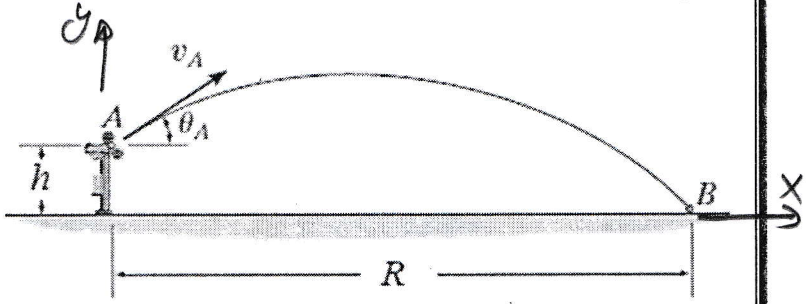
Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Dynamics	**First Quiz**	Course number:620212 class(1)
Instructor: Eng. Laith Batarseh	**Tuesday 7/11/2017**	Allowed time: 10 minutes

Student Name: **Student ID number:**

Problem: The pitching machine has a height (h) = 0.8 m is adjusted so that the baseball is launched with a speed of $v_A = 25$ m/s at angle $\theta_A = 25^o$.If the ball strikes the ground at *B*, determine the range R (in m).



$V_x = 22.66 \frac{m}{s}$ $V_y = 10.57 \frac{m}{s}$

$X_0 = 0 (m)$, $X = R (m)$ $y_0 = 0.8 (m)$ $y = 0 (m)$

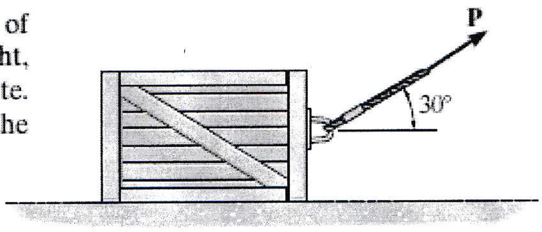
$0 = 0.8 + 10.57t - 4.91t^2 \rightarrow t = \boxed{2.23 sec}, -0.0731$

$R = (2.23)(22.66) = 50.53m$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Dynamics	**Second Quiz**	Course number:620212 class(1)
Instructor: Eng. Laith Batarseh	**Sunday 3/12/2017**	Allowed time: 10 minutes

Student Name: **Student ID number:**

If the 50-kg crate starts from rest and achieves a velocity of $v = 4$ m/s when it travels a distance of 5 m to the right, determine the magnitude of force **P** acting on the crate. The coefficient of kinetic friction between the crate and the ground is $\mu_k = 0.3$.



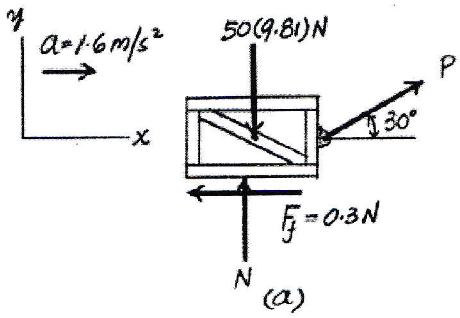
SOLUTION

Kinematics: The acceleration **a** of the crate will be determined first since its motion is known.

$(\xrightarrow{+})\quad v^2 = v_0^{\,2} + 2a_c(s - s_0)$

$$4^2 = 0^2 + 2a(5 - 0)$$

$$a = 1.60 \text{ m/s}^2 \rightarrow$$



Free-Body Diagram: Here, the kinetic friction $F_f = \mu_k N = 0.3N$ is required to be directed to the left to oppose the motion of the crate which is to the right, Fig. *a*.

Equations of Motion:

$+\uparrow \Sigma F_y = ma_y;\quad N + P\sin 30° - 50(9.81) = 50(0)$

$$N = 490.5 - 0.5P$$

Using the results of **N** and **a**,

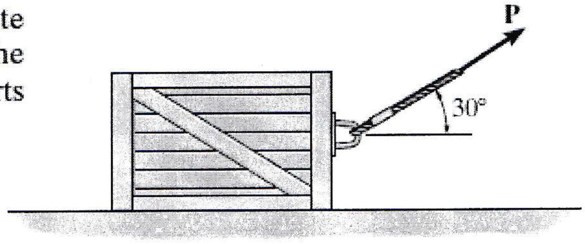
$\xrightarrow{+} \Sigma F_x = ma_x;\quad P\cos 30° - 0.3(490.5 - 0.5P) = 50(1.60)$

$$P = 224 \text{ N}$$ **Ans.**

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Dynamics	**Second Quiz**	Course number:620212 class(1)
Instructor: Eng. Laith Batarseh	**Sunday 3/12/2017**	Allowed time: 10 minutes

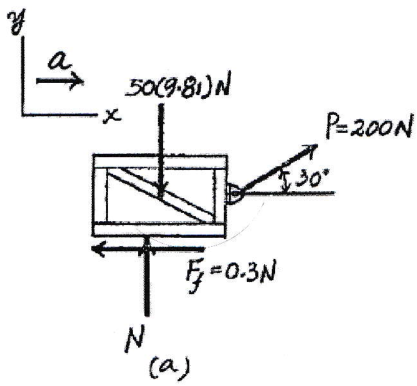
Student Name: **Student ID number:**

If the coefficient of kinetic friction between the 50-kg crate and the ground is $\mu_k = 0.3$, determine the distance the crate travels and its velocity when $t = 3$ s. The crate starts from rest, and $P = 200$ N.



SOLUTION

Free-Body Diagram: The kinetic friction $F_f = \mu_k N$ is directed to the left to oppose the motion of the crate which is to the right, Fig. *a*.



Equations of Motion: Here, $a_y = 0$. Thus,

$$+\uparrow \Sigma F_y = 0; \qquad N - 50(9.81) + 200\sin 30^\circ = 0$$

$$N = 390.5 \text{ N}$$

$$\overset{+}{\rightarrow} \Sigma F_x = ma_x; \quad 200\cos 30^\circ - 0.3(390.5) = 50a$$

$$a = 1.121 \text{ m/s}^2$$

Kinematics: Since the acceleration **a** of the crate is constant,

$$(\overset{+}{\rightarrow}) \qquad v = v_0 + a_c t$$

$$v = 0 + 1.121(3) = 3.36 \text{ m/s} \qquad \textbf{Ans.}$$

and

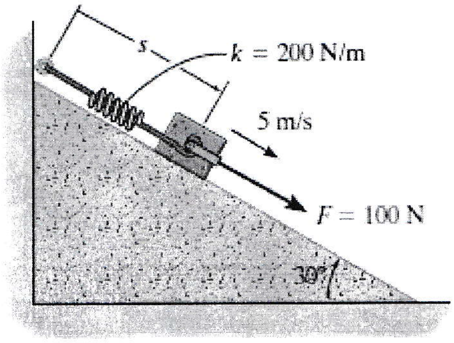
$$(\overset{+}{\rightarrow}) \qquad s = s_0 + v_0 t + \frac{1}{2}a_c t^2$$

$$s = 0 + 0 + \frac{1}{2}(1.121)(3^2) = 5.04 \text{ m} \qquad \textbf{Ans.}$$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Dynamics	third: ~~**Second**~~ **Quiz**	Course number:620212 class(1)
Instructor: Eng. Laith Batarseh	**Sunday 3/12/2017**	Allowed time: 10 minutes

Student Name: Typical **Student ID number:**

When $s = 0.6$ m, the spring is unstretched and the 10-kg block has a speed of 5 m/s down the smooth plane. Determine the distance s when the block stops.



Sol:

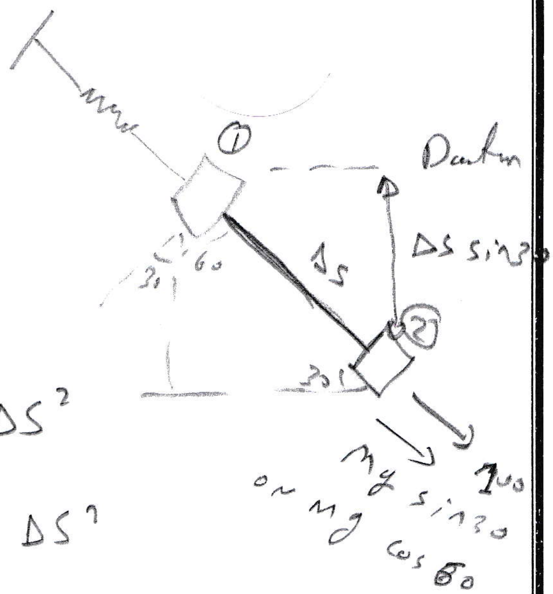
1) Work & Energy:

$T_1 + \sum U_{1-2} = T_2$

$V_1 = 5\,\frac{m}{s}$, $m = 10$ kg

$T_1 = \frac{1}{2} m v_1^2 = \frac{1}{2}(10)(5)^2 = 125$ J

$T_2 = 0 \quad (V_2 = 0)$



$\overset{s+}{\rightarrow} \sum U_{1-2} = F\,\Delta s + mg\sin 30\,\Delta s - \frac{1}{2}k\,\Delta s^2$

$\sum U_{1-2} = 100\,\Delta s + 10(9.81)\sin 30\,\Delta s - \frac{1}{2}200\,\Delta s^2$

$= 149.05\,\Delta s - 100\,\Delta s^2$ --(1)

$\Rightarrow 125 + 149.05\,\Delta s - 100\,\Delta s^2 = 0 \rightarrow \Delta s = 2.08$ m ✓ $\quad -0.598$ m ✗

$s = 2.08 + 0.6 = 2.68$ m

2) Energy conservation: $T_1 + \cancel{V_1}^{\,0} + U_F = \cancel{T_2}^{\,0} + V_2$

$\frac{1}{2} m v_1^2 + 100\,\Delta s = -mg(\sin 30\,\Delta s) + \frac{1}{2}k\,\Delta s^2$

$125 + 100\,\Delta s = -49.05\,\Delta s + 100\,\Delta s^2$

$-100\,\Delta s^2 + 149.05\,\Delta s + 125 = 0$ (same as Eq(1))

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Dynamics	**Third Quiz**	Course number:620212 class(1)
Instructor: Eng. Laith Batarseh	**Tuesday 19/12/2017**	Allowed time: 10 minutes

Student Name: **Student ID number:**

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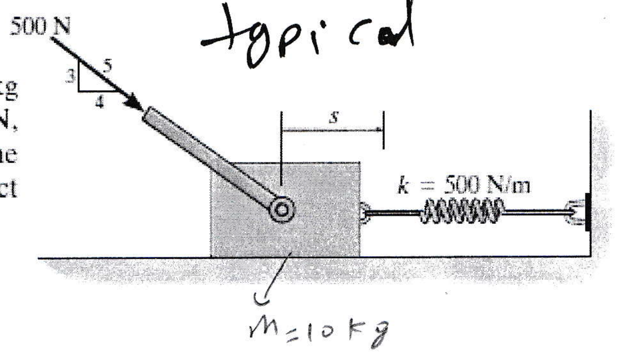
topical

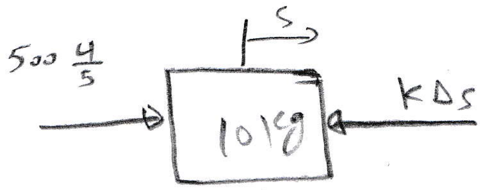
The spring is placed between the wall and the 10-kg block. If the block is subjected to a force of $F = 500$ N, determine its velocity when $s = 0.5$ m. When $s = 0$, the block is at rest and the spring is uncompressed. The contact surface is smooth.



Solution:-

$S_0 = 0\,m \quad V_0 = 0\,\frac{m}{s} \;,\; S = 0.5\,m$

$V = ??$



Work & Energy:-

$T_1 + U_{1-2} = T_2$

$\cancel{\frac{1}{2} m V_0^2} + \left[500\,\frac{4}{5}(0.5) - \frac{1}{2}\,500\,(0.5)^2\right] = \frac{1}{2}(10)\,V^2$

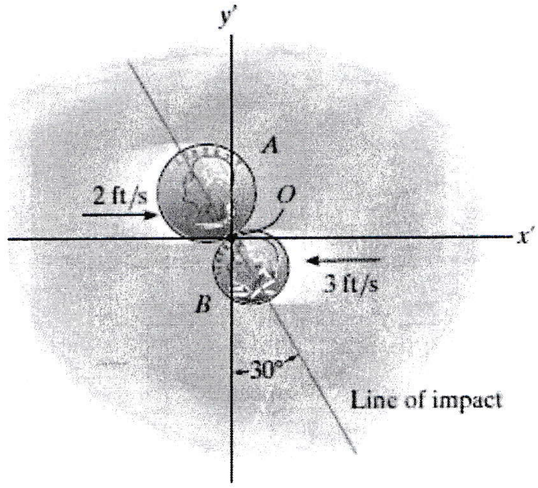
$\Rightarrow V = 5.24\,\frac{m}{s}$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Dynamics	**4^{th} and 5^{th} Quiz**	Course number:620212 class(1)
Instructor: Eng. Laith Batarseh	**Thursday 11/1/2018**	Allowed time: 20 minutes

Student Name: **Student ID number:**

Problem1:

Two coins A and B have the initial velocities shown just before they collide at point O. If they have weights of $W_A = 13.2(10^{-3})$ lb and $W_B = 6.60(10^{-3})$ lb and the surface upon which they slide is smooth, determine their speeds just after impact. The coefficient of restitution is $e = 0.65$.



$$(+\searrow) \qquad m_A(v_{A_x})_1 + m_B(v_{B_x})_1 = m_A(v_{A_x})_2 + m_B(v_{B_x})_2$$

$$\left(\frac{13.2(10^{-3})}{32.2}\right)2\sin 30^\circ - \left(\frac{6.6(10^{-3})}{32.2}\right)3\sin 30^\circ$$

$$= \left(\frac{13.2(10^{-3})}{32.2}\right)(v_{A_x})_2 + \left(\frac{6.6(10^{-3})}{32.2}\right)(v_{B_x})_2$$

$$(+\searrow) \qquad e = \frac{(v_{B_x})_2 - (v_{A_x})_2}{(v_{A_x})_1 - (v_{B_x})_1} \qquad 0.65 = \frac{(v_{B_x})_2 - (v_{A_x})_2}{2\sin 30^\circ - (-3\sin 30^\circ)}$$

Solving:

$(v_{A_x})_2 = -0.3750$ ft/s

$(v_{B_x})_2 = 1.250$ ft/s

$$(+\nearrow) \qquad m_A(v_{A_y})_2 = m_A(v_{A_y})_2$$

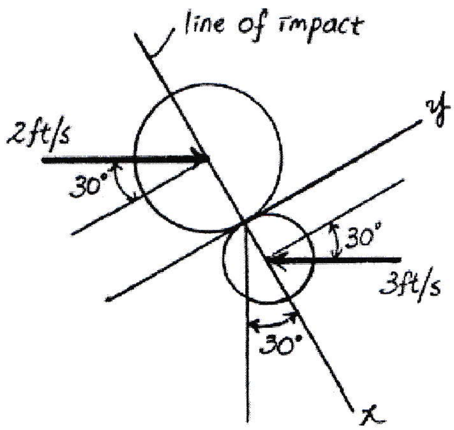
$$\left(\frac{13.2(10^{-3})}{32.2}\right)2\cos 30^\circ = \left(\frac{13.2(10^{-3})}{32.2}\right)(v_{A_y})_2$$

$(v_{A_y})_2 = 1.732$ ft/s

$$(+\swarrow) \qquad m_B(v_{B_y})_1 = m_B(v_{B_y})_2$$

$$\left(\frac{6.6(10^{-3})}{32.2}\right)3\cos 30^\circ = \left(\frac{6.6(10^{-3})}{32.2}\right)(v_{B_y})_2$$

$(v_{B_y})_2 = 2.598$ ft/s



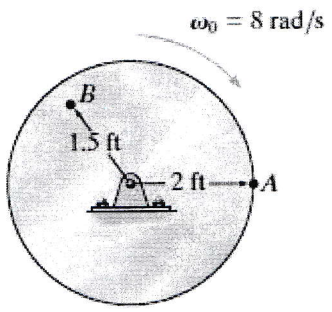
Thus:

$(v_B)_2 = \sqrt{(1.250)^2 + (2.598)^2} = 2.88$ ft/s **Ans.**

$(v_A)_2 = \sqrt{(-0.3750)^2 + (1.732)^2} = 1.77$ ft/s **Ans.**

Problem 2:

The disk is originally rotating at $\omega_0 = 8\ \text{rad/s}$. If it is subjected to a constant angular acceleration of $\alpha = 6\ \text{rad/s}^2$, determine the magnitudes of the velocity and the n and t components of acceleration of point A at the instant $t = 0.5$ s.



$\omega = \omega_0 + \alpha_c t$

$\omega = 8 + 6(0.5) = 11\ \text{rad/s}$

$v = r\omega;\quad v_A = 2(11) = 22\ \text{ft/s}$

$a_t = r\alpha;\quad (a_A)_t = 2(6) = 12.0\ \text{ft/s}^2$

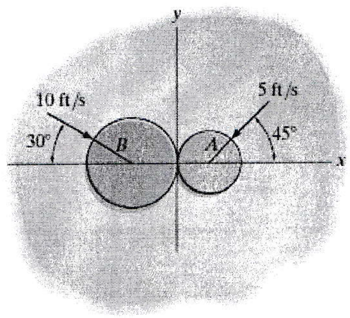
$a_n = \omega^2 r;\quad (a_A)_n = (11)^2(2) = 242\ \text{ft/s}^2$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Dynamics	**4th and 5th Quiz**	Course number:620212 class(1)
Instructor: Eng. Laith Batarseh	**Thursday 11/1/2018**	Allowed time: 20 minutes

Student Name: **Student ID number:**

Problem1:

Two disks A and B weigh 2 lb and 5 lb, respectively. If they are sliding on the smooth horizontal plane with the velocities shown, determine their velocities just after impact. The coefficient of restitution between the disks is $e = 0.6$.



Conservation of Linear Momentum: By referring to the impulse and momentum of the system of disks shown in Fig. *a*, notice that the linear momentum of the system is conserved along the n axis (line of impact). Thus,

$$(\overset{+}{\rightarrow}) \qquad m_A(v_A)_n + m_B(v_B)_n = m_A(v'_A)_n + m_B(v'_B)_n$$

$$-\frac{2}{32.2}(5)\cos 45^\circ + \frac{5}{32.2}(10)\cos 30^\circ = \frac{2}{32.2}v'_A\cos\theta_A + \frac{5}{32.2}v'_B\cos\theta_B$$

$$2v'_A\cos\theta_A + 5v'_B\cos\theta_B = 36.23 \qquad (1)$$

Also, we notice that the linear momentum a of disks A and B are conserved along the t axis (tangent to the plane of impact). Thus,

$$(+\downarrow) \qquad m_A(v_A)_t = m_A(v'_A)_t$$

$$\frac{2}{32.2}(5)\sin 45^\circ = \frac{2}{32.2}v'_A\sin\theta_A$$

$$v'_A\sin\theta_A = 3.5355 \qquad (2)$$

and

$$(+\downarrow) \qquad m_B(v_B)_t = m_B(v'_B)_t$$

$$\frac{2}{32.2}(10)\sin 30^\circ = \frac{2}{32.2}v'_B\sin\theta_B$$

$$v'_B\sin\theta_B = 5 \qquad (3)$$

Coefficient of Restitution: The coefficient of restitution equation written along the n axis (line of impact) gives

$$(\overset{+}{\rightarrow}) \qquad e = \frac{(v'_A)_n - (v'_B)_n}{(v_B)_n - (v_A)_n}$$

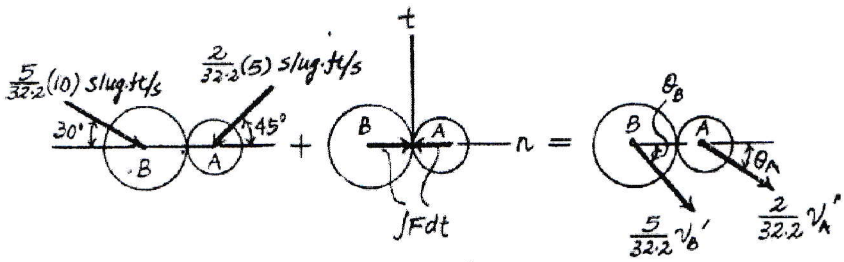
$$0.6 = \frac{v'_A\cos\theta_A - v'_B\cos\theta_B}{10\cos 30^\circ - (-5\cos 45^\circ)}$$

$$v'_A\cos\theta_A - v'_B\cos\theta_B = 7.317 \qquad (4)$$

Solving Eqs. (1), (2), (3), and (4), yields

$v'_A = 11.0$ ft/s $\qquad \theta_A = 18.8^\circ$ **Ans.**

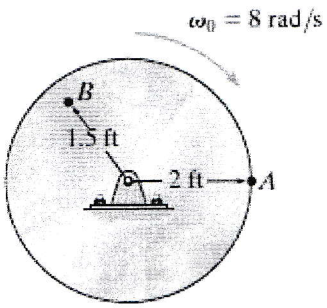
$v'_B = 5.88$ ft/s $\qquad \theta_B = 58.3^\circ$ **Ans.**



(a)

Problem 2:

The disk is originally rotating at $\omega_0 = 8\ \text{rad/s}$. If it is subjected to a constant angular acceleration of $\alpha = 6\ \text{rad/s}^2$, determine the magnitudes of the velocity and the n and t components of acceleration of point B just after the wheel undergoes 2 revolutions.



$$\omega^2 = \omega_0^2 + 2\alpha_c(\theta - \theta_0)$$

$$\omega^2 = (8)^2 + 2(6)[2(2\pi) - 0]$$

$$\omega = 14.66\ \text{rad/s}$$

$$v_B = \omega r = 14.66(1.5) = 22.0\ \text{ft/s}$$

$$(a_B)_t = \alpha r = 6(1.5) = 9.00\ \text{ft/s}^2$$

$$(a_B)_n = \omega^2 r = (14.66)^2(1.5) = 322\ \text{ft/s}^2$$