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## FORCES, MOMENTS AND COUPLES

Force is the :

• influence tending to change the motion of a body or produce stress in a stationary body

vector is represented by an

- arrow that points in the direction the force is applied.
- The longer the arrow, the greater the force
- This mean that force is a vector

If two equal forces act on the same point of a rigid body but in exact opposite directions:

• they cancel each other out.

When two forces are equal in magnitude and in opposite directions but are applied to the body parallel to each other:

• the forces are said to be coupled

# CENTER OF GRAVITY

The CG is the point about which the

• weight of an airplane (or any object) is concentrated.

# ELEMENTS OF THEORY OF STRESS

There are five major stresses to which all aircraft are subjected:

- Tension
- Compression
- Torsion
- Shear
- Bending

Tension:

• is the stress that resists a force that tends to pull something apart.



Compression:

• is the stress that resists a crushing force



Torsion:

• Torsion is the stress that resists twisting



Shear:

• Shear is the stress that resists the force tending to cause one layer of a material to slide over an adjacent layer



Bending Stress:

• a combination of compression and tension.



## STRAIN

If the stress acting on an object is great enough:

• it can cause the object to change its shape or to become distorted.

When an object becomes distorted by an applied force:

the object is said to be strained

# PRESSURE AND BUOYANCY IN LIQUIDS

#### FLUID PRESSURE

The pressure exerted on the bottom of a container by a liquid is determined by the :

• height of the liquid and not by the shape of the container.

pressure due to the height of a fluid column is known as :

• static pressure

When a fluid is in motion, and its velocity is converted to pressure:

that pressure is known as ram

When ram pressure and static pressure are added together:

• the result is known as total pressure

Atmospheric pressure is often measured by a :

mercury barometer



BUOYANCY

Pressure And BuoYancy

Archimeos princiPle:

 Buoyant Force which a FluiD Exerts upon a submerged body is Equal to the weight of FluiD the body displacement

BuoYant Force formula:

Volume of object X density of the fluid displaced

If the buoyant force is more than the object weight:

the object will float

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If the buoyant force is less than the object weight :

the object will sink

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## KINETICS

# SPEED AND VELOCITY

Velocity is that quantity in physics which denotes both ;

- the speed of an object
- the direction in which the object moves

Velocity can be defined as the :

• rate of motion in a particular direction

Velocity is also described as being a

- vector quantity,
- a vector being a line of specific length, having an arrow on one end or the other.

ACCELER ATION	
ACCELERATION	
defined as the	Acceleration - Velocity Final (Vf) - Velocity Initial (Vi)
• rate of change of velocity	Time (t)

## NEWTON'S LAWS OF MOTION

First law:

• Objects at rest tend to remain at rest and objects in motion tend to remain in motion at the same speed and in the same direction, unless acted on by an external force

Second Law:

- When a force acts upon a body, the momentum of that body is changed.
- The rate of change of momentum is proportional to the applied force.



Third Law:

• For every action there is an equal and opposite reaction

#### ROTATIONAL MOVEMENT

Centripetal force is

• inversely proportional to the radius of the circle in which an object travels.

Centripetal force is thus

• directly proportional to the square of the velocity of the object.

The formula for centripetal force is:



# PERIODIC MOVEMENT

## PENDULAR MOTION

Periodic motion is evident during :

• pendular motion and vibration.

The period is the :

• time it takes for the weight to complete one cycle of motion.

 $T = 2\pi \sqrt{\frac{L}{g}}$ 

Where:

T = period in seconds (s)

L = length of the pendulum in feet or meters

g = acceleration of gravity (32.2  $ft/s^2$  or 9.82  $m/s^2$ )

## THEORY OF VIBRATION, HARMONICS, RESONANCE

# VIBRATION

Vibration is periodic motion caused by

• oscillation of the parts of a fluid or an elastic solid whose equilibrium has been disturbed.

Vibratory motion is also known as :

• harmonic motion

Vibration is characterized by having a period

• which is the time it takes for a complete cycle of movement.

frequency is the

number of times per second a complete cycle occurs

The unit of measure for frequency is the :

• hertz (Hz)

One cycle per second is equal to :

• one hertz.



#### Where:

T = period in seconds (s) M = mass in pounds or kilograms (kg) k = force in pound/feet or Newton/meters (N/m)

# HARMONICS

wave pattern results

# RESONANCE

If two pieces of matter have the same natural frequency, and one of them starts to vibrate, it can transfer its wave energy to the other one and cause it to vibrate:

• This transfer of energy is known as resonance.

# VELOCITY RATIO, MECHANICAL ADVANTAGE AND EFFICIENCY:

# SIMPLE MACHINE

Lever

	The 6 simple machines:
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1	2 Pulley
-	3 wheel and axle
-	U ihcliho Plah
-	5 Screw
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#### DYNAMICS

## MASS AND WEIGHT

Mass is :

• a measure of the quantity of matter in an object

Mass = Weight ÷ Acceleration due to gravity

Weight is a :

• measure of the pull of gravity acting on the mass of an object

Weight = Mass × Gravity

## FORCE

Force is the :

• intensity of an impetus, or the intensity of an input.

#### INERTIA

Inertia is the resistance of an object to :

• a change in its state of motion, including changes to its speed or direction.

## WORK

Work in the mechanical sense of the term is done when

- a resistance is overcome by a force acting through a measurable distance.
- Two factors are involved:
- (1) force and
- (2) movement through a distance.

To calculate work, the following formula is used:

Work = Force  $(F) \times Distance (d)$ 

Power

power involves the previously discussed topic of work, which was a force being applied over a

- measured distance,
- but adds one more consideration: time.

The formula for power is as follows:

Power = Force × Distance ÷ Time

Torque

torque is described as a force acting along a

• distance.

Torque is something that creates

• twisting and tries to make something rotate.

Torque = Force × Distance

#### ENERGY

Energy is typically defined as

• something that gives us the capacity to perform work

Potential Energy

Potential energy is defined as:

- energy at rest,
- or energy that is stored

Potential Energy = Weight × Height

Potential energy may be classified into three groups:

- (1) that due to position,
- (2) that due to distortion of an elastic body,
- (3) that which produces work through chemical action.

Kinetic Energy

Kinetic energy is defined as :

• being energy in motion

kinetic energy for something in motion, the following formula is used:



Kinetic Energy = ½ Mass × Velocity<sup>2</sup>

#### MOMENTUM

• Body moving in a constant speed

#### Impulse

In physics

- Force × time is known as impulse.
- Impulse = change in momentum.



## GYROSCOPIC PRINCIPLES

A gyroscope is like a spinning wheel that helps things stay steady or know which way they're turning.

How It Works:

• When the wheel spins, it tries to stay in the same position. This makes it useful for balancing or detecting movement.

- The way the wheel is held (mounted) determines how it can move:
- 1. One Ring: The wheel can only tilt in one direction.
- 2. Two Rings: The wheel can tilt in two directions, making it even more flexible.

## Example:

Imagine holding a spinning toy top. If you try to tilt it, it resists because it wants to keep spinning the same way. A gyroscope works like that but is mounted in rings so it can tilt and turn in specific ways.

This is why gyroscopes are used in airplanes and phones—to help them stay balanced or know which way they're turning

A gyroscope has two key properties when its rotor is spinning:

1, Rigidity in Space: The spinning rotor stays fixed in its orientation, resisting changes in direction. This depends on its weight, speed, size, and low friction. It's used in instruments like attitude indicators to maintain orientation.

2, Precession: When a force is applied, the gyro reacts 90° from the point of force in the direction of its spin. This is used in instruments like turn indicators to measure changes in direction.

## FRICTION

Is the

- actual resistance to be overcome is measured
- not necessarily the weight of the object being moved.

Static Friction:

$$F = kF'$$

**Sliding Friction** 

Sliding friction is the :

• resistance to motion offered by an object sliding over a surface.



### **Rolling Friction**

Resistance to motion is greatly reduced if an object is mounted on :

• wheels or rollers.



#### FLUID DYNAMICS DENSITY

The density of a substance is:

• its weight per unit volume

# SPECIFIC GRAVITY

specific gravity is calculated by

• comparing the weight of a definite volume of the given substance with the weight of an equal volume of water.

The terms "specific weight" or "specific density" are sometimes used to :

• express this ratio

Specific Gravity =  $\frac{\text{Weight of the substance}}{\text{Weight of an equal volume of water}}$ 

or,

Specific Gravity = Density of the substance Density of water

## VISCOSITY

Viscosity is :

• internal resistance to flow

A liquid such as gasoline that has a :

low viscosity flows easily,

while a liquid such as tar that has a :

• high viscosity flows slowly.

Viscosity increases as :

temperature decreases

## PASCAL'S LAW

• pressure set up in a fluid acts equally in all directions



## BERNOULLI'S PRINCIPLE

# 5, BERNOULLI'S PRINCIPLE

• The static pressure of a fluid (liquid or gas) decreases at points where the velocity of the fluid increases, provided no energy is added to nor taken away from the fluid

Or

#### My statement:

• Bernoulli's principle states that an increase in the speed of a fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy

