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In[259]:= Clear[Tryd];
Tryd[t_, a_: 1, b_: 0] := Tryd[t, x_: 0, y_: 0] = (Tryd[t, s1_: 1, s0_: 0] = (b - s0) / (s1 - a);
Module[{u = (t + 1) * 3 / 2, n}, n = Floor[u]; u = 2 * (u - n) - 1;
FullSimplify[
Switch[n, 0, -I * w / 2 * Tryd[u, Expand[-I * a * w / 2], Expand[b + a * w / 2 - a * I]] + w / 2 - I
, 1, (I * w + 1) * Tryd[u, Expand[a * (I * w + 1)], b], 2,
-I * w / 2 * Tryd[u, Expand[-I * a * w / 2], Expand[b - a * w / 2 + a * I]] - w / 2 + I, 3, I]]]
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In[263]:= Table[Z[t] == Tryd[t], {t, {1 / 3, 1 / 2, 2 / 3, 1 / 5, 2 / 5, 3 / 5, 1 / 7, 3 / 7,
1 / 9, 5 / 9, 1 / 11, 3 / 11, 3 / 13, 1 / 15, 2 / 15, 1 / 18, 1 / 27, 27 / 40, 27 / 41}}]
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$$\text{Out[263]} = \left\{ Z\left(\frac{1}{3}\right) = -w + i, Z\left(\frac{1}{2}\right) = -\frac{4}{w + 2i} - i, Z\left(\frac{2}{3}\right) = -\frac{w}{2} + i, Z\left(\frac{1}{5}\right) = -\frac{2}{w + i} - i, Z\left(\frac{2}{5}\right) = \frac{i(w - 2i)^2}{w^2 - 4}, \right. \\ Z\left(\frac{3}{5}\right) = -\frac{1}{w + i}, Z\left(\frac{1}{7}\right) = \frac{4w}{-2 + w(w + i)} + i, Z\left(\frac{3}{7}\right) = \frac{w - 2i}{-2 + w(w + i)}, Z\left(\frac{1}{9}\right) = -i(w - i)^2, \\ Z\left(\frac{5}{9}\right) = -\frac{iw^2}{2} - w + i, Z\left(\frac{1}{11}\right) = -\frac{4(w^3 + w - 2i)}{4 + w(w^3 - w - 2i)} - i, Z\left(\frac{3}{11}\right) = -\frac{(w - i)(4 + w(w - 2i))}{4 + w(w^3 - w - 2i)}, \\ Z\left(\frac{3}{13}\right) = \frac{w - i}{w^2 - 1}, Z\left(\frac{1}{15}\right) = \frac{(w - i)^2}{w + i}, Z\left(\frac{2}{15}\right) = -\frac{(w - i)(w - 2i)^2}{w^2 - 4}, Z\left(\frac{1}{18}\right) = \frac{(2 + iw)(w - i)^2}{w + 2i}, \\ \left. Z\left(\frac{1}{27}\right) = (w - i)^3, Z\left(\frac{27}{40}\right) = \frac{-w + 2i}{2 + w(w - i)^3}, Z\left(\frac{27}{41}\right) = \frac{1}{w(-1 + w(w - i)) - i} \right\}$$

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In[264]:= Series[Differences[Tryd /@ {27 / 41, 2 / 3, 27 / 40}, 2][[1]], {w, I, 7}]
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$$\text{Out[264]} = -\frac{1}{4} i (w - i)^6 - \frac{1}{4} (w - i)^7 + O((w - i)^8)$$