Grade 8 Science

Systems in Action

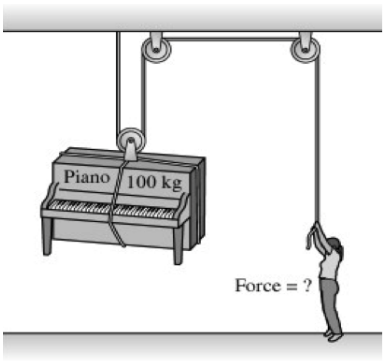
Class 6

Big Ideas

Understanding Structures and Mechanisms: Systems in Action

- Systems are designed to accomplish tasks
- All systems include an input and an output
- Systems are designed to optimize human and natural resources

Think About It…



Types of Systems

- System – a group of parts that work together to perform a desired function
- Types:
  - **Physical System** – group of physical parts that work together to perform a function
  - **Social System** – a group of organisms joining together to perform tasks

Physical System

- Natural Physical Systems
  - Solar System
  - Animal's Digestive System
- Human-made Physical Systems
  - Mechanical System
  - Optical System
  - Electrical System

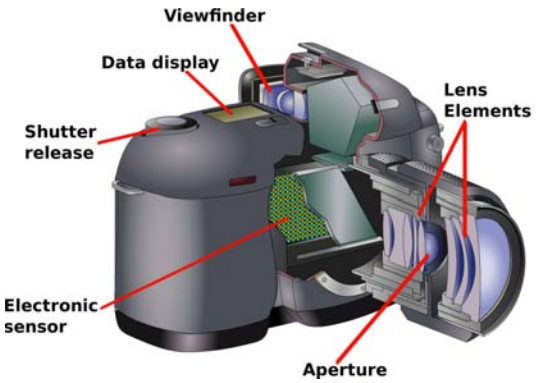
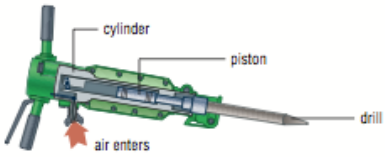
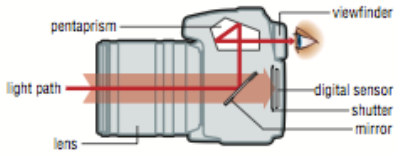
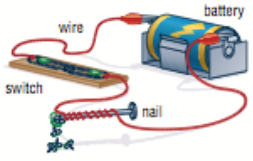
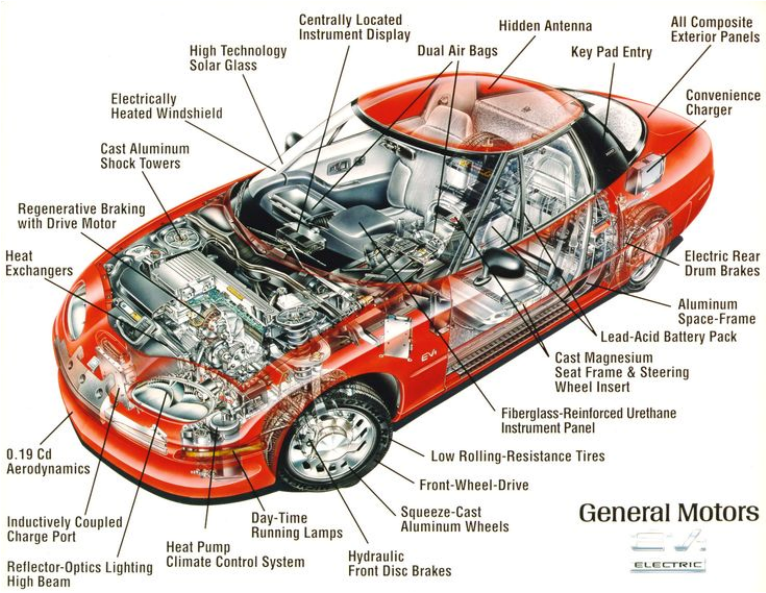


Table 1 Some Human-Made Physical Systems

Type of system	Example	Type of energy used	
mechanical	jackhammer (pneumatic hammer)	mechanical energy of pressurized air	
optical	camera	light energy	
electrical	electric circuit	electrical energy	

- Human-made physical systems help us accomplish tasks faster
- Many devices that we use are combinations of systems



Social Systems

- Natural Social Systems
  - Ant colonies
  - Bee colonies
  - Wolf or coyote pack
- Human-made Social Systems
  - Health care
  - Education
  - Waste management

Checkpoint

Give an example of each of the following:

a) Physical system designed by people
b) Naturally occurring physical system
c) Social systems that you are a part of
d) Naturally occurring social systems

System Components

- Systems have smaller systems within it called subsystems
- Ex: Can Opener has the holding and cutting subsystem and the turning subsystem

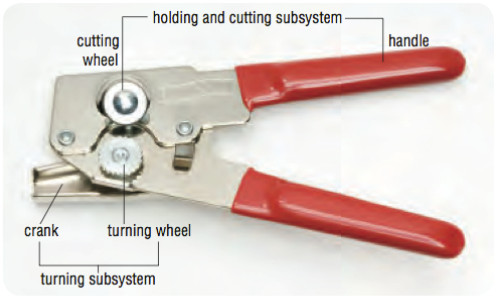
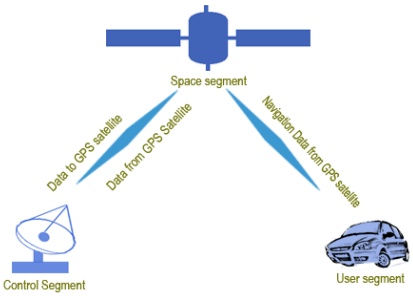


Figure 1 A can opener is made of different subsystems.



- GPS (Global Positioning System) has three major subsystems
  - Space Subsystem: 24 orbiting satellites that transmit signals to Earth
  - Control Subsystem: several U.S. Air Force monitoring stations
  - User Subsystem: receiver that takes signals from at least three satellites and turns them into useful information

Industries

- Industries are complex combinations of systems to produce goods and services

Table 1 Sample Industries and Some Related Systems

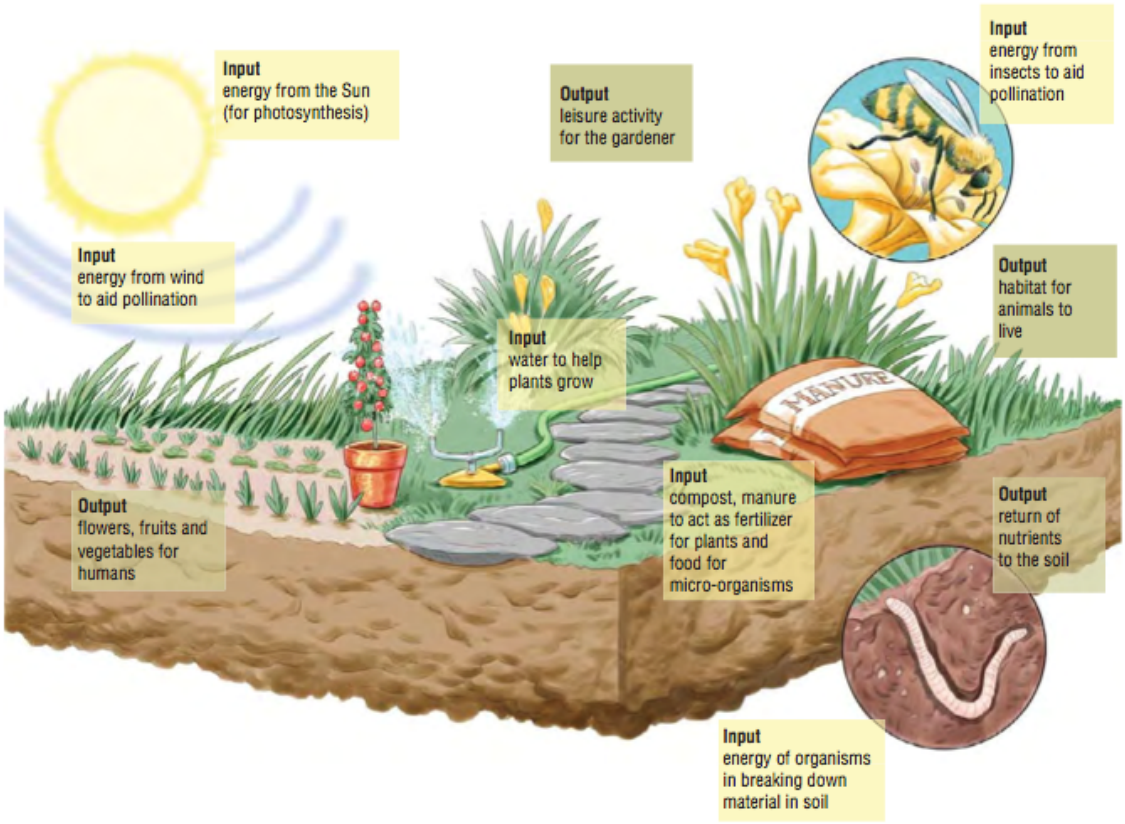
Industry	Some related physical systems (devices)	Some related social systems
communications	computer, scanner, electrical circuits, video recorder, television, radio satellites, transmission antennas	advertising services, authors, animators, set design
construction	power saw, air compressor, backhoe, crane	architectural design, land surveying, real estate sales office
green	chainsaw, irrigation systems, greenhouse, lawnmower	landscape design, composting services, forest management
service	hair stylist's chair, stethoscope, food mixer	health spas, walk-in clinics, ecotourism
transportation	car hoist, diagnostic equipment, highway, gas pump, trucks, airplanes	small engine repair, auto body repair, aeronautical engineering, gas station

System Inputs and Outputs

- Inputs – the force, energy or raw materials that you put into a system
- Output – the task or service that a system performs

Input: Downward force the rider applies to the bicycle's pedals

Output: Forward motion of the bicycle



Checkpoint

Using Ontario's health care system as an example, describe the purpose, the subsystems and the outputs and inputs of this system.

Side Effects

- Side Effects – the unintended or undesired outputs of a system
- Ex: Car
  - Desired Output: Motion
  - Side Effects: Air pollution, traffic congestion, noise pollution, loss of natural habitat
- Systems Thinking – taking into consideration the input, outputs and side effects of systems

Systems Evolve

- All systems need to evolve over time
- Waste Management Systems
  - Canadians produce 31 million tonnes of waste each year
  - In the past, all garbage was buried in landfill sites
  - Today, there are recycling programs, hazardous waste drop-off depots, composting, incineration and public education

- Telephone Systems
  - Early telephones required many physical mechanisms including a spring-loaded hook and a rotary dial
  - Phones then turned to electronic touch-tone phones which were connected by wires
  - Today's phones are small, mobile with few moving parts

- Education System
  - Mary Ward Catholic Secondary School in Markham is one of two self-directed learning schools in Ontario
  - Students learn at their own pace and write tests when they are ready
  - The belief is that students are more successful when they take responsibility for their own learning

Consumerism

- Consumerism – the practice and belief that happiness and satisfaction come from purchasing goods and services
- Relatively new devices are discarded while still usable

Customer Service

- Customer Service – help provided so that customers can use a physical or social system efficiently
- Owners' manuals provide information on how to put the object together, how to use the system, how to change the settings
- Technical support on the phone and internet can help customers

- Weather reports may be used to predict air traffic patterns in airports, preparation of police and other emergency services
- Businesses depend on weather reports to help determining staffing needs

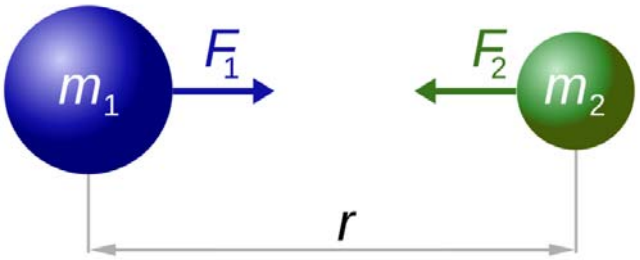
Force

- Force – a push or a pull that acts on an object
- Classification:
  - **Contact Forces** – force that must touch the object that they push or pull (i.e. friction)
  - **Non-Contact Forces** – forces that can push or pull an object without touching it (i.e. gravity, static electricity, magnetism)

Forces

- There are four fundamental forces:

  1) Gravitational force – attraction between two objects due to their mass

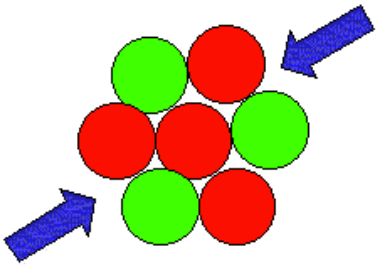


$$F_1 = F_2 = G\frac{m_1 \times m_2}{r^2}$$

2) Electromagnetic Force – the force that occurs between two charged particles

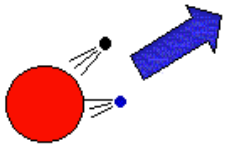
Table 1 Types of Force in Everyday Life

Scientific terms	Common terms and expressions
gravitational force (gravity)	pull of Earth
magnetic force	magnetic pull; magnetic push
electrical force (electricity)	static cling; static electricity; force of an electric current; force of lightning
mechanical force	muscular force; hurricane force; slapshot; punch
frictional force (friction)	rubbing; abrasion; roughness; force of resistance
tensile force	tightening
compressive force	crush; squash; squeeze; press; pinch; grip
rotational force	twist; turn; wring; coil; twirl



Strong force binds the nucleus

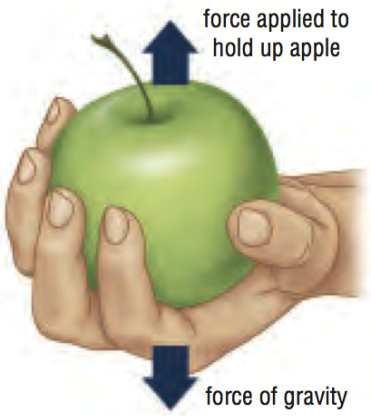
3) Strong nuclear force – force responsible for the stabilizing the protons within a nucleus of an atom



Weak force in radioactive decay

4) Weak nuclear force – force responsible for nuclear decay in atoms

Representing Forces



- All forces have two components:
  - Magnitude – measure of how strong the force is
  - Direction – which way the force is pulling or pushing
- Forces are represented by arrows
- Unit: newton (N) named after Sir Isaac Newton

Free-Body Diagrams

- Used to show the relative magnitude and direction of all forces acting upon an object in a situation

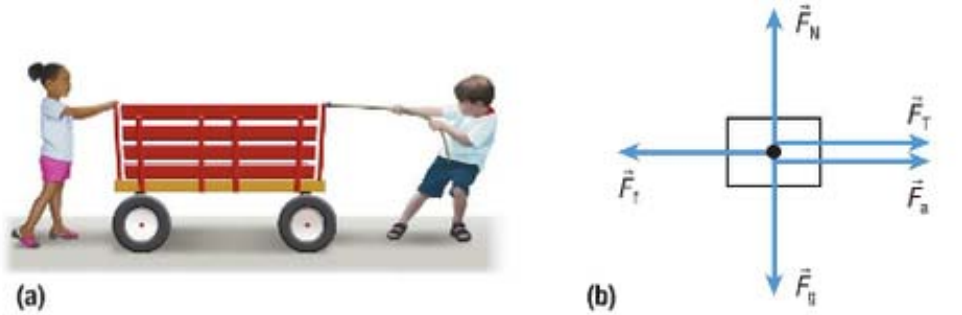


Figure 4 (a) The system diagram of a wagon and the two children pushing and pulling on it (b) The FBD showing all the forces acting on the wagon

Checkpoint

A book is at rest on a tabletop. Draw a free-body diagram showing all the forces acting on the book.

Checkpoint

A spider is suspended motionless from the ceiling by two spider web filaments. Draw a free-body diagram showing all the forces acting on the spider.