[00:08:34.07]
[00:08:45.27] Interviewer: So, um, when you would be studying for an exam in high school, and maybe you've started thinking about it for 151 as well,
[00:09:00.04] but, if you would study for an exam, what would you do? Like, what kind of things would you do to prepare for it?
[00:09:23.18] Felix: Well, first thing, I use flash cards a lot. So, I kind of use them for concepts.
[00:09:28.07] Like, maybe one side says, like, "electricty and magnetism", and the other side there's like a bunch of... stuff
[00:09:36.19] like, info about that... and I'd pretty much just go over that.
[00:09:42.00] Or do problems, I guess.
[00:09:45.29] I: Cool. So, like with the electricity and magnetism, what kind of thing would be on the back of that card?
[00:09:50.08] F: I guess um, formulas I have to memorize, uh, right hand rule, um...
[00:10:01.17] I guess that's it.
[00:10:04.02] I: OK, so there might be like a topic and then, uh, a few formulas, like how many formulas would you put on the back of a given card?
[00:10:09.02] F: Uh, 2 or 3 I guess, or 1.
[00:10:15.26] I: OK, OK.
[00:10:26.08] And then, I'm trying to visualize like how that would work out on a test. Like, if I'm trying to think "electromagnetism" and there's like three equations on the back, and
[00:10:32.24] like, I'm going through the test and I come to a question and somehow I know that it's on electromagnetism, it's talking about magnetic field or current or something like that.
[00:10:44.02] Then my mind goes to that card, and, like I remember those three equations, and I pull one of those? Or, walk me through how that helps with
[00:10:50.08] the test.
[00:10:52.01] F: Because, I guess I would write notes on, cause different equations would be useful for different problems, like one on the current of a wire wouldn't be useful on a question about
[00:10:59.25] magnetic flux, so I guess I would put, like some context that each equation would be used.
[00:11:11.24] I: Oh, OK, so it would be like "electromagnetism" and then on the back it would be like context-equation, context-equation kind of thing?
[00:11:17.22] F: Yeah
[00:11:20.17] I: Cool, OK I get it, I get it.

I introduce physics problems

******Oval Track
[00:12:09.05] Interviewer: So the question is, I've got a car, and I'm cruising around this oval-shaped track. I'm going at a constant speed, and feel free to draw it bigger if you want. But the question is, "what direction is the acceleration at these different points?" I think that's all it's asking for... yeah, it's moving clockwise, so it's going in

this direction, and then at each of these points, can you draw an arrow in the direction of the acceleration?
[00:12:35.11] Felix:Well, since it's in a circle, I think of centripetal, or centripege, I don't know which one's which, but I know "center-seeking".
[00:12:41.29] That would be my guess, but it's not a circular surface, it's an oval.
[00:12:49.02] So that's getting me a little bit... But at least, I think, on the turns -- not the straightaways -- like, C would be
[00:12:56.18] a straightaway -- it would be pointing towards the center.
[00:14:03.03] (He draws)
[00:13:11.27] I: And can you also indicate the center that you're drawing the arrows to?
[00:13:18.15] F: I'll just put an X there... and for C, I think, it's moving more in a straight path, so it would be
[00:13:26.05] Maybe it would be no acceleration because it's a constant speed... no, because its moving...
[00:13:33.16] it's changing directions... hmm, it's kind of a straight-away but not really...
[00:13:43.27] D is still that, and E is still that.
[00:13:51.23] I: OK, this is great so far. And you're thinking that for C, like it could be just a straight direction acceleration, because it's kind of straight, but then you're saying it's kind of not straight?
Can you tell me more about what you mean by that?
[00:14:04.11] F: Like It's not completely a straight like, there's still, like, a little curvature. But also, since it that constant speed, if it was straight,
[00:14:11.21] there'd be no acceleration.
[00:14:13.06] Or... that's... Could it... I can't tell if it's changing direction or not... I'm not sure if they count that as straight.
[00:14:22.10] I: I see. Uh, OK, OK, so if it were straight... I think I understand what you're saying. So for example, what about this point
[00:14:34.20] here? What would you say for that?
[00:14:42.13] F: Uh... still towards the center, I guess like E
[00:14:54.09] I: Oh, I see, you're saying it's like E? OK, yeah I guess it is kind of like E isn't it? OK, cool.
[00:14:56.22] But if it would be straight at this point here and then go like that (I draw the blue curve), or something like that, if it were shaped like that, then here, you're saying it would have no acceleration? Or it would have an acceleration this way?
[00:15:14.25] F: Uh... no acceleration, because it's a constant speed and it's not changing direction.
[00:15:24.10] I: OK, cool! Thank you...
********END CLIP****

[00:15:30.21] Interviewer: I have a ball and its mass 1 kg, and its tied to this rope here, and the rope is 3 m, and it's tied to the other end of this pole, and this pole is kind of rigid. And what I'm going to do is spin it around the pole in circular motion

[00:15:51.18] with a speed of 5 m/s, and it makes this angle of 45 degrees. And I want to know the total kinetic energy of this ball. Just think out loud.
[00:16:04.20] It can be like "I don't remember kinetic energy"
[00:16:04.20] F: Wow
[00:16:06.02] I: That's totally fine
[00:16:09.13] F: (Sighs)
[00:16:37.08] F: Is the pole also 3 m long?
[00:16:40.07] I: Uh...
[00:16:42.16] F: Because I was thinking like...
[00:16:45.05] I: No
[00:16:45.05] F: No?
[00:16:45.05] F: Uh...
[00:16:49.08] I: Or... what difference does it make? You were going to say that you were thinking that...
[00:16:49.29] F: That Maybe I would find total energy somewhere along the line, and I'd have subtract potential energy from it. I don't know.
[00:17:00.23] I: Actually, let's go down that road. Let's give that a shot. But before we do that, um, when you first looked at it you said "Wow." What were you thinking at that moment?
[00:17:08.25] F: I don't know, It's just, um, a lot of angles, a lot of sin/cos stuff... I'm not really good at that.
[00:17:19.07] I: Cool, OK, great. So let's say that this is 3 m long. OK, go for it.
[00:17:26.17] F: Then you'd put a triangle there, this would be a right angle, this would be 45, and the pythagorean theorem, I don't know what the angle to angle/ side to side ratio for this is, but
[00:17:44.01] $2a^2 + a^2 = 9$, $2a^2 = 9$, ... $9/2$
[00:18:08.01] So this would be 3 over radical 2 meters. And I'd have to see if that does anything for me.
[00:18:20.22] Then this would be 3 - 3 radical 2, and I don't have a calculator, so I have no idea what that is
[00:18:33.12] That would be its height.
[00:18:38.01] I: OK, OK.
[00:18:40.08] F: So I'd be able to get its potential energy, but I'm not sure that does anything for me.
[00:18:44.12] I: No, this is great - how would you find the potential energy?
[00:18:48.11] F: It's just, um, mgh, right? So, gravity, 1 kg, and the, but... would the...
[00:19:01.22] Nah, it's still 1 kg
[00:19:04.21] Gravity, and that would be height, so I could find the potential energy.
[00:19:09.29] I: Nice, OK. Cool.
[00:19:14.09] F: But I don't think that does anything for me.
[00:19:18.02] I: So, when you hear "kinetic energy", what comes to your mind? So, so far this is excellent, this is great, I just want to encourage you to keep doing it.
[00:19:22.25] F: Um, $1/2\ mv^2$
[00:19:27.13] I: OK
[00:19:27.13] F: So wait, would I just put the mass and the velocity?

[00:19:42.26]Would it just be kinetic energy equals one-half m-v squared, mass 20 kg, velocity 5 m/s... [00:19:52.12] -Does the fact that it's moving in a circle make any difference? -...No? -Okay... Are you sure? -I feel like I'm not, I feel like I'm wrong, because you're asking squestions about it. [00:20:19.06] -I want to be able to know, to what degree are you able to convince yourself that it is right, and I want to know, once you reach an answer, what doubts you still have. -I would say... Kinetic energy would be a scalar quantity. I actually didn't learn about scalars and vectors in AP Physics. I just learned about them now. So, I'm guessing I would be taking the magnitude of the velocity instead of the vector components.

[00:34:12.06] -I'm going with the anvil, because... the monkey has less are to distribute the force. -So, maybe there's the same force, but there's a different area that the force is acting on to increase the tension. [00:35:01.07] Well yeah, because every action has an equal and opposite reaction, so if that force of tension has to be enough to keep the monkey up.... [00:36:26.04] I would say the tension in the rope pulled the monkey up, but it's just one tension in the rope. [00:50:01.00] -At what point would you go to the book? Did you reach a point here where you were like, alright, this is where I'm stuck. This is where I would go to do the book. -I guess when I realized that both of them are on the ground, and I realized there was no tension in the rope to begin with.

[00:51:03.24] I: The rest of the work that you did before that point might not be uncommon for you if you're solving a physics problem?

[00:51:24.16] Going bacck tot his problem, another thing I noticed that you did here, that was really interesting, is you had this equation that you remembered for KE

[00:51:51.27] all that matters is the size, so the direction doesn't matter...

[00:52:03.22] is that kind of approach something that you usually do?

[00:52:20.29] Before you had learned about that, if I had asked you if going around a circle makes a difference...

[00:52:41.28] Interviewer: You were saying that a strategy that you have for preparing for exams is, you use flash cards, and you'd have equations on the back
[00:52:50.09] Felix: Yeah
[00:52:52.00] I: Looking at these three problems, is there anything in here that kind of represents that sort of thing? Like were there any equations that you used or anything that might have been on the back of a flashcard?
[00:53:04.14] Felix: Um, I guess rules for centripetal motion, uh...
[00:53:12.07] I: What would this flash card have looked like?

[00:53:15.26] F: Like, maybe like, a circle diagram with where the force is pointing, the velocity is pointing, and the acceleration is pointing, and the centripetal force equation, the centripetal acceleration equation,
[00:53:26.04] stuff like that.
[00:53:29.00] I: Cool, OK. Awesome.
[00:53:35.02] Interviewer: And either of these other two?
[00:53:43.00] Felix: I guess I would talk about, like, energy - kinetic energy, potential energy... uh...
[00:53:56.08] I: And maybe have the equations?
[00:53:56.08] F: Yeah
[00:53:56.08] I: OK
[00:54:01.19] I: And what about for this guy? And the answer can certainly be "no". You know, I mean, I'm just...
[00:54:09.23] F: OK. Might have something about tension... I don't know.
[00:54:20.10] I: OK, sure, so you might have something on "tension is equal throughout a rope" or something like that?
[00:54:23.05] F: Yeah.
[00:54:25.11] I: Or, like, evenly distributed throughout a rope?
[00:54:26.24] F: If that's true, yes
[00:54:29.28] I: And if there's the equation for the length and the tension, that might be on there as well?
[00:54:32.24] F: Yeah
[00:54:35.29] I: Great. Awesome. Very cool.

[00:51:40.01]

[00:55:03.01] Photographic memory?
[00:55:42.28] F: You need to know what happens in the real world and connect the equation to it

[00:57:48.17] -How do you know when you got it? -I don't think I can know. I guess, when I can get the questions right? -So like, when you use the equations? -Yeah. -I mean, do you ever, like, see a new equation for the first time and are sort of like, "Woah, that's weird", whereas some of the equations are like, yeah I know that. Is the difference... -I know, like, what real-world equation is gotten from. Like, I know what kind of problems to use the equations to solve. [01:00:06.20]The velocity depends on your acceleration times your time. So, I guess you know acceleration is velocity over time. If you move the t over to the other side, then you have velocity equals acceleration times time. But, if you're already moving, or you're moving at a constant velocity, you need to like, add in your original velocity plus the acceleration.

[01:06:20.27] Debriefing
[01:06:31.14] He said what he says he does: use pre-memorized facts about centripetal motion, for example, not thinking why it points towards the center, though I could have asked him that...
[01:06:58.05] and then with the other one, the equation 1/2 mv^2

[01:07:01.23] At the same time, he did some other cool sense-making things, he approached the monkey problem in many different ways, and when asked to explain [01:07:16.15] it to a kid, he had a physical significance for the at term
[01:07:34.27] But he did want an equation to relate the length of the rope to the tension