SURDS – GCSE

Pupil Name

Handbook Designed by Dr B. C. Arowosola

Timetable

Timetable – Tutorials

Tutorial	Date	Time	Location
1 (Baseline)			
2			
3			
4 (Final Assignment)			
5(Feedback)			

Timetable – Homework Assignments

Homework Assignment	Description	Due Date
Tutorial 1		
Tutorial 2		
Tutorial 3		
Tutorial 4		
Tutorial 5		

Uni Pathways – Pupil Feedback Report

Name of RIS Teacher	Dr C. B. Arowosola
Topic of Assignment	Surds
Name of Pupil	
Name of School	Hylands School

Learning Feedback Comment 1 - *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority *Enter feedback here*	How you could improve in the future *Enter feedback here*
Learning Feedback Comment 2 – *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority *Enter feedback here*	How you could improve in the future *Enter feedback here*
Learning Feedback Comment 3 – *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority *Enter feedback here*	How you could improve in the future *Enter feedback here*
Resilience Comment	
How you showed learning resilience during the course *Enter feedback here*	How you could build learning resilience in the future *Enter feedback here*

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Tutorial 1 P6

- Activity 1
- Activity 2
- Activity

Tutorial 2 P13

- Activity 1
- Activity 2
- Activity

Tutorial 3 P20

- Activity 1
- Activity 2
- Activity

Tutorial 4 P25

- Activity 1
- Activity 2
- Activity

Tutorial 5 P26

- Reflection on feedback

Appendices P28

- Referencing correctly

Baseline Assignment

$\sqrt{4}$ $\sqrt{9}$ $\sqrt{16}$ $\sqrt{25}$ $\sqrt{36}$ $\sqrt{49}$ $\sqrt{100}$

LEARN THESE OFF BY HEART

1

Simplify each of these following surds fully:

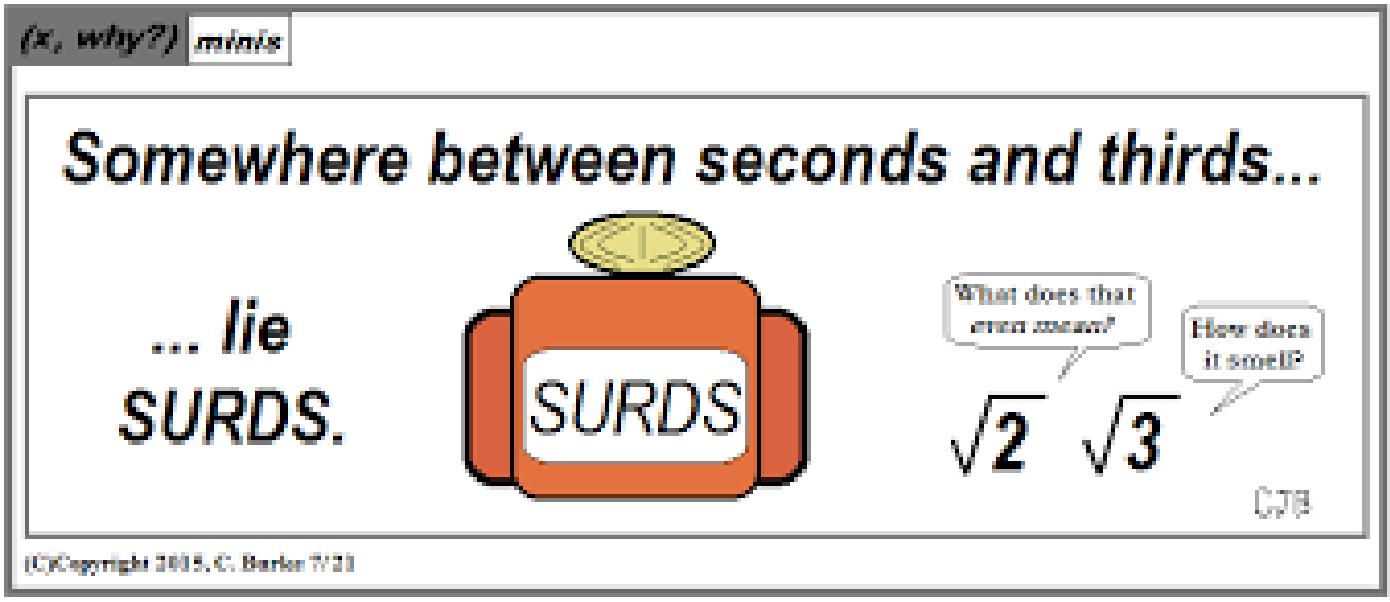
(a) $5\sqrt{2}$ x $3\sqrt{3}$ **(b)** $2\sqrt{8}$ x $3\sqrt{4}$ **(c)** $6\sqrt{25} \div 3\sqrt{5}$ **(d)** $20\sqrt{32} \div 4\sqrt{2}$

2

Simplify the following surd:

$$\left(\frac{\sqrt{3}}{2}\right)^2$$

Tutorial 1– Definition of Surds



What is the Purpose of Tutorial 1?

Objectives this tutorial:

- **A) Definition of Surds**
- **B) Understanding the use of Surds**
- **C) Simplifying Surds**

Tutorial One

Definition of Surds
Laws and Rules of

In your books, write down the first 12 square numbers

Like this:

1 x 1 = 1
2 x 2 = 4
3 x 3 = etc….

Can you go any further (at least up to 20) without a calculator

1 x 1 = 1
2 x 2 = 4
3 x 3 =
4 x 4 =
5 x 5 =
6 x 6 =
7 x 7 =
8 x 8 =
9 x 9 =
10 x 10 =
11 x 11 =
12 x 12 =

13 x 13 =
14 x 14 =
15 x 15 =
16 x 16 =
17 x 17 =
18 x 18 =
19 x 19 =
20 x 20 =

Tutorial One

Definition of Surds
Laws and Rules of

Objective A: Defining Surds

The use of numbers in a form that cannot be represented as a whole number. This is seen as having infinite number of non-reoccurring decimal numbers and the numbers are left in root form "(√)" to express its exact value.

For example: The number 9 has two square roots: +3 and -3. However, we always represent the square root as 3.
Every positive number has exactly two square roots

If *a is a rational number, and n is a positive integer, any irrational number of the form* $\sqrt[n]{a}$ *will be referred to as a surd*

<u>Examples</u>:

√2 is a surd.
√5 is a surd.
√81 *looks like* a surd, but isn't really...however these are still important when dealing with surds!

Objective A: Defining Surds

$$\sqrt{2} = 1.414213562.....$$

- This may look too long to write but it can be said not to be accurate!

We leave it as $\sqrt{2}$ ← surd.

$\sqrt{2} = 1.41421356237309504 88...$
$\sqrt{8} = 2.828427124746190097 6...$

Objective A: Defining Surds

Surds can also be multiplied together as shown.

$$\sqrt{2} \times \sqrt{8} = \sqrt{16}$$

A general rule: $\sqrt{x} \times \sqrt{y} = \sqrt{xy}$

$\sqrt{xy} = \sqrt{x} \quad \sqrt{y}$

$\sqrt{\frac{x}{y}} = \frac{\sqrt{x}}{\sqrt{y}}$

e.g. $\sqrt{12} = \sqrt{3} \quad \sqrt{4}$, $\sqrt{6} \quad \sqrt{5} = \sqrt{30}$

e.g. $\sqrt{\frac{10}{3}} = \frac{\sqrt{10}}{\sqrt{3}}$, $\sqrt{\frac{50}{21}} = \frac{\sqrt{50}}{\sqrt{21}}$

Objective A: Defining Surds

Examples of simplifying a surd.

Example 1

$$\sqrt{75}$$

$$\sqrt{25 \times 3}$$

$$5\sqrt{3}$$

Example 2

$$\sqrt{40}$$

$$\sqrt{4 \times 10}$$

$$2\sqrt{10}$$

A real number such as $2\sqrt{3}$ will be loosely referred to as a surd, since it can be expressed as $\sqrt{12}$.

Tutorial One

Definition of Surds
Laws and Rules of

Practice A: Defining Surds

A. State what you understand by surds?

B. How many roots are expected of a square number.

C. Differentiate between surds and numbers?

D. Write $\sqrt{80}$ in the form $c\sqrt{5}$, where c is a positive constant

Set A

$\sqrt{45}$ $\sqrt{18}$

$\sqrt{8}$ $\sqrt{27}$

$\sqrt{20}$ $\sqrt{24}$

Set B

$\sqrt{200}$ $\sqrt{63}$

$\sqrt{28}$ $\sqrt{50}$

$\sqrt{44}$ $\sqrt{54}$

Challenge

$\sqrt{192}$ $\sqrt{108}$ $\sqrt{147}$

$\sqrt{180}$ $\sqrt{112}$

Tutorial 2 – Simplification – addition, multiplying surds, expanding brackets, working backwards

Tutorial Two

Simplification – addition, multiplying surds, expanding brackets, working backwards

Objectives B: Simplification of Surds

The Rules of Roots and Surds

adding/subtracting:

$$a\sqrt{x} \pm b\sqrt{x} = (a \pm b)\sqrt{x}$$

e.g. $3\sqrt{2} + 5\sqrt{2} = 8\sqrt{2}$

$8\sqrt{7} - 2\sqrt{7} = 6\sqrt{7}$

Note

Although these rules are shown with square roots, they work with all roots, i.e. cube roots, fourth roots etc

$$\sqrt{xy} = \sqrt{x}\ \sqrt{y}$$

$$\sqrt{\frac{x}{y}} = \frac{\sqrt{x}}{\sqrt{y}}$$

$$\sqrt{xy} = (xy)^{\frac{1}{2}} = x^{\frac{1}{2}}\ y^{\frac{1}{2}} = \sqrt{x}\ \sqrt{y}$$

$$\sqrt{\frac{x}{y}} = \left[\frac{x}{y}\right]^{\frac{1}{2}} = \frac{x^{\frac{1}{2}}}{y^{\frac{1}{2}}} = \frac{\sqrt{x}}{\sqrt{y}}$$

adding/subtracting:

$$a\sqrt{x} \pm b\sqrt{x} = (a \pm b)\sqrt{x}$$

c $(a \pm b)$ = ca $\pm cb$

Tutorial Two

Simplification – addition, multiplying surds, expanding brackets, working backwards

Objectives B: Simplification of Surds

The Rules of Roots and Surds

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$$a\sqrt{x} \pm b\sqrt{x} = (a \pm b)\sqrt{x}$$

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$$\sqrt{xy} = \sqrt{x}\ \sqrt{y}$$

$$\sqrt{\frac{x}{y}} = \frac{\sqrt{x}}{\sqrt{y}}$$

$$\sqrt{xy} = (xy)^{\frac{1}{2}} = x^{\frac{1}{2}}\ y^{\frac{1}{2}} = \sqrt{x}\ \sqrt{y}$$

$$\sqrt{\frac{x}{y}} = \left[\frac{x}{y}\right]^{\frac{1}{2}} = \frac{x^{\frac{1}{2}}}{y^{\frac{1}{2}}} = \frac{\sqrt{x}}{\sqrt{y}}$$

adding/subtracting:

$$a\sqrt{x} \pm b\sqrt{x} = (a \pm b)\sqrt{x}$$

c $(a \pm b)$ = ca $\pm cb$

Tutorial Two

Simplification – addition, multiplying surds, expanding brackets, working backwards

Objectives B: Simplification – addition and subtraction

$$\sqrt{5} + \sqrt{45}$$

$$= \sqrt{9} \times \sqrt{5}$$

$$= 3\sqrt{5}$$

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

1 lot of root 5

ADD 3 lots of root 5

$$= 4\sqrt{5}$$

$$\sqrt{72} - \sqrt{18}$$

$$= \sqrt{36} \times \sqrt{2}$$

$$= 6\sqrt{2}$$

$$= \sqrt{9} \times \sqrt{2}$$

$$= 3\sqrt{2}$$

$$6\sqrt{2} - 3\sqrt{2}$$

$$= 3\sqrt{2}$$

Tutorial Two

Simplification – addition, multiplying surds, expanding brackets, working backwards

Objectives B: Simplification – multiplying surds

$$2\sqrt{20} \times 6\sqrt{5}$$

$$= 12 \times 10$$

$$= 120$$

$$= \sqrt{20} \times \sqrt{5}$$

$$= \sqrt{100}$$

$$= 10$$

Objectives B: Simplification – Expanding brackets

evaluate: $(2+\sqrt{2})(3-\sqrt{2})$

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

$$= 4 + \sqrt{2}$$

Note: $\sqrt{a} \times \sqrt{a} = a$

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

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

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

we treat surds like algebraic quantities

Tutorial Two

Simplification – addition, multiplying surds, expanding brackets, working backwards

Practice : Simplifying Surds

A. State the rules of surds you can remember?

B. Simplify

SET 1	SET 2	SET 3
$7\sqrt{3}+4\sqrt{3}$	$\sqrt{40}+\sqrt{10}$	$14\sqrt{5}-6\sqrt{5}$
$3\sqrt{5}+6\sqrt{5}$	$\sqrt{27}+\sqrt{12}$	$4\sqrt{8}+2\sqrt{18}$
$12\sqrt{11}-6\sqrt{11}$	$\sqrt{24}-\sqrt{6}$	$5\sqrt{32}+\sqrt{50}$
$2\sqrt{13}+13\sqrt{13}$	$\sqrt{44}+\sqrt{99}$	$4\sqrt{20}-3\sqrt{500}$
$14\sqrt{6}--2\sqrt{6}$	$\sqrt{125}-\sqrt{75}$	$3\sqrt{100}-2\sqrt{49}$

C. Simplify and evaluate fully,

SET 1 (write each in the form $k\sqrt{m}$ where k and m are both integers)	SET 2	SET 3
$\sqrt{20}$	$\sqrt{20}\times\sqrt{5}$	$(5+\sqrt{3})(6+\sqrt{3})$
$\sqrt{32}$	$\sqrt{6}\times\sqrt{8}\times\sqrt{3}$	$(7+\sqrt{5})(7-\sqrt{5})$
$\sqrt{147}$	$4\sqrt{27}\times 6\sqrt{3}$	$(7-\sqrt{2})(4-3\sqrt{2})$
$\sqrt{256}$	$5\sqrt{24}\times 2\sqrt{6}$	$(2+\sqrt{2})(5-\sqrt{8})$
$\sqrt{288}$	$3\sqrt{6}\times 2\sqrt{8}\times 4\sqrt{3}$	$(6+3\sqrt{3})(6-3\sqrt{3})$

1. Momentum

Keywords: momentum, mass, velocity, vector

Objectives this tutorial:

A) Understanding the use of Surds
B) Simplifying Surds
C) Calculating change in momentum

Objective A: Defining momentum

Momentum is defined by the equation $p=mv$, where:

- *p* is momentum (in kg m/s)

- *m* is mass (in kg)

- *v* is velocity (m/s)

Note that velocity is a vector – it has both a magnitude and a direction.

Practice A: Defining momentum

1) State the equation for momentum, defining the terms used.

2) Explain why the units for momentum are kg m/s.

3) Write a sentence defining momentum in words.

4) Rank the following from low to high momentum: an airliner in flight, a crawling ant, a man jogging, a falling acorn.

5) A car accelerates on the motorway. Explain whether the momentum of the car changes.

6) A car travels at a constant speed in a circle at a roundabout. Explain whether the momentum of the car changes.

Assessment A: Defining momentum

Tutorial 3 – **Rationalisation**

What is the Purpose of Tutorial 3?

Rationalisation – Principles, Key concept
Simplification – rationalization (simple & complex denominator)

Objective C: Rationalising

In higher level mathematics, we usually want the denominators of fractions surd -free.

Some of the reasons for this are:

- Easier to add fractions with rational denominators
- Easier to get a "feel" for the size of a fraction with a surd-free denominator
- Looks!

Given a fraction with a surd appearing in the denominator, we can find another equivalent fraction with the denominator surd-free.

We are <u>rationalising the denominator</u>

Here are some of the "tricks" involved in this process:

Tutorial Three

Rationalisation – Principles, Key concept
Simplification – rationalization (simple & complex denominator)

Objective C: Rationalising

Rationalising Denominators with simple Surds

To rationalise the denominator of $\frac{1}{\sqrt{2}}$, the expression is multiplied by the denominator

$$\frac{1}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = \frac{\sqrt{2}}{2}$$

To rationalise the denominator of $\frac{3}{\sqrt{3}}$, the expression is multiplied by the denominator

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

To rationalise the denominator of $\frac{3}{2\sqrt{5}}$, the expression is multiplied by the denominator

$$\frac{3}{2\sqrt{5}} \times \frac{\sqrt{5}}{5} = \frac{3\sqrt{5}}{2 \times 5} = \frac{3}{10}\sqrt{5}$$

Tutorial Three

Rationalisation – Principles, Key concept
Simplification – rationalization (simple & complex denominator)

Objective C: Rationalising

Rationalising Denominators with complex Surds

To rationalise the denominator of $\frac{1}{3+\sqrt{2}}$, the expression is multiplied by the conjugate surd of the denominator which is $3-\sqrt{2}$

$$\frac{1}{3+\sqrt{2}} \times \frac{3-\sqrt{2}}{3-\sqrt{2}} = \frac{3-\sqrt{2}}{9-3\sqrt{2}+3\sqrt{2}-2} = \frac{3-\sqrt{2}}{7}$$

To rationalise the denominator of $\frac{5}{\sqrt{5}-2}$, the expression is multiplied by the conjugate surd of the denominator which is $\sqrt{5}+2$

$$\frac{5}{\sqrt{\mathbf{5}}-\mathbf{2}} \times \frac{\sqrt{\mathbf{5}}+\mathbf{2}}{\sqrt{\mathbf{5}}+\mathbf{2}} = \frac{3\times(\sqrt{\mathbf{5}}+\mathbf{2})}{5+2\sqrt{5}-2\sqrt{5}-4} = \frac{3\sqrt{5}+6}{1} = 3\sqrt{5}+6$$

To rationalise the denominator of $\frac{\sqrt{2}}{\sqrt{3}+\sqrt{2}}$, the expression is multiplied by the conjugate surd of the denominator which is $\sqrt{3}-\sqrt{2}$

$$\frac{\sqrt{2}}{\sqrt{\mathbf{3}}+\sqrt{\mathbf{2}}} \times \frac{\sqrt{\mathbf{3}}-\sqrt{\mathbf{2}}}{\sqrt{\mathbf{3}}-\sqrt{\mathbf{2}}} = \frac{\sqrt{2}\times(\sqrt{\mathbf{3}}-\sqrt{\mathbf{2}})}{3-6+\sqrt{6}-2} = \frac{\sqrt{6}-2}{1} = \sqrt{6}-2$$

Tutorial Three

Rationalisation – Principles, Key concept
Simplification – rationalization (simple & complex denominator)

Practice: Rationalising

A. State what is understood by conjugate surd?

B. Evaluate and Simplify

SET 1

$$\frac{\sqrt{50}}{\sqrt{2}}$$

$$\frac{\sqrt{320}}{\sqrt{5}}$$

$$\frac{\sqrt{1000}}{\sqrt{10}}$$

$$\frac{\sqrt{35}\times\sqrt{5}}{\sqrt{7}}$$

$$\frac{\sqrt{30}\times\sqrt{12}}{\sqrt{2}\times\sqrt{5}}$$

SET 2

$$\frac{6\sqrt{160}}{3\sqrt{10}}$$

$$\frac{4\sqrt{72}\times 3\sqrt{4}}{12\sqrt{2}}$$

$$\frac{1}{1+\sqrt{2}}$$

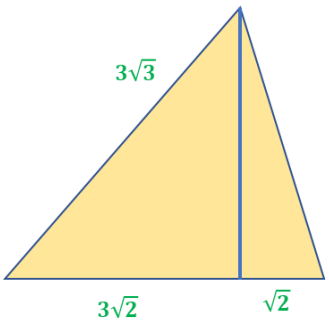
$$\frac{3+\sqrt{2}}{3-\sqrt{2}}$$

$$\frac{6-\sqrt{5}}{6+\sqrt{5}}$$

SET 3

$$\frac{6}{\sqrt{3}}+\sqrt{75}$$

$$\frac{8}{\sqrt{2}}+\sqrt{18}$$



Calculate the area of the triangle

Tutorial 4 – Revision Techniques/Final Assignment

- Solving Past exam question papers
- Understanding and comprehending skills required to answer each question

Tutorial 5– Feedback tutorial

What is the Purpose of Tutorial 5?

- To receive feedback on final assignments.
- To share examples of best practice with the other pupils in your group.
- To write targets for improvement in school lessons.

To reflect on the programme including what was enjoyed and what was challenging.

Final assignment feedback

What I did well...	What I could have improved on...

My target for future work is...

Reflecting on Uni Pathways

What did you most enjoy about Uni Pathways?

What did you find challenging about the programme?	How did you overcome these challenges?

Appendix 1 – Referencing correctly

When you get to university, you will need to include references in the assignments that you write, so we would like you to start getting into the habit of referencing in your Brilliant Club assignment. This is really important, because it will help you to avoid plagiarism. Plagiarism is when you take someone else's work or ideas and pass them off as your own. Whether plagiarism is deliberate or accidental, the consequences can be severe. In order to avoid losing marks in your final assignment, or even failing, you must be careful to reference your sources correctly.

What is a reference?

A reference is just a note in your assignment which says if you have referred to or been influenced by another source such as book, website or article. For example, if you use the internet to research a particular subject, and you want to include a specific piece of information from this website, you will need to reference it.

Why should I reference?

Referencing is important in your work for the following reasons:

It gives credit to the authors of any sources you have referred to or been influenced by.
It supports the arguments you make in your assignments.
It demonstrates the variety of sources you have used.
It helps to prevent you losing marks, or failing, due to plagiarism.

When should I use a reference?

You should use a reference when you:

Quote directly from another source.
Summarise or rephrase another piece of work.
Include a specific statistic or fact from a source.

How do I reference?

There are a number of different ways of referencing, and these often vary depending on what subject you are studying. The most important to thing is to be consistent. This means that you need to stick to the same system throughout your whole assignment. Here is a basic system of referencing that you can use, which consists of the following two parts:

1. **A marker in your assignment:** After you have used a reference in your assignment (you have read something and included it in your work as a quote, or re-written it your own words) you should mark this is in your text with a number, e.g. [1]. The next time you use a reference you should use the next number, e.g. [2].

2. **Bibliography:** This is just a list of the references you have used in your assignment. In the bibliography, you list your references by the numbers you have used, and include as much information as you have about the reference. The list below gives what should be included for different sources.

Websites – Author (if possible), title of the web page, website address, [date you accessed it, in square brackets].

E.g. Dan Snow, 'How did so many soldiers survive the trenches?', http://www.bbc.co.uk/guides/z3kgjxs#zg2dtfr [11 July 2014].

Books – Author, date published, title of book (in italics), pages where the information came from.

E.g. S. Dubner and S. Levitt, (2006) *Freakonomics*, 7-9.

Articles – Author, 'title of the article' (with quotation marks), *where the article comes from* (newspaper, journal etc.), date of the article.

E.g. Maev Kennedy, 'The lights to go out across the UK to mark First World War's centenary', Guardian, 10 July 2014.

Notes

Notes

Notes

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