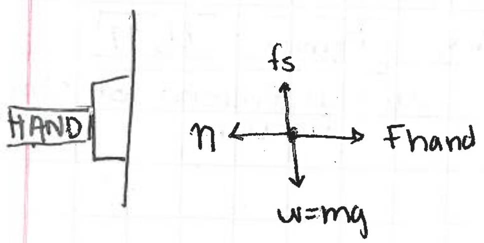
ch.6 + Recap + ch 7 march 5, 2019

Rolling Friction → friction between a rolling wheel & a surface

$\boxed{f_r = \mu_r n}$ μ_r → coefficient of rolling friction

$\mu_s > \mu_k > \mu_r$



pushing harder ↑n, but not fs

March 7, 2019

Recap N/A

CHAPTER 7: Newton's 3rd Law

only covering Newton's 3rd law conceptually & pulleys & ropes

Newton's 3rd law → for every action there is an equal but opposite reaction

in direction

in magnitude

Ex

I push backwards on the floor, the floor pushes forwards on me with the same strength force (opposite direction)

→ the pair of forces is called an action/reaction pair

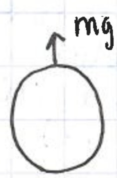
* action/reaction forces always act on different objects (this is why they don't cancel)
* action/reaction forces always have the same magnitude but opposite direction ($\vec{F}_{A\ on\ B} = -\vec{F}_{B\ on\ A}$)

<u>NOTE</u>: The masses of the objects are different, the accelerations will be different

Ex Ball falling towards earth w/o air resistance

$w = mg$ (force of earth on ball)

$a = \frac{F}{m}$ $a = \sum \frac{F}{m}$



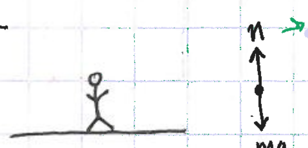
(force of ball on earth)

$a = \frac{F}{m}$

$m_{ball} = 1.0kg$
$m_{earth} = 5.93 \times 10^{24}\ kg$

$\underline{\vec{F} = m\vec{a}} \longrightarrow \Sigma\vec{F} = \frac{d}{dt}(\vec{p}) = \boxed{\frac{d}{dt}(m\vec{v})}$

<u>1Q</u>



n → floor pushing up on the person
• person pushing down on the floor

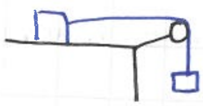
are $\vec{n} + \vec{w}$ equal & opposite? <u>YES ($a_y = 0$)</u>
are they an action/reaction pair? <u>NO</u>

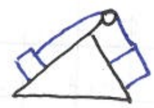
mg → • Earth pulling down on the person
• person pulling up on the earth

• Action
• Reaction

march 7, 2019

Ropes & pulleys





assumptions ⇒ Rope or string is massless & stretchless

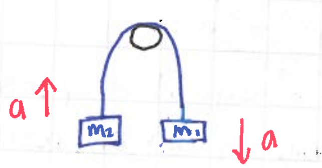
↓

The two objects connected by the rope will have the same magnitude acceleration (not the same direction)

⇒ Pulley is massless & frictionless } magnitude of the tension is same everywhere in the rope (direction is Not the same).

→ Massless pulleys just change the direction of the tension but not the magnitude

Ex Atwood Machine



$m_1 > m_2$

mass 2 :

mass 1:

$\Sigma F_y = ma_y$

$T - m_2 g = m_2 a_y$

→ $\boxed{T - m_2 g = m_2 a}$

$\Sigma F_y = ma_y$

$T - m_1 g = m_1(-a_y)$

→ $\boxed{T - m_1 g = m_1(-a)}$

Ch 7 + Recap

March 7, 2019

(1) $\boxed{T - m_2 g = m_2 a}$

(2) $\boxed{T - m_1 g = m_1(-a)}$

$T = m_2 g + m_2 a \rightarrow$ put into (2)

$$(m_2 g + m_2 a) - m_1 g = -m_1 a$$

$$m_1 a + m_2 a = m_1 g - m_2 g$$

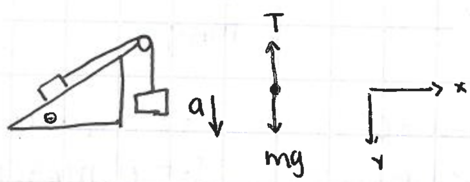
$$\boxed{a = \frac{m_1 g - m_2 g}{m_1 + m_2}} \rightarrow \text{magnitude of the acceleration of each block}$$

RECAP

March 11, 2019

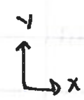
Newton's 3rd law $\rightarrow$ for every action there is an equal but opposite reaction.

$\rightarrow$ action/reaction forces never act on the same object (which is why they don't cancel)



$\Sigma F_y = ma_y$

$mg - T = ma_y$



$\Sigma F_y = ma_y$

$T - mg = m(-a)$

$\rightarrow$ Objects connected by a massless, stretchless rope passing over a massless, frictionless pulley:

- * Magnitude of the tension is the same everywhere in the rope
- * Magnitude of the acceleration of each object is the same (direction is different)

Review Problems
↳ forgot to give $\theta = 30°$

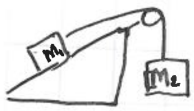
↳ must use $(-a)$ in $\Sigma F = m\vec{a}$ if $\vec{a}$ is in the negative direction.

Ch 7

March 11, 2019

What is direction of fs?

$a = \dfrac{m_2 g - m_1 g \sin\theta}{m_1 + m_2}$



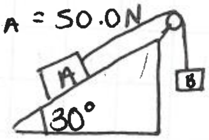
$\vec{f_s} = 0 \rightarrow m_1 g \sin\theta = m_2 g$

$\vec{f_s}$ is up the slope $\rightarrow m_1 g \sin\theta > m_2 g$

$\vec{f_s}$ is down the slope $= m_2 g > m_1 g \sin\theta$

Problem 7.A (ch 7)

$W_A = 50.0N$



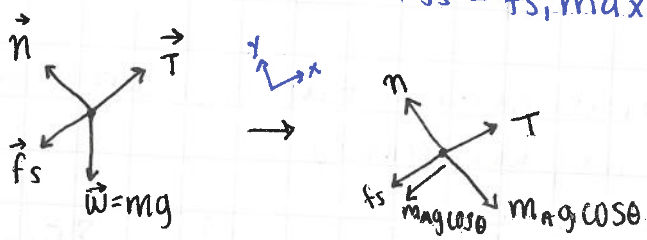
$\mu_k = 0.20$

maximum mass of B so that blocks remain stationary

↳ $\vec{f_s}$ points down the incline

↳ $\vec{f_s} = f_{s,max} = \mu_s n$

A)



B)

A: $\sum F_y = ma_y = 0$

$n = m_A g\cos\theta$

$\sum F_x = ma_x = 0$

$T - m_A g\sin\theta - f_s = 0$

$f_s = f_{s,max} = \mu_s n$

$f_s = \mu_s m_A g\cos\theta$

$\boxed{T - m_A g\sin\theta - \mu_s m_A g\cos\theta = 0}$

B: $\sum F_y = ma_y = 0$

$T - m_B g = 0$

$\boxed{T = m_B g}$

$m_B g - m_A g\sin\theta - \mu_s m_A g\cos\theta = 0$

$m_B = m_A \sin\theta + \mu_s g\cos\theta$

$\boxed{m_B = 3.43\text{kg}}$

$w = m_A g \longrightarrow m_A = \dfrac{W_A}{g} = \dfrac{50\text{N}}{9.80\text{m/s}^2} = \boxed{5.10\text{kg}}$

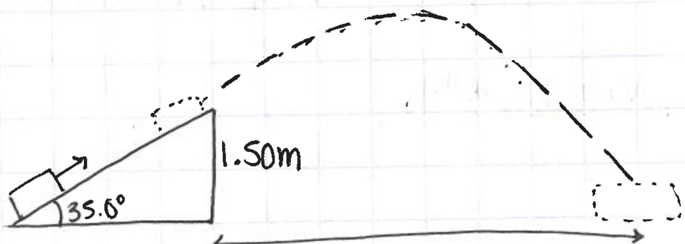
ch 7 March 11, 2019

Celebration #1 (185 minutes)

6 short Answers Questions (5 points each)

10 problems (10 points each)

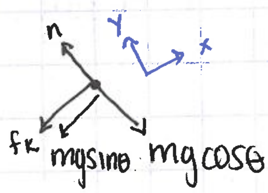
Allowed 8.5x11" sheet of notes



A pokemon lunchbox is given an initial speed of 10.0m/s up a 35.0° inclined plane. $\mu_k = 0.30$. what is x?

1) Find acceleration of lunch bag from $\Sigma\vec{F} = m\vec{a}$
2) Find speed at end of incline from equations of Constant acce.
3) find x from projectile motion

Part 1



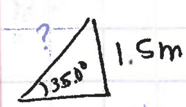
$\Sigma F_y = ma_y \quad (a_y = 0)$

$n = mg\cos\theta$

$\Sigma F_x = ma_x \qquad f_k = \mu_k n = \mu_k \cdot mg\cos\theta$

$-f_k - mg\sin\theta = ma_x$

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



2.615m

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

$a_x = -(0.30 \cdot 9.80\cos 35) - 9.80(\sin 35°)$

$a_x = -8.03\,m/s^2$

Part 2

$x_0 = 0m \quad x = 2.615m \quad V_{0x} = 10.0m/s \quad V_x = ? \quad a_x = -8.03m/s^2 \quad t = ?$

Practice

March 12, 2019
March 11, 2019

Part 2

$x_0 = 0\,m$

$x = 2.615m$

$V_{ox} = 10.0 m/s$

$v_x = ?$

$a_x = -8.03 m/s^2$

$t = ?$

$$V_x^2 = V_{ox}^2 + 2a_x(x - \overset{=0}{x_0})$$

$$V_x \pm \sqrt{V_{ox}^2 + 2a_x x}$$

$$\pm\sqrt{(10.0 m/s)^2 + 2(-8.03 m/s^2)(2.615 m)}$$

$$\boxed{V_x = 7.62 m/s}$$

Part 3

$V_{ox} = 7.62 m/s \cos 35° = 6.24 m/s$

$V_{oy} = 7.62 m/s \sin 35° = 4.37 m/s$

$x = x_0 + V_{ox} t \qquad V_x = V_{ox}$

$y_0 = 1.50m$

$y = 0m$

$V_{oy} = 4.37 m/s$

$V_y =$

$a_y = -9.80 m/s^2$

$t =$

$$\overset{=0}{y} = y_0 + V_{oy} t + \tfrac{1}{2} a_y t^2$$

$$At^2 + Bt + C = 0$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\tfrac{1}{2} a_y t^2 + V_{oy} t + y_0 = 0$$

$A = \frac{1}{2} a_y = -4.90 m/s^2$

$B = 4.37 m/s$

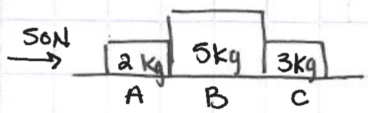
$C = 1.50 m$

$$\frac{-4.37 \pm \sqrt{(4.37)^2 - 4(-4.90)(1.50)}}{2(-4.9)} = \frac{-4.37 \pm 6.96}{-9.80}$$

$$\boxed{t = 1.157 s}$$

Practice Problems — March 12, 2019

Ex

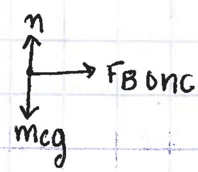


No friction

$F = m \cdot a$ — $a = \frac{F}{m}$

$a = \frac{50N}{10kg} = 5 m/s^2$ ← acceleration of each block

block C:



$\Sigma F_x = ma_x$

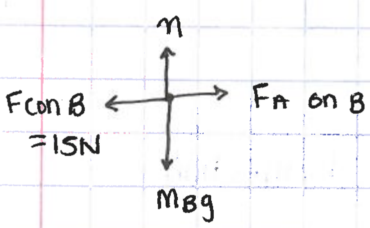
$F_{B\,on\,C} = (3kg)(5.0 m/s^2)$

$= \boxed{15N}$

By newton's 3rd law

$\boxed{F_{C\,on\,B} = -15N \quad 15N \text{ to the left}}$

Block B:



$\Sigma F_x = ma_x$

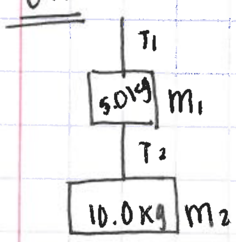
$F_{A\,on\,B} - 15N = (5kg \cdot 5m/s^2)$

$\boxed{F_{A\,on\,B} = 40N}$

By Newton's 3rd law

$\boxed{F_{B\,on\,A} = -40N}$

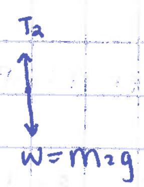
Ex



$\uparrow a = 2.0 m/s^2$

What is $T_1 + T_2$?

start with m_2:



$\Sigma F_y = ma_y$

$T_2 - m_2 g = m_2 a$

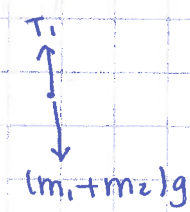
$T_2 = m_2(g + a)$

$T_2 = (10.0kg)(9.80 m/s^2 + 2.0 m/s^2)$

$T = 118N$

mass m_1:

2nd way



$\Sigma F_y = ma_y$

$T_1 - T_2 - m_1 g = m_1 a_y$

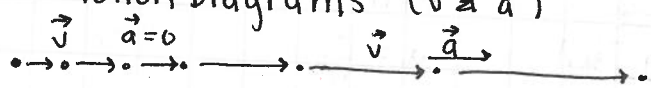
$T_1 = T_2 + m_1 g + m_1 a_y$

$T = 118N + (5.0kg)(9.80 m/s^2 + 2.0 m/s^2)$

$\boxed{T = 177N}$

Study Guide

Chapter 1: Motion Diagrams ($\vec{v}$ & $\vec{a}$)



unit conversion

Prefixes

Chapter 2: Equations of constant $\vec{a}$ in 1 dimension

$a = g\sin\theta$ on a frictionless, inclined plane

x vs. t, v vs. t, a vs. t graphs

$x(t)$ $\quad v = \frac{dx}{dt}$ $\quad a = \frac{dv}{dt}$

Chapter 3: Vectors

↳ unit vector notation magnitude & direction

$\vec{A} - 4\vec{B} + 3\vec{C} = \vec{D}$

Chapter 4: Projectile motion

Chapter 5: Intro to forces

↳ conceptual question

Friction → ch 6 } Using Newton's laws

Ch. 7 ← Pulleys & strings

Practice Problems | March 12, 2019

Ex $x(t) = (3.0\,m/s^2)t^2 - (2.0\,m/s)t$

1. what is $\vec{v}_{avg}$ between $t = 1.0s$ & $t = 5.0s$? $\rightarrow v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x(5.0s) - x(1.0s)}{5.0s - 1.0s}$
2. what is $\vec{v}$ at $t = 2.0s$? $\rightarrow v(t) = \frac{dx(t)}{dt}$ then plug in $t = 2.0s$ to $v(t)$
3. what is $\vec{a}_{avg}$ between $t = 1.0s$ & $t = 5.0s$? $\rightarrow \vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v}(5.0s) - \vec{v}(1.0s)}{5.0s - 1.0s}$
4. what is $\vec{a}$ at $t = 2.0s$? $a(t) = \frac{dv(t)}{dt}$

1. $v_{avg} = \frac{\Delta x}{\Delta t} = \frac{(3.0\,m/s^2)(5.0s)^2 - (2.0\,m/s)(5.0s) - [(3.0\,m/s^2)(1.0s)^2 - (2\,m/s)(1)}{5.0s - 1.0s}$

$v_{avg} =$

2. $v(t) = \frac{dx(t)}{dt} = (6.0\,m/s^2)t - 2.0\,m/s$

$v(2.0s) = (6.0\,m/s^2)(2.0s) - 2.0\,m/s^2 = 10.0\,m/s$