Formatting answers

I have received questions about formatting answers for WA and related matters. I will address this with an example. I will look at the third WA assignment, which covers section 6.4.

Problem 6 involves the work done in lifting a rocket into the air from the surface of the Earth. You are given the relevant formula for the Force: $F = -\frac{GMm}{r^2}$, where r is the distance from the center of the Earth to the rocket. The radius of the Earth is taken to be $R = 4000$ (in miles), and this formula is valid for $r \geq R$. We are to find the work done when the rocket is lifted from the surface of the Earth to a certain height, let's say 1700 miles, above the Earth. The minus sign in the formula for F is there because this is the force gravity applies to the rocket to push it in the direction of decreasing r. To push the rocket upward we must counter that force with a force of the same magnitude.

The upshot of all of this is that we must calculate $\int_{4000}^{5700} \frac{1}{r^2}\,dr$. That is, we integrate from the surface of the Earth, where $r = 4000$, to 1700 miles above the Earth, where $r = 4000 + 1700 = 5700$. The integration is easy:

$$\int_{4000}^{5700} \frac{1}{r^2}\,dr = \left(-\frac{1}{r}\right)\Big|_{4000}^{5700} = \frac{1}{4000} - \frac{1}{5700}$$

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Now what? In fact, and I just tried this, WA accepts the answer $\frac{1}{4000} - \frac{1}{5700}$ in exactly that form. Or (preferably in my opinion) you can simplify this by putting the two fractions over a common denominator to get : $\frac{17}{228000}$.

Or, you can convert to decimals. Five significant digits should be enough unless the problem specifically asks for more. This works but be careful when you round off. Errors often creep in when rounding off.

Possibly the easiest part of this is the integration. On exams, I will try to keep the calculations after the integration simple.

Often, in practice, we do the following: We calculate the work done in lifting the rocket, from the surface to some height h miles above the surface, of a planet of radius R.

The answer, obtained in the same manner, is $(\frac{1}{R} - \frac{1}{R+h})GMm$. When $R = 4000$ and $h = 1700$ we get the answer for the particular case above.

Side note: My preference is to replace GMm with w, the weight of the rocket at the surface of the Earth, but that's a detail.