NÚMEROS REALES. SOLUCIONES.

① a) Falso: $\sqrt{2}$ es irracional y real, pues todos los nº irracionales son reales.

b) Verdadero: todo entero puede escribirse en forma fraccionaria (de denominador 1, por ejemplo).

c) Falso: todos los nº racionales son reales.

d) Falso: sólo son racionales los números obtenidos a partir del cociente de dos enteros.

e) Falso: el desarrollo decimal, o es periódico, o no lo es. Los conjuntos $\mathbb{Q}$ e $\mathbb{I}$ son mutuamente excluyentes.

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② a) $L = 2\pi r = 2\pi \cdot 2 = 4\pi$ Irracional.

b) hipotenusa $= \sqrt{3^2+4^2} = 5$ Natural.

c) diagonal $= \sqrt{2^2+2^2} = \sqrt{8}$ Irracional

d) área $= 2 \cdot 2 = 4$ Natural.

e) 

$h = \sqrt{4^2-2^2} = \sqrt{12}$ Irracional.

f) área $= \frac{1}{2} \cdot 4 \cdot 2\sqrt{3} = 4\sqrt{3}$ Irracional.

g) perímetro $= 4+4+4 = 12$ Natural.

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③ $2'8383\ldots$ $\mathbb{Q}$ (racional); $\frac{-3}{4}$ $\mathbb{Q}$ (racional); $-\frac{\sqrt{5}}{2}$ $\mathbb{I}$ (irracional).

$\frac{1+\sqrt{5}}{2}$ $\mathbb{I}$ (irracional); $\sqrt[3]{8}+2 = 4$ $\mathbb{N}$ (natural); $\frac{\pi}{4}$ $\mathbb{I}$ (irracional).

$-\frac{8}{4} = -2$ $\mathbb{Z}$ (entero); $3'25$ $\mathbb{Q}$ (racional); $\frac{1}{3}$ $\mathbb{Q}$ (racional)

$\sqrt[4]{16} = \pm 2$ $\mathbb{Z}$ (entero); $\sqrt[3]{-8} = -2$ $\mathbb{Z}$ (entero); $1'020020002\ldots$ $\mathbb{I}$ (irracional).

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④ $x = 5'21\widehat{3}$; $1000x = 5213'333\ldots$

$100x = 521'333\ldots$

$900x = 4692 \longrightarrow x = \frac{4692}{900}$

$x = 3'8\widehat{7}$; $100x = 387'777\ldots$

$10x = 38'777\ldots$

$90x = 349 \longrightarrow x = \frac{349}{90}$

$\frac{4692}{900} - \frac{349}{90} = \frac{4692}{900} - \frac{3490}{900} = \frac{601}{450} = 1'33\widehat{5}$

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⑤ a) $\frac{13}{6} \simeq 2'17$; $\varepsilon_a = \left|2'17 - \frac{13}{6}\right| = \left|\frac{217}{100} - \frac{13}{6}\right| = \left|\frac{651-650}{300}\right| = \frac{1}{300}$

$\varepsilon_r = \frac{1}{300} : \frac{13}{6} = \frac{6}{3900} \simeq 0'00154 = 0'154\,\%$

b) $\frac{17}{6} \simeq 2'83$; $\varepsilon_a = \left|\frac{17}{6} - 2'83\right| = \left|\frac{17}{6} - \frac{283}{100}\right| = \left|\frac{850-849}{300}\right| = \frac{1}{300}$

$\varepsilon_r = \frac{1}{300} : \frac{17}{6} = \frac{6}{5100} \simeq 0'00118 = 0'118\,\%$

c) $\frac{32}{9} \simeq 3'56$; $\varepsilon_a = \left|3'56 - \frac{32}{9}\right| = \left|\frac{356}{100} - \frac{32}{9}\right| = \left|\frac{3\,204 - 3200}{900}\right| = \frac{4}{900} = \frac{1}{225}$

$\varepsilon_r = \frac{1}{225} : \frac{32}{9} = \frac{9}{7200} \simeq 0'00125 = 0'125\,\%$

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⑥ a) $1897'67 \times 1900$; $987.514 \simeq 987.500$; $123 \simeq 100$

b) $34'2345 \simeq 34'235$; $0'8765 \simeq 0'877$; $0'12345 \simeq 0'123$

c) $\varepsilon = |1900 - 1897'67| = 2'33$; $\varepsilon_r = \frac{2'33}{1897'67} \simeq 0'00123 = 0'123\,\%$

$\varepsilon = |987.500 - 987.514| = 14$; $\varepsilon_r = \frac{14}{987514} \simeq 1'42 \cdot 10^{-5} = 0'00142\,\%$

$\varepsilon = |123 - 100| = 23$; $\varepsilon_r = \frac{23}{123} \simeq 0'187 = 18'7\,\%$

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⑧ a) 1.er telèmetro: $\varepsilon_a = |14'48 - 14'39| = 0'09$ m.

$\varepsilon_r = \frac{0'09}{14'39} = 0'625\,\%$

2.º telèmetro: $\varepsilon_a = |7'85 - 7'92| = 0'07$ m

$\varepsilon_r = \frac{0'07}{7'92} = 0'884\,\%$

b) És més precís el 1.er telèmetro, perquè el error relatiu és menor.

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⑦ $\varepsilon_a < 0'0005$ mm.

$\varepsilon_r < \frac{0'0005}{2'318 - 0'0005} \simeq 2'16 \cdot 10^{-4} = 0'0216\,\%$

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(9) $\sqrt{7} = 2'6457\ldots \simeq 2'65$

$\varepsilon_a < 0'005$; $\varepsilon_r < \dfrac{0'005}{2'65 - 0'005} \simeq 1'89 \cdot 10^{-3} = 0'189\ \%$

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(10) $N = \frac{1}{10} + \frac{1}{10^3} + \frac{1}{10^6} + \frac{1}{10^{10}} + \frac{1}{10^{15}} + \ldots = 0'1 + 0'001 + 0'000001 + 0'0000000001 +$

$+ 0'000000000000001 + \ldots = 0'1\,0\,1\,0\,0\,1\,0\,0\,0\,1\,0\,0\,0\,0\,1\ldots$

Infinitas cifras decimales no periódicas, luego irracional.

———— o ————

(11) a) Falso. Por ejemplo:

$$\begin{array}{rl} & 0'1\,0\,1\,0\,0\,1\,0\,0\,0\,1\,0\,0\,0\,0\,1\ldots \quad \text{(irrac.)} \\ + & 0'0\,1\,0\,1\,1\,0\,1\,1\,1\,0\,1\,1\,1\,1\,0\ldots \quad \text{(irrac.)} \\ \hline & 0'1\,1\,1\,1\,1\,1\,1\,1\,1\,1\,1\,1\,1\,1\,1\ldots \end{array}$$

racional, por ser un decimal periódico.

b) Falso. Por ejemplo:

$\sqrt{12}$ es irracional. } $\sqrt{12} \cdot \sqrt{3} = \sqrt{36} = \pm 6$ entero.
$\sqrt{3}$ es irracional }

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(12) $9'08$

———— o ————

(13) a) $5'83 \cdot 10^2$; b) $4'66 \cdot 10^{-1}$; c) $8'75 \cdot 10^{-3}$

———— o ————

(14) $3 \cdot 10^5 \ \frac{Km}{seg} \cdot 8'31 \cdot 60\ seg = 1'4958 \cdot 10^8 \simeq 1'50 \cdot 10^8\ Km.$

———— o ————

(15) Masa del sol $= 1'670 \cdot 10^{-24} \cdot 1'191 \cdot 10^{57} = 1'989 \cdot 10^{33}\ g = 1'989 \cdot 10^{30}\ Kg$

———— o ————

(16) a) $18 : 6'02 \cdot 10^{23} = 2'99 \cdot 10^{-23}$ g/molec.

b) $12'7 \cdot 10^6 : 0'34 \cdot 10^7 = 3'74$ veces mayor.

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(17) a) $\frac{a^{2x}}{a} = a^{2x-1}$; b) $\frac{2^t \cdot 4^t}{8^{t-1}} = \frac{2^t \cdot 2^{2t}}{2^{3t-3}} = \frac{2^{3t}}{2^{3t-3}} = 2^{3t-3t+3} =$

$= 2^3 = 8$; c) $(5^4)^{x-1} = 5^{4x-4}$; d) $10hk^3 \cdot 4h^4 = 40h^5k^3$;

e) $\frac{3^{x+1}}{3^{x-1}} = 3^{x+1-x+1} = 3^2 = 9$

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(18) a) $(-3m^2n^2)^3 = -27m^6n^6$; b) $(3b^2)^{-2} = \frac{1}{(3b^2)^2} = \frac{1}{9b^4}$

c) $\frac{(ab)^2}{b^{-1}} = (ab)^2 b = a^2b^2b = a^2b^3$

d) $\left(\frac{m^3}{2n^2}\right)^4 = \frac{m^{12}}{16n^8}$; e) $(2ab)^{-1} = \frac{1}{2ab}$

f) $2(ab)^{-1} = \frac{2}{ab}$; g) $2ab^{-1} = \frac{2a}{b}$

h) $\left(\frac{-4a^3}{b}\right)^2 = \frac{16a^6}{b^2}$

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(19) $81 = 3^4$; $0{,}5 = \frac{1}{2} = 2^{-1}$; $\frac{1}{25} = \frac{1}{5^2} = 5^{-2}$; $\sqrt[3]{9} = \sqrt[3]{3^2} = 3^{2/3}$;

$\frac{1}{\sqrt{2}} = \frac{1}{2^{1/2}} = 2^{-1/2}$

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(20) a) $\frac{2^3 \cdot 5^{-7} \cdot 7^3}{2^{-4} \cdot 5^7 \cdot 7^{-3}} = 2^7 \cdot 5^{-14} \cdot 7^6$

b) $\frac{(a \cdot b)^2 (a^{-3}b^3)^3}{(ab^2c^3)^{-5}} = \frac{a^2b^2a^{-9}b^9}{a^{-5}b^{-10}c^{-15}} = \frac{a^{-7}b^{11}}{a^{-5}b^{-10}c^{-15}} = a^{-12} \cdot b^{21} \cdot c^{15}$

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(22) a) $\sqrt[4]{3^{-3}} = 3^{-\frac{3}{4}}$; b) $= \frac{1}{\sqrt[3]{4^2}} = \frac{1}{4^{2/3}} = 4^{-2/3} = 2^{-4/3}$

c) $a^3 \cdot \sqrt[3]{a^{-2}} = a^3 \cdot a^{-\frac{2}{3}} = a^{\frac{7}{3}}$; d) $\frac{\sqrt[5]{2^3}}{\sqrt[3]{2^{-2}}} = \frac{2^{\frac{3}{5}}}{2^{-2/3}} = 2^{\frac{3}{5}+\frac{2}{3}} = 2^{\frac{19}{15}}$

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(23) No es correcto: $\sqrt{4'25} \neq \sqrt{4} + \sqrt{0'25} = 2 + 0'5 = 2'5$

La raíz cuadrada de una suma NO es la suma de las raíces cuadradas.

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(26) a) $\frac{\sqrt{5}}{\sqrt{2}} = \frac{\sqrt{5}\sqrt{2}}{\sqrt{2}\sqrt{2}} = \frac{\sqrt{10}}{2}$

b) $\frac{2+\sqrt{2}}{\sqrt{2}} = \frac{(2+\sqrt{2})\sqrt{2}}{\sqrt{2}\sqrt{2}} = \frac{2\sqrt{2}+2}{2} = \sqrt{2}+1$

c) $\frac{3}{2-\sqrt{3}} = \frac{3(2+\sqrt{3})}{(2-\sqrt{3})(2+\sqrt{3})} = \frac{3(2+\sqrt{3})}{4-3} = 3(2+\sqrt{3}) = 6+3\sqrt{3}$

d) $\frac{4}{\sqrt{3}+\sqrt{2}} = \frac{4(\sqrt{3}-\sqrt{2})}{(\sqrt{3}+\sqrt{2})(\sqrt{3}-\sqrt{2})} = \frac{4(\sqrt{3}-\sqrt{2})}{3-2} = 4(\sqrt{3}-\sqrt{2})$

e) $\frac{1}{3\sqrt{2}-2\sqrt{3}} = \frac{3\sqrt{2}+2\sqrt{3}}{(3\sqrt{2}-2\sqrt{3})(3\sqrt{2}+2\sqrt{3})} = \frac{3\sqrt{2}+2\sqrt{3}}{18-12} = \frac{3\sqrt{2}+2\sqrt{3}}{6}$

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(28) $\frac{(\sqrt[3]{a^2})^4 \cdot (a^2 \cdot \sqrt{a})^3}{\sqrt[6]{a^5}} = \frac{(a^{\frac{2}{3}})^4 \cdot (a^2 \cdot a^{\frac{1}{2}})^3}{a^{5/6}} = \frac{a^{\frac{8}{3}} \cdot a^6 \cdot a^{\frac{3}{2}}}{a^{5/6}} = \frac{a^{\frac{61}{6}}}{a^{5/6}} =$

$= a^{\frac{56}{6}} = a^{\frac{28}{3}} = \sqrt[3]{a^{28}} = \sqrt[3]{a^{27} \cdot a} = a^9 \cdot \sqrt[3]{a}$

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(31) a) $\sqrt{5} + \sqrt{45} + \sqrt{180} - \sqrt{80} = \sqrt{5} + 3\sqrt{5} + 6\sqrt{5} - 4\sqrt{5} = 6\sqrt{5}$

b) $3\sqrt{72} - \sqrt{18} + 5\sqrt{2} + \sqrt{50} - 2\sqrt{8} = 18\sqrt{2} - 3\sqrt{2} + 5\sqrt{2} + 5\sqrt{2} - 4\sqrt{2} = 21\sqrt{2}$

c) $9\sqrt{27} + 2\sqrt{3} - 8\sqrt{300} - 4\sqrt{3} = 27\sqrt{3} + 2\sqrt{3} - 80\sqrt{3} - 4\sqrt{3} = -55\sqrt{3}$

d) $8\sqrt{8} - 5\sqrt{2} + 4\sqrt{20} - 12\sqrt{5} + 3\sqrt{18} = 16\sqrt{2} - 5\sqrt{2} + 8\sqrt{5} - 12\sqrt{5} + 9\sqrt{2} =$

$= 20\sqrt{2} - 4\sqrt{5}$

e) $\sqrt[3]{-54} + 2 \cdot \sqrt[3]{16} = -3\sqrt[3]{2} + 4\sqrt[3]{2} = \sqrt[3]{2}$

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(30) $\sqrt{\frac{5}{12}} - \sqrt{\frac{10}{6}} = \frac{\sqrt{5}}{2\sqrt{3}} - \frac{\sqrt{10}}{\sqrt{6}} = \frac{\sqrt{5}\sqrt{3}}{2\sqrt{3}\sqrt{3}} - \frac{\sqrt{10}\cdot\sqrt{6}}{\sqrt{6}\cdot\sqrt{6}} = \frac{\sqrt{15}}{6} - \frac{\sqrt{60}}{6} =$

$= \frac{\sqrt{15}-\sqrt{60}}{6} = \frac{\sqrt{15}-2\sqrt{15}}{6} = -\frac{\sqrt{15}}{6}$

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(32) $\sqrt[4]{9} + \sqrt{\frac{1}{3}} - \sqrt{\frac{4}{27}} = \sqrt[4]{3^2} + \frac{1}{\sqrt{3}} - \frac{2}{3\sqrt{3}} = \sqrt{3} + \frac{1}{\sqrt{3}} - \frac{2}{3\sqrt{3}} =$

$= \sqrt{3} + \frac{\sqrt{3}}{3} - \frac{2\sqrt{3}}{9} = \frac{9\sqrt{3}+3\sqrt{3}-2\sqrt{3}}{9} = \frac{10\sqrt{3}}{9} \Rightarrow \begin{cases} a = 10 \\ b = 9 \end{cases}$

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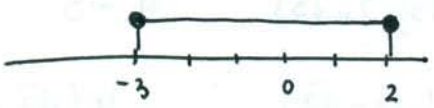
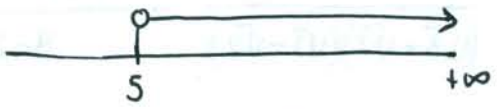
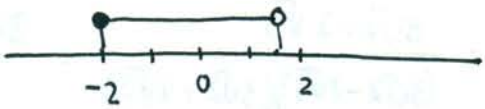
(33) a) $[-3, 2]$



b) $(5, +\infty)$

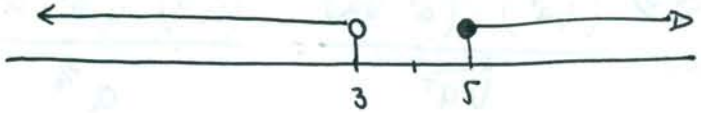


c) $[-2, \frac{3}{2})$



d) $[-2, +\infty)$

e) $(-\infty, 3) \cup [5, +\infty)$



f) $(0, 4)$

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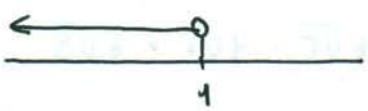
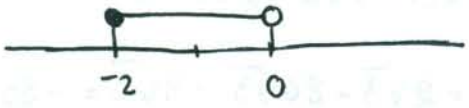
(34)



A ;

B



C

$A \cap B = (-3, 1)$; $A \cap C = [-2, 0)$; $A \cup B = (-\infty, 2]$

$A \cup C = (-\infty, 1)$; $A \cap B \cap C = [-2, 0)$

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(35) a) $|2x| > 6 \Rightarrow \begin{cases} 2x > 6 \\ \sigma \\ 2x < -6 \end{cases} \Rightarrow \begin{cases} x > 3 \\ \sigma \\ x < -3 \end{cases} \Rightarrow (-\infty, -3) \cup (3, +\infty)$.

b) $|2x-1| < 4 \Rightarrow -4 < 2x-1 < 4 \Rightarrow -3 < 2x < 5 \Rightarrow -\frac{3}{2} < x < \frac{5}{2}$

$\Rightarrow \left(-\frac{3}{2}, \frac{5}{2}\right)$

c) $|2x-6| = 4 \Rightarrow \begin{cases} 2x-6 = 4 \Rightarrow 2x = 10 \Rightarrow x = 5 \\ 2x-6 = -4 \Rightarrow 2x = 2 \Rightarrow x = 1 \end{cases}$

d) $|5x+2| = 8-x \Rightarrow \begin{cases} 5x+2 = 8-x \Rightarrow 6x = 6 \Rightarrow x = 1 \\ 5x+2 = -8+x \Rightarrow 4x = -10 \Rightarrow x = -\frac{5}{2} \end{cases}$

e) $|3x-8| < 10 \Rightarrow -10 < 3x-8 < 10 \Rightarrow -2 < 3x < 18 \Rightarrow -\frac{2}{3} < x < 6 \Rightarrow$

$\Rightarrow \left(-\frac{2}{3}, 6\right)$

f) $|4x+3| \leq 1 \Rightarrow -1 \leq 4x+3 \leq 1 \Rightarrow -4 \leq 4x \leq -2 \Rightarrow -1 \leq x \leq -\frac{1}{2}$

$\Rightarrow \left[-1, -\frac{1}{2}\right]$.

g) $|2-x| > 0 \Rightarrow \begin{cases} 2-x > 0 \Rightarrow 2 > x \Rightarrow x < 2 \\ \sigma \quad\quad \sigma \quad\quad \sigma \\ 2-x < 0 \Rightarrow 2 < x \Rightarrow x > 2 \end{cases} \Rightarrow (-\infty, 2) \cup (2, +\infty) =$

$= \mathbb{R} - \{2\}$

h) $|1-3x| \leq 2 \Rightarrow -2 \leq 1-3x \leq 2 \Rightarrow -3 \leq -3x \leq 1 \Rightarrow$

$\Rightarrow -\frac{1}{3} \leq x \leq 1 \Rightarrow \left[-\frac{1}{3}, 1\right]$

i) $|-x| > 2 \Rightarrow \begin{cases} -x > 2 \Rightarrow x < -2 \\ 0 \quad\quad \sigma \\ -x < -2 \Rightarrow x > 2 \end{cases} \Rightarrow (-\infty, -2) \cup (2, +\infty)$

j) $|2x-1| \leq \frac{1}{2} \Rightarrow -\frac{1}{2} \leq 2x-1 \leq \frac{1}{2} \Rightarrow \frac{1}{2} \leq 2x \leq \frac{3}{2} \Rightarrow$

$\Rightarrow \frac{1}{4} \leq x \leq \frac{3}{4} \Rightarrow \left[\frac{1}{4}, \frac{3}{4}\right]$

———— o ————

(21) a) $\left(\frac{27}{8}\right)^{\frac{2}{3}} = \left(\frac{3^3}{2^3}\right)^{\frac{2}{3}} = \frac{(3^3)^{\frac{2}{3}}}{(2^3)^{\frac{2}{3}}} = \frac{3^2}{2^2} = \frac{9}{4}$

b) $-125^{-\frac{1}{3}} = \frac{-1}{125^{\frac{1}{3}}} = \frac{-1}{(5^3)^{\frac{1}{3}}} = -\frac{1}{5}$

c) $\left(\frac{81}{16}\right)^{-\frac{3}{4}} = \left(\frac{3^4}{2^4}\right)^{-\frac{3}{4}} = \frac{(3^4)^{-\frac{3}{4}}}{(2^4)^{-\frac{3}{4}}} = \frac{3^{-3}}{2^{-3}} = \frac{2^3}{3^3} = \frac{8}{27}$

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(24) a) $\sqrt[6]{27} = \sqrt[6]{3^3} = 3^{\frac{3}{6}} = 3^{\frac{1}{2}} = \sqrt{3}$

b) $\sqrt[6]{125} = \sqrt[6]{5^3} = 5^{\frac{3}{6}} = 5^{\frac{1}{2}} = \sqrt{5}$

c) $\frac{3\sqrt{512} + 5\sqrt{32}}{\sqrt{50} - \sqrt{18}} = \frac{3 \cdot 16\sqrt{2} + 5 \cdot 4\sqrt{2}}{5\sqrt{2} - 3\sqrt{2}} = \frac{48\sqrt{2} + 20\sqrt{2}}{5\sqrt{2} - 3\sqrt{2}} =$

$= \frac{68\sqrt{2}}{2\sqrt{2}} = 34.$

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(25) $m.c.m(2, 5, 15) = 30.$

$\sqrt{5} = \sqrt[30]{5^{15}}$; $\sqrt[5]{2^3} = \sqrt[30]{2^{18}}$; $\sqrt[15]{7^2} = \sqrt[30]{7^4}$

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(27) a) $\frac{3}{\sqrt{6}} = \frac{3\sqrt{6}}{\sqrt{6} \cdot \sqrt{6}} = \frac{3\sqrt{6}}{6} = \frac{\sqrt{6}}{2}$

b) $\frac{6}{\sqrt[3]{2}} = \frac{6\sqrt[3]{2^2}}{\sqrt[3]{2} \cdot \sqrt[3]{2^2}} = \frac{6\sqrt[3]{4}}{\sqrt[3]{2^3}} = \frac{6\sqrt[3]{4}}{2} = 3\sqrt[3]{4}$

c) $\frac{\sqrt{27} + \sqrt{12}}{\sqrt{12} - \sqrt{3}} = \frac{(\sqrt{27} + \sqrt{12})(\sqrt{12} + \sqrt{3})}{(\sqrt{12} - \sqrt{3})(\sqrt{12} + \sqrt{3})} = \frac{\sqrt{324} + \sqrt{81} + \sqrt{144} + \sqrt{36}}{12 - 3} =$

$= \frac{18 + 9 + 12 + 6}{9} = \frac{45}{9} = 5$

d) $\frac{6}{\sqrt{7}+\sqrt{3}} = \frac{6(\sqrt{7}-\sqrt{3})}{(\sqrt{3}+\sqrt{7})(\sqrt{7}-\sqrt{3})} = \frac{6\sqrt{7}-6\sqrt{3}}{7-3} = \frac{6(\sqrt{7}-\sqrt{3})}{4} = \frac{3(\sqrt{7}-\sqrt{3})}{2}$ (5)

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(29) a) $\frac{\sqrt{27}\cdot\sqrt[5]{\sqrt{81}}}{3^5\cdot(\sqrt[3]{3})^4\cdot 9^{-2}} = \frac{\sqrt{3^3}\cdot\sqrt[10]{3^4}}{3^5\cdot\sqrt[3]{3^4}\cdot(3^2)^{-2}} = \frac{3^{\frac{3}{2}}\cdot 3^{\frac{2}{5}}}{3^5\cdot 3^{\frac{4}{3}}\cdot 3^{-4}} =$

$= \frac{3^{\frac{15}{10}}\cdot 3^{\frac{4}{10}}}{3\cdot 3^{\frac{4}{3}}} = \frac{3^{\frac{19}{10}}}{3^{\frac{7}{3}}} = 3^{\frac{19}{10}-\frac{7}{3}} = 3^{\frac{57-70}{30}} = 3^{-\frac{13}{30}}$

b) $\frac{2^{\frac{3}{2}}\cdot 8^0\cdot 4^{-\frac{1}{3}}}{2^{-1}\cdot\sqrt[3]{2}} = \frac{2^{\frac{3}{2}}\cdot 1\cdot 2^{-\frac{2}{3}}}{2^{-1}\cdot 2^{\frac{1}{3}}} = \frac{2^{\frac{9-4}{6}}}{2^{-\frac{2}{3}}} = \frac{2^{\frac{5}{6}}}{2^{-\frac{2}{3}}} = 2^{\frac{5}{6}+\frac{2}{3}} =$

$= 2^{\frac{5+4}{6}} = 2^{\frac{9}{6}} = 2^{\frac{3}{2}}$

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