15 - Counting, accuracy, powers and surds

Reciprocals
- We just flip the fraction to get the reciprocal
  \[ 5 = \frac{5}{1} \quad \frac{5}{1} \rightarrow \frac{1}{5} \]
- If we need the negative reciprocal, switch the sign and flip the fraction
  \[ -\frac{1}{2} \rightarrow \frac{2}{1} \quad \frac{2}{6} \rightarrow -\frac{6}{2} \]

Surds
- \( \sqrt{a} \times \sqrt{b} = \sqrt{ab} \)
- \( C\sqrt{a} \times D\sqrt{b} = CD\sqrt{ab} \)
- \( \sqrt{a} \div \sqrt{b} = \sqrt{\frac{a}{b}} \)
- \( C\sqrt{a} \div D\sqrt{b} = \frac{C}{D}\sqrt{\frac{a}{b}} \)

- When adding, treat it like algebra, you can only add together the same surd, so change the \( \sqrt{\text{s}} \) to like terms.
- Do this by leaving the same irrational number.

Simplifying Surds
- e.g. \( \sqrt{12} \)
  1. Find 2 numbers that are factors, one must be a square number
     \[ 4 \times 3 = 12 \]
  2. Simplify \( \rightarrow \) Root of square number goes outside, other number goes inside
     \[ 2\sqrt{3} \]
     \[
     \text{Root of 4} \quad \text{Other factor}
     \]
     You want the biggest possible root as a in \( -a\sqrt{b} \)

Expanding surds
- Square a \(-a^2\)
- Multiply \(a^2 \times b\)
- \(\sqrt{a^2} \times \sqrt{b} = \sqrt{a^2b} \)

Simplifying Surd x Surd
- Times outside numbers together
  \[ C\sqrt{a} \times D\sqrt{b} = CD\sqrt{ab} = 2\sqrt{45} \times 3\sqrt{2} \]
- Times irrational numbers together
  \[ 2\sqrt{6}\sqrt{45}\sqrt{2} = 6\sqrt{90} \]
- Simplify further, want biggest possible number outside. Recognise square factors, root then multiply them to the outside number.
  \[6 \times 3 \times \sqrt{10} = 18\sqrt{10} \]

Rationalising
Getting rid of surd from the denominator

For normal rationalising, just multiply the surd by itself:
- \( 5 \times \sqrt{3} = 5\sqrt{3} \)
  \[
  \sqrt{3} \quad \sqrt{3} \quad 3
  \]
For rationalising when there is more than just the surd as the denominator, multiply by the opposite ±:

\[ \frac{b}{2 + \sqrt{a}} \times 2 - \sqrt{a} = \frac{b(2 - \sqrt{a})}{(2 + \sqrt{a})(2 - \sqrt{a})} = \frac{2b - b\sqrt{a}}{4 - a} \]

**Limits of accuracy**

Degree of rounding

e.g.

1100 = 2 s.f.

Find the values that would round to 1100 for 2sf

1050 ≤ 1100 < 1150

Max speed = greatest distance/shortest time

Population density = total population/total area

**Choices and outcomes**

<table>
<thead>
<tr>
<th>Permutation</th>
<th>Combination</th>
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</thead>
<tbody>
<tr>
<td>Order/position does matter</td>
<td>Order does not matter</td>
</tr>
<tr>
<td>With repetition = nR</td>
<td>With repetition = nR</td>
</tr>
<tr>
<td>Without repetition = nPr</td>
<td>Without repetition = nCr</td>
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</tbody>
</table>