Answer on Question#50178 - Chemistry - Physical Chemistry

For the ques :- PH of 10 * 10^(-8) of HCL. the solution given is

[H+] total = [H+] acid + [H+] water
Since HCl is a strong acid and is completely ionized
[H+] HCl = 1.0 x 10-8
The concentration of H+ from ionization is equal to the [OH-] from water,
[H+] H2O = [OH-] H2O
= x (say)
[H+] total = 1.0 x 10-8 + x
But
[H+] [OH-] = 1.0 x 10-14
(1.0 x 10-8 + x) (x) = 1.0 x 10-14
X2 + 10-8 x – 10-14 = 0
Solving for x, we get x = 9.5 x 10-8
Therefore,
[H+] = 1.0 x 10-8 + 9.5 x 10-8
= 10.5 x 10-8
= 1.05 x 10-7
pH = – log [H+] = – log (1.05 x 10-7) = 6.98

so, x= [OH-] =9.5 X 10-8, so, POH is 7.02

But If it is so what would be the case for 10*-7 M of HCL, x = [OH-] would be 1.6 X 10-7
and POH <7, BUT HOW IT IS POSSIBLE as it cant be less than 7 and PH-POH=PH would be more than 7. HOW it is possible?

Solution
True pH of 10^{-7} M HCl is 6.79. The reason you got wrong answer is that **you calculated wrong root of the quadratic equation**.

We replace 10^{-8} with 10^{-7} and start from the red line for 10^{-7} M HCl:
$x^2 + 10^{-7} x – 10^{-14} = 0$
This equation has two roots: x1 = 6.18 x 10^{-8} M and x2 = -1.61 * 10^{-7} M.
x2 does not make sense, as it is less than zero.
Thus, x = 6.18 * 10^{-8} M.
[H+] = 1.0 * 10^{-7} + 6.18 * 10^{-8} = 1.62 * 10^{-7} M.
pH = - log [H+] = 6.79
pOH = 14 - pH = 7.21

Alternative solution
To compute pH of acidic solution, you could also use pH solver
http://www.webqc.org/phsolver.php with the following input lines:
HCl pKa=-10 c=1e-8
which gives 6.98 for 10^{-8} M HCl and
HCl pKa=-10 c=1e-7
which gives 6.79 for 10^{-7} M HCl.