A word on how to write a check of a D.E. solution:

Suppose we have the D.E. $xy' - 3y = -x^2$ and we wish to check if $y = x^2$ is a solution.

Here's an UNdesirable way to write this up:

$$\begin{aligned} xy' - 3y &= -x^2, \text{ so since } y = x^2, \\ x(2x) - 3\left(x^2\right) &= -x^2, \\ 2x^2 - 3x^2 &= -x^2, \\ -x^2 &= -x^2, \text{ and yes, we have a solution.} \end{aligned}$$

WHY is this undesirable? Because in this work, we start by assuming that we have a solution. That is, we write down immediately that $xy' - 3y$ really is equal to $-x^2$, which is the very thing we want to check. In this work, we concluded by saying, *apparently*, that since the algebra didn't blow up in our faces, that everything must have been fine.

If you think that's a good way to prove equations, you'll love this:

$$\begin{aligned} \text{I want to prove that } -3 &= 3. \\ \text{well, suppose that } -3 &= 3, \\ \text{so } (-3)^2 &= 3^2, \\ 9 &= 9, \\ \text{and that's OK, so it must be that } -3 &= 3. \end{aligned}$$

Here's a DESIRABLE way to write up the original problem:

Suppose $y = x^2$,

[Note: This is what we want to assume;
what we don't know is whether $xy' - 3y = -x^2$]

$$\begin{aligned} & \text{So } xy' - 3y \\ = \; & x(2x) - 3\left(x^2\right) \\ = \; & 2x^2 - 3x^2 \\ = \; & -x^2, \text{ and therefore we have shown that} \\ \text{If } y \; = \; & x^2, \text{ then indeed } xy' - 3y = -x^2. \end{aligned}$$

The actual work done is no greater (actually less), and it's logically correct.

Finally, note that it's tacky to write question marks over your equal signs (like this: $\stackrel{?}{=}$), at least it's tacky if you aren't in high school, and anyway this notation still leaves us liable to the errors above.