--------------------------------APPLYING THE FIRST LAW--------------------------------

[00:21:11.24] (ACTIVITY)(Students begin section II, reading quietly to themselves.)
Student 4: On the gas by the piston is positive.

[00:21:21.18] (ACTIVITY) (More quiet reading.)

[00:22:03.01] Student 1: [reading] Does the internal energy of the gas in an insulated cylinder increase, decrease, or remain the same when the piston is pushed inward?

[00:22:10.29] Student 1: Increase, because work on the system is positive.
[00:22:19.20] Student 1: [reading] Does the temperature of the gas change? Yes, increases, because its proportional to the internal energy, which increases.

[00:22:27.17] Student 4: Yeah, that's exactly what I have.

---------------- ANALYZING THE STUDENT DIALOG: STUDENT 1 ----------------

[00:22:34.11] (ACTIVITY)Students read the student dialog quietly.

[00:22:51.19] Student 4: 'Cause for adiabatic processes, don't pressure, volume, temperature all change? So you can have pressure and volume change, without… I mean, that could potentially be true, it's not necessarily true.

[00:23:07.20] Student 2: Well, I mean, that only is the same if they decrease or increase by the same amount. Like, pressure could really drop and volume [inaudible]

[00:23:17.03] Student 1: If it's adiabatic, which we're supposed to assume it is, right? [Looking at instructor 2 offscreen.]

[00:23:24.05] Instructor 2: Well, they don't actually explicitly say anything about adiabatic processes.

[00:23:28.22] Student 1: Ok, but thermally insulated, right?

[00:23:30.00] Instructor 2: Thermally insulated, that just means there's no heat exchange between it and the outside world. It's a system that's isolated.

[00:23:37.20] Student 4: So, the volume could decrease, the temperature could decrease, the pressure could increase. And it would still… maintain the ideal gas law. [inaudible]

[00:23:50.24] Student 1: Oh, wait…

[00:23:52.16] Student 2: Yeah, since they could decrease or increase by different amounts, T can change.

[00:23:56.26] Student 1: Pressure-volume graphs always give you something proportional to temperature, right? So if they don't change… No.

[00:24:06.04] Student 2: They don't have to change, like, along a straight line. It could be a curvy line, in which case temperature is also changing.

[00:24:22.00] Student 4: [to instructor 2] but this is an adiabatic process, right?

[00:24:25.02] Instructor 2: They don't explicitly state that. Just take into account…

[00:24:30.28] Student 4: I'm just trying to see if I understand the other course material.

[00:24:34.12] Instructor 2: OK

[00:24:35.13] Student 4: Adiabatic is, pressure, volume, and temperature can all change?

[00:24:39.27] Student 3: Yeah.

[00:24:44.15] Student 1: Ok, so what's the flaw in student 1's reasoning?

[00:24:48.15] Student 4: T can change and offset the pressure-volume change. In such a way that the pressure-volume change isn't linear. Or isn't proportional.

[00:25:09.01] Student 1: Volume decreases, pressure increases, therefore temperature doesn't change. So I'm just going to say, pressure and volume don't necessarily change by the same factor.

[00:25:19.03] Student 4: Right.

[00:25:19.14] Student 2: Not by the same ratio…

[00:25:21.09] Student 4: Yeah, they're not always inversely proportional, because temperature could change.

---------------- ANALYZING THE STUDENT DIALOG: STUDENT 2 ----------------

[00:25:32.23] Student 1: [reading the "student 2" dialog] "But I know the temperature goes up. The volume is less, and therefore the particles collide with one another more often."

[00:25:44.02] Student 1: Ok, the second sentence is flawed, because…

[00:25:46.25] Student 4:

[00:25:47.00] Student 4: They don't interact. Right? Ideal gas, the particles don't interact?

[00:25:51.06] Student 1: Ok, that's one answer, and another could be that, um, ok, ideal… no interaction… and another could be that…

[00:26:01.09] Student 3: [to instructor 1] Is the volume being less, is that an inference from the first statement?

[00:26:10.18] Student 4: [reading] The volume is less…

[00:26:11.02] Student 3: Or are they just saying [inaudible]

[00:26:13.19] Instructor 1: Well if you look at the process that's described, of the piston being pushed inward,

[00:26:19.25] Student 3: Ah!

[00:26:20.07] Instructor 1: Is there any question in your mind as to how the volume has changed.

[00:26:23.15] Student 3: No, OK.

[00:26:23.26] Student 1: Gotcha.

[00:26:28.29] Instructor 1: So I think their assertion that the volume is less is completely fair, but, the question is…

[00:26:35.08] Student 4: Do we know that the temperature goes up? If the pressure doesn't increase as much as the volume decreases… no, if the pressure increases more than the volume decreases, then yeah, the temperature would go up, but I don't think that we necessarily know that temperature goes up.

[00:27:06.05] Student 4: Like, couldn't it be that the volume decreases by a factor of two, the pressure increases by a factor of one and a half, so then the temperature would have to go down?

[00:27:17.13] Student 3: Are you talking about student 1 or student 2?

[00:27:18.22] Student 4: Student 2. It says, "But I know the temperature goes up." And I'm saying, "well, maybe not."

[00:27:27.04] Instructor 1: [to the rest of the group] What do you guys think? Do you know the temperature goes up, or not?

[00:27:30.16] Student 2: I think we do.

[00:27:31.09] Student 1: Yeah.

[00:27:31.24] Student 2: We've determined that temperature goes up. [laughs]

[00:27:35.01] Student 3: Because, we can say that Q…

[00:27:39.20] Student 1: Work. Because it's thermally isolated.

[00:27:42.06] Instructor 1: Thermally insulated.
Student 3: Oh, that's true.

[00:27:43.03] Student 1: There's work on the system…

[00:27:44.05] Student 3: Work is positive, right, and if work is positive, then, internal energy increases, and then temperature must increase.

[00:27:52.02] Student 4: Yeah. OK.

[00:27:54.24] Student 1: Right. So we know the temperature goes up, and the volume is less. Um…

[00:27:59.20] Student 4: Then I guess it's just um, we're assuming… they would, though. They would collide more often.

[00:28:06.26] Instructor 1: So what are the assumptions on which the ideal gas law is based?

[00:28:09.13] Student 4: That's what I put initially! That they don't interact, but I thought that was kind of a technicality to get out on.