Grade 11: Wave Model Applications

Curriculum Connections

Waves and Sound

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

Physics Curriculum Connections (SPH3U)
Activity 1: Wave Interference
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]
– **A1.10** 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., zoologist, botanist, geneticist, ecologist, pharmacologist, farmer, forester, horticulturalist) and the education and training necessary for these careers
Waves and Sound
– **E1.1** analyse how properties of mechanical waves and sound influence the design of structures and technological devices (e.g., the acoustical design of a concert hall; the design of headphones, hearing aids, musical instruments, wave pools) [AI, C]
– **E1.2** analyse the negative impact that mechanical waves and/or sound can have on society and the environment, and assess the effectiveness of a technology intended to reduce this impact [AI, C]
– **E2.1** use appropriate terminology related to mechanical waves and sound, including, but not limited to: *longitudinal wave*, *transverse wave*, *frequency*, *period*, *cycle*, *amplitude*, *phase*, *wavelength*, *velocity*, *superposition*, *constructive interference*, *destructive interference*, *standing waves*, and *resonance* [C]
– **E2.2** conduct laboratory inquiries or computer simulations involving mechanical waves and their interference (e.g., using a mass oscillating on a spring, a mass oscillating on a pendulum, the oscillation in a string instrument) [PR]
– **E3.3** explain and graphically illustrate the principle of superposition with respect to standing waves and beat frequencies
– **E3.6** explain selected natural phenomena (e.g., echo location, or organisms that produce or receive infrasonic, audible, or ultrasonic sound) with reference to the characteristics and properties of waves

Physics Curriculum Connections (SPH3U)

Activity 2: Applications of Sound Waves

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., sampling instruments, a microscope, a stethoscope, dissection instruments) and materials (e.g., dichotomous keys, computer simulations, plant cuttings), 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]
- **A1.6** compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables, flow charts, graphs, and/or diagrams [PR]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data to 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, symbolic, and graphic modes of representation (e.g., biological diagrams, Punnett squares), and appropriate units of measurement (e.g., SI and imperial units) [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., zoologist, botanist, geneticist, ecologist, pharmacologist, farmer, forester, horticulturalist) and the education and training necessary for these careers

Waves and Sound

- **E1.2** analyse the negative impact that mechanical waves and/or sound can have on society and the environment, and assess the effectiveness of a technology intended to reduce this impact [AI, C]
- **E2.1** use appropriate terminology related to mechanical waves and sound, including, but not limited to: *longitudinal wave*, *transverse wave*, *frequency*, *period*, *cycle*, *amplitude*, *phase*, *wavelength*, *velocity*, *superposition*, *constructive interference*, *destructive interference*, *standing waves*, and *resonance* [C]
- **E2.4** investigate the relationship between the wavelength, frequency, and speed of a wave, and solve related problems [PR, AI]
- **E2.5** analyse the relationship between a moving source of sound and the change in frequency perceived by a stationary observer (i.e., the Doppler effect) [AI]
- **E3.6** explain selected natural phenomena (e.g., echo location, or organisms that produce or receive infrasonic, audible, or ultrasonic sound) with reference to the characteristics and properties of waves

Physics Curriculum Connections (SPH3U)

Activity 3: Investigating Earthquakes

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, flow charts, graphs, and/or diagrams [PR]
- **A1.7** select, organize, and record relevant information on research topics from a variety of appropriate sources, including electronic, print, and/or human sources, using suitable formats and an accepted form of academic documentation [PR]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data to 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, symbolic, and graphic modes of representation (e.g., biological diagrams, Punnett squares), and appropriate units of measurement (e.g., SI and imperial units) [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]

Waves and Sound

- **E1.1** analyse how properties of mechanical waves and sound influence the design of structures and technological devices (e.g., the acoustical design of a concert hall; the design of headphones, hearing aids, musical instruments, wave pools) [AI, C]
- **E1.2** analyse the negative impact that mechanical waves and/or sound can have on society and the environment, and assess the effectiveness of a technology intended to reduce this impact [AI, C]
- **E2.1** use appropriate terminology related to mechanical waves and sound, including, but not limited to: *longitudinal wave*, *transverse wave*, *frequency*, *period*, *cycle*, *amplitude*, *phase*, *wavelength*, *velocity*, *superposition*, *constructive interference*, *destructive interference*, *standing waves*, and *resonance* [C]
- **E2.3** plan and conduct inquiries to determine the speed of waves in a medium (e.g., a vibrating air column, an oscillating string of a musical instrument), compare theoretical and empirical values, and account for discrepancies [IP, PR, AI, C]
- **E3.1** distinguish between longitudinal and transverse waves in different media, and provide examples of both types of waves
- **E3.5** explain the relationship between the speed of sound in various media and the particle nature of the media (e.g., the speed of sound in solids, liquids, and gases; the speed of sound in warm and cold air
- **E3.6** explain selected natural phenomena (e.g., echo location, or organisms that produce or receive infrasonic, audible, or ultrasonic sound) with reference to the characteristics and properties of waves

Physics Curriculum Connections (SPH3U)

Activity 4: How Do We Hear?

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., sampling instruments, a microscope, a stethoscope, dissection instruments) and materials (e.g., dichotomous keys, computer simulations, plant cuttings), 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 and biological materials (e.g., preserved specimens); 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, flow charts, graphs, and/or diagrams [PR]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data to 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, symbolic, and graphic modes of representation (e.g., biological diagrams, Punnett squares), and appropriate units of measurement (e.g., SI and imperial units) [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., zoologist, botanist, geneticist, ecologist, pharmacologist, farmer, forester, horticulturalist) and the education and training necessary for these careers

Waves and Sound

- **E1.1** analyse how properties of mechanical waves and sound influence the design of structures and technological devices (e.g., the acoustical design of a concert hall; the design of headphones, hearing aids, musical instruments, wave pools) [AI, C]
- **E1.2** analyse the negative impact that mechanical waves and/or sound can have on society and the environment, and assess the effectiveness of a technology intended to reduce this impact [AI, C]
- **E2.1** use appropriate terminology related to mechanical waves and sound, including, but not limited to: *longitudinal wave*, *transverse wave*, *frequency*, *period*, *cycle*, *amplitude*, *phase*, *wavelength*, *velocity*, *superposition*, *constructive interference*, *destructive interference*, *standing waves*, and *resonance* [C]
- **E2.2** conduct laboratory inquiries or computer simulations involving mechanical waves and their interference (e.g., using a mass oscillating on a spring, a mass oscillating on a pendulum, the oscillation in a string instrument) [PR]
- **E2.3** plan and conduct inquiries to determine the speed of waves in a medium (e.g., a vibrating air column, an oscillating string of a musical instrument), compare theoretical and empirical values, and account for discrepancies [IP, PR, AI, C]
- **E2.4** investigate the relationship between the wavelength, frequency, and speed of a wave, and solve related problems [PR, AI]
- **E2.6** predict the conditions needed to produce resonance in vibrating objects or air columns (e.g., in a wind instrument, a string instrument, a tuning fork), and test their predictions through inquiry [IP, PR, AI]
- **E2.7** analyse the conditions required to produce resonance in vibrating objects and/or in air columns (e.g., in a string instrument, a tuning fork, a wind instrument), and explain how resonance is used in a variety of situations (e.g., to produce different notes in musical instruments; to limit undesirable vibrations in suspension bridges; to design buildings so that they do not resonate at the frequencies produced by earthquakes) [AI, C]
- **E3.2** explain the components of resonance, and identify the conditions required for resonance to occur in vibrating objects and in various media (e.g., with reference to a musical instrument, a child on a swing, the Tacoma Narrows Bridge)
- **E3.3** explain and graphically illustrate the principle of superposition with respect to standing waves and beat frequencies
- **E3.4** identify the properties of standing waves, and, for both mechanical and sound waves, explain the conditions required for standing waves to occur
- **E3.6** explain selected natural phenomena (e.g., echo location, or organisms that produce or receive infrasonic, audible, or ultrasonic sound) with reference to the characteristics and properties of waves

Physics Curriculum Connections (SPH3U)

Activity 5: Exploring Gravitational Waves

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]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data to 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]
- **A1.13** 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., zoologist, botanist, geneticist, ecologist, pharmacologist, farmer, forester, horticulturalist) and the education and training necessary for these careers

Waves and Sound

- **E2.1** use appropriate terminology related to mechanical waves and sound, including, but not limited to: *longitudinal wave*, *transverse wave*, *frequency*, *period*, *cycle*, *amplitude*, *phase*, *wavelength*, *velocity*, *superposition*, *constructive interference*, *destructive interference*, *standing waves*, and *resonance* [C]
- **E2.4** investigate the relationship between the wavelength, frequency, and speed of a wave, and solve related problems [PR, AI]
- **E3.1** distinguish between longitudinal and transverse waves in different media, and provide examples of both types of waves
- **E3.6** explain selected natural phenomena (e.g., echo location, or organisms that produce or receive infrasonic, audible, or ultrasonic sound) with reference to the characteristics and properties of waves

Physics Curriculum Connections (SPH3U)

Design Challenge: Resisting Earthquakes with Engineering

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., sampling instruments, a microscope, a stethoscope, dissection instruments) and materials (e.g., dichotomous keys, computer simulations, plant cuttings), and identify appropriate methods, techniques, and procedures, for each inquiry [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 and biological materials (e.g., preserved specimens); 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]
- **A1.7** select, organize, and record relevant information on research topics from a variety of appropriate sources, including electronic, print, and/or human sources, using suitable formats and an accepted form of academic documentation [PR]
- **A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data to 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]
- **A2.1** identify and describe a variety of careers related to the fields of science under study (e.g., zoologist, botanist, geneticist, ecologist, pharmacologist, farmer, forester, horticulturalist) and the education and training necessary for these careers

Waves and Sound

- **E1.1** analyse how properties of mechanical waves and sound influence the design of structures and technological devices (e.g., the acoustical design of a concert hall; the design of headphones, hearing aids, musical instruments, wave pools) [AI, C]
- **E2.1** use appropriate terminology related to mechanical waves and sound, including, but not limited to: *longitudinal wave*, *transverse wave*, *frequency*, *period*, *cycle*, *amplitude*, *phase*, *wavelength*, *velocity*, *superposition*, *constructive interference*, *destructive interference*, *standing waves*, and *resonance* [C]
- **E2.2** conduct laboratory inquiries or computer simulations involving mechanical waves and their interference (e.g., using a mass oscillating on a spring, a mass oscillating on a pendulum, the oscillation in a string instrument) [PR]
- **E2.6** predict the conditions needed to produce resonance in vibrating objects or air columns (e.g., in a wind instrument, a string instrument, a tuning fork), and test their predictions through inquiry [IP, PR, AI]
- **E2.7** analyse the conditions required to produce resonance in vibrating objects and/or in air columns (e.g., in a string instrument, a tuning fork, a wind instrument), and explain how resonance is used in a variety of situations (e.g., to produce different notes in musical instruments; to limit undesirable vibrations in suspension bridges; to design buildings so that they do not resonate at the frequencies produced by earthquakes) [AI, C]
- **E3.2** explain the components of resonance, and identify the conditions required for resonance to occur in vibrating objects and in various media (e.g., with reference to a musical instrument, a child on a swing, the Tacoma Narrows Bridge)
- **E3.4** identify the properties of standing waves, and, for both mechanical and sound waves, explain the conditions required for standing waves to occur