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In[1]:= f[x_] := x - E^(-x)
Out[1]:= f[0]
Out[2]:= -1
In[3]:= f[1]
Out[3]:=  $1 - \frac{1}{e}$ 
In[4]:= N[%]
Out[4]:= 0.632121
In[5]:= Table[{k, N[-(1/2)^(k+1)(1-0)+10^(-6)]}, {k, 1, 20}]
Out[5]:= {{1, -0.249999}, {2, -0.124999}, {3, -0.062499}, {4, -0.031249},
{5, -0.015624}, {6, -0.0078115}, {7, -0.00390525}, {8, -0.00195213},
{9, -0.000975563}, {10, -0.000487281}, {11, -0.000243141}, {12, -0.00012107},
{13, -0.0000600352}, {14, -0.0000295176}, {15, -0.0000142588}, {16, -6.62939 × 10-6},
{17, -2.8147 × 10-6}, {18, -9.07349 × 10-7}, {19, 4.63257 × 10-8}, {20, 5.23163 × 10-7}}
In[6]:= N[6 Log[10] / Log[2] - 1]
Out[6]:= 18.9316
In[7]:= a = 0; b = 1; For[k = 0, k ≤ 19, k++, {x = (a + b) / 2,
Print[N[{k, a, b, x, f[x], Abs[b - a] / 2}, 10]], If[f[x] == 0, k = 20, If[f[x] > 0, b = x, a = x]]}]
{0, 0, 1.000000000, 0.500000000, -0.1065306597, 0.5000000000}
{1.000000000, 0.500000000, 1.000000000, 0.750000000, 0.2776334473, 0.2500000000}
{2.000000000, 0.500000000, 0.750000000, 0.625000000, 0.08973857148, 0.1250000000}
{3.000000000, 0.500000000, 0.625000000, 0.562500000, -0.007282824731, 0.06250000000}
{4.000000000, 0.562500000, 0.625000000, 0.593750000, 0.04149754984, 0.03125000000}
{5.000000000, 0.562500000, 0.593750000, 0.578125000, 0.01717583919, 0.01562500000}
{6.000000000, 0.562500000, 0.578125000, 0.570312500, 0.004963760389, 0.007812500000}
{7.000000000, 0.562500000, 0.570312500, 0.566406250, -0.001155202015, 0.003906250000}
{8.000000000, 0.566406250, 0.570312500, 0.568359375, 0.001905359613, 0.001953125000}
{9.000000000, 0.566406250, 0.568359375, 0.5673828125, 0.0003753491691, 0.0009765625000}
{10.00000000, 0.566406250, 0.5673828125, 0.5668945313, -0.0003898587974, 0.0004882812500}
{11.00000000, 0.5668945313, 0.5673828125, 0.5671386719, -7.237911847 × 10-6, 0.0002441406250}
{12.00000000, 0.5671386719, 0.5673828125, 0.5672607422, 0.0001840598537, 0.0001220703125}
{13.00000000, 0.5671386719, 0.5672607422, 0.5671997070, 0.00008841202725, 0.00006103515625}
{14.00000000, 0.5671386719, 0.5671997070, 0.5671691895, 0.00004058732179, 0.00003051757813}
{15.00000000, 0.5671386719, 0.5671691895, 0.5671539307, 0.00001667477100, 0.00001525878906}
{16.00000000, 0.5671386719, 0.5671539307, 0.5671463013, 4.718446081 × 10-6, 7.629394531 × 10-6}
{17.00000000, 0.5671386719, 0.5671463013, 0.5671424866, -1.259728757 × 10-6, 3.814697266 × 10-6}
{18.00000000, 0.5671424866, 0.5671463013, 0.5671443939, 1.729359694 × 10-6, 1.907348633 × 10-6}
{19.00000000, 0.5671424866, 0.5671443939, 0.5671434402, 2.348157265 × 10-7, 9.536743164 × 10-7}
In[8]:= N[x, 20]
Out[8]:= 0.56714344024658203125
In[9]:= FindRoot[f[y] == 0, {y, 1/2}, WorkingPrecision → 20]
Out[9]:= {y → 0.56714329040978387300}
In[10]:= %[[1]][[2]] - N[x, 20]
Out[10]:= -1.498367981583 × 10-7

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