

$$f(u) = \begin{cases} u^3 - 4 & u > \alpha \\ 12u - 20 & u \leq \alpha \end{cases} \Rightarrow u = \alpha \Rightarrow \alpha^3 - 4 = 12\alpha - 20 \Rightarrow \alpha^3 - 12\alpha + 16 \geq 0$$

$$\Rightarrow (\alpha - 2)^2(\alpha + 4) \geq 0 \Rightarrow \alpha + 4 \geq 0 \Rightarrow \alpha \geq -4$$

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الف) $f(u) = 3u + 10$ و $f^{-1}(v) = 4 \Rightarrow f(4) = 2 \Rightarrow f(c) = 3(4) + 10 = 2 \Rightarrow c = -10$ ✓

$$\Rightarrow f(u) = 3u - 10 \Rightarrow f(v) = 21 - 10 \Rightarrow f(v) = 11$$
 ✓

ب) $f(f(u)) \leq f \circ f(u) \Rightarrow 3(3u - 10) - 10 \Rightarrow 9u - 30 - 10 \Rightarrow f \circ f(u) = 9u - 40$ ✓

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$$f(u) = \frac{u}{u-1} \Rightarrow A(2u+u) \Rightarrow f^{-1}(u) \Rightarrow f(u) = (2u+u) \Rightarrow \frac{u(u)}{u-1} = 2u$$

$$2u^2 - 2u = u^2 \Rightarrow u^2 - 2u = 0 \Rightarrow u(u-2) = 0 \Rightarrow u = 0 \text{ یا } u = 2$$

عقده ۰ و ۲
از هر دو عدد به ازای هر عدد و یک به یک نیست

$$u = 2$$
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الف) $f \circ f^{-1} = \{(2, 2), (7, 7), (2, 2), (4, 4)\}$ ✓

ب) $f^{-1} \circ f = \{(2, 2), (4, 4), (7, 7), (9, 9)\}$ ✓

ج) $f \circ g^{-1} = \{(2, 2), (2, 4)\}$ ✓

د) $g^{-1} \circ f = \{(3, 9), (7, 3), (9, 8)\}$ ✓

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$$f = \{(1, 4), (4, 8), (4, 0)\} \quad g = \{(2, 1), (4, 3), (9, 5)\} \quad h = \{(1, 2), (3, 4), (4, 1), (5, 1)\}$$

$$\frac{h}{f \circ g^{-1}} \Rightarrow f(g^{-1}(u)) \Rightarrow \{(1, 4), (3, 8), (5, 0)\}$$

$$\Rightarrow \frac{h}{f \circ g^{-1}} \Rightarrow \{(1, \frac{2}{4}), (3, \frac{4}{8}), (\cancel{5, \frac{1}{0}})\} \Rightarrow \{(1, \frac{1}{2}), (3, \frac{1}{2})\}$$
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