

Physics Problem Solving Evaluation Tool

Introduction



Meet Jasmine and Sara, two interns working for your company. Both have been working for you all summer and done a great job. You have been informed by the higher ups that you can hire one of them permanently but not both. This summer they've both done a terrific job. Both are very personable and reliable. You know that a permanent position will be more



challenging than the internship positions they've held so far. In an attempt to determine the stronger problem solver, you ask them to complete the Rescue at Boone's meadow challenge. The challenge is a 15 minute video about three people who must work together to save a wounded Eagle. In an attempt to determine the stronger problem solver, you listen to the Sara and Jasmine's dialog and analyze how they're progressing as they discuss the details of the problem and some possible solutions.

Important: You won't be able to watch the video, but lots of pictures have been provided along with the story. There is information necessary for solving the problem embedded within these pictures.

About You

First, please answer a few questions about yourself.

Name: _____

Year in School:

Declared Major:

If planning to change your major change, intended major:

Gender:

Race/Ethnicity:

Age:

of credits:

Do you work? If so, how many hours per week:

Current GPA:

Please read the story summary and then proceed to analyze Jasmine and Sara's problem solving.

"Rescue at Boone's Meadow"

Story Summary



Larry Peterson, a friend of Jasper Woodbury, flies an ultralight plane over Cumberland City. Soon, Larry begins to teach Emily Johnson to fly the ultralight. He gives her some information about the plane: Its total weight is 250 pounds and it can carry a payload of up to 220 pounds. Larry explains that payload is the weight the plane can safely carry in addition to its own weight; payload includes the weight of the pilot, the fuel, and cargo. Emily says she doesn't see any place for cargo. Larry then shows Emily a box used for carrying extra cargo. "Here it is but I hardly ever use it since the box alone weighs ten pounds." Says Larry.



Emily comes closer to the ultralight so she can see as Larry is teaching her. He explains that the propeller does the pushing, just like it does with a boat; the wing does the lifting. He then demonstrates how the unique shape of the wing helps lift the plane. He shows Emily that the air over the top of the wing has further to go than the air under the bottom. He says "This causes the air over the top to move faster since it has further to go. The difference in speed creates a difference in pressure. Here let me show you."

Larry demonstrates with a piece of paper. Blowing over the top of the paper lowers the pressure on the top and the paper lifts into the air. Emily tries and produces the same result.



A few days later Larry teaches Emily about the engine of the ultra light. He tells her that his ultra light's engine was originally used for a snowmobile, so it uses regular fuel and not aviation fuel. Emily points out that one and one-half gallons of fuel are left in each of the two sides of the fuel tank. She asks Larry how far he flew on the two gallons missing from the tank. He tells her that he had filled up the fuel tank in the morning and had flown over to Headlyville and back, which was about 30 miles in total. She asked him how long that took. Larry replied, "My rule of thumb is one mile every two minutes < on a calm day, that is." "Headlyville? They've got an airfield over there?", asks Emily. "Nope, just give me a field 100 yards long to get this little darlin' off the ground and you're in business," says Larry.



A few weeks later Emily takes her first flight. Emily, Larry, and Jasper go out to supper to celebrate. At the restaurant, Jasper talks about his plans for a fishing trip. He says that he plans to drive the 60 miles from Cumberland City to Hilda's Service Station and then hike to his favorite fishing spot, which is about 18 miles or so on foot. Larry mentions that he flew his ultra light to see Hilda the previous week, "I set the ultra light down in that field next door. Good golly, I thought old Hilda and her eyeballs were in for a permanent separation."

For desert Emily orders a scoop of strawberry ice cream in a dish. Larry tries to ask nicely for lemon Jell-O in a sugar cone but the veteran waitress is set in her ways and will have none of it. She says the Jell-O is in the Jell-O section and the sugar cones are in the ice cream section. "Sir in all my years in the restaurant business I've never seen it done that way. I truly never have and I don't expect I ever will!" Jasper sees a better solution than attempting to reason with the waitress. Instead he asks for a strawberry ice cream cone and a dish of lemon Jell-O. When the desserts come, he simply transfers the ice cream to the dish and the Jell-O to the cone. Larry says "Jasper, you're a genius." Emily replies "I second that."



Their bill comes to \$17.50. Emily suggests they include a 20% tip for all the grief Larry gave the waitress, and they agree to split the check equally. They each put money down on the table: Jasper puts \$11.00 down, Emily puts \$12.00, and Larry puts \$9.00 down. Larry calculates the total bill and makes change for each of them.



Before leaving the restaurant, Emily and Larry weigh themselves. The scale shows that Larry weighs 180 pounds.



While fishing, Jasper catches a nice looking trout. He fries it over a campfire and as he's taking his first bite, he hears a gunshot. Jasper packs up and goes to



investigate. He discovers that an eagle has been shot. After giving first-aid to the eagle, he makes an emergency call to Hilda on his two-way radio.

A customer in a convertible drives up to Hilda's, a gas station along a highway in the middle of nowhere. Hilda is pumping gas for her customer as Jasper radios

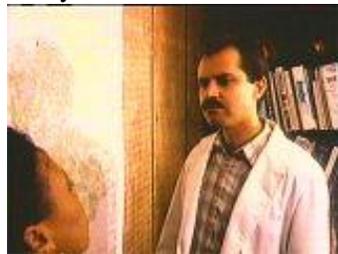


for help. When Hilda is finished, the gas pump shows that the customer got a total of 13.9 gallons and that gas costs \$1.259 per gallon. Her customer records his mileage and tells Hilda that he got 312 miles on his last tank of gas. Hilda says "I'm real happy for ya fella. That'll be \$17.50", and he pays for it with a \$20.00 bill.

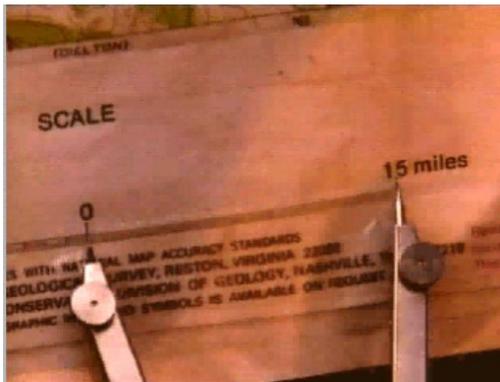
When Hilda answers Jasper's emergency call, Jasper tells her about the wounded eagle and explains that he needs to get it to Dr. Ramirez, a veterinarian in Cumberland City, ASAP. Jasper tells Hilda that he is at Boone's Meadow, which is about a six hour walk from her service station. He asks Hilda "call Emily Johnson and explain the situation, she'll think of something."



Emily drives to Dr. Ramirez's office. They go into his office where he has a map of the area on his wall. He marks the locations of his office in Cumberland City, Boone's Meadow, and Hilda's. Dr. Ramirez points out that Hilda's is right off the highway and that there are no roads leading into Boone's Meadow. Emily asks how much a bald eagle weighs. Dr. Ramirez estimates that it would weigh about 12 pounds.



On the map, Dr. Ramirez uses a pair of calipers to determine that the distance by air between Boone's Meadow and Cumberland City is about 65 miles. He tells Emily that most planes need about 2,000 feet of runway and Boone's Meadow is just half that long. Before he leaves, Dr. Ramirez tells Emily that the sooner he can treat the eagle, the better chance he has of saving it.





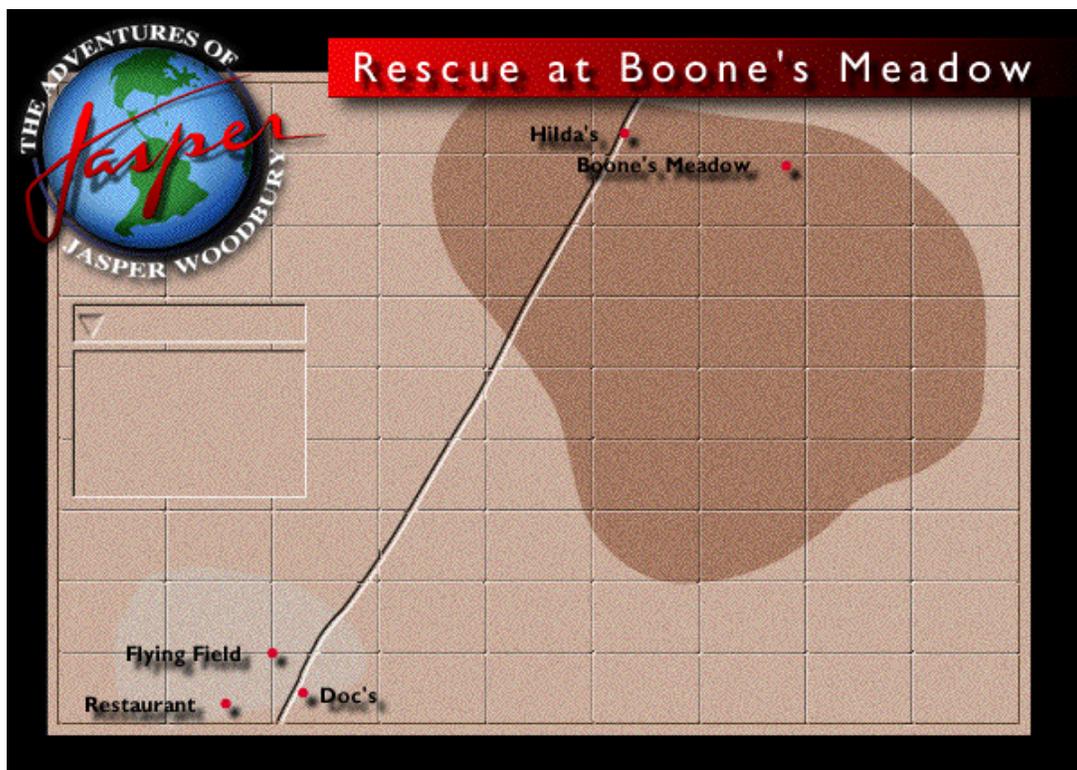
Emily plans for the eagle's rescue. She uses the map to determine the distance by air between Boone's Meadow and Hilda's. Next, she calls Larry, who is just down the road. She learns that Larry is available to fly, that the ultra light is fueled up and ready, and that "the winds are calm as a church on a Monday morning."

Emily thinks about the information she has gathered. She estimates that if the ultra light is used in the rescue, she had better add five minutes for each stop.

Challenge for Interns

Emily wants to know two things:

- The quickest way to move the eagle to Cumberland City?
- And how long will that take?



Please begin the Survey now to follow along with the Interns' problem solving process.

Analysis

Please answer the questions in bold as you go. Answer each question in order before reading ahead to see what Jasmine and Sara think of next. Feel free to refer back to the story summary as often as you like. Remember you must choose which intern to hire so keep this in mind while critiquing their solution process.

After watching the video, Jasmine and Sara sit down and start thinking about the problem.



Jasmine thinks awhile and says, "I just don't know what to do about Boone's meadow. Remember at the vet's? Dr. Ramirez said that the field is only half as long as you need to land a plane. However long that was, I don't remember. Anyway, I was thinking that maybe someone could hike in halfway and meet Jasper..."

- 1. Do you have any ideas about the fastest plan to rescue the Eagle? What would you try to figure out first?** (No need to work out the whole problem right now.)

- 2. How do you feel about this problem?**
 - a. Could solve it on my own right now.
 - b. Would rather solve it in a group setting.
 - c. Need more information before I could say.
 - d. It's completely over my head.

Please explain further:

I'm sure they expect the ultra light to land in the field at Boone's meadow, that's sort of the whole point of the video. Don't you think? They also mention payload a lot so it must be important too.



Sure. I guess that's probably true. Why else would they have shown us the plane if it couldn't land there?

3. What do you think?

After a little discussion they agree on a plan.

Ok, so we'll have Larry fly straight to Boone's Meadow, pick up the Eagle and then come back to Doc's? There aren't any extra stops so it should be the fastest way to save the Eagle.



4. Is this a reasonable plan? Is there any reason that their plan might not work?

5. Is there something you want to do next or would you rather see what the girls are planning?



I think Larry weighs 180 pounds, plus we need the box for the Eagle.

Yeah, that sounds right. I think they said the payload that the plane could carry was 220 pounds.





So unless it's a really heavy box we should be fine. I guess we should watch that part again just to be sure.

6. What is the safe payload capacity and the weight of the box?

7. How confident are you about your answer?

- a. Positive
- b. Pretty sure
- c. Think it's close
- d. Not sure at all



Do you think that means we have to count the gas in the tanks as part of the payload or maybe it only counts extra fuel that you take along?

Sara considers this for awhile. That seems strange but he did say the payload includes fuel so I think we should count that. What does a full tank of gas weigh?



How should I know? It held 5 gallons, does that help?

8. Do you know what the gas weighs or how they could figure this out?

Well.... I remember learning that water weighs 8 pounds per gallon. What's 5 gallons times 8 pounds per gallon?



They both said "40 pounds" in unison.



Jasmine writes this down and says, "Ok. I have 180 pound Larry, 40 pounds of fuel plus the 10 pound box. That's too much. It comes to 230 pounds!"

9. What are you thinking right now?

Let me think... Gas floats so it must be lighter than water.



Really?

At this point it is 5:00 so Jasmine and Sara pack up for the day.

10. Does the 5 gallons of gas weigh 40 pounds, or is Sara right that it weighs less since it floats?

11. Is the weight of the gas important?

12. After the end of the first day, what are your initial impressions of Sara's and Jasmine's problem solving skills?

13. Do they both seem to know what they are talking about? Do you trust the facts and calculations that they've provided so far?

14. Who would you hire if you had to pick right now? Why?

The second day:



Where were we yesterday when we quit? Let me look at my notes... Ok, it looks like you were thinking that gas is lighter than water. So far it seems like all the information has been in the video, maybe we should start watching it again to see if they tell us the weight of the gas.

I'm sure they didn't say anything about the weight of the fuel. I would have remembered. You can look if you want.



While Jasmine started the video, Sara sat and thought about everything they'd done the day before, trying to recall the weights and payload capacity. Thinking about anything else they might need to calculate or a way they could stop and get more fuel since 5 gallons was too heavy.



Sara, look at this. There's a number on the gas tank. It looks like it says 30 pounds above the 5 gallons!"

Nice. I missed that. That means we're right at 220 pounds, just right!"



Jasmine consults her notebook, writes down the new value for the weight of the fuel and rechecks the calculation.



Let me see... 180 pounds plus 30 pounds plus 10 pounds....Ok, I get 220 pounds also.
So is that it? Are we done?

15. Are they done? Is this a good plan to get the Eagle? If not, why not?

16. How confident are you about your answer?

- a. Positive
- b. Pretty sure
- c. Think it's close
- d. Not sure at all

It can't be that simple. We'd better check to see if 5 gallons is enough gas. What kind of mileage does the plane get?



How should I know the mileage for an ultra light plane?

I remember Emily said something about 1 ½ gallons gone in each tank and Larry said he'd flown somewhere that morning. Do you remember how far?



No. He said he'd gone to Hattonville, or somewhere like that, and back... I think. We need that map on Doc Ramirez's wall!

17. Do you remember how far and how much gas it was?

18. How many miles per gallon can the ultra-light go on a calm day? How did you figure this?

19. How confident are you about your answer?

- a. Positive
- b. Pretty sure
- c. Think it's close
- d. Not sure at all

They watched the appropriate bit of video and found that he'd gone to Headlyville which was 30 miles round trip and it took 2 gallons to make the complete trip. Sara does a quick calculation in her head while Jasmine wrote it all down in her notebook.

So what's that... 15 miles to the gallon? So how far is it to Boone's meadow? I remember Jasper said something about 60 miles but... I think that was to the service station. The vet measured it on the map didn't he?



They watched the video again and saw that the vet did measure the distance to Boone's meadow with his calipers to be about 65 miles. Jasmine writes down the 65 miles and pulls out her calculator.

Hmmm... So 65 miles to Boone's Meadow and 60 miles to Hilda's so it must be 5 miles between Hilda's and Boone's Meadow but we don't need that. Anyway, let's see.... 5 gallons is enough for 75 miles. That gets us to Boone's meadow!



Wait! You're going too fast. Give me a second to work this all out.

20. Now that they've checked the plane's mileage does this confirm that their plan to have Larry fly straight to Boone's Meadow, pick up the Eagle and fly back work? Why?

21. How far does Sara say it is between Boone's Meadow and Hilda's? Do you agree with her?

22. At this point is there anything on your mind that you would like to check or try or are you happy to wait for the girls?

Oh No! You know what we forgot? We have to have enough gas to get back again!

Wait! I think I saw an extra gas can when Larry showed Emily the box. If we fill that up, Larry can get the Eagle, refill the tank from the extra can and fly back.



That sounds alright as long as the gas smell in the cargo box doesn't hurt the Eagle. That would be sad

23. Is there any reason it won't work to take along enough extra gas in the gas can that Larry pulls out of the cargo box?

What about money? They made a point of showing how much money each person had left after supper. How much did they each have? I couldn't really see but it looked like Jasper had the most. Since we need more gas than the one tank, maybe we're supposed to go to the gas station after getting the Eagle and when we get the Eagle we get some more money from Jasper. I bet that's why they showed all that stuff with the guy driving the Mustang. We need to know how much per gallon gas costs at Hilda's. It was cheap. Remember?"



Ahhhh, does this problem never end? Oh, look at the time. We have to go to lunch. Shucks, I really wanted to work on the money thing.

24. Do you think money is a part of the problem that they must consider?

25. This is the end of their 2nd session. If you had to choose now, who would you hire permanently? Why?

You know what? I was thinking about this problem during lunch and just don't think we should worry about the money. The plane is fueled up right now and they didn't ever say that was all the money they each had. Let's just skip this part and worry about the rest.



Do you think they showed us the money and price of gas for no reason?

Maybe they want to rub it in how much gas prices have gone up since the mid 90's.



I guess how to get a lemon Jell-O cone out of a stubborn old waitress doesn't really matter either.

26. Are they overlooking an important detail with the money?



So where were we? Let me see what I have written here.... Ok, I have that we have enough gas to get to Boone's meadow since the plane is fueled up. 5 gallons = 75 miles. The vet measured Boone's meadow to be 65 miles from his clinic. 10 miles to spare but we still have to get the Eagle back to Doc's so we were talking about using the gas can to carry extra fuel. 65 miles to Boone's Meadow and back again is 130 miles.

So how many gallons do we need? How do I do this? Is it 130 miles divided by 75 miles....?

27. What does Jasmine need to do to figure out how many gallons they need to go the 130 miles?

So 4 gallons in the spare container. (Looking up at the ceiling while she does a quick calculation.) The payload with Larry, the box, a full tank plus the extra fuel is 25 or so pounds too much not to mention the eagle...

What about Emily? What did she weigh?



28. What about Emily? Is this a good idea?

- a. No, Larry is supposed to fly the plane.
- b. No, Emily does not know how to fly the plane.
- c. No, it'll be fine using Larry.
- d. I didn't think of this but it just might work.
- e. Yes, I've been waiting for them to figure this out.



Stop it! You're confusing me. I need to work this out on my own. (Takes a few minutes to work everything out and confirm that Sara did her math right) Actually it's not 4 gallons. It's 3.67 gallons. That's still more than the plane can carry because it adds another 22 pounds. Emily huh....? Ok, let's watch the video and see what the scale said she weighs.

The girls start watching parts of the video again. They look closely in the beginning at Emily standing next to Larry.

Look at her here. She's a little heavy set and she's got strong arms and shoulders. She probably came from the dense side of the family too! I'd guess, even though she's pretty short, that she weighs at least 150 pounds, maybe more.



Let's look at the part where Larry weighs himself. I think they showed her weight in that part.

29. Does it look like they'll be able to get what they need from the scale? (What you see in the pictures is as much detail as Sara and Jasmine were able to see on the video.)

30. What do you think Emily's weight is?

31. How did you decide this?

They don't show Emily's weight. There's no way to read the numbers on the scale when the camera is behind her like that. We'll just have to guess.



Can I see? (Jasmine looks again at Larry's weight and spends some time going back and forth between Larry and Emily on the scale.) I think Emily weighs 120 pounds.

How can you see that?



See in the picture of Larry's weight. The needle points almost to where half past 2 o'clock would be. I looked at the picture of Emily and it looks like the needle has to be pointing almost straight up, but not quite. That would be about the 120 pound mark."

No Way! Just look at her!



32. Does Jasmine have a good idea here?

33. What do you think Emily weighs?

34. How did you decide this?

150 pound Emily plus 9 gallons of gas, plus the 10 pound cargo box should be just fine. I think I figured 6 pounds for each gallon. So 9 gallons times 6 pounds per gallon is 54 pounds. Plus the box plus Emily. Emily is 150 pounds. No problem, we have 6 pounds to spare!"





Hold on... I need to get this all down... Ok. Now, what about the Eagle? The vet said how much it weighed - I think?

35. Will this put them over the maximum payload? What should they do?

Uh oh. I didn't think of that. Ummm..... Oh, we'll have used up half of the gas getting there so we'll have room for the Eagle! So Emily's going to fill up the extra gas can with 4 more gallons of gas, fly the plane to Boone's meadow, fill the plane back up with the four gallons from the extra gas container, pick up the Eagle and fly back. Sounds good ?



Sure. That works. Are we done, *yet?*

Yes, I think so.



36. Are they done?

37. How confident are you about your answer?

- a. Positive
- b. Pretty sure
- c. Think it's close
- d. Not sure at all

The instructor comes by and asks if they're finished. They said yes and told her the plan. The instructor asks them if they answered both questions.



It looks like we only answered the first question. The quickest way to get the Eagle to Cumberland City. Now we have to figure out how long that will take. I guess that means we need to know how fast the plane flies.

Well.... in the beginning when Larry talks about how much gas he used to go to Headlyville he said "2 minutes for every mile is my rule of thumb"



38. What is this in miles per hour? How did you figure this?

5 minutes for Emily to get to the flying field.
5 minutes for her to fill the extra gas can with 4 gallons of fuel.
5 minutes to load the plane and take off.
65 miles times 2 minutes per mile gives us 130 minutes to Boone's Meadow.
5 minutes for Jasper to load the Eagle while Emily refuels using the extra gas can.
130 minutes to fly back to the airfield.
5 minutes to the vet's.



So a grand total of 270 minutes. Right?

39. Does this look reasonable?



Let me check.... Yeah, I get the same answer. It seems like a long time. What is that in hours? 270 divided by 60 minutes per hour gives us exactly 5 hours.



Well, it would take six hours for Jasper to hike out and then he'd still have to get to Doc's. So our plan is better than that.

40. Are they set?

41. Now that they are done, would you like to suggest any changes or does this look good to you?

After presenting their plan, Sara and Jasmine see that other teams who've solved this problem in the past have not gotten the same times. One team's rescue took a little longer and there are a couple other teams with times quite a bit faster than theirs. The slowest time was 5 hours and 25 minutes while the fastest time was 3 hours and 55 minutes.

42. How do you think the other teams got different times?

43. Were Sara and Jasmine both good problem solvers? Was one of them better at it than the other? Please rank each of them on a scale from 1 to 5 where 1 is poor and 5 is excellent. Also please fill in the last column ranking how important the skill is for solving this particular problem for anyone. 1 is not useful and 5 is critical for solving the problem.

	Jasmine	Sara	Useful for this problem.
Could pick out important facts and details.			
Remembered useful information			
Math skills			
Figured out what to do next			
Stopped to check on progress every so often			
Made sense of each thing as they progressed			
Was able to bring facts together to understand the big picture.			
Wanted to solve the problem because interested in it.			
Wanted to solve the problem for the job.			
Confidence in problem solving ability			
Worked hard to solve the problem			
Overall problem solving ability			

44. Who's the better problem solver? Who would you hire and why?

45. Were you as the solver interested in the problem of saving the Eagle?

46. Would you like to solve a problem like this one again?

47. Did you enjoy analyzing the two interns?

48. Would you have preferred to solve it on your own?

49. Do you work better on your own or in groups? Why?

50. Did you find yourself looking ahead at what Jasmine and Sara were doing before answering the questions about their conversation?

51. How many ideas or facts did they point out that you had overlooked or not thought of yet?

a. What were the items that they pointed out?

52. Did you think about your own solution as you evaluated the interns?

a. Yes, I couldn't resist

b. Oh, I could resist.

Explain:

53. Did you feel that you personally did a good job solving this problem?

54. Were you in a hurry and/or felt that you could have done a better job solving this problem in a different situation?

55. What parts of problem solving do you consider yourself good at and what parts do you enjoy?

56. Which parts of problem solving do you not like and/or are not as good at?

57. Do you think there's a better solution than what you've come up with?

58. Do you think the author's of the Rescue at Boone's Meadow have a correct solution in mind or is this the type of problem that has more than one correct answer? Is it realistic or did they miss some important ideas?