Réfraction d'un rayon sortant d'un aquarium

Méthode trigonométrique

restart

$eq1 := \sin(r) = n \cdot \sin(i)$

$$\sin(r) = n \sin(i) \qquad \textbf{(1.1)}$$

$eq2 := ye \cdot tan(r) - ya \cdot \tan(i) = xe$

$$ye \tan(r) - ya \tan(i) = xe \qquad \textbf{(1.2)}$$

$xe := 50 : ye := 10 : n := 1.33 :$

$aqua := [[0, 0], [20, 0], [20, -20], [0, -20], [0, 0]] :$

$vir := [\,] : vxcybr := [\,] : ech := [\,] :$

après vérication, la solution cherchée est la seconde

(les autres sont complexes ou hors de l'intervalle physiquement acceptable)

for k **to** 9 **do**

$ya := -2\,k;$

$ir := solve(\{eq1, eq2\}, [i, r])[2];$

$ii := rhs(ir[1]);$

$rr := rhs(ir[2]);$

$vir := [op(vir), [ii, rr]];$

$xxc := -ya \cdot \tan(ii);$

$$yb := -\frac{xxc}{\tan(rr)};$$

$$\rho := \frac{yb}{ya};$$

$vxcybr := [op(vxcybr), [xxc, yb, \rho]];$

$xxa := xxc \cdot \left(1 - (n \cdot \rho)^2\right);$

$$yya := \frac{xxa - xxc}{\tan(rr)};$$

$ech := [op(ech), [xxa, yya]];$

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end do:

vir

$$[[0.8270892438, 1.364674098], [0.8248991611, 1.355239945], [0.8224264413, 1.345029473], [0.8196292553, 1.333970075], [0.8164605446, 1.321987070], [0.8128682702, 1.309006396], [0.8087962411, 1.294958526], [0.8041857537, 1.279783745], [0.7989782515, 1.263438725]] \qquad \textbf{(1.3)}$$

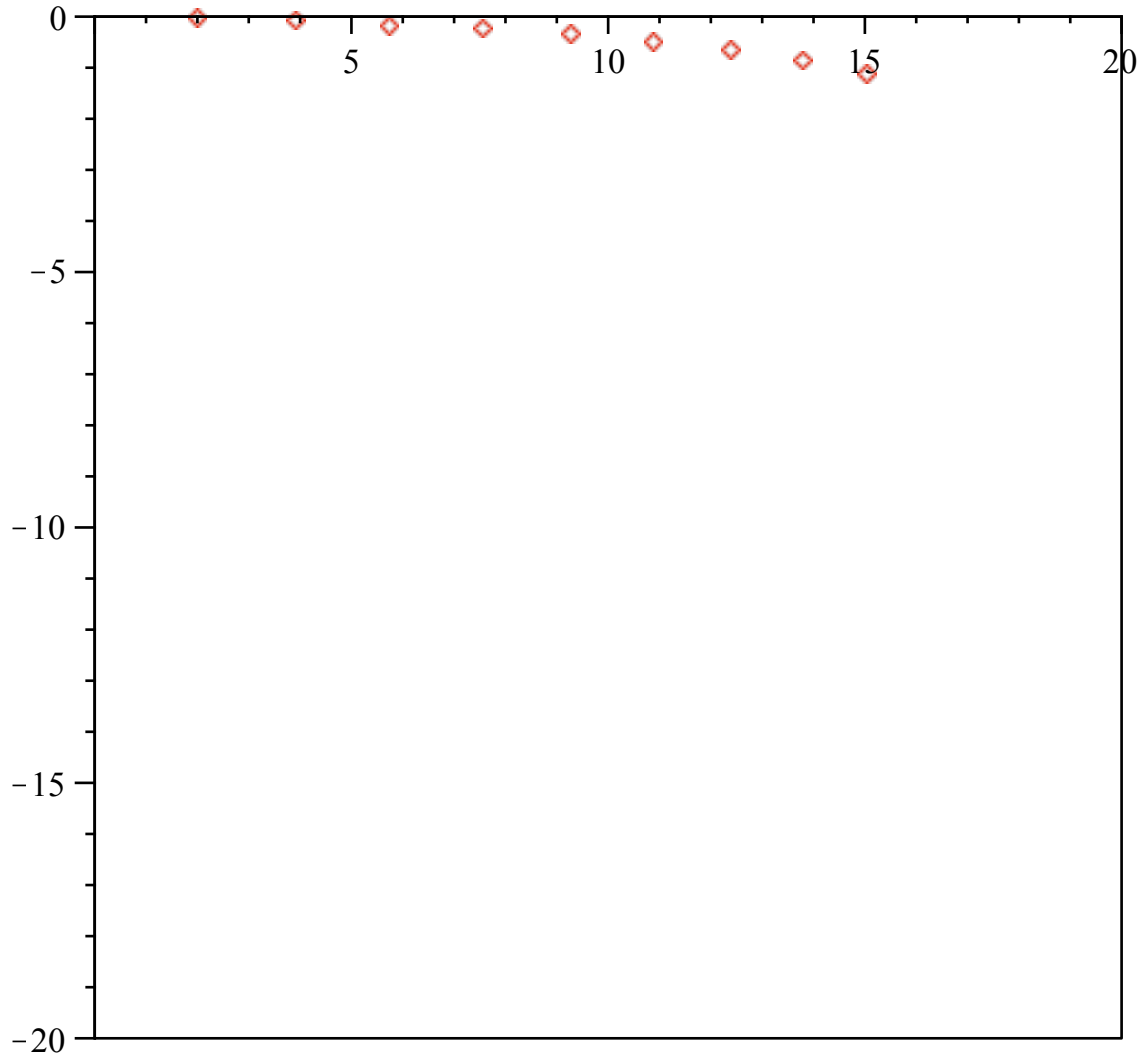
vxcybr

$$[[2.174124664, -0.4545917150, 0.2272958575], [4.329182236, -0.9479099429, 0.2369774857], [6.461644230, -1.484126838, 0.2473544730], [8.567339744, -2.067774480, 0.2584718100], [10.64137660, -2.703696343, 0.2703696343], [12.67808006, -3.396952809, 0.2830794007], [14.67096799, -4.152666283, 0.2966190202], [16.61278779, -4.975793632, 0.3109871020], [18.49564454, -5.870821432, 0.3261567462]] \qquad \textbf{(1.4)}$$

ech

[[1.975437063, -0.04154395504], [3.899127906, -0.09416392131], [5.762308269, -0.1606252575], [7.554884953, -0.2443615220], [9.265381389, -0.3496045069], [10.88097566, -0.4815144573], [12.38768341, -0.6462912942], [13.77074538, -0.8512368125], [15.01527400, -1.104726786]] **(1.5)**

plot([*aqua*, *ech*], *color* = [*black*, *red*], *scaling* = *constrained*, *style* = [*line*, *point*])



Méthode algébrique

restart

$$equa := \frac{n^2\, xc^2}{xc^2 + ya^2} = \frac{(xe - xc)^2}{(xe - xc)^2 + ye^2}$$

$$\frac{n^2\,xc^2}{xc^2+ya^2}=\frac{(xe-xc)^2}{(xe-xc)^2+ye^2} \tag{2.1}$$

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xe := 50 : ye := 10 : n := 1.33 :
vxcyb := [ ] :
for k to 9 do
 ya := -2 k;
 xxc := solve(equa, xc)[1];
 yb := - ye xxc / (xe - xxc);

 vxcyb := [op(vxcyb), [xxc, yb]];
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 end do:
vxcyb
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$$[[2.174124663,\ -0.4545917137],[4.329182237,\ -0.9479099454],[6.461644231,\ -1.484126839],[8.567339743,\ -2.067774478],[10.64137660,\ -2.703696339],[12.67808007,\ -3.396952808],[14.67096799,\ -4.152666279],[16.61278780,\ -4.975793636],[18.49564454,\ -5.870821437]] \tag{2.2}$$