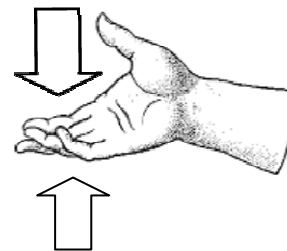


Physical Science Chapters 3, 4 and 5

I. Forces in Fluids

A. **Pressure: a force pushing on a surface**

1. Pressure = Force / Area
2. Unit of measure for Pressure is the Pascal
 - a) 1 Pascal = 1 N / meter²
 - b) Remember that 1 N = 1 Newton = 1kg x 1 meter / 1 second²
 - c) When surface area is smaller than meter² then the unit used is N/cm²
3. Fluid Pressure
 - a) Fluid is a substance that can flow easily. Therefore gas can be classified as a "fluid".
 - b) In fluids, molecules are constantly moving in all directions.
 - c) As a molecule moves and collides w/ a surface, it exerts a force on that surface.
 - d) All of the forces exerted by the individual molecules are added together to make up the pressure exerted by the fluid.
 - e) Fluid Pressure is the total force exerted by the fluid divided by the area over which the force is exerted: Pressure = Force / Area
4. Air Pressure
 - a) At sea level air exerts a pressure of about 14 lbs / inch² in the American system
 - b) In the metric system, air pressure at sea level is about 10.13 N/cm²
 - c) 1 cubic meter of air at sea level weighs about 1 kilogram
 - d) Balanced force when fluid is **NOT** moving: the pressure pushing down on your hand is balanced by the pressure pushing up on your hand
5. Variations in Fluid Pressure
 - a) Air pressure decreases as elevation increases
 - b) Water pressure increases as depth increases



B. **Pascal's Principle**

1. When force is applied to a **CONFINED FLUID**, an increase in pressure is transmitted equally to **ALL** parts of the fluid.
2. Hydraulic lift, hydraulic brakes and starfish tube feet

C. **Archimede's Principle**

1. The buoyant force on an object is equal to the weight of the fluid displaced by the object.
2. The buoyant force is opposite (pushes up) to the force of gravity (pulls down)
3. Archimede's Principle is why boats float
4. Density of water is 1 gm /ml
 - a) If an object has a density greater than water: it sinks, less than water: it floats

D. **Bernoulli's Principle**

1. The pressure exerted by a moving stream of a fluid is less than the pressure of the surrounding fluid.
2. The faster the fluid moves, the less pressure it exerts on the surface of the object
3. Bernoulli's principle is why planes fly!

Chapter 4

Lecture Notes

A. Section 4-1: What is Work?

Work is force exerted on an object that causes the object to move some distance

Force without moving a distance yields **NO WORK!!**

If you push on a wall until your arms are soooooo tired you can't push anymore and the wall doesn't move..... then you have done no work.

If you blow on a piece of paper and it moves..... you have done more work than the example above.

In order for work to be done on an object, the force you apply must be in the same direction as the movement of the object.

The formula for Work:

Work = Force x Distance

SI Unit for work is the **Joule**

1 Joule = 1Newton x 1 Meter

Problems: Work = Force x Distance

How much work performed:

$$85\text{N} \times 3\text{Meters} = 255 \text{ J}$$

$$37\text{N} \times 4.3 \text{ Meters} = 159.1 \text{ J}$$

How much force required:

$$75 \text{ Joules in } 3 \text{ Meters} = 75\text{J} = \text{N} \times 3\text{M} \quad \text{N}=25\text{Newtons}$$

$$124 \text{ Joules in } 12 \text{ Meters} = 124 \text{ J} = \text{N} \times 12\text{M} \quad \text{N}=10.3$$

What distance is covered:

$$12 \text{ newtons of force performs } 24 \text{ Joules of Work } 24=12 \times \text{D} \quad \text{D}=2\text{Meters}$$

$$18 \text{ newtons of force performs } 46.8 \text{ Joules of Work } 46.8=18 \times \text{D}$$

$$\text{D}=2.6\text{Meters}$$

B. Section 4-2 Mechanical Advantage and Efficiency

What is a **Machine**?

A device that makes work easier or more effective

A machine makes work easier by changing the amount of force, the distance covered or by changing the direction of the force

Input Force (AKA the effort force) = the force you exert on the machine

Output Force (AKA resistance force)= the force exerted by the machine

Ideal Situation: the input work into a machine will be exactly the same as the output work of that machine; however, friction causes this not to happen.

Mechanical Advantage

A machine's **mechanical advantage** is the number of times a force exerted on a machine is multiplied.

MA = output force / input force

Efficiency of a machine

Some input work is used to overcome friction, i.e. rusty old scissors are harder to use than new sharp scissors.

Calculate the efficiency of a machine by:

$$\text{efficiency} = \text{output work} / \text{input work} \times 100\%$$

Section 4-3 Simple Machines

Six basic simple machines

Inclined Plane: a flat slanted surface

Wedge: a device thick on one end and thin on the other (an inclined plane tipped on its side)

Screw: an inclined plane wrapped around a cylinder

Lever: a rigid bar that is free to pivot about a fixed point (the fulcrum)

Wheel & Axle: two circular objects attached together about a common axis

Pulley: a grooved wheel w/ a rope or chain wrapped around it.

Inclined Plane

Ideal MA of an incline plane

$$\text{IMA} = \text{length of incline} / \text{height of incline}$$

Examples – handicap ramp, stairs

Input force is the force you use to push or pull the object up the ramp

Output force is the force required to lift the object straight up (its weight)

Wedge

The wedge moves along or thru the object where as the object moves along an incline plane

Examples – ax, wood splitter, zipper

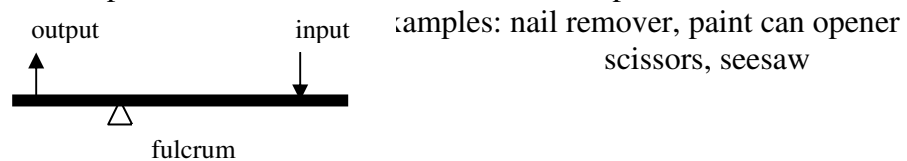
Screw

Examples – screw, bolt, jar lid

Levers –

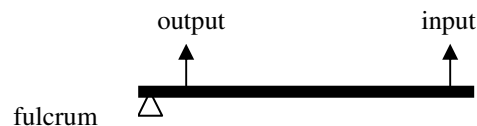
$\text{IMA} = \text{Distance from input force to fulcrum} / \text{distance from output force to fulcrum}$

1st Class –



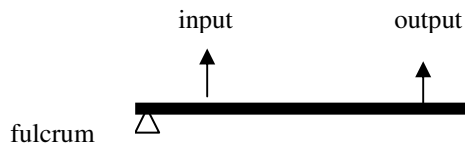
2nd Class -

example: wheel barrow, door, nutcracker



iv. 3rd Class

example: rake, shovel, baseball bat



Wheel and Axle

Wheel is the large cylinder

Axle is the small cylinder

$$\text{IMA} = \text{Radius of the wheel} / \text{radius of the axle}$$

C. Pulley

1. IMA of a pulley system = the number of ropes that support the weight of the object

D. Compound Machines – a machine that utilizes two or more simple machines

Chapter 5
Energy and Power
Lecture Notes

I. 5.1 The Nature of Energy

- a. **Energy** – the ability to do work or cause a change.
 - i. work is the transfer of energy
 - ii. SI unit for energy is the same as the SI unit for work – Joule
- b. Two main types of energy: **Kinetic and Potential**
 - i. **Kinetic Energy**: the energy of motion
 1. The amount of kinetic energy depends on the objects **mass and velocity**
 2. Energy is transferred during work – the more work one does on an object, the more energy one imparts on the object.

3. Calculating Kinetic Energy

$$\text{a. } \underline{\text{Kinetic energy}} = \frac{\text{Mass}}{2} \times \frac{\text{Velocity}^2}{2} \quad \text{K.E} = \frac{10 \text{ kg}}{2} \times \frac{(10\text{m/s})^2}{2}$$

$$\text{K.E.} = \frac{10 \times 100}{2} = \frac{1000}{2} = 500$$

- b. **When mass is doubled; Kinetic Energy is doubled** (from 500 to 1000)

$$\frac{\text{Mass}}{2} \times \frac{\text{Velocity}^2}{2} \quad \text{K.E} = \frac{20 \text{ kg}}{2} \times \frac{(10\text{m/s})^2}{2}$$

$$\text{K.E.} = \frac{20 \times 100}{2} = \frac{2000}{2} = 1000$$

- c. **When velocity is doubled; Kinetic Energy is quadrupled!!** (from 500 to 2000)

$$\frac{\text{Mass}}{2} \times \frac{\text{Velocity}^2}{2} \quad \text{K.E} = \frac{10 \text{ kg}}{2} \times \frac{(20\text{m/s})^2}{2}$$

$$\text{K.E.} = \frac{10 \times 400}{2} = \frac{4000}{2} = 2000$$

- ii. **Potential Energy**: Energy stored for use at a later time

1. **Elastic Potential Energy**:

- a. Energy stored in springs, bow and arrow, stretched elastic or rubber bands.
- b. Associated w/ objects that can be stretched or compressed.

2. **Gravitational Potential Energy**:

- a. **Height** and **weight** dependant
- b. GPE = work done to lift and object to a height
- c. Joules = Newtons x Meters
- d. **GPE = Weight x Height**
- e. Weight = Mass x Acceleration_g = mass x 9.8 m/s²
- f. Therefore..... **GPE = mass x 9.8 m/s² x height**

- iii. Different Forms of Energy

1. **Mechanical** – associated w/ the motion or position of an object

2. **Thermal Energy**– associated w/ the total energy of the particles (atoms and Molecules) in an object. As thermal energy increases, the particles increase in speed and the thermal energy (temperature) of the object increases.
 3. **Chemical Energy** – the energy stored in chemical bonds. The potential energy stored in compounds.
 4. **Electrical Energy** – moving electrical charges. Electricity!!
 5. **Electromagnetic energy** – Travels in waves, associated w/ light, infrared, ultraviolet, microwaves, x-rays, etc.
 6. **Nuclear Energy** – Associated w/ the fusion or fission of nuclear atoms.
- iv. 5.2 Energy Conversion and Conservation
1. Most forms of **energy can be converted from one type to another.**
 - a. Water falling onto a water turbine: mechanical energy converting into electrical energy
 - b. A Toaster: Converts electrical energy into thermal energy to toast bread
 - c. Striking a match: Converts mechanical energy (rubbing the match on a surface) into chemical energy (breaking chemical bonds to form fire) which is converted into thermal energy (heat from the fire) and Electromagnetic energy (see light coming from the fire on the match)
 2. **Conservation of energy**
 - a. **Law of the Conservation of Energy** states that energy cannot be created or destroyed. It simply changes from one form into another
 - b. Part of Einstein’s theory of Relativity tells us that a small amount of mass can be changed directly into a tremendous amount of energy
 - i. **$E = mc^2$**
 1. $E =$ **the energy produced**
 2. $m =$ **the mass being converted**
 3. $c =$ **the speed of light (186,000 miles/second)**
- v. 5.4 Power: the rate at which work is done
1. Power = work / time
 2. Power = **$\frac{\text{Force} \times \text{Distance}}{\text{Time}}$**
 3. SI Unit for Power is the **Watt**
 4. **1 Watt = 1Joule / 1 Second**
 5. 1 Watt is approx the power required to raise a glass of water to your mouth in 1 second.
 6. **1000 watts = 1 kilowatt**
 7. Power can also be described as the rate energy is transferred from one object to another or the rate energy is converted.
 8. **Horsepower** : An American unit of power
 - a. The amount of work a horse does when it lifts 33,000 pounds of coal to a height of 1 foot in 1 minute.
 - b. **1 horsepower = 746 watts**