

# Australian Math Olympiad Past Papers

AMO 2022

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**Problem 1:** A convex pentagon has integer side lengths and odd perimeter. Prove that it can have 2 right angles, but not 3.

**Problem 2:** A point  $P$  exists inside convex hexagon  $ABCDEF$  such that  $PABC$ ,  $PCDE$ , and  $PEFA$  are all parallelograms of equal area. Prove that  $PBCD$ ,  $PDEF$ , and  $PFAE$  are also all parallelograms of equal area.

**Problem 3:** Find all polynomials  $P(x)$  with real coefficients such that:

- $P(x) > 0$  for  $x > 0$
- $\frac{1}{P(1)} + \frac{1}{P(2)} + \frac{1}{P(3)} = 1$  for  $abc = 1$

**Problem 4:** Consider the set of lattice points  $(x, y)$  in the plane such that  $x, y \in \{1, 2, 3, \dots, 2022\}$  and  $x < y$ . Colour the points blue and red, following the rule that if  $(i, j)$  and  $(j, k)$  are coloured the same, then so is  $(i, k)$ . How many possible colourings are there?

**Problem 5:** Consider a set of reals  $a_1, a_2, \dots, a_{2022}$  such that  $a_1 + a_2 + \dots + a_{2022} > 0$ . Suppose there is an integer  $k < 2022$  such that:

- $a_i \leq 0$  for  $i \leq k$
- $a_i \geq 0$  for  $i \geq k$

Prove  $a_1 + 2a_2 + 3a_3 + \dots + 2022a_{2022} > 0$

**Problem 6:** There are 20 cities in Biphania, including Adabu and Belrot. Each pair of cities is connected by either a red or blue flight. Martha only uses blue flights, and Bobby only uses red flights. Bobby can travel from Adabu to Belrot in 4 flights, but not less. Prove that Martha needs at most 2 flights to travel in between any two pairs of cities.

**Problem 7:** Define a function  $f(n)$  as the absolute difference between an integer  $n$  and the nearest power of two. For example,  $f(56) = |56 - 64| = 8$ . Define  $S(n)$  as the stopping time of  $n$ , or the smallest number  $k$  such that  $f^k(n) = 0$ . For example,  $f(f(56)) = f(8) = 0 \implies S(56) = 2$ .

- Find the smallest  $n$  such that  $S(n) = 2022$
- Find the largest  $k$  such that there exist  $k$  consecutive integers with the same stopping time.

**Problem 8:** Let  $ABC$  be an acute scalene triangle with orthocenter  $H$ .  $BH, CH$  (extended) meet the angle bisector of  $\angle BAC$  at  $D, E$ . The tangents of the circumcircle of  $DEH$  and  $D, E$  intersect at point  $X$ . Prove  $BX = CX$ .

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**AUSTRALIAN MATH OLYMPIAD PAST PAPERS** ARE INVALUABLE RESOURCES FOR STUDENTS PREPARING FOR ONE OF THE MOST PRESTIGIOUS MATHEMATICS COMPETITIONS IN THE COUNTRY. THE AUSTRALIAN MATHEMATICS OLYMPIAD (AMO) PROVIDES A PLATFORM FOR TALENTED YOUNG MATHEMATICIANS TO SHOWCASE THEIR SKILLS, SOLVE COMPLEX PROBLEMS, AND COMPETE AT A NATIONAL LEVEL. IN THIS ARTICLE, WE WILL EXPLORE THE SIGNIFICANCE OF PAST PAPERS, HOW TO UTILIZE THEM EFFECTIVELY FOR PREPARATION, AND THE BENEFITS THEY OFFER TO ASPIRING MATHEMATICIANS.

## THE IMPORTANCE OF AUSTRALIAN MATH OLYMPIAD PAST PAPERS

PAST PAPERS FROM THE AUSTRALIAN MATH OLYMPIAD SERVE SEVERAL CRUCIAL PURPOSES:

- **FAMILIARIZATION WITH EXAM FORMAT:** UNDERSTANDING THE STRUCTURE OF THE EXAM IS ESSENTIAL FOR EFFECTIVE PREPARATION. PAST PAPERS PROVIDE INSIGHT INTO THE TYPES OF QUESTIONS ASKED, THE FORMAT OF THE PAPER, AND

THE MARKING SCHEME.

- **IDENTIFYING KEY TOPICS:** BY ANALYZING PREVIOUS YEARS' PAPERS, STUDENTS CAN IDENTIFY RECURRING THEMES AND TOPICS. THIS CAN HELP PRIORITIZE THEIR STUDY EFFORTS ON AREAS THAT ARE FREQUENTLY TESTED.
- **PRACTICE UNDER EXAM CONDITIONS:** SOLVING PAST PAPERS UNDER TIMED CONDITIONS MIMICS THE ACTUAL EXAM EXPERIENCE, HELPING STUDENTS MANAGE THEIR TIME EFFECTIVELY AND BUILD CONFIDENCE.
- **SELF-ASSESSMENT:** PAST PAPERS ALLOW STUDENTS TO GAUGE THEIR PROFICIENCY IN MATHEMATICS, IDENTIFY STRENGTHS AND WEAKNESSES, AND TRACK THEIR PROGRESS OVER TIME.

## ACCESSING PAST PAPERS

OBTAINING PAST PAPERS FOR THE AUSTRALIAN MATH OLYMPIAD IS RELATIVELY STRAIGHTFORWARD. HERE ARE SOME METHODS TO ACCESS THEM:

### OFFICIAL AMO WEBSITE

THE AUSTRALIAN MATHEMATICS TRUST (AMT), WHICH ORGANIZES THE AMO, PROVIDES ACCESS TO PAST PAPERS ON ITS OFFICIAL WEBSITE. STUDENTS CAN FIND A COMPREHENSIVE ARCHIVE OF PAPERS FROM PREVIOUS YEARS, ALONG WITH SOLUTIONS AND MARKING SCHEMES.

### SCHOOL RESOURCES

MANY SCHOOLS THAT PARTICIPATE IN MATHEMATICS COMPETITIONS MAINTAIN A COLLECTION OF PAST AMO PAPERS. STUDENTS SHOULD CONSULT THEIR MATHEMATICS TEACHERS OR SCHOOL LIBRARY FOR ACCESS TO THESE RESOURCES.

### ONLINE FORUMS AND COMMUNITIES

VARIOUS ONLINE PLATFORMS AND FORUMS, SUCH AS MATHEMATICS-FOCUSED DISCUSSION BOARDS AND SOCIAL MEDIA GROUPS, OFTEN SHARE PAST PAPERS AND SOLUTIONS. ENGAGING WITH THESE COMMUNITIES CAN PROVIDE STUDENTS WITH ADDITIONAL RESOURCES AND SUPPORT.

## STRATEGIES FOR USING PAST PAPERS EFFECTIVELY

TO MAXIMIZE THE BENEFITS OF STUDYING WITH PAST PAPERS, STUDENTS SHOULD ADOPT A SYSTEMATIC APPROACH:

### 1. START EARLY

BEGIN PREPARING WELL IN ADVANCE OF THE COMPETITION. THIS ALLOWS AMPLE TIME TO COVER ALL RELEVANT TOPICS AND PRACTICE WITH PAST PAPERS WITHOUT THE PRESSURE OF AN IMPENDING DEADLINE.

## 2. REVIEW THE SYLLABUS

FAMILIARIZE YOURSELF WITH THE SYLLABUS AND GUIDELINES PROVIDED BY THE AMT. UNDERSTAND THE TOPICS THAT WILL BE COVERED IN THE EXAM AND ALIGN YOUR STUDY PLAN ACCORDINGLY.

## 3. SOLVE PAPERS IN TIMED CONDITIONS

SIMULATE EXAM CONDITIONS BY TIMING YOURSELF WHILE SOLVING PAST PAPERS. THIS NOT ONLY IMPROVES TIME MANAGEMENT SKILLS BUT ALSO HELPS BUILD A SENSE OF URGENCY THAT IS OFTEN PRESENT DURING THE ACTUAL EXAM.

## 4. ANALYZE SOLUTIONS

AFTER ATTEMPTING A PAPER, REVIEW THE SOLUTIONS CAREFULLY. UNDERSTAND THE REASONING BEHIND EACH SOLUTION, ESPECIALLY FOR PROBLEMS YOU FOUND CHALLENGING. THIS REFLECTION PROCESS ENHANCES PROBLEM-SOLVING SKILLS.

## 5. FOCUS ON WEAK AREAS

IDENTIFY TOPICS OR TYPES OF PROBLEMS WHERE YOU STRUGGLE AND DEDICATE EXTRA TIME TO PRACTICE THOSE AREAS. USE PAST PAPERS TO REINFORCE YOUR UNDERSTANDING AND BUILD CONFIDENCE.

## 6. DISCUSS WITH PEERS OR MENTORS

ENGAGE IN DISCUSSIONS WITH FELLOW STUDENTS OR TEACHERS ABOUT THE PROBLEMS YOU ENCOUNTER. COLLABORATIVE LEARNING CAN PROVIDE NEW INSIGHTS AND STRATEGIES FOR TACKLING DIFFICULT QUESTIONS.

## BENEFITS OF PRACTICING WITH PAST PAPERS

PRACTICING WITH PAST PAPERS PROVIDES NUMEROUS ADVANTAGES FOR STUDENTS PREPARING FOR THE AMO:

### ENHANCED PROBLEM-SOLVING SKILLS

WORKING THROUGH VARIOUS TYPES OF PROBLEMS SHARPENS CRITICAL THINKING AND ANALYTICAL SKILLS. STUDENTS LEARN TO APPROACH PROBLEMS FROM DIFFERENT ANGLES AND DEVELOP CREATIVE SOLUTIONS.

### INCREASED CONFIDENCE

AS STUDENTS BECOME MORE FAMILIAR WITH THE EXAM FORMAT AND TYPES OF QUESTIONS, THEIR CONFIDENCE IN TACKLING THE ACTUAL EXAM INCREASES. CONFIDENCE PLAYS A CRUCIAL ROLE IN PERFORMANCE, ESPECIALLY UNDER PRESSURE.

### BETTER TIME MANAGEMENT

REPEATED PRACTICE WITH PAST PAPERS HELPS STUDENTS LEARN TO ALLOCATE THEIR TIME EFFECTIVELY DURING THE EXAM. THIS SKILL IS VITAL FOR ENSURING THAT THEY CAN ATTEMPT ALL QUESTIONS AND MANAGE ANY UNEXPECTED CHALLENGES.

## PREPARATION FOR FUTURE COMPETITIONS

THE SKILLS AND KNOWLEDGE GAINED FROM PRACTICING WITH AMO PAST PAPERS ARE NOT ONLY BENEFICIAL FOR THE OLYMPIAD BUT ALSO FOR OTHER MATHEMATICS COMPETITIONS AND ASSESSMENTS. STUDENTS DEVELOP A STRONG FOUNDATION THAT SERVES THEM WELL IN THEIR ACADEMIC PURSUITS.

## CONCLUSION

IN CONCLUSION, **AUSTRALIAN MATH OLYMPIAD PAST PAPERS** ARE ESSENTIAL TOOLS FOR ANY STUDENT SERIOUS ABOUT EXCELLING IN MATHEMATICS COMPETITIONS. THEY PROVIDE A WEALTH OF INFORMATION ABOUT THE EXAM FORMAT, KEY TOPICS, AND PROBLEM-SOLVING STRATEGIES. BY ACCESSING THESE RESOURCES AND EMPLOYING EFFECTIVE STUDY TECHNIQUES, STUDENTS CAN ENHANCE THEIR MATHEMATICAL ABILITIES, BUILD CONFIDENCE, AND IMPROVE THEIR CHANCES OF SUCCESS IN THE COMPETITION. WHETHER THROUGH OFFICIAL CHANNELS, SCHOOL RESOURCES, OR ONLINE COMMUNITIES, STUDENTS HAVE AMPLE OPPORTUNITIES TO ENGAGE WITH PAST PAPERS AND PREPARE THEMSELVES FOR THE CHALLENGES OF THE AMO. WITH DEDICATION AND THE RIGHT APPROACH, ASPIRING MATHEMATICIANS CAN ACHIEVE THEIR GOALS AND UNLOCK THEIR POTENTIAL IN THE FASCINATING WORLD OF MATHEMATICS.

## FREQUENTLY ASKED QUESTIONS

### WHAT IS THE AUSTRALIAN MATH OLYMPIAD?

THE AUSTRALIAN MATH OLYMPIAD IS A PRESTIGIOUS MATHEMATICS COMPETITION FOR HIGH SCHOOL STUDENTS IN AUSTRALIA, AIMED AT IDENTIFYING AND NURTURING YOUNG MATHEMATICAL TALENT.

### WHERE CAN I FIND PAST PAPERS FOR THE AUSTRALIAN MATH OLYMPIAD?

PAST PAPERS FOR THE AUSTRALIAN MATH OLYMPIAD CAN TYPICALLY BE FOUND ON THE OFFICIAL AUSTRALIAN MATH TRUST WEBSITE OR THROUGH EDUCATIONAL RESOURCES THAT SPECIALIZE IN MATHEMATICS COMPETITIONS.

### HOW CAN PRACTICING WITH PAST PAPERS BENEFIT STUDENTS PREPARING FOR THE AUSTRALIAN MATH OLYMPIAD?

PRACTICING WITH PAST PAPERS HELPS STUDENTS FAMILIARIZE THEMSELVES WITH THE FORMAT AND TYPES OF QUESTIONS ASKED, IMPROVES PROBLEM-SOLVING SKILLS, AND BUILDS CONFIDENCE FOR THE COMPETITION.

### ARE THE QUESTIONS IN THE AUSTRALIAN MATH OLYMPIAD PAST PAPERS REPRESENTATIVE OF THE CURRENT COMPETITION'S DIFFICULTY?

YES, THE QUESTIONS IN PAST PAPERS ARE DESIGNED TO BE REPRESENTATIVE OF THE TYPES AND DIFFICULTY LEVELS OF QUESTIONS THAT STUDENTS CAN EXPECT IN THE CURRENT COMPETITIONS, ALTHOUGH THEY MAY EVOLVE SLIGHTLY OVER TIME.

### WHAT RESOURCES SHOULD STUDENTS USE ALONGSIDE PAST PAPERS TO PREPARE FOR THE AUSTRALIAN MATH OLYMPIAD?

STUDENTS SHOULD USE A COMBINATION OF PAST PAPERS, MATH TEXTBOOKS, ONLINE RESOURCES, AND COACHING FROM EXPERIENCED MENTORS TO EFFECTIVELY PREPARE FOR THE AUSTRALIAN MATH OLYMPIAD.

## HOW CAN TEACHERS INCORPORATE AUSTRALIAN MATH OLYMPIAD PAST PAPERS INTO THEIR CURRICULUM?

TEACHERS CAN USE PAST PAPERS AS PRACTICE ASSIGNMENTS, INCORPORATE THEM INTO MATH CLUBS, OR ORGANIZE MOCK COMPETITIONS TO ENHANCE STUDENTS' PROBLEM-SOLVING SKILLS AND PREPARE THEM FOR THE OLYMPIAD.

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