Figure 1 Learning activity for introducing the quantitative problem-solving rubric

Orientation:

In this activity you will be examining a quantitative problem-solving rubric that we will use periodically throughout the term to gage growth in applying and effectively working through the problem-solving process. You will work with a peer, performing an assessment of their homework assignment. Giving and receiving feedback using the rubric should deepen your understanding of this assignment and stimulate ideas for improving your own problem-solving process in future assignments.

Learning Objectives:

1. Attain shared understanding of the role and importance of dimensions (row labels) in the quantitative problem-solving rubric.
2. Gain experience scoring your own homework and that of a peer with the quantitative problem-solving rubric.
3. Make plans to elevate the quality of future homework solutions based on your peer review and class insights about use of the rubric.

Targeted Skills:

- assessing performance – providing feedback for improving performance
- seeking assessment – analyzing past performance to improve future performance
- leveraging solutions – modifying homework for wider audiences and reusability

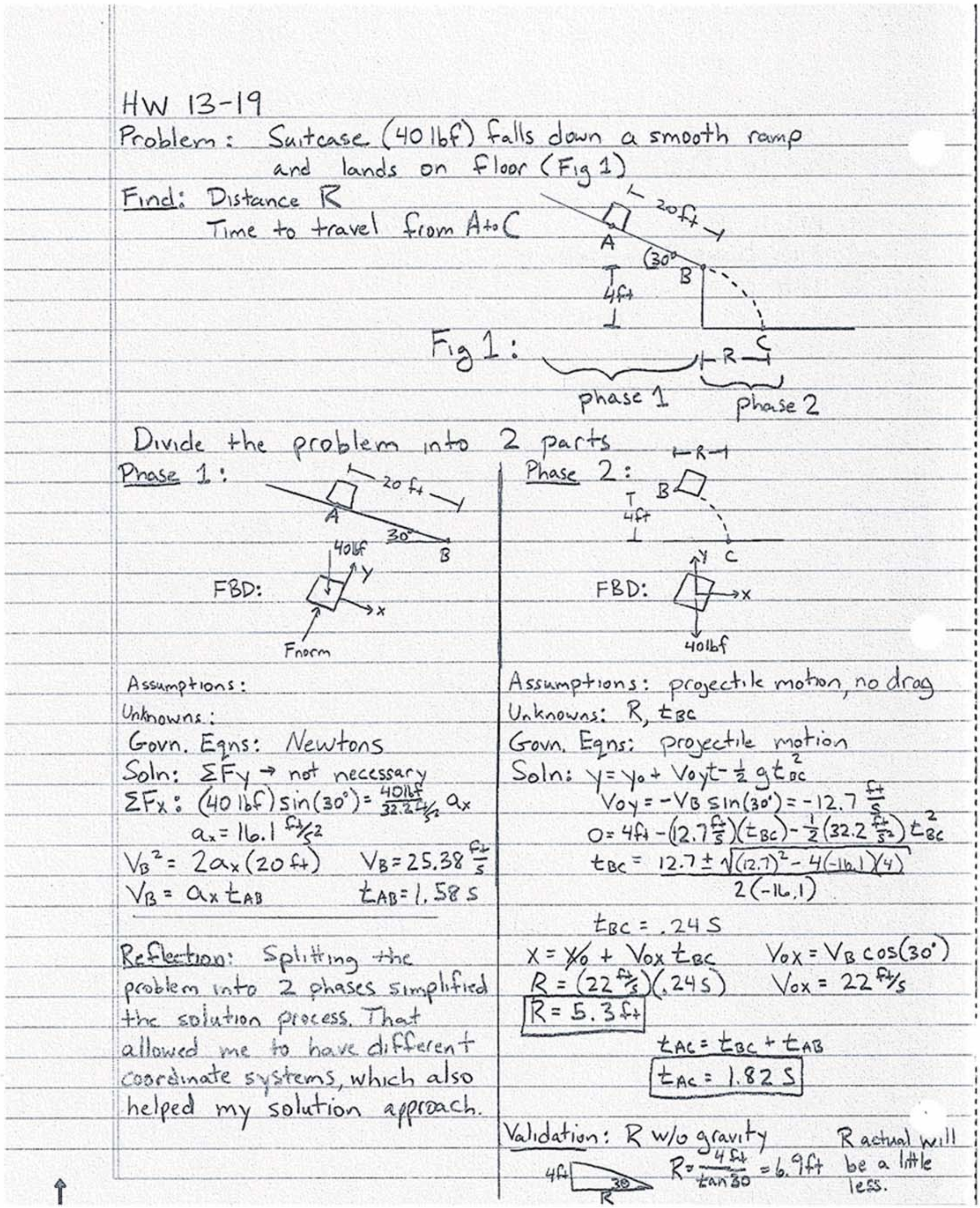
Resources:

- your latest homework assignment
- scored student work
- blank quantitative problem-solving rubric

Tasks:

1. Work with a partner.
2. Review the format and content of the quantitative problem-solving rubric as well as the scored example of student work.
3. Answer the following critical thinking questions:
   - What is meant by each dimension (row labels) and why are these important?
   - What evidence is found in the sample work for the assigned scores?
   - What strengths do you see in the sample work that you want to emulate?
   - Why are these valuable?
   - What improvements in the sample work would increase its value?
   - How might these be implemented?
   - What overall performance level given in the column headers should be your goal by the end of this course? Why?
   - What is your most burning question about the rubric or its use in this class?
4. Exchange homework papers and score them using the rubric. Give a global score in each dimension for the entire assignment rather than for each problem.
5. On the back of the rubric:
   - Give two strengths in the homework and explain their significance.
   - Give two areas for improvement in the homework along with an action plan.
   - Give two insights about using the rubric as a tool in this class.
6. Exchange papers and debrief one another about your findings.
7. As a class, inventory observed strengths, improvements, and insights that would add value to future homework assignments as well as to subsequent use of the rubric.
8. Discuss ideas for relative weighting, if any, for each of the dimensions in the rubric.
9. Submit your homework and your peer score to the instructor for validation.

Figure 2 Sample of student work from a dynamics class



HW 13-19

Problem: Suitcase (40 lbf) falls down a smooth ramp and lands on floor (Fig 1)

Find: Distance R
Time to travel from A to C

Divide the problem into 2 parts

Phase 1:

Assumptions:

Unknowns:

Govn. Eqns: Newtons

Soln: $\Sigma F_y \rightarrow$ not necessary

$\Sigma F_x: (40\ \text{lbf})\sin(30°) = \frac{40\ \text{lbf}}{32.2\ \text{ft/s}^2} a_x$

$a_x = 16.1\ \text{ft/s}^2$

$V_B^2 = 2a_x(20\ \text{ft})$ $\quad V_B = 25.38\ \frac{\text{ft}}{\text{s}}$

$V_B = a_x t_{AB}$ $\quad t_{AB} = 1.58\ \text{s}$

Reflection: Splitting the problem into 2 phases simplified the solution process. That allowed me to have different coordinate systems, which also helped my solution approach.

Phase 2:

Assumptions: projectile motion, no drag

Unknowns: R, t_{BC}

Govn. Eqns: projectile motion

Soln: $y = y_0 + V_{oy}t - \frac{1}{2}g t_{BC}^2$

$V_{oy} = -V_B \sin(30°) = -12.7\ \frac{\text{ft}}{\text{s}}$

$0 = 4\text{ft} - (12.7\frac{\text{ft}}{\text{s}})(t_{BC}) - \frac{1}{2}(32.2\frac{\text{ft}}{\text{s}^2})t_{BC}^2$

$t_{BC} = \frac{12.7 \pm \sqrt{(12.7)^2 - 4(-16.1)(4)}}{2(-16.1)}$

$t_{BC} = .24\ \text{s}$

$x = x_0 + V_{ox} t_{BC}$ $\quad V_{ox} = V_B\cos(30°)$

$R = (22\ \text{ft/s})(.24\ \text{s})$ $\quad V_{ox} = 22\ \text{ft/s}$

$\boxed{R = 5.3\ \text{ft}}$

$t_{AC} = t_{BC} + t_{AB}$

$\boxed{t_{AC} = 1.82\ \text{s}}$

Validation: R w/o gravity

$R = \frac{4\ \text{ft}}{\tan 30} = 6.9\ \text{ft}$

R actual will be a little less.

	Dimension	**Weighting/ Applicability**	**0-Absent**	**1-Somewhat On Track**	**2 - On Track**	**3 - Proficient**	**4 - Exemplary**
Problem Definition	**SYSTEM DESCRIPTION** (representation, notation, and annotation)		missing system diagram	missing components of system diagram	all components identified in system diagram	all components identified and linked in system diagram	insightful system diagram
	ASSUMPTIONS		none or incorrect	implicit and incomplete	(implicit and complete) or (explicit and incomplete)	explicit and complete	explicit, complete, justified
	KNOWNS & UNKNOWNS		not identified	incompletely identified	completely identified and cryptically labeled	completely identified and mostly labeled	completely identified and labeled
	GOVERNING EQUATIONS		missing	partial set	complete set, inconvenient form for solution	complete set, convenient form for solution	annotated, complete set
Solution	**SOLUTION METHOD** (line of reasoning, use of tools)		missing	poorly ordered	logical with minor flaws	logical and correct	optimal
	ANSWER (boxed, correct, units, sig figures)		missing all attributes	boxed	boxed and units	boxed, units, and correct	boxed, units, correct, and significant figures
	VALIDATION (unit consistency, order of magnitude, independent verification)		no effort to validate	incorrect unit check	units checked	units checked, magnitude checked	units checked magnitude checked, checked against alternative solution
Professionalism	**TECHNICAL COMMUNICATION** (legibility, layout, formatted tables, graph labels, etc.)		missing component(s)	not organized	organized for reuse by the author	organized for reuse by a third party	suitable for professional dissemination
	REFLECTION (transferability of solution, lessons learned about process, audience)		no effort	not relevant	no insights	insightful (in a narrow context)	thoughtful (able to transfer to new context)

Strengths: *Your system diagram highlighted your solution approach, which helpfully divided the problem into 2 parts. The validation method used for the projectile motion part of the problem was quite good as was the reflection. Decomposition is an excellent problem-solving technique that can be leveraged later.*

Improvements: *Your statement of assumptions and unknowns was incomplete with regard to the box sliding down the ramp. The governing equations were correct, but the form that you used was not expressed. The organization and layout of your solution was a bit haphazard. Aim to make your work usable and readable by classmates.*

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Strengths:

Improvements: