Mechanical Systems

Overall Expectations

MSV.01 · describe and apply concepts related to forces, Newton's laws of motion, static and kinetic friction, simple machines, torques, and mechanical advantage;

MSV.02 · design and carry out experiments to investigate forces, coefficients of friction, and the operation of simple machines;

MSV.03 · identify and analyse applications of applied forces, friction, and simple machines in real-world machines and in the human body.

Understanding Basic Concepts

MS1.01 – define and describe the concepts and units related to force, coefficients of friction, torque, mechanical advantage, and work;

MS1.02 – state Newton's laws of motion, and apply them to mechanical systems (e.g., identify and explain the conditions associated with the movement of objects at constant velocity);

MS1.03 – analyse, in qualitative and quantitative terms, the forces (e.g., gravitational forces, applied forces, friction forces) acting on an object in a variety of situations, and describe the resulting motion of the object;

MS1.04 – identify, describe, and illustrate applications of types of simple machines, that is, the inclined plane and the lever, and modifications of these (the wedge, the screw, the pulley, and the wheel and axle);

MS1.05 – apply quantitatively the relationships among torque, force, and displacement in simple machines;

MS1.06 – state the law of the lever, and apply it quantitatively in a variety of situations for all three classes of levers;

MS1.07 – explain the operation and mechanical advantage of simple machines;

MS1.08 – determine the mechanical advantage of a variety of compound machines and bio-mechanical systems.

Developing Skills of Inquiry and Communication

MS2.01 – verify Newton's second law of motion through experimentation;

MS2.02 – determine, through experimentation, the factors affecting static and dynamic friction and the corresponding coefficients of friction;

MS2.03 – select appropriate instruments and use them effectively and accurately in investigating the relationships among force, displacement, and torque for the load arm and effort arm of levers;

MS2.04 – analyse, in quantitative terms, a mechanical system with respect to its component simple machines, input and output forces, and mechanical advantage (e.g., determine the mechanical advantage of the simple machines in a bicycle);

MS2.05 – construct a simple or compound machine to solve a practical problem, and determine its mechanical advantage (e.g., design and construct a prototype of a machine for lifting a patient from a hospital bed, calculate the mechanical advantage of each of the simple machines used in the device, and explain the operation of each simple machine).

Relating Science to Technology, Society, and the Environment

MS3.01 – describe advantages and disadvantages of friction in real-world situations, as well as methods used to increase or reduce friction in these situations (e.g., advantages of, and methods for increasing, friction on the surface of car tires and the soles of mountain-climbing boots; disadvantages of, and methods for reducing, friction between moving parts on industrial machines, and on wheels spinning on axles);

MS3.02 – describe the role of machines in everyday domestic life and in industry (e.g., identify simple machines that are part of a device used in the home, and explain the function of each machine; explain the function of the simple machines used in one of the following: robotics equipment, pulley systems, lever systems on backhoes, bulldozers, winches, the "Canadarm");

MS3.03 – analyse natural and technological systems that employ the principles of simple machines, and explain their function and structure (e.g., analyse the operation of the human arm in terms of the operation of a lever).

Electricity and Electronics

Overall Expectations

EEV.01 · demonstrate an understanding of common applications of electrical and electronic circuits, and the function and configuration of the components used;

EEV.02 · construct, analyse, and troubleshoot simple electrical circuits by using schematic diagrams and appropriate electrical tools and measuring equipment, and by examining familiar electrical devices;

EEV.03 · investigate the development and application of electrical technologies and their impact on local and global economies and the environment.

Understanding Basic Concepts

EE1.01 – define and describe the concepts and units related to electrical and electronic systems (e.g., direct current, alternating current, electric potential, resistance, power, energy);

EE1.02 – compare direct current and alternating current in qualitative terms, and describe situations in which each is used;

EE1.03 – describe the function of basic circuit components (e.g., power supplies, resistors, diodes, fuses, circuit breakers, light-emitting diodes [LEDs], capacitors, and switching devices);

EE1.04 – analyse and describe the operation of electrical and electronic devices that control other systems (e.g., programmable thermostats, control switches for fans or pumps, logic circuits, security systems, smoke detectors);

EE1.05 – analyse, in quantitative terms, circuit problems involving potential difference, current, and resistance;

EE1.06 – distinguish between, and explain the functions of, analog and digital circuits (e.g., identify one device that requires an analog circuit to function – audio amplifier, audio-tape recorder – and another that requires a digital circuit – computer data storage device, alarm circuit, compact disc [CD] recording, digital video disc [DVD] – and explain why each kind of circuit is used);

EE1.07 – describe examples of electrical sub-circuits that are micro-miniaturized and used as "black boxes" that serve a particular purpose in electronic equipment (e.g., identify and describe the function of a computer central processing unit [CPU] and a "smart" telephone card).

Developing Skills of Inquiry and Communication

EE2.01 – use appropriate meters (analog or digital), computer probes, and oscilloscopes to measure electric potential difference, current, and resistance in electrical circuits;

EE2.02 – construct simple electrical circuits using common tools appropriately and safely (e.g., soldering irons, wire strippers, crimping tools, screwdrivers, common connectors);

EE2.03 – draw, by hand or using a computer, schematic diagrams to represent real circuits;

EE2.04 – analyse, in quantitative terms, real or computer-simulated circuits, using Ohm’s law and Kirchhoff’s rules;

EE2.05 – design and construct an electrical circuit to perform a simple function (e.g., perimeter security system, water-level detector), and evaluate it on the basis of specified criteria;

EE2.06 – analyse real or simulated circuits to identify faults and suggest corrective changes (e.g., analyse the operation of a small home appliance and identify the problem in one that is broken or defective).

Relating Science to Technology, Society, and the Environment

EE3.01 – describe common applications of simple circuits, and identify the energy transformations that occur (e.g., energy transformations in one of the following appliances or devices: refrigerator, kettle, food mixer, amplifier, television set, light bulb, oscillator, electromagnet, electric motor, garage door opener);

EE3.02 – investigate the use and historical development of an electrical or electronic appliance or device (e.g., dry-cell, rechargeable battery, toaster, refrigerator, computer), and describe its performance since its development with respect to safety, cost, availability, and environmental impact;

EE3.03 – identify and describe proper safety procedures to be used when working with electrical circuits, and identify electrical hazards that may occur in the science classroom or at home.

Hydraulic and Pneumatic Systems

Overall Expectations

HPV.01 · demonstrate an understanding of the scientific principles related to fluid statics and dynamics, and to hydraulic and pneumatic systems;

HPV.02 · design and carry out investigations of fluid statics and dynamics, and of simple hydraulic and pneumatic systems;

HPV.03 · analyse and describe the social and economic consequences of the development of technological applications related to the motion and control of fluids.

Understanding Basic Concepts

HP1.01 – define and describe the concepts and units related to fluids and to hydraulic and pneumatic systems (e.g., density, atmospheric pressure, absolute pressure, laminar and turbulent flow, static pressure head, pressure, volume, flow rate);

HP1.02 – identify factors affecting laminar flow, and describe examples of laminar flow (e.g., identify the factors affecting the streamlining of cars, boats, planes, turbine blades, propellers, golf balls, or shark skin, and describe how each of these factors has been considered in the design of at least one of these applications);

HP1.03 – state Bernoulli's principle and explain some of its applications in the fields of technology and health (e.g., explain spray atomizers, propellers, spoilers on racing cars, turbine blades in jet engines);

HP1.04 – identify factors affecting static pressure head, analyse static pressure head in quantitative terms, and explain its effects in liquids and gases (e.g., identify factors affecting static pressure head in the Earth's atmosphere and calculate the absolute pressure at 5000 m);

HP1.05 – state Pascal's principle and explain its applications in the transmission of forces in fluid systems;

HP1.06 – describe common components used in hydraulic and pneumatic systems (e.g., cylinders, valves, motors, fluids, hoses, connectors, pumps, reservoirs);

HP1.07 – apply quantitatively the relationships among force, area, pressure, volume, and time in hydraulic and pneumatic systems (e.g., calculate the force exerted by the hydraulically operated brake pad on the wheel of a motorcycle or car; calculate the time required for a robotic system to complete one cycle of operation);

HP1.08 – analyse, in quantitative terms, the relationships among work, power, and time in hydraulic and pneumatic circuits.

Developing Skills of Inquiry and Communication

HP2.01 – demonstrate Bernoulli's principle through experiments (e.g., experiments involving wind tunnel demonstrations, suspension of table tennis balls, blowing between pieces of paper, or use of a Venturi tube);

HP2.02 – identify factors that affect the static pressure head in fluids by carrying out procedures, compare theoretical and empirical values, and account for discrepancies;

HP2.03 – verify Pascal's principle through experimentation;

HP2.04 – draw simple hydraulic or pneumatic circuits, using correct circuit symbols;

HP2.05 – determine, through experimentation, the relationships among force, area, pressure, volume, and time in a hydraulic or pneumatic system (e.g., build a two-cylinder circuit using small plastic cylinders filled with air or water, and measure and quantitatively analyse the extension of the cylinders and the forces exerted by them);

HP2.06 – design, construct, and evaluate a hydraulic or pneumatic system (e.g., the braking system on a car; a clamping device; a model of a crane) and solve problems as they arise.

Relating Science to Technology, Society, and the Environment

HP3.01 – describe the historical development of fluid systems, analyse their design, and determine why these technologies were developed and improved (e.g., identify examples of the use of hydraulic systems in aircraft and other transportation vehicles, in heavy equipment, and in precision machining, and explain why they have become the preferred system for each of the identified uses);

HP3.02 – identify and analyse some of the social and economic consequences of the use of robotic systems for many different kinds of operations (e.g., identify examples of the use of robotic systems in the computer-manufacturing industry, for lifting and manoeuvring heavy objects on assembly lines in factories, for handling hazardous materials, and for activities under water and in space, and explain how the use of robotics has affected the training required of people employed in these industries);

HP3.03 – identify various applications of hydraulic and pneumatic systems in everyday life, and evaluate the impact of the use of these systems on the quality of life.

Communications Technology

Overall Expectations

CTV.01 · demonstrate an understanding of the scientific principles and technological applications involved in the design, development, and operation of communications systems;

CTV.02 · design and carry out experiments to investigate and illustrate the fundamental operating principles and basic components of communications systems;

CTV.03 · identify and describe Canadian contributions to communications technology, and demonstrate awareness of the wide-ranging and ever-growing infuence of communications technology on the global community.

Understanding Basic Concepts

CT1.01 – define and explain the concepts and units related to communications technology (e.g., frequency, period, cycle, wavelength, amplitude, longitudinal and transverse waves, electromagnetic waves, reflection, refraction, total internal reflection, interference, transmission, absorption);

CT1.02 – describe the periodic motion of a vibrating object in qualitative terms, and analyse it in quantitative terms (e.g., the motion of a pendulum, a vibrating spring, a tuning fork);

CT1.03 – describe the characteristics of waves, and analyse, in quantitative terms, the relationships among velocity, frequency, and wavelength to explain the behaviour of waves in different media;

CT1.04 – explain and illustrate the principle of superposition of waves (e.g., explain the sound produced by a musical instrument in terms of its fundamental frequency and the associated overtones, and draw diagrams to show the relationships between them);

CT1.05 – describe how the interference of waves is used in communications technology;

CT1.06 – explain, in qualitative terms, and illustrate how the reflection of waves is used in communications technology (e.g., in loudspeaker enclosures, police radar, communications satellites, parabolic reflectors);

CT1.07 – explain and predict, in quantitative terms and with the use of Snell's law, the refraction of electromagnetic waves;

CT1.08 – describe and illustrate total internal reflection, and explain its significance in communications systems;

CT1.09 – analyse and describe the sequences of energy transformations and transmissions that occur in commonly used communications systems (e.g., analyse and describe the function of each of the energy transformations that occur in a sound system, a video camera, a video cassette recorder [VCR], and a television set).

Developing Skills of Inquiry and Communication

CT2.01 – determine, through experimentation, the properties of and the relationships among the major variables for a vibrating object (e.g., conduct an experiment to determine the factors that affect the frequency of a pendulum);

CT2.02 – investigate, through experimentation or the use of computer simulations, the characteristics of transverse and longitudinal mechanical waves (e.g., conduct experiments, using slinkies, springs, wave machines, ripple tanks);

CT2.03 – demonstrate and explain the principle of superposition (e.g., explain the production of standing waves, overtones in musical instruments, beats in sound waves, amplitude and frequency modulation in radio waves);

CT2.04 – verify Snell's law through experimentation, and identify the conditions required for total internal reflection;

CT2.05 – investigate the reflection and refraction of light through experimentation, and interpret results using algebraic and geometric models (e.g., investigate reflection of light from differently shaped surfaces, refraction of light in different media, and total internal reflection);

CT2.06 – analyse, in qualitative terms, the operation of simple transducers used in communications systems or in information-processing equipment (e.g., in microphones, loudspeakers, tape recorder heads, remote controllers, product code readers), and describe the energy transformations that occur;

CT2.07 – design and construct a simple communications system, and demonstrate the operation of each of the major components in the system (e.g., design and construct a simple house intercom system).

Relating Science to Technology, Society, and the Environment

CT3.01 – evaluate, using their own criteria, available models of a particular communications system or device (e.g., cell phone, computer system, satellite data transmission system, home entertainment system), and determine which model is the best on the basis of their evaluation;

CT3.02 – describe and evaluate Canadian contributions to communications science and technology (e.g., evaluate the contributions of Alexander Graham Bell, Reginald A. Fessenden, the Canadian communications industry, or the Canadian satellite and space exploration industry);

CT3.03 – assess, using their own criteria, the risks and benefits to society and the environment of introducing a particular technology from the communications industry (e.g., consider such factors as effects on personal privacy, control of the mass media, criminal activities, health concerns related to electric and magnetic fields, and the transfer of information).

Energy Transformations

Overall Expectations

ETV.01 · demonstrate an understanding of forms of energy, energy sources, energy transformations, energy losses, and efficiency, and the operation of common energy-transforming devices;

ETV.02 · construct or investigate devices that involve energy sources, energy transformations, and energy losses, and assess their efficiency;

ETV.03 · analyse and describe the operation of various technologies based on energy transfers and transformations, and evaluate the potential of energy-transformation technologies that use sources of renewable energy.

Understanding Basic Concepts

ET1.01 – define and describe the concepts and units related to energy transformations (e.g., energy, forms of energy, power, efficiency);

ET1.02 – describe and compare various energy transformations (e.g., describe energy transformations among mechanical, sound, thermal, electromagnetic, gravitational, and nuclear forms of energy);

ET1.03 – describe, with the aid of diagrams, the operation of energy-transforming devices (e.g., electric motors and generators, heat engines, photoelectric cells, electrochemical cells);

ET1.04 – analyse and describe, using energy flow diagrams, the relationships among and efficiencies of various energy sources (e.g., the sun, natural gas, oil, coal, moving water), transformations (e.g., between thermal energy and its transfer [heat] and electrical energy), transmissions (e.g., of electrical energy), and energy losses (e.g., of electrical energy as a result of resistance);

ET1.05 – determine, in quantitative terms, the power and efficiency of energy transformations in some common devices (e.g., electric motor, internal combustion engine, incandescent light bulb, fluorescent light bulb).

Developing Skills of Inquiry and Communication

ET2.01 – determine, through experimentation, the efficiency of a simple process of energy transformation (e.g., a rubber band stretched to propel a cart through photogates; an electric motor used to lift a mass);

ET2.02 – collaboratively design and build a device that uses at least four functional energy transformations to complete a task (e.g., an alarm system for a house), and explain its operation.

Relating Science to Technology, Society, and the Environment

ET3.01 – analyse and describe examples of technologies based on various combinations of energy transfer and transformation (e.g., a shock absorber, a vehicular airbag, a Mars landing system);

ET3.02 – evaluate the benefits and drawbacks, with respect to such factors as economic viability, use of energy resources, efficiency, safety, and general utility, of energy-transforming devices based on sources of renewable energy (e.g., photoelectric cells, solar cookers, hydrogen fuel cells, wind-up radios, Archimedes' pumps).