Project 1 -- Pretty Printing of Polynomials

In the simple polynomial package we have used a "dense" representation of polynomials as an array of coefficients. For convenience we also store the degree. So the polynomial \( f = 3x^2 + 2x + 1 \) is stored as

\[
\begin{array}{|c|}
\hline
\text{deg} & a_0 & a_1 & a_2 \\
\hline
2 & 1 & 2 & 3 & 0 & \ldots & 0 \\
\hline
\end{array}
\]

Our output word \( P \) just prints the coefficients (starting from the highest). So \( f \ P \) will produce \( 3 \ 2 \ 1 \)

This project is to produce a "pretty print" word \( PP \) which will put in powers of \( x \) and have other fancy features we use when printing polynomials. \( f \ PP \) should give \( 3x^2 + 2x + 1 \)

The problem is not as simple as it might first appear, because there are rules which we implicitly use about what to do with signs, zero coefficients, coefficients of +1 or –1, etc. Let’s call a “term” the combination of coefficient and \( x^e \) exponent. The “degree” of a term is the associated exponent. The “sign” of a term is + if the coefficient is positive or zero and – if the coefficient is negative.

1. There is only one term of any degree.
2. Terms are written in decreasing order of degree
3. If the coefficient is zero, the term is not printed unless all coefficients are 0 (in which case print 0)
4. We print \( x^e \) if the exponent, \( e \), is > 1
   we print \( x \) if the exponent is 1
   we do not print \( x \) (or a power) if the exponent is 0.
5. The first term (leading term) is printed

To formulate further rules, consider the following examples:

\[
\begin{array}{|l|}
\hline
2x^3 + 3x - 1 & 6. The sign of each middle or end term is printed in front of it surrounded by spaces. \\
\hline
-2x^3 - 3x - 1 & 7. The sign of the first term is only printed if it is negative. It is not surrounded by spaces \\
x^3 + x - 1 & 8. The coefficients of starting or middle terms are not printed if they are 1 or –1. \\
\hline
\end{array}
\]

\( f \) is the polynomial \( 1 \ 2 \ 1 \ 0 \ 5 \ -1 \) and here are some attempts which do not work. You can see that they don't look right (except \( pp9 \)). Which rules are violated?

\[
\begin{array}{l}
f \ pp1 \ 1 \ x^5 \ -2 \ x^4 \ 1 \ x^3 \ 0 \ x^2 \ 5 \ x^1 \ -1 \ x^0 \\
f \ pp2 \ 1 \ x^5 \ -2 \ x^4 \ 1 \ x^3 \ 5 \ x^1 \ -1 \ x^0 \\
f \ pp3 \ 1x^5 \ -2x^4 \ 1x^3 \ 5x^1 \ -1x^0 \\
f \ pp4 \ +1x^5 \ +-2x^4 \ +1x^3 \ +5x^1 \ +-1x^0 \\
f \ pp5 \ +1x^5 \ +-2x^4 \ +1x^3 \ +5x \ +-1 \\
f \ pp6 \ +1x^5 \ -2x^4 \ +1x^3 \ +5x \ -1 \\
f \ pp7 \ +x^5 \ -2x^4 \ +x^3 \ +5x \ - \\
f \ pp8 \ +x^5 \ -2x^4 \ +x^3 \ +5x \ -1 \\
f \ pp9 \ x^5 \ -2x^4 \ +x^3 \ +5x \ -1 \\
\end{array}
\]