UNIT 1 – MOTION

CHAPTER 2 – Machines

2.1 Simple Machines

A machine is a device that helps us perform tasks

5 main functions

1. Change energy from 1 form to another

Ex. hydroelectric generators use the movement of water and friction to create energy which can then be turned into electrical energy

2. Change the direction of a force

* + - * + Ex. pulley’s

3. Transfer forces

Ex. a car – hitting the gas pedal makes the engine pistons moves which then makes the car move

4. Change the magnitude of a force

5. Change the direction or speed

1. main types of simple machines

1. Lever family

* + - * Consists of levers, pulleys, wheels, axle, and gears
      * A lever is a rigid bar that can rotate freely around a support
        + Is known as the fulcrum which allows the lever to rotate or pivot
      * Effort force, FE, is force applied to the lever in order to move another part
      * Load force, FL, is the force exerted by load
        + Measurements for levers

1. Perpendicular distance from fulcrum to effort force

Called effort arm, dE

2. Perpendicular distance from fulcrum to load force

Called load arm, dL

* + - * 3 classes of levers:
        + 1. 1st class lever – fulcrum is between load and effort force
        + 2. 2nd class lever – load is between fulcrum and effort force
        + 3. 3rd class lever – effort force is exerted between fulcrum and load

See figure 2-6 pg 72, 73

2. Inclined Plane Family

* + - * Consists of inclined plane, wedge, and screw
        + Inclined plane is a ramp that increases the load that can be raised by an effort force

Ex. ramp or stairs

* + - * + Wedge is a double incline plane that increases the applied force

Ex. axe

A compound machine is made of 2 or more simple machines

* 1. Torque and Levers

Torque is a turning effort caused by a force on an object around an axis or fulcrum

Given symbol, T and measured in N·m

Ex. trying to push a door open

Fulcrum is hinges

The shorter the distance from the fulcrum the larger the force

Therefore, torque increases as force and distance increase

T = Fd

Force is perpendicular to object

Ex. using a screw driver, where the screw acts as the fulcrum

Ex. 1. Calculate the torque on a 35 cm screw driver that requires an applied force of 65 N

T = ? T = Fd

F = 65 N = (65) (0.35)

d = 35 cm = 22.75 N·m

= 0.35 m

For levers we can have 2 types of torque calculations:

1. Effort torque, TE

* + - * T = FEdE

2. Load torque, TL

* + - * TL = FLdL

Both effort and load force are perpendicular to object

Law of lever

When a lever is in static equilibrium the magnitude of the effort and load torques equal

* + - * + Therefore, FEdE = FLdL

Ex. 2. A man wants to place his RV on blocks for the winter but doesn’t have a jack. He uses a metal plank which is 4.3 m long and places a fulcrum 0.6 m from the back of the RV. If the required effort force is 2.8 x 104 N, what is the load force created by the RV?

* 2.4 Mechanical Advantage

Actual mechanical advantage

Ideal mechanical advantage

Helps determine efficiency of machines

If load force = effort force

If load force is greater than effort force

If load forces is less than effort force

Ex. 1. A class 1 lever has a mass of 2.6 kg and an effort force of 72 N. Calculate load force and AMA.

Because AMA is less than 1 the fulcrum must be near effort force

* + Percent efficiency of a machine