How Much Does the Earth's Speed Change?

First, what do we mean by "how much does the Earth's speed change?

What would we mean by "how much has the Tesla price increases?"

The article says $1,000 and that the Model Y now costs $43,700. So the old price was $42,700.

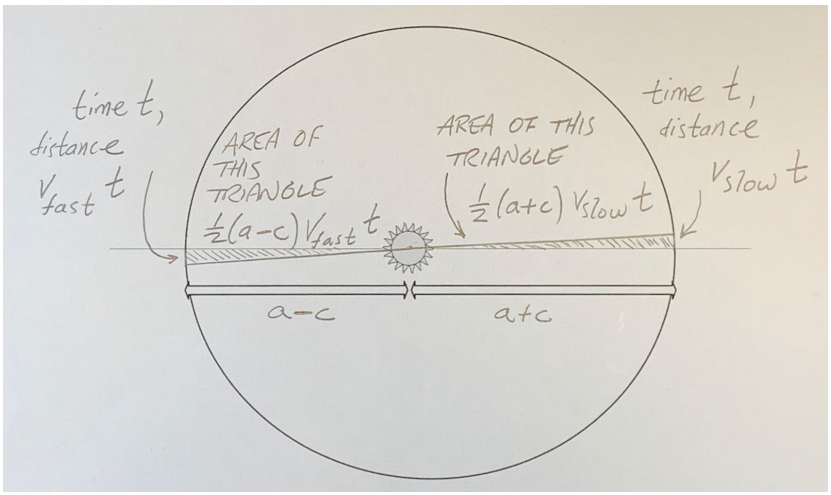
Everyone agrees that the percentage increase is: $\frac{\$43{,}700 - \$42{,}700}{\$42{,}700} = 0.023 = 2.3\,\%$?

As long as you understand that for the Tesla price, you'll understand that for Earth, we want to do the same thing:

$$\frac{v_{fast} - v_{slow}}{v_{slow}}$$

where v_{fast} is how fast the Earth is going when it is closest to the Sun and v_{slow} is how fast the Earth is going when it is farthest from the Sun. That is how we'll get our percentage change.

Next we need a drawing of what is going on:



Now set the area of the two triangles equal (Kepler's equal areas in equal times Law!):

$$\frac{1}{2}(a-c)\,v_{\text{fast}}\,t = \frac{1}{2}(a+c)\,v_{\text{slow}}\,t$$

Cancel the $\frac{1}{2}$ and the t. Solve for v_{fast}.

$$v_{\text{fast}} = \frac{a+c}{a-c}\,v_{\text{slow}}$$

Put that in the percentage change formula:

$$\frac{v_{\text{fast}}-v_{\text{slow}}}{v_{\text{slow}}} = \frac{\frac{a+c}{a-c}\,v_{\text{slow}}-v_{\text{slow}}}{v_{\text{slow}}} = \frac{a+c}{a-c} - 1 = \frac{a+c-(a-c)}{a-c} = \frac{2\,c}{a-c}$$

That's as far as I got in class. Now put $c = a\,e$, where e is the "eccentricity."

$$\frac{v_{\text{fast}}-v_{\text{slow}}}{v_{\text{slow}}} = \frac{2\,c}{a-c} = 2\,\frac{a\,e}{a-a\,e} = 2\,\frac{e}{1-e}$$

Now just plug in $e_{\text{Earth}} = 0.0167$ and get

$$\frac{v_{\text{fast}}-v_{\text{slow}}}{v_{\text{slow}}} = 0.034 = 3.4\,\%$$

I Googled to double-check my answer. The top website said $v_{\text{fast}} = 30\,300$ m/s and $v_{\text{slow}} = 29\,300$ m/s.

$\frac{30\,300-29\,300}{29\,300} = 0.034 = 3.4\,\%$. Voila.