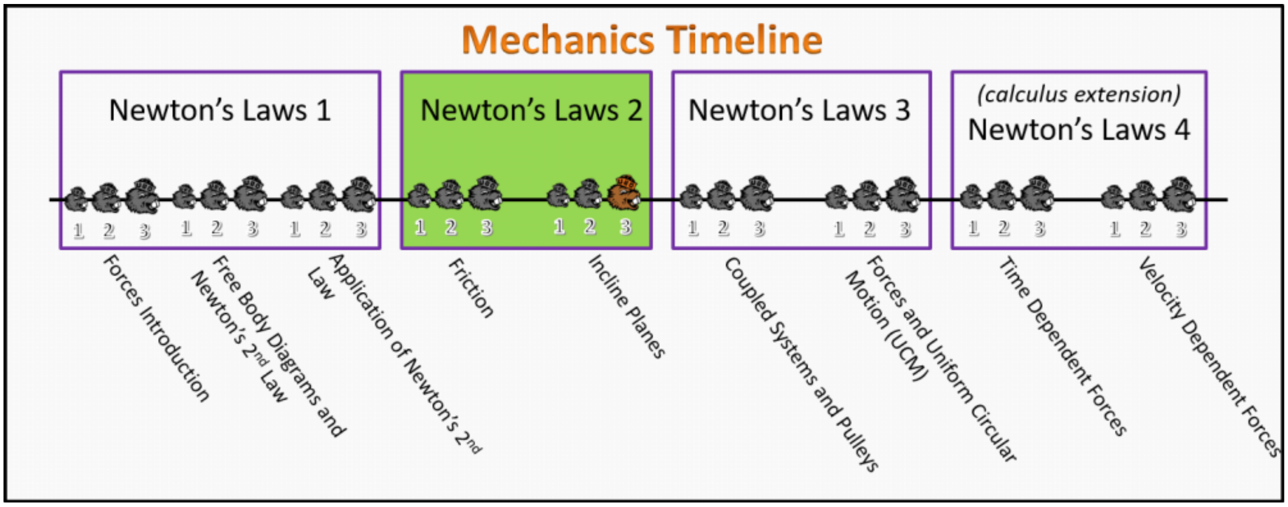
(N2.L2.3-sols) Practice Stage Solutions

Thursday, March 29, 2018 8:34 PM

Newton's Laws 2

Foundation Stage (N2.L2.3)

Post-Lecture 2
Incline Planes



Questions

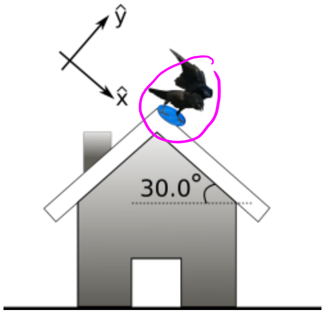
N2.L2.3-01

Description: Force analysis to find acceleration of object sliding down incline with and without friction.

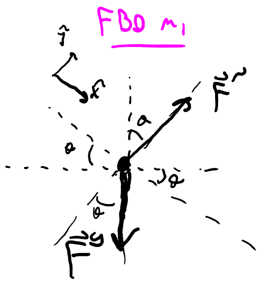
Learning Objectives: [?]

Problem Statement: A 0.680 kg crow slides down an inclined roof as shown in the figure. The roof makes an angle of 30.0° with respect to the horizontal. There is negligible friction between the roof and the crow. Use **g** = 9.80 m/s^2.

(a) Using a coordinate system with the positive x axis pointing down the ramp, use a force analysis to determine the acceleration of the crow?



(1) < 0 , 0 > m/s^2
(2) < 9.80 , 0 > m/s^2
(3) < 0 , 9.80 > m/s^2
[✓ (4)] < 4.90 , 0 > m/s^2
(5) < 8.49 , 0 > m/s^2
(6) < 4.24 , -2.45 > m/s^2
(7) < 2.45 , -4.24 > m/s^2



$\Sigma F_x = ma_x$

$F^g \sin\theta = ma_x$

$\cancel{m}g \sin 30 = \cancel{m}a_x$

$a_x = g\sin 30$

$a_x = 4.9\ m/s^2$

(b) Using the acceleration found in part **(a)**, what is the magnitude of the acceleration of the crow?

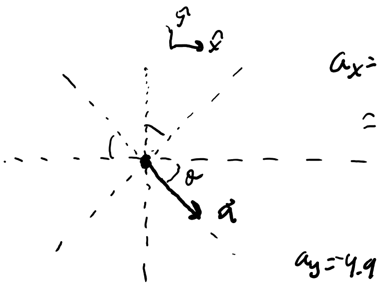
(1) 0 m/s^2
(2) 3.33 m/s^2

(1) 0 m/s^2
(2) 3.33 m/s^2
(3) 9.80 m/s^2
[✓ (4)] 4.90 m/s^2
(5) 8.49 m/s^2
(6) 4.24 m/s^2
(7) 2.45 m/s^2

$|\vec{a}| = \sqrt{a_x^2 + a_y^2}$

(c) Using a standard coordinate system, use a force analysis to determine the acceleration of the crow.

(1) < 0 , 0 > m/s^2
(2) < 9.80 , 0 > m/s^2
(3) < 0 , 9.80 > m/s^2
(4) < 4.90 , 0 > m/s^2
(5) < 8.49 , 0 > m/s^2
[✓ (6)] < 4.24 , -2.45 > m/s^2
(7) < 2.45 , -4.24 > m/s^2

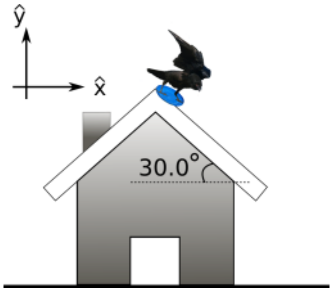


$a_x = 4.9 \cos\theta$

$= 4.2435 \text{ m/s}^2$

$a_y = -4.9 \sin\theta$

$= -2.45 \text{ m/s}^2$



(d) Using the acceleration found part **(c)**, what is the magnitude of the acceleration of the crow?

(1) 0 m/s^2
(2) 3.33 m/s^2
(3) 9.80 m/s^2
[✓ (4)] 4.90 m/s^2
(5) 8.49 m/s^2
(6) 4.24 m/s^2
(7) 2.45 m/s^2

$|\vec{a}| = \sqrt{a_x^2 + a_y^2}$

(e) Using your answers from parts **(a)** through **(d)**, what can you conclude about how the choice of a coordinate system affects the acceleration found via a force analysis? There may be more than one correct answer.

(1) The x and y components of a vector remain unchanged when a different coordinate system is used.
T [✓ (2)] The x and y components of a vector change when a different coordinate system is used.
T [✓ (3)] The magnitude of a vector remains unchanged when a different coordinate system is used.
(4) The magnitude of a vector changes when a different coordinate system is used.

N2.L2.3-02

Description: Conceptual question about choice of coordinate system for a system that requires multiple analysis tools.

Learning Objectives: [?]

Problem Statement: Often times when analyzing a system, a force analysis needs to be done along with a kinematics analysis. True or false: The coordinate system chosen for the force analysis stage must be the same coordinate system you use for the kinematics analysis stage.

(1) True
[✓ (2)] False

N2.L2.3-03

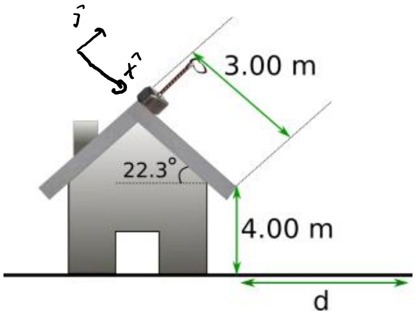
Description: Scaffolded question to find the horizontal distance an object lands after it slides down an incline with friction.

Learning Objectives: [?]

Problem Statement: A 0.850 kg hammer is initially at rest on a 3.00 meter long inclined roof. The roof makes an angle of 22.3° with respect to the horizontal as shown in the image below. The edge of the roof is about 4.00 meters above the level ground below. The coefficient of kinetic friction between the roof and the hammer is 0.10. We eventually wish to determine the horizontal distance the hammer lands away from the house. Use **g** = 9.80 m/s^2.

(a) To determine the horizontal distance the hammer lands away from the house, this problem requires:

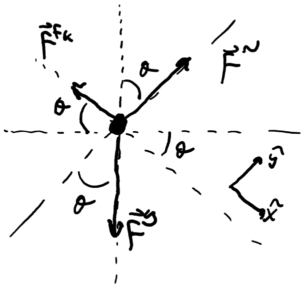
(1) a force analysis only.
(2) a kinematics analysis only.
[✓ (3)] a force and a kinematics analysis used together.



(b) What is the magnitude of acceleration of the hammer as it slides down the roof?

[✓ (1)] 2.812 m/s^2
(2) 3.719 m/s^2
(3) 8.695 m/s^2
(4) 9.067 m/s^2
(5) 9.800 m/s^2

$\theta = 22.3°$



$$\Sigma F_y = m\cancel{a_y}^0$$

$$F^N - F^g\cos\theta = 0$$

$$F^N = mg\cos\theta$$

$$\Sigma F_x = ma_x$$

$$-F^{fk} + F^g\sin\theta = ma_x$$

$$-\mu_k F^N + mg\sin\theta = ma_x$$

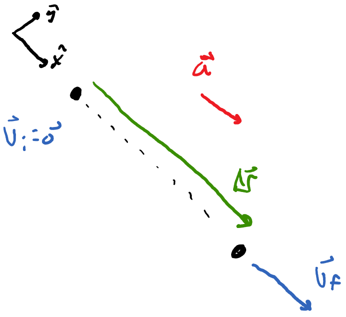
$$-\mu_k mg\cos\theta + mg\sin\theta = ma_x$$

$$a_x = g\sin\theta - \mu_k g\cos\theta$$

$$a_x \approx 2.81196\ m/s^2$$

(c) What is the final speed the hammer has the moment it leaves the end of the roof?

(1) 16.87 m/s
(2) 22.31 m/s
(3) 52.17 m/s
[✓ (4)] 4.108 m/s
(5) 0 m/s



x

K	UK
$\Delta x = 3$	
$v_{ix} = 0$	v_{fx}
$a_x = 2.812$	Δt

$$v_{fx}^2 = \cancel{v_{ix}^2}^{\,0} + 2a_x\Delta x$$

$$v_{fx}^2 = 2(2.812)(3)$$

$$v_{fx} = 4.10755 \text{ m/s}$$

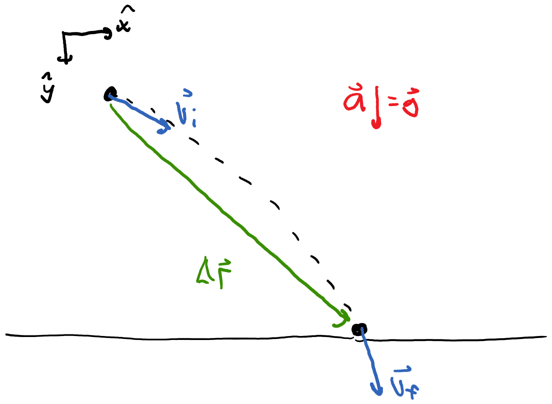
(d) What is the magnitude of acceleration of the hammer the moment it leaves the end of the roof?

(1) 2.812 m/s²
(2) 3.719 m/s²
(3) 8.695 m/s²
(4) 9.067 m/s²
[✓ (5)] 9.800 m/s²
(6) 0.000 m/s²

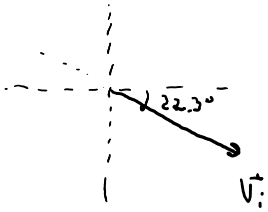
PROJECTILE MOTION

(e) What is the horizontal distance the hammer lands away from the house?

(1) 1.53 m
[✓ (2)] 2.88 m
(3) 3.58 m
(4) 7.21 m
(5) 15.2 m



VEctors



$v_{ix} = 4.108 \cos 22.3$

$= 3.8008$ m/s

$v_{iy} = 4.108 \sin 22.3$

$= 1.55881$ m/s

X

K	UK
	Δx
$v_{ix} = 3.8008$	

y

K	UK
$\Delta y = 4$	

K	UK
$V_{ix} = 3.8008$	Δx
$a_x = 0$	V_{fx}
	Δt

$\Delta y = 4$	
$V_{iy} = 1.5588$	V_{fy}
$a_y = 9.8$	Δt

$$\Delta x = V_{ix}\Delta t + \tfrac{1}{2}\cancelto{0}{a_x}\Delta t^2$$

$$\overset{?}{\Delta x} = \overset{\checkmark}{V_{ix}}\,\overset{?}{\Delta t}$$

$$\overset{\checkmark}{\Delta y} = \overset{\checkmark}{V_{iy}}\,\overset{?}{\Delta t} + \tfrac{1}{2}\overset{\checkmark}{a_y}\Delta t^2$$

$$4 = 1.5588\,\Delta t + \tfrac{1}{2}(9.8)\Delta t^2$$

$$4.9\Delta t^2 + 1.5588\,\Delta t - 4 = 0$$

$$\Delta t = \underline{\underline{0.7583}} \text{ SEC OR } -1.0785 \text{ SEC}$$

$$\Delta x = (3.8008)(0.7583)$$

$$\boxed{\Delta x = 2.88 \text{ m}}$$