Constrained Motion of Connected Particles

Lecture 8

ME 231: Dynamics

Question of the Day

How many ***degrees of freedom*** does a computer mouse have?

degrees of freedom ***are translations and/or rotations that specify the position and/or orientation of a system***

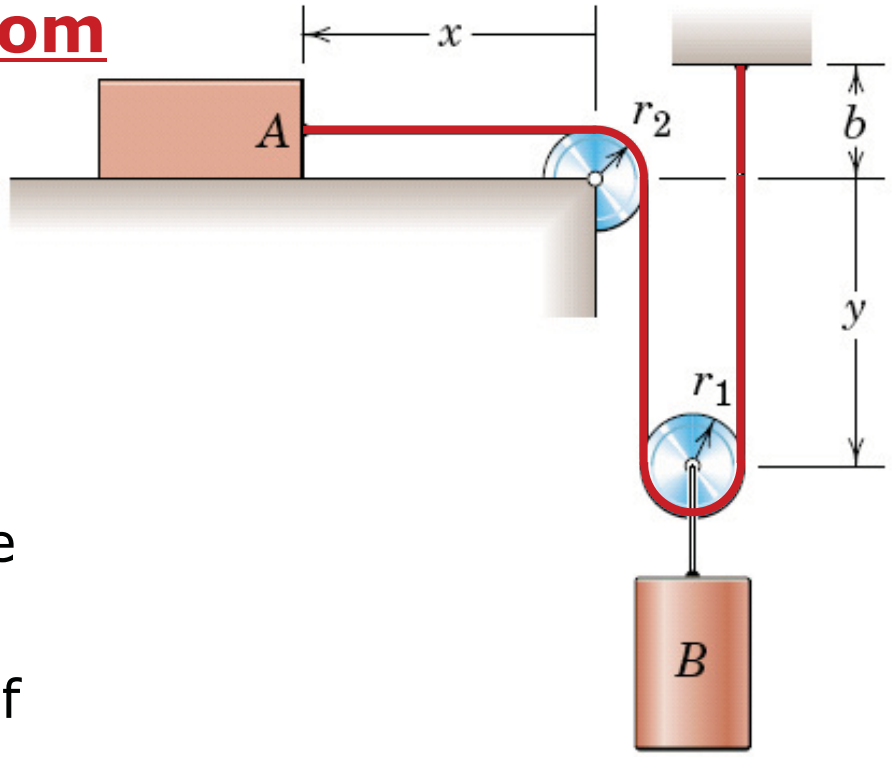
What ***constraints*** are introduced when we use it?

constraints ***are restrictions on translations and/or rotations that limit the position and/or orientation of a system***

Outline for Today

- Question of the day
- One degree of freedom
- Two degrees of freedom
- Answer your questions!

One Degree of Freedom



- Simple system of ***two interconnected particles***
- With L, r_2, r_1, and b are constant
- Horizontal motion (x) of A is twice the vertical motion (y) of B
- Only ***one variable*** (x or y) is needed to specify the ***positions of all parts*** of the system

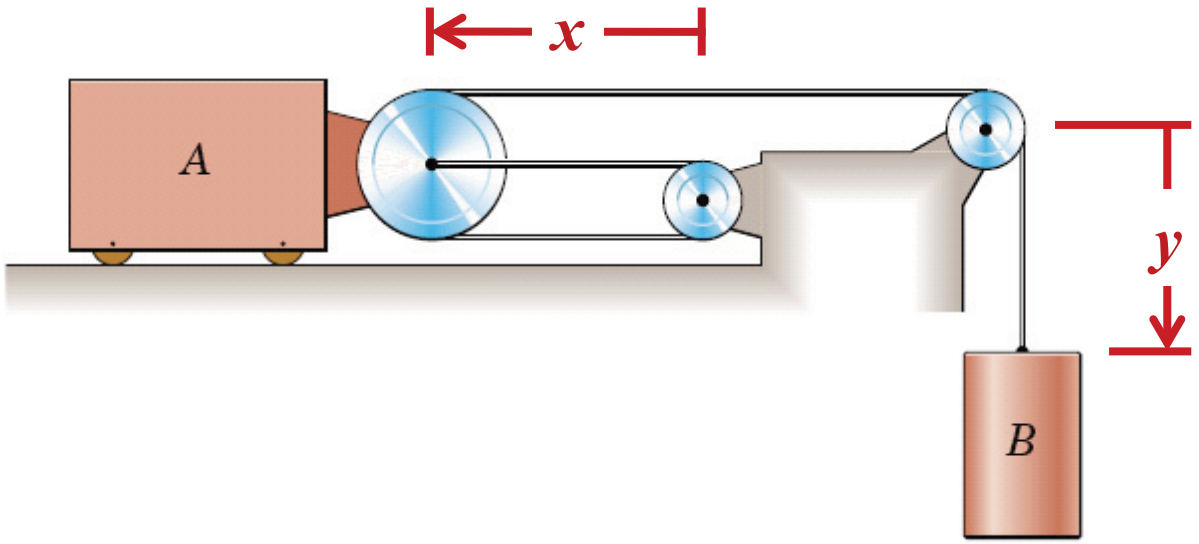
Constraint Equations

$$L = x + \frac{\pi}{2} r_2 + 2y + \pi r_1 + b$$

$$0 = \dot{x} + 2\dot{y} \qquad 0 = v_A + 2v_B$$

$$0 = \ddot{x} + 2\ddot{y} \qquad 0 = a_A + 2a_B$$

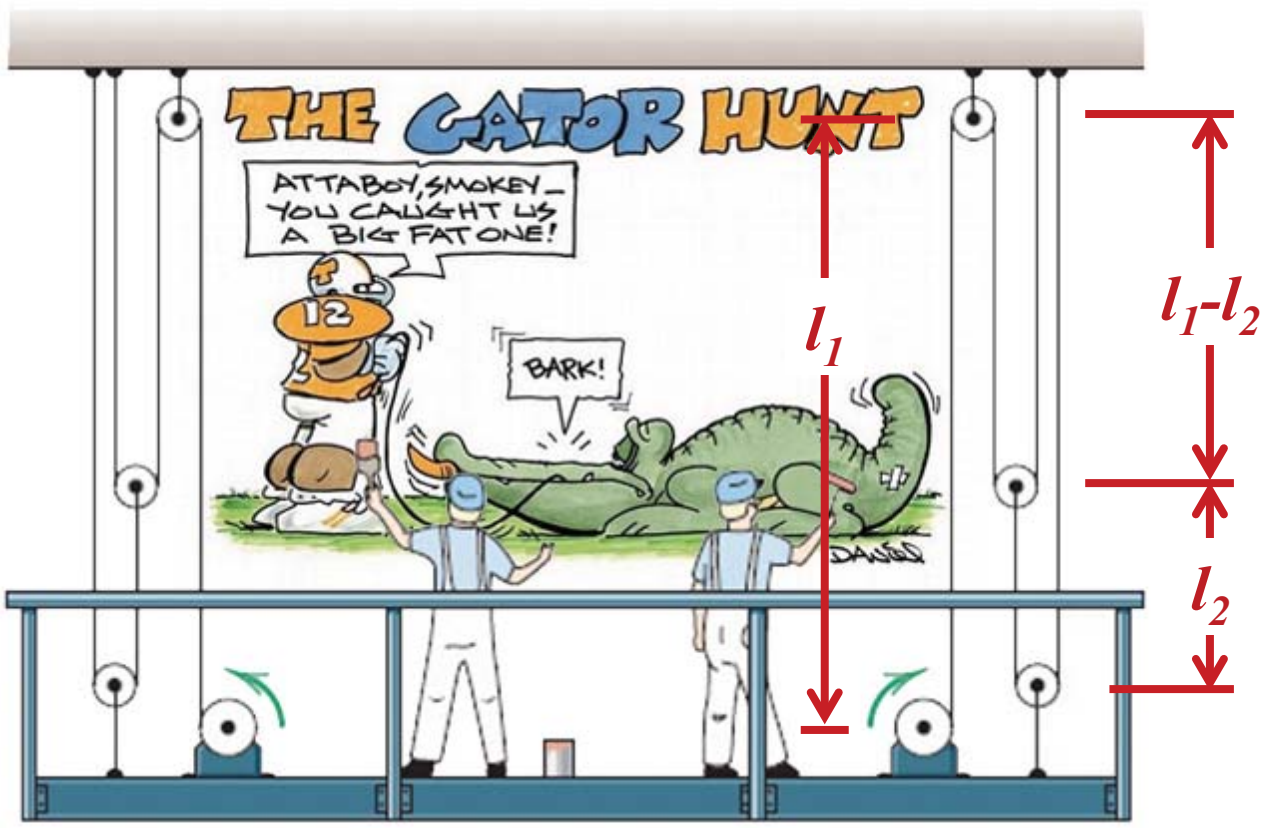
One Degree of Freedom: Exercise



Block A has a ***velocity*** of 3.6 ft/s to the right.

Determine the ***velocity*** of cylinder B.

One Degree of Freedom: Another Exercise



The scaffold is being raised. Each winch drum has a diameter of 200 mm and turns at the rate of 40 rpm.

Determine the upward ***velocity*** of the scaffold.

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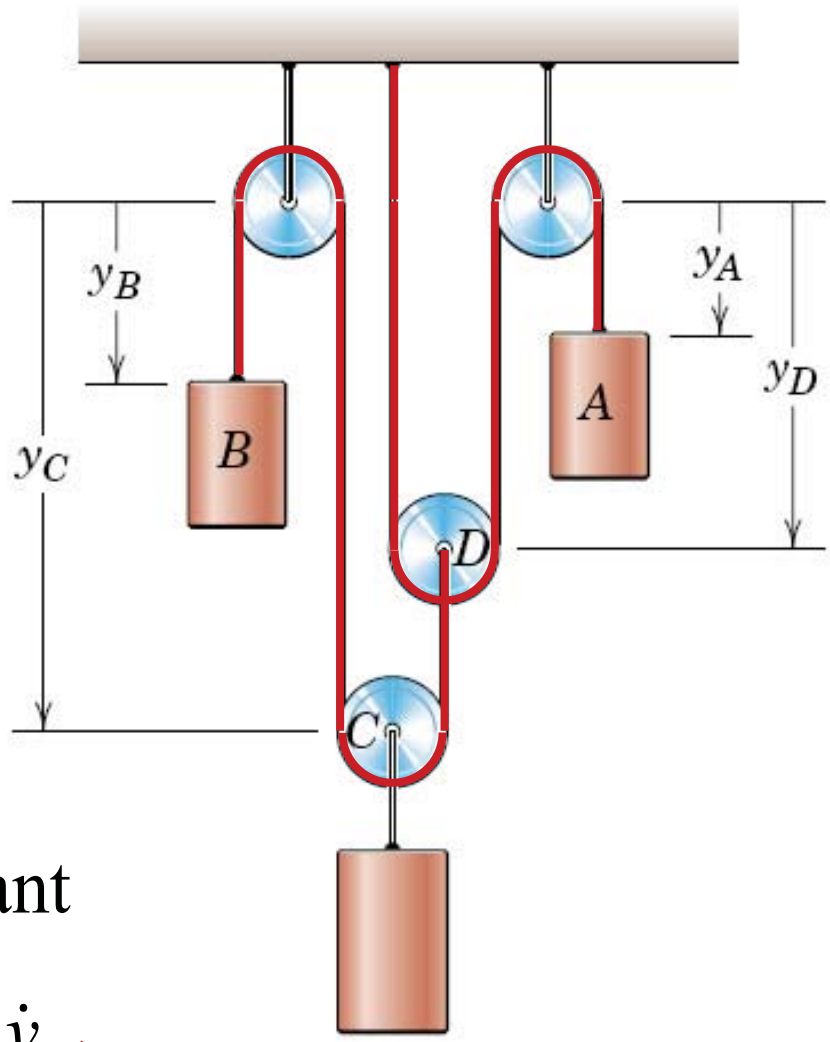
Two Degrees of Freedom



Position of lower cylinder depends on ***two variables*** (y_A and y_B)

Constraint Equations

$$L_A = y_A + 2y_D + \text{constant}$$

$$L_B = y_B + y_C + (y_C - y_D) + \text{constant}$$

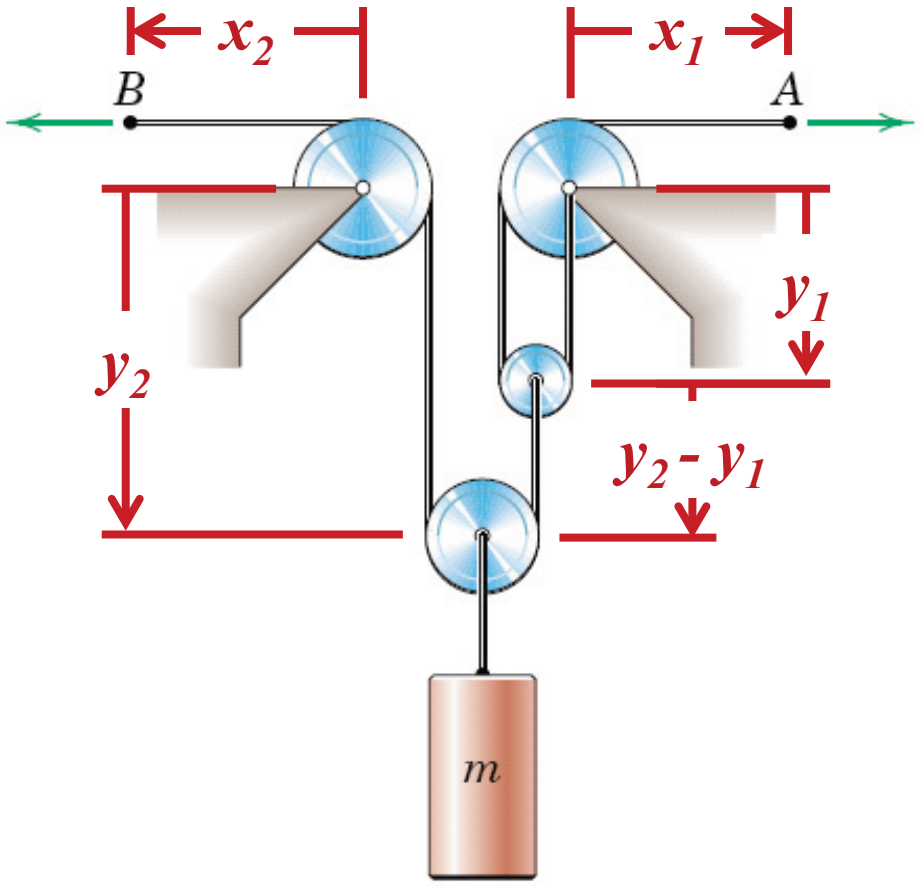
$$0 = \dot{y}_A + 2\dot{y}_D \qquad 0 = \dot{y}_B + 2\dot{y}_C - \dot{y}_D$$

$$0 = \ddot{y}_A + 2\ddot{y}_D \qquad 0 = \ddot{y}_B + 2\ddot{y}_C - \ddot{y}_D$$

$$0 = \dot{y}_A + 2\dot{y}_B + 4\dot{y}_C$$

$$0 = \ddot{y}_A + 2\ddot{y}_B + 4\ddot{y}_C$$

Two Degrees of Freedom: Exercise



Each of the cables at ***A*** and ***B*** is given a ***velocity*** of 2 m/s in the direction of the arrow.

Determine the upward ***velocity*** of load ***m***.

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For Next Time…

- Continue Homework #3 due ***Thursday(9/13)***
- Read Chapter 6, Section 6.1