

## FE Exam Review

Tristan Hill (thill@tnitech.edu)

Mechanical Engineering  
Tennessee Technological University

### Chapter 8 Dynamics - Lecture 1

## Chapter 8 Dynamics - Lecture 1

- Introduction to Dynamics
- Kinematics of a Particle
- Rigid Body Kinematics
- Newton's Laws of Motion
- Examples



image: wikimedia-commons(flickr)

Also in Ch. 8

- Work and Energy Methods
- Kinetics of Rigid Bodies

# Introduction to Dynamics

## What is Dynamics?

- **Dynamics** is a subset of mechanics focused on the motion of bodies and the forces that affect them.
- .. fundamental to many disciplines of engineering.
- .. essential in **mechanical engineering** and **design**.

# Kinematics of a Particle

We begin with a particle (point mass) moving in space.

$$\vec{v} = \frac{d\vec{r}}{dt} = v\hat{e}_t$$

$$\vec{a} = \frac{d\vec{v}}{dt} = \dot{v}\hat{e}_t + v\frac{ds}{dt}\frac{d\hat{e}_t}{ds} = \dot{v}\hat{e}_t + \frac{v^2}{\rho}\hat{e}_n$$

$$\frac{d\hat{e}_t}{ds} = \kappa\hat{e}_n$$

## Kinematics of a Particle

Distance Velocity and the Tangential Component of Acceleration

$$\frac{dv}{dt} = a_t \quad \text{or} \quad v = v_0 + \int a_t dt$$

$$\frac{ds}{dt} = v \quad \text{or} \quad s = s_0 + \int v dt$$

$$v \frac{dv}{ds} = a_t$$

$$v^2 = v_0^2 + 2 \int a_t ds$$

# Kinematics of a Particle

## Constant Tangential Acceleration

$$v = v_0 + a_t t$$

$$s = s_0 + v_0 t + \frac{1}{2} a_t t^2$$

$$v^2 = v_0^2 + 2a_t s$$

# Rigid Body Kinematics

## Rigid Body Kinematics

### Constraint of Rigidity

$$\frac{d}{dt}|\vec{r}_{pq}|^2 = \frac{d}{dt}(\vec{r}_{pq} \cdot \vec{r}_{pq}) = 2\vec{r}_{pq} \cdot \frac{d\vec{r}_{pq}}{dt} = 0$$

### Instantaneous Zero Velocity

# Newton's Laws of Motion

## Newton's Laws of Motion

*Every object persists in its state of rest or uniform motion in a straight line unless it is compelled to change that state by forces impressed on it.*

*Force is equal to the change in momentum ( $mV$ ) per change in time. For a constant mass, force equals mass time acceleration ( $F = ma$ ).*

*For every action, there is an equal and opposite re-action.*



# Newton's Laws of Motion

$$\vec{f} = m\vec{a}$$

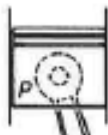
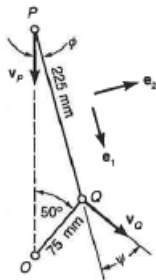
$$\vec{p} = \sum_i m_i \vec{v}_i$$

$$\frac{d\vec{p}}{dt} = \sum_i m_i \vec{a}_i$$

# Newtons Laws of Motion

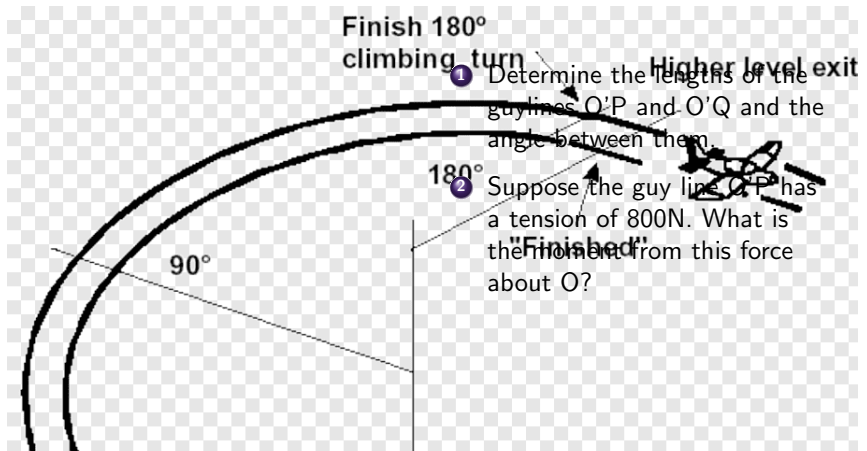


Exhibit 7



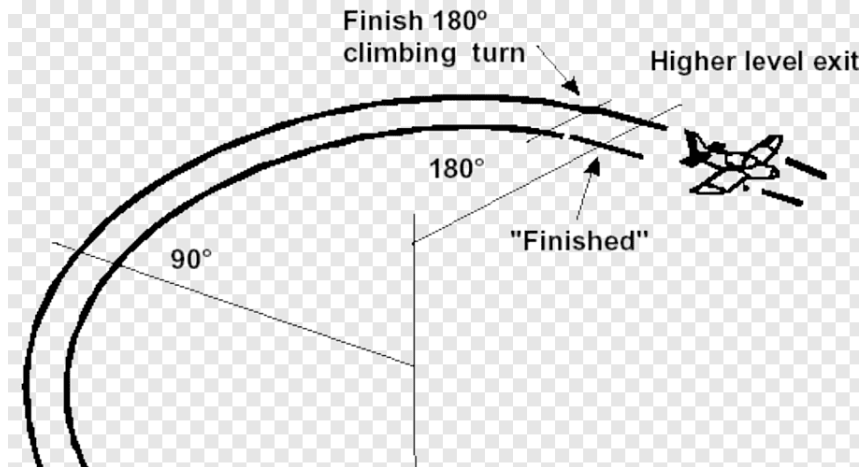
## Examples

### Example 1:



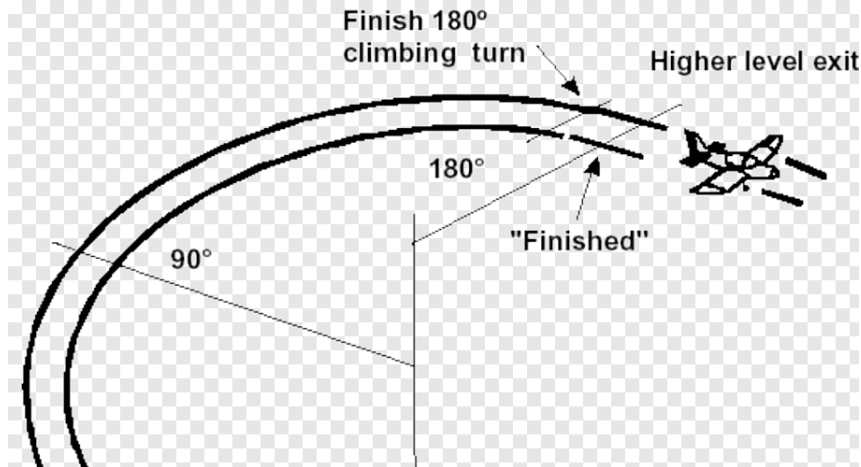
## Examples

Example 1 (cont.):



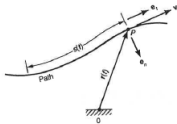
## Examples

Example 1 (cont.):



## Examples

### Example 2:



## Examples

Example 1 (cont.):

