Head in the clouds

Air pressure decreases as we move above sea level. Oxygen makes up about 21% of earth's atmosphere whether we're up high or at the seaside, but because molecules are packed less densely at higher altitudes, we get less oxygen in each breath. The function $P(h)$ (pressure at a given altitude h) is *not* linear, but at low altitudes we can use a linear approximation.

1. At the beach in San Francisco (0 meters) the pressure of the atmosphere is 101.325 kPa (kilopascals) and in Denver, 1609.344 meters above sea level, the pressure of the atmosphere is about 83.437 kPa. Using this data, find a *linear* equation for pressure P in terms of altitude h. (Hint: write the pressure and altitude in each location as a point (h, P). Then use point-slope form to find the equation of the line.)

2. What is the *rate of change* of the pressure of the atmosphere as altitude increases in meters? Write a sentence answering this question using the phrase "rate of change."

3. Mount Everest is 8848 meters high. What does your linear approximation predict for the pressure of the atmosphere on Mount Everest?

4. Compared to San Francisco, how much oxygen is available in a breath of air in Denver? Since 21% of the molecules in the air are oxygen molecules in either situation, we can just compute the ratio $\frac{P(\text{Denver})}{P(\text{SF})}$.

5. Using the same technique as question 3, express as a percentage how much oxygen is available in a breath on Mount Everest as compared to San Francisco.

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6. Let's do a very basic check of whether our linear model is good. What would it mean for the pressure of the atmosphere $P(h)$ at an altitude h to equal zero? Discuss this with your peers or professor.

7. Does our model indicate that $P(h)$ will equal zero at some altitude? If so, $P(h) = 0$ at what altitude?

8. The air pressure at the peak of Mount Everest is actually closer to 31.5 kPa. Draw some conclusions about the validity of our model.