12-1

- To do work on an object, you must move the object a certain distance provided the force exerted is in the same direction as the object's motion.
- Work = Force x Distance
  Newton.meter or Joule = Newton x meter

12-2

- Machine: device that makes work easier/more effective by
  - Multiplying the force you exert
  - Multiplying the distance over which you exert your force
  - Changing the direction in which you exert the force
- Input or effort force: force exerted by you on the machine
- Output or resistance force: force exerted by machine
- Mechanical Advantage: # of times force exerted on a machine is multiplied by the machine. MA = Output force / Input force
- Explanation of the three cases:
  - Output force > Input force; Output distance <Input distance
    This is the case when your force is multiplied; MA >1
    Ex. ramp, manual can opener
  - Output force < Input force; Output distance > Input distance
    This is the case when your distance is multiplied; MA <1
    Ex. bicycle at high gear, hockey stick, fan
  - Output force = input force; Output distance = Input distance
    This is the case when the direction of your force is changed; MA =1
    Ex. sail
- Efficiency of a machine is the comparison of a machine's output work to its input work. E = Output work/Input work x 100%
  In real situations, the work output is less than the work input due to friction and therefore the efficiency is less than 100%.
  AMA or Actual mechanical advantage of a machine is the mechanical advantage in a real situation and depends on its efficiency.
  IMA or Ideal mechanical advantage does not involve friction.
  The more efficient the machine, the closer are the AMA and IMA.
  By lubricating the moving parts of a machine you can make this happen.

12-3
Simple Machines

- Inclined Plane
  - flat, slanted surface
  - Ex. ramp
  - makes work easier because the input force is over a larger distance; input force < output force
  - MA = length/height
  - you can increase efficiency by adding rollers to decrease friction

- Wedge
  - device that is thick at one end and tapers to a thin edge at the other end; it is an inclined plane that moves
  - Ex. knife, ax, zipper
  - The longer and thinner the wedge, the less the input force, the easier the work
- Screw
  - inclined plane wrapped around a cylinder (threads)
  - Ex. bolt, faucet, jar lid
  - The closer the threads of the screw, the more the MA because it multiplies the force, the easier the work
- Lever
  - rigid bar free to rotate about a point called the fulcrum
  - Ex. scissors, broom, bottle opener
  - makes work easier by increasing the input force or changing direction
  - IMA = input distance/output distance

Class 1	Class 2	Class 3
Fulcrum in the middle of input and output but closer to output	Fulcrum at one end, input at other, output distance less	Fulcrum at one end, output at other, output distance more
Scissors, see saw, pliers	Wheel barrow, nut cracker, bottle opener	Fishing pole, shovel, baseball bat
Output force more; changes direction	Output force more	Output distance more

See figures in the book.

- Wheel & Axle
  - 2 circular/cylindrical objects fastened together and rotating about a common axis. The larger object is the wheel and the smaller one is the axle.
  - Ex. screwdriver, doorknob, water wheel of mill, steering wheel, eggbeater handle
  - it multiplies your force over a longer distance
  - IMA = radius of wheel/radius of axle
  - if the input force were applied to the axle rather than the wheel, the machine would multiply distance such as the case in the wheel of the riverboat.
- Pulley
  - a grooved wheel with a rope/chain/cable wrapped around it
  - Ex. flagpole, blinds
  - can change the amount and direction of the input force
  - fixed pulleys are attached to structures and don't change the amount of the force you apply; they change the direction (sail, flagpole); IMA =1
  - Movable pulleys are attached to the object and exert your force over a greater distance (crane); IMA =2
  - Pulley systems combine fixed and movable pulleys and are called "block and tackle'. The IMA then is equal to the # of sections of the rope that support the object without considering the rope on which you pull down

- Compound machines
  - machines that use 2 or more simple machines
  - the overall MA is the product of the individual IMA's of the simple machines

12-4

- Machines in your body:
  - Tendons (connective tissue attaching bone to muscle) and muscles pull on bones making them work as levers; the joint near the tendon is the fulcrum
  - Lever in neck, leg/foot
  - Incisor teeth act as wedges