Additional Problem III for Physics 102 (from an old exam)

One hot afternoon, the temperature outside is 98° F. Returning home, you find to your dismay that the temperature inside is the same as outside. The pressure in both places is also initially the same, $P_0 = 1.01 \times 10^5$ Pa.

You quickly turn on the air conditioning, and in a short time, the temperature inside your house drops to 70° F.

a) Convert these two temperatures, 98° F and 70° F, ...

(i) ... to degrees Celsius.

(ii) ... to kelvins.

b) Suppose that the air inside your house maintains the same volume as its temperature changes, and that the number of moles of air remains constant. Using the ideal gas law, calculate the pressure of the air inside the house when the temperature has reached 70° F.

c) Meanwhile, the air outside has remained at its original temperature and pressure. Estimate the surface area of the inside of your front door. What is the net force on this door due to the air pressure inside and out? (Find both the magnitude and direction of the force.)

d) Convert this force from newtons to pounds (1 newton = 0.2248 pounds). Do you think you could lift such a weight?

e) Assume the door swings outward; what would happen if you tried to push it open? This result should not agree with your everyday experience in opening doors! Where did this calculation go wrong? What invalid assumption(s) did we make?