



# CHAPTER 3: SURDS





# CHAPTER ANALYSIS



- Four operations on surds, including rationalizing the denominator.
- Simplifying surds.
- Solving equations involving surds.

**Surds is a topic that will be tested together with several topics such as Differentiation, Integration.**

**The questions tested on this topic will always involve RATIONALISATION.**

\*This chapter has a pre-requisite of E-Math Chapter 3: Indices.\*



# LAWS OF INDICES

- You are expected to know Indices before starting on the topic of Surds.

- Some laws of indices are related to the 4 operations of surds ("Same Power")

## Common Mistake

The following 2 statements are **INCORRECT**, but many students still get confused and use these 2 statements in their solutions

$$a^m + b^m = (a + b)^m \dots\dots(*)$$

$$a^m - b^m = (a - b)^m$$

**Proof that (\*) is incorrect**

By substituting values of  $a = 1$ ,  $b = 2$  and  $m = 3$

$$\text{LHS} = 1^3 + 2^3 = 9$$

$$\text{RHS} = (1 + 2)^3 = 27$$

$$\therefore \text{LHS} \neq \text{RHS}$$

Laws of Indices	
Same Base	$a^m \times a^n = a^{m+n}$
	$\frac{a^m}{a^n} = a^{m-n}$
	$(a^m)^n = a^{mn}$
Same Power	$a^m \times b^m = (ab)^m$
	$\frac{a^m}{b^m} = \left(\frac{a}{b}\right)^m$
Radicals	$\sqrt[n]{a} = a^{\frac{1}{n}}$
	$a^{\frac{m}{n}} = (\sqrt[n]{a})^m = \sqrt[n]{a^m}$
Others	$a^0 = 1$
	$a^{-n} = \frac{1}{a^n}$



## 4 OPERATIONS OF SURDS

- The law of multiplication and division occurs due to law of indices (same power), which explains why we can combine the base (a and b in this case) together.

- The law of addition and subtraction involves factorising the common surd before performing addition/subtraction.

Common misconception about addition/subtraction

$$\sqrt{3} + \sqrt{2} = \sqrt{5} \quad \times$$

**We only can combine the numbers inside the surd when it is multiplication or division.**

Laws of Surds	
Multiplication	$\sqrt{a} \times \sqrt{b} = a^{\frac{1}{2}} \times b^{\frac{1}{2}} = (ab)^{\frac{1}{2}} = \sqrt{ab}$
Division	$\sqrt{a} \div \sqrt{b} = \frac{a^{\frac{1}{2}}}{b^{\frac{1}{2}}} = \left(\frac{a}{b}\right)^{\frac{1}{2}} = \sqrt{\frac{a}{b}}$
Addition	$m\sqrt{a} + n\sqrt{a} = (m + n)\sqrt{a}$
Subtraction	$m\sqrt{a} - n\sqrt{a} = (m - n)\sqrt{a}$



## RATIONALISATION OF SURDS

We rationalise surds so that we can remove the roots from the denominator since there should not be any roots in your denominators when presented as the final answer.

Case 1: When the denominator is  $\sqrt{a}$ , we rationalise by multiplying the denominator by  $\sqrt{a}$  so that the square root will be removed. However, remember to multiply the numerator by the same surd so that the value of equation remains constant.

Case 2: You rationalise the denominator by multiplying by its conjugate surd. The same rule applies here: remember to multiply the numerator by the same surd so that the value of equation remains constant.

\*The conjugate surd of  $m\sqrt{a} \pm n\sqrt{b}$  will be  $m\sqrt{a} \mp n\sqrt{b}$ .\*

Reason behind is to make use of the special identity of:

$$(a + b)(a - b) = a^2 - b^2$$

The act of removing the roots from the denominators. There are **2** cases of rationalisation

- **Case 1:** Denominator of single-term surds

- Rationalise by multiplying the numerator and denominator by  $\sqrt{a}$  to get  $a$

$$\begin{aligned}\frac{3}{\sqrt{12}} &= \left(\frac{3}{\sqrt{12}}\right)\left(\frac{\sqrt{12}}{\sqrt{12}}\right) \\ &= \frac{3\sqrt{2^2 \times 3}}{12} \\ &= \frac{3(2)\sqrt{3}}{12} \\ &= \frac{\sqrt{3}}{2}\end{aligned}$$

- **Case 2:** Denominator of sum/difference of surds

- Rationalise by multiplying the numerator and denominator by its conjugate surd to get a rational number

$$\begin{aligned}\frac{1}{\sqrt{5}-2} &= \left(\frac{1}{\sqrt{5}-2}\right)\left(\frac{\sqrt{5}+2}{\sqrt{5}+2}\right) \\ &= \frac{1(\sqrt{5}+2)}{(\sqrt{5})^2 - (2)^2} \\ &= \sqrt{5}+2\end{aligned}$$





## SOLVING EQUATIONS INVOLVING SURDS

$$\sqrt{5x + 2} - \sqrt{3x - 8} = 0$$

1) Make the equation in the form of LHS = RHS.

$$\sqrt{5x + 2} = \sqrt{3x - 8}$$

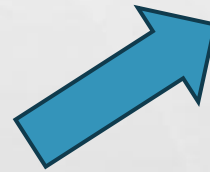
2) Remove the square roots by applying square on both sides .

$$5x + 2 = 3x - 8$$

3) Solve the algebraic equation.

$$2x = -6$$

$$x = -3$$



If you obtain a quadratic equation which results in 2 solutions, check for your solutions by subbing it back into the original equation (question). Reject accordingly if the answers do not match.



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6,214 subscribers



OVERMUGGED, 'A' Levels Channel  
2,778 subscribers

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# LEADERS IN THE CHANGING EDUCATION LANDSCAPE

## FEATURED ON STRAITS TIMES

Our efforts to go out of our way to support our students were captured by local new publications.

OVERMUGGED was SG first tuition center to host large scale mock exam!

Our student's needs comes first!

**Vulcan Post** 12h

Overmugged launched a tuition subscription plan for 'O' Levels subjects to make education more affordable and accessible, and has achieved a six-figure revenue in its first year.

**TODAY** June 16 at 5:49 PM

One Primary 6 student who is sitting mock exams told TODAY: "I feel stress didn't do any exams all the way until prelims and PSLE... I'll be unfamiliar with environment and I cannot concentrate."

**OVERMUGGED: This 28-year-old built S'pore's first online tuition subscription service**

You and 8 others

1 comment 5 shares

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**TODAYONLINE.COM**

Hundreds sign up for tuition centre mock exams costing up to \$100 after scrapping of all mid-year school exams

53

Like



**P6 and Sec 4 students flock to tuition centres for mock exams after scrapping of school midterms**

Wong Shiyong

The Ministry of Education (MOE) scrapped mid-year exams for all primary and secondary schools from 2023. Education Minister Chan Chun Sing said in March 2022 that the move would give students space to develop their interests and skills outside the classroom and to focus more on their learning and well-being. MOE said it would consider opening up mock exams in 2023 for students not with the center of Learning, Progress and Achievement (LPA) which offers English and primary, secondary and JC level, tuition centres said. The Straits Times reported that the Ministry of Education (MOE) scrapped mid-year exams for all primary and secondary schools from 2023. Education Minister Chan Chun Sing said in March 2022 that the move would give students space to develop their interests and skills outside the classroom and to focus more on their learning and well-being. MOE said it would consider opening up mock exams in 2023 for students not with the center of Learning, Progress and Achievement (LPA) which offers English and primary, secondary and JC level, tuition centres said. The Straits Times reported that the Ministry of Education (MOE) scrapped mid-year exams for all primary and secondary schools from 2023.



## With midterms scrapped, students take mock exams at tuition centres



Students taking a mock exam paper at tuition centre Overmugged. Tuition centres said they organized such sessions following strong demand after mid-year exams were scrapped for all primary and secondary schools from 2023. Education Minister Chan Chun Sing previously said the move would give students space to develop their interests and skills outside the classroom and to focus more on their learning and well-being. MOE said it would consider opening up mock exams in 2023 for students not with the center of Learning, Progress and Achievement (LPA) which offers English and primary, secondary and JC level, tuition centres said. The Straits Times reported that the Ministry of Education (MOE) scrapped mid-year exams for all primary and secondary schools from 2023.

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# OUR LOCATIONS



**BUKIT TIMAH**  
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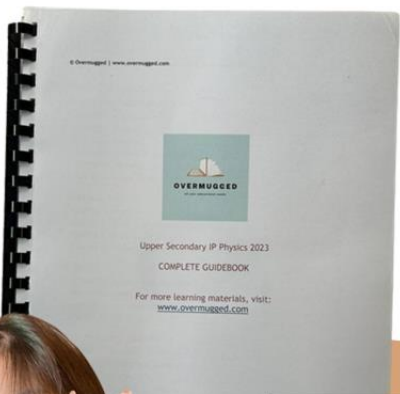
## WEEKLY WORKSHEETS

Topical, Thematic, Mock Test, Mock Exam,  
Prelim Prep, Practical Prep

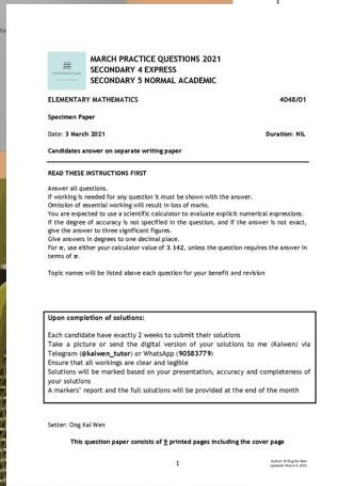


## EXCLUSIVE CHEATSHEETS

Revision booklets, extra cheatsheets,  
Practical Assessment booklet



TOPIC: KINEMATICS			
Concept	Definition	Formula	Remarks
Linear Motion	<ul style="list-style-type: none"> <li>Object that is moving in a straight line</li> <li>1-D motion</li> </ul>	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$	<ul style="list-style-type: none"> <li>Motion can be represented (upwards or right) or -ve (down or left) sign.</li> <li>Equations can only be used if acceleration is constant.</li> </ul>
2-D Motion	<ul style="list-style-type: none"> <li>Object that is moving in a projectile trajectory (x and y directions)</li> <li>2-D motion</li> <li>Acceleration is experienced in both axes</li> <li>Vertical and horizontal motion are independent of each other</li> </ul>	<p>Horizontal motion (acceleration = 0)</p> $v_x = u_x$ $s_x = u_x t$ <p>Vertical motion (uniform vertical acceleration = g)</p> $v_y = u_y + at$ $s_y = u_y t + \frac{1}{2}at^2$ $v_y^2 = u_y^2 + 2as$	<ul style="list-style-type: none"> <li>Acceleration always act down</li> <li>Projectile will free fall and parabolic if resistance is negligible</li> </ul>
2 Vectors	Analyse the horizontal and vertical motion separately	<p>For a vector <math>\vec{v}</math> pointing at an angle <math>\theta</math> from the horizontal:</p> $v_x = v \cos\theta \text{ (horizontal)}$ $v_y = v \sin\theta \text{ (vertical)}$ $v = \sqrt{v_x^2 + v_y^2}$ $\tan\theta = \frac{v_y}{v_x} \Rightarrow \theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$	



$v^2 = (u \sin\theta)^2 - 2gh$ $\Delta H = \frac{u^2 \sin^2\theta}{2g}$	With air resistance, <ul style="list-style-type: none"> <li>Drag force acts in the same as the weight of object.</li> <li>Net acceleration <math>&gt;&gt; g</math></li> <li>Maximum height reached lower.</li> </ul>
$v_y = u \sin\theta - gt_{up}$ $\Delta t_{up} = \frac{u \sin\theta}{g}$	With air resistance, <ul style="list-style-type: none"> <li>Drag force acts in the same as the weight of object.</li> <li>Net acceleration <math>&gt;&gt; g</math></li> <li>Final vertical speed smaller than vertical speed</li> <li>Average speed upwards <math>&gt;&gt; g</math></li> </ul>



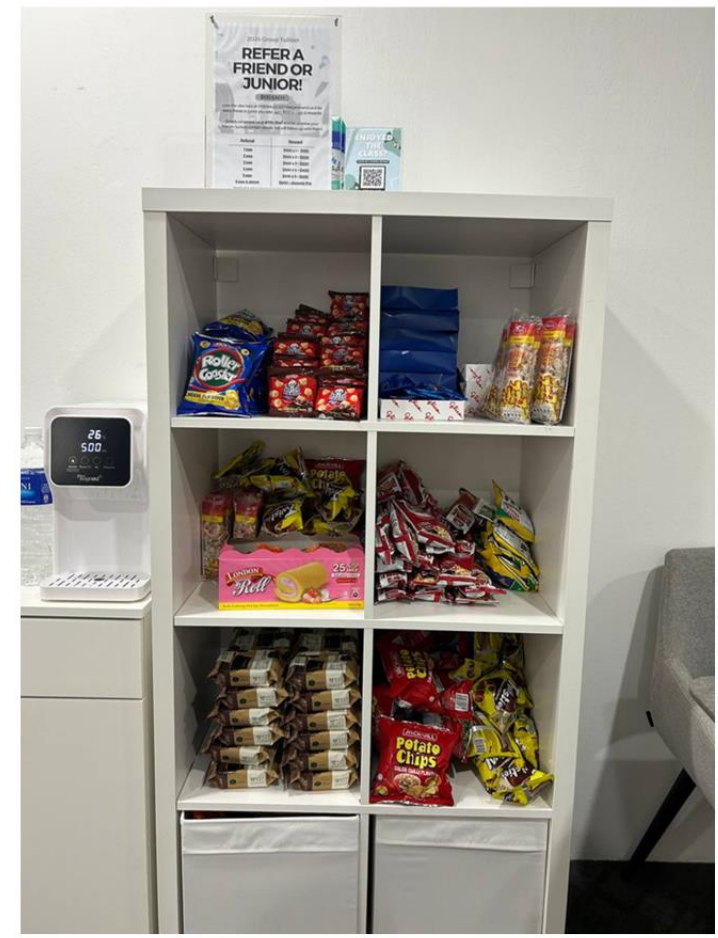




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\$85/lesson (weekend)

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*10% if signing up for 2 'A' Levels subject & above*

*Fees are collected at the start of the term  
(every 3 months).*



# ACADEMIC YEAR

## TERM 1: NOV – JAN

### Topical Recaps

Key highlight: Christmas Party

## TERM 2: FEB – APR

### Topical Mastery

Key highlight: March Holiday Cohesion Program

## TERM 3: MAY – JUL

### Prelim/EOY Preparation

Key highlight: Mock Prelim/EOY

## TERM 4: AUG – OCT

### 'O' Levels / 'A' Levels Preparation

Key highlight: Mock Exams, Science Practical Assessment







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