NATIONAL JUNIOR COLLEGE
JUNIOR HIGH 3
Mathematics

NAME	Yi Jun

CLASS	JH30 2	REGISTRATION NUMBER	11

ADVANCED MATHEMATICS I — MA300

Quiz 2 (Question Paper)

22 or 23 July 2026

1 hour 15 minutes

Candidates answer in the **Answer** Booklet.

Additional Materials: Printed Answer Booklet

READ THESE INSTRUCTIONS FIRST

This paper constitutes 15% of your overall score for the module MA300.

Write your name, class and registration number in the boxes above. Please write clearly and use capital letters.

Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
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Answer **all** the questions.

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Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

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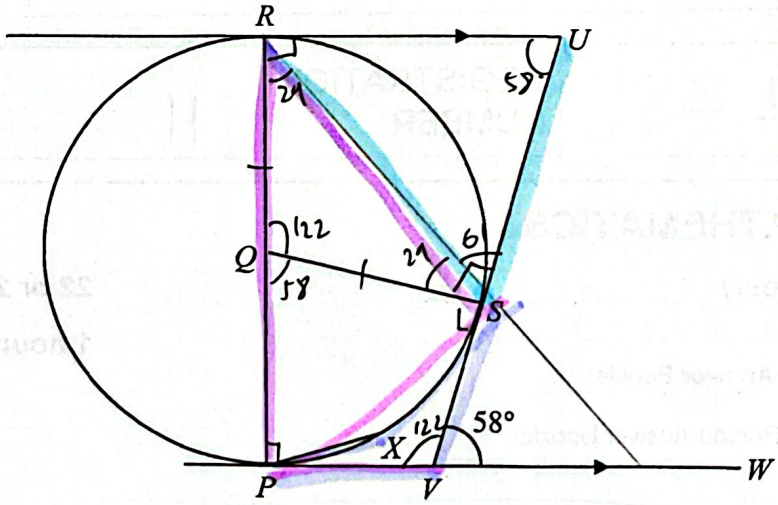
The number of marks is given in the brackets [ ] at the end of each question or part question.

This document consists of **5** printed pages and **1** blank page.

[Turn over

1 Solve the inequality $\log_{\frac{1}{3}} x + \log_3 (x^2 - 2) \geq 0$. [5]

2 In the diagram, RU, UV and PW are tangents to the circle at R, S and P respectively. RU is parallel to PW and RP is a diameter of the circle. X is a point on the circle and $\angle UVW = 58°$.



(a) By giving appropriate reasons, find the value of the following angles.

(i) $\angle RSU$, [3]

(ii) $\angle PRS$, [1]

(iii) $\angle PXS$, [1]

(iv) $\angle VPS$. [1]

(b) Q is a point in the circle such that $\angle PQS = 58°$.

Explain clearly with reasons why Q is the centre of the circle. [2]

3 The equation of a curve is $y = (2k+2)x^2 - 3kx + 2k - 6$, where k is a constant.

(a) Find the range of values of k for which the curve is always negative for all real values of x. [4]

For the rest of the question, $k = 3$.

(b) The line with equation $y = px - 8$ is tangent to the curve. Find the value(s) of p. [3]

4 **(a)** The table summarizes the number of passengers in each of the cars over a particular time period.

Number of passengers	0	1	2	3	4
Number of cars	32	19	12	11	6

80

(i) One of the cars is selected at random. Find the probability that it has at most 2 passengers. [1]

(ii) Two of the cars are selected at random. Events A, B and C are defined as follows:
A: Each of the car has more than 2 passengers.
B: Both cars have a total of 4 passengers,
C: Both cars have a total of more than 4 passengers.

(a) Find, as a fraction in its simplest form, $\mathrm{P}(A)$. [1]

(b) Determine whether events A and B are mutually exclusive. [1]

(c) Without finding the numerical value of $\mathrm{P}(C)$, explain why $\mathrm{P}(A) < \mathrm{P}(C)$. [2]

(b) In a certain poultry farm, the probability of an egg chosen at random being fertilised is q.

A machine is used to detect whether an egg is fertilized. It gives only 2 outcomes, 'positive' and 'not positive'. If an egg is fertilized, there is a probability of 0.85 that it will be detected 'positive', and if the egg is not fertilized, there is a probability of 0.1 that it will be detected 'positive'.

(i) Illustrate the above information using a tree diagram. [2]

(ii) Write down the probability that a randomly chosen egg is fertilised and is detected positive. [1]

(iii) An egg is chosen at random and tested. Find the probability of the test being positive. [1]

5 **(a)** It is given that $f(x) = mx^3 - x^2 + nx - 3$. If $f(x)$ is exactly divisible by $(1-3x)$ and leaves a remainder of 1 when divided by $(2x-1)$, find the values of m and n. [4]

(b) Express $\dfrac{4x^2+7x+39}{(x-1)(x^2+9)}$ in partial fractions. [4]

(c) To travel from his home to his workplace, John drives 60 km on an expressway and then 25 km on local roads. He drives on the expressway at an average speed of x km/h.

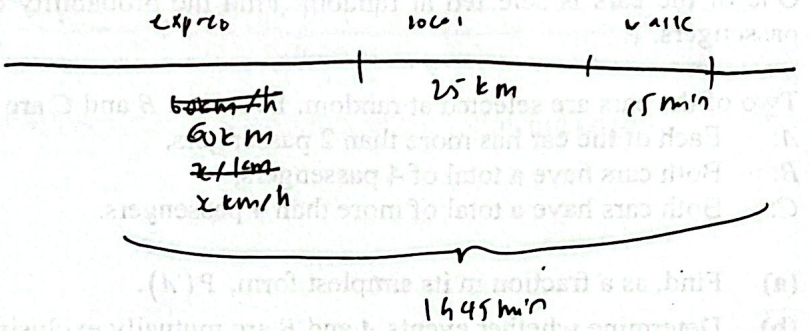
His average speed on the local roads is 30 km/h slower than his average speed on the expressway.

After he parks his car, he walks for 15 minutes to his workplace.

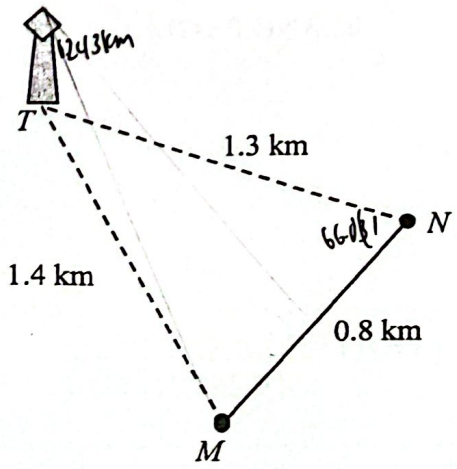
The journey takes John a total of 1 hour and 45 minutes.

Show that $3x^2 - 260x + 3600 = 0$ and ~~solve the equation.~~ [5]

find the avg speed in km/h that John drive on the express way



6 (a)



The figure above, not drawn to scale, shows a simplified map of a city, featuring a tower at T and two subway stations M and N 0.8 km apart along a street MN.

The tower stands vertically tall at 234 m. The direct distances between the foot of the tower and stations M and N are 1.4km and 1.3km respectively.

A tourist walks along the street MN, and reaches a point P where the angle of elevation of the top of the tower from P is the greatest.

It may be assumed that this part of the city is horizontal and flat, and the tourist is able to always view the top of the tower at any point on street MN.

Find the angle of elevation of the top of the tower from P. [5]

(b) Three points A, B and C lie on a horizontal ground such that the bearing of B from A is $200°$ and C is south of A. Given that the value of $\frac{AB}{BC}=\frac{5}{4}$ and $\frac{AB}{AC}>1$, find the bearing of C from B. [3]

- END OF PAPER -

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Question Number	Marks Possible	Marks Obtained
1	5	1
2	8	0
3	7	4
4	9	5
5	13	12
6	8	1
Presentation Deduction		−1
TOTAL	50	23

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1

$\log_{\frac{1}{3}} x + \log_3 (x^2-2) \geq 0$

$\frac{\log_3 x}{\log_3 \frac{1}{3}} + \log_3 (x^2-2) \geq 0$

$-\log_3 x^{-1} + \log_3 (x^2-2) \geq 0$

~~x^{-1}~~ ~~$\frac{1}{x}$~~ ~~$x^{-1} + x^2$~~

$\log_3 (x^{-1})(x^2-2) \geq 0$

$\log_3 (x-2) \geq 0$

$x \geq 2$

~~$-\log_3 x + \log_3 (x$~~

$x^2 - 2 \geq x$

$x^2 - x - 2 \geq 0$

$(x-2)(x+1) \geq 0$

$x \leq -1$ or $x \geq 2$

~~$x > 0$~~

since $x > 0$, $x \geq 2$

2 (a) (i)

~~ER~~ $\angle QRU = 90°$ (tan ⊥ rad)

$\angle PVS = 180° - 58°$
$= 122°$ (∠ on a str line)

$\angle PQS = 180° - 122°$
$= 58°$ (~~opp.∠ in a~~)

$\angle RQS = 180° - 58°$ → assume Q is centre
$= 122°$ (∠ on a str line)

~~TF~~ $RQ = RS$ (radius), ∴ ΔPQS is an isosceles

$\angle QSR = \frac{180 - 122°}{2}$
$= 29°$

$\angle QSU = 90°$ (rad ⊥ tan)

$\angle RSU = 90° - 29°$ (rad ⊥ tan)
$= 61°$ ~~(∠ in a)~~

$\therefore \angle RSU = 61°$

2(a) (ii)

$RQ = RS$ (radius), ∴ ΔPQS is an isosceles assume Q is centre

$\angle PRS = \frac{180 - 122°}{2}$
$= 29°$

$\therefore \angle PRS = 29°$

2(a) (iii)

~~$\angle PXS = 58° \times 2$~~
=
reflex $\angle PQS = 360° - 58°$ (∠ at ○)
$= 302°$

$\angle PXS = 302 \div 2$
$= 151°$ (∠ @ centre = 2∠ @ circumference)

$\angle PXS = 151°$
$\therefore \angle PXS$

Assume Q is centre

2(a) (iv)

PQ = QS (radii), ∴ △PQS is an isosceles,

$\angle QPS = \frac{180° - 58°}{2}$

$= 61°$

$\angle VPS = 90° - 61°$

$= 29°$ (rad ⊥ tan)

∴ ∠VPS = 29°

2 (b)

From a iv), ∠QPS = 61°

You are abt assuming Q is centre

If QP = QS, △QPS is isosceles,

so, 29° × 2° + 58° must be equivalent to 180°.

61° × 2 + 58 = 180°

∴ Q is the centre of circle

∠PQS = 58° (given)

∠PRS = 29° (from a ii)

since ∠PQS = 2 ∠PRS, (by '∠ @ centre = 2 ∠ @ circumference')

Q is the centre of circle.

3(a)

$y=(2k+2)x^2+(-3)kx+(2k-6)$

$\Delta = b^2-4ac = (-3k)^2-4(2k+2)(2k-6)$

$= 9k^2-(8k+8)(2k-6)$

$= 9k^2-(16k^2-48k+16k-48)$

$= 9k^2-16k^2+48k-16k+48$

$= -7k^2+32k+48$

$-7k^2+32k+48<0$

$\frac{-b\pm\sqrt{b^2-4ac}}{2a}$

$\frac{-32-\sqrt{2368}}{49} < k < \frac{-32+\sqrt{2368}}{49}$

Show sub?

No method shown.

Isn't it $a(-7)$??

$k<-1.19$, or $k>5.76$

2

3(b)

when $c=3$,

$y=(2(3)+2)x^2-3(3)x+2(3)-6$

$= 8x^2-9x+6-6$

$= 8x^2-9x$

$y=px-8$

$px-8=8x^2-9x$

$8x^2-9x-px+8=0$

$\Delta=0 \quad \Delta=b^2-4ac=(-9-p)^2-4(8)(8)$

$= -(9+p)^2-256$

$= -(81+18p+p^2)-256$

$= -p^2-18p-337$

$-p^2-18p-337=0$

$8x^2+(-9-p)x+8=0$

$(-9-p)^2-4(8)(8)=0$

$(-9-p)^2=256$

$-9-p=\pm 16$

$p=7$ or -25

4

[Turn over

4 (a) (i)

1

$P(\text{at most 2 passengers}) = \frac{32+19+12}{32+19+12+11+6}$

$= \frac{63}{80}$

4(a) (ii)(a)

0

$P(A) = 1 - \frac{63}{80}$

$= \frac{17}{80}$ ✗

$\frac{14}{80} \times \frac{16}{79} = \frac{17}{395}$

4(a) (ii)(b)

0

~~$P(A \cap B) =$~~

~~$P(B) =$~~

~~$P(A \cup B) = \frac{17}{80} + \ldots$~~

~~$P(A \cap B) = \frac{533}{6320} + \frac{17}{80}$~~

~~$0 + \frac{32}{80} \times \frac{6}{79} + \frac{19}{80} \times \frac{11}{79} + \frac{12}{80} \times \frac{11}{79}$~~

$\frac{32}{80} \times \frac{6}{79} + \frac{19}{80} \times \frac{11}{79} + \frac{12}{80} \times \frac{11}{79}$

$\frac{533}{6320}$

No, they are not as each of the car have more than 2 passengers meaning totally cannot be 4 pp!- So what total?

4 (a) (ii)(c)

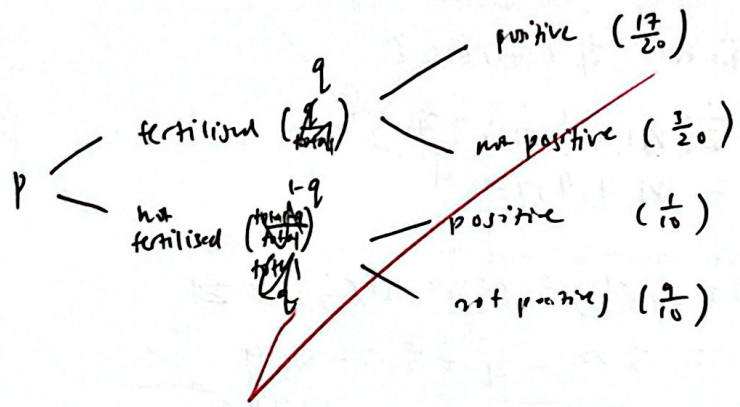
0

$P(A)$ can only happen from the cars that have 0, 1 & 2 passengers. However, $P(C)$ can ~~happen~~ ~~happy~~ happen when either the cars with the number of passengers is 1, 2, 3 or 4 is paired with 4, and when the cars with 2, 3, 4 passengers are paired with 3, or the cars with 3 or 4 passengers paired with 2, which has many possibilities as it happening compared to $P(A)$.

Show outcomes!

What are the outcomes for each event?

4(b)(i)



2

4(b)(ii)

$P(\text{fertilised, positive}) = q \times \frac{17}{20}$

$= \frac{17}{20}q$

1

4(b)(iii)

$P(\text{positive}) = \frac{17}{20}q + (1-q)\left(\frac{1}{10}\right)$

$= \frac{17}{20}q + \frac{1}{10} - \frac{1}{10}q$

$= \frac{1}{10} + \frac{17}{20}q - \frac{1}{10}q$

$= \frac{1}{10} + \frac{3}{4}q$

1

5

5(a) Using remainder theorem,

$x = \frac{1}{3}$

$f(\frac{1}{3}) = m(\frac{1}{3})^3 - (\frac{1}{3})^2 + n(\frac{1}{3}) - 3$

$= \frac{1}{27}m - \frac{1}{9} + \frac{1}{3}n - 3$

$x27 \; 0 = \frac{1}{27}m + \frac{1}{3}n - 3\frac{1}{9}$) $\times 27$

$0 = m + 9n - 8u$

$x = \frac{1}{2}$

$f(\frac{1}{2}) = m(\frac{1}{2})^3 - (\frac{1}{2})^2 + n(\frac{1}{2}) - 3$

$= \frac{1}{8}m - \frac{1}{4} + \frac{1}{2}n - 3\frac{1}{4}$

$0 = 1m + 4n - 26u \quad \times 8$

$\frac{1}{27}m + \frac{1}{3}n - 3\frac{1}{9} = \frac{1}{8}m + \frac{1}{2}n - 2\frac{1}{4}$

$u = m + 4n - 3u$

$m + 4n - 8 = 9m + 9n - 8u$

$4n - 9n = 3u - 8u$

$-5n = -5u$

$\therefore n = 10, \quad m = -6$

When $n = 10$, $m + 9(10) = 8u$

$m = 8u - 90$

$= -6$

5(b)

$\frac{4x^2+7x+39}{(x-1)(x^2+9)} = \frac{A}{x-1} + \frac{Bx+C}{x^2+9}$

$= \frac{A}{(x-1)} + \frac{B}{(x+2)} + \frac{C}{(x-2)}$

$4x^2+7x+39 = A(x^2+9) + (Bx+C)(x-1)$

$1C+ \; x = 1, \quad 39 = 10A$

$A = 3$

$1C+ \; x = 0, \quad 39 = 9A - C$

$= 27 - C$

$C = 6$

$\frac{4x^2+7x+39}{(x-1)(x^2+9)} = \frac{3}{x-1} + \frac{Bx-6}{x^2+9}$

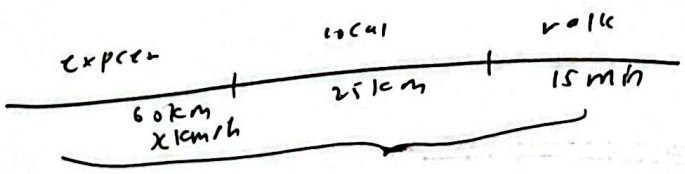
compare x^2 coefficients,

$4 = A + B$

$= 3 + B$

$B = 1$

5(c)



1h 45 min

1h 45 min − 15 min = 1h 30 min

= 90 min

~~60 ÷ x = 60 x~~ (time spent @ express way)

$60 \div x = \frac{60}{x}$

$\frac{60}{\frac{60}{x}} = x$ (avg speed)

$x - 30 = x - 30$ (avg speed @ local)

$\frac{25}{x-30} = \frac{25}{x-30}$ (time spent @ local)

$\frac{25}{x-30} + \frac{60}{x} = 90$ X

$\frac{25x}{x(x-30)} + \frac{60(x-30)}{x(x-30)} = 90x(x-30)$

$\frac{25x + 60x - 1800}{x(x-30)} = \frac{90x^2 - 2700x}{x(x-30)}$

$25x + 60x - 1800 = 90x^2 - 2700x$

$90x^2 - 2700x - 25x - 60x - 1800 = 0$

$90x^2 - 2785x - 1800 = 0$ X

$3x^2 - 260x - 1800 = 0$

$x = 69.3670$ or 17.299 (rej as $x > 30$)

When $x = 69.367$, $\frac{60}{69.367} = 0.86496$, $\frac{25}{69.367 - 30} = 0.63505$

When $x = 17.299$, $\frac{60}{17.299} = 3.4684$

$\therefore x = 69.4$ km/h (3 s.f.)

4

12

6 (a)

$\angle CAB = 200° - 184°$

$= 20°$ ($\angle$ on a str line)

~~$AC^2 = A^2 + 5^2 - 2(AB)$~~

$4^2 = 5^2 + AC^2 - 2(5)(AC)\cos(20°)$

$16 = 25 + AC - 10AC\cos 20$

~~$AC + 10AC$~~

~~$-AC = 25 - 16 - 10AC\cos 20$~~

$1.3^2 = 0.8^2 + 1.4^2 - 2(0.8)(1.4)\cos\angle MNT$

$\angle MNT = \cos^{-1}\dfrac{0.8^2 + 1.4^2 - 1.3^2}{2(0.8)(1.4)}$

$= 66.031°$ (3 sf)

(b) $\angle MNT = \dfrac{3.01}{3.14}$

$\angle MTN = 34.21°$

$\frac{1}{2}(1.4)(1.3)\sin\angle MTN = \frac{1}{2}TP(0.8)$

$TP = 2.275\sin(34.21°)$

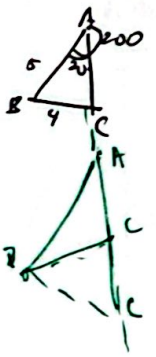
$= 1.2793$ km

$\tan\theta = 0.4$

6 (b)

$\angle CAB = 200 - 180$ (∠s on a straight line)

$= 20°$



$20 \times \frac{5}{4} = 25$

$360 - 25$

$4^2 = 5^2 + AC^2 - 2(5)(AC)\cos 20$

$16 = 25 + AC^2 - 10AC\cos 20$

$10AC\cos 20 - AC^2 = 25 - 16$

$10AC\cos 20 - AC^2 = 9$

$AC - AC = \frac{9}{10\cos 20}$

$\frac{\sin \angle BCA}{\sin \angle BAC} = \frac{5}{4}$

$\sin \angle BCA = \frac{5}{4}\sin 20°$

$\angle BCA = \sin^{-1}\left(\frac{5}{4}\sin 20°\right)$

$= 25.311$ (3 dp)

$\frac{AB}{AC} > 1$, $\angle BCA = 154.688°$

$\angle ABC = 180° - 25 - 154.688°$

$= 5.311°$ (3 dp)

$20° + 5.311° = 25.3°$ (1 dp)

$180° - 25.3° = 154.7°$

$\therefore 25.3°$ or $154.7°$