$$x^3 - x^2 = 48$$

$$x^3 + x^2 = 48$$

$x^3 - x^2 = 48$

$x^3 - x^2 = 48$

$x = ?$

---< S T A R T >---

---< 1. calculation of root(s) belonging to the set of real numbers >---

$x^3 - x^2 = 48$

$x^3 - x^2 - 48 = 0$

$a = +1$

$b = -1$

cancelation of degree 2 term (x^2):

set $x = k - b/3a = k - (-1)/3 = k + 1/3$

if $x = (k + 1/3)$ then $x^3 - x^2 - 48 = 0$ becomes:

$(k + 1/3)^3 - (k + 1/3)^2 - 48 = 0$

recall: $(a - b)^3 = a^3 - 3a^2b + 3ab^2 + b^3$

$(k^3 + k^2 + k/3 + 1/27) - (k^2 + 2k/3 + 1/9) - 48 = 0$

$k^3 + k^2 + k/3 + 1/27 - k^2 - 2k/3 - 1/9 - 48 = 0$

$k^3 - k^2 + k^2 + k/3 - 2k/3 + 1/27 - 1/9 - 48 = 0$

$k^3 - k^2 + k^2 + k/3 - 2k/3 + 1/27 - 3/27 - 1296/27 = 0$

$k^3 - k/3 - 1298/27 = 0$

$k^3 - k/3 - 1298/27 = 0$ is based on the template $k^3 + pk + q = 0$ with:

$p = -1/3$

$q = -1298/27$

TARTAGLIA formula:

note (recall): cubic root of $n = n$^(1/3)

$k = [-q/2 + \sqrt{(q^2/4 + p^3/27)}]$^(1/3) +

$[-q/2 - \sqrt{(q^2/4 + p^3/27)}]$^(1/3)

$k = [-(-1298/27)/2 + \sqrt{((-1298/27)^2/4 + (-1/3)^3/27)}]$^(1/3) +

$[-(-1298/27)/2 - \sqrt{((-1298/27)^2/4 + (-1/3)^3/27)}]$^(1/3)

$k = 3 + 2/3$

$x = k + 1/3 \Rightarrow x = 3 + 2/3 + 1/3 = 4$ <--- root #1

---< 2. calculation of root(s) belonging to the set of complex numbers >---

$x^3 - x^2 = 48$

$x^3 - x^2 = 4^3 - 4^2$

$x^3 - 4^3 - x^2 + 4^2 = 0$

$(x^3 - 4^3) - (x^2 - 4^2) = 0$

recall: $(a^3 - b^3) = (a - b)(a^2 + ab + b^2)$

recall: $(a^2 - b^2) = (a - b)(a + b)$

$(x - 4)(x^2 + 4x + 16) - (x - 4)(x + 4) = 0$

$(x - 4)[(x^2 + 4x + 16) - (x + 4)] = 0$

$(x - 4)(x^2 + 4x + 16 - x - 4) = 0$

$(x - 4)(x^2 + 4x - x + 16 - 4) = 0$

$(x - 4)(x^2 + 3x + 12) = 0$

$x^2 + 3x + 12 = 0$

$\Delta = 3^2 - 4*1*12 = 9 - 48 = -39$

$\sqrt{\Delta} = i\sqrt{39}$

$x = (-3 + i\sqrt{39})/2*1 = -3/2 + i\sqrt{39}/2$ <--- root #2

$x = (-3 - i\sqrt{39})/2*1 = -3/2 - i\sqrt{39}/2$ <--- root #3

---< F I N AL R E S U L T S >---

root #1: $x = 4$

root #2: $x = -3/2 + i\sqrt{39}/2$

root #3: $x = -3/2 - i\sqrt{39}/2$

$$x^3 + x^2 = 48$$

$x^3 + x^2 = 48$

$x = ?$

---<   S T A R T   >---

---< 1. calculation of root(s) belonging to the set of real numbers >---

$x^3 + x^2 = 48$

$x^3 + x^2 - 48 = 0$

$a = +1$

$b = +1$

cancelation of degree 2 term (x^2):

set $x = k - b/3a = k - 1/3$

if $x = (k - 1/3)$ then $x^3 + x^2 - 48 = 0$ becomes:

$(k - 1/3)^3 + (k - 1/3)^2 - 48 = 0$

recall: $(a - b)^3 = a^3 - 3a^2b + 3ab^2 + b^3$

$(k^3 - k^2 + k/3 - 1/27) + (k^2 - 2k/3 + 1/9) - 48 = 0$

$k^3 - k^2 + k/3 - 1/27 + k^2 - 2k/3 + 1/9 - 48 = 0$

$k^3 - k^2 + k^2 + k/3 - 2k/3 - 1/27 + 1/9 - 48 = 0$

$k^3 - k^2 + k^2 + k/3 - 2k/3 - 1/27 + 3/27 - 1296/27 = 0$

$k^3 - k/3 - 1294/27 = 0$

$k^3 - k/3 - 1294/27 = 0$ is based on the template $k^3 + pk + q = 0$ with:

$p = -1/3$

$q = -1294/27$

TARTAGLIA formula:

note (recall): cubic root of $n = n^{(1/3)}$

$k = [-q/2 + \sqrt{(q^2/4 + p^3/27)}]^{(1/3)} +$

$\quad [-q/2 - \sqrt{(q^2/4 + p^3/27)}]^{(1/3)}$

$k = [-(-1294/27)/2 + \sqrt{((-1294/27)^2/4 + (-1/3)^3/27)}]^{(1/3)} +$

$\quad [-(-1294/27)/2 - \sqrt{((-1294/27)^2/4 + (-1/3)^3/27)}]^{(1/3)}$

$k = 3.6629$

$x = k - 1/3 \Rightarrow x = 3.6629 - 1/3 = 3.3295$ <--- root #1

---< 2. calculation of root(s) belonging to the set of complex numbers >---

$x^3 + x^2 = 48$

set $t = 3.3295$ (root #1 result)

$x^3 + x^2 = t^3 + t^2$

$x^3 - t^3 + x^2 - t^2 = 0$

$(x^3 - t^3) + (x^2 - t^2) = 0$

recall: $(a^3 - b^3) = (a - b)(a^2 + ab + b^2)$

recall: $(a^2 - b^2) = (a - b)(a + b)$

$(x - t)(x^2 + tx + t^2) - (x - t)(x + t) = 0$

$(x - t)[(x^2 + tx + t^2) - (x + t)] = 0$

$(x - t)(x^2 + tx + t^2 - x - t) = 0$

$(x - t)(x^2 + tx - x + t^2 - t) = 0$

$t = 3.3295 \Rightarrow$

$(x - 3.3295)(x^2 + 3.3295x - x + 3.3295^2 - 3.3295) = 0$

$(x - 3.3295)(x^2 + 2.3295x + 11.0855 - 3.3295) = 0$

$(x - 3.3295)(x^2 + 2.3295x + 7.756) = 0$

$x^2 + 2.3295x + 7.756 = 0$

$\Delta = 2.3295^2 - 4*1*7.756 = 5.4265 - 31.024 = -25.5975$

$\sqrt{\Delta} = i\sqrt{25.5975}$

$x = (-2.3295 + i\sqrt{25.5975})/2*1 = -2.3295/2 + i\sqrt{25.5975}/2 = -1.1647 + i\sqrt{25.5975}/2$ <--- root #2

$x = (-2.3295 - i\sqrt{25.5975})/2*1 = -2.3295/2 - i\sqrt{25.5975}/2 = -1.1647 - i\sqrt{25.5975}/2$ <--- root #3

---< F I N AL R E S U L T S >---

root #1: $x = 3.3295$

root #2: $x = -1.1647 + i\sqrt{25.5975}/2$

root #3: $x = -1.1647 - i\sqrt{25.5975}/2$