Question #1.

Automobile A is traveling along a straight highway, while automobile B is moving along a circular exit ramp having a radius of 150 m as illustrated in Figure 1. The speed of A is being increased at the rate of 1.5 m/s^2 and the speed of B is being decreased at the rate of 0.9 m/s^2. For the position shown, determine:

a) the velocity of A relative to B, and
b) the acceleration of A relative to B.

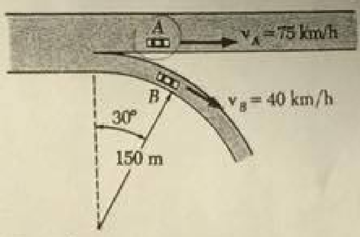

Figure 1.

Question #2.

After rolling down a 20° incline a sphere, having a mass of 0.03 kg, has a velocity of $\vec{v}_o$ at point A, as illustrated in Figure 2. Determine the range of values of $|\vec{v}_o|$ for which the sphere will enter the horizontal pipe BC, having a diameter of 0.5 m, shown.

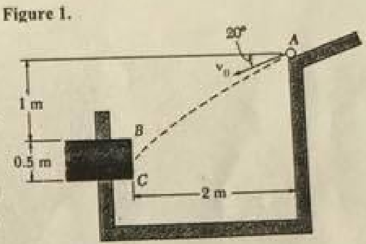

Figure 2.

Question #3.

The mechanism illustrated in Figure 3 is used at a local pumpkin processing facility to generate high quality jack-o-lanterns. Rod BE is the input driving rod to the system and point A will hold a knife edge used for carving pumpkins. Knowing that at the instant shown the velocity of collar D is 1.33 m/s downwards, determine, **using only an analytical method**, the following:

a) the angular velocity of rod BE, and
b) the velocity of point A.

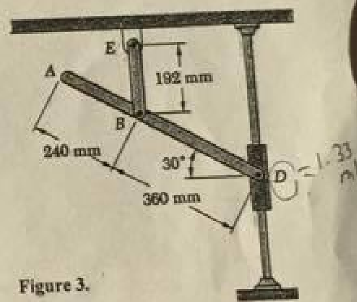

Figure 3.

Note:

$$\vec{a} = \frac{dv}{dt}\cdot\vec{u}_t + \frac{v^2}{\rho}\cdot\vec{u}_n$$

$$\rho = \frac{\left(1+\left(\frac{dy}{dx}\right)^2\right)^{3/2}}{\left|\frac{d^2y}{dx^2}\right|}$$

$$x = x_0 + v_{x0}\cdot t + \frac{a_x\cdot t^2}{2}$$

$$v_x = v_{x0} + a_x\cdot t$$

$$v_2^2 = v_1^2 + 2\cdot a\cdot s$$

$$\theta = \theta_0 + \omega_0\cdot t + \frac{\alpha\cdot t^2}{2}$$

$$\omega_2 = \omega_1 + \alpha\cdot t$$

$$\omega_2^2 = \omega_1^2 + 2\cdot\alpha\cdot\Delta\theta$$

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

$$\vec{a}_A = \vec{a}_B + \vec{\alpha}\times\vec{r}_{A/B} + \vec{\omega}\times(\vec{\omega}\times\vec{r}_{A/B})$$

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

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

Question #1.

A soccer ball is kicked by a player at ground level with an initial speed of 8 m/s at an angle of 40° from the horizontal. For 0.25 seconds after the ball was kicked, determine:

(i) the horizontal and vertical components of the ball's acceleration, and
(ii) the normal and tangential components of the ball's acceleration.

Question #2.

It is known that the static-friction force between the small block B and the plate, both shown in **Figure 1**, will be exceeded and that the block will start sliding on the plate when the total acceleration of the block reaches 4 m/s^2. If the plate starts from rest at $t = 0$ s and is accelerated at the constant rate of 5 rad/s^2, determine the time t and the magnitude of the angular velocity of the plate when the block starts sliding.

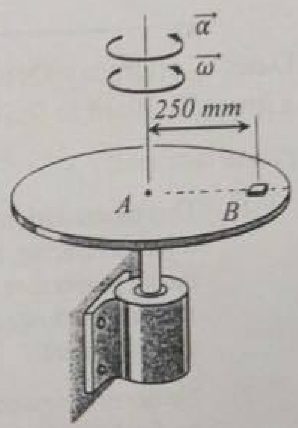

Figure 1

Question #3.

The hydraulic cylinder CD is welded to an arm which rotates clockwise about A at the constant rate $\bar{\omega} = 2.4$ rad/s in the direction shown in **Figure 2**. Knowing that in the position shown rod BE is being moved to the right at a constant rate of 375 mm/s with respect to the cylinder, determine for the instant shown, (a) the velocity of point B, and (b) the acceleration of point B.

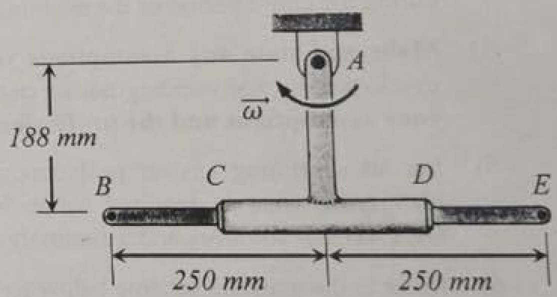

Figure 2.

Note: 12.7

$$\vec{a} = \underbrace{\frac{dv}{dt}\cdot\vec{u}_t}_{a_t} + \underbrace{\frac{v^2}{\rho}\cdot\vec{u}_n}_{an}$$

$$\rho = \frac{\left(1+\left(\frac{dy}{dx}\right)^2\right)^{3/2}}{\left|\frac{d^2y}{dx^2}\right|}$$

$$x = x_0 + v_{x0}\cdot t + \frac{a_x \cdot t^2}{2}$$

$$v_x = v_{x0} + a_x \cdot t$$

$$v_2^{\,2} = v_1^{\,2} + 2\cdot a\cdot s$$

12.6

$$\theta = \theta_0 + \omega_0 \cdot t + \frac{\alpha \cdot t^2}{2}$$

$$\omega_2 = \omega_1 + \alpha \cdot t$$

$$\omega_2^{\,2} = \omega_1^{\,2} + 2\cdot\alpha\cdot\Delta\theta$$

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

$$\vec{a}_A = \vec{a}_B + \vec{\alpha}\times\vec{r}_{A/B} + \vec{\omega}\times(\vec{\omega}\times\vec{r}_{A/B})$$

$$\vec{a}_A = \vec{a}_B + \vec{\alpha}\times\vec{r}_{A/B} + \vec{\omega}\times(\vec{\omega}\times\vec{r}_{A/B}) + 2\cdot\vec{\omega}\times(\vec{v}_{A/B})_{xyz} + (\vec{a}_{A/B})_{xyz}$$

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

$$\vec{v}_A = \vec{v}_B + \vec{\omega}\times\vec{r}_{A/B} + (\vec{v}_{A/B})_{xyz}$$

$$I_{x'} = I_x + A\cdot d^2$$