# Standards-based Grading in College Physics

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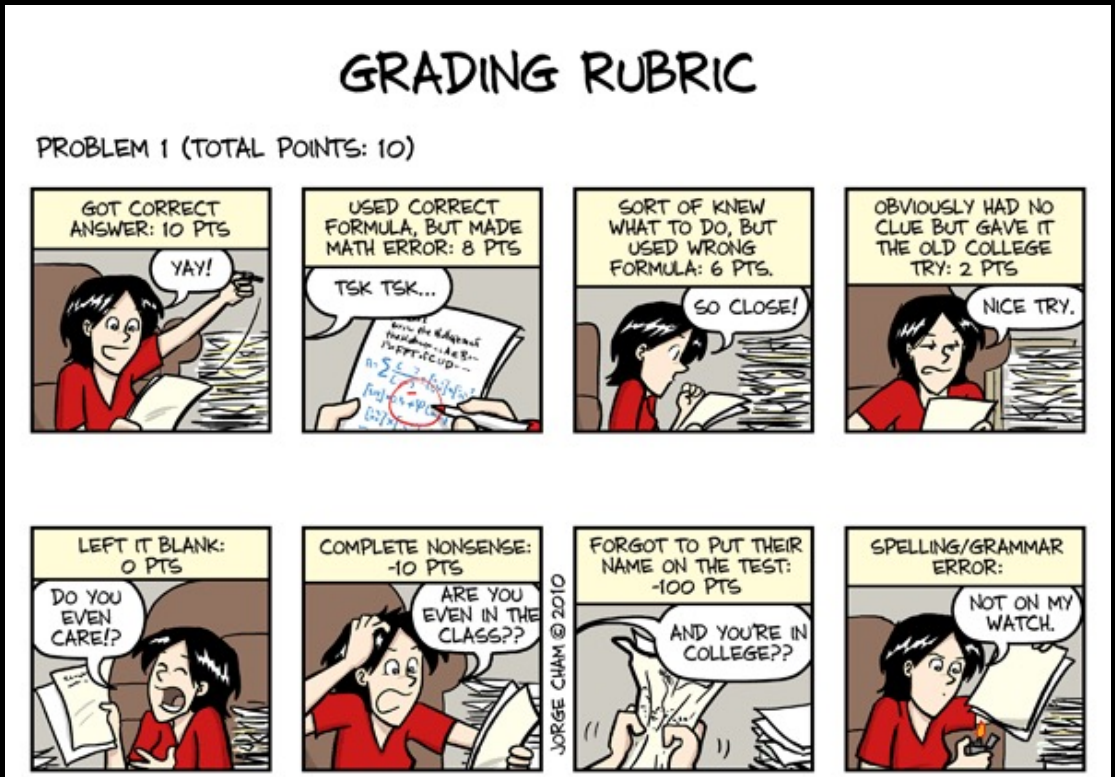
# Thank you, UMN PER group!

# Grading: The worst part of the job!



# Typical points model of grading

- What are the benefits?
- What are the problems?

# Scenario A

- Adam has been averaging 70/100 on his tests, a bit lower than the average. With attendance and participation points, his final grade is a B+.

- Do you think Adam is a B+ student?

# Scenario B

- Beth is getting near perfect scores on every test, but she never shows up to class. She told you that she had a really good high school class and learned it all then. With participation and attendance points, her final grade is a B+.

- Do you think Beth is a B+ student?

# Scenario C

- Curtis is an engineering student who did great work on labs and projects, though his tests scores were around the B- mark. When he takes the next course in his major, the teacher is frustrated because Curtis can't do a basic skill he should have learned in your class. But he got a B+ in your class.

- How do grades tell you what a student has learned?

# Summative only grading

- Typical course assessments are focused on the summative—tests, final exam
- Learning is a process
- Growth mindset
- How does summative assessment help with growth?

- Why do we put feedback on exams?

# Grading Philosophies

- Norm-referenced grading: standard curve, your grade tells you where you are relative to the class
- Criterion-referenced grading: your grade is based on a predetermined set of criteria

(Your philosophy might be between these two)

# An Alternative to Points: Standards-based grading (Objectives-based grading)

- Been used for years at various educational levels
- Outcomes based
- Focuses on formative assessment

# My journey to SBG

- Colleague in department tried it
- Community of practice in department
- Spring 2012 and onwards
- Started easy—used colleague's list of standards/course objectives
- Adjusted every semester
- Still adjusting!

# What it looks like for me

- No points, no attendance checked, no participation grades
- No homework collected
- Grades based solely on quizzes (assessments)
- Assessments directly tied to course objectives/standards
- Students have three tries per assessment
- Assessments weekly
- No final exam

# Schedule

- Thursday: start content (projectile motion concepts)
- Friday: projectile motion concepts and start problem solving [homework/practice available on Canvas]
- Monday: lab on projectile motion
- Tuesday: practice problem solving [more practice on Canvas]
- Wednesday: practice (1 hour) and assess (1 hour) on projectile motion
- Thursday: hand back assessment
- Friday through Thursday: Students re-assess up to two more times if necessary

# Reassessing

- Pros:
  - Students have motivation to go back and learn material
  - Three tries allows almost every student to pass
- Cons:
  - Can be lots of grading
  - Need many versions of assessments
- What other pros & cons can you think of?

# Grading

- Simplified scheme, no points
  - High Pass
  - Pass
  - Minor Error
  - Major Error
  - Insufficient/Incomplete

- Very fast; minimal feedback

# Student Responsibility

- Students are responsible for their own learning, keeping track of what they need, what grade they are earning
  - They step up!
- Do homework as needed, do practice as needed
- Some students are comfortable skipping classes and showing up to assessments only

# The Good Parts

- Student feedback is positive about the grading system
- I feel like students are more motivated
- Definitely puts the responsibility of learning on the student
- No keeping track of attendance or participation
- No graded homework
- No arguing about 87 vs 88 on a test
- Start hard and they have a chance to improve without hurting their grade

# The Bad Parts

- Students really like points; they understand how they are doing and they understand how to make the system work to their advantage
- Can be a lot of grading (though FAST)
- Takes time to implement
- Requires proctors or your time
- Might be uncomfortable at first

# Unexpected Benefits

- No disability accommodations for tests
- Accrediting agencies ❤️❤️❤️ it!
- Other teachers use proctoring room too
- Students read feedback!

# The Details—Objectives

- Used old tests to determine what I really was assessing/testing for
- Decided which objectives were absolutely essential to pass the class (to get a C)
- Other objectives help improve grade above C
    - Ended up with C-level and A-level objectives

# The Details—Objectives

**Projectile Motion**

(C) I can solve problems involving objects experiencing projectile motion with horizontal launch *in a clear and understandable manner*.

(A) I can solve problems involving objects experiencing projectile motion with angled launch *in a clear and understandable manner*.

**Balanced Forces**

(C) I can draw a properly labeled force diagram showing all forces acting on an object.

(C) I can relate balanced/unbalanced forces to an object's constant/changing motion.

# The Details—Objectives

**Lab Standards**

(C) I can communicate clearly in complete sentences.

(C) I include all necessary information in a lab report.

(C) I use correct physics in my labs.

(C) I understand the errors associated with experimental design.

**Science Communication**

(C) I can communicate clearly about science topics.

(C) I can apply scientific principles to science writing.

**Learning**

(C) I actively and respectfully participate in this course.

(C) I have shown commitment to learning physics and I take responsibility for my learning.

# The Details--Reassessing

- Google form for students to sign up
- I print at end of day for next day
- Different version for each day or each student
- Open lab for retakes
- Student workers as proctors
- Available 10-20 hours a week
- Students show up, give name, get assessment
- Picked up at end of day for grading

# The Details--Assessment

Assessment #8D for Forces

Name: _____

*Objectives being assessed:*

*9* *I can solve problems using Newton's 2nd Law ($F_{net} = ma$).*

*10* *I can solve force problems that involve solving kinematics too.*

9: ____

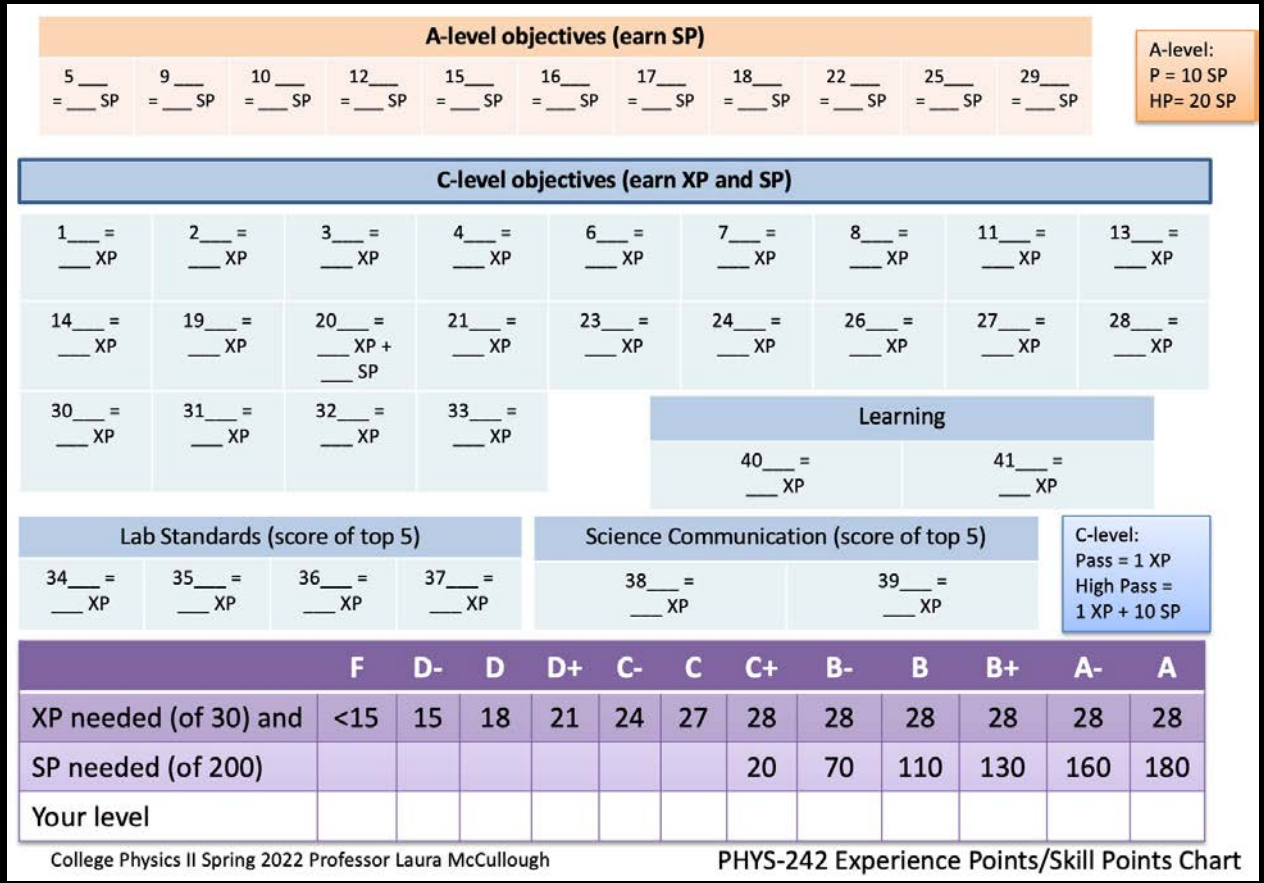
10: ____

Black Widow slides a set of handcuffs up a ramp to Iron Man. The cuffs leave her hand at 0.89 m/s, and after sliding up the ramp a distance, they have slowed to 0.12 m/s. The ramp is at 8° and the coefficient of friction between the cuffs and the ramp is 0.16. How far have the cuffs traveled?

# The Details--Gradescheme

- Different for each course
- Based on objectives
  - C-level objectives
  - A-level objectives
- Pass on C-level earns *experience points* towards "C"
- High pass or A-level earns *skill points* towards "A"
- Number of points needed carefully calculated
  - All pass, no high pass → "B"
  - All high pass on C-level, no A-level → "B"

# Details: Gradescheme



**A-level objectives (earn SP)**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5 ___ = ___ SP | 9 ___ = ___ SP | 10 ___ = ___ SP | 12 ___ = ___ SP | 15 ___ = ___ SP | 16 ___ = ___ SP | 17 ___ = ___ SP | 18 ___ = ___ SP | 22 ___ = ___ SP | 25 ___ = ___ SP | 29 ___ = ___ SP |

A-level:
P = 10 SP
HP= 20 SP

**C-level objectives (earn XP and SP)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 ___ = ___ XP | 2 ___ = ___ XP | 3 ___ = ___ XP | 4 ___ = ___ XP | 6 ___ = ___ XP | 7 ___ = ___ XP | 8 ___ = ___ XP | 11 ___ = ___ XP | 13 ___ = ___ XP |
| 14 ___ = ___ XP | 19 ___ = ___ XP | 20 ___ = ___ XP + ___ SP | 21 ___ = ___ XP | 23 ___ = ___ XP | 24 ___ = ___ XP | 26 ___ = ___ XP | 27 ___ = ___ XP | 28 ___ = ___ XP |
| 30 ___ = ___ XP | 31 ___ = ___ XP | 32 ___ = ___ XP | 33 ___ = ___ XP | | | | | |

**Learning**

| | |
|---|---|
| 40 ___ = ___ XP | 41 ___ = ___ XP |

**Lab Standards (score of top 5)**

| | | | |
|---|---|---|---|
| 34 ___ = ___ XP | 35 ___ = ___ XP | 36 ___ = ___ XP | 37 ___ = ___ XP |

**Science Communication (score of top 5)**

| | |
|---|---|
| 38 ___ = ___ XP | 39 ___ = ___ XP |

C-level:
Pass = 1 XP
High Pass =
1 XP + 10 SP

| | F | D- | D | D+ | C- | C | C+ | B- | B | B+ | A- | A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| XP needed (of 30) and | <15 | 15 | 18 | 21 | 24 | 27 | 28 | 28 | 28 | 28 | 28 | 28 |
| SP needed (of 200) | | | | | | | 20 | 70 | 110 | 130 | 160 | 180 |
| Your level | | | | | | | | | | | | |

College Physics II Spring 2022 Professor Laura McCullough

PHYS-242 Experience Points/Skill Points Chart

# Details: Gradebook

| | |
|---|---|
| 5 | I can solve problems involving objects experiencing projectile motion with horizontal launch. |
| 6 | I can solve problems involving objects experiencing projectile motion with angled launch. |

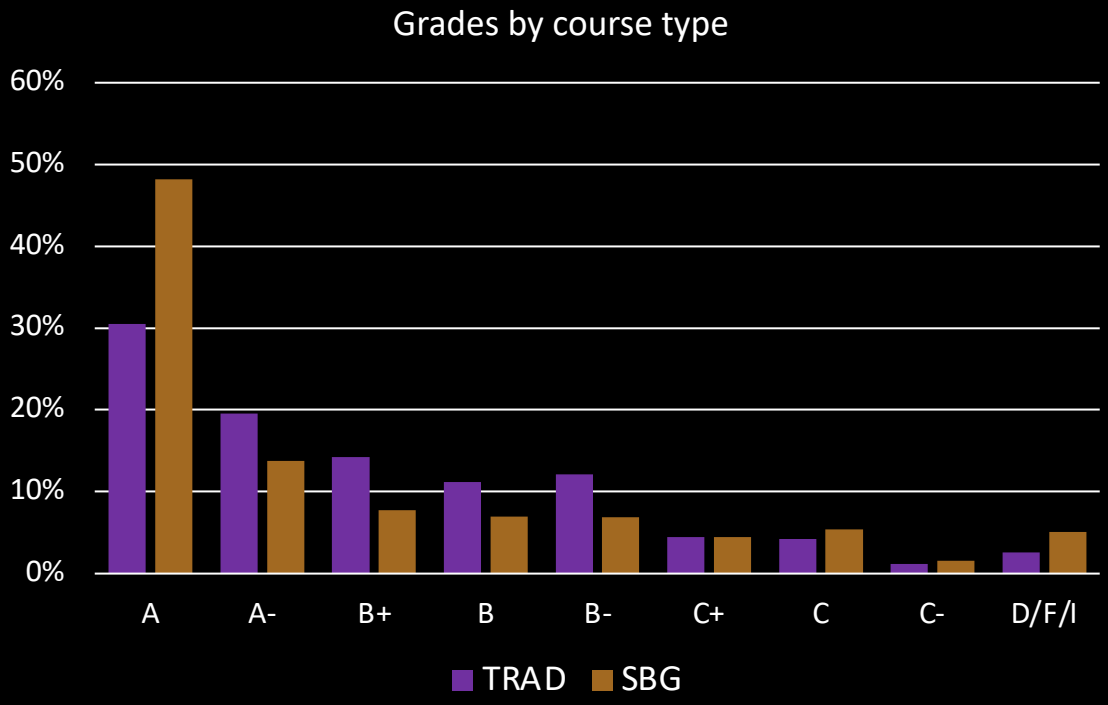
| | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Student 1 | 3 | | | | | | | 3 | 3 | 2 | 3 | 3 | | | |
| Student 2 | | | | | | | | | | | | | | | |
| Student 3 | 4 | 4 | | | | | | | | | | | | | |
| Student 4 | 2 | 3 | 5 | 5 | | | | 2 | 1 | 3 | 5 | 5 | | | |
| Student 5 | 1 | 1 | | | | | | 1 | 1 | | | | | | |
| Student 6 | 5 | 5 | | | | | | 5 | 5 | | | | | | |
| Student 7 | 4 | 4 | 5 | 5 | | | | 5 | 5 | | | | | | |
| Student 8 | 1 | 1 | | | | | | 2 | 2 | | | | | | |
| Student 9 | 3 | 5 | | | | | | 5 | 5 | | | | | | |
| Student 10 | 5 | 5 | | | | | | 3 | 3 | 5 | 3 | | | | |
| Student 11 | 4 | 2 | | | | | | 5 | 1 | | | | | | |
| Student 12 | 5 | | | | | | | 4 | 3 | | | | | | |
| Student 13 | 4 | 4 | | | | | | 2 | 4 | | | | | | |
| Student 14 | 5 | 3 | | | | | | 5 | | | | | | | |
| Student 15 | 5 | 2 | | | | | | 3 | 1 | 5 | 3 | | | | |
| Student 16 | 5 | 5 | | | | | | 3 | 3 | | | | | | |

# Details: Gradebook

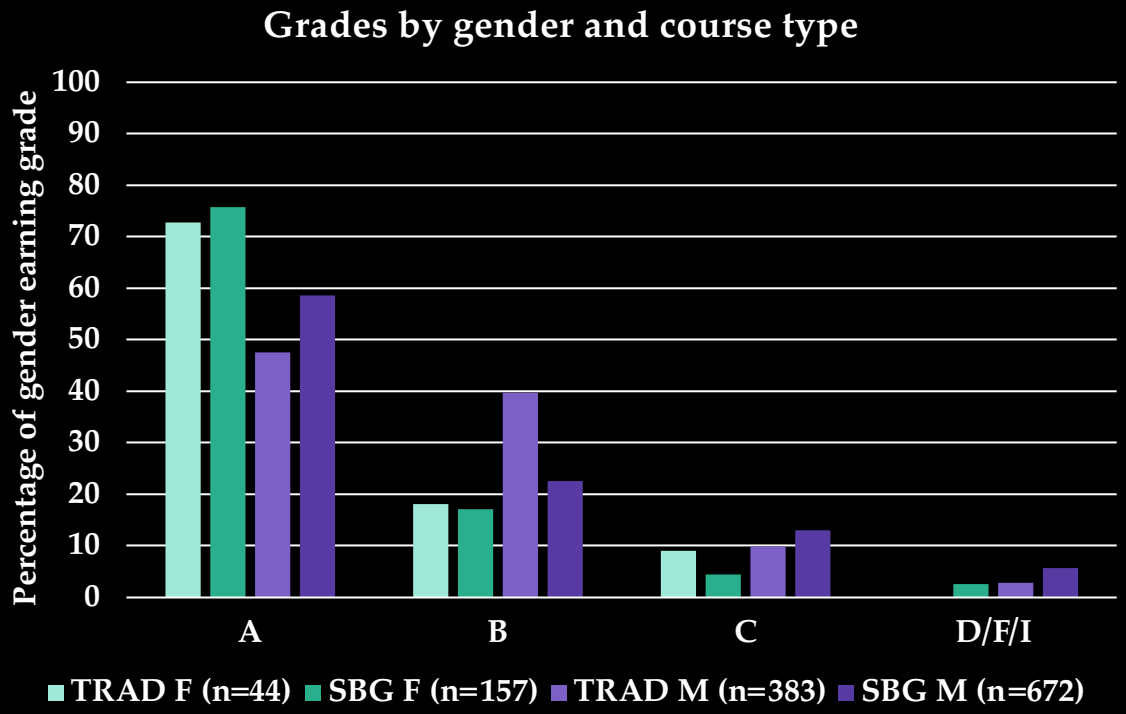
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Final grade | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | c | c | c | c | c | c | c | c | | c | | c | | c | | c | | c | c | | | c | | c | c | | | c | c | c | | c | | |
| | LAB26 | LAB27 | LAB28 | SC29 | SC30 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | XP | SP |
| Student 1 | 4.0 | 2.3 | 4.0 | 2.4 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 2 | 1.3 | 1.3 | 1.3 | 0.8 | 0.6 | 3 | 3 | 2 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 3 | 4.0 | 3.7 | 4.0 | 1.6 | 1.4 | 4 | 3 | 4 | 4 | 4 | 0 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 4 | 3.7 | 2.7 | 3.7 | 2.4 | 1.8 | 4 | 3 | 5 | 5 | 5 | 5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 5 | 1.0 | 1.3 | 1.3 | 1.6 | 1.2 | 3 | 3 | 0 | 0 | 1 | 1 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 6 | 3.7 | 2.0 | 3.0 | 2.4 | 2.2 | 4 | 4 | 5 | 5 | 5 | 5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 7 | 4.0 | 3.0 | 3.7 | 2.4 | 2 | 4 | 4 | 5 | 5 | 5 | 5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 8 | 3.3 | 3.0 | 3.0 | 2.2 | 2.2 | 4 | 4 | 4 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 9 | 3.7 | 3.7 | 4.0 | 2.4 | 2.2 | 4 | 4 | 5 | 5 | 5 | 5 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 10 | 4.0 | 2.7 | 2.7 | 2.4 | 1.8 | 4 | 4 | 5 | 5 | 5 | 5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 11 | 4.0 | 3.3 | 4.0 | 0.8 | 0.6 | 4 | 3 | 3 | 3 | 4 | 5 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 12 | 4.0 | 2.7 | 2.7 | 2 | 1.6 | 4 | 4 | 5 | 5 | 5 | 4 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 13 | 3.7 | 2.7 | 3.3 | 2 | 1.8 | 4 | 3 | 4 | 4 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 14 | 2.7 | 2.3 | 3.0 | 1.4 | 1.4 | 4 | 3 | 5 | 4 | 5 | 5 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 15 | 3.7 | 4.0 | 3.7 | 2.4 | 2.4 | 4 | 4 | 5 | 3 | 5 | 5 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Student 16 | 3.3 | 2.7 | 4.0 | 0.6 | 0.4 | 4 | 4 | 5 | 4 | 5 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Average score | 3.6 | 3.0 | 3.4 | 1.9 | 1.8 | 3.8 | 3.7 | 4.4 | 4.0 | 4.4 | 4.3 | 2.6 | 2.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| # passing | 17 | 6 | 17 | 0 | 0 | 44 | 35 | 40 | 35 | 42 | 40 | 12 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| % passing | 35.4 | 12.5 | 35.4 | 0.0 | 0.0 | 90 | 71 | 82 | 71 | 85.7 | 81.6 | 24.5 | 42.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |

SN grading | Roster | Names | Labs | SC | CV CA | Proj | BF | UBF | Circular | Spring | BT | CE | Mom | Summary

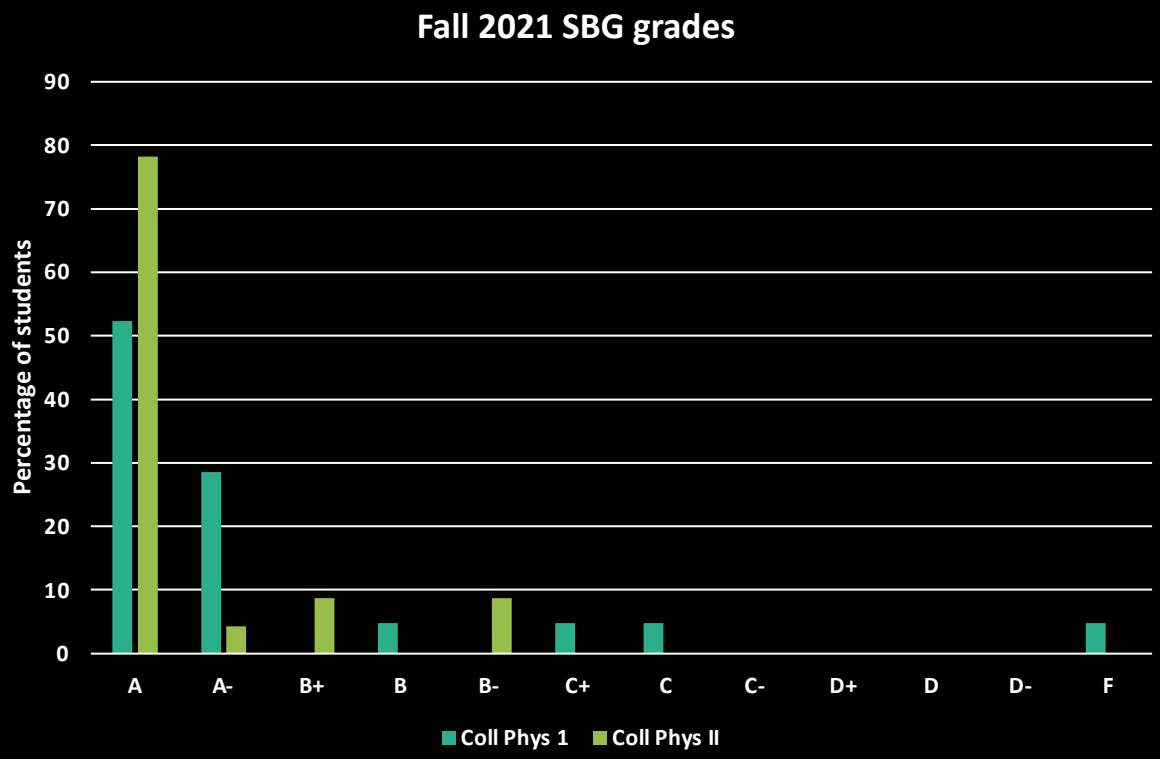
# The Details: Effect on Grades



# Grades by Gender



# <Whoa>


Fall 2021 SBG grades
Percentage of students
90
80
70
60
50
40
30
20
10
0
A
A-
B+
B
B-
C+
C
C-
D+
D
D-
F
Coll Phys 1
Coll Phys II

# Is SBG Right for You?

- Criteria-based or norm-based grading?
- Clear set of objectives?
- Resource availability?
- Other issues?

# How Could You Start?

- Step one: develop set of objectives based on current class
  - Decide if all objectives are equal or if you want levels
  - Determine what needs to be known for passing/"C" grade
- Step two: determine resources (current/needed)
  - Grading help?
  - Proctor room and proctors?
- Step three: given your resources and your philosophy, how many retakes? Timeframe for retakes?

# Moving Towards SBG

- Step four: develop grading scheme
  - Ease of understanding how grade is earned
  - Ease of calculating grade
  - Ease of keeping track of grades
  - Level of feedback given
- Step five: write an assessment designed for one or more objectives
- Step six: get colleagues to look at your plan***
- Step seven: make (frantic, last-minute) changes

# Moving Towards SBG

- Step eight: set low expectations for the first run
- Step nine: give it a try!
- Step ten: tweak, adjust, retry
- Step eleven: repeat step ten

# Resources on Standards-Based Grading

- Laura McCullough: McCulloughL@uwstout.edu
- https://www.chemedx.org/article/standards-based-grading-chemistry-classroom
- http://mctownsley.net/top-10-standards-based-grading-articles/

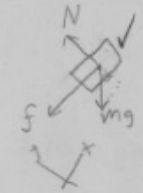
# Thank you!

http://lauramccphd.com/

# High pass

8: HP

Black Widow slides a set of handcuffs up a ramp to Iron Man. The cuffs leave her hand at 0.89 m/s, and after sliding up the ramp a distance, they have slowed to 0.12 m/s. The ramp is at 8° and the coefficient of friction between the cuffs and the ramp is 0.16. How far have the cuffs traveled?




$x_i = 0$

$x_f =$

$v_i = .89 m/s$

$v_f = .12 m/s$

$a = -2.91$

$t =$

$\mu_s = .16$

$\theta = 8°$

| F | X | Y |
|---|---|---|
| N | - | +N |
| f | -f | - |
| mg | $-mg\sin\theta$ | $-mg\cos\theta$ |

$\Sigma F_X \neq 0$

$\Sigma F_Y = 0$

$N = mg\cos\theta$ ✓

$-f - mg\sin\theta = ma$ ✓

$f = \mu N$

$.12^2 = .89^2 + 2(-2.91)\Delta x$

$.014 = .79 - 5.82\Delta x$

$-\mu mg\cos\theta - mg\sin\theta = ma$

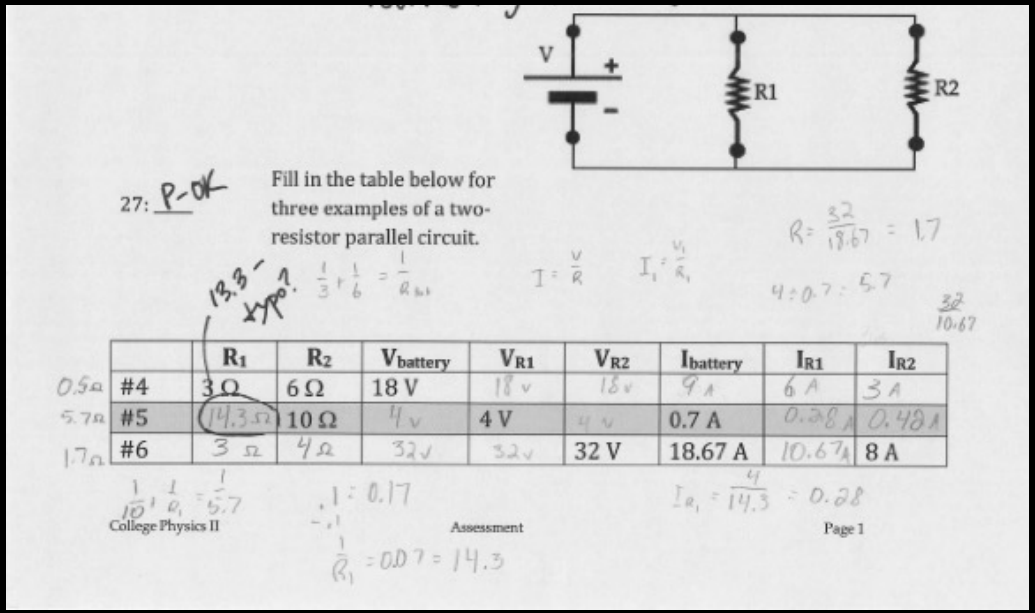
$\frac{5.82\Delta x}{5.82} = \frac{.776}{5.82}$

$\Delta x = .13m$

$a = -.16(9.8)\cos(8) - (9.8)\sin(8)$

$a = -2.91$

# Pass-OK

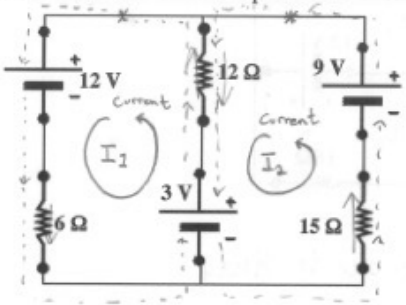



| | $R_1$ | $R_2$ | $V_{battery}$ | $V_{R1}$ | $V_{R2}$ | $I_{battery}$ | $I_{R1}$ | $I_{R2}$ |
|---|---|---|---|---|---|---|---|---|
| #4 | 3 Ω | 6 Ω | 18 V | 18 V | 18 V | 9 A | 6 A | 3 A |
| #5 | 14.3 Ω | 10 Ω | 4 V | 4 V | 4 V | 0.7 A | 0.28 A | 0.40 A |
| #6 | 3 Ω | 4 Ω | 32 V | 32 V | 32 V | 18.67 A | 10.67 A | 8 A |

# Self-reflection

29: M

What is the current in each part of this circuit?




[Left]: $-12\text{v} + 6I_1 + 3\text{v} + 12I_1 + 12I_2 = 0$

$\rightarrow -9\text{v} - 6I_1 + 12 \rightarrow 3\text{v} - 6I_1 = 0$

$\frac{6I_1}{6} = \frac{3}{6}$

$I_1 = .5\text{A}$

[Right]: $+12I_2 + 12I_1 - 3\text{v} - 15I_2 + 9\text{v} = 0$ ✓

$\rightarrow 6\text{v} - 27I_2 + 12I_1 \rightarrow 18\text{v} - 27I_2 = 0$

$\frac{27I_2}{27} = \frac{18\text{v}}{27}$

$I_2 = \frac{2}{3}\text{A} \approx .67\text{ A}$

[Outer]: $-12\text{v} + 6I_1 - 15I_2 + 9\text{V} = 0$

I'll need to retake this, I am definitely missing something.