Free-Response Question

Background: Deflate-Gate is an excellent lesson in why jumping to conclusions is a bad idea and appreciating thermodynamics' relevance to a practical problem.

Physicist Neil deGrasse Tyson did not change gauge pressure to absolute pressure. Bill Nye, a mechanical engineer, who calls himself the science guy, did not give convincing arguments and took off 15% from the gauge pressure for his calculations. Others did not change temperature to absolute temperature. Variables like water vapor pressure and compressed air temperature (compressed air is hot) to inflate balls were not considered. The time interval between when balls were inflated to when balls were taken to the field was not accounted for.

I am also giving this problem with incomplete data so that you develop skills for formulating a problem. See this TED video on Math Needs a Makeover.

Questions:

1. Assume the NFL football was inflated in a room at 80°F, left in the room for a while, and brought to field at 40°F, and left there for a while. The ideal gas law is given by $pv = RT$ where p is the pressure, v is the specific volume, R is the universal gas constant, and T is the absolute temperature.

(A) What variable values would you seek from the professor? Ask the professor in the chatbox. You should seek the least number of variable values from him.
(B) What is the decrease in pressure in psi?

2. The above problem does not fall under any of the mathematical processes we talk about in the class unless one wants to use van der Waals equation. The ideal gas law equation is only accurate for a limited range of pressure and temperature. Johannes Diderik van der Waals came up with an empirical equation that was accurate for larger ranges of pressure and temperature given by

$$\left(p + \frac{a}{v^2}\right)(v - b) = RT$$

(A) What variable values would you seek from the professor?
(B) Only outline the problem. What mathematical process does the mathematical model fall under. What would be your approach in finding the decrease in pressure in psi?

P.S. When you have time, watch a 2021 documentary, "Four Games in Fall", where the story is debunked.

Source of Photo: http://bostinno.streetwise.co/2015/01/23/nfl-deflate-gate-statement-full-text-of-nfls-statement-on-deflategate-investigation/)