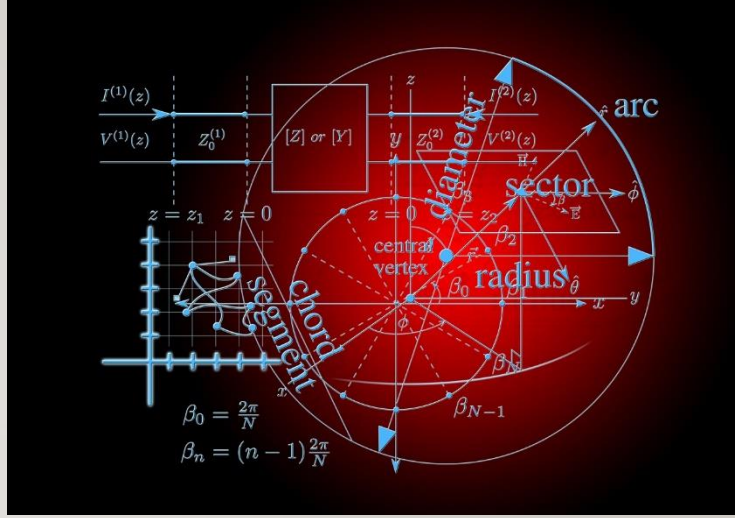


Chapter 2: Equations and Inequalities

CHAPTER ANALYSIS

1) Discriminant ($b^2 - 4ac$)

- $b^2 - 4ac > 0$: 2 real and distinct roots
- $b^2 - 4ac < 0$: No real roots
- $b^2 - 4ac = 0$: 2 real and equal roots (1 root)

2) Making use of discriminant and real roots to identify the relationship between a line and curve

- Line is a tangent to the curve
- Line does not intersect the curve
- Line intersects the curve at 2 points

3) Solving quadratic inequalities

QUADRATIC EQUATIONS AND ITS ROOTS

A quadratic equation is usually expressed in the form of $ax^2 + bx + c = 0$.

Methods to solve quadratic equations and obtain its roots (solutions):

1) Factorisation

$$\boxed{ax^2 + bx + c = 0} \Rightarrow \boxed{a(x - \alpha)(x - \beta) = 0}$$

Solving the equation gives $x = \alpha$ or $x = \beta$

2) Quadratic formula

$$\boxed{x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{where, } a \neq 0}$$

(This is the reason why the discriminant matters! Can you guess why?)

IMPORTANT

Students are not allowed to assume the discriminant signature as this is a show question. Students are supposed to reach the discriminant signature on their own, hence, proving the claim of the question

Example

Show that the following has real and distinct roots for all real values of x

$$(p+1)x^2 + (4p+3)x + 2p - 1 = 0$$

[S4 CWSS P1/2009 PRELIM Qn 9(b)]

Solution:

To show that the function has real and distinct roots

$$\text{WTS: } b^2 - 4ac > 0$$

$$\begin{aligned} D &= (4p+3)^2 - 4(p+1)(2p-1) \\ &= 16p^2 + 24p + 9 - 4\left(2p^2 + p - 1\right) \\ &= 16p^2 + 24p + 9 - 8p^2 - 4p + 4 \\ &= 8p^2 + 20p + 13 \\ &= 8\left(p^2 + \frac{5}{2}p + \frac{13}{8}\right) \\ &= 8\left[\left(p + \frac{5}{4}\right)^2 - \left(\frac{5}{4}\right)^2 + \frac{13}{8}\right] \\ &= 8\left(p + \frac{5}{4}\right)^2 + \frac{1}{2} \end{aligned}$$

Since $\left(p + \frac{5}{4}\right)^2 > 0$,

$$8\left(p + \frac{5}{4}\right)^2 > 0$$

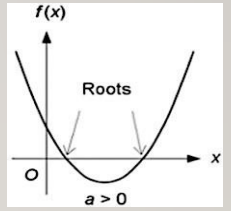
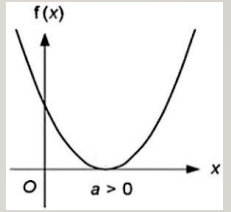
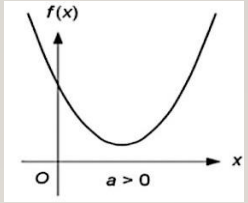
$$8\left(p + \frac{5}{4}\right)^2 + \frac{1}{2} > 0$$

Hence, the function has real and distinct roots **(shown)**

□

Discriminant of a quadratic equation and its roots

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad \text{Discriminant } = b^2 - 4ac$$

Nature of Roots	Discriminant	Graphical Representation
2 real and distinct roots	$b^2 - 4ac > 0$	
2 equal roots	$b^2 - 4ac = 0$	
No real roots	$b^2 - 4ac < 0$	

Sub the values of discriminant (positive, negative or zero) into the quadratic formula above and find out how many solutions are there (equivalent to number of roots).
Note: You cannot square root a negative number, hence there is no solution.

IMPORTANT

Students are not allowed to assume the discriminant signature as this is a show question. Students are supposed to reach the discriminant signature on their own, hence, proving the claim of the question

Example

Show that the line meets the curve at 2 distinct points for all real values of k

$$y = 5 - k$$

$$y = x^2 - kx$$

[S3 SQSS P1/2011 MYE Qn 10(b) (MODIFIED)]

Solution:

$$y = 5 - k \quad .....(1)$$

$$y = x^2 - kx \quad .....(2)$$

Take Equation (1) = Equation (2)

$$5 - k = x^2 - kx$$

$$x^2 - kx + (k - 5) = 0$$

To show that the line meets the curve

WTS: $b^2 - 4ac > 0$

$$D = (-k)^2 - 4(1)(k - 5)$$
$$= k^2 - 4k + 20$$
$$= (k - 2)^2 - (2)^2 + 20$$
$$= (k - 2)^2 + 16$$

Since k can take any real value,

$$(k - 2)^2 > 0$$

$$(k - 2)^2 + 16 > 0$$

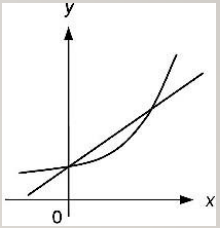
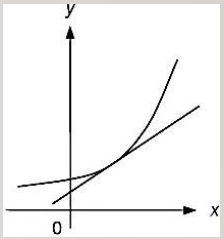
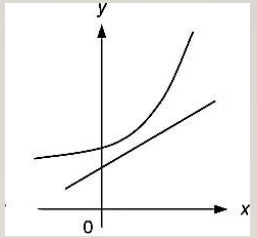
Hence, the line will meet the curve at 2 distinct points for all real values of k **(shown)**

□

Relationship between line and curve

Step 1: Solve the equations simultaneously by substituting the equation of the line into the equation of the curve to eliminate one of the variables (make x the only unknown)

Step 2: Make one side equals to 0 and find the discriminant

Intersection	Discriminant	Graphical Representation
Intersect at 2 distinct points	$b^2 - 4ac > 0$	
Tangential	$b^2 - 4ac = 0$	
Do not intersect	$b^2 - 4ac < 0$	

SOLVING QUADRATIC INEQUALITIES

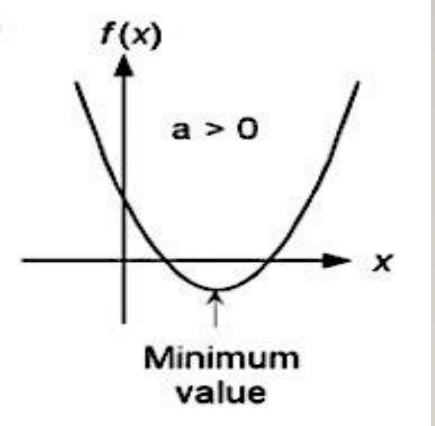
Step 1: Expand the equation and make one side equals to zero.

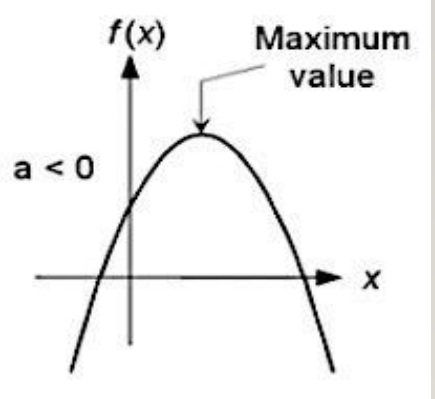
Step 2: Factorise the quadratic equation into this form:

$$a\ (x - \alpha)(x - \beta)\ = 0$$

Step 3: Sketch the quadratic graph

(*Make use of the coefficient of x^2 to identify the shape of graph*)



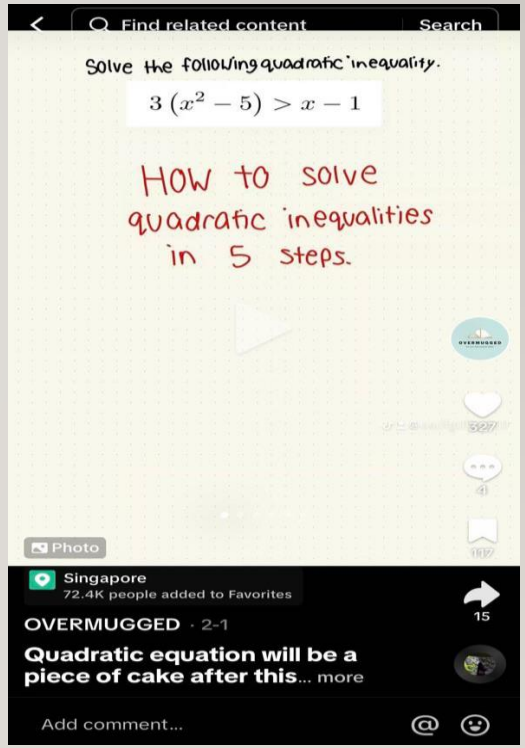


SOLVING QUADRATIC INEQUALITIES

Step 4: Label the x-intercepts of the graph

Step 5: Shade the region between the curve and the x-axis and you will obtain your answer.

If you need a question example for better understanding, check out this video on Overmugged's TikTok channel: https://vt.tiktok.com/ZSFj43eEF/



CONDITIONS FOR QUADRATIC EQUATION TO BE ALWAYS POSITIVE OR ALWAYS NEGATIVE

- ALWAYS POSITIVE

1) Coefficient of $x^2, also\ known\ as\ a\ > 0$
2) Discriminant $b^2 - 4ac\ < 0$

- ALWAYS NEGATIVE

1) Coefficient of $x^2, also\ known\ as\ a\ < 0$
2) Discriminant $b^2 - 4ac\ < 0$

Discriminant must always be negative as there should not be any intersections between the curve and the x-axis for it to always be above or below the x-axis.

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07

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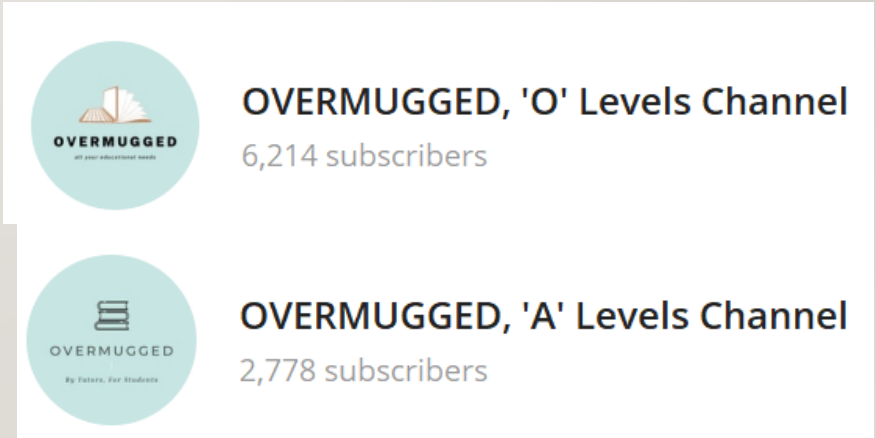

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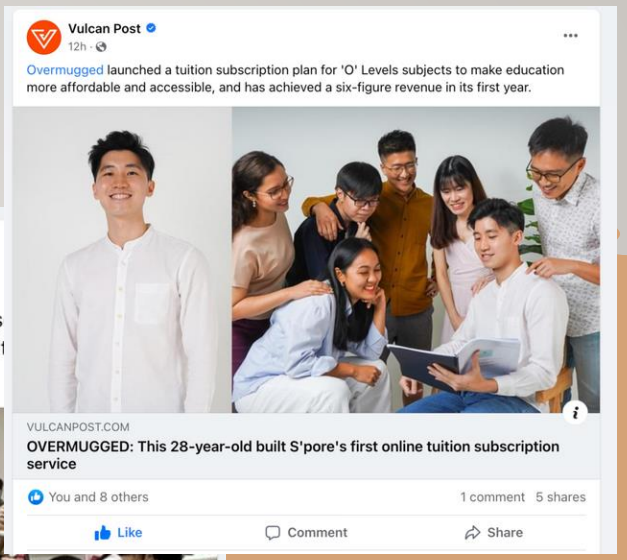
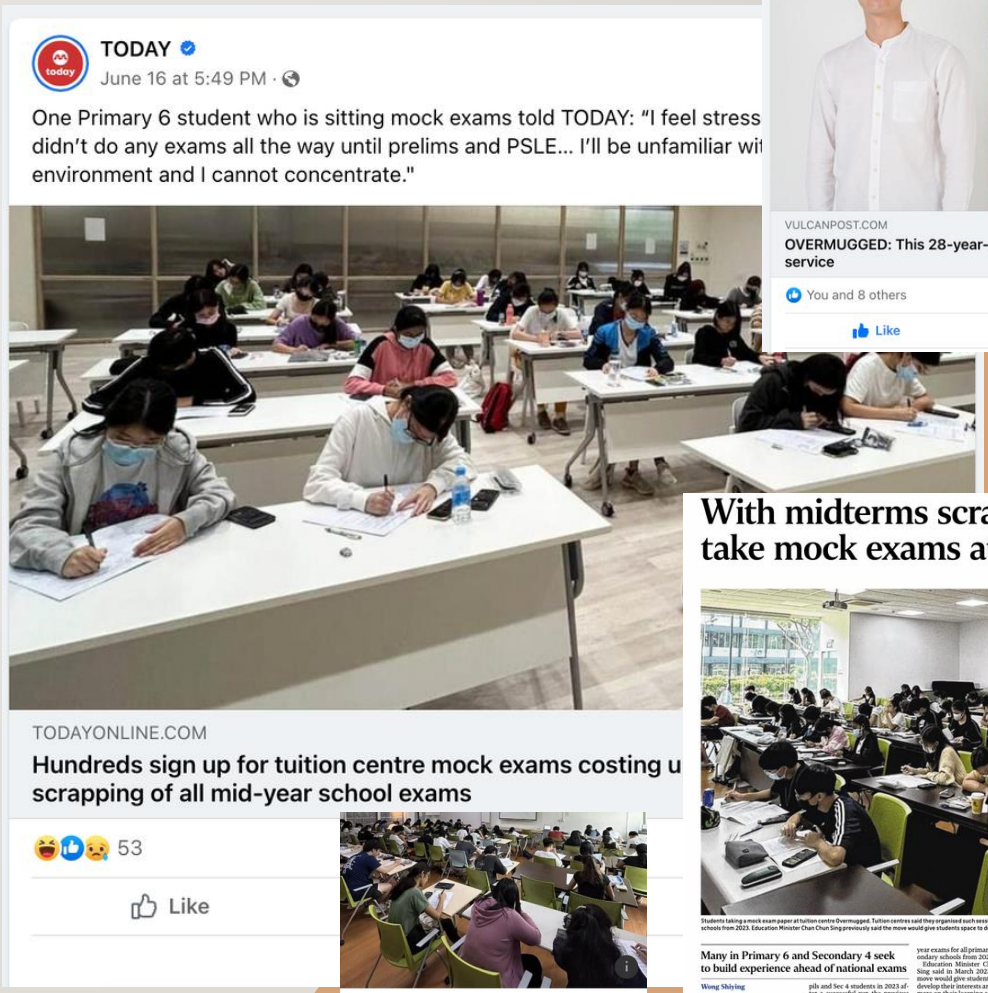
OVERMUGGED was SG first tuition center to host large scale mock exam!

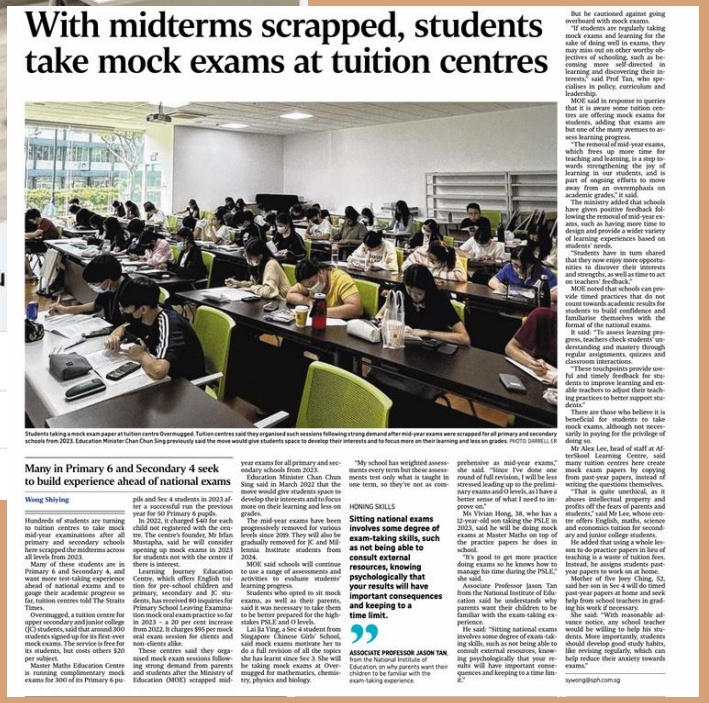
Our student's needs comes first!





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

Wong Shiying
The Straits Times



With midterms scrapped, students take mock exams at tuition centres

Students taking a mock exam paper at tuition centre Overmugged. Tuition centres said they organised 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 to focus more on their learning and less on grades. PHOTO: DARRELL LE

Many in Primary 6 and Secondary 4 seek to build experience ahead of national exams

Wong Shiying

Hundreds of students are turning to tuition centres to take mock mid-year examinations after all primary and secondary schools here scrapped the midterms across all levels from 2023.

Many of these students are in Primary 6 and Secondary 4, and want more test-taking experience ahead of national exams and to gauge their academic progress so far, tuition centres told The Straits Times.

Overmugged, a tuition centre for upper secondary and junior college (JC) students, said that around 300 students signed up for its first-ever mock exams. The service is free for its students, but costs others $20 per subject.

Master Maths Education Centre is running complimentary mock exams for 300 of its Primary 6 pupils and Sec 4 students in 2023 after a successful run the previous year for 50 Primary 6 pupils.

In 2022, it charged $40 for each child not registered with the centre. The centre's founder, Mr Irfan Mustapha, said he will consider opening up mock exams in 2023 for students not with the centre if there is interest.

Learning Journey Education Centre, which offers English tuition for pre-school children and primary, secondary and JC students, has received 80 inquiries for Primary School Leaving Examination mock oral exam practice so far in 2023 – a 20 per cent increase from 2022. It charges $95 per mock oral exam session for clients and non-clients alike.

These centres said they organised mock exam sessions following strong demand from parents and students after 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 to focus more on their learning and less on grades.

The mid-year exams have been progressively removed for various levels since 2019. They will also be gradually removed for IC and Millennia Institute students from 2024.

MOE said schools will continue to use a range of assessments and activities to evaluate students' learning progress.

Students who opted to sit mock exams, as well as their parents, said it was necessary to take them to be better prepared for the high-stakes PSLE and O levels.

Lai Ja Ying, a Sec 4 student from Singapore Chinese Girls' School, said mock exams motivate her to do a full revision of all the topics she has learnt since Sec 3. She will be taking mock exams at Overmugged for mathematics, chemistry, physics and biology.

"My school has weighted assessments every term but these assessments test only what is taught in one term, so they're not as comprehensive as mid-year exams," she said. "Since I've done one round of full revision, I will be less stressed leading up to the preliminary exams and O levels, as I have a better sense of what I need to improve on."

HONING SKILLS

Sitting national exams involves some degree of exam-taking skills, such as not being able to consult external resources, knowing psychologically that your results will have important consequences and keeping to a time limit.

ASSOCIATE PROFESSOR JASON TAN, from the National Institute of Education, on why parents want their children to be familiar with the exam-taking experience.

Ms Vivian Hong, 38, who has a 12-year-old son taking the PSLE in 2023, said he will be doing mock exams at Master Maths on top of the practice papers he does in school.

"It's good to get more practice doing exams so he knows how to manage his time during the PSLE," she said.

Associate Professor Jason Tan from the National Institute of Education said he understands why parents want their children to be familiar with the exam-taking experience.

He said: "Sitting national exams involves some degree of exam-taking skills, such as not being able to consult external resources, knowing psychologically that your results will have important consequences and keeping to a time limit."

But he cautioned against going overboard with mock exams.

"If students are regularly taking mock exams and learning for the sake of doing well in exams, they may miss out on other worthy objectives of schooling, such as becoming more self-directed in learning and discovering their interests," said Prof Tan, who specialises in policy, curriculum and leadership.

MOE said in response to queries that it is aware some tuition centres are offering mock exams for students, adding that exams are but one of the many avenues to assess learning progress.

"The removal of mid-year exams, which frees up more time for teaching and learning, is a step towards strengthening the joy of learning in our students, and is part of ongoing efforts to move away from an overemphasis on academic grades," it said.

The ministry added that schools have given positive feedback following the removal of mid-year exams, such as having more time to design and provide a wider variety of learning experiences based on students' needs.

"Students have in turn shared that they now enjoy more opportunities to discover their interests and strengths, as well as time to act on teachers' feedback."

MOE noted that schools can provide timed practices that do not count towards academic results for students to build confidence and familiarise themselves with the format of the national exams.

It said: "To assess learning progress, teachers check students' understanding and mastery through regular assignments, quizzes and classroom interactions.

"These touchpoints provide useful and timely feedback for students to improve learning and enable teachers to adjust their teaching practices to better support students."

There are those who believe it is beneficial for students to take mock exams, although not necessarily in paying for the privilege of doing so.

Mr Alex Lee, head of staff at AfterSkool Learning Centre, said many tuition centres here create mock exam papers by copying from past-year papers, instead of writing the questions themselves.

"That is quite unethical, as it abuses intellectual property and peeps off the fears of parents and students," said Mr Lee, whose centre offers English, maths, science and economics tuition for secondary and junior college students.

He said that using a whole lesson to do practice papers in lieu of teaching is a waste of tuition fees. Instead, he assigns students past-year papers to work on at home.

Mother of five Joey Ching, 52, said her son in Sec 4 will do timed past-year papers at home and seek help from school teachers in grading his work if necessary.

She said: "With reasonable advance notice, any school teacher would be willing to help his students. More importantly, students should develop good study habits, like revising regularly, which can help reduce their anxiety towards exams."

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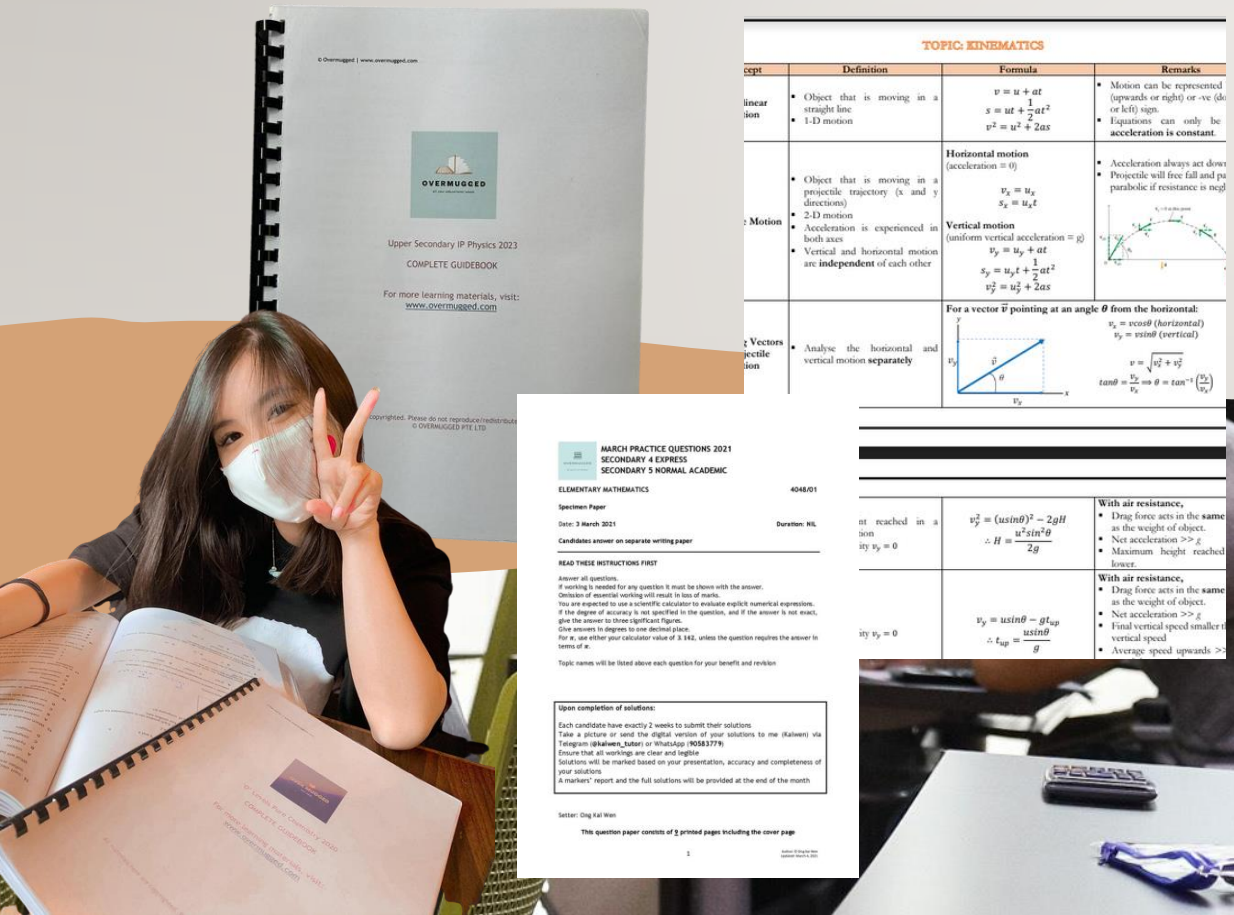

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TERM 4: AUG - OCT

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