FE Exam Review

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Chapter 8 Dynamics - Lecture 1

Chapter 8 Dynamics - Lecture 1

- Introductory to Dynamics
- Kinematics of a Particle
- Rigid Body Kinematics
- Newtons Laws of Motion
- Examples

Also in Ch. 8

- Work and Energy Methods
- Kinetics of Rigid Bodies

Introductory 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.

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

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

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

Kinematics of a Particle

Distance Velocity and the Tangential Component of Acceleration

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

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

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

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

Kinematics of a Particle

Constant Tangential Acceleration

$$v = v_0 + a_t t$$

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

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

Rigid Body Kinematics

Rigid Body Kinematics
Constraint of Rigidity

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

Instantaneous Zero Velocity

Newtons Laws of Motion

Newtons 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.

Newtons Laws of Motion

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

$$\vec{p} = \Sigma_i m_i v_i$$

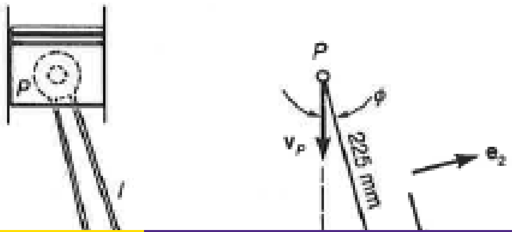
$$\frac{d\vec{p}}{dt} = \Sigma_i m_i a_i$$

Newtons Laws of Motion

As the crank OQ in Exhibit 7 rotates clockwise at 200 rad/s, the piston P moves vertically. What will be the velocity of the piston at the instant when the angle θ is 50 degrees?

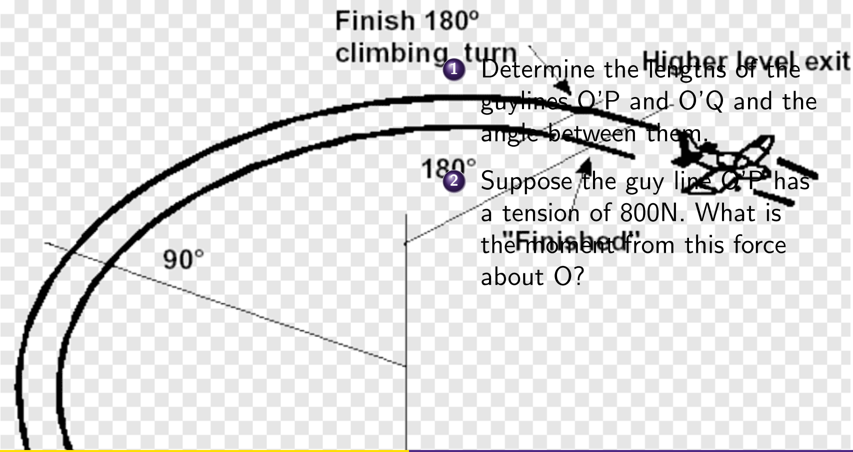
Solution

Since point Q must follow a circular path, its speed may be determined from Eq. (8.15): $v_Q = (0.075\text{ m})(200\text{ s}^{-1}) = 15\text{ m/s}$, with the direction of $\mathbf{v}_Q$ as indicated in the figure. Because the cylinder wall constrains the piston, its velocity is vertical. The connecting rod PQ is rigid, so the velocities of the points P and Q must



Examples

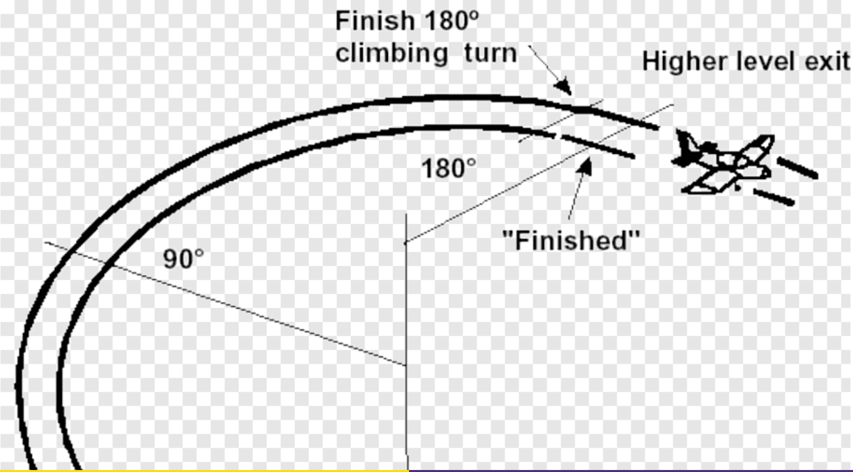
Example 1:



1. Determine the lengths of the guylines O'P and O'Q and the angle between them.
2. Suppose the guy line O'P has a tension of 800N. What is the moment from this force about O?

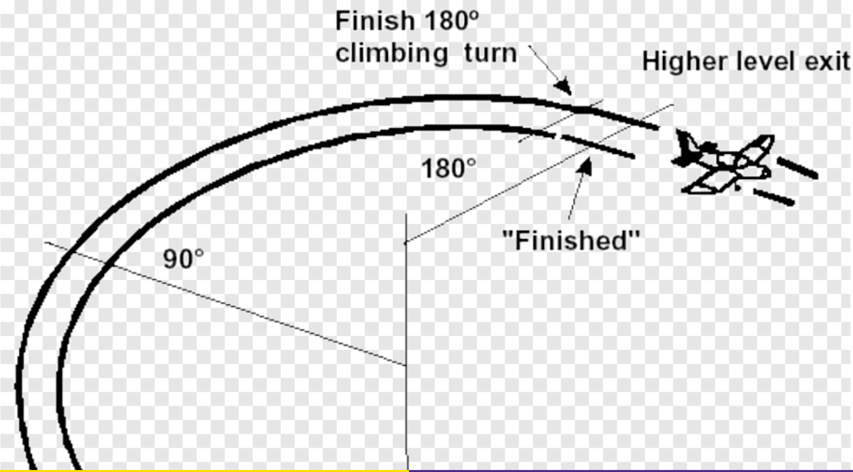
Examples

Example 1 (cont.):



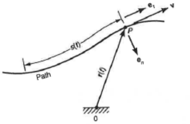
Examples

Example 1 (cont.):



Examples

Example 2:



Examples

Example 1 (cont.):