



Rossmoyne Senior High School

Semester One Examination, 2023

Question/Answer booklet

MATHEMATICS SPECIALIST UNIT 1

Section Two: Calculator-assumed

WA student number: In figures

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Circle your teacher:

Ms Chua	Mr Koulianos
Mr Liu	Ms Robinson

In words

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Time allowed for this section

Reading time before commencing work: ten minutes
Working time: one hundred minutes

Number of additional
answer booklets used
(if applicable):

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Materials required/recommended for this section

To be provided by the supervisor

This Question/Answer booklet
Formula sheet (retained from Section One)

To be provided by the candidate

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: drawing instruments, templates, notes on two unfolded sheets of A4 paper, and up to three calculators, which can include scientific, graphic and Computer Algebra System (CAS) calculators, are permitted in this ATAR course examination

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Working time (minutes)	Marks available	Percentage of examination
Section One: Calculator-free	7	7	50	50	35
Section Two: Calculator-assumed	12	12	100	91	65
Total					100

Instructions to candidates

- The rules for the conduct of examinations are detailed in the school handbook. Sitting this examination implies that you agree to abide by these rules.
- Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.
- You must be careful to confine your answers to the specific question asked and to follow any instructions that are specific to a particular question.
- Show all your working clearly. Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning. Incorrect answers given without supporting reasoning cannot be allocated any marks. For any question or part question worth more than two marks, valid working or justification is required to receive full marks. If you repeat any question, ensure that you cancel the answer you do not wish to have marked.
- It is recommended that you do not use pencil, except in diagrams.
- Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.
- The Formula sheet is not to be handed in with your Question/Answer booklet.

Markers use only		
Question	Maximum	Mark
8	8	
9	6	
10	8	
11	9	
12	7	
13	9	
14	8	
15	8	
16	6	
17	7	
18	6	
19	9	
S2 Total	91	
S2 Wt ($\times 0.6915$)	65%	

Section Two: Calculator-assumed**65% (91 Marks)**

This section has **twelve** questions. Answer **all** questions. Write your answers in the spaces provided.

Working time: 100 minutes.

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Question 8

(8 marks)

Let $\underline{a} = \binom{4}{k-1}$ and $\underline{b} = \binom{k}{3}$. Determine

(a) $\underline{a} - \underline{b}$ when $k = 5$. (1 mark)

(b) the value(s) of k for which $|\underline{b}| = 3\sqrt{5}$. (2 marks)

(c) the value(s) of k for which $\underline{a}$ and $\underline{b}$ are perpendicular. (2 marks)

(d) the value(s) of k for which $\underline{a}$ and $\underline{b}$ are parallel. (3 marks)

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Question 9

(6 marks)

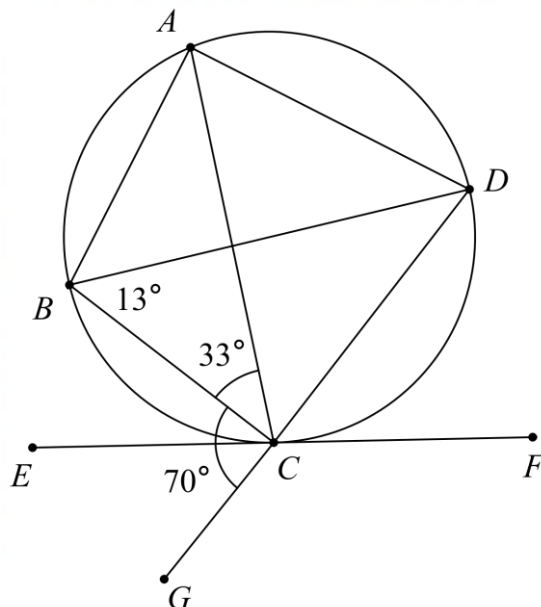
$ABCD$ is a cyclic quadrilateral.

EF is a tangent at C , and DCG is a straight line.

$$\angle BCA = 33^\circ$$

$$\angle GCB = 70^\circ$$

$$\angle DBC = 13^\circ$$



(a) Determine the following angles, giving reasons

(i) $\angle BAD$

(2 marks)

(ii) $\angle BDA$

(1 marks)

(b) Prove that AC passes through the centre of the circle, justifying your answer.

(3 marks)

Question 10**(8 marks)**

Two forces act on a particle. One force of 145 N acts on a bearing of $200^\circ T$ and another force of 250 N acts on a bearing of $067^\circ T$.

Let the perpendicular unit vectors $\hat{i}$ and $\hat{j}$ act in an easterly and northerly direction respectively.

In this question give coefficients correct to 2 decimal places.

- (a) Sketch a neat, clearly labelled diagram of the two forces acting on the particle showing all magnitudes and angles. (1 mark)
- (b) Express the 250 N force in component form using the unit vectors $\hat{i}$ and $\hat{j}$. (2 marks)
- (c) Determine the resultant of the two forces, leaving your answer in component form. (3 marks)

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- (d) A third force of 215 N is added to these existing two forces, so there are now three forces acting on the same particle. Can the three forces be brought to a state of equilibrium? Justify your answer. (2 marks)

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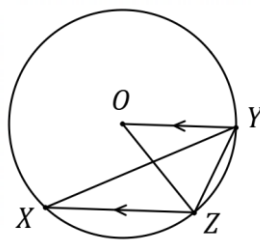
Question 11

(9 marks)

- (a) The diagram shows a circle, centre O , and points X, Y and Z that lie on it. OY is parallel to XZ .

Determine the size of $\angle OZY$ and the size of $\angle XZY$ when $\angle OYX = 26^\circ$.

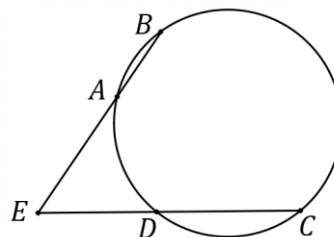
Reasons are not required.



(3 marks)

- (b) In the diagram, secants AB and CD of a circle intersect at E .

(i) Prove that $EA \times EB = ED \times EC$.



(4 marks)

(ii) Determine the length AB when $AE = 6$ cm, $DE = 5$ cm and $DC = 4$ cm.

(2 marks)

Question 12**(7 marks)**

- (a) An unordered selection of 5 dishes must be chosen from 7 cold and 6 hot dishes. Determine the number of ways the selection can be made if

(i) there are no restrictions. (1 mark)

(ii) there must be at least one of each type and more cold than hot dishes. (2 marks)

- (b) Given ${}^nP_r = 90$ and ${}^nC_r = 45$, determine the value of n and the value of r . (4 marks)

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Question 13**(9 marks)**

A sports club is selling raffle tickets. The tickets are left over from a previous event and are numbered consecutively from 462 to 900 inclusive.

(a) Determine how many of the tickets have a number that is

(i) a multiple of 6. (2 marks)

(ii) a multiple of 6 or a multiple of 21. (3 marks)

(iii) a multiple of 6 or a multiple of 21 but not a multiple of both. (1 mark)

Once all these leftover tickets have been sold, they will be placed in a large bucket, thoroughly mixed and drawn from the bucket at random and without replacement.

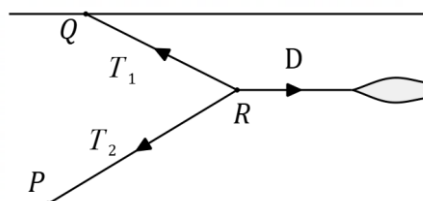
(b) After how many draws can you be certain that at least four of the tickets taken from the bucket have numbers that start with the same digit? Justify your answer. (3 marks)

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Question 14

(8 marks)

The diagram below shows a small boat is moored by ropes QR and PR that make angles of 24° and 33° respectively with the banks of the river.



- (a) Determine T_1 and T_2 , the tensions in each rope, when the force D , caused by the water current acting on the boat, is 320 N. (4 marks)

A steady current of 0.7 m/s flows eastwards, and the parallel banks of the river are 170 m apart.

- (b) Another small boat leaves P at a speed of 4 m/s and heads slightly upstream, steering a course that makes an angle of 85° with the bank of the river. Determine how far the boat is from Q when it reaches the opposite bank, given that Q is 25 m downstream from P . (4 marks)

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Question 15

(8 marks)

In $\triangle OPQ$, R and S are the midpoints of sides OP and OQ respectively. PS intersects QR at T .

- (a) Sketch a diagram to show this information. (1 mark)

Let $\underset{\sim}{p} = \overrightarrow{OP}$, $\underset{\sim}{q} = \overrightarrow{OQ}$, $\overrightarrow{PT} = \lambda \times \overrightarrow{PS}$ and $\overrightarrow{QT} = \mu \times \overrightarrow{QR}$.

- (b) Express $\overrightarrow{OT}$ in terms of $\underset{\sim}{p}, \underset{\sim}{q}$ and λ . (2 marks)

- (c) Express $\overrightarrow{OT}$ in terms of $\underset{\sim}{p}, \underset{\sim}{q}$ and μ . (1 mark)

- (d) Prove that $\overrightarrow{OP} + \overrightarrow{OQ} = 3 \times \overrightarrow{OT}$. (4 marks)

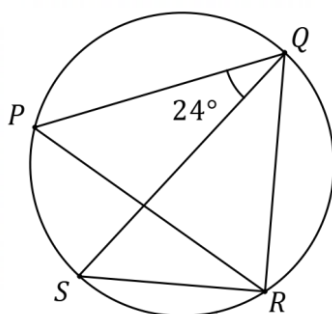
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Question 16

(6 marks)

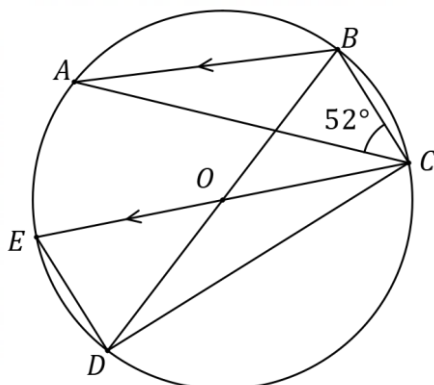
- (a) In the diagram, points P, Q, R and S lie on a circle so that QS is a diameter and $PQ = PR$. Determine the size of $\angle RQS$ when $\angle PQS = 24^\circ$.
Reasons are not required.

(3 marks)



- (b) In the diagram, points A, B, C, D and E lie on a circle with centre O . BD and CE are diameters, and AB is parallel to EC . Determine the size of $\angle OED$ when $\angle BCA = 52^\circ$.

(3 marks)



Question 17**(7 marks)**

Five cubes, identical apart from their colour, are to be placed one on top of another to form a tower. Determine the number of different towers that can be made using:

- (a) eight different coloured cubes. (1 mark)
- (b) a blue, a green and three red cubes. (1 mark)
- (c) three green and two red cubes. (1 mark)
- (d) one green, one blue, one yellow, one pink, two white and two red cubes. (4 marks)

Question 18**(6 marks)**

Use an algebraic method to prove the following conjecture is true:

“For every $k \in \mathbb{Z}$, $k^2 - 8k + 4$ is odd if and only if k is odd.”

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Question 19**(9 marks)**

Water in a large river estuary flows at a constant 2.8 km/h on a bearing $070^\circ T$. At 1:45 pm, a fishing boat in the estuary has just dropped a crab pot at A and heads off towards B to drop its last one, 1.47 km away on a bearing of $120^\circ T$. The fishing boat travels at a constant 8.3 km/h.

- (a) Sketch a neat, clearly labelled diagram to represent the situation, then determine the bearing the boat should steer from A to B . (4 marks)

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Once the boat reaches B it will spend 5 minutes dropping the last pot and then head off to an anchorage 2.2 km away from B on a bearing of $250^\circ T$.

- (b) Determine the time at which the boat is expected to reach the anchorage. (5 marks)

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Supplementary page

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