Year 9 Knowledge Organiser

Surds

Simplifying Surds

$$\sqrt{a} \times \sqrt{b} = \sqrt{ab}$$

$$\sqrt{a} \div \sqrt{b} = \sqrt{\frac{a}{b}}$$

Any coefficients infront of the surds are dealt with separately.

e.g. $2\sqrt{5} \times 3\sqrt{4} = 2 \times 3 \times \sqrt{5 \times 4} = 6\sqrt{20}$

We can use this in reverse to simplify the value inside the surd. Take out a factor of the surd which is a **square number** as this can be square rooted.

e.g. $\sqrt{48} = \sqrt{16} \times \sqrt{3} = 4\sqrt{3}$

Check your final answer to see if it can be further simplified. This will happen if you do not spot the largest factor when simplifying (similar to fractions).

e.g. $\sqrt{72} = \sqrt{9} \times \sqrt{8}$

$= 3\sqrt{8}$

$= 3\sqrt{4} \times \sqrt{2}$

$= 3 \times 2 \times \sqrt{2}$

$= 6\sqrt{2}$

8 has a factor of 4 which is square

Surds of the **same value** can be **added and subtracted**

e.g.

$$5\sqrt{3} + 4\sqrt{3} = 9\sqrt{3}$$

Brackets and Surds

You can expand brackets with surds in them using normal methods

e.g. $\sqrt{5}(3+\sqrt{3}) = 3 \times \sqrt{5} + \sqrt{3} \times \sqrt{5}$

$= 3\sqrt{5} + \sqrt{15}$

For a double bracket, use whichever method you would normally use e.g. partitioning, multiplication grid, smiley face, etc.

e.g. $(3+\sqrt{5})(4-\sqrt{5}) =$

$3 \times 4 = 12$

$3 \times -\sqrt{5} = -3\sqrt{5}$

$\sqrt{5} \times 4 = 4\sqrt{5}$

$4\sqrt{5} - 3\sqrt{5} = \sqrt{5}$

$\sqrt{5} \times \sqrt{5} = \sqrt{25} = 5$

$= 17 + \sqrt{5}$

Rationalising Surds

Rationalising a surd means to not have an irrational number on the denominator of the fraction. As most surds are irrational numbers we need to remove any surds from the denominator.

In order to achieve these we need to choose an appropriate value to multiply both the numerator and denominator by which will cancel out the surd.

If there is only a single term on the denominator, multiply by the surd which is on the denominator.

e.g. Rationalise $\frac{4}{3\sqrt{5}}$

$$\frac{4}{3\sqrt{5}} = \frac{4}{3\sqrt{5}} \times \frac{\sqrt{5}}{\sqrt{5}}$$

$$= \frac{4 \times \sqrt{5}}{3\sqrt{5} \times \sqrt{5}}$$

$$= \frac{4\sqrt{5}}{3 \times 5}$$

$$= \frac{4\sqrt{5}}{15}$$

If there are 2 terms on the denominator, multiply by the difference of two squares and simplify.

e.g. Rationalise $\frac{3+\sqrt{2}}{2-\sqrt{5}}$

$$\frac{3+\sqrt{2}}{2-\sqrt{5}} = \frac{3+\sqrt{2}}{2-\sqrt{5}} \times \frac{2+\sqrt{5}}{2+\sqrt{5}}$$

$$= \frac{(3+\sqrt{2})(2+\sqrt{5})}{(2-\sqrt{5})(2+\sqrt{5})}$$

$$= \frac{6+2\sqrt{2}+3\sqrt{5}+\sqrt{10}}{4-2\sqrt{5}+2\sqrt{5}-5}$$

$$= \frac{6+2\sqrt{2}+3\sqrt{5}+\sqrt{10}}{-1}$$

$$= -6-2\sqrt{2}-3\sqrt{5}-\sqrt{10}$$

Tip:

The need to rationalise a surd is usually a non-calculator question as most modern scientific calculators will rationalise a surd for you just by inputting it and pressing '='. Should you need to do it on a calculator paper you can normally just use your calculator, however, a complicated one such as the second example here may not display properly and instead be given as a decimal!