


Palestine Technical University- Kadoorie (PTUK)

Mechanical Engineering Department

12210244: Dynamics

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This is an explanation of the Dynamics course offered at Palestine Technical University - Kadoorie

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Textbook:

Engineering Mechanics: Dynamics, 7th Edition

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Chapter Two: Kinematics of Particles

Section Eight: Relative Motion (Translating Axes)

2.8 Relative Motion (Translating Axes)

2.8.1 Vector Representation

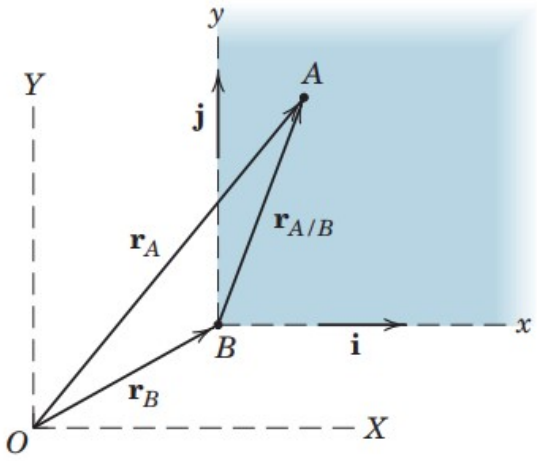


Figure 2/17

2.8.2 Position ($\vec{r}$)

$$\vec{r}_A = \vec{r}_B + \vec{r}_{A/B}$$

2.8.3 Velocity ($\vec{v}$)

$$\dot{\vec{r}}_A = \dot{\vec{r}}_B + \dot{\vec{r}}_{A/B}$$

$$\vec{v}_A = \vec{v}_B + \vec{v}_{A/B}$$

2.8.4 Acceleration ($\vec{a}$)

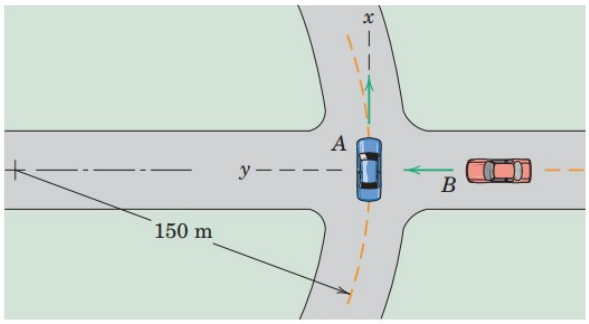
$$\ddot{\vec{r}}_A = \ddot{\vec{r}}_B + \ddot{\vec{r}}_{A/B}$$

$$\vec{a}_A = \vec{a}_B + \vec{a}_{A/B}$$

Example 1:

Car A rounds a curve of 150-m radius at a constant speed of 54 km/h. At the instant represented, car B is moving at 81 km/h but is slowing down at the rate of 3 m/s^2. Determine the velocity and acceleration of car A as observed from car B.

ans. $\vec{v}_{A/B} = 15i - 22.5j\,\text{m/s}$ and $\vec{a}_{A/B} = 4.5j\,\text{m/s}^2$

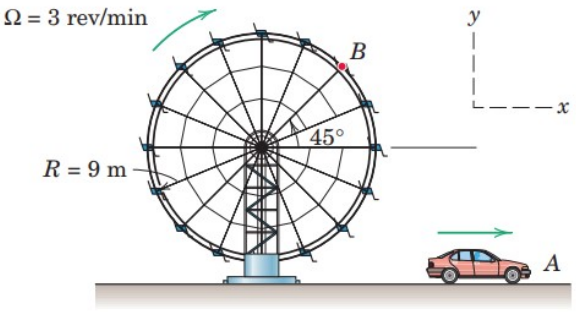


Ans.

Example 2:

The car A has a forward speed of 18 km/h and is accelerating at 3 m/s^2. Determine the velocity and acceleration of the car relative to observer B, who rides in a nonrotating chair on the Ferris wheel. The angular rate $\Omega = 3$ rev/min of the Ferris wheel is constant.

ans. $\vec{v}_{A/B} = 3i + 2j$ m/s and $\vec{a}_{A/B} = 3.63i + 0.628j$ m/s^2

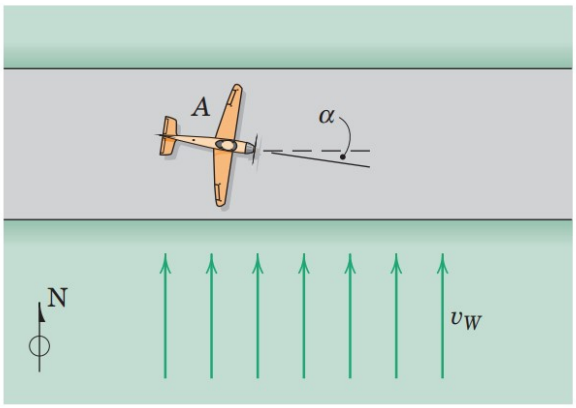


Ans.

Example 3:

A small aircraft A is about to land with an airspeed of 80 mi/hr. If the aircraft is encountering a steady side wind of speed $u_w = 10\ mi/hr$ as shown, at what angle α should the pilot direct the aircraft so that the absolute velocity is parallel to the runway? What is the speed at touchdown?

ans. $\alpha = 7.18^o$ and $v_A = 79.4\ mi/hr$



Ans.

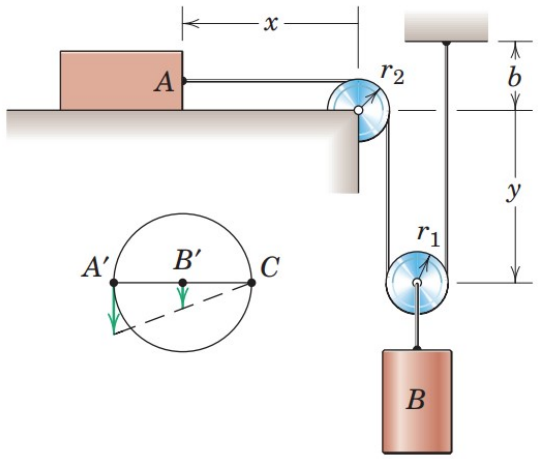
End of Section 2.8

Chapter Two: Kinematics of Particles

Section Nine: Constrained Motion of Connected Particles

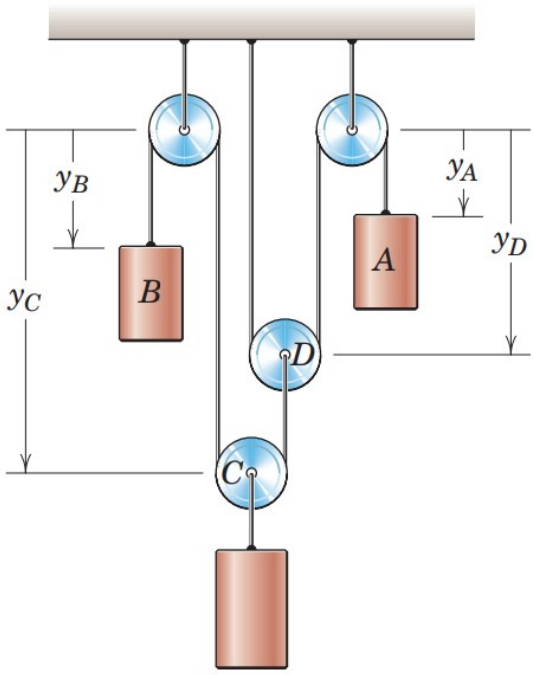
2.9 Constrained Motion of Connected Particles

2.9.1 One Degree of Freedom



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

2.9.2 Two Degrees of Freedom



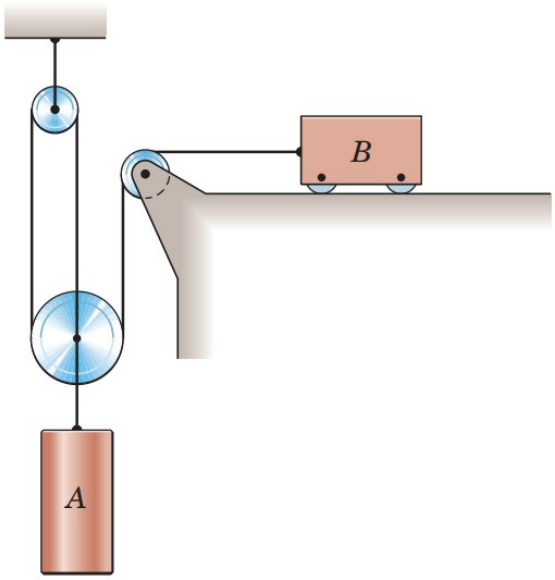
$$L_A = y_A + 2y_D + const$$

$$L_B = y_B + y_C + (y_C - y_D) + const$$

Example 4:

If block B has a leftward velocity of 1.2 m/s, determine the velocity of cylinder A.

ans. $v_A = 0.4\ m/s$ *Downward*

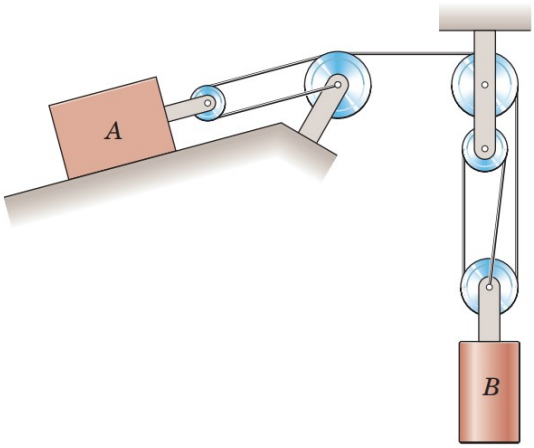


Ans.

Example 5:

At a certain instant, the velocity of cylinder B is 1.2 m/s down and its acceleration is 2 m/s^2 up. Determine the corresponding velocity and acceleration of block A.

ans. $v_A = 1.8\ m/s$ *Upward* $a_A = 3\ m/s^2$ *Downward*

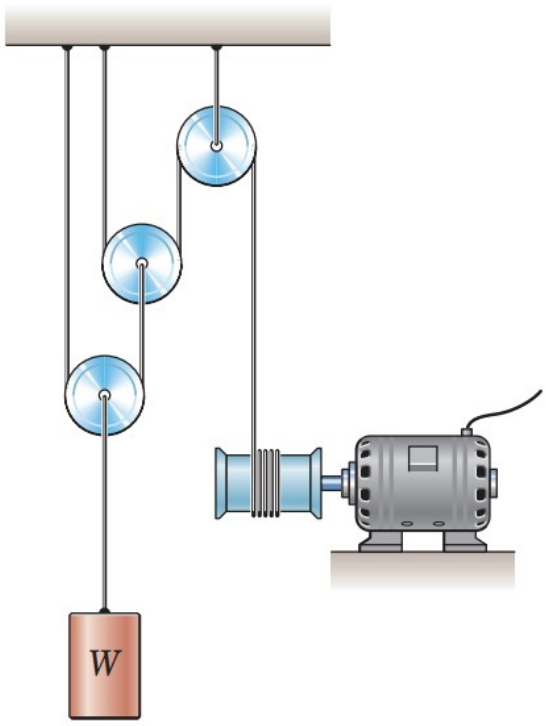


Ans.

Example 6:

Determine the vertical rise h of the load W during 5 seconds if the hoisting drum wraps cable around it at the constant rate of 320 mm/s.

ans. $h = 400\ mm$

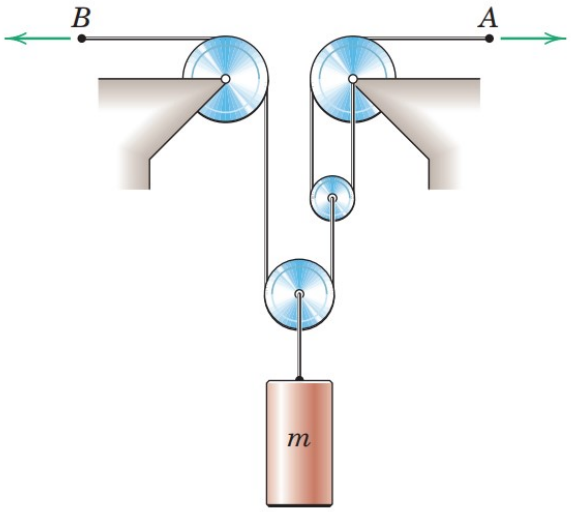


Ans.

Example 7:

For the pulley system shown, 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 v of the load m.

ans. $v = 1.5\ m/s \quad Upward$



End of Section 2.9