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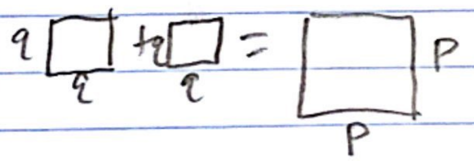
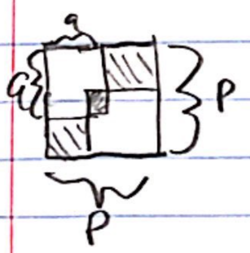
Okay

1. Assume that $\sqrt{2}$ is rational. Then it can be written as $\frac{a}{b}$ where $b \neq 0$ and $\gcd(a,b)=1$. Now we have $\sqrt{2}=\frac{a}{b}$ or that $2b^2=a^2$. Since b^2 is being multiplied by 2, then $2b^2$ is even so a^2 is even. If a^2 is even then a is even. So $a=2k$ for $k \in \mathbb{Z}$. Now we have $2b^2=(2k)^2$ or that $b^2=2k^2$ and by the same argument b is even. Since a, b are both even, they both have a factor of 2 so that contradicts that the $\gcd(a,b)=1$. Thus $\sqrt{2}$ is irrational.

2. Suppose $\sqrt{2}$ is rational then $\sqrt{2}=\frac{p}{q}$ where $q \neq 0$ then $p^2=2q^2$. written as squares we get



we can assume that the $p \times p$ square is the smallest such square



the area of the two $q \times q$ squares combines to the area of the $p \times p$ square, so the area of the dark shaded overlap must equal the area of the two lighty shaded squares.
Both the dark square and lighty dark squares have int. side length, This contradicts that the $p \times p$ square was the smallest square of it size thus $\sqrt{2}$ is irrational.

3a. $\frac{29}{16} = 1\frac{13}{16} = 1 + \frac{1}{\frac{16}{13}} = 1 + \frac{1}{1+\frac{1}{\frac{13}{3}}} = 1 + \frac{1}{1+\frac{1}{4+\frac{1}{3}}}$

3b. $\frac{32}{19} = 1 + \frac{13}{19} = 1 + \frac{1}{\frac{19}{13}} = 1 + \frac{1}{1+\frac{1}{\frac{13}{6}}} = 1 + \frac{1}{1+\frac{1}{2+\frac{1}{6}}}$

4. $x = 1 + \sqrt{2} = 1 + 1 + \frac{1}{2+\frac{1}{2+\frac{1}{2\ldots}}}$

$x - 1 = 1 + \frac{1}{2+\frac{1}{2+\frac{1}{2\ldots}}}$

Since $x-1 = \sqrt{2}$ then $x-1$ is irrational since it equals $\sqrt{2}$ and $\sqrt{2}$ is a countined infinate fraction and $x-1$ being irrational, taking off the -1 still makes x irrational so x is irrational and $\sqrt{2}$ is irrational.

5. $\frac{\sqrt{3}+1}{2} = x \rightarrow 2x-1 = \sqrt{3} = 2x-1 = 1+\cfrac{1}{1+\cfrac{1}{2+\cfrac{1}{1+\cfrac{1}{2+\cfrac{1}{4+\dots}}}}}$

$2x-1$ is irrational because $\sqrt{3}$ can be written as a continued fraction and multiply and subtracting a rational number from an irrational number still gives us a irrational number, thus $x = \frac{\sqrt{3}+1}{2}$ is irrational.

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