Grade 11: A Deeper Understanding of Energy

Curriculum Connections

Energy and Society

IP = Initiating and Planning, PR = Performing and Recording, AI = Analysing and Interpreting, C = Communicating

Physics Curriculum Connections (SPH3U)
Activity 1: The Conservation and Transformation of Energy
Scientific Investigation Skills and Career Exploration
– **A1.1** formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research [IP]
– **A1.2** select appropriate instruments (e.g., probeware, calorimeters, pendulums, solenoids) and materials (e.g., drag sleds, electric bells, balls, ramps), and identify appropriate methods, techniques, and procedures, for each inquiry [IP]
– **A1.5** conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data [PR]
– **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data; solve problems involving quantitative data; determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and/or error; and suggest improvements to the inquiry to reduce the likelihood of error [AI]
– **A1.10** draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge [AI]
– **A1.11** communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models) [C]
– **A1.13** express the results of any calculations involving data accurately and precisely, to the appropriate number of decimal places or significant figures [C]
Energy and Society
– **D2.1** use appropriate terminology related to energy transformations, including, but not limited to: *mechanical energy*, *gravitational potential energy*, *kinetic energy*, *work*, *power*, *fission*, *fusion*, *heat*, *heat capacity*, *temperature*, and *latent heat* [C]
– **D2.3** use the law of conservation of energy to solve problems in simple situations involving work, gravitational potential energy, kinetic energy, and thermal energy and its transfer (heat) [AI]
– **D2.4** plan and conduct inquiries involving transformations between gravitational potential energy and kinetic energy (e.g., using a pendulum, a falling ball, an object rolling down a ramp) to test the law of conservation of energy [IP, PR]
– **D3.1** describe a variety of energy transfers and transformations, and explain them using the law of conservation of energy
– **D3.2** explain the concepts of and interrelationships between energy, work, and power, and identify and describe their related units
– **D3.3** explain the following concepts, giving examples of each, and identify their related units: *thermal energy*, *kinetic energy*, *gravitational potential energy*, *heat, specific heat capacity*, *specific latent heat*, *power*, and *efficiency*

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Activity 2: Innovative Technologies

Scientific Investigation Skills and Career Exploration

- **A1.1** formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research [IP]
- **A1.3** identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately [IP]
- **A1.5** conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data [PR]
- **A1.6** compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables [PR]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data; solve problems involving quantitative data; determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and/or error; and suggest improvements to the inquiry to reduce the likelihood of error [AI]
- **A1.9** analyse the information gathered from research sources for logic, accuracy, reliability, adequacy, and bias [AI]
- **A1.10** draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge [AI]
- **A1.11** communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models) [C]
- **A1.12** use appropriate numeric (e.g., SI and imperial units), symbolic, and graphic modes of representation for qualitative and quantitative data (e.g., vector diagrams, free-body diagrams, algebraic equations) [C]
- **A1.13** express the results of any calculations involving data accurately and precisely, to the appropriate number of decimal places or significant figures [C]

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- **D1.1** analyse, using the principles of energy transformations, a technology that involves the transfer and transformation of thermal energy (e.g., a power station, an air conditioner, a fuel cell, a laser printer) [AI, C]
- **D2.1** use appropriate terminology related to energy transformations, including, but not limited to: *mechanical energy*, *gravitational potential energy*, *kinetic energy*, *work*, *power*, *fission*, *fusion*, *heat*, *heat capacity*, *temperature*, and *latent heat* [C]
- **D2.3** use the law of conservation of energy to solve problems in simple situations involving work, gravitational potential energy, kinetic energy, and thermal energy and its transfer (heat) [AI]
- **D2.4** plan and conduct inquiries involving transformations between gravitational potential energy and kinetic energy (e.g., using a pendulum, a falling ball, an object rolling down a ramp) to test the law of conservation of energy [IP, PR]
- **D2.5** solve problems involving the relationship between power, energy, and time [AI]
- **D2.7** compare and contrast the input energy, useful output energy, and per cent efficiency of selected energy generation methods (e.g., hydroelectric, thermal, geothermal, nuclear fission, nuclear fusion, wind, solar) [AI, C]
- **D3.1** describe a variety of energy transfers and transformations, and explain them using the law of conservation of energy
- **D3.2** explain the concepts of and interrelationships between energy, work, and power, and identify and describe their related units
- **D3.3** explain the following concepts, giving examples of each, and identify their related units: *thermal energy*, *kinetic energy*, *gravitational potential energy*, *heat, specific heat capacity*, *specific latent heat*, *power*, and *efficiency*
- **D3.4** identify, qualitatively, the relationship between efficiency and thermal energy transfer

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Activity 3: Nuclear Transformations

Scientific Investigation Skills and Career Exploration

- **A1.1** formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research [IP]
- **A1.3** identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately [IP]
- **A1.4** apply knowledge and understanding of safe laboratory practices and procedures when planning investigations by correctly interpreting Workplace Hazardous Materials Information System (WHMIS) symbols; by using appropriate techniques for handling and storing laboratory equipment and materials and disposing of laboratory materials; and by using appropriate personal protection [IP]
- **A1.5** conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data [PR]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data; solve problems involving quantitative data; determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and/or error; and suggest improvements to the inquiry to reduce the likelihood of error [AI]
- **A1.10** draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge [AI]
- **A1.12** use appropriate numeric (e.g., SI and imperial units), symbolic, and graphic modes of representation for qualitative and quantitative data (e.g., vector diagrams, free-body diagrams, algebraic equations) [C]
- **A2.1** identify and describe a variety of careers related to the fields of science under study (e.g., theoretical physicist; communications, networks, and control systems professional; engineer; metallurgist) and the education and training necessary for these careers

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- **D1.2** assess, on the basis of research, how technologies related to nuclear, thermal, or geothermal energy affect society and the environment (e.g., thermal regulating units, radiopharmaceuticals, dry-steam power plants, ground-source heat pumps) [IP, PR, AI, C]
- **D2.1** use appropriate terminology related to energy transformations, including, but not limited to: *mechanical energy*, *gravitational potential energy*, *kinetic energy*, *work*, *power*, *fission*, *fusion*, *heat*, *heat capacity*, *temperature*, and *latent heat* [C]
- **D2.3** use the law of conservation of energy to solve problems in simple situations involving work, gravitational potential energy, kinetic energy, and thermal energy and its transfer (heat) [AI]
- **D2.8** investigate the relationship between the concepts of conservation of mass and conservation of energy, and solve problems using the mass–energy equivalence [PR, AI]
- **D3.5** describe, with reference to force and displacement along the line of force, the conditions that are required for work to be done
- **D3.9** identify and describe the structure of common nuclear isotopes (e.g., hydrogen, deuterium, tritium)
- **D3.10** compare the characteristics of (e.g., mass, charge, speed, penetrating power, ionizing ability) and safety precautions related to alpha particles, beta particles, and gamma rays

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Activity 4: Ionizing Radiation

Scientific Investigation Skills and Career Exploration

- **A1.1** formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research [IP]
- **A1.3** identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately [IP]
- **A1.5** conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data [PR]
- **A1.6** compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables [PR]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data; solve problems involving quantitative data; determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and/or error; and suggest improvements to the inquiry to reduce the likelihood of error [AI]
- **A1.10** draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge [AI]
- **A2.1** identify and describe a variety of careers related to the fields of science under study (e.g., theoretical physicist; communications, networks, and control systems professional; engineer; metallurgist) and the education and training necessary for these careers
- **A2.2** describe the contributions of scientists, including Canadians (e.g., Richard E. Taylor, Leonard T. Bruton, Willard S. Boyle, Martha Salcudean, Harriet Brooks, Louis Slotin), to the fields under study

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- **D1.2** assess, on the basis of research, how technologies related to nuclear, thermal, or geothermal energy affect society and the environment (e.g., thermal regulating units, radiopharmaceuticals, dry-steam power plants, ground-source heat pumps) [IP, PR, AI, C]
- **D2.1** use appropriate terminology related to energy transformations, including, but not limited to: *mechanical energy*, *gravitational potential energy*, *kinetic energy*, *work*, *power*, *fission*, *fusion*, *heat*, *heat capacity*, *temperature*, and *latent heat* [C]
- **D3.2** explain the concepts of and interrelationships between energy, work, and power, and identify and describe their related units
- **D3.8** distinguish between and provide examples of conduction, convection, and radiation
- **D3.10** compare the characteristics of (e.g., mass, charge, speed, penetrating power, ionizing ability) and safety precautions related to alpha particles, beta particles, and gamma rays

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Activity 5: Mass-Energy Equivalence

Scientific Investigation Skills and Career Exploration

- **A1.1** formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research [IP]
- **A1.5** conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data [PR]
- **A1.6** compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables [PR]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data; solve problems involving quantitative data; determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and/or error; and suggest improvements to the inquiry to reduce the likelihood of error [AI]
- **A1.10** draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge [AI]
- **A1.11** communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models) [C]
- **A1.12** use appropriate numeric (e.g., SI and imperial units), symbolic, and graphic modes of representation for qualitative and quantitative data (e.g., vector diagrams, free-body diagrams, algebraic equations) [C]
- **A1.13** express the results of any calculations involving data accurately and precisely, to the appropriate number of decimal places or significant figures [C]
- **A2.1** identify and describe a variety of careers related to the fields of science under study (e.g., theoretical physicist; communications, networks, and control systems professional; engineer; metallurgist) and the education and training necessary for these careers

Energy and Society

- **D2.1** use appropriate terminology related to energy transformations, including, but not limited to: *mechanical energy*, *gravitational potential energy*, *kinetic energy*, *work*, *power*, *fission*, *fusion*, *heat*, *heat capacity*, *temperature*, and *latent heat* [C]
- **D2.3** use the law of conservation of energy to solve problems in simple situations involving work, gravitational potential energy, kinetic energy, and thermal energy and its transfer (heat) [AI]
- **D2.4** plan and conduct inquiries involving transformations between gravitational potential energy and kinetic energy (e.g., using a pendulum, a falling ball, an object rolling down a ramp) to test the law of conservation of energy [IP, PR]
- **D2.8** investigate the relationship between the concepts of conservation of mass and conservation of energy, and solve problems using the mass–energy equivalence [PR, AI]
- **D3.1** describe a variety of energy transfers and transformations, and explain them using the law of conservation of energy
- **D3.2** explain the concepts of and interrelationships between energy, work, and power, and identify and describe their related units
- **D3.3** explain the following concepts, giving examples of each, and identify their related units: *thermal energy*, *kinetic energy*, *gravitational potential energy*, *heat, specific heat capacity*, *specific latent heat*, *power*, and *efficiency*
- **D3.5** describe, with reference to force and displacement along the line of force, the conditions that are required for work to be done
- **D3.6** describe and compare nuclear fission and nuclear fusion

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Activity 6: Where Do the Elements Come From?

Scientific Investigation Skills and Career Exploration

- **A1.1** formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research [IP]
- **A1.4** apply knowledge and understanding of safe laboratory practices and procedures when planning investigations by correctly interpreting Workplace Hazardous Materials Information System (WHMIS) symbols; by using appropriate techniques for handling and storing laboratory equipment and materials and disposing of laboratory materials; and by using appropriate personal protection [IP]
- **A1.5** conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data [PR]
- **A1.6** compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables [PR]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data; solve problems involving quantitative data; determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and/or error; and suggest improvements to the inquiry to reduce the likelihood of error [AI]
- **A1.10** draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge [AI]
- **A2.1** identify and describe a variety of careers related to the fields of science under study (e.g., theoretical physicist; communications, networks, and control systems professional; engineer; metallurgist) and the education and training necessary for these careers
- **A2.2** describe the contributions of scientists, including Canadians (e.g., Richard E. Taylor, Leonard T. Bruton, Willard S. Boyle, Martha Salcudean, Harriet Brooks, Louis Slotin), to the fields under study

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- **D2.1** use appropriate terminology related to energy transformations, including, but not limited to: *mechanical energy*, *gravitational potential energy*, *kinetic energy*, *work*, *power*, *fission*, *fusion*, *heat*, *heat capacity*, *temperature*, and *latent heat* [C]
- **D2.3** use the law of conservation of energy to solve problems in simple situations involving work, gravitational potential energy, kinetic energy, and thermal energy and its transfer (heat) [AI]
- **D2.4** plan and conduct inquiries involving transformations between gravitational potential energy and kinetic energy (e.g., using a pendulum, a falling ball, an object rolling down a ramp) to test the law of conservation of energy [IP, PR]
- **D2.8** investigate the relationship between the concepts of conservation of mass and conservation of energy, and solve problems using the mass–energy equivalence [PR, AI]
- **D3.1** describe a variety of energy transfers and transformations, and explain them using the law of conservation of energy
- **D3.2** explain the concepts of and interrelationships between energy, work, and power, and identify and describe their related units
- **D3.3** explain the following concepts, giving examples of each, and identify their related units: *thermal energy*, *kinetic energy*, *gravitational potential energy*, *heat, specific heat capacity*, *specific latent heat*, *power*, and *efficiency*
- **D3.5** describe, with reference to force and displacement along the line of force, the conditions that are required for work to be done
- **D3.6** describe and compare nuclear fission and nuclear fusion

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Activity 7: Dark Energy

Scientific Investigation Skills and Career Exploration

- **A1.1** formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research [IP]
- **A1.2** select appropriate instruments (e.g., probeware, calorimeters, pendulums, solenoids) and materials (e.g., drag sleds, electric bells, balls, ramps), and identify appropriate methods, techniques, and procedures, for each inquiry [IP]
- **A1.4** apply knowledge and understanding of safe laboratory practices and procedures when planning investigations by correctly interpreting Workplace Hazardous Materials Information System (WHMIS) symbols; by using appropriate techniques for handling and storing laboratory equipment and materials and disposing of laboratory materials; and by using appropriate personal protection [IP]
- **A1.5** conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data [PR]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data; solve problems involving quantitative data; determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and/or error; and suggest improvements to the inquiry to reduce the likelihood of error [AI]
- **A1.10** draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge [AI]
- **A1.12** use appropriate numeric (e.g., SI and imperial units), symbolic, and graphic modes of representation for qualitative and quantitative data (e.g., vector diagrams, free-body diagrams, algebraic equations) [C]
- **A1.13** express the results of any calculations involving data accurately and precisely, to the appropriate number of decimal places or significant figures [C]
- **A2.2** describe the contributions of scientists, including Canadians (e.g., Richard E. Taylor, Leonard T. Bruton, Willard S. Boyle, Martha Salcudean, Harriet Brooks, Louis Slotin), to the fields under study

Energy and Society

- **D2.1** use appropriate terminology related to energy transformations, including, but not limited to: *mechanical energy*, *gravitational potential energy*, *kinetic energy*, *work*, *power*, *fission*, *fusion*, *heat*, *heat capacity*, *temperature*, and *latent heat* [C]
- **D2.3** use the law of conservation of energy to solve problems in simple situations involving work, gravitational potential energy, kinetic energy, and thermal energy and its transfer (heat) [AI]
- **D2.8** investigate the relationship between the concepts of conservation of mass and conservation of energy, and solve problems using the mass–energy equivalence [PR, AI]
- **D3.1** describe a variety of energy transfers and transformations, and explain them using the law of conservation of energy
- **D3.3** explain the following concepts, giving examples of each, and identify their related units: *thermal energy*, *kinetic energy*, *gravitational potential energy*, *heat, specific heat capacity*, *specific latent heat*, *power*, and *efficiency*