Head in the clouds: (rates of) rates of change

Air pressure decreases as we move above sea level. If we assume that temperature decreases linearly with altitude, the function $P(h)$ (pressure in kilopascals at altitude h meters) is given by

$$P(h) = \frac{1}{10}\left(\frac{44331.514 - h}{11880.516}\right)^{1/0.1902632}.$$

We know air pressure decreases as altitude increases, but does it decrease *more or less quickly* as altitude increases?

1. Fill in the following table using the altitudes given and then in the second table fill in the *average rate of change between each pair of consecutive cities* – ask if this doesn't make sense:

city	San Francisco CA, U.S.	New York NY, U.S.	Minneapolis MN, U.S.	Antananarivo Madagascar	Lake Titicaca Peru	Wenquan China
elevation (m)	11	125	264	1275	3860	5019
pressure (kPa)						

	SF to NY	NY to MSP	MSP to Ant.	Ant. to Lake T.	Lake T. to Wenquan
$\frac{\Delta kPa}{\Delta \text{m}}$					

2. As altitude increases, do these average rates of change increase or decrease?

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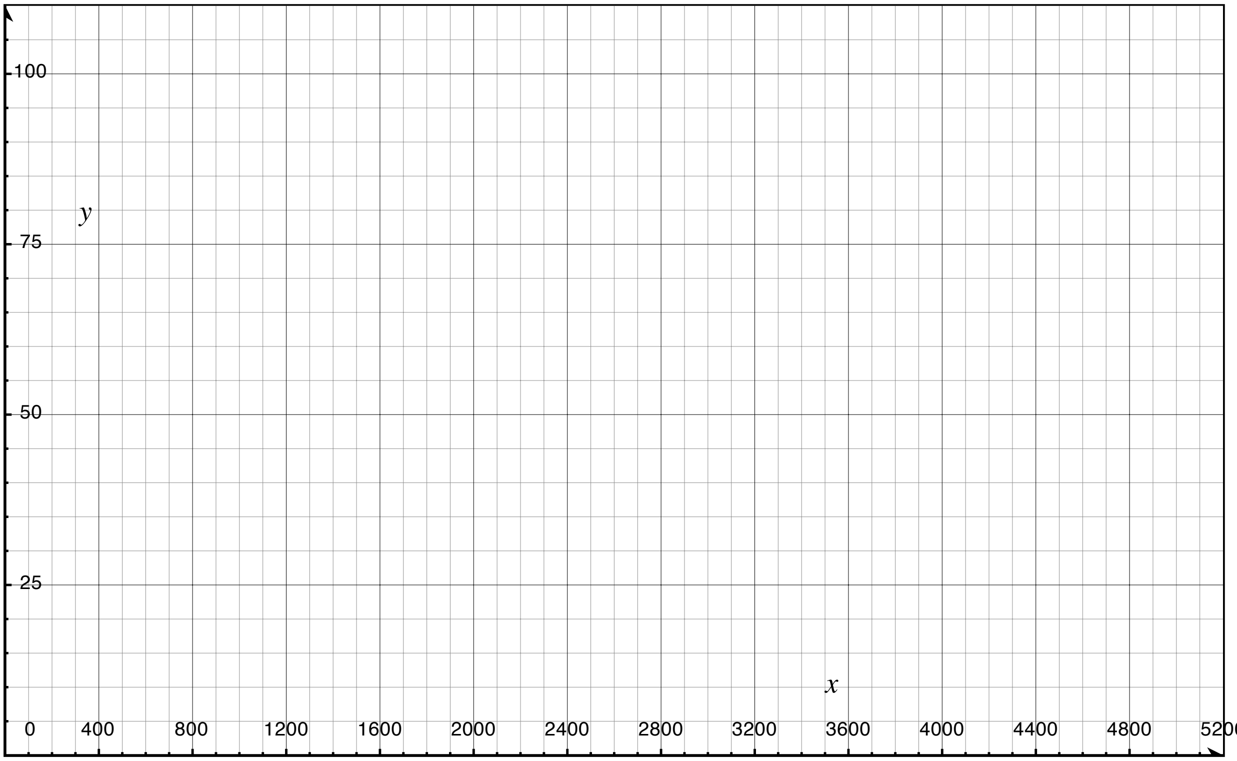
3. Use your table above to graph the pressure against altitude, and then graph the *secant lines* corresponding to the average rates of change you computed above.



4. What does this mean for the shape of the pressure curve? In particular, is the curve concave up or concave down?

5. What does this mean for the amount of oxygen you'll get in each breath as you climb Mount Everest? Will the climb get more or less difficult as you proceed, and is oxygen availability the only factor?

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