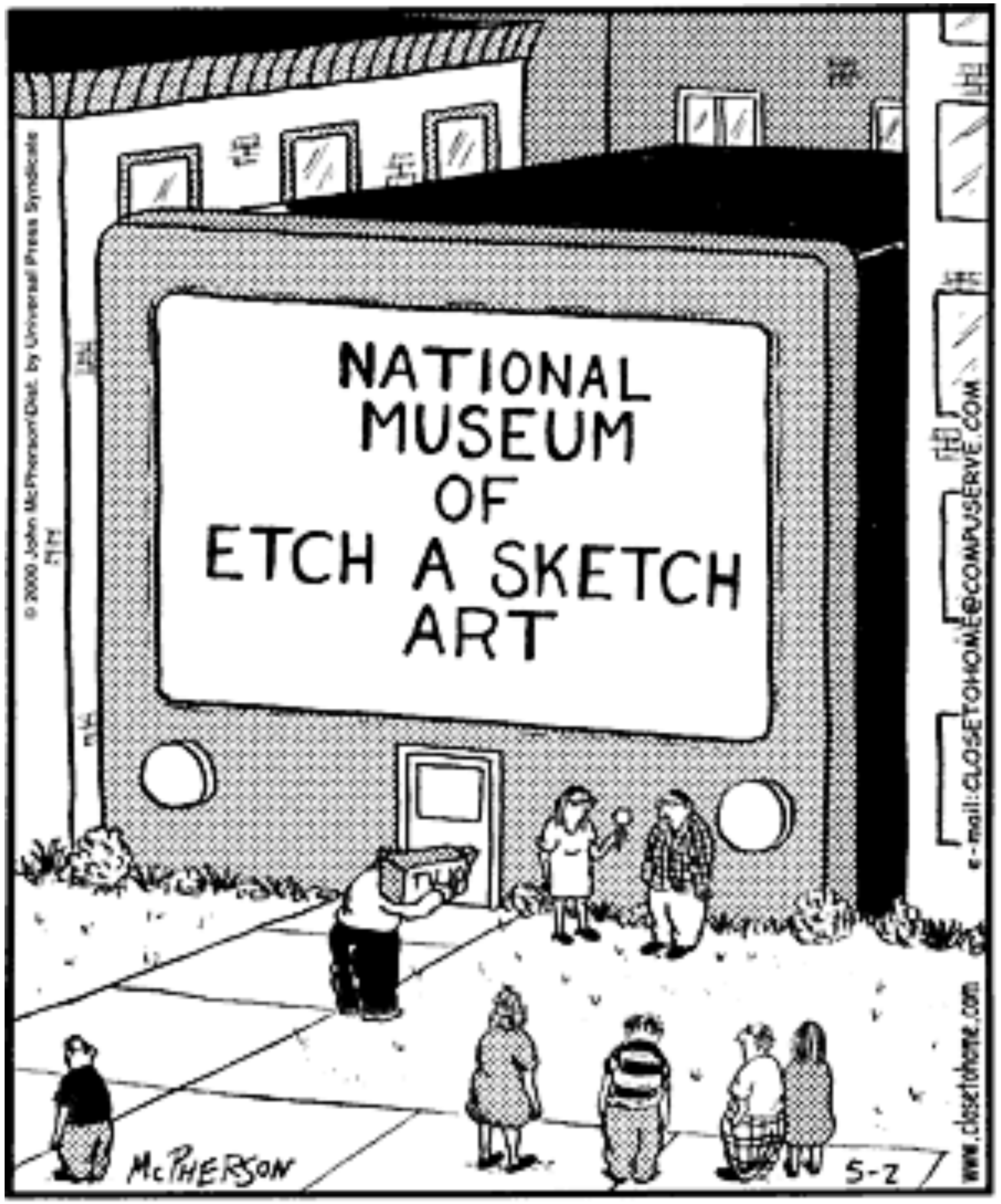
Physics 220

On the 3 x 5 card, please write

1. Preferred name
2. Your hometown
3. Interests, hobbies, major
4. Some interesting/funny facts about yourself that you don't mind sharing with the class.

Share what you wrote with someone around you. In a moment, I'll ask you to introduce someone else.

Hand in your card before you leave today.



"Structurally, the building is fine. But sadly, the earthquake destroyed all of our art pieces."

Physics 220: Principles of Physics III

<u>Who am I?</u>

Lance Nelson

Rigby, Idaho

Computational Physics
Materials Physics

“Range” by David Epstein

I like to play handball but I’m not very good.

What’s handball?

Course Structure (Schedule)

PHYSICS 220 COURSE SCHEDULE, SPRING SEMESTER, 2022

	Date	Reading	Topic/Activity	Due
1	Mon, Apr 18	Syllabus	Intro to PH220	
2	Tues, Apr 19	22.1–22.3	Charge, Insulators, Conductors	
3	Wed, Apr 20	–	HW 1	
4	Thurs, Apr 21	22.4–22.5	Coulomb's Law, Electric Fields	
5	Fri, Apr 22	–	HW 2	
6	Mon, Apr 25	–	grade HW/Numerical Problem 2	HW 1
7	Tues, Apr 26	23.1–23.3	Multiple charges/ Continuous charge distributions	
8	Wed, Apr 27	–	HW 2	
9	Thurs, Apr 28	23.4	Special Geometry	
10	Fri, Apr 29	–	HW 3	
11	Mon, May 2	–	grade HW/Numerical Problem 3	HW 2
12	Tues, May 3	23.5–23.7	Parallel-Plate Capacitor/Particles in Fields	
13	Wed, May 4	–	HW 3	
14	Thurs, May 5	24.1–24.3	Electric Flux	
15	Fri, May 6	–	HW 4	
16	Mon, May 9	–	grade HW/Numerical Problem 4	HW 3
17	Tues, May 10	24.4–24.6	Gauss's Law	
18	Wed, May 11	–	HW 4	
19	Thurs, May 12	25.1–25.3	Electric Potential Energy	
20	Fri, May 13	–	HW 5	
21	Mon, May 16	–	grade HW/Numerical Problem 5	HW 4
22	Tues, May 17	25.4–25.7	Electric Potential	
23	Wed, May 18	–	HW 5	
24	Thurs, May 19	26.1–26.3	Field from Potential	

Course Weights

- Warm-ups (before coming to class) - 20%
  - Read assigned material before class.
  - Take a short quiz to get your mind thinking about topic.
- HW - 35%
  - Given on Wednesdays and Fridays. (With exceptions due to holidays)
  - Graded together on Mondays.
  - Numerical problem given on Mondays. (I'll provide some in-class instruction.)
- Midterm Exams - 45%
  - Administered in testing center
  - Calculator and Equation sheet allowed
- Final Exam - Optional
  - Comprehensive
  - Mix of conceptual and mathematical questions.
  - Administered in person at university-scheduled time.

Want a job? Learn this.

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Python Download

Homework

- Given on Wednesdays and Fridays
- Due on Mondays
- Usually can be completed in class.
- Extra credit problems available
- Graded in class on Mondays.

Projectile Motion

Required Problems

Problem 1 (Beginnning Level) - 5 points

A particle's velocity is given by the function $v_x = kt^2$ m/s, where k is a constant and t is in seconds. That particle's position at $t_0 = 0.0$ s is $x_0 = -9.0$ m. At $t_1 = 3.0$ s, the particle is at $x_1 = 9.0$ m. Determine the value of the constant k. Be sure to include proper units on your answer. What is the acceleration function?

Problem 2 (Beginning Level) - 5 points

While on the roof at your house, Santa loses his footing and begins to slide down your frictionless roof. Your roof has a slope of 35°. If Santa reaches a speed of $10\frac{m}{s}$ by the time he reaches the end of the roof, what distance did he slide?

Problem 3 (Intermediate Level) - 10 points

A rocket with a mass of 1500 kg is launched straight up. The rocket motor provides a constant acceleration of $30\frac{m}{s^2}$ for 20 s, then runs out of fuel.

(a) What is the rocket's maximum altitude?

(b) How long is the rocket in the air before hitting the ground?

Problem 4 (Intermediate Level) - 10 points

You are driving your car at a steady $20\frac{m}{s}$, looking at the cute girl/guy driving next to you, and not paying attention to the road. When you look up you notice that you are 50 m away from a railroad crossing. A train is moving towards the crossing at a steady $30\frac{m}{s}$, and is only 60 m away from the crossing. In an instant you realize that the train is going to beat you to the crossing and that there is not enough distance to stop. You're only hope is to accelerate enough to cross the tracks before the train arrives. If your reaction time before starting to accelerate is 0.5 s, what minimum acceleration do you need to beat the train across the tracks?

Problem Solving Approach

Solving problems in physics can become much easier for you when you have a regular pattern to follow. 3D BE SNUB is the mnemonic used at BYU to help students remember the steps used by experienced problem solvers everywhere.

D_1 Diagram or draw the situation described in the problem. Label the picture with symbols (you may include numbers too) to represent the information given and needed.

D_2 Define the symbols when the diagram doesn't explain them enough. List them in a short table, giving their numerical value. Identify the ones you are solving for.

D_3 Describe what is happening, and what needs to be found in the problem. One line will do. List any assumptions that you are making about the situation.

These three D steps comprise what we might describe as making a representation of the problem.

BE Identify the Basic Equation that you will use for your solution. At this step we require that you write a very short essay. Describe why this is the correct equation by identifying the assumptions it makes, and the concept it uses; Examine your choice carefully; Why does this equation work and not others? . . . Select the equation that fits the physics involved and box the variable you are looking for, and check the variables whose values you know. If you are not sure which equations to use, list all of the equations that are likely, boxing, checking and examining each equation as above.

S Using the basic equations(s) and math, rearrange the equation until you have Solved for the variable needed. It is indeed usually a bad mistake to plug numbers in at this stage. (It is often helpful, however, to plug in the zeros that apply.)

N After S, then plug in the Numbers. **Every number must include its units**. Plug in the numbers as given, and keep three significant figures.

U Check the Units to make sure they match the expected answer. If you have not done the algebra on the units earlier, do it here.

BeSNU steps comprise what we might describe as the olve step.

B Check the numerical answer for Ballpark accuracy. Use a B✓ to indicate if you believe the answer is reasonable, and a B? to indicate that you have no experience with this kind of situation that would help you judge whether the answer is reasonable.

Expert problem solvers constantly apply **B** to each step. *Does what I'm doing fit? Does it make sense? Does it really describe* ***my*** *situation.*

The last step could be called the work assess step.

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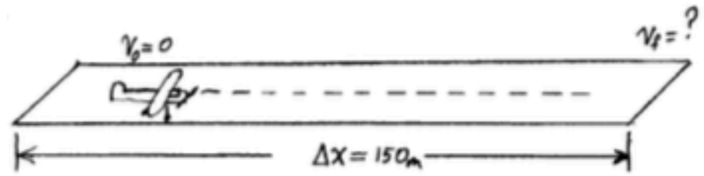
Sample Homework Problem

The Problem: You are designing an airport for small planes. One kind of craft used in the community must reach a speed of 100 km/hr (27.8 m/s) in order to lift off. Its steady acceleration is 2.0 m/s². If the runway is 150 m long, will it take off, or crash and burn?

D₁



D₂
$v_0 = 0$, the plane starts from rests.
$v_f = ?$, the speed at the end of the runway. (We hope this is 100 km/hr or more.)
$a = 2.0$ m/s², the *constant* acceleration of the plane.
$\Delta x = 150$ m, the difference between beginning and ending positions.

D₃ With the airplane we have, we need to know if our runway is long enough. That is, with $v_0 = 0$ m/s, $a = 2.0$ m/s², and $\Delta x = 150$ m, will $v_f \overset{?}{>} 100$ km/hr?

Be The equations listed are OK for motion if the acceleration is constant, and it is in this problem. Notice that the first two equations have a clock reading- the time- in them. I do not know the time, *nor do I want to!* The last of the three equations is exactly what we need.

$$\boxed{v_f} = \overset{\checkmark}{v_i} + \overset{\checkmark}{a}\overset{?}{t}$$
$$\overset{\checkmark}{\Delta x} = \overset{\checkmark}{v_i}\,\overset{?}{t} + \frac{1}{2}\overset{\checkmark}{a}\overset{?}{t^2}$$
$$\boxed{v_f^2} = \overset{\checkmark}{v_i^2} + 2\overset{\checkmark}{a}\overset{\checkmark}{\Delta x}$$

S $\sqrt{v_f^2} = \sqrt{v_i^2 + 2a\Delta x}$, so $v_f = \sqrt{v_i^2 + 2a\Delta x}$

N $v_f = \sqrt{(0\text{ m/s})^2 + 2(2.0\text{ m/s}^2)(150\text{ m})} = \sqrt{600\text{ m}^2/\text{s}^2} = 24.5$ m/s
NO! This plane won't be taking off from this runway.

U We got units of m/s, and we were looking for a speed. Yup! Our units match our goal.

B Well, 24.5 m/s is in the neighborhood of the 27.8 m/s speed we were hoping for. Our answer claims the plane is going too slow. Nevertheless, our answer is a speed that we could reasonably expect a plane to have near takeoff.

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D$_1$

D$_2$ $v_0 =$ $v_f =$ $a = 2$ $\Delta x =$

D$_3$ With ... s, with $v_0 =$

Be The ... is co... two ... not ... equa...

S $\sqrt{v_f^2}$

N $v_f =$ NO!

U We g... goal.

B Well, ... r. Our answ... hat we could reasonably expect a plane to have near takeoff.

C - Work is correct	/50
3D - Picture Drawn and labeled. Variables defined. Situation described	/15
Be-Basic Equations defined	/5
S/N - Algebra done with symbols. Numbers plugged in with units.	/20
U - Units of results have been verified	/5
B - Ballpark Accuracy.	/5
Total Score:	/100

3D-BE-SNUB

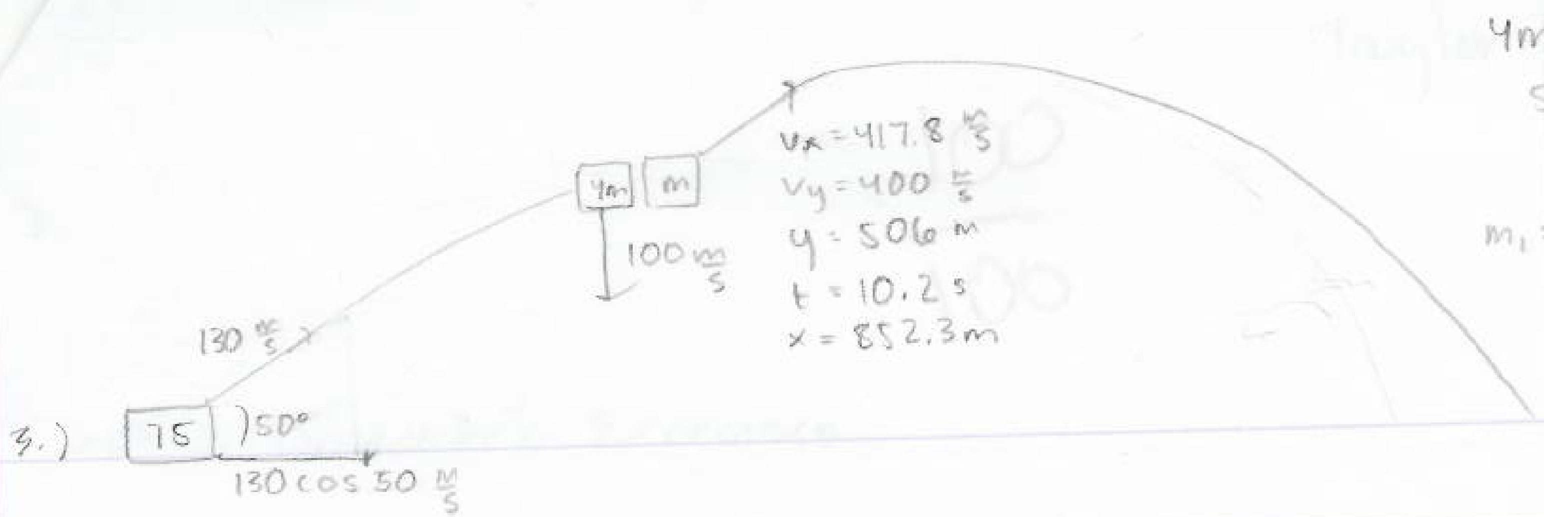
$4m + m = 75$

$5m = 75$

$m = 15$

$m_1 = 60\,kg \quad m_2 = 15\,kg$

3.)



at the highest point, no vel. in y-direction

all momentum → $P_i = P_f$

$P_{iy} = P_{fy}$

$0 = -4m(100) + m v_y$

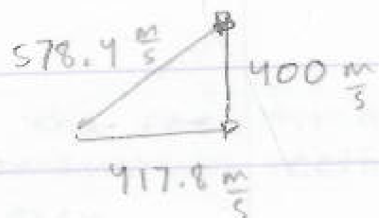
$(60)(100) = 15 v_y$

$v_y = 400 \frac{m}{s}$ ✓

$P_{ix} = P_{fx}$

$(75)\,130\cos 50 = \cancel{m}^{15} v_x$

$v_x = 417.8 \frac{m}{s}$ ✓



for first interval before explosion:

$v_{fy}^2 = v_{iy}^2 + 2a\Delta y$

$\Delta y = \dfrac{0 - (130\sin 50)^2}{2(-9.8)} = 506$ ✓

$x_f = x_i + v_{ix}t + \cancel{\tfrac{1}{2}a_x t^2}$

✓ $852.3\,m = 0 + 130\cos 50\,(10.2)$

$v_{fy} = v_{iy} + a\Delta t$

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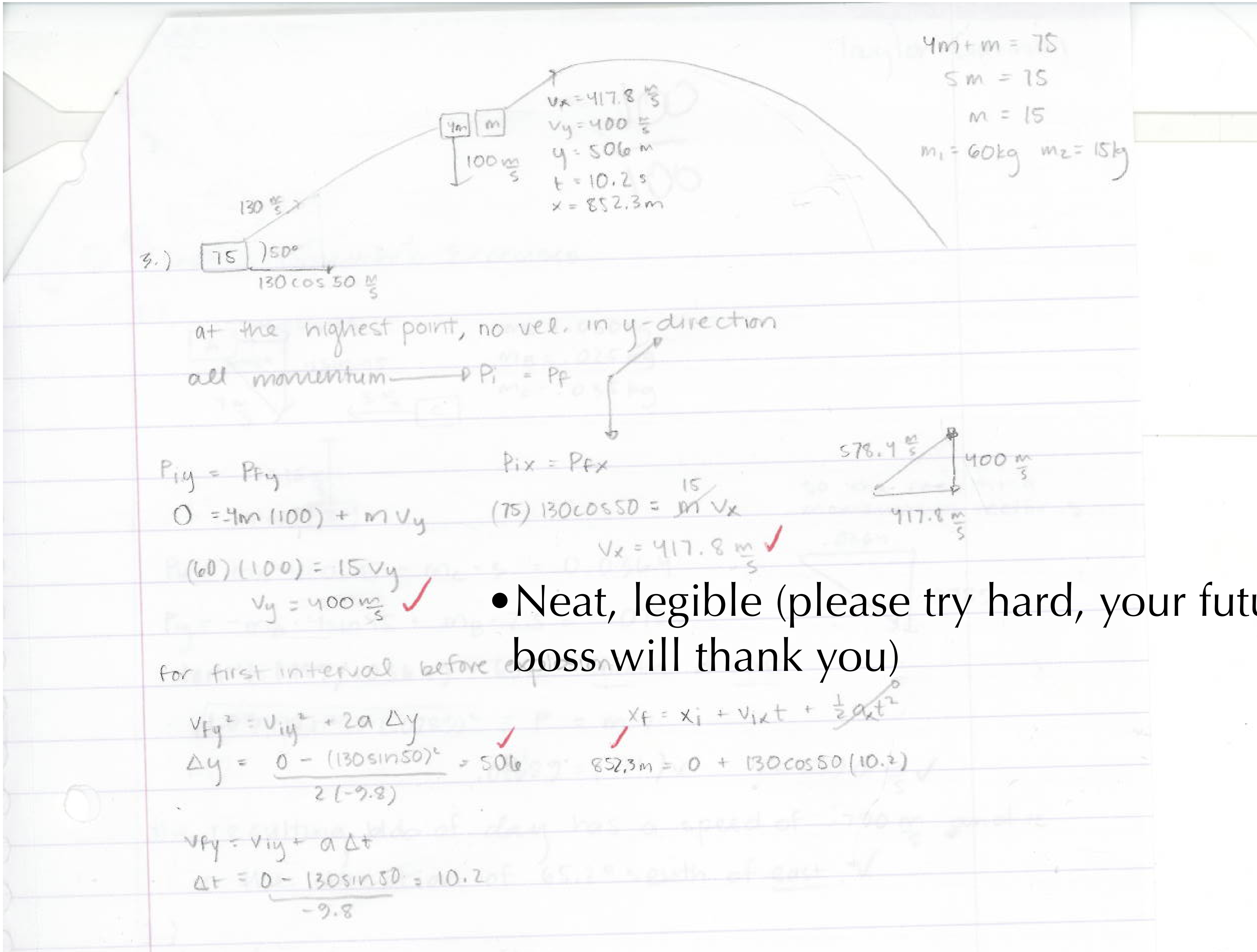

$4m + m = 75$
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$m = 15$
$m_1 = 60kg \quad m_2 = 15kg$

$v_x = 417.8 \frac{m}{s}$
$v_y = 400 \frac{m}{s}$
$y = 506\ m$
$t = 10.2\ s$
$x = 852.3m$

$\boxed{4m}\ \boxed{m}$ $100 \frac{m}{s}$

$130 \frac{m}{s}$

3.) $\boxed{75}$ $50°$ $130 \cos 50 \frac{m}{s}$

at the highest point, no vel. in y-direction

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$578.4 \frac{m}{s}$, $400 \frac{m}{s}$, $417.8 \frac{m}{s}$

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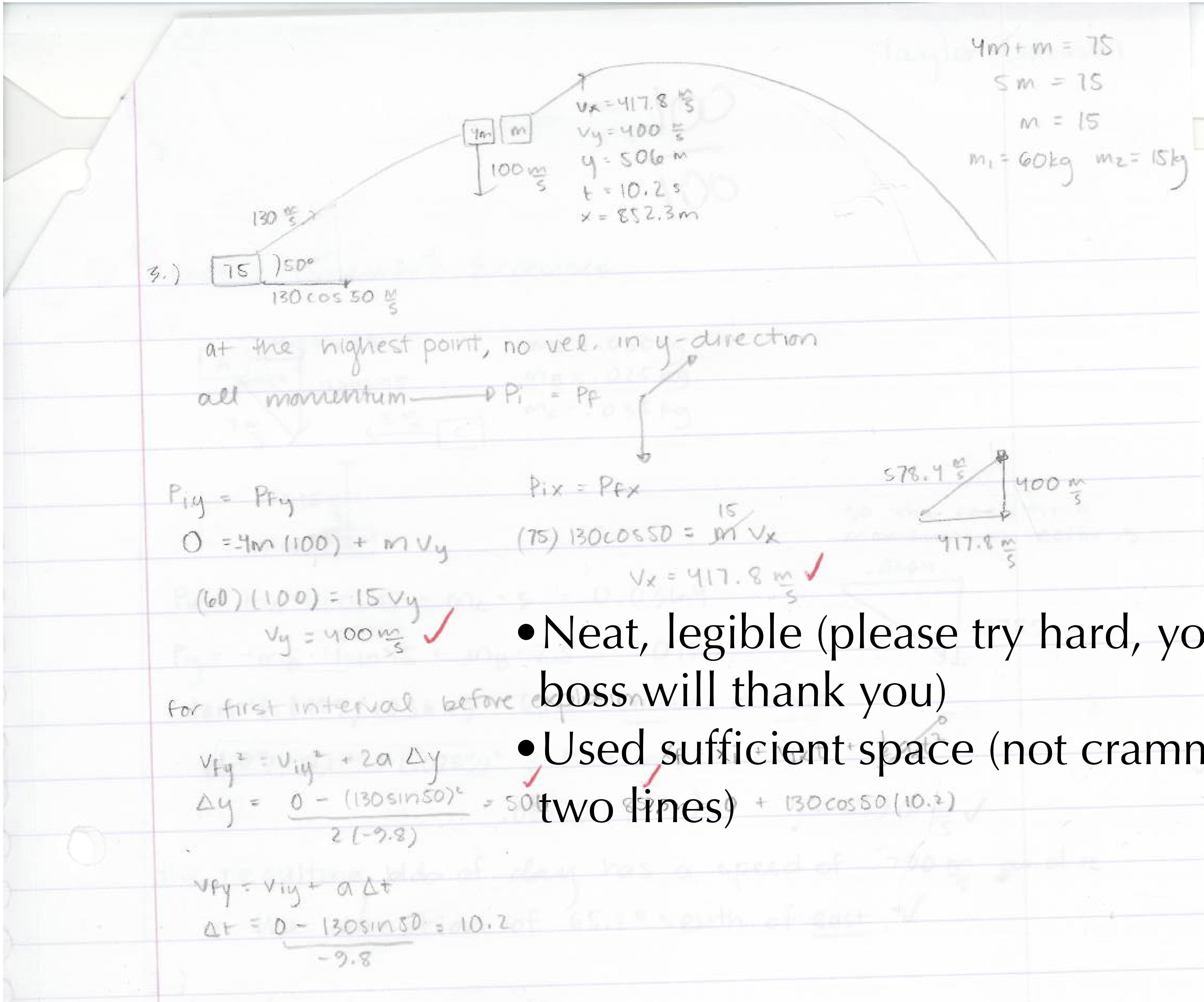
- Neat, legible (please try hard, your future boss will thank you)

3D-BE-SNUB



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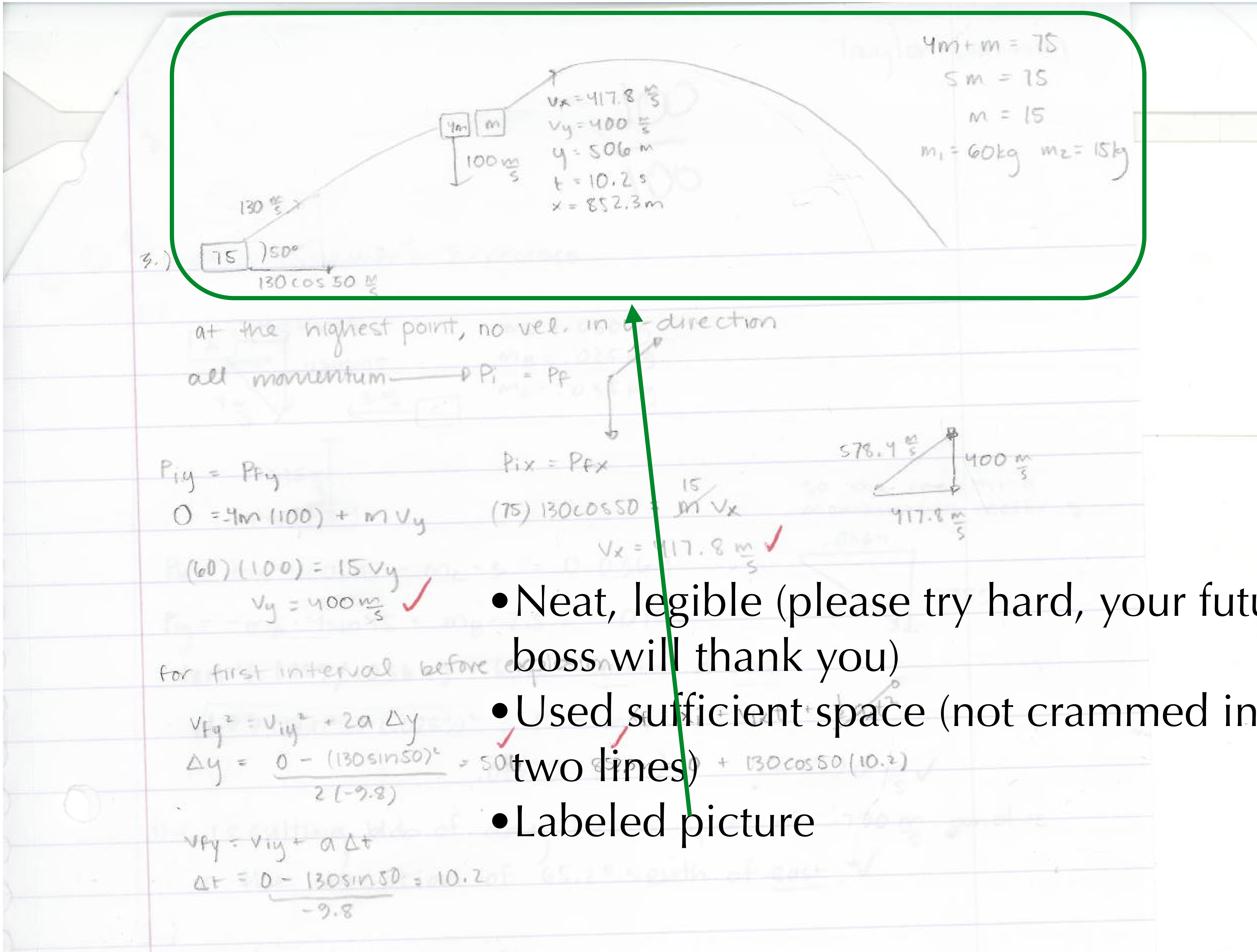
3D-BE-SNUB



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$y = 506\ m$

$t = 10.2\ s$

$x = 852.3\ m$

4m | m

$100\ \frac{m}{s}$

$130\ \frac{m}{s}$

75 | 50°

$130\cos 50\ \frac{m}{s}$

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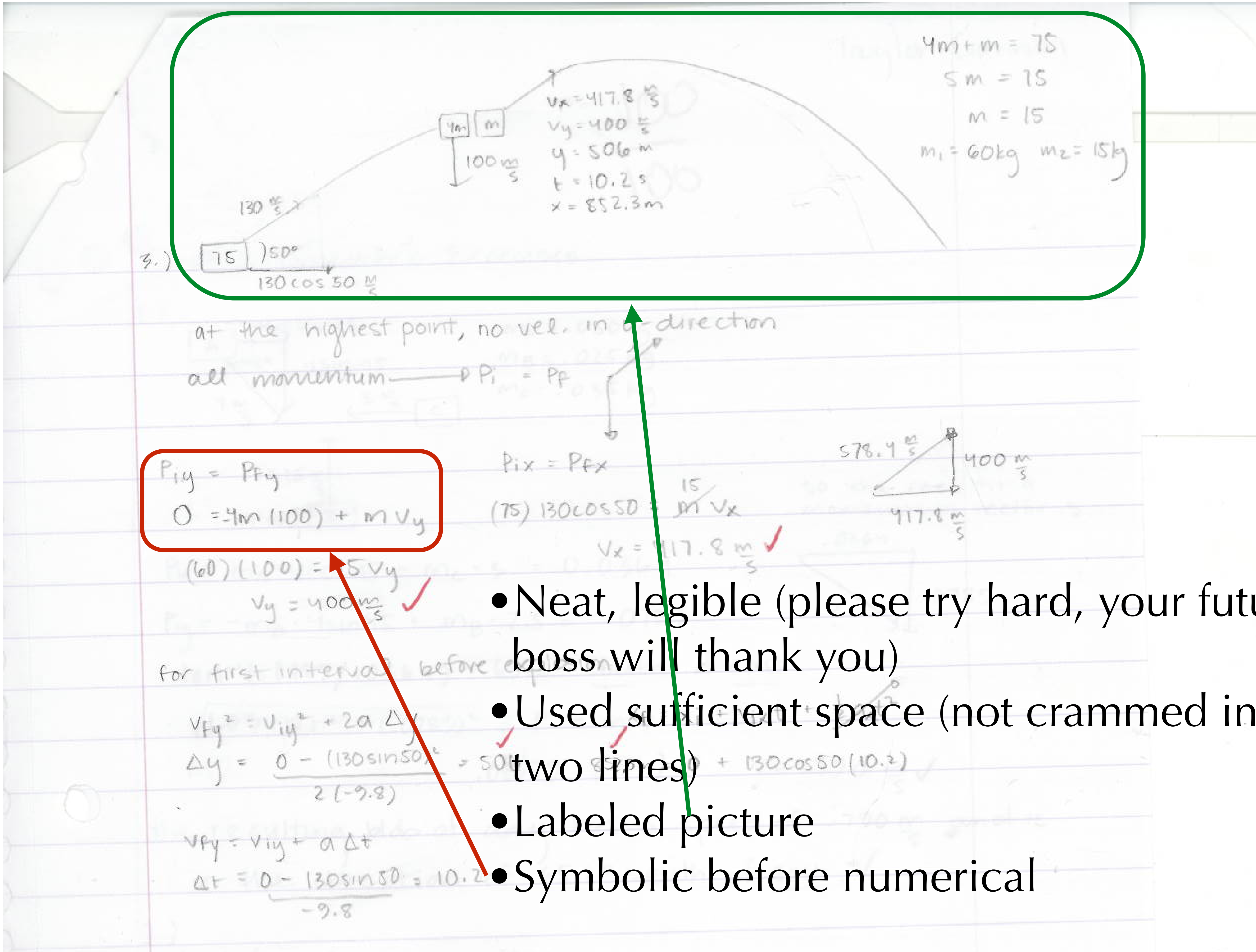
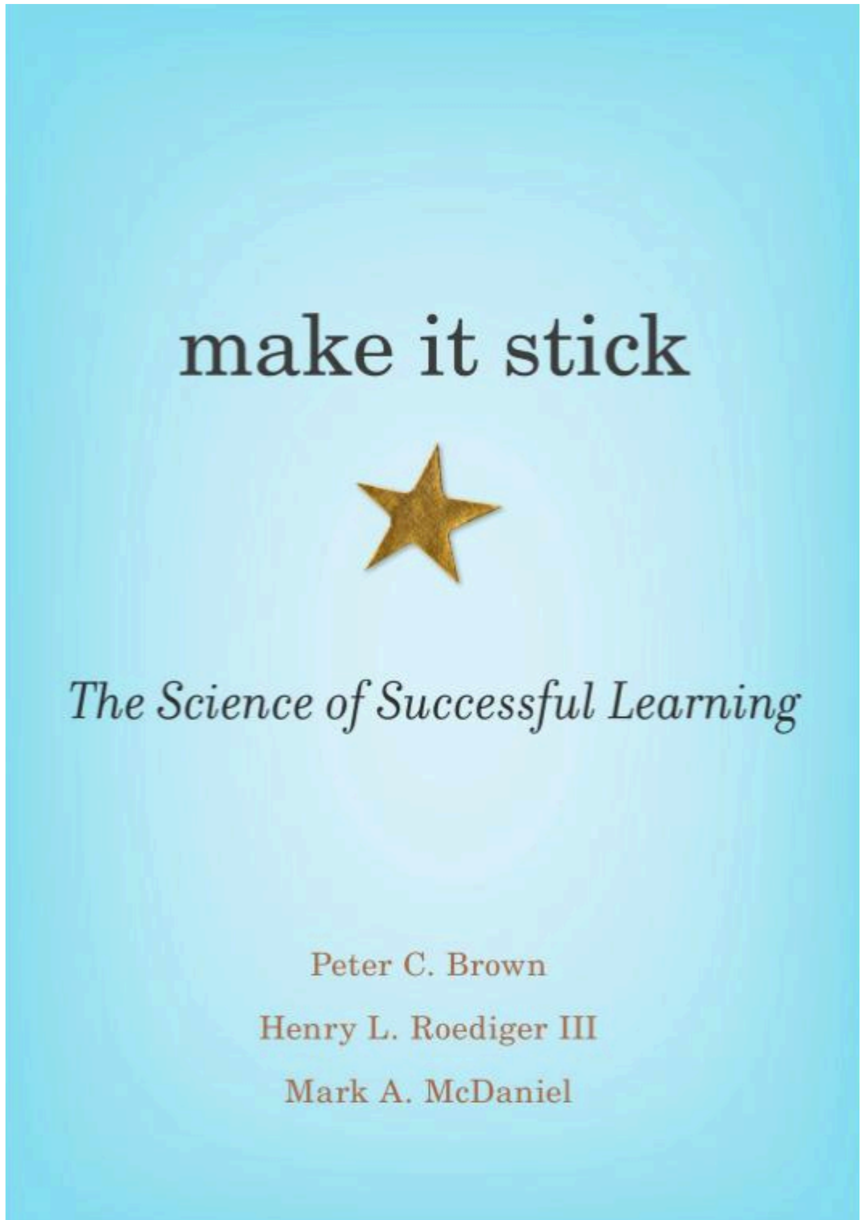
- Labeled picture



- Neat, legible (please try hard, your future boss will thank you)
- Used sufficient space (not crammed into two lines)
- Labeled picture
- Symbolic before numerical

Extra Credit

- Read “Make it Stick”: bump your grade at end of semester. (1%)
- Do extra HW problems.
- Extra credit problems on every exam.



ANACONDA.

WOLFRAM
COMPUTATION MEETS KNOWLEDGE

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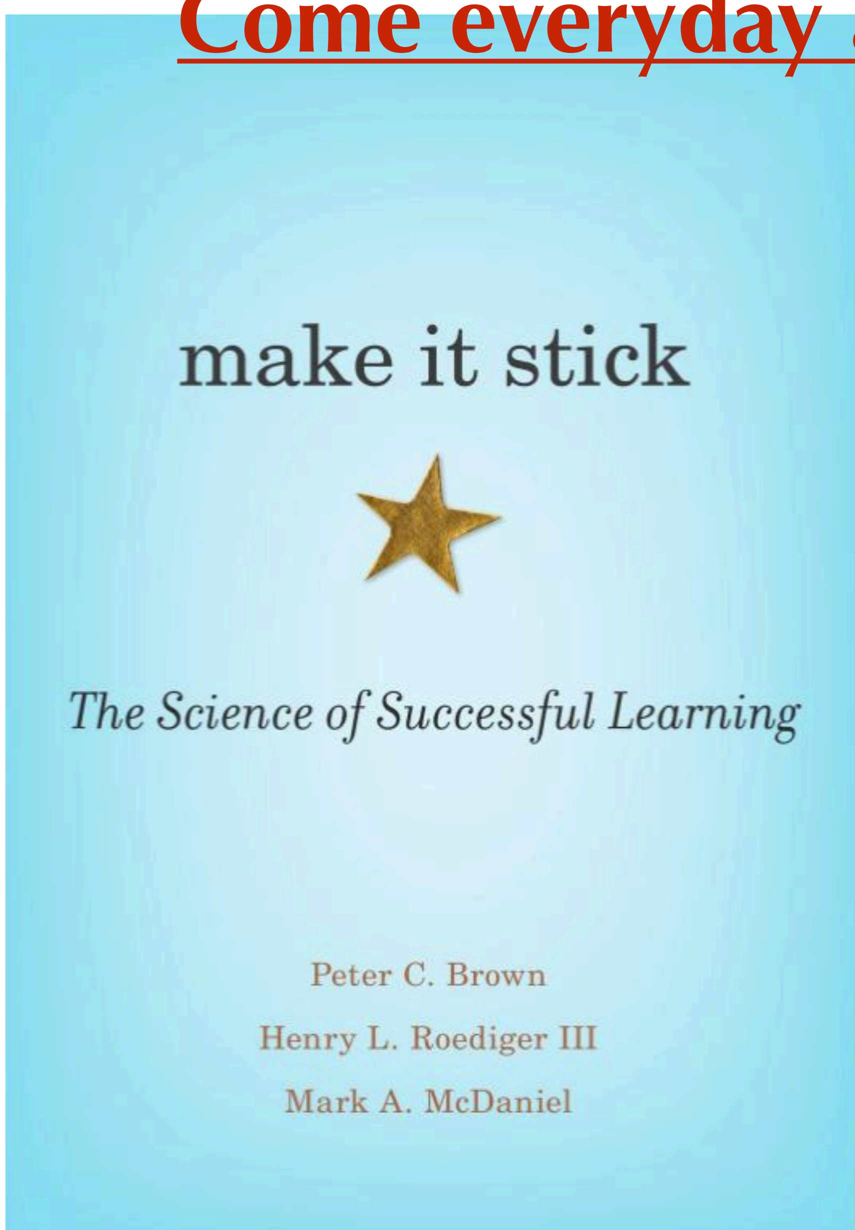
Come everyday and you’ll soon get the routine.



Institutional Learning Outcomes

Course Outcomes (What we want you to gain)

- have a strong conceptual understanding of Newtonian physics on the topic of electricity and magnetism.
- have strong problem-solving skills.
- be able to use dimensional analysis as a problem-solving tool.
- be able to work productively in a group setting.
- become comfortable using a computer to perform calculations and solve problems.
- be comfortable using graphical analysis to:
    - enhance your understanding of electricity and magnetism.
    - extract meaningful relationships from data.
    - represent solutions.

Physics majors

LSAT scores (law school)

MCAT scores (medical school)

GMAT (business school)

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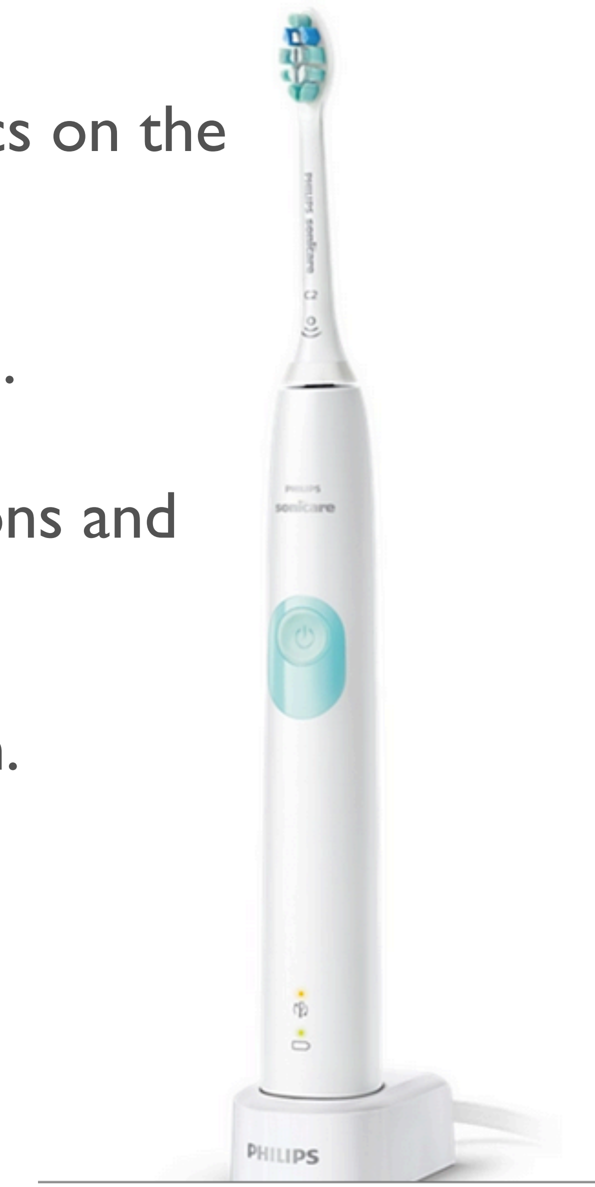

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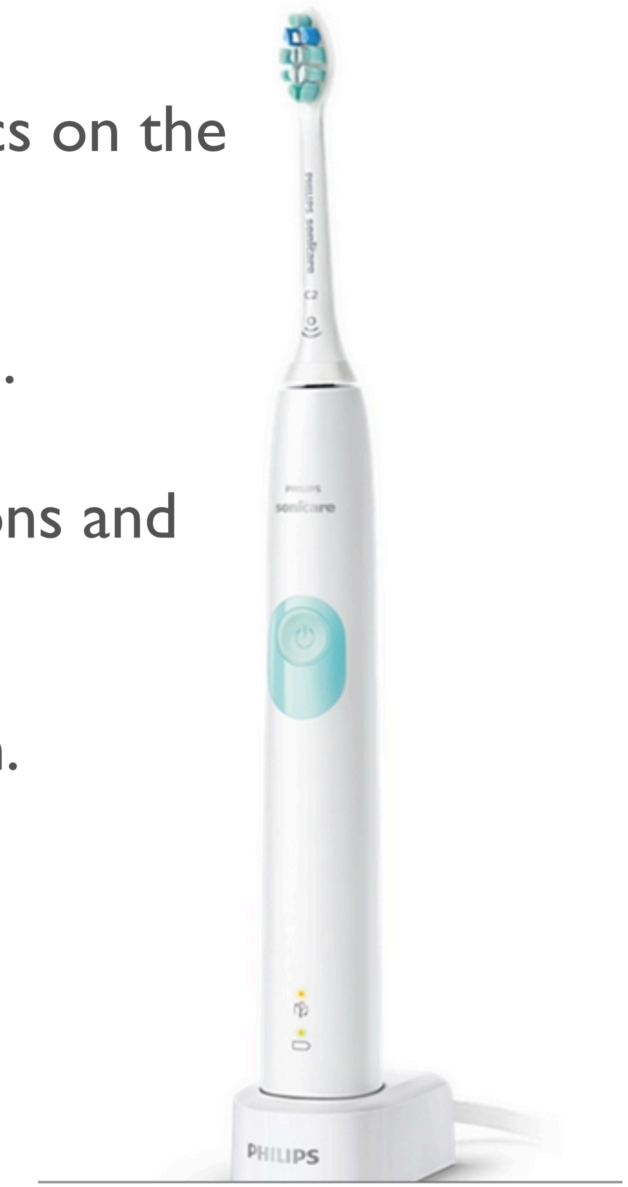

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l)

Things you should already be good at!

- Quadratic formula
- Cross product
- Dot product
- Algebra
- Trigonometry
- Pythagorean theorem
- Integration
- Derivatives
- Systems of Equations
- Degrees vs. Radians in your calculator.
- Vectors and components of vectors.
- Conservation of Energy (PH121!!!)

Learning (teaching philosophy)

Think of something you do really well (or know a lot about).

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How did you get so good at it?

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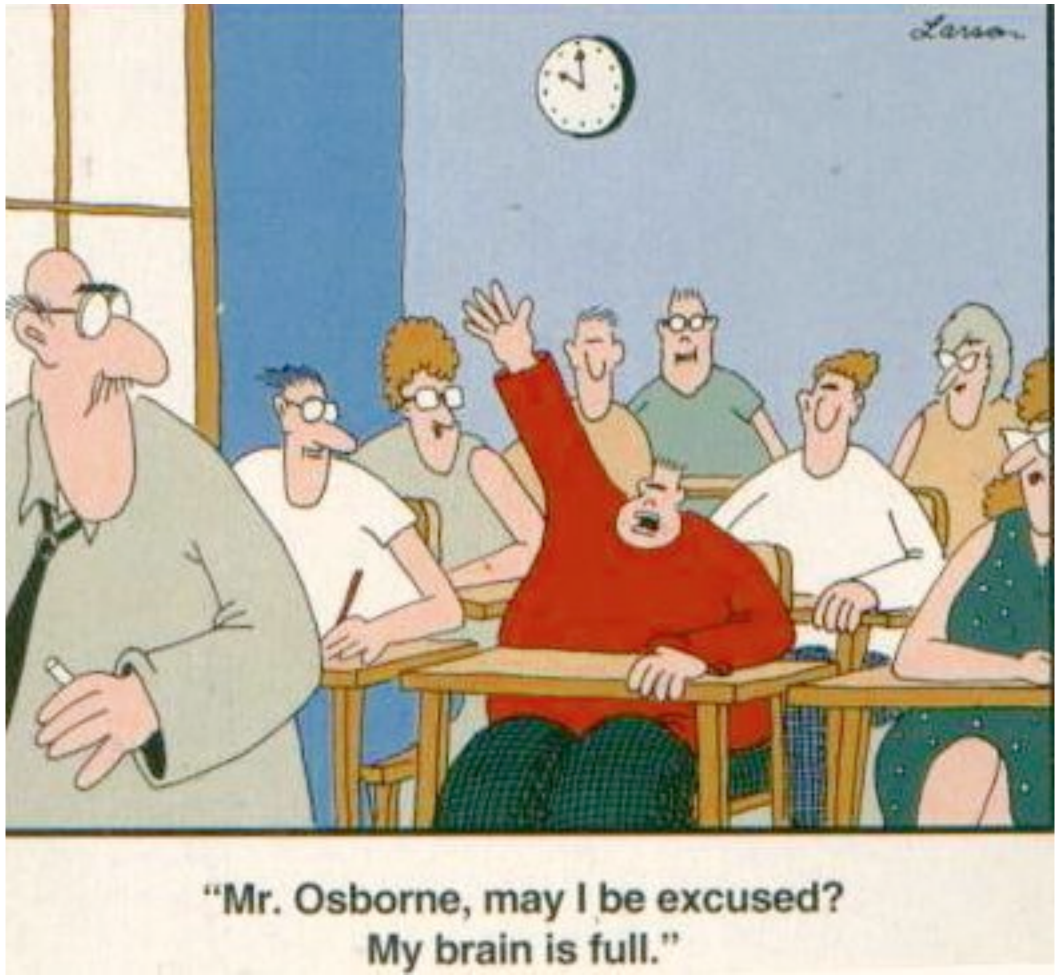

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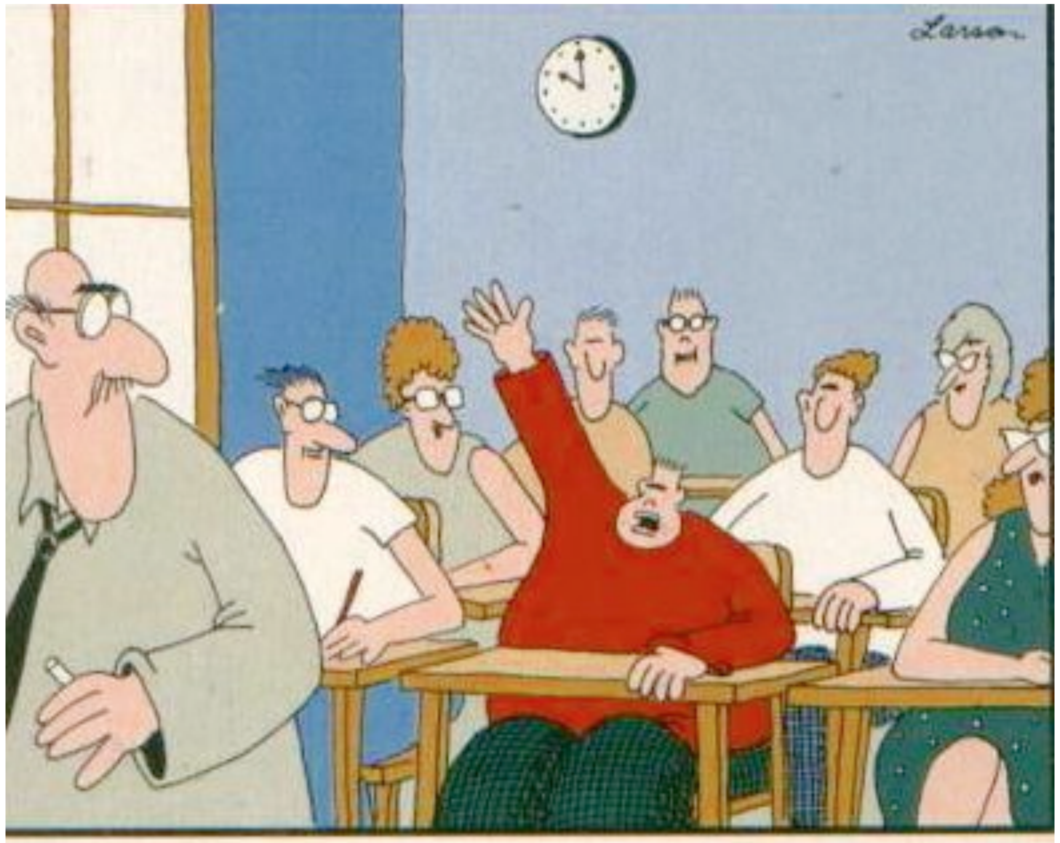
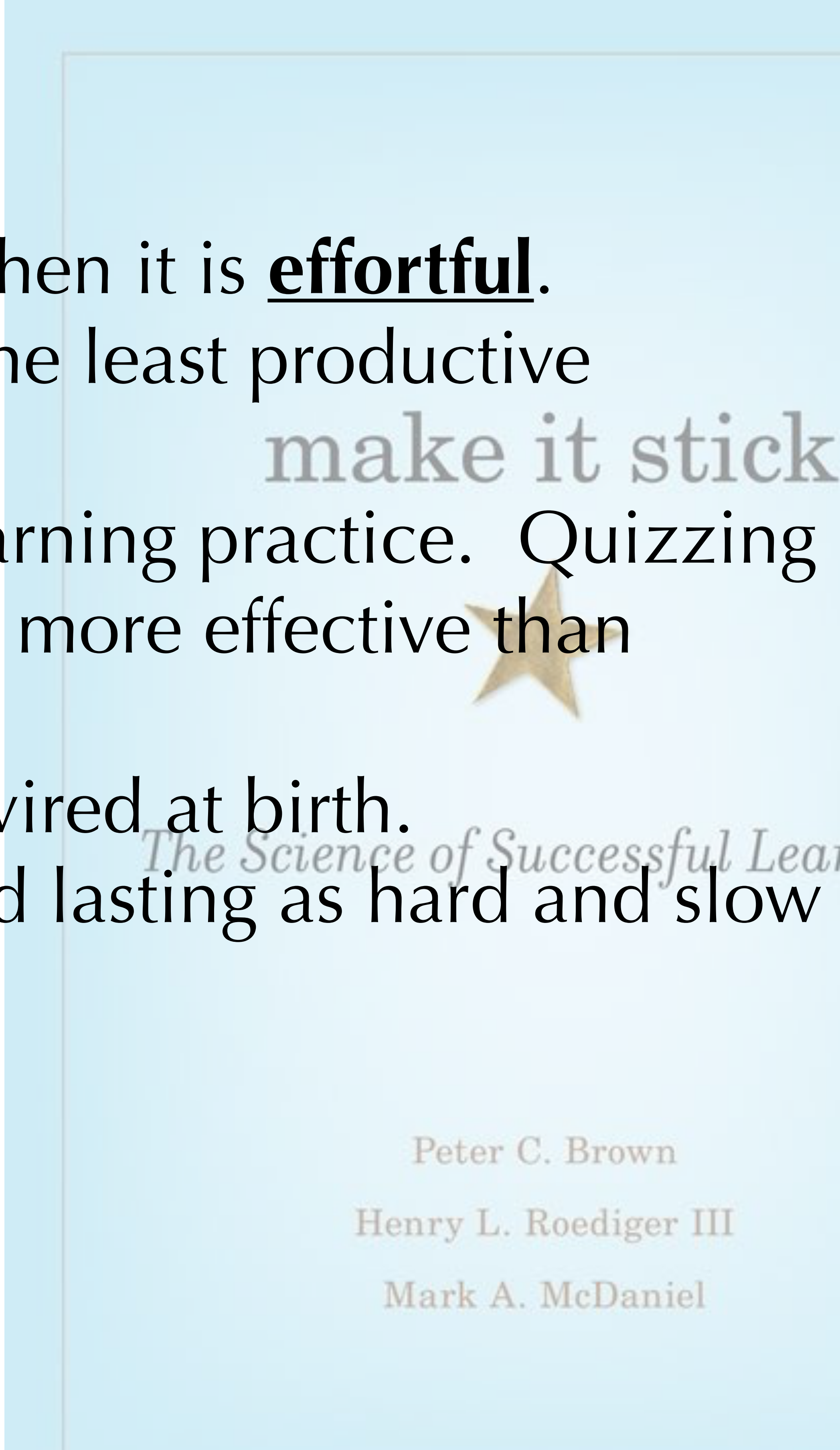


"Mr. Osborne, may I be excused?
My brain is full."

Facts about learning

- Learning is deeper and more durable when it is **<u>effortful</u>**.
- Rereading text and massed practice is the least productive learning strategy (and most deceptive).
- Retrieval practice is a more effective learning practice. Quizzing yourself on key concepts after lecture is more effective than reviewing the lecture notes or text.
- Your intellectual abilities are not hard-wired at birth.
- Easy and fast learning is not as deep and lasting as hard and slow learning(sorry).



Why did the Savior teach using parables?

Why did the Savior teach using parables?

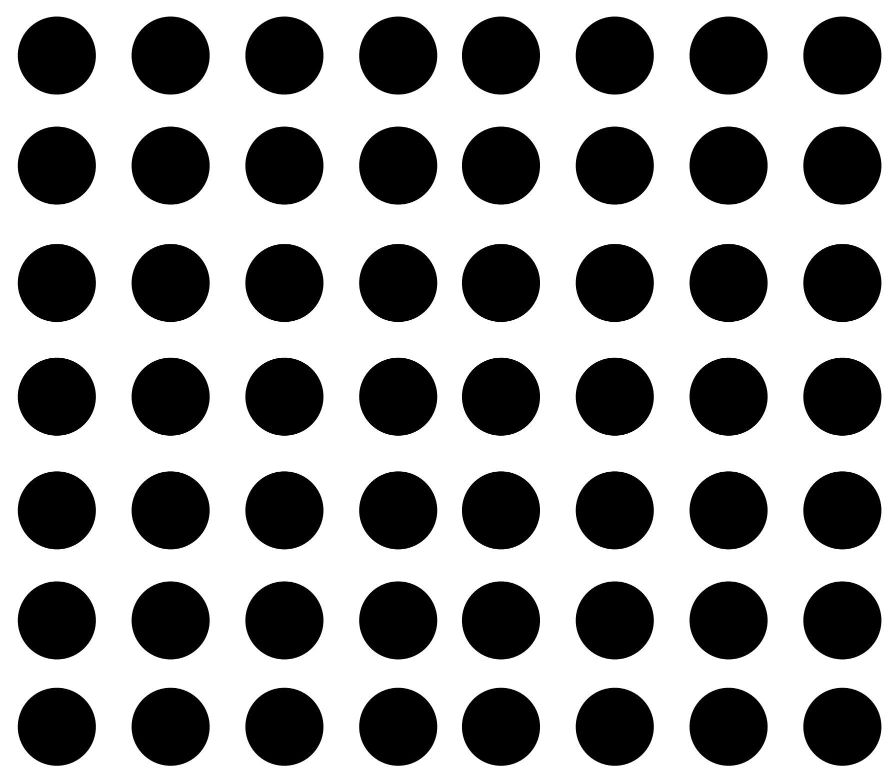
Matt 13:10-11

Alma 12:9-10

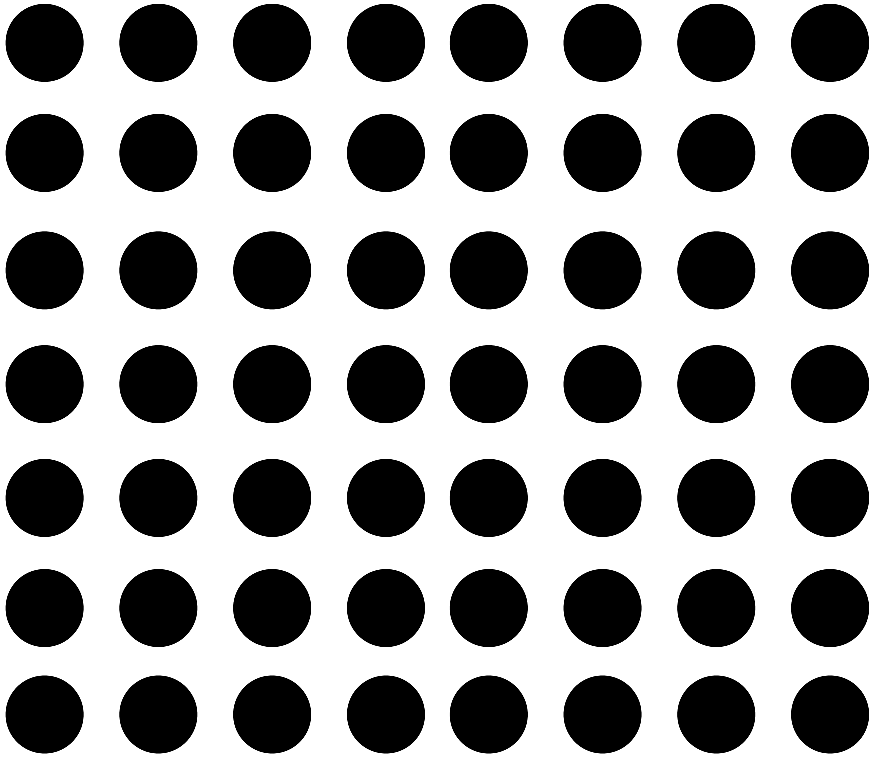
Spiritual Thought

Spiritual Thought

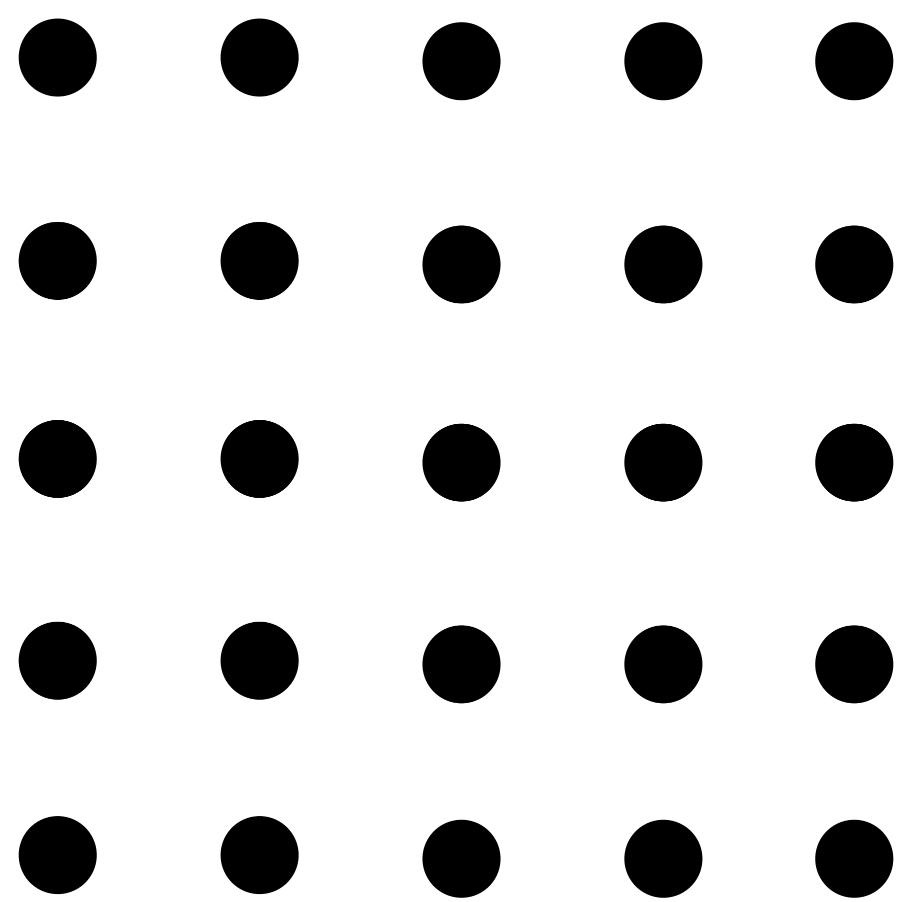
Spiritual Thought



Cold



Hot



Will the hole get a) bigger or
b) smaller?