CEE 271 APPLIED MECHANICS II

Lecture 20: Absolute Motion Analysis

Department of Civil & Environmental Engineering
University of Hawai'i at Mānoa

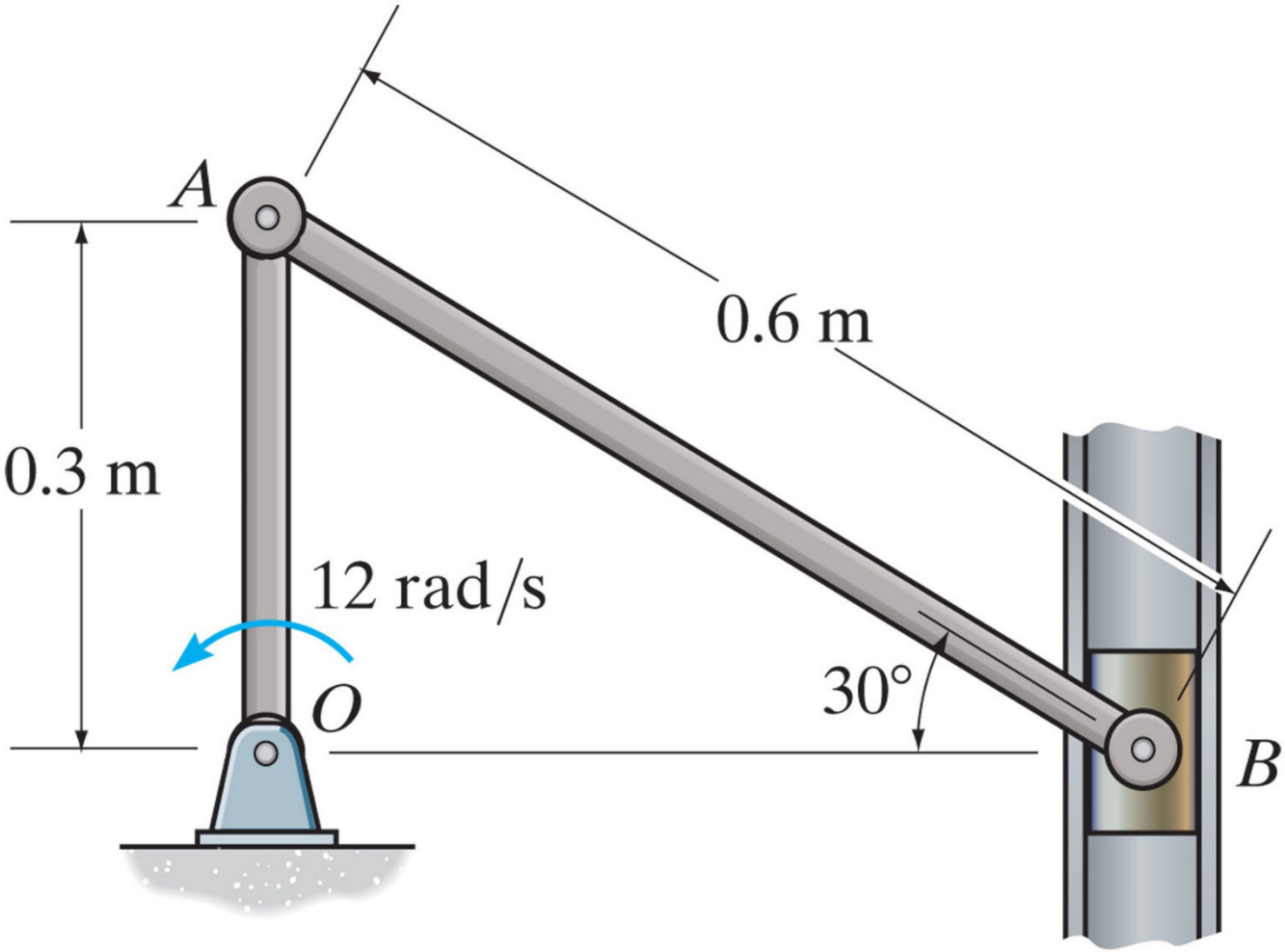
Today's Objectives

- Determine the velocity and acceleration of a rigid body undergoing general plane motion using an **absolute motion analysis**.

Outline (Pre-Job Brief)

- General Plane Motion
- Absolute Motion Analysis
- Examples and Questions
- Summary and Feedback

Absolute Motion Analysis



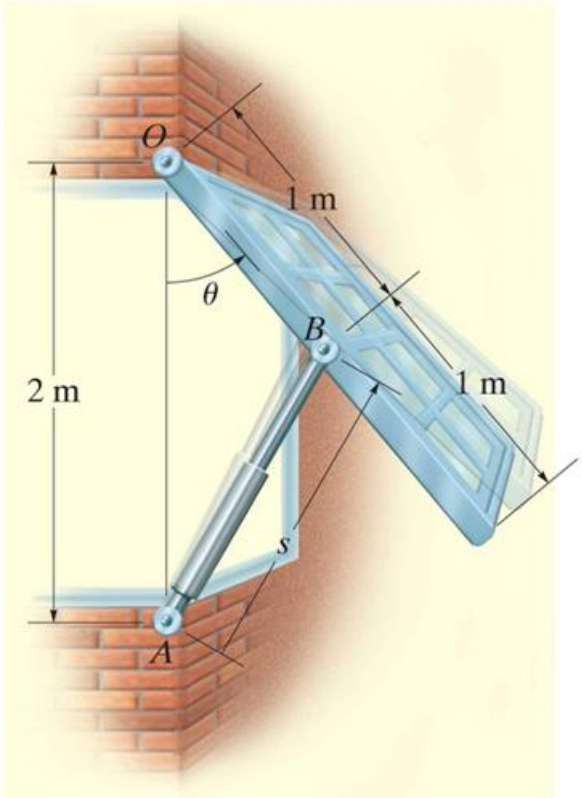
Applications

The dumping bin on the truck rotates about a fixed axis passing through the pin at A. It is operated by the extension of the hydraulic cylinder BC.

The angular position of the bin can be specified using the angular position coordinate θ and the position of point C on the bin is specified using the coordinate s.

As a part of the design process for the truck, an engineer had to relate the velocity at which the hydraulic cylinder extends and the resulting angular velocity of the bin.

Applications (continued)

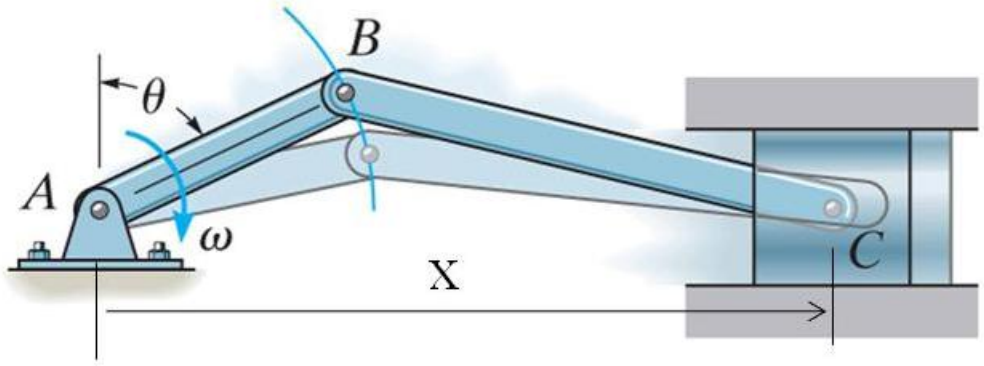


The large window is opened using a hydraulic cylinder AB.

The position B of the hydraulic cylinder rod is related to the angular position, θ, of the window.

A designer has to relate the translational velocity at B of the hydraulic cylinder and the angular velocity and acceleration of the window? How would you go about the task?

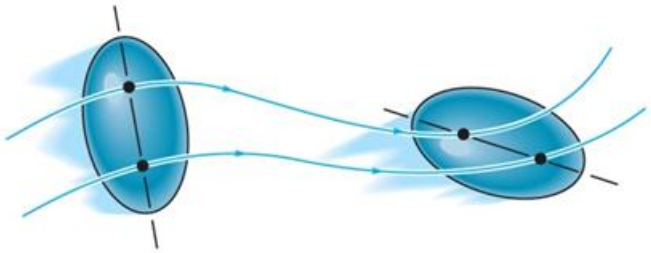
Applications (continued)



The position of the piston, x, can be defined as a function of the angular position of the crank, θ. By differentiating x with respect to time, the velocity of the piston can be related to the angular velocity, ω, of the crank. This is necessary when designing an engine.

The stroke of the piston is defined as the total distance moved by the piston as the crank angle varies from 0 to 180°. How does the length of crank AB affect the stroke?

General Plane Motion

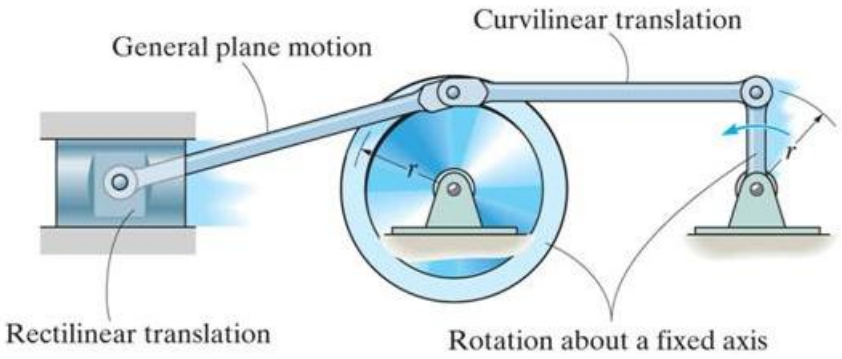


General plane motion

General plane motion: In this case, the body undergoes both translation and rotation.

Translation occurs within a plane and rotation occurs about an axis perpendicular to this plane.

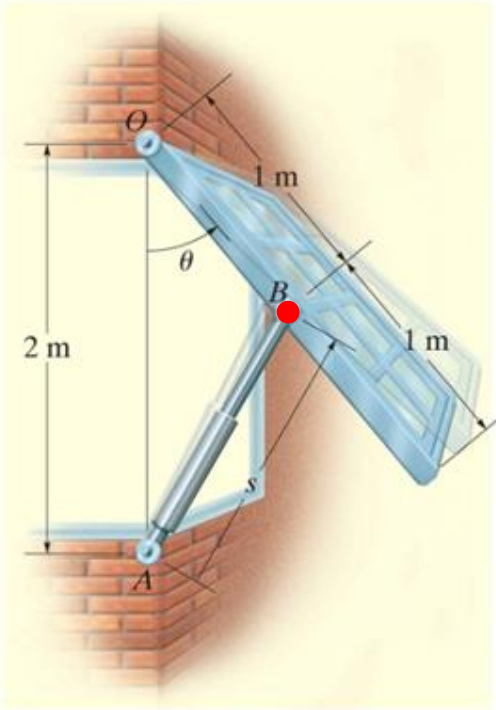
Motion can be completely specified by knowing both the angular rotation of a line fixed in the body and the motion of a point on the body.



The connecting rod undergoes general plane motion, as it will both translate and rotate.

Absolute Motion Analysis

The figure below shows the window using a hydraulic cylinder AB.



The absolute motion analysis method relates the position of a point, B, on a rigid body undergoing rectilinear motion to the angular position, θ, of a line contained in the body.

Once a relationship in the form of $s_B = f(\theta)$ is established, the velocity and acceleration of point B are obtained in terms of the angular velocity and angular acceleration of the rigid body by taking the first and second time derivatives of the position function.

Usually the chain rule must be used when taking the derivatives of the position coordinate equation.

Procedure

The velocity and acceleration of a point undergoing rectilinear motion can be related to the angular velocity and angular acceleration of a line contained within a body using the following procedure.

1. Locate point on the body using position coordinate s, which is measured from a fixed origin.
2. From a fixed reference line, measure the angular position θ of a line lying in the body. Using the dimensions of the body, relate s to θ, e.g., $s = f(\theta)$.
3. Take the first time derivative of $s = f(\theta)$ to get a relationship between v and ω.
4. Take the second time derivative to get a relationship between a and α.

Examples & Questions

Learning Catalytics™

- Please sign in:
  - www.learningcatalytics.com