Surds

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A surd can simply be defined as the root of a number which does not have an exact decimal equivalent.

e.g. $\sqrt{3} = 1.732.......$ Is a surd

$\sqrt{25} = 5$ Is not a surd

It is common place in the exams to be asked to simplify a given surd. To simplify a surd we use the basic rules of arithmetic, especially multiplication and division.

It is essential that you know the following:-

$s = \sqrt{s} \cdot \sqrt{s}$ $\qquad 33 = \sqrt{33} \cdot \sqrt{33}$

$\sqrt{s} \cdot \sqrt{s} = s$ $\qquad \sqrt{33} \cdot \sqrt{33} = 33$

$\sqrt{s} + \sqrt{s} = \sqrt{s}(1+1) = 2\sqrt{s}$ $\qquad \sqrt{33} + \sqrt{33} = \sqrt{33}(1+1) = 2\sqrt{33}$

$\sqrt{mn} = \sqrt{m} \cdot \sqrt{n}$ $\qquad \sqrt{3 \cdot 2} = \sqrt{3} \cdot \sqrt{2} = \sqrt{6}$

$\sqrt{m} \cdot \sqrt{n} = \sqrt{mn}$ $\qquad \sqrt{3} \cdot \sqrt{2} = \sqrt{6}$

$$(a+\sqrt{b})(a-\sqrt{b}) = a^2 + a\sqrt{b} - a\sqrt{b} - b = a^2 - b$$

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Some examples

Simplify the following

$\sqrt{12} = \sqrt{4} \cdot \sqrt{3} = 2 \cdot \sqrt{3}$

$\sqrt{96} = \sqrt{32} \cdot \sqrt{3} = \sqrt{16} \cdot \sqrt{2} \cdot \sqrt{3} = 4\sqrt{2} \cdot \sqrt{3} = 4\sqrt{6}$

$\sqrt{48} = \sqrt{16} \cdot \sqrt{3} = 4\sqrt{3}$

$\sqrt{18} = \sqrt{9} \cdot \sqrt{2} = 3\sqrt{2}$

More complicated questions ask you to rationalise the denominator of an expression whose denominator is a surd. Rationalise simply means to not have any root signs in the denominator. These type of questions are all done by the same method.

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Example of rationalising

Rationalise the following expression

$$\frac{1}{(c+\sqrt{d})}$$

Method: Using the rules of arithmetic multiply top and bottom by

$$c-\sqrt{d}$$

This will make the dominator the difference of two squares and will eliminate any root signs in the denominator. We have:-

$$\frac{1}{(c+\sqrt{d})}=\frac{1}{(c+\sqrt{d})}\cdot\frac{(c-\sqrt{d})}{(c-\sqrt{d})}=\frac{(c-\sqrt{d})}{\left[c^2-c\sqrt{d}+c\cdot\sqrt{d}-(\sqrt{d})^2\right]}=\frac{(c-\sqrt{d})}{(c^2-d)}$$

Rationalise the following expression

$$\frac{2}{(1-\sqrt{3})}$$

Method: Using the rules of arithmetic multiply top and bottom by

$$(1+\sqrt{3})$$

Not this time since the denominator has a minus sign in the middle we multiply by a plus sign the middle. You always multiply by the opposite sign so you are guaranteed to have no roots in the denominator. We have:-

$$\frac{2}{(1-\sqrt{3})}=\frac{2}{(1-\sqrt{3})}\cdot\frac{(1+\sqrt{3})}{(1+\sqrt{3})}=\frac{2\cdot(1+\sqrt{3})}{\left[1^2-\sqrt{3}+\sqrt{3}-(\sqrt{3})^2\right]}=\frac{2\cdot(1+\sqrt{3})}{(-2)}=-(1+\sqrt{3})$$