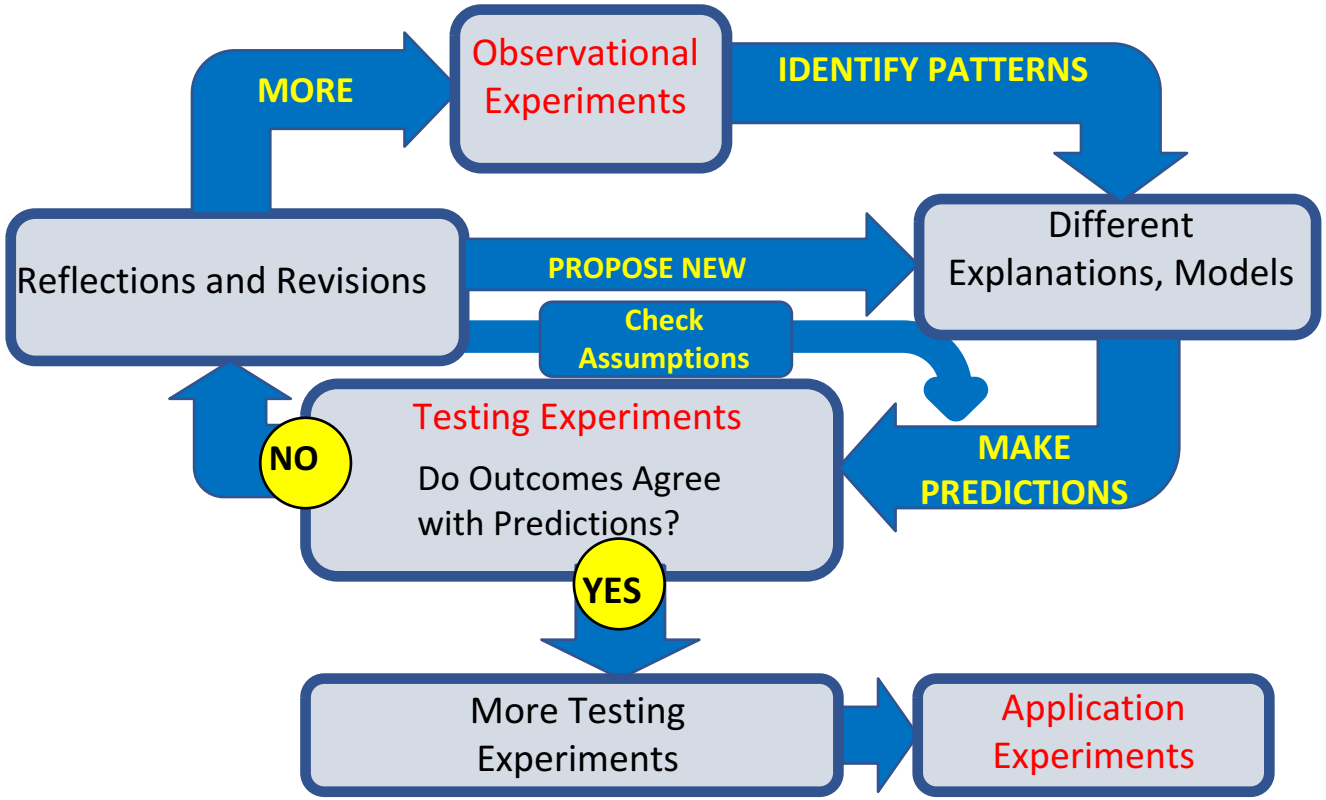
How to create opportunities for the students to improve their work without losing your own life

Lots of people contributed to this meeting, you will see their slides as we go on.

Investigative Science Learning Environment (ISLE) process

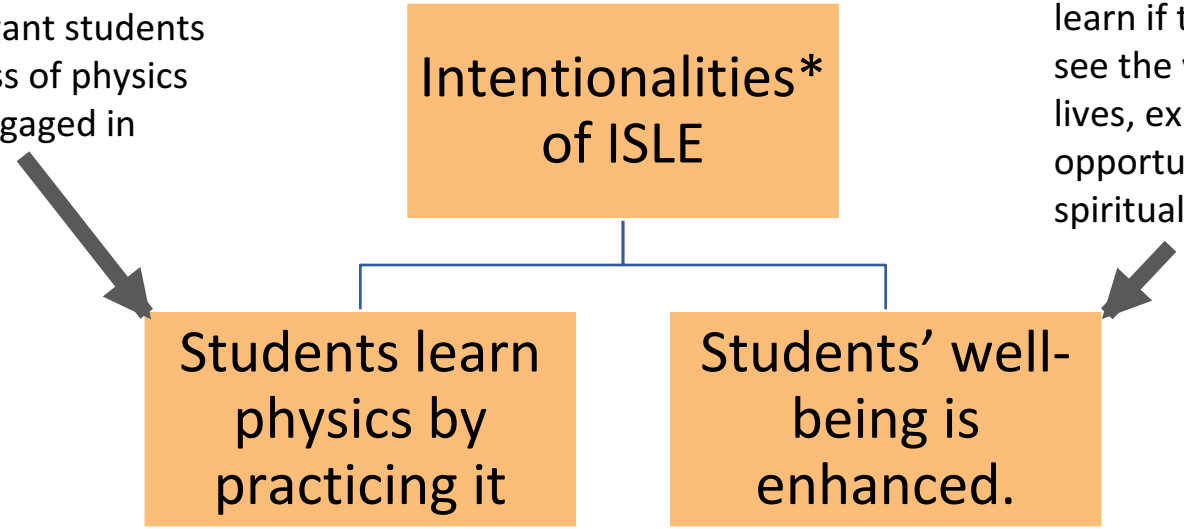


Etkina and Van Heuvelen, 2001, 2007; Etkina, 2015

The ISLE approach– an intentional approach to curriculum design and learning

Based on: "the medium is the message" - If we want students to learn the process of physics they have to be engaged in that process.

Based on: Theories of human motivation: People will only learn if they enjoy it (c.f. Flow), see the value in their personal lives, experience learning as an opportunity for mental and spiritual growth.



*Intentionality = a purposeful mental state that guides all of our decisions about assessment, activity design, course goals, classroom set-up and even how we interact with students in the classroom on a minute-by-minute basis.

Eugenia’s story - started in 1982, long before the ISLE approach was created and intentionalities articulated

Why did my students have to do quizzes every day?

Why did I allow my students to improve their work on any assignment?

Did my students abuse the system?

Did I have no life?

Did I use the same system in my teaching at the university level (undergraduate courses, graduate courses)?

Assessment Resubmissions (Allison Daubert)

Algebra (& Calculus) Based Physics I/II
Bridgewater State University
Bridgewater, Massachusetts, United States

2 Sections of 32 students each.

Formative Assessment Policy: All quizzes are graded on a scale of 0-5. Any quiz that scores above a 2 *(student was in class and put in some effort)* may recover all points by submitting a points recovery form. Quizzes are given 1-2x per week.

Points Recovery Grading: Binary checkbox - “points recovered” or “not yet”

Summative Assessment Policy: Students meet with me or my Learning Assistants during hallway office hours and must “teach” us how to solve the problem. We play students and ask **tons** of questions. Once we are convinced that students understand the material they are given a new question under standard testing conditions that completely over-writes the original grade. New questions are on the same topic but may be slightly more challenging.

Low Stakes, Low Stress Formative Assessments, Early in Learning Process (Allison Daubert)

Daubert Physics 182

Name _____ Section _____

Quiz 1
Open Note, Partner Lite

"What is partner lite?"
Partner lite means that you should first do the problem yourself. If you have a quick question, feel free to ask a neighbor. When you've solved it, talk to your neighbor and see if they have the same answer. Check each other's work.

---

1. A child's toy arrow has a circular suction cup of radius 1cm on one end. When the arrow hits the wall, it sticks. Draw a force diagram for the arrow stuck on the wall and estimate how much force the air exerts on the arrow. The mass of the arrow is about 10g.

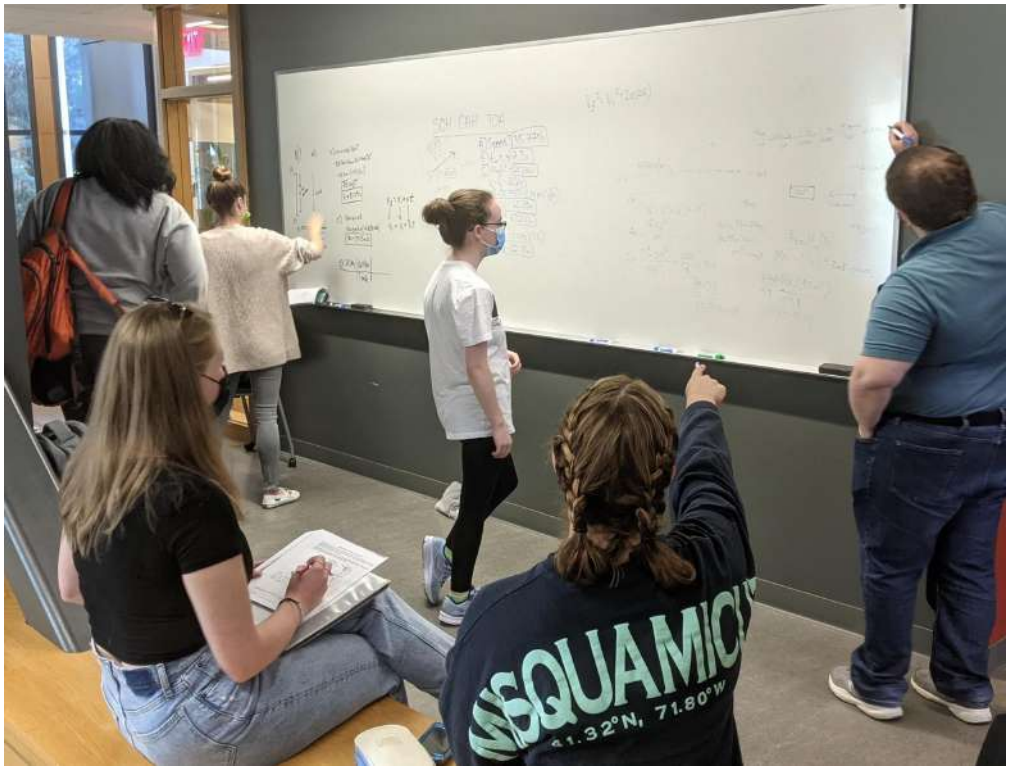
   We call them suction cups, but what actually holds the arrow to the wall?

Assessment Resubmissions (Allison Daubert)

"How do you have so many students at your office hours?!"

Assessment resubmission policy increases student effort after class. Most of these students are working on points recovery forms for quizzes or are re-learning material to try a new summative assessment question.

Typical day sees about 15-20 students after class continuing to work in groups during office hours (20-25% of class).



Points Recovery Application (Allison Daubert)

Describe your original thought process.

What was wrong with your original thought process?

What is the correct solution?

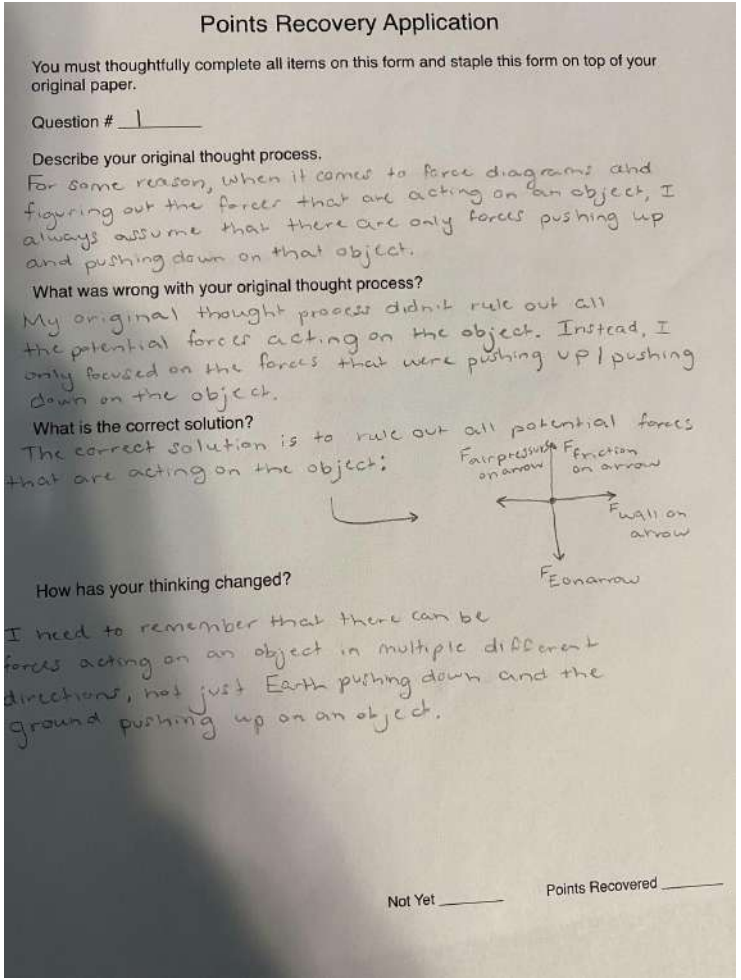
How has your thinking changed?

Points Recovered _____ Not Yet _____

	ADVANCED (3)	DEVELOPING (2)	EMERGING (1)	INITIAL (0)
1. Reflection and Self-assessment (Providing opportunities for individuals to question prior experiences and assess previously learned knowledge)	Students demonstrate a strong sense of self as learner by challenging their previous perceptions in new contexts. Students articulate these changes in thinking clearly and confidently.	Students articulate how new information and concepts have directly changed their previous ideas about a topic.	Students demonstrate that learning new information changes their previous understandings and preconceptions.	Students do not show any understanding of changes in their thinking.

In order to be eligible for "points recovered", students must score 1 or above on this rubric.

Sample Student Answers



Points Recovery Application

You must thoughtfully complete all items on this form and staple this form on top of your original paper.

Question # 1

Describe your original thought process.

For some reason, when it comes to force diagrams and figuring out the forces that are acting on an object, I always assume that there are only forces pushing up and pushing down on that object.

What was wrong with your original thought process?

My original thought process didn't rule out all the potential forces acting on the object. Instead, I only focused on the forces that were pushing up / pushing down on the object.

What is the correct solution?

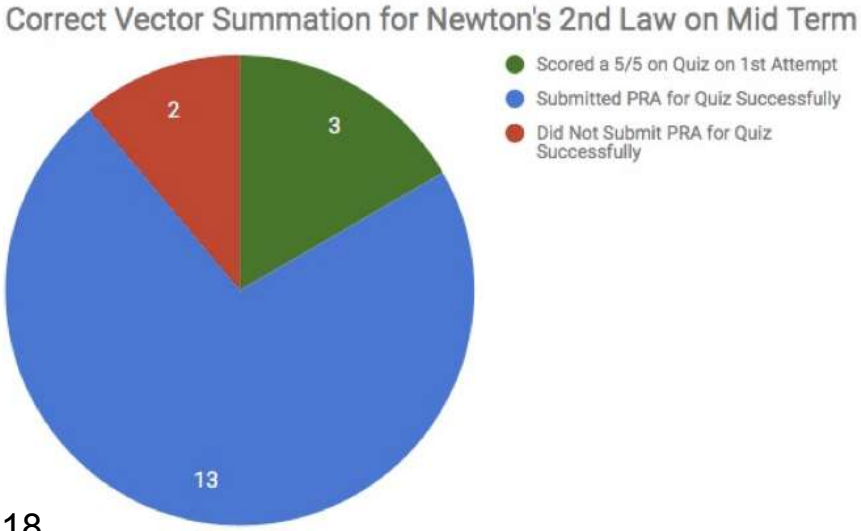
The correct solution is to rule out all potential forces that are acting on the object:

How has your thinking changed?

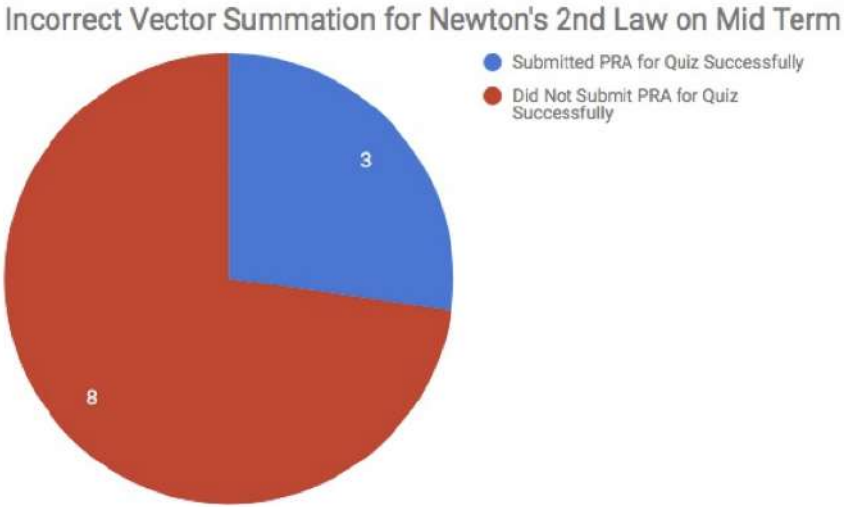
I need to remember that there can be forces acting on an object in multiple different directions, not just Earth pushing down and the ground pushing up on an object.

Not Yet _____ Points Recovered _____

Some Light Data Collection…. (Allison Daubert)



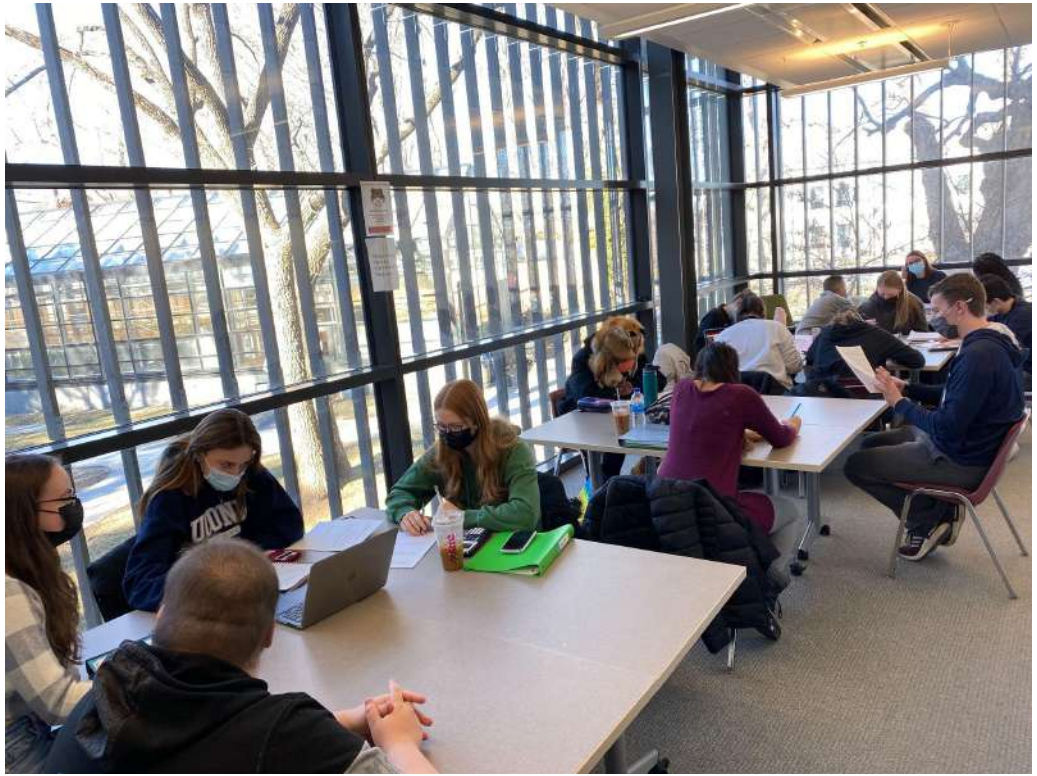
n=18



n=11

“That seems like a lot of work.” ….It’s less.

- Students take more responsibility for their own learning.
- Students work collaboratively and look to each other for help before seeking help from me or a Learning Assistant.
- Students work harder and longer on physics problems out of class which means that I am able to move faster during actual class time.
- Students are happier.
- Despite having 15-20 students in my office hours for 3 days per week, I am rarely actually asked questions.



“Office Hours”

Andrew Yolleck

Currently teach at:

Siena College - Loudonville, New York, USA (near Albany)

Previously taught at:

Elizabethtown College - Elizabethtown, Pennsylvania, USA

Exam Improvement Policy

QUESTION 1

Rubric Item	Adequate	Needs improvement	Inadequate
…is able to clearly explain and justify the key steps of their reasoning process (3 points)	Student verbally explains *what* they are doing and *why*. Explanation is clear, sufficiently detailed, easy to follow, and shows physical and conceptual understanding.	Student explains *what* they are doing, but missing *why* they are doing it. And/or there is some difficulty in following their explanation.	Explanation is incoherent, confusing, or missing; and/or invokes incorrect/irrelevant physics ideas; and/or is unrelated to that which is being explained.
…is able to create 2 or more *consistent* representations of the problem (3 points)	Two or more representations are constructed according to accepted standards learned in class, and the representations are consistent with each other.	Two or more different representations are present, but they are not consistent and/or there are mistakes or missing elements in the representations.	There are major (key) mistakes/missing elements in the representations and the different representations are inconsistent with each other.
…is able to choose and apply productive mathematical representations and procedures for solving the problem (2 points)	Mathematical procedure is productive for solving the problem. Implementation of procedure is free of major conceptual errors.	Productive mathematical procedures are chosen, but implementation reveals misunderstanding about how to implement them.	Mathematical procedures are unproductive/inappropriate and will not lead to a physically reasonable answer to the problem, even if implemented correctly.
…is able to evaluate the reasonableness of final result. (2 points)	Evaluates reasonableness of the result, correctly applying all the steps of one of the possible evaluation techniques listed below: a. limiting/special case analysis, b. unit analysis, c. physical reasonableness of answer, d. two independent methods, e. cross substitution consistency, f. consistency of representations. A valid conclusion is drawn from the analysis.	An appropriate evaluation technique is used, but there are mistakes in the implementation of the technique (wrong units, misunderstanding of how reasonable the numbers are) and/or student neglects to draw a conclusion from their analysis.	There is no evaluation, or evaluation technique is implemented in an incoherent way, and/or an invalid conclusion is drawn, such as concluding the answer is reasonable when evaluation analysis shows it is not reasonable.

COMMENTS & RECOMMENDATIONS:

Andrew Yolleck

Exam Improvement Policy

You may select however many problems from the midterm exam in which you can complete what is listed below in order to improve your score. To prove that you have mastered the material, complete the following for EACH problem you wish to improve upon.

PART A

1. Re-write the same problem on a separate sheet of paper and solve the problem correctly.
2. For each part of the problem that was not originally perfect, answer the following questions in as much detail as possible:
    a. What mistakes did I make on my first try?
    b. Why did I make these mistakes?
    c. How did I learn to do these parts correct? (If you simply write, "I reviewed the solutions," then you will not receive any credit).

Andrew Yolleck

Exam Improvement Policy

PART B

1. **If you are only looking to receive back 50% of the credit you lost,** then you need to do everything in Part A in addition to the following:
    a. Design a completely NEW problem that focuses on the same content as covered in the original problem, and solve it completely. Show all of your work and explanations. You must do this for EACH problem that you are correcting.
    b. Send me all of your work from parts A and B via email. No meeting is needed.

Andrew Yolleck

Exam Improvement Policy

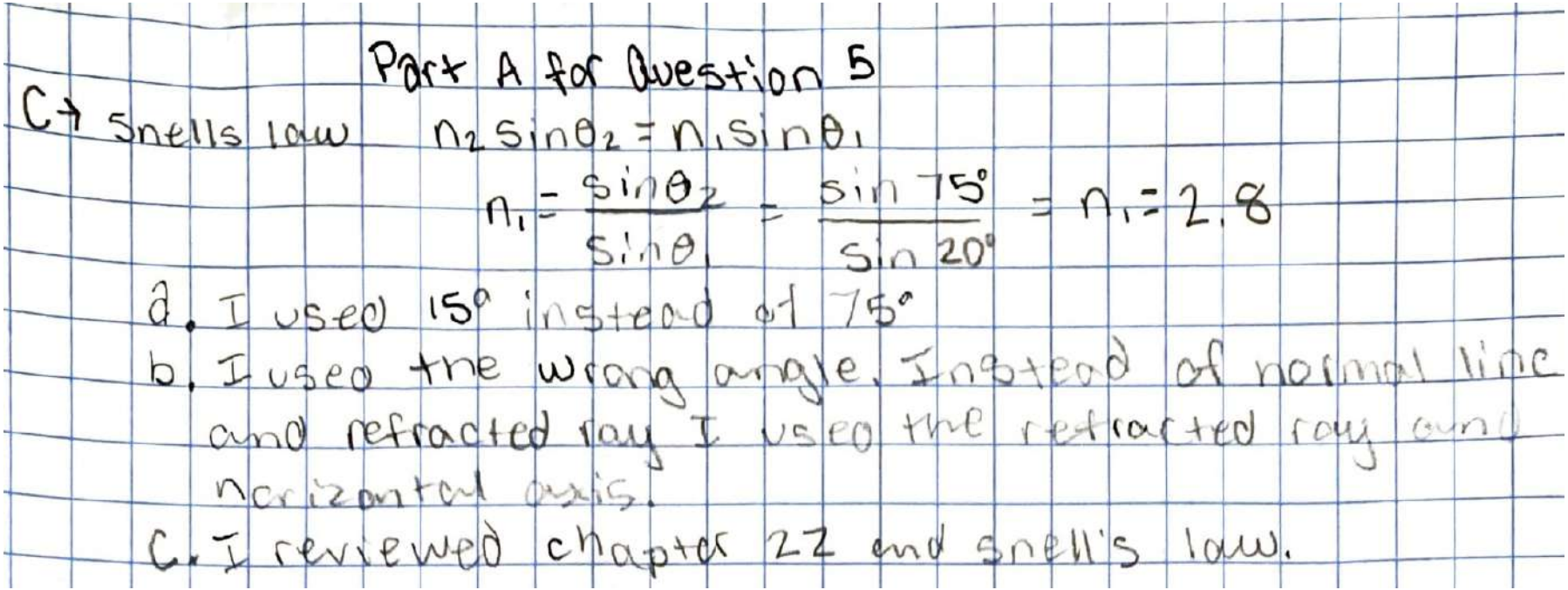
PART C

1. **If you would like to receive back 100% of the credit you lost,** then you will need to do everything in Part A (not Part B) in addition to the following:
    a. Schedule a meeting with me. In your email, tell me which problems you are looking to improve upon. On the morning prior to our meeting, I will email you the similar problems that you will need to complete.
    b. Send me all of your work from Part A and Part C prior to our meeting. During our meeting, you will walk me through step-by-step how you solved each problem AND answer all of my probing questions.
    c. Come prepared knowing **everything** about the problems you are improving upon.
    d. If you are unsuccessful at proving mastery for a certain exam problem during our meeting, you will not receive the full credit back for that question. However, you will have the option to schedule another meeting (only if time permits).

Important Notice – In order to be eligible to improve your midterm exam score, you must complete all of the above by the last day of class (Thursday, May 6th). Plan your time accordingly and schedule a meeting with me ASAP.

Andrew Yolleck

Example of Student Improvements



Part A for Question 5

C→ Snells law $n_2 \sin\theta_2 = n_1 \sin\theta_1$

$$n_1 = \frac{\sin\theta_2}{\sin\theta_1} = \frac{\sin 75^\circ}{\sin 20^\circ} = n_1 = 2.8$$

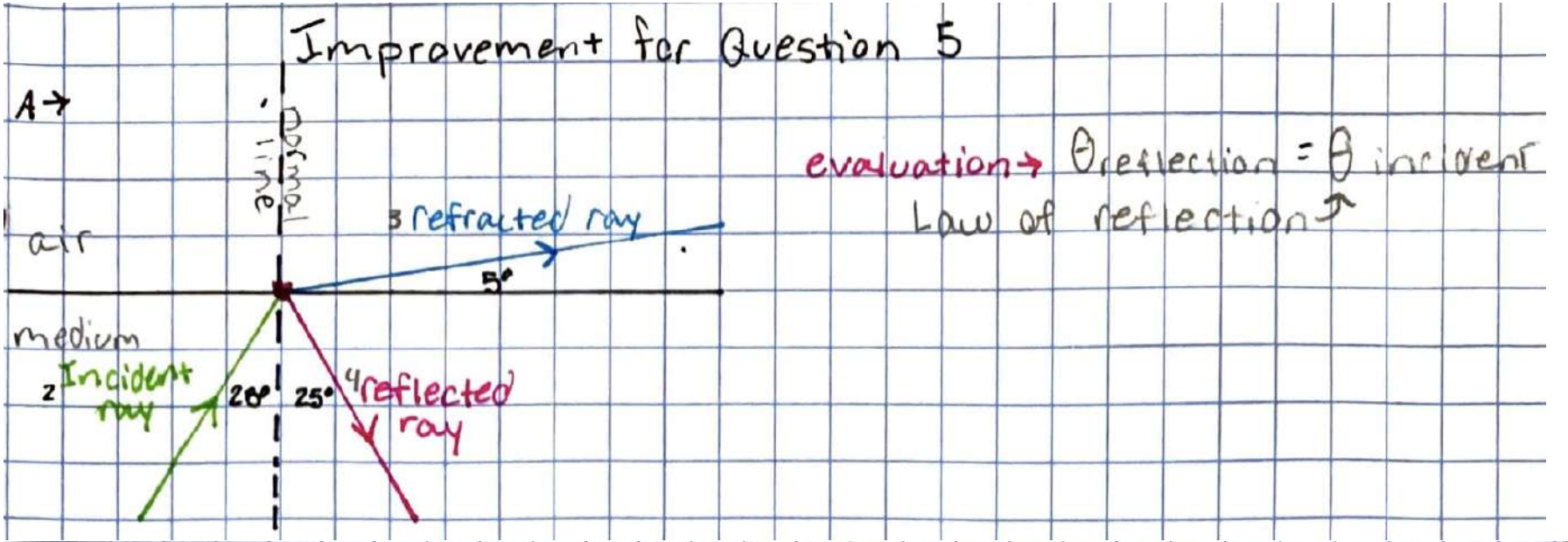
a. I used 15° instead of 75°

b. I used the wrong angle. Instead of normal line and refracted ray I used the refracted ray and horizontal axis.

C. I reviewed chapter 22 and snell's law.

Andrew Yolleck

Example of Student Improvements



C→ $n_2 \sin\theta_2 = n_1 \sin\theta_1$

$\sin 85° = n_1 \sin 26°$

$n_1 = \frac{\sin 85°}{\sin 25°} = 2.36$

evaluation → snells law

evaluation → 90 - 5 = 85° for angle of refraction

evaluation → 1(sin85) = 2.36 (sin25)

1 = 1

Andrew Yolleck

Student Thoughts on Being Allowed to Improve their Work

Fall 2020

How did being given multiple opportunities to demonstrate mastery on a particular topic through a variety of assignments contribute to your overall learning experience? -

- That helped immensely because it allowed me to show that I can learn the material over time and can prove my learning by looking at my mistakes.
- I learned much faster and more effectively because I had multiple areas to learn from
- This was my favorite part of the course. For other classes if I got something wrong on a test I never learned it after. However, for this class I could go back and truly understand the topics and why I misunderstood it the first time. I do not think I would have learned the same amount without this feature.
- A great great amount! It makes you relearn the subjects you forgot or needed more help with and can work 1 on 1 the teacher to achieve this
- It was very helpful, once I was able to retrace my steps and figure out where I went wrong I could apply myself better the second time in similar problems and concepts.
- It was definitely helpful but it took a substantial amount of time out of my week and there were many times that we got overwhelmed and put less of an effort into certain aspects of the course, most notably the homework assignments due at the end of the week.
- Being given second and third tries to complete the course work did allow me to make a little more sense of the material and learn it better. Going back after already completing the problem allowed me to see where my mistakes were but the sheer amount of work that was due was overwhelming.
- It definitely made the class feel more like it was about learning the content than just making a grade. I think possibly making a shorter time frame for midterm corrections would have been helpful for the chronic procrastinators like myself. I think in a normal semester it might also be nice to have some set times where we can just come and sit in a room and work on corrections and then ask questions. Maybe that's ridiculous, but I think if there were one or two set "we're working on midterm corrections" times, like come sit in the classroom, it would have been motivating and helpful.
- It was a key part to my learning experience and greatly helped increase my understanding of the subject.
- Professor Yolleck gives us the opportunity to do corrections on a majority of the course work we submit. This allowed me to learn from my mistakes and strengthen my understanding of the material.

Spring 2021

Describe how you feel this course has improved your ability to learn specifically with regards to being able to re-submit previously attempted assignments and exams. -

- I feel that this has allowed me to get a better understanding of the topic because if I did make an error instead of forgetting about it I could correct it and help me learn.
- difficult course but very great professor
- I liked that we were given the opportunity to improve upon our past mistakes and receive credit back in return. Going back and looking at my mistakes helped me to further understand the material and it also helped me to remember certain concepts more efficiently
- I cannot emphasize enough how much this aspect has improved my ability to learn physics. Physics is a hard subject for many students, and if each student were graded on their initial performance, the grades would be very unforgiving. My first midterm in PHY101 last semester, which operated on this principle as well, was horrible. Had I not been able to improve that score, that would have been the end of it. I would have moved on with my objectively lackluster understanding of the subject, because what's the point of figuring it out if it won't change anything now? I wouldn't have spent the hours that I did re-reading the book and doing practice problems to understand what I didn't before. Resubmitting assignments and exams wasn't easy, and it required a lot of work, but having that option is what really pushed me to understand the course on a far deeper level than I ever expected to.

Andrew Yolleck

Conversation with Colleagues on 1.3.22

So, here are the 4 action items that I am requesting from each of you in your reply email:

1) A brief overall evaluation of how well you felt that this past semester proceeded in terms of logistics, the labs we ran with students, and the way we graded (using rubrics). Also comment on how you think most students felt about the labs.

2) Any equipment concerns/suggestions you have to improve the 110/130 labs. And Meg, please do the same for 120 too.

3) Your thoughts on allowing students to make corrections to all of their lab write-ups and the extent to which we should allow for corrections.

4) (Optional) Please share any other thoughts, questions, or concerns you may have in relation to our labs. I am always more than open and happy to hear your thoughts and constructive criticisms so that we can continue to improve the lab experience we provide to our students.

If you would prefer, I am happy to set up a zoom meeting with anyone that would rather not discuss these matters via email. An in-person meeting on campus would be fine if any individual(s) would prefer this too.

Thank you for your hard work, and I look forward to continuing working with each of you this coming semester and beyond!

Best,

Andrew

Andrew Yolleck

Conversation with Colleagues on 1.3.22

3) Your thoughts on allowing students to make corrections to all of their lab write-ups and the extent to which we should allow for corrections. I am not a fan of that and if I had the choice I wouldn't allow it. I feel that if students know they can have a second (or many) chance to improve a lab report they will not put forth their best effort the first time because they know they can keep trying until they get it right. This makes more unnecessary work for the instructor. I believe that if the environment and expectations are established right off the bat from the instructor the students will do very good work the first time. I felt that the work my students turned in was of high quality and they didn't leave for the evening until they submitted their best work at that point and their grades reflected it. At the end of the day I'll do whatever you tell us to but I am not in favor of revisions on all the labs.

Andrew Yolleck

Conversation with Colleagues on 1.3.22

I appreciate your thoughts on this matter, but I completely disagree with you for the following reasons.

I've had numerous conversations with instructors that are hesitant or downright opposed to allowing students to ever make any corrections to any of their work. You mentioned two of the most common rationales that instructors will give - (1) students will take advantage of the policy by not submitting their best work on the first try and (2) it will give the instructor a significant amount of extra work. I disagree with both of these rationales based on physics education research (that I would be happy to share) and what I've seen first-hand with my own students.

Rarely do students take advantage of this policy beyond being able to do what it is intended, which is to allow for a learning environment in which students are not punished for submitting incorrect work the first time around. Most of the time, I've found that students use this policy to go from already high scores to perfect ones. It's great to hear that your students often submit high quality work the first-time around. That is not likely to change. Just because students have opportunities to make improvements on a subsequent attempt does not mean (for the vast majority) that students will turn in horrific work on their first attempt. I look at this as establishing an environment in which students are not pressured to be perfect on the first try every single time, which is far from what a scientist can be considered. Scientists end up being wrong all the time and they certainly have opportunities to make improvements to their work. Can you imagine what scientific journals would look like if every scientist that submitted a research paper for publication would be accepted on the first try?

Andrew Yolleck

Conversation with Colleagues on 1.3.22

Allowing for students to make corrections helps instill what's called a growth mindset, which means that students believe that they are able to improve and grow as learners rather than being forever fixed in their current state of knowledge. If we don't allow for corrections and a student is able to later prove that they mastered one of the scientific abilities that we are assessing with our rubrics, then what does that mean? Does this mean that the student should not get credit simply because they are "too late" or didn't get it right on the first try? To me, this doesn't make any sense and is completely inequitable. It means that students that need more attention and more opportunities to prove that they have mastered the abilities we are assessing them on are stripped of those opportunities and are given lower grades because they could not learn as quickly as their peers. We all need different amounts of time to learn how to do everything in life (ride a bike, play an instrument, play a sport) so I don't understand why physics education should be any different. When a student tries to play a new sport, they are not punished for not being able to swing a baseball bat correctly on the first try. And they are certainly given ample opportunities to get it correct such that they can play the sport at a higher level.

To address the concern with an increased work-load, all I can say is that with the use of rubrics, the extra work is fairly limited with grading labs. Especially for the students that use this policy as a means of going from an already high score to a perfect score, the extra amount of grading is simply insignificant. What I'll usually do is have students highlight their corrected work on their next submission such that I am only focusing on the portion of their lab that needs to be re-graded. All other parts that have previously been graded as perfect by using the rubrics do not need any further attention.

I hope that you are not finding any of my remarks as insulting, as I am saying this with the utmost respect for you. When said through email, I am limited to how respectful I can come off given that there is no face-to-face dialogue. I am more than happy to discuss any of this further.

Have you ever implemented any policy that allows for corrections? Are your thoughts based on gut feelings, things you've heard from other instructors, research?

Andrew Yolleck

“Check” Resubmissions

Danielle Buggé
West Windsor-Plainsboro High School South
New Jersey, USA

Short, formative, approximately 1/week

Evaluated* as follows:

▢ Missing	▢ Emerging	▢ Developing	▢ Demonstrating	▢ Refining

Recovery consists of **Reflection, Revision,** and **Additional Practice**

Sample Check

Sample Recovery Sheet**

*Revised terminology for levels developed with D. Andres

**Reflection questions on current version modified from M. Blackman

Laboratory Report Resubmissions

Two or three larger ISLE investigations per quarter

Written up ***collaboratively*** in Google Docs

Evaluated using scientific abilities rubrics (4-6 per lab)

Required self-assessment

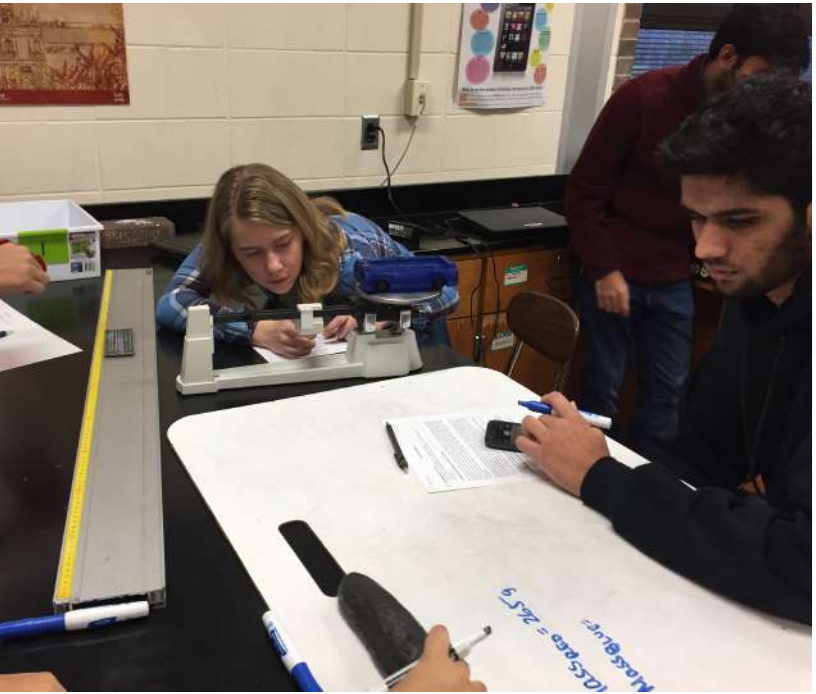
Feedback provided as comments on the document as well as rubric scores

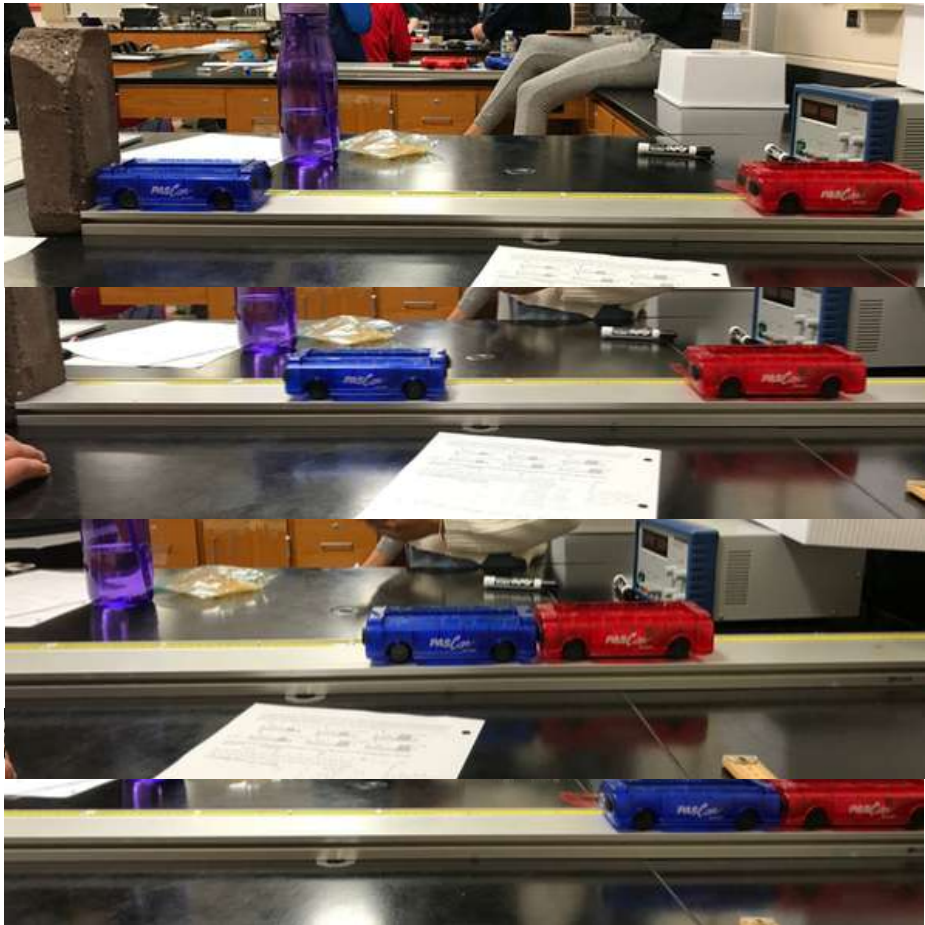
Revisions in a ***different*** color

Time limit

Danielle Buggé

Sample Investigation

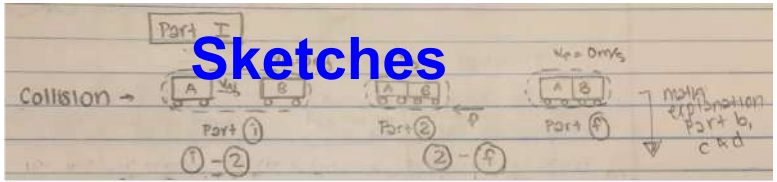


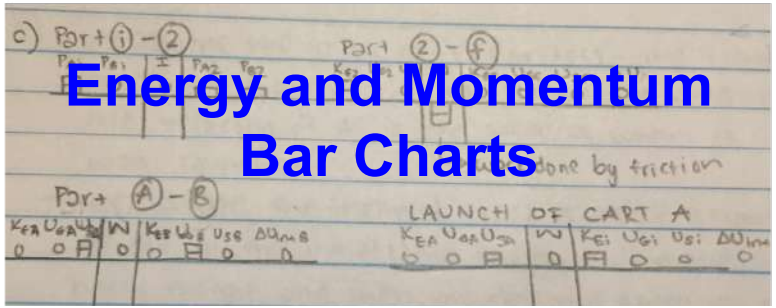


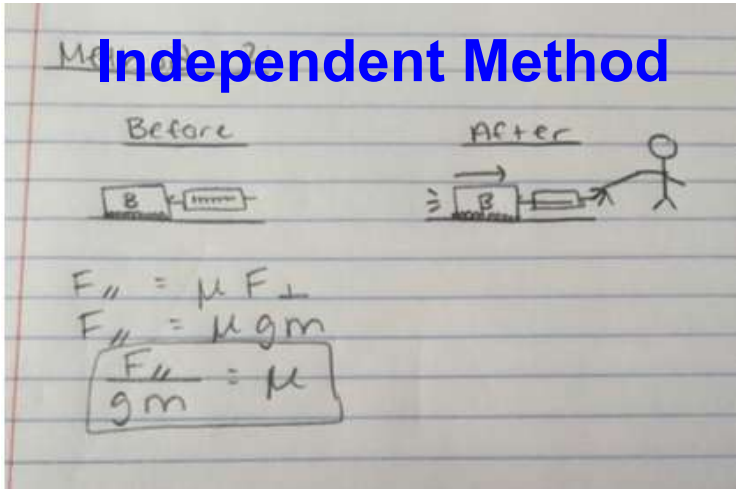
Danielle Buggé

Danielle Buggé

Original Submission







$$\mu_k = (m_A{}^2 h) \div (\Delta x m_B)$$

Where did this come from?

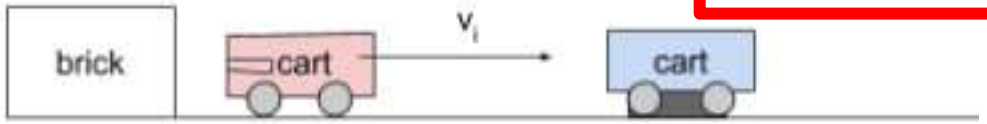
"After testing our mathematical model, and comparing the results to our independent method, we found that the results of the two methods were pretty consistent with each other.

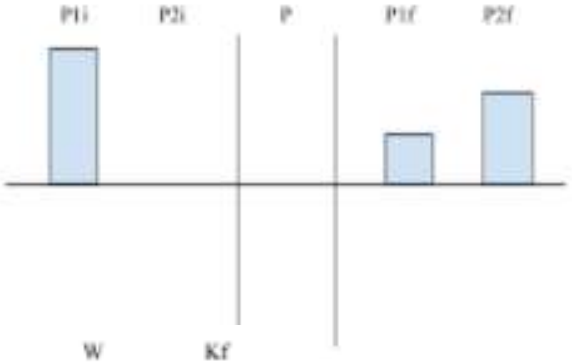
For our first model, we found that the coefficient of friction is about 0.392 ± 0.003. For our independent model, we found that the coefficient of friction is about 0.2 ± 0.04."

Danielle Buggé

Revisions

1. Momentum Bar Chart





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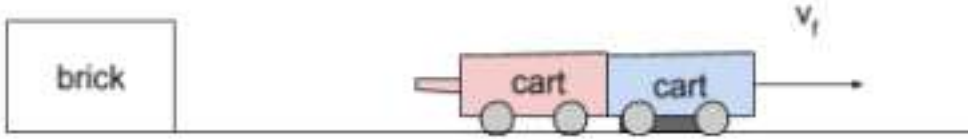
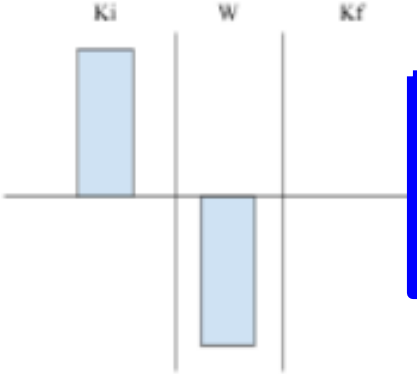




2. Work and Energy Bar Chart

System: both carts, Earth

* $m = m_A + m_b$

2 $K_{E2} - W = K_{EF} \rightarrow 0.5mv^2 - \mu m_b g \Delta x = 0 \rightarrow 0.5mv^2 = \mu m_b g \Delta x \rightarrow \mu = \frac{mv^2}{2mm_b g \Delta x}$

1 $P_{Ai} = P_f \rightarrow m_A v_{Ai} = m v_2 \rightarrow v_2 = \left(\frac{m_A v_{Ai}}{m}\right) \rightarrow v_2 = \mu = \frac{m\left(\frac{m_A v_{Ai}}{m}\right)^2}{2mm_b g \Delta x}$

3 $\mu = \frac{m_A{}^2 h}{m_g m \Delta x}$

“After testing our mathematical model, and comparing the results to our independent method, we found that the results of the two methods were **not entirely consistent with each other**. For our **revised** model, we found that the coefficient of friction is about **0.362** ± 0.003. For our independent model, we found that the coefficient of friction is about 0.2 ± 0.04. **Due to the rather significant difference, we believe that is due to our model being imperfect, as we had several assumptions discussed above in the derivations…**”

	Missing	Inadequate	Needs Improvement	Proficient
Is able to choose a productive mathematical procedure for solving the problem.				

Justification: Our mathematical procedure for both methods were consistent with design and both were calculated correctly. **We revised our model twice in order to account for certain discrepancies - such as in our first original model, our frictional force was supposedly applied to both cart A and B, and we calculated our model accordingly - which was incorrect because the felt causing the friction was only on cart B, and we also had to revise that the height we use to calculate the gravitational potential energy in the experiment must include the width of the track. In our second unrevised model we found a small calculation error that was immediately resolved as well.**

Danielle Buggé

Elana Resnick
Gilman School
Baltimore, Maryland, USA

Revision Reflection Sheet

Name: _____

What assignment are you requesting to retake?

Why did you receive the score that you did? *You should include your areas of strength as well as where you need to improve in order to show top-level work.*

What additional resources did you use to prepare for your retake? List specifically what you did.

Please provide a worked out solution based on the improvement(s) you identified above (if it was a mathematical error make sure you solve the problem using DLESSUE - Diagram, List, Equation, Substitute, Solve, Units, Evaluate):

Create or find 2 alternate problems that would assess the skill(s) in each problem you made a mistake on. Please provide complete solutions as well. You may attach a separate sheet of paper with the solutions to this document.

What do you understand now that you did not understand before?

Accepted Y / N

Elana Resnick

- What assignment am I correcting?

- I am correcting the Projectile Motion Test

Why did I recieve the score that I did?

- I was not confident in the material and although I could complete problems with support, I wasn't able to do so without it. I should have reviewed more ahead of time and met with the teacher to clarify my misunderstanding.

- What resources did I use to prepare?

- Re-read text book chapters, reviewed notes, studied past material, used online questions/guides.

2. Two identical objects are held the same distance off the ground. Object A is dropped and at that exact time, object B is thrown directly horizontal with a velocity of 10 meters per second. The object that hits the ground first is

(a) Ball A
(b) Ball B
(c) Both hit at the same time
(d) There isn't enough information to determine which will hit first

A = B = 10 m/s
-9.81 m/s²

Multiple Choice.

2.) Correct Answer is (C) (Hit at same time)

This is because the horizontal and vertical velocities are independant of each other. The horizontal velocity of object B can be ignored, and then the vertical acceleration (gravity) is the same for both objects.

What assignment are you requesting to retake?

Unit 2 Test

Why did you receive the score that you did? *You should include your areas of strength as well as where you need to improve in order to show "refining" level work.*

a. On Question 13 part b. ii., I made an incorrect calculation for the mass of the cart. Instead of solving for the slope of the line of best fit, I instead divided the acceleration by the Force at a single point, falsely believing this would yield the right answer. I should have used the standard slope formula of m=(y2-y1)/(x2-x1) instead.

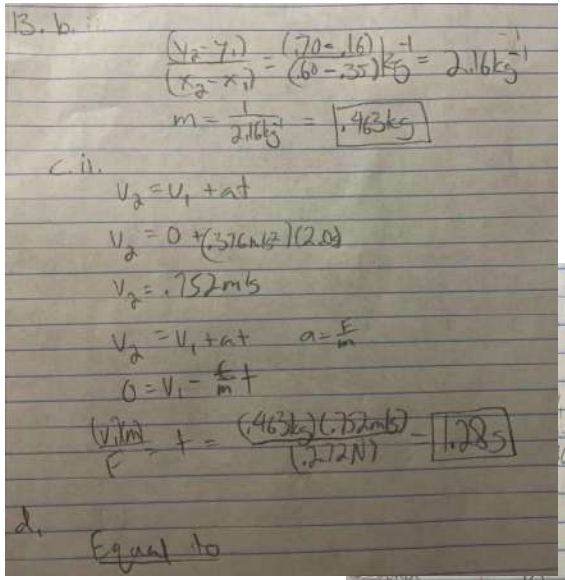
b. For question 13. c. ii., I incorrectly left out a negative mark besides the cart's acceleration. The cart's acceleration should be negative because the cart is slowing down in the positive direction.

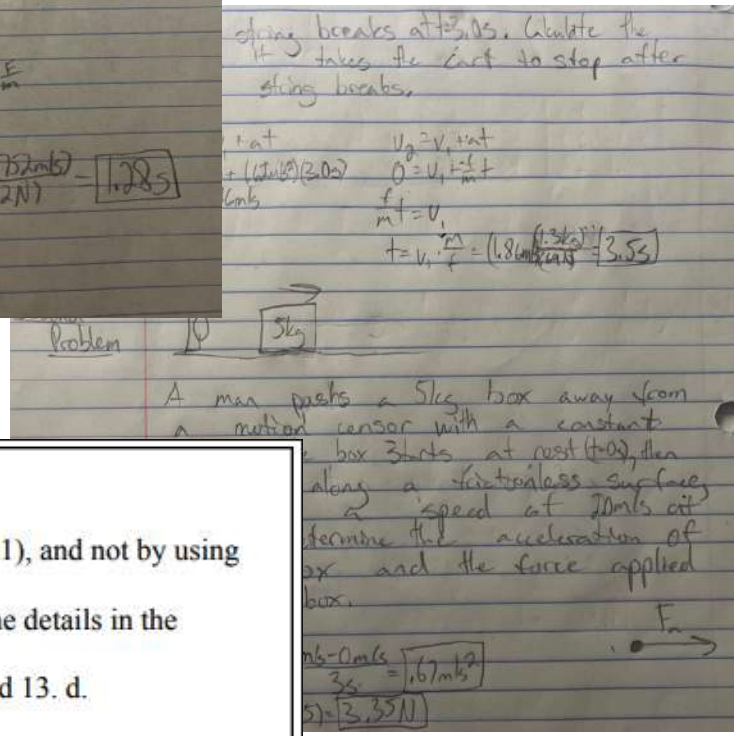
c. For question 13. d. iii., I selected less than when I should have selected equal to. The slope which measures the relationship between Force and acceleration should not change as the relationship between force and acceleration did not change from one equation to the other.

What additional resources did you use to prepare for your retake? List specifically what you did.

I read back through the Unit 2 slides and retook my notes. Further, I drafted additional practice problems to study and comp

Dimension - Phys





What do you understand now that you did not understand before?

I understand that the way to determine a slope is to use the formula: (y2-y1)/(x2-x1), and not by using individual data points. Further, I understand that I should pay closer attention to the details in the problems because my lack of attention cost me two points on question 13. c. ii. and 13. d.

Alternative Methods Tried

Follow the general guide from the previous slide with the revision reflections sheet - with various caveats for different types of assignments.

- For MC: Explain why the answer you chose was wrong and why the right answer is correct. Show your work. You may also explain why the other answer choices are incorrect.
- For Open Ended: Complete the problem as if you were completing it for the first time. Then, find or create two more problems that assess the same skills on which you lost points.

Integrating Standards-Based Grading into a First-Year HS Physics Course

Debbie Andres, *Paramus High School*, *New Jersey, USA*

I will discuss:

- Why SBG? And what is it?
- SBG as a grading practice to keep track of your students' work
- Examples of its use in the classroom

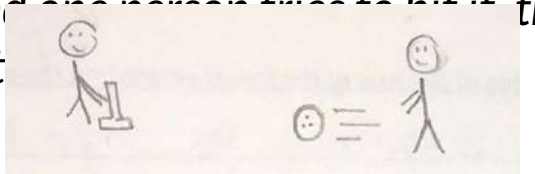
Kimmy thinks that objects ***always*** move in the direction of the sum of the forces (**ΣF**) exerted on them by other objects.

a. Design experiment(s) to test this idea. Describe carefully what you are going to do.

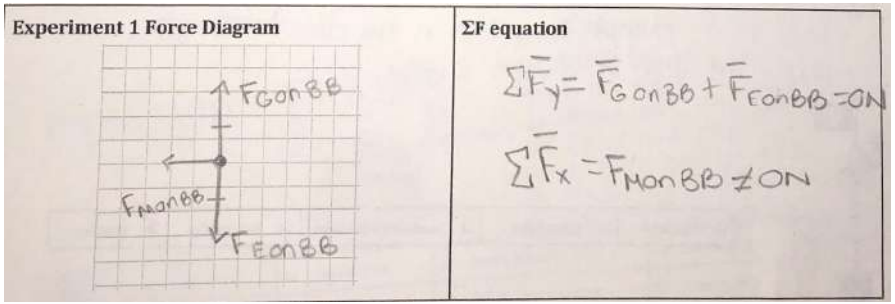
Student A

Experiment 1:

One person pushes the bowling towards you, and one person tries to hit it, trying to make it



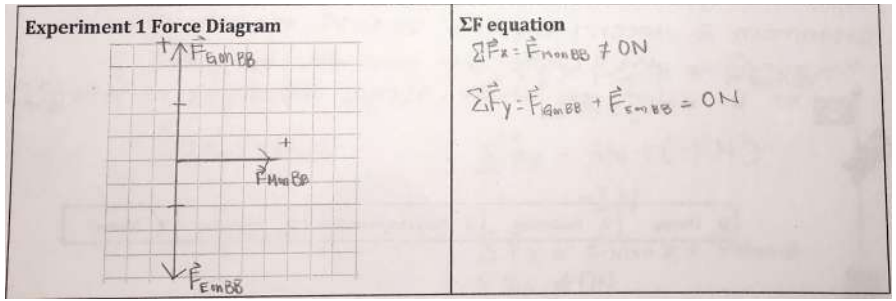
a. Draw a force diagram for the experiment you described.



Student B

Experiment 1:

Hit the bowling bowl with mallet to right.



Etkina, Brahmia, Lopez, et al (2010) Physics Union Mathematics. Retrieved from url pum.islephysics.net

What is Standards-Based Grading?

Standards-Based learning is often interchangeable with proficiency-based learning. An instructor designs activities that help students develop a set of learning standards.

Standards-Based Grading (SBG) is different than traditional grading in that the "grades" students receive are not traditional numerical grades. Feedback is in the form of descriptors that describe a student's progress towards mastery of a standard.

The key components to standards-based grading are:

- Feedback linked to learning objectives
- Multiple opportunities to learn
- Accurate Communication of students' level of mastery

Marzano, R.J., & Heflebower, T. (2011). Grades That Show What Students Know.

Strategies for Implementation

- **Adaption of Rubrics for Classwide Standards**
  - Rubrics were adapted for the three categories: STEM Practices (Modified Rutgers Scientific Abilities Rubrics), Content Standards, and Professional Expectations
- **Modifying the Online Grading System**
  - A student's grade can be broken down to equally weigh all the standards and still provide an accurate numerical final grade.
- **Frequent Assessments**
  - In addition to communication of standards, the students are given frequent checkpoint tickets to help monitor their progress.

Etkina, E., Van Heuvelen, A., White-Brahmia, S., Brookes, D. T., Gentile, M., Murthy, S., ... Warren,A. (2006). Scientific abilities and their assessment. Physical Review Special Topics - Physics Education Research, 2(2), 020103.

S2

S4

P2

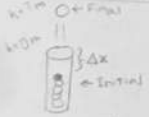
R3

S5

9.3 Test Your Idea

Use the idea of energy conservation to *predict* the maximum height a marble will reach from when launched from the 4th launch position.

Experimental Design



System: Earth, Marble, Launcher

Ugi Usi Ki | W | Ugf Usf Kf

0J ☐ 0 | 0J | ☐ 0J 0J

Math statement: $U_{si} = U_{gf}$

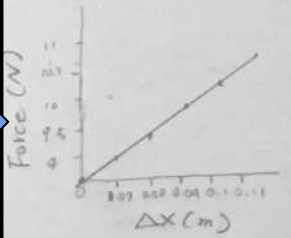
$\frac{1}{2}k(\Delta x)^2 = m \cdot g \cdot h$ → Prediction

↓ side experiment ↓ sensitive ↓ use a scale ↓ 10 N/kg

k =

Δx = 0.1m

Δx (m) Vs. F(N)



Δx(m)	F(N)
0	0
0.07	9
0.08	9.5
0.09	10
0.1	10.5
0.11	11

(Prediction)

$\frac{1}{2}(100)(0.1)$

$50(0.1) = mgh$

$50(0.01) = mgh$

$0.5 = m(10)h$

$0.5 = 0.0039(10)h$

$0.5 = 0.039h$

$h = 12.8m$

m = 0.0039

《Result》

(Trial)

1) 1.2m

2) 1.25m

3) 1.3m

(We used the scale on the frame of the door)

- Our prediction didn't match the result because there was a negative work which cause a thermal energy. Friction was putting work to the launcher. It made the launcher to slow down. (Less gravitational force → Doesn't go high)
- We had 6 points for prediction and 3 points for results to make it purpose as possible.

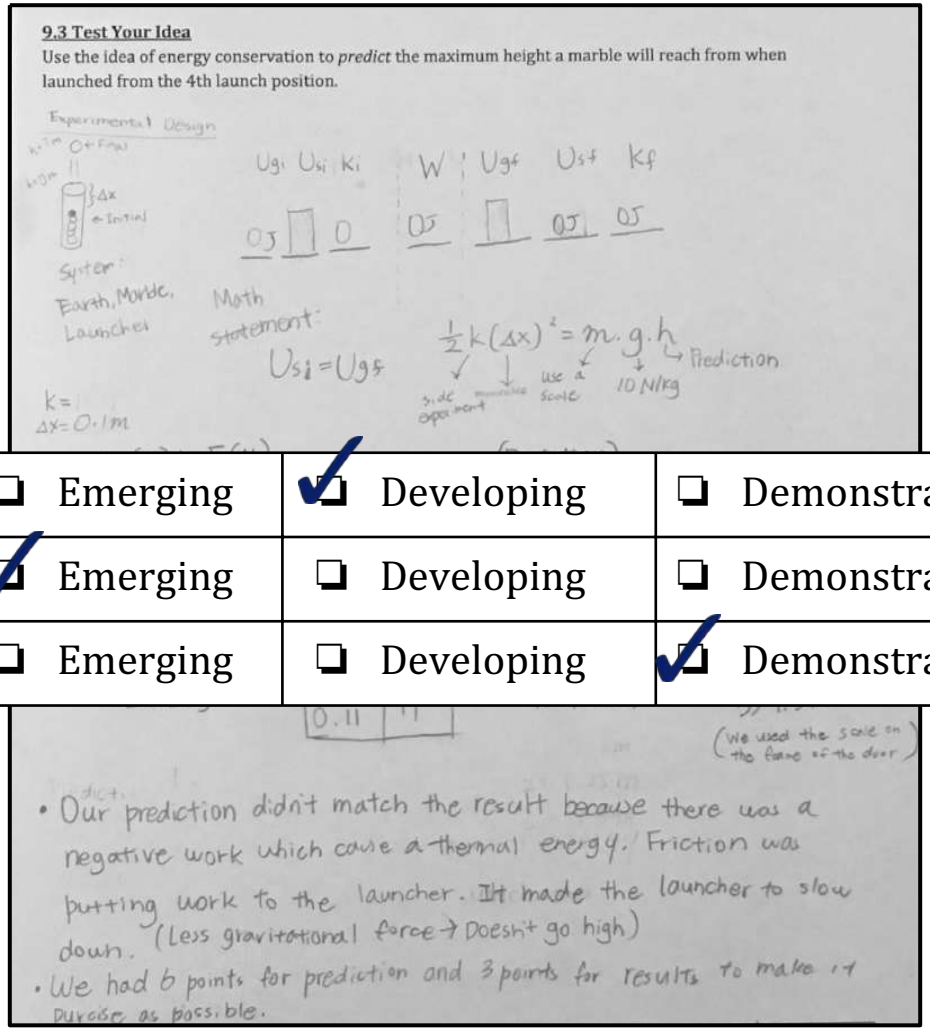
Debbie Andres

STEM Practices - Scientific Abilities and Representations						
	Standard *(Corresponding NGSS SEPs in **bold italics**)*	***Missing*** 0%	***Emerging*** 50%	***Developing*** 70%	***Demonstrating*** 85%	***Refining*** 100%
S2	**Experimental Design (Testing)** *I am able to design a relevant experiment to test a hypothesis. I am able to make a correct prediction that follows from the hypothesis and correctly describes the outcome of my designed experiment.* ***Planning and Carrying out Investigations*** SA Rubric Elements C2 & C4	No work	The experiment does not test the hypothesis.	The experiment tests the hypothesis, but due to the nature of the design there is a moderate chance the data will lead to an inconclusive judgment.	he experiment tests he hypothesis, but ue to the nature of he design there is a oderate chance the ata will lead to an nconclusive judgment.	The experiment tests the hypothesis and has a high likelihood of producing data that will lead to a conclusive judgment.
			No prediction is made.	Prediction is flawed, incomplete or inconsistent with the hypothesis.	rediction is flawed, ncomplete or nconsistent with the ypothesis.	A prediction is made that follows from the hypothesis is distinct from the hypothesis, accurately describes the expected outcome of the designed experiment, incorporates relevant assumptions if needed.

Developing 70%

The experiment tests the hypothesis, but due to the nature of the design there is a moderate chance the data will lead to an inconclusive judgment.

Prediction is flawed



9.3 Test Your Idea

Use the idea of energy conservation to *predict* the maximum height a marble will reach from when launched from the 4th launch position.

Experimental Design

U_{gi} U_{si} K_i | W | U_{gf} U_{sf} K_f

0J ☐ 0 | 0J | ☐ 0J 0J

Δx = Initial

System: Earth, Marble, Launcher

Math statement: $U_{si} = U_{gf}$

$\frac{1}{2}k(\Delta x)^2 = m \cdot g \cdot h$ → Prediction

k = (side operant) $\Delta x = 0.1m$ (movable) use a scale m ✓ g ↓ 10 N/kg

0.11 11

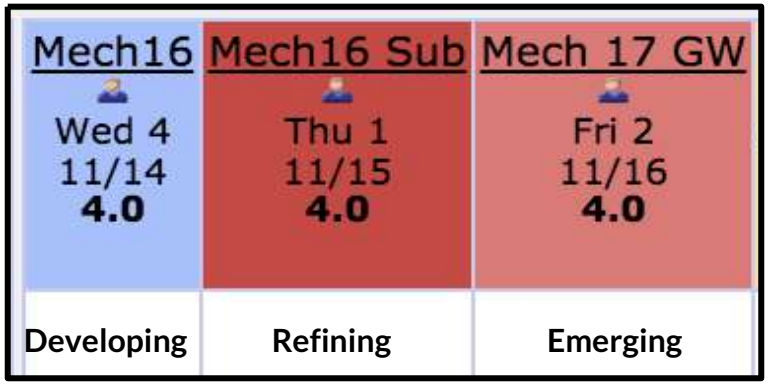
(We used the scale on the frame of the door)

- Our prediction didn't match the result because there was a negative work which cause a thermal energy. Friction was putting work to the launcher. It made the launcher to slow down. (Less gravitational force → Doesn't go high)
- We had 6 points for prediction and 3 points for results to make it purpose as possible.

S2	❑ Missing	❑ Emerging	✓ ❑ Developing	❑ Demonstrating	❑ Refining
R3	❑ Missing	✓ ❑ Emerging	❑ Developing	❑ Demonstrating	❑ Refining
P2	❑ Missing	❑ Emerging	❑ Developing	✓ ❑ Demonstrating	❑ Refining

Debbie Andres

Modifying the Online Grading System



Standard:	*Mech.1 - I can use physics language to describe real-world motion scenarios.*		
Assignment	*Exit Ticket (9/12)*	*Mini-Lab (9/17)*	*Quiz (9/26)*
Mastery Level	Needs Improvement	Developing	Developing
Point Equivalence	2.8	3.4	3.4
Average for Individual Standard			3.2

Thank you!

This work is done between myself and fellow Rutgers grad Jade Pinheiro.

You can find a link to our resources here.

Weekly lab resubmission in large-enrollment course

Mike Gentile, Rutgers University, New Jersey, USA

- Two-semester algebra-based introductory physics course. 280 students (ages ~19-21) split into 10 lab weekly sections of 7 4-student groups each. 10 hours of help sessions outside of class time.
- 3-hour weekly lab sessions often with complete ISLE cycles. When a full cycle isn't practical students describe how an experiment fits into the larger investigative process.
- Each group collaborates on a single writeup using Google docs. Writeup is free-form and includes diagrams, photos, video, etc.
- Writeups are scored using provided scientific abilities rubrics. Comments are used to draw students attention and provide brief guidance. Detailed scoring report provided. All group members receive the same score.
- Students have 1 week to revise all aspects of their work which is then rescored, to full credit if earned. Specific feedback given when score isn't raised to full.
- Each group has a persistent virtual conference allowing them to meet and work on resubmits when colocation is difficult. Also allows remote students to contribute to in-person labs using multiple cameras rather than missing class.
- Students make a weekly promise in writing to contribute significantly to labs and resubmits. Google docs allows easy comparison between original and resubmitted work, and for auditing level of individual student contribution.
- Group writeups (vs. individual) allow instructor much more time to provide thoughtful feedback, score resubmits carefully, meet with students in their conferences outside of class time, and provide support for teaching assistants.
- Transparent scoring system and resubmits allow completely honest feedback. Low scores can be recovered. Students in control of their progress.

Here are the rubric elements your TA will be looking at for this experiment:

Scientific Ability		Missing	Inadequate	Needs improvement	Adequate
C2	**Is able to design a reliable experiment that tests the hypothesis**	The experiment does not test the hypothesis.	The experiment tests the hypothesis, but due to the nature of the design it is likely the data will lead to an incorrect judgment.	The experiment tests the hypothesis, but due to the nature of the design there is a moderate chance the data will lead to an inconclusive judgment.	The experiment tests the hypothesis and has a high likelihood of producing data that will lead to a conclusive judgment.
C4	**Is able to make a reasonable prediction based on a hypothesis**	No prediction is made. The experiment is not treated as a testing experiment.	A prediction is made but it is identical to the hypothesis, OR Prediction is made based on a source unrelated to hypothesis being tested, or is completely inconsistent with hypothesis being tested, OR Prediction is unrelated to the context of the designed experiment.	Prediction follows from hypothesis but is flawed because * relevant experimental assumptions are not considered and/or * prediction is incomplete or somewhat inconsistent with hypothesis and/or * prediction is somewhat inconsistent with the experim	A prediction is made that * follows from hypothesis, * is distinct from the hypothesis, * accurately describes the expected outcome of the designed experiment, * incorporates relevant
C9	**Is able to revise the hypothesis when necessary**	A revision is necessary but none is made.	A revision is made but the new hypothesis is not consistent with the results of the experiment.	A revision is made and is cons with the results of the experi but other relevant evidence i taken into account.	

Group	Pre-lab	Scientific abilities C2	C4	C9	A11	B8	F1	C8	How this fits into scientific investigation	TA choice	Why did we do this lab?	Working hard for 3 hours	Total
Max	5	3	3	3	3	3	3	3	5	5	5	9	50
1	3	3	3	2	3	3	3	3	5	3	5	9	45
1 resub	3	3	3	2	3	3	3	3	5	3	5	9	45
2	3	3	1	2	2	3	2	3	2	3	4.5	9	37.5
2 resub	4	3	2	3	3	3	3	3	3	4	5	9	45
3	3	3	2	2	3	3	2	2	5	3	4	9	41
3 resub	3	3	3	2.5	3	3	3	3	5	3	4	9	44.5
4	4.5	3	3	2	3	3	3	3	5	4.5	5	9	48
4 resub	5	3	3	3	3	3	3	3	5	5	5	9	50
5	4.5	3	3	3	2	2	2	3	5	4.5	5	9	46
5 resub	5	3	3	3	3	3	3	3	5	5	5	9	50
6	4	3	3	3	3	2	3	3	2	4	5	9	44
6 resub	5	3	3	3	3	2	3	3	4	5	5	9	48
7	3.5	3	3	3	2	3	1	3	5	3.5	5	9	44
7 resub	3.5	3	3	3	3	3	3	3	5	3.5	5	9	47

2-hr Weekly Labs in Large-Enrollment Courses

(500-1000 students)

C. Sealfon
UToronto

In Person

- Students work on whiteboards
  - In groups of 3-4
  - Students call over their TA when they think they've completed the activity and shown their abilities
- TAs mark Scientific Abilities in real time
  - Abilities are marked pass/fail on a clipboard
  - Can say "not yet" and come back later, unless time is running out
  - Any student may be asked to explain the group's work
  - TAs "raise the bar" during the semester

Online

- Students work on shared powerpoints
  - In groups of 3-4 on Teams
- Groups present their ppts to each other
  - Complete peer feedback form with feedback on each ability
  - TA also provides informal feedback
- TAs mark Scientific Abilities 2-4 days after lab session
  - Students may revise their slides before they are marked by the TA

Online Auto-graded Aligned Assessments are Hard

C. Sealfon
UToronto

An attempt: http://metalearning.ca/phy2quizzes

- 2-stage tests with unmarked collaboration FIRST
  - Provided students with a “context” two days in advance
  - Encouraged to discuss how to apply the unit learning goals to the context
  - Then students answered timed, closed-response quiz on Canvas
- Quiz A & Quiz B for each unit
  - Two weeks apart
  - A higher score on Quiz B would replace the Quiz A score
- Might work better as formative or low-stakes activities

Core features of a successful assessment correction/retake system

1. Student accountability
2. Requires metacognition
3. Reasonable time requirement
4. Minimal teacher effort
5. Consistent with course philosophy

Matt Blackman
Ridge High School / Rutgers University (US)
Universe & More

Physics Grade Improvement Form

Name: Item Number: Original Score Received:

Correct solution / Explanation of reasoning:

Correct solution / Explanation of reasoning:

Description of underlying physical laws:

Description of underlying physical laws:

What went wrong and why:

What went wrong and why:

Matt Blackman
Ridge High School / Rutgers University (US)
Universe & More

My first test correction policy

Students had one week to fill out correction forms for the questions they missed. I graded the forms for up to 50% credit back for each question.

Pros

- Students could work together
- Quick to grade for students who put in the effort
- No need to schedule time in or out of class for reassessments

Cons

- Students could work together
- Slow to grade for students who did not put in the effort
- Lacks student accountability (reassessment)
- 50% credit not consistent with course philosophy

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Ridge High School / Rutgers University (US)
Universe & More

My improved test correction policy

Students have one week to fill out correction forms for questions they missed. I skim forms and give each a check/no check. Forms with a check act as a ticket to reassess with a similar question for full credit. Students all reassess at the same time with questions that are quick to grade. Students cannot keep reassessments, and minimal feedback is provided. One chance for reassessment (for accountability and my sanity)

Pros

- Ends up taking less of my time overall
- Students can work together on forms
- Full student accountability (forms are only as valuable as knowledge gained in making them)
- Skimming forms as “check/no check” is very fast
- Potential for 100% credit is consistent with my course philosophy

Cons

- More assessment questions needed
- Scheduling time for the retake
- Holding students accountable if they miss the retake

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Ridge High School / Rutgers University (US)
Universe & More

Core features of a successful assessment correction/retake system

1. Student accountability
2. Requires metacognition
3. Reasonable time requirement
4. Minimal teacher effort
5. Consistent with course philosophy

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