

$$x \pm r \sqrt{x-\varepsilon} \quad (x-\varepsilon) \pm r \sqrt{x-\varepsilon} + \varepsilon = (\sqrt{x-\varepsilon} \pm r)^2 \quad -1$$

$$f(x) = \sqrt{(\sqrt{x-\varepsilon} + r)^2} = \sqrt{x-\varepsilon} + r$$

$$g(x) = \sqrt{x-\varepsilon} - r$$

$$f(x) + g(x) = \sqrt{x-\varepsilon} + r + \sqrt{x-\varepsilon} - r = 2\sqrt{x-\varepsilon}$$

$$a = 0 \quad b = r \quad c = -\varepsilon$$

$$\frac{a+b}{c} = -\frac{1}{r}$$

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$$D_{\frac{g}{f}} = D_g \cap D_f$$

$$D_g = \{0, 1, 2, 3\}$$

$$x^2 - \varepsilon x + r^2 = 0$$

$$(x-1)(x-3) = 0 \rightarrow x = 1, 3$$

$$x+r=0 \rightarrow x=-r$$

$$g(0) = \varepsilon, f(0) = \frac{r}{r} = 1 \rightarrow \frac{g}{f} = \frac{\varepsilon}{1} = \varepsilon$$

$$D_{\frac{g}{f}} = \{0, 2\}$$

$$g(r) = 1, f(r) = \frac{r+r}{\varepsilon-r+r} = \frac{\varepsilon}{-1} = -\varepsilon$$

$$\frac{g}{f}(r) = -\frac{1}{\varepsilon}$$

$$\frac{g}{f} = \left\{ (0, \varepsilon), (2, -\frac{1}{\varepsilon}) \right\}$$

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$$a) \rightarrow x = 1 \rightarrow y = 2$$

$$x = 3 \rightarrow y = -1$$

$$x = \varepsilon \rightarrow y = 2$$

$$x = -1 \rightarrow y = 4$$

$$f(x) = \left\{ \left(\frac{1}{r}, r \right), \left(\frac{r}{r}, -1 \right), (r, 2), \left(-\frac{r}{r}, 4 \right) \right\}$$

$$b) \quad x^2 = 1 \rightarrow x = \pm 1 \rightarrow y = 2 \quad x^2 = \varepsilon \rightarrow x = \pm \sqrt{\varepsilon} \rightarrow y = 2$$

$$x^2 = -1 \rightarrow x = \pm \sqrt{-1} \rightarrow y = -1 \quad x^2 = 1 - \delta \rightarrow x = \pm \sqrt{1-\delta} \rightarrow y = 2$$

$$\left\{ (1, 2), (-1, 2), (\sqrt{\varepsilon}, 2), (-\sqrt{\varepsilon}, 2), (1, -1), (-1, -1), (\sqrt{1-\delta}, 2), (-\sqrt{1-\delta}, 2) \right\}$$

$$x = -2 \rightarrow f(x)^2 + 1 = 19$$

$$x = -1 \rightarrow f(x)^2 + 1 = 1$$

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$$x = 1 \rightarrow f(-1)^2 + 1 = 3$$

$$fg^{f(x)+1} = \{(-2, 19), (1, 3), (2, 9), (-1, 1)\}$$

$$x = 2 \rightarrow f(2)^2 + 1 = 9$$

$$\frac{f}{g} = 2 \rightarrow \frac{f(1)}{g(1)} = \frac{f(2)}{-1} = -2$$

$\nearrow x=1$

$$\frac{f(-1)}{f} = -1$$

$\nearrow x=2$

$$\frac{f}{g} = \{(1, -2), (2, -1)\} \quad \hookrightarrow$$

$$h = f + g \quad D_f = \{2, 3, 4, -2\} \quad D_g = \{0, 2, -5, -1, 3\}$$

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$$D_h = D_f \cap D_g = \{2, 3, -2\}$$

$$f(2) + g(2) = f(1) + 2 = 0$$

$$f(3) + g(3) = 2 + 3 = 5$$

$$f(-2) + g(-2) = f(-1) + 2 = 2$$

$$h = \{(2, 0), (3, 5), (-2, 2)\}$$

$$3x \geq 0 \rightarrow x \geq 0$$

$$3x \geq x^2$$

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$$x^2 - 3x \leq 0 \rightarrow 0 \leq x \leq 3$$

$$D_f = [0, 3] - \{2\} = [0, 2) \cup (2, 3]$$

$$[x] + [-x] = \begin{cases} 0 & x \in \mathbb{Z} \\ -1 & x \notin \mathbb{Z} \end{cases}$$

$$g(x) + 1 = 0 + 1 = 1 \neq 0 \rightarrow 2$$

$$g(x) + 1 = -1 + 1 = 0 \quad (\text{ن})$$

$$D = D_f \cap \mathbb{Z} = \{0, 1, 3\}$$

$$\omega x - x^2 \geq 0 \rightarrow x(\omega - x) \geq 0 \rightarrow D_f = [0, \omega] \quad , D_g = \{1, r, \varepsilon, \omega\}$$

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$$D_h = D_f \cap D_g$$

$$h(x) \rightarrow f(1) = \sqrt{\omega - 1} - \varepsilon = -\varepsilon \rightarrow h(1) = -\frac{\varepsilon}{\omega}$$

$$f(r) = \sqrt{\omega(r) - r^2} - \varepsilon = \sqrt{r - \varepsilon} \rightarrow h = \frac{\sqrt{r - \varepsilon}}{r}$$

$$f(\varepsilon) = \sqrt{\omega(\varepsilon) - \varepsilon^2} - \varepsilon = \sqrt{\varepsilon - \varepsilon} = 0 \rightarrow h = -\frac{1}{\omega}$$

$$f(\omega) = \sqrt{\omega(\omega) - \omega^2} - \varepsilon = -\varepsilon \rightarrow h = \frac{-\varepsilon}{1} = -\varepsilon$$

$$h = \left\{ \left(1, -\frac{\varepsilon}{\omega}\right), \left(r, \frac{\sqrt{r - \varepsilon}}{r}\right), \left(\varepsilon, -\frac{1}{\omega}\right), \left(\omega, -\varepsilon\right) \right\}$$

-v

$$\text{a)} (x^3 - 3x^2 + 3x - 1) \rightarrow f = (x-1)^3 + 1 \rightarrow (x-1)^3 = y - 1 \rightarrow (x-1) = \sqrt[3]{y-1} \rightarrow u = 1 + \sqrt[3]{y-1}$$

$$R_f = \mathbb{R}$$

$$\text{b)} y(x^3 - 3x^2 + 3x - 1) \rightarrow yx^3 - 3yx^2 + 3yx - 1 = 0 \quad \Delta = (-3y)^2 - 4(y)(-1) = 9y^2 + 4y \geq 0$$

$$y^2 + y \geq 0 \rightarrow y(y+1) \geq 0 \rightarrow y \leq -1 \text{ , } y \geq 0$$

$$R_f = (-\infty, -1] \cup [0, +\infty)$$

-1

$$x^2 - 2x + 1 = 0 \quad x_0 = -\frac{b}{2a} = -\frac{-2}{2} = 1$$

$$y_{\min} = (r)^2 - \varepsilon(r) + 1 = 4 \quad R_f = [4, +\infty)$$

$$-x^2 + 4x + 7 \quad x_0 = -\frac{b}{2a} = 2$$

$$y_{\max} = -(r)^2 + 4(r) + 7 = -9 + 16 + 7 = 14 \quad R_f = (-\infty, 14]$$

$$u^T - \varepsilon u - r > 0 \rightarrow R_f = [0, +\infty)$$

$$\frac{\varepsilon}{r} = r \quad y_{\min}^{\varepsilon - 1 - r} = -v$$

$$4x - u^2 \rightarrow u_{\sqrt{r}} = \frac{4}{r(-1)} = r \rightarrow u(r) = (r)^2 + 4(r) = 9$$

$$0 \leq \sqrt{u(x)} \leq \sqrt{9} \rightarrow 0 \leq y \leq 3$$

$$R_f = [0, 3]$$

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$$\text{الف) } \sup_{\text{محدود}} = R_f = R$$

$$\text{ب) } R_f = R$$

$$\text{ج) } \sqrt{R} = [0, +\infty)$$

$$\text{د) } (R)^2 = [0, +\infty)$$

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$$\text{الف) } \frac{a}{c} = 3 \rightarrow R_f = R - \{3\}$$

$$\text{ب) } \frac{a}{c} = 2 \rightarrow R_f = R - \{2\}$$