4-24-13

Test 3 Review

Hints Quiz 12, Ch9.

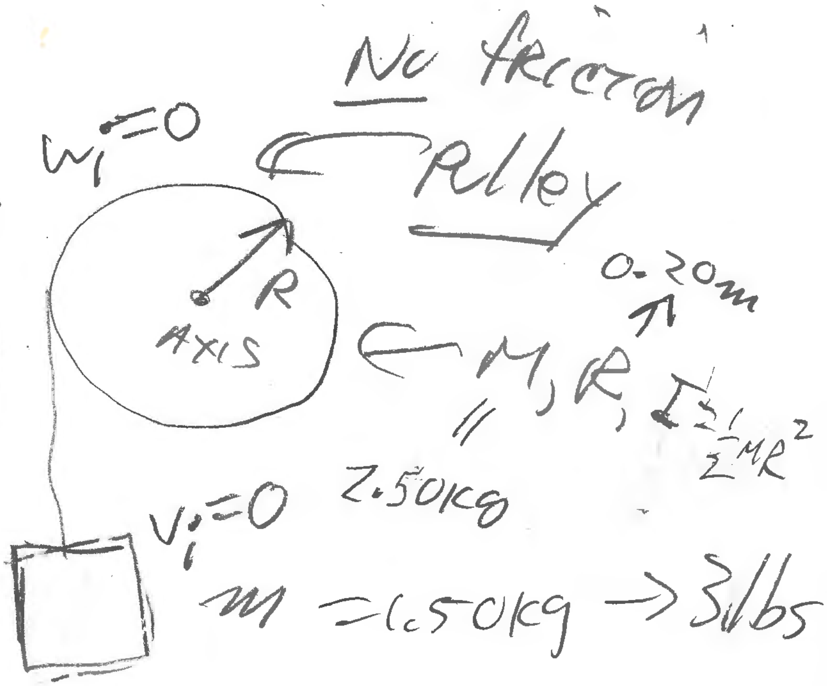
(47) and beyond

(47)

$\frac{1}{2}MR^2$

$= \frac{1}{2}(2.5)(0.2)^2$

$= 0.20\,kg\text{-}m^2$



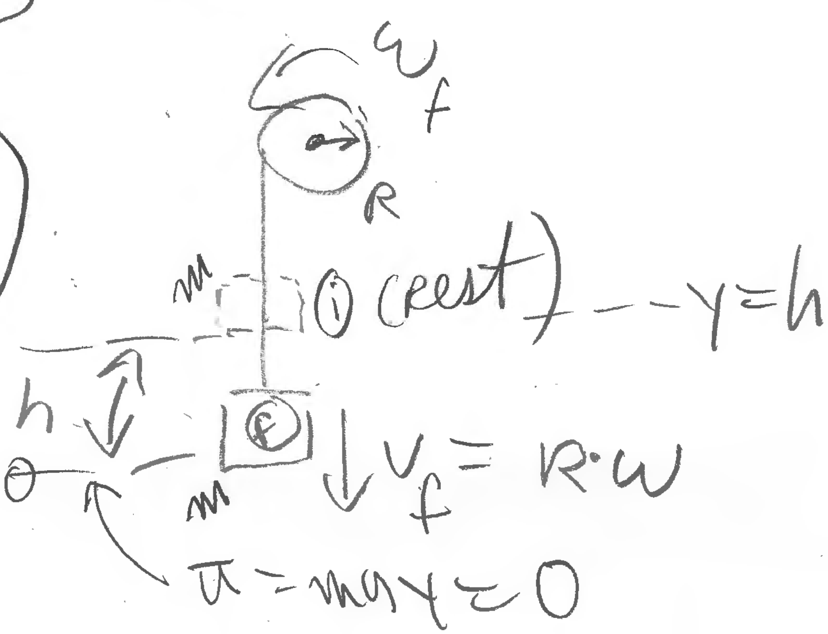
(a) h when

$\frac{1}{2}I\omega^2 = 4.50J$

$KE_i + U_i = KE_f + U_f$

$0 + mgh$

$= \frac{1}{2}I\omega_f^2 + \frac{1}{2}mv^2$



(47)

$h = ?$ $mgh = \frac{1}{2} I \omega_f^2 + \frac{1}{2} m v_f^2$

$\frac{1}{2} I \omega_f^2 \downarrow$ 4.50 J

Use: $v_f = R \cdot \omega_f \rightarrow \omega_f = \frac{v_f}{R}$

HINT: FIND v_f from ω_f from $\frac{1}{2} I \omega_f^2 = 4.5$

←

Find h.

comment: FOR future reference:

Nice relationship

$mgh = \frac{1}{2} I \frac{v_f^2}{R^2} + \frac{1}{2} m v_f^2$

$mgh = \frac{1}{2}(I/R^2 + m) \cdot v_f^2$

(54.)

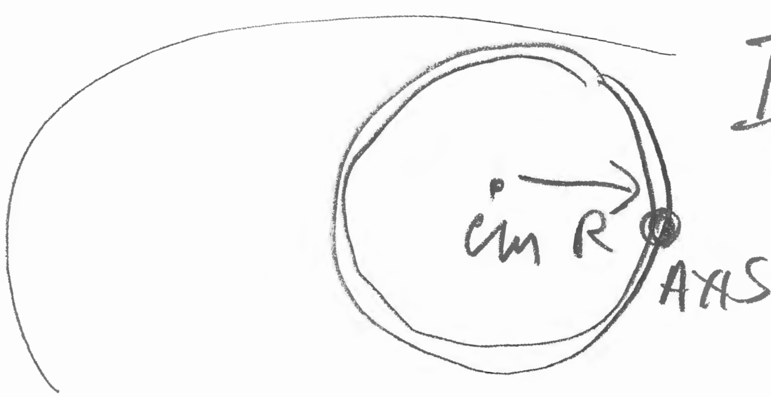
$I_{cm} = MR^2$

hoop

Table 9.2

parallel-AXIS Theorem

$I_{AXIS} = MR^2 + MD^2$



D = Distance between cm and AXIS.

$I_{AXIS} = I_{cm} + MD^2$

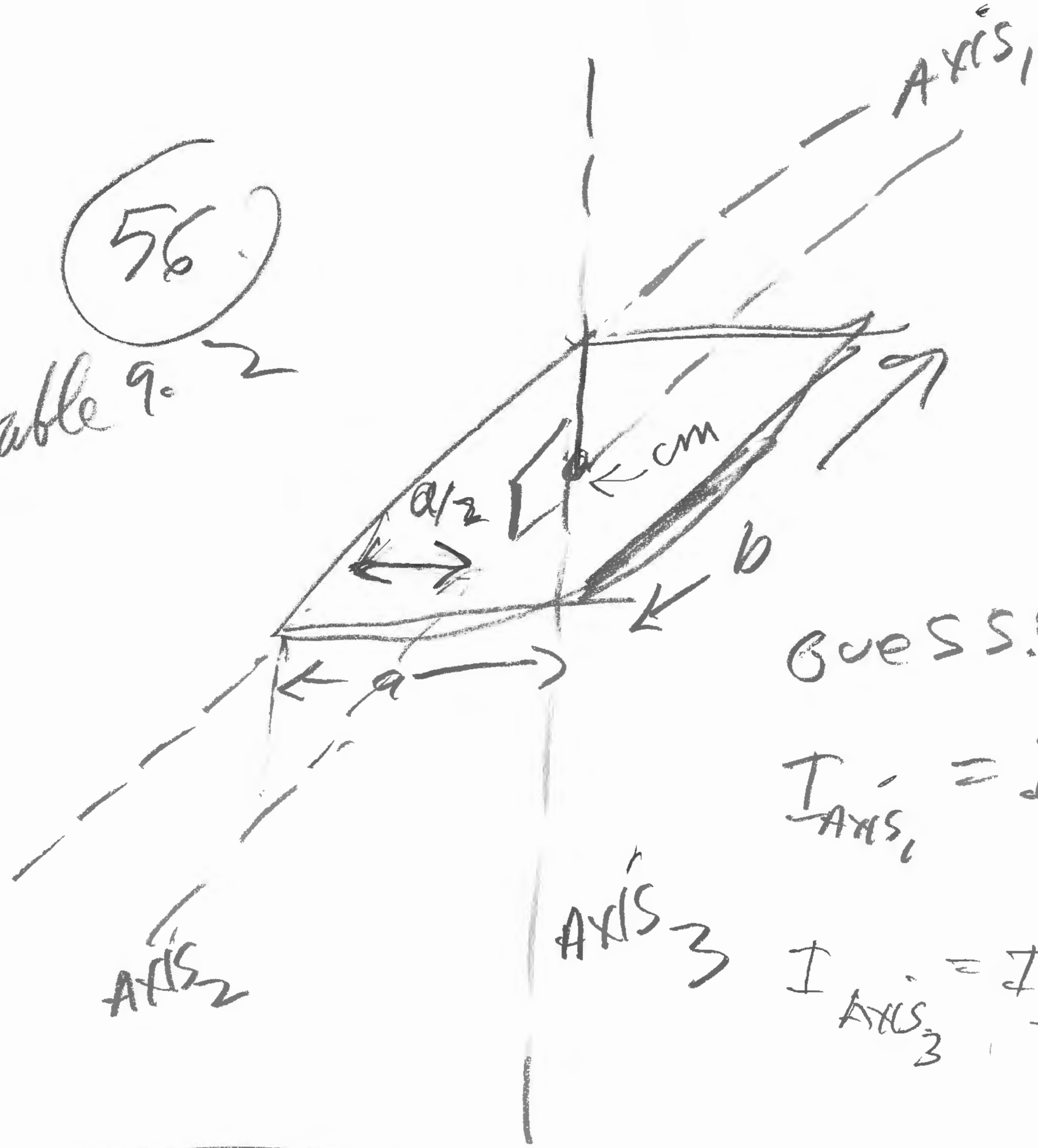
D = distance between AXIS and CM.

Note: D = R.

$I_{AXIS} = MR^2 + MR^2$
$= 2MR^2$

(56)

table 9.2



Guess:

$I_{Axis_1} = I_1 = \frac{1}{3} Ma^2$

$I_{Axis_3} = I_3 = \frac{1}{12} M(a^2+b^2)$

$I_1 > I_3 \quad (a \approx b)$

Parallel-Axis Theorem:

$I_1 = I_2 + M\left(\frac{a}{2}\right)^2$ ← I_{cm}

solution:

(a)

$I_2 = I_1 - M\left(\frac{a}{2}\right)^2$

$= \frac{1}{3}Ma^2 - \frac{Ma^2}{4}$

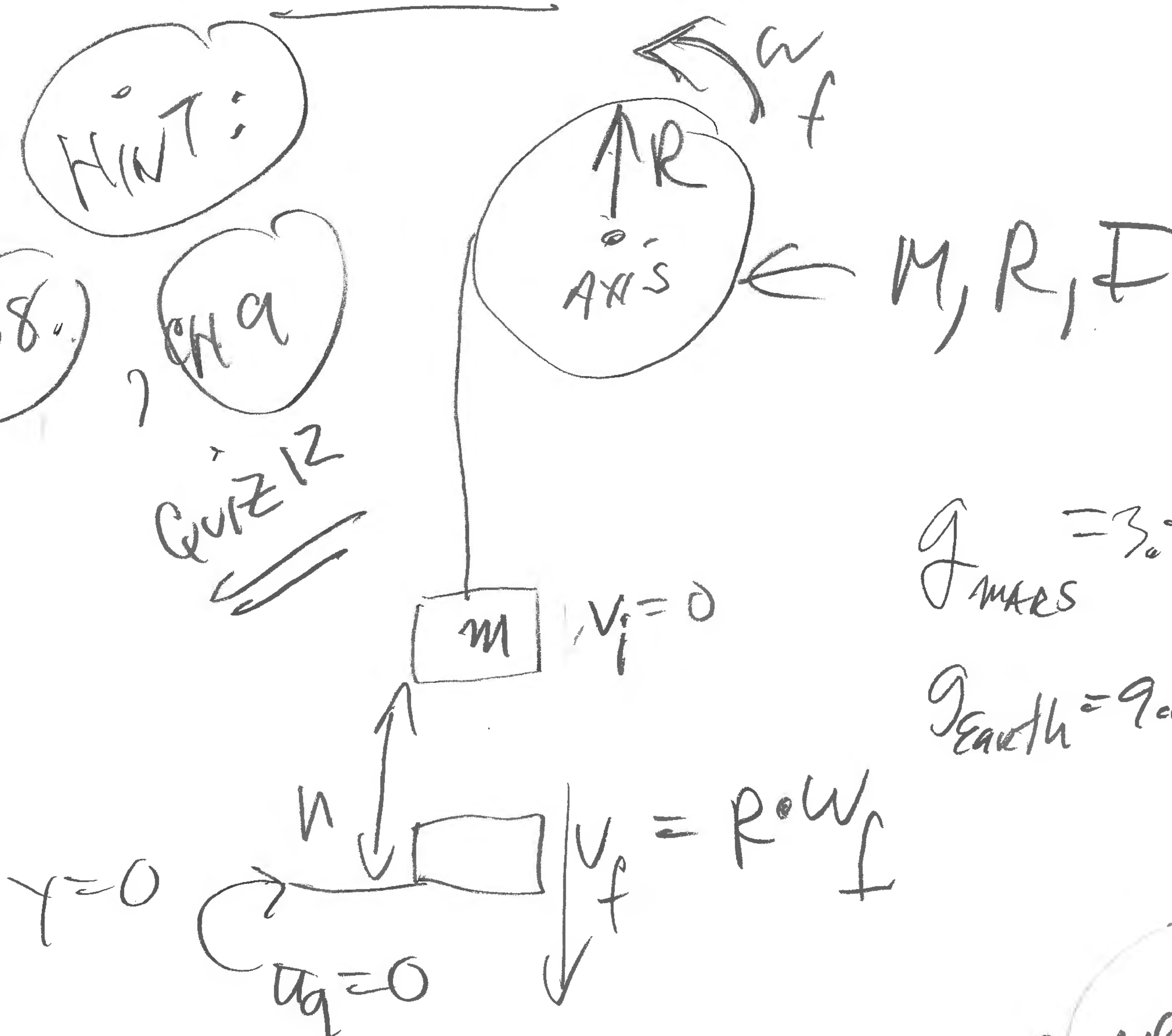
$= \frac{Ma^2}{12}$ not a surprise.

} similar to rod

$I_{cm} = \frac{ML^2}{12}$

Test 3

HINT: 68., CH 9, QUIZ 12



$g_{MARS} = 3.71 \frac{m}{s^2}$

$g_{Earth} = 9.8 \frac{m}{s^2}$

$KE_i + U_i = KE_f + U_f$ → $mgY = 0$ at $Y = 0$

$0 + mgh = \frac{1}{2}mv_f^2 + \frac{1}{2}I\frac{v_f^2}{R^2} + 0$

ALSO: $\omega_f = \frac{v_f}{R}$

Earth: $h = 5.00\,m$, $m = 15.0\,kg$ → $\frac{1}{2}I\omega_f^2 = 250\,J$

(a) IF on MARS: $h' > 5.00\,m$ if $\frac{1}{2}I\omega_f^2 = 250\,J$

ASSUME $g = 3.71\,m/s^2$ ∴ $h' > h$

MORE HINTS TO (# 68)

Earth: $mgh = \frac{1}{2}mv_f^2 + 250$ (1)

$h = 5.00\,m$

$250 = \frac{1}{2}\frac{I}{R^2}v_f^2$ (2)

$= \frac{1}{2}I\omega_f^2$

$\omega_f = \frac{v_f}{R}$ (3)

(1.) find v_f

(2.) find $\frac{I}{R^2}$

250 J

MARS: (3.) use $mg'h' = \frac{1}{2}mv_f'^2 + \frac{1}{2}\frac{I}{R^2}v_f'^2$

$250 = \frac{1}{2}\frac{I}{R^2}v_f'^2$; find v_f'.

find h': $mg'h' = \frac{1}{2}mv_f'^2 + 250$

Is $h' > 5.00\,m$? Explain.

83, CH 9, Q12,

at rest

CHECKLIST

- EXTERNAL FORCE (NO) ✓
- friction (yes) ✓
- pulley have mass (yes) ✓
- pulley friction (NO) ✓

CH 7

$$KE_i + U_i = KE_f + U_f + \boxed{\text{Heat}} \;**$$

$$0 + m_B g h^* = \frac{1}{2} I \omega_f^2 + \frac{1}{2}(m_A + m_B) v_f^2 + f_k d$$

* Note: $U_{g_A} = m_A g H = \text{constant}$

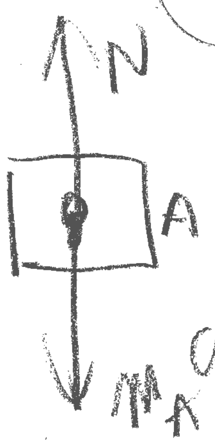
** Heat $= -W_{fk} = -(-f_k d) > 0$

83

Ch 9

$* \; f_k = \mu_k \cdot N$

$h = d$



$$m_B g d = \frac{1}{2} I \frac{v_f^2}{R^2} + \frac{1}{2}(m_A + m_B) v_f^2 + \mu_k m_A g d \; *$$

$N = m_A g$

$$m_B g d - \mu_k m_A g \cdot d = \frac{v_f^2}{2}\left(\frac{I}{R^2} + m_A + m_B\right)$$

$\sum F_y = pos - neg$

$0 = N - m_A g$

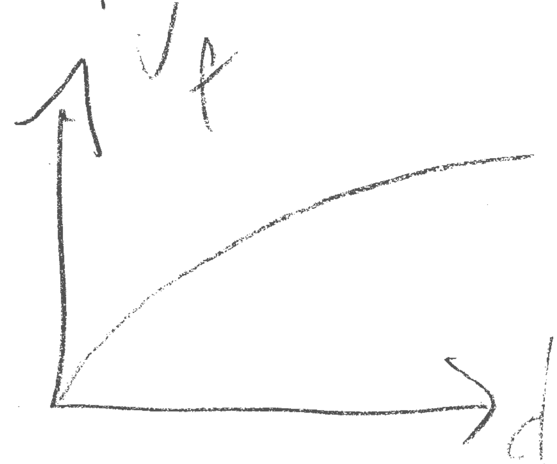
$N = m_A g$

$f_k = \mu_k \cdot N$

$= \mu_k \cdot m_A \cdot g$

Sobe for $v_f = f(d)$

$v_f \propto \sqrt{d}$



84.

Schaum's Outlines "Physics 3000"

(i)

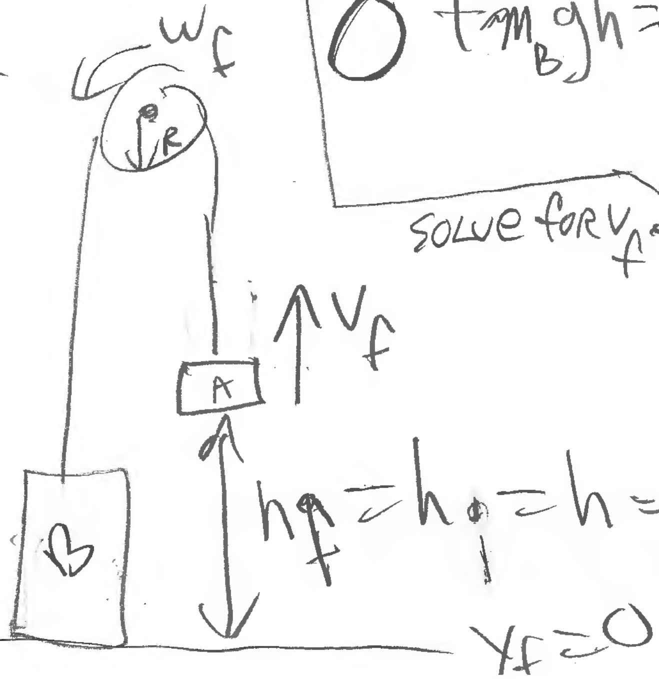
post

$m_B > m_A$

m_B = 4.00 kg

(f.)

$w_f = \frac{v_f}{R}$



Just before B hits ground

Conservation of Energy

$KE_i + U_i = KE_f + U_f + \text{Heat}$

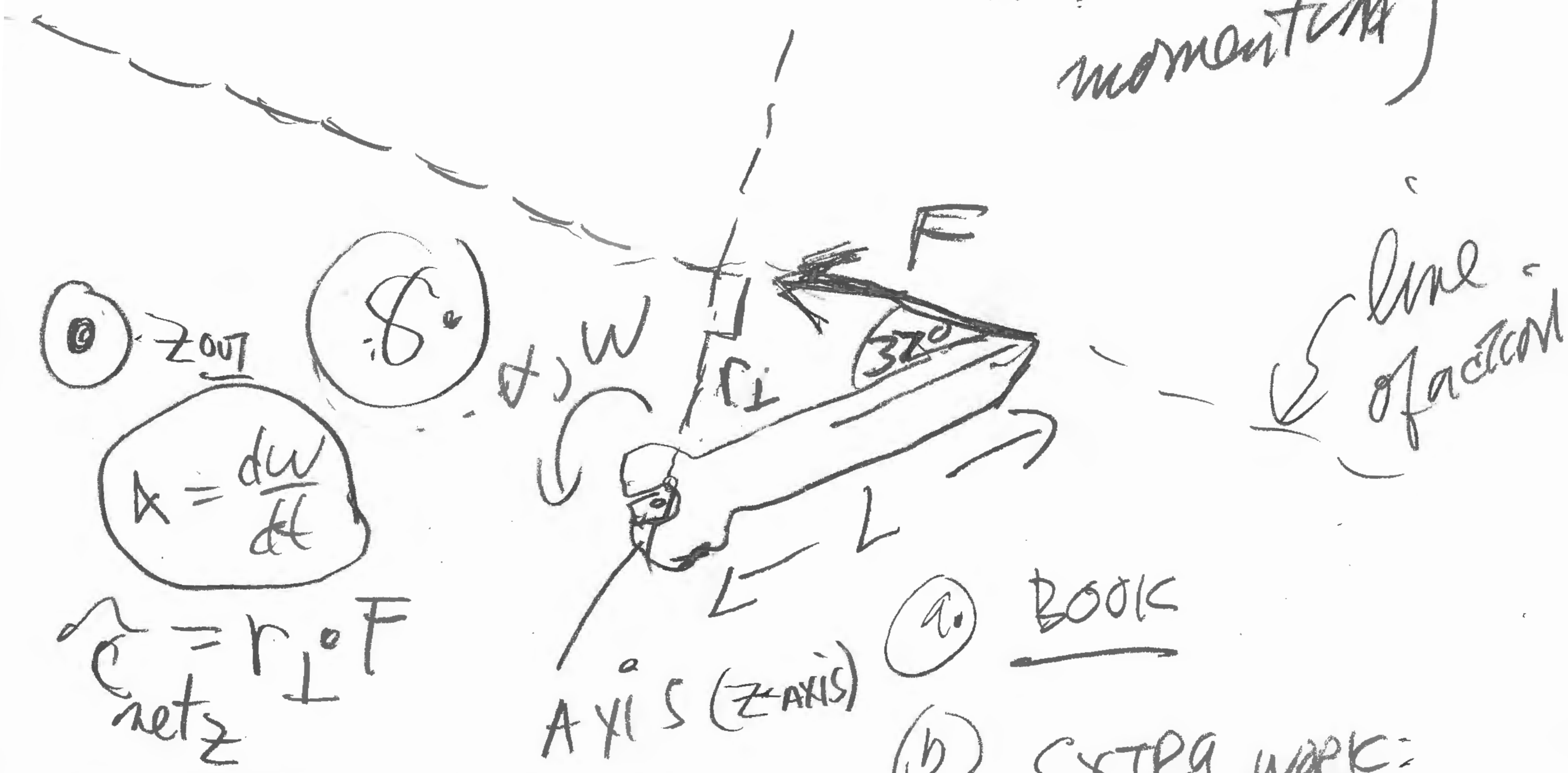
$0 + m_B g h = \frac{1}{2} I \frac{v_f^2}{R^2} + \frac{1}{2}(m_A + m_B) v_f^2 + m_A g h$

Solve for v_f.

(Heat = 0)

CH10 – QUIZ 13

(8.) (7a) (7b) wide spectrum covers this except angular momentum



(8.) (c) Z OUT

$$\alpha = \frac{d\omega}{dt}$$

$$\tau_{net_z} = r_\perp \cdot F$$

$$\boxed{\tau_{net_z} = L \cdot \sin 37 \cdot F}$$

CHECKLIST:

✓ L = 25 cm (= 0.25 m)

✓ F = 17.0 N

(a) BOOK

(b) EXTRA WORK: using $\tau_{net_z} = I\alpha$ (assume wrench = uniform rod, M = mass)

<u>Assume:</u> $M = 0.500 kg$

$L = 0.25 m$

(follow up:)

Find α: α, ω

analogy:

$F_x = m a_x \longleftrightarrow \tau_{z\,net} = I \cdot \alpha$ (CCW)

$I = \frac{ML^2}{3}$

CH 4, 5.

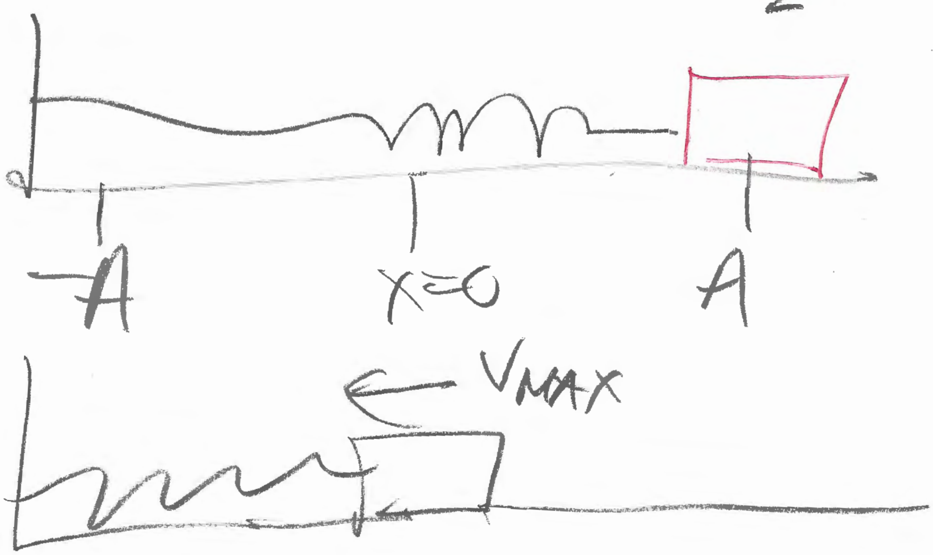
$\Rightarrow (0.25 m) \cdot \sin 37° \cdot 17.0 N = \frac{1}{3}(0.50 kg)(0.25 m)^2 \cdot \alpha$

$$245 \frac{RAD}{s^2} = \frac{3 \cdot (\sin 37)(17.0 N)}{(0.50 kg)(0.25 m)} = \alpha$$

Virtual lab 2

Q1

$\frac{1}{2}KA^2$



$\frac{1}{2}KA^2 = \frac{1}{2}mV_{MAX}^2$ Solve for K

$A = 0.60\,m$

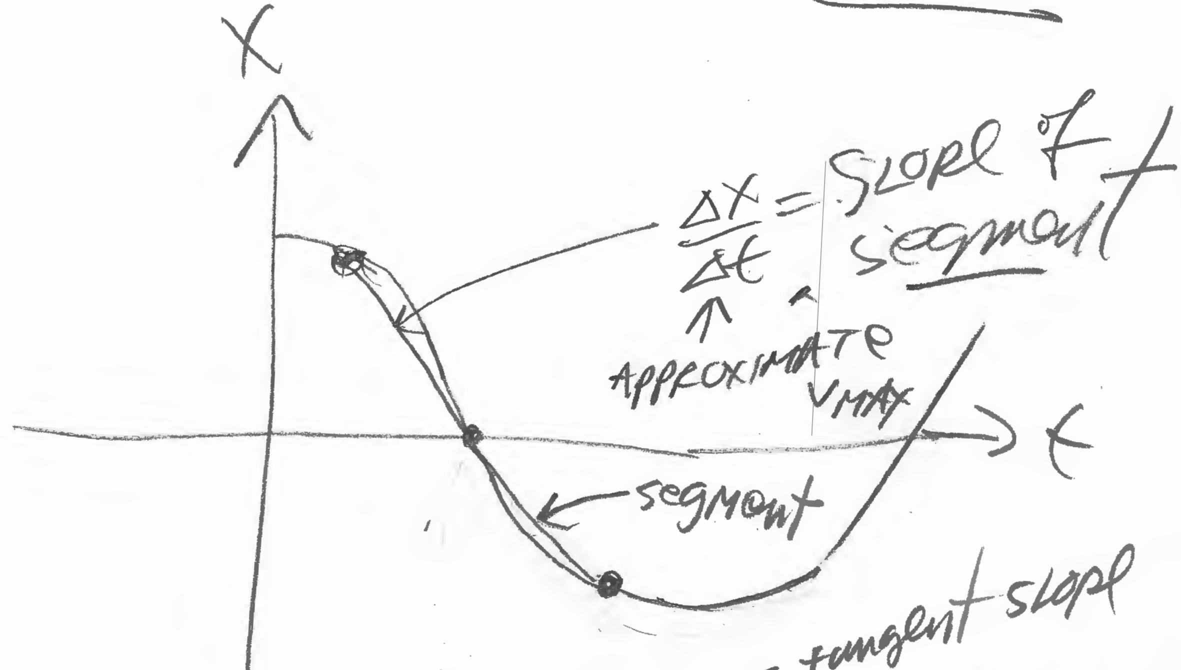
Solve for K ← graph

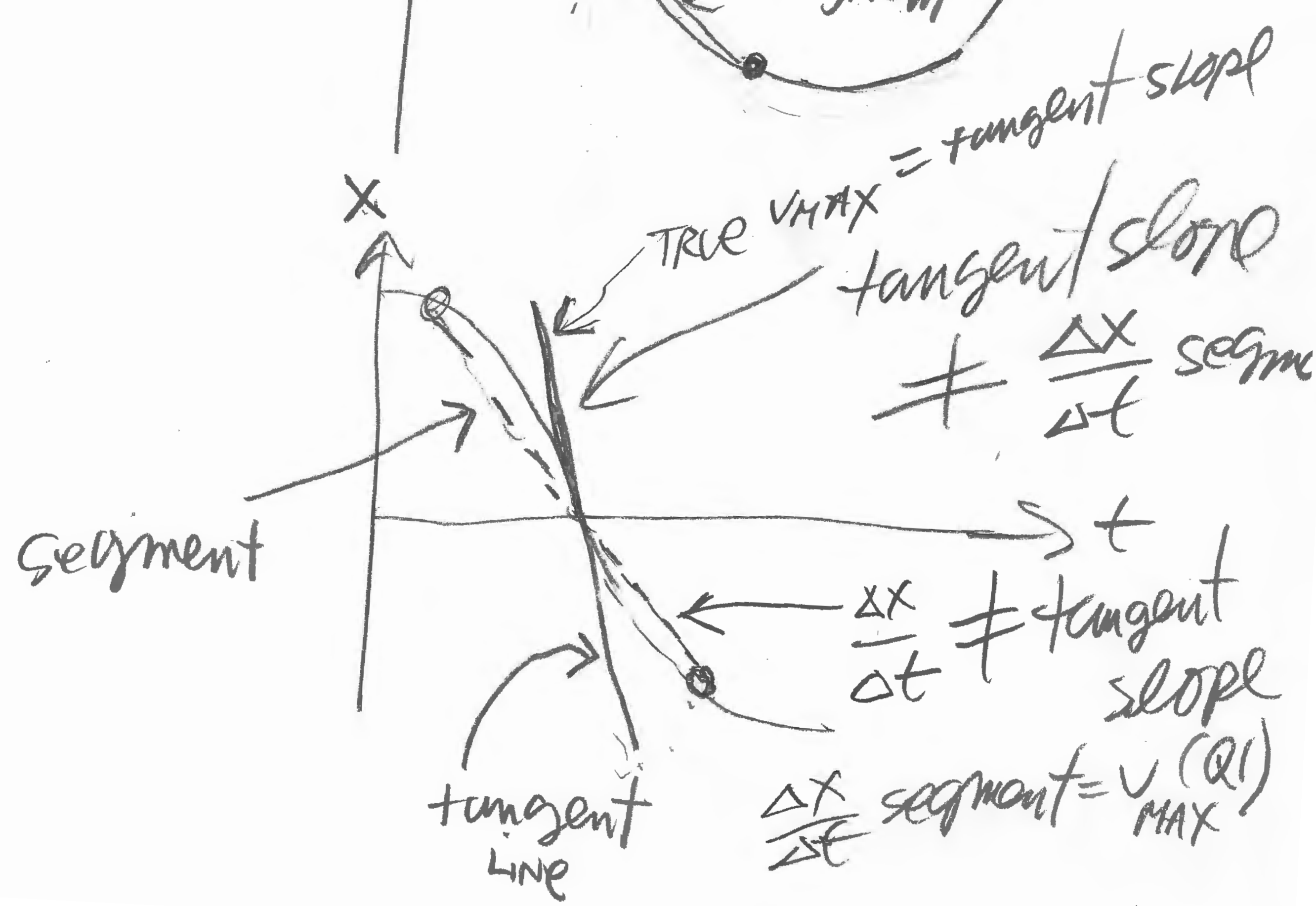
$V_{MAX} \approx \frac{\Delta x}{\Delta t}$

← step with 0.05(s) increments

Q2 use calculus

CH14 see QUIZ 11





(Q3) calculate:

$$\frac{1}{2}mv_x^2 + \frac{1}{2}kx^2 = \frac{1}{2}kA^2$$

(CH14 (Q11)

A = amplitude

set $\frac{1}{2}mv_x^2 = \frac{1}{2}kx^2$

$$\frac{1}{2}mv_x^2 + \frac{1}{2}kx^2$$

$$= \frac{1}{2}kx^2 + \frac{1}{2}kx^2$$

$$= kx^2$$

solve for x.

HINT $x \neq A/2$

Newton's Third Law

You may have learned this statement of Newton's third law: "To every action there is an equal and opposite reaction." What does this sentence mean?

Unlike Newton's first two laws of motion, which concern only individual objects, the third law describes an interaction between two bodies. For example, what if you pull on your partner's hand with your hand? To study this interaction, you can use two Force Sensors. As one object (your hand) pushes or pulls on another object (your partner's hand) the Force Sensors will record those pushes and pulls. They will be related in a very simple way as predicted by Newton's third law.

The *action* referred to in the phrase above is the force applied by your hand, and the *reaction* is the force that is applied by your partner's hand. Together, they are known as a *force pair*. This short experiment will show how the forces are related.

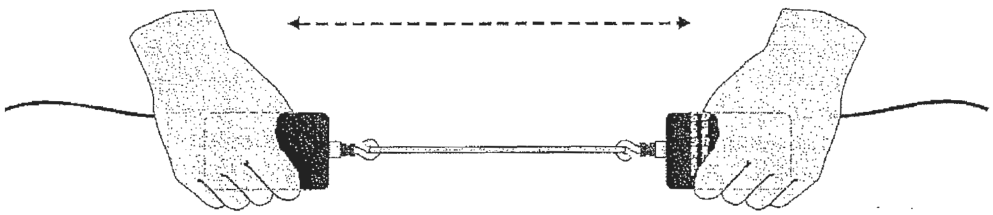
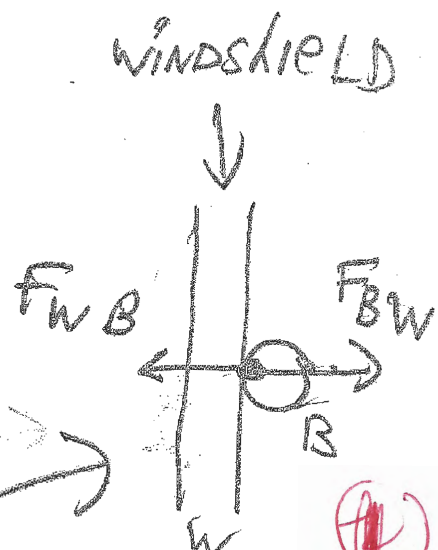


Figure 1

OBJECTIVES

- Calibrate two Force Sensors.
- Observe the directional relationship between force pairs.
- Observe the time variation of force pairs.
- Explain Newton's third law in simple language.



MATERIALS

Power Macintosh or Windows PC
LabPro or Universal Lab Interface
Logger *Pro*
two Vernier Force Sensors
500-g mass
string
rubber band

EXPLAIN

$F_{WB} \overset{?}{=} F_{BW}$

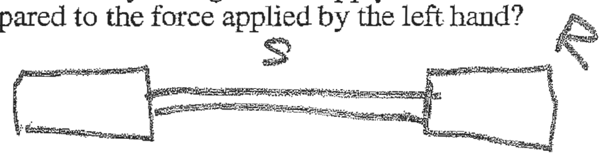
PRELIMINARY QUESTIONS

1. You are driving down the highway and a bug splatters on your windshield. Which is greater: the force of the bug on the windshield, or the force of the windshield on the bug?

EXPLAIN WHY BUG WAS MORE DAMAGE

2. Hold a rubber band between your right and left hands. Pull with your left hand. Does your right hand experience a force? Does your right hand apply a force to the rubber band? What direction is that force compared to the force applied by the left hand?

DIR DIFF
MAG SAM
opposite
magnitude



3. Pull harder with your left hand. Does this change any force applied by the right hand?
4. How is the force of your left hand, transmitted by the rubber band, related to the force applied by your right hand? Write a rule, in words, for the force relationship.

PROCEDURE

1. Connect the two Student Force Sensors or the two Dual-Range Force Sensors to Channels 1 and 2 on the LabPro or Universal Lab Interface. If you are using Force Probes, connect them to PORT 1 and PORT 2.

2. Open the Experiment 11 folder from *Physics with Computers*. Then open the experiment file that matches the force sensors you are using. If your sensor has a range switch, set it to 50 N. One graph will appear on the screen. The vertical axis will have force scaled from –20 to 20 N. The horizontal axis has time scaled from 0 to 10 s.

3. Force Sensors measure force only along one direction; if you apply a force along another direction, your measurements will not be meaningful. The Dual Range Force Sensor and the ULI Force Probe respond to force directed parallel to the long axis of the sensor. The Student Force Sensor responds to forces applied to the hook along the line (between the ends of the "U" formed by the sensor).

4. Since you will be comparing the readings of two different Force Sensors, it is important that they both read force accurately. In other words, you need to *calibrate* them. To calibrate the first sensor,
   a. Choose Calibrate from the Experiment menu. Click on the port of the first Force Sensor so the port is highlighted, and if necessary, on the port of the second Force Sensor so it is *not* highlighted. Click on the [Perform Now] button.
   b. Remove all force from the first sensor and hold it vertically with the hook pointed down. Enter a **0** (zero) in the Value 1 field, and after the reading shown for Input 1 is stable, click [Keep]. This defines the zero force condition.
   c. Hang the 500-g mass from the sensor. This applies a force of 4.9 N. Enter **4.9** in the Value 2 field, and after the reading shown for Input 1 is stable, then click [Keep].
   d. Click [OK] to complete the calibration of the first Force Sensor.

5. Repeat the process for the second Force Sensor with one important exception: Instead of entering 4.9 for the Value 2 field, enter **– 4.9**. The minus sign indicates that for the second sensor a pull is negative. For this activity it is helpful to set up the two Force Sensors differently, since later you will have the sensors positioned so that a pull to the left will generate the same sign of force on each sensor.

6. You will be using the sensors in a different orientation than that in which they were calibrated. Zero the Force Sensors to account for this. Hold the sensors horizontally with no force applied, and click [Zero]. Click [Zero all sensors] to zero both sensors. This step makes both sensors read exactly zero when no force is applied.

7. Click [Collect] to take a trial run of data. Pull on each Force Sensor and note the sign of the reading. Use this to establish the positive direction for each sensor.

8. Make a short loop of string with a circumference of about 30 cm. Use it to attach the hooks of the Force Sensors. Hold one Force Sensor in your hand and have your partner hold the

other so you can pull on each other using the string as an intermediary. Be careful to apply force only along the sensitive direction of your particular Force Sensor.

9. Click [Collect] to begin collecting data. Gently tug on your partner's Force Sensor with your Force Sensor, making sure the graph does not go off scale. Also, have your partner tug on your sensor. You will have 10 seconds to try different pulls. Choose Store Latest Run from the Data menu.

10. What would happen if you used the rubber band instead of the string? Would some of the force get "used up" in stretching the band? Sketch a prediction graph, and repeat Steps 8-9 using the rubber band instead of the string.

ANALYSIS

1. Examine the two data runs. What can you conclude about the two forces (your pull on your partner and your partner's pull on you)? How are the magnitudes related? How are the signs related?
2. How does the rubber band change the results—or does it change them at all?
3. While you and your partner are pulling on each other's Force Sensors, do your Force Sensors have the same positive direction? What impact does your answer have on the analysis of the force pair?
4. Is there any way to pull on your partner's Force Sensor without your partner's Force Sensor pulling back? Try it.
5. Reread the statement of the third law given at the beginning of this activity. The phrase *equal and opposite* must be interpreted carefully, since for two vectors to be equal ($\vec{\mathbf{A}} = \vec{\mathbf{B}}$) and opposite ($\vec{\mathbf{A}} = -\vec{\mathbf{B}}$) then we must have $\vec{\mathbf{A}} = \vec{\mathbf{B}} = 0$; that is, both forces are always zero. What is really meant by *equal and opposite*? Restate Newton's third law in your own words, not using the words "action," "reaction," or "equal and opposite."
6. Re-evaluate your answer to the bug-windshield question.

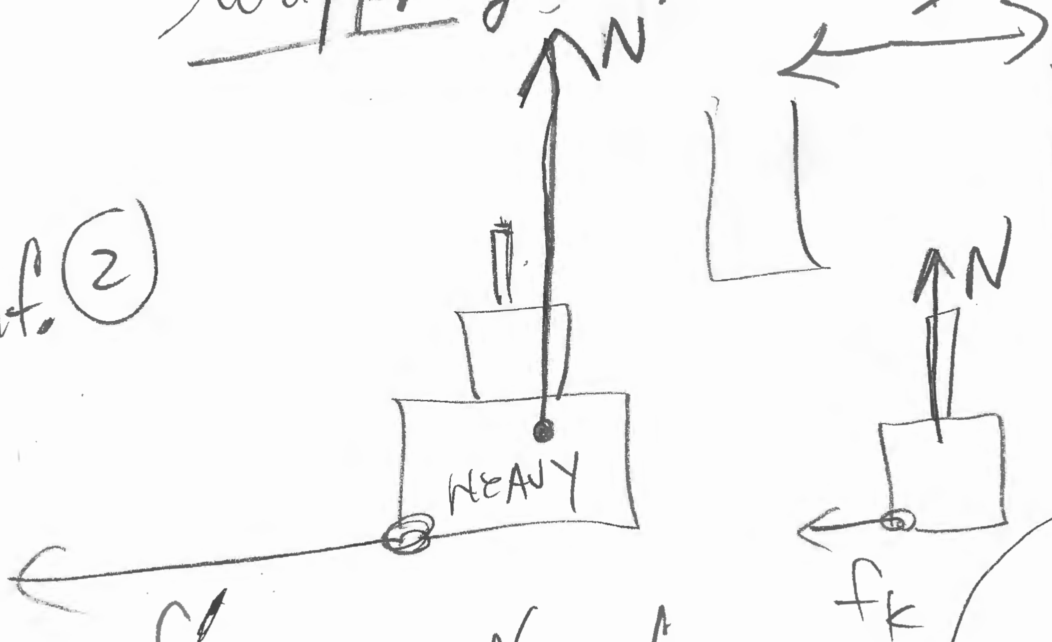
EXTENSIONS

1. Fasten one Force Sensor to your lab bench and repeat the experiments. Does the bench pull back as you pull on it? Does it matter that the second Force Sensor is not held by a person?
2. Use a rigid rod to connect your Force Sensors instead of a string and experiment with mutual pushes instead of pulls. Repeat the experiments. Does the rod change the way the force pairs are related?

momentum LAB notes;

Swapping:

conf. ②



$f_k' > f_k$

$f_k \propto N$

↑ PROPORTIONAL TO

$N' > N$

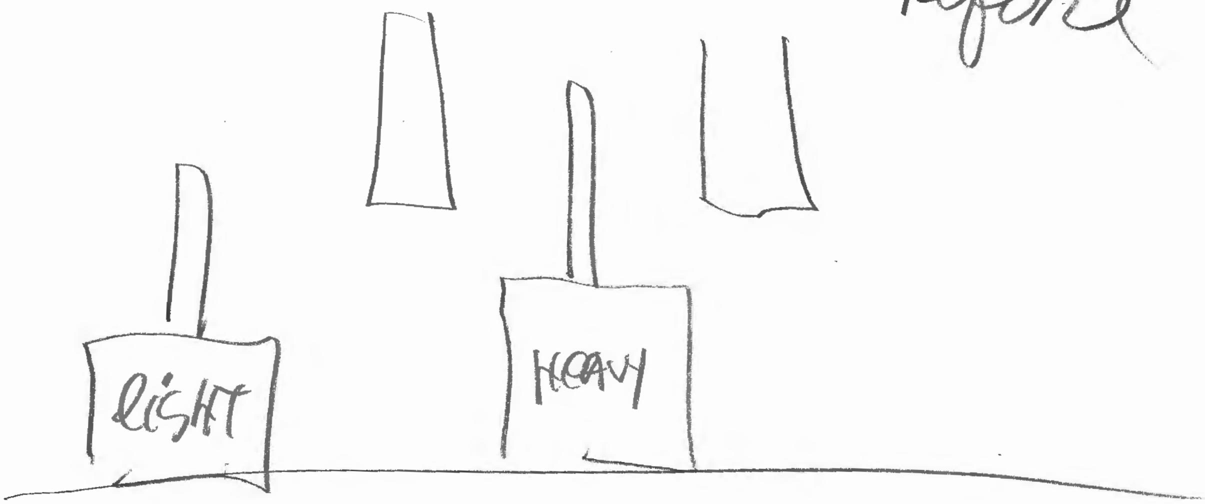
HEAVY HAS LARGE N', LARGE heat = f_k

before: | after:

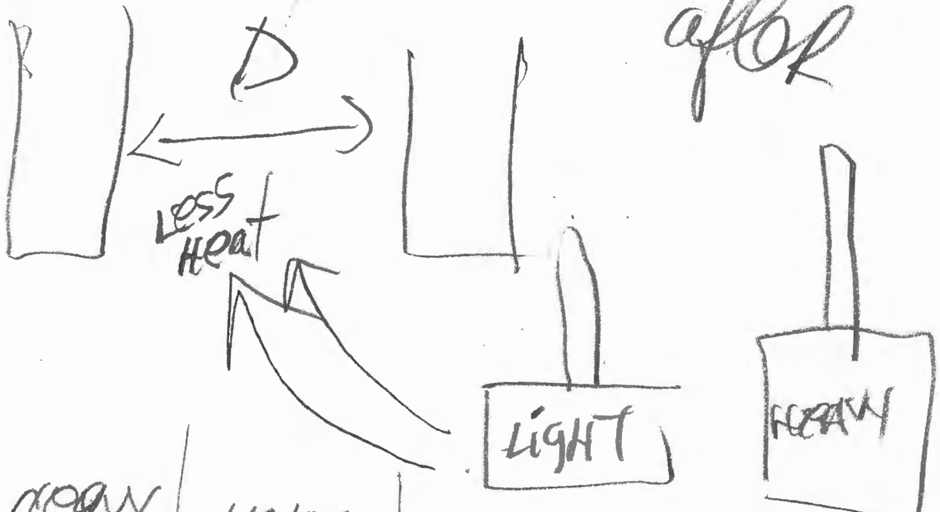
SWAP E.C.

Compare with FIRST configuration (1)

before



after



	HEAVY	LIGHT	
config. 1 (HEAVY between gates)	D/2	D	← less heat
config. 2 (HEAVY outside gates)	D	D/2	← MORE heat