Given:

Before going on a long trip you should measure your tire pressure. Before you drive off you measure the (gauge) pressure in your tires and find it to be 210 kPa. The temperature of the air both outside and inside your tire is 25°C. After traveling for a few hours, you measure the tire pressure and get a reading of 220 kPa.

$P_1 := 210\ \text{kPa} \quad T_1 := 25\ °\text{C} = 298.15\ \text{K} \quad P_2 := 220\ \text{kPa}$

Required:

Assuming the tire volume does not change, what is the new temperature? Does this make sense?

Solution:

It is always good practice when dealing with gauge pressure and the Ideal Gas Law to go ahead and express all your pressures in absolute terms. Thus

$$P_1 := P_1 + 101.325\ \text{kPa} = 311.325\ \text{kPa}$$

$$P_2 := P_2 + 101.325\ \text{kPa} = 321.325\ \text{kPa}$$

It should also be noted that the Ideal Gas Law expects the temperature values to be in absolute terms. The absolute temperature values are not explicitly calculated here because Smath Solver does it for us. However, if this problem were to be worked by hand the temperature values would need to be in Kelvin.

Now beginning with the Ideal Gas Law

$$P \cdot V = m \cdot R \cdot T$$

Rearranging to solve for the ratio of temperature to pressure shows

$$\frac{T}{P} = \frac{V}{m \cdot R}$$

It is stated that the volume is assumed to remain constant throughout the process. It will also be assumed that the mass inside the tire remains constant (or else you would have a flat tire). Thus the right hand side may be seen as a constant throughout the process. Thus

$\frac{V}{m \cdot R} = C$ and $\frac{T_1}{P_1} = \frac{T_2}{P_2}$

Solving for T_2 may then be found by

$$\boxed{T_2 := T_1 \cdot \frac{P_2}{P_1} = 34.6\ °\text{C}}$$

This temperature is higher than the initial temperature. This is reasonable as one would expect the tire to heat up after use for a few hours.