Dynamics of Particles

1. Introduction to Dynamics : Newton's Laws, units, dimensions
2. Kinematics of Particles
3. Kinetics of Particles
4. Kinetics of Systems of Particles

Dynamics of Rigid Bodies

1. Plane Kinematics of Rigid Bodies
2. Plane Kinetics of Rigid Bodies
3. 3D Dynamics of Rigid Bodies
4. Vibration

Chapter 2. Kinematics of Particles

Rectilinear Motion

Plane Curvilinear Motion

Rectangular coordinate $(x-y)$

Normal and Tangential Coordinate $(n-t)$

Polar Coordinates $(r-\theta)$

Space Curvilinear Motion

Rectangular Coordinates $(x-y-z)$

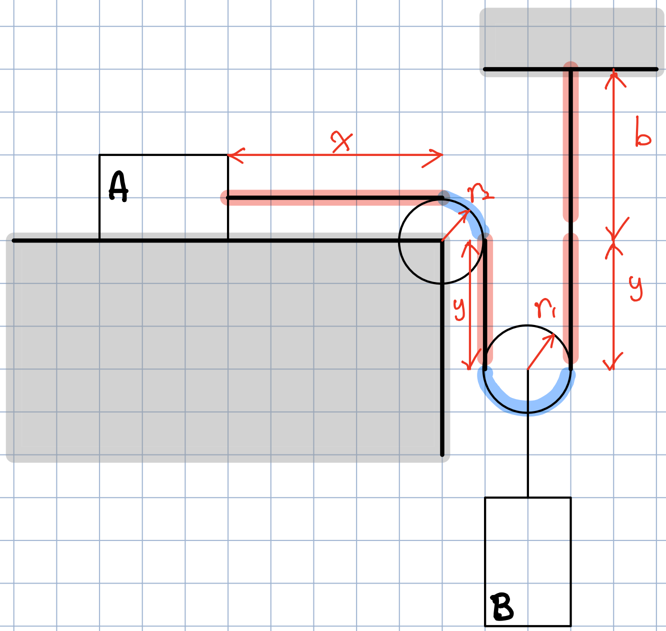
Cylindrical Coordinates $(r-\theta-z)$

Spherical Coordinates $(R-\theta-\phi)$

Constrained Motion of Connected Particles

Constrained Motion of Connected Particles

1. One Degree of Freedom



The length of the cable :

$$L = x + \frac{2\pi r_2}{4} + 2y + \frac{2\pi r_1}{2} + b$$

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

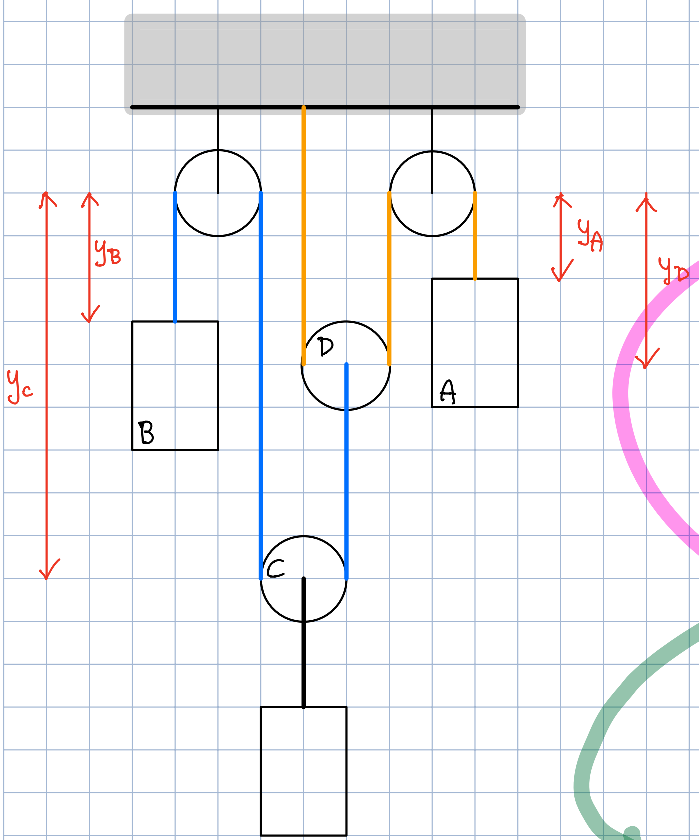
$L,\ r_2,\ r_1,\ b$ = constant

미분

$$\boxed{\begin{aligned} 0 &= \dot{x} + 2\dot{y} \\ 0 &= v_A + 2v_B \end{aligned}}$$

$$\boxed{\begin{aligned} 0 &= \ddot{x} + 2\ddot{y} \\ 0 &= a_A + 2a_B \end{aligned}}$$

2. Two Degree of Freedom



L_A :

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

$$0 = \dot{y}_A + 2\dot{y}_D$$

$$0 = \ddot{y}_A + 2\ddot{y}_D$$

L_B :

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

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

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

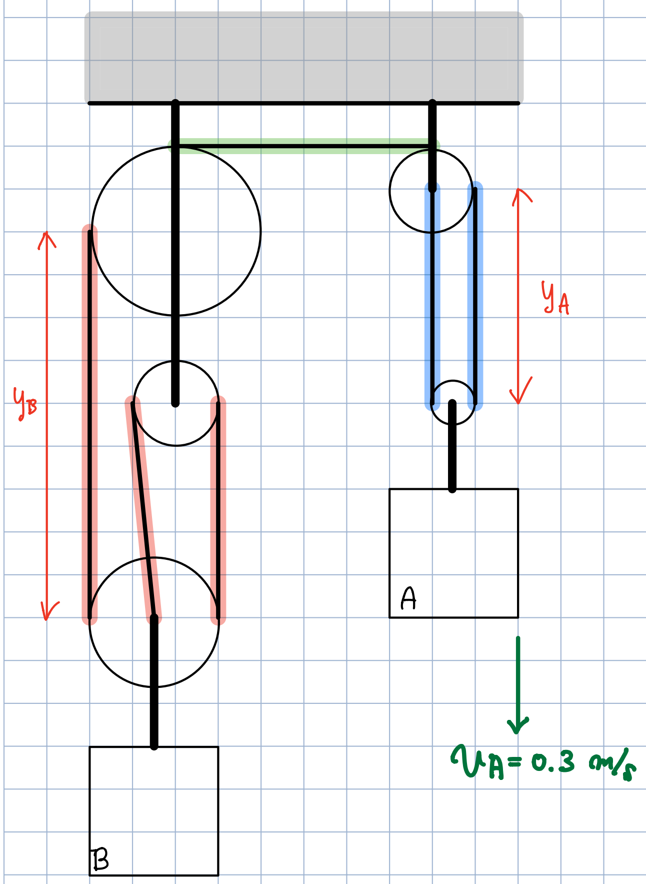
$$2\dot{y}_D = 2\dot{y}_B + 4\dot{y}_C$$

$$0 = \dot{y}_A + 2\dot{y}_B + 4\dot{y}_C \longrightarrow \boxed{v_A + 2v_B + 4v_C = 0}$$

$$\ddot{y}_D = \ddot{y}_B + 2\ddot{y}_C$$

$$0 = \ddot{y}_A + 2\ddot{y}_B + 4\ddot{y}_C \longrightarrow \boxed{a_A + 2a_B + 4a_C = 0}$$

Example > 2.15



A has a downward velocity of 0.3 m/s

Determine the velocity of B.

$$L = 2y_A + 3y_B + \text{const}$$

$$0 = 2\dot{y}_A + 3\dot{y}_B \longleftarrow \dot{y}_A = v_A = 0.3 \ (\downarrow)$$

$$0 = 2v_A + 3v_B$$

$$v_B = -\frac{2}{3} \cdot v_A = -0.2 \text{ m/s}$$

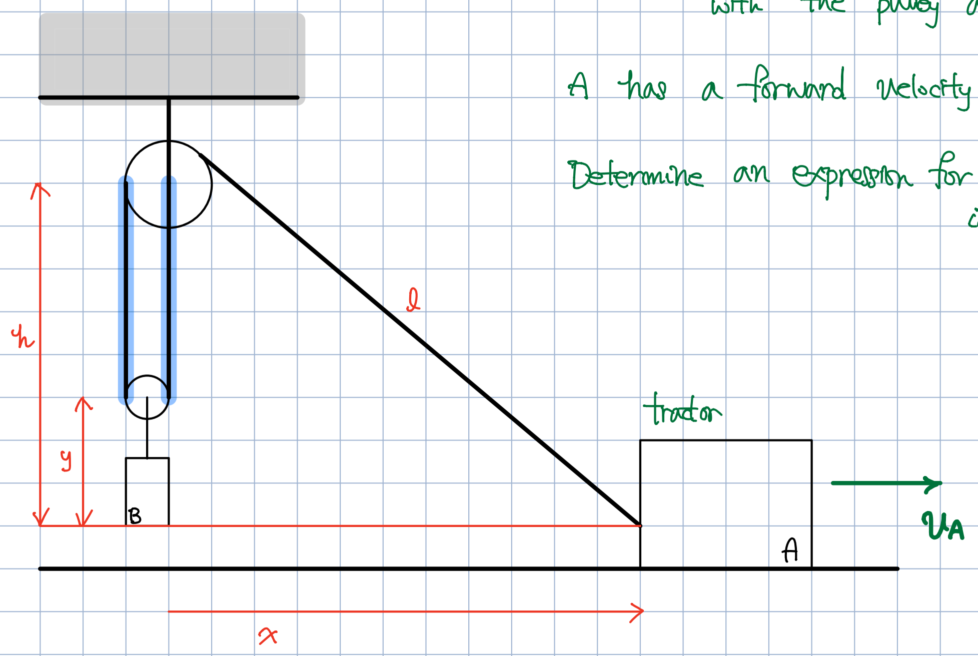
Ans.

Example 2.16

The tractor A is used to hoist B with the pulley arrangement

A has a forward velocity v_A

Determine an expression for upward velocity v_B in terms of x



$$L = l + 2\cdot(h-y)$$

$$0 = \dot{l} - 2\dot{y} \longleftarrow l = \sqrt{x^2+h^2}$$

$$\dot{l} = dl/dt = dl/dx \cdot dx/dt$$

$$dl/dx = \frac{\cancel{2}x}{\cancel{2}\sqrt{x^2+h^2}}$$

$$\dot{l} = \frac{x}{\sqrt{x^2+h^2}} \cdot dx/dt$$

$$= \frac{x}{\sqrt{x^2+h^2}} \cdot \dot{x}$$

$$0 = \frac{x \cdot \dot{x}}{\sqrt{x^2+h^2}} - 2\dot{y}$$

$$v_B = \dot{y} = \frac{x \cdot v_A}{\sqrt{x^2+h^2}}$$

Ans.