Science in Context*. Topic Page/Definition, with links to reference articles, news, magazines, academic journals, images, videos, audio and websites.

Laws of Motion: *Science in Context*. Topic Page/Definition, with links to reference articles, news, magazines, academic journals, images, videos, audio and websites.

Velocity: *Science in Context*. Topic Page/Definition, with links to reference articles, news, magazines, academic journals, images, videos, audio and websites.

Section 2: Definitions

"Acceleration." *UXL Encyclopedia of Science*. Ed. Amy Hackney Blackwell and Elizabeth Manar. 3rd ed. Farmington Hills, MI: UXL, 2015. *Science in Context*. Web. 31 Aug. 2015.

Image: "Clay shooting illustrates linear momentum conservation." *The Gale Encyclopedia of Science*. Ed. K. Lee Lerner and Brenda Wilmoth Lerner. 5th ed. Farmington Hills, MI: Gale, 2014. *Science in Context*. Web. 12 Aug. 2015.

"Force." *The Gale Encyclopedia of Science*. Ed. K. Lee Lerner and Brenda Wilmoth Lerner. 5th ed. Farmington Hills, MI: Gale, 2014. *Science in Context*. Web. 31 Aug. 2015.

"Linear momentum." *World of Physics*. Gale, 2001. *Science in Context*. Web. 12 Aug. 2015.

"Momentum." *World of Scientific Discovery*. Gale, 1999. *Science in Context*. Web. 31 Aug. 2015.

"Motion." *World of Physics*. Gale, 2001. *Science in Context*. Web. 31 Aug. 2015.

"Moving objects and velocity." *World of Physics*. Gale, 2001. *Science in Context*. Web. 31 Aug. 2015.

"Velocity." *The Gale Encyclopedia of Science*. Ed. K. Lee Lerner and Brenda Wilmoth Lerner. 5th ed. Farmington Hills, MI: Gale, 2014. *Science in Context*. Web. 31 Aug. 2015.

Section 3: Articles

"A Three-Dimensional Finite Element Model Of The Cervical Spine: An Investigation Of Whiplash Injury." *Medical & Biological Engineering & Computing* 49.2 (2011): 193. *Academic One File*. Web. 24 Aug. 2017.

"Automated highway system." *World of Invention*. Gale, 2006. *Science in Context*. Web. 10 Aug. 2015.

"Ice hockey: Forces in the check." *World of Sports Science*. Ed. K. Lee Lerner and Brenda Wilmoth Lerner. Detroit: Gale, 2007. *Science in Context*. Web. 12 Aug. 2015.

"Inspiration from the world's best road safety videos." *Bulletin of the World Health Organization* Nov. 2014: 776. *Science in Context*. Web. 10 Aug. 2015.

"Heavy hitting: concussions and safety law." *CMAJ: Canadian Medical Association Journal* 4 Sept. 2012: E641+. *Science in Context*. Web. 12 Aug. 2015.

"Helmet Sensors Try to Answer if Football Can Ever Be Safe; The question isn't, 'Is football dangerous?' It's, 'Can it ever be safe?'." *Newsweek* 15 May 2015. *Science in Context*. Web. 10 Aug. 2015.

"Lights, camera, vehicle safety." *Mechanical Engineering-CIME* Feb. 2015: 12+. *Science in Context*. Web. 10 Aug. 2015.

Online Library of Road Safety Mass Media Campaigns. *World Health Organization.* Web. 10 Aug. 2015.
Countries interested in launching a new road safety campaign can now refer to a unique collection of 60 public information videos in nine languages from 13 countries, considered some of the best in the world.

"Plastics take the lead in sports safety and performance." *Plastics Engineering* Sept. 2013: 38+. *Science in Context*. Web. 12 Aug. 2015.

"Safety Performance Of Freeway Sections And Relation To Length Of Speed-Change Lanes." *Canadian Journal Of Civil Engineering* 35.5 (2008): 531. *Academic One File*. Web. 24 Aug. 2017.
The design of **freeway** entrances and exits requires managing the high operating speeds on the through lanes and the intense lane-change manoeuvres due to merging and diverging. Therefore, adequate lengths between these entrances and exits and provision of adequate speed-change lanes would help drivers execute such tasks safely.

"Sports safety and kids: Plastics contribute to 46% decline in children's deaths resulting from unintentional Injuries. (APC News)." *Plastics Engineering* July 2001: 14+. *Science in Context*. Web. 12 Aug. 2015.

"Why is it so hard to stop sports concussions?" *American Scientist* 102.5 (2014): 346+. *Science in Context*. Web. 10 Aug. 2015.

SEAT BELTS:
"Safety belt." *World of Invention*. Gale, 2006. *Science in Context*. Web. 12 Aug. 2015.

AIR BAGS
"Airbag, automobile." *World of Invention*. Gale, 2006. *Science in Context*. Web. 12 Aug. 2015.

"Airbag, automobile." *UXL Science*. Detroit: UXL, 2008. *Science in Context*. Web. 12 Aug. 2015.

"Way beyond airbags." *New Scientist* 186.2495 (2005): 25. *Science in Context*. Web. 12 Aug. 2015

AUTOMOBILE ACCIDENTS
"Automobile accidents." *World of Forensic Science*. Ed. K. Lee Lerner and Brenda Wilmoth Lerner. Detroit: Gale, 2006. *Science in Context*. Web. 12 Aug. 2015.

ACCIDENT RECONSTRUCTION
"Accident reconstruction." *World of Forensic Science*. Ed. K. Lee Lerner and Brenda Wilmoth Lerner. Detroit: Gale, 2006. *Science in Context*. Web. 12 Aug. 2015.

AUTOMOBILE SAFETY
"Car-to-car communication: a simple wireless technology promises to make driving much safer." *Technology Review* [Cambridge, Mass.] Mar.-Apr. 2015: 38+. *Science in Context*. Web. 12 Aug. 2015.

"Eyes on the road: two new sensor-based safety systems lead toward the crash-proof car." *Popular Science* Aug. 2011: 18. *Science in Context*. Web. 12 Aug. 2015.

"Government Backs Up On Rearview Car Cameras." *Morning Edition* 2 Mar. 2012. *Science in Context*. Web. 12 Aug. 2015.

"In the car, safety tech is the driving concern." *USA Today* 23 Apr. 2015: 03B. *Science in Context*. Web. 12 Aug. 2015.

"Motor vehicle safety." *World of Health*. Gale, 2007. *Science in Context*. Web. 12 Aug. 2015.

"A Sharper Picture for Night Vision." *New York Times* 7 Dec. 2014: 2(L). *Science in Context*. Web. 12 Aug. 2015.

"Yes, Your New Car Has A 'Black Box.' Where's The Off Switch?" *All Things Considered* 20 Mar. 2013. *Science in Context*. Web. 12 Aug. 2015.