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National Science Board draws the US public’s attention to the increasing shortage of qualified science and engineering (S&E) workforce by its biannual publications; Indicators. Indicators 2004 emphasizes the following serious problems:

- The number of jobs requiring S&E skills in the U.S. labor force is growing almost 5 percent per year. In comparison, the rest of the labor force is growing at just over 1 percent.

- Between 1990 and 2000 the proportion of foreign-born people with bachelor’s degrees in S&E occupations rose from 11 to 17 percent; the proportion of foreign-born with master’s degrees rose from 19 to 29 percent; and the proportion of foreign-born with PhDs in the S&E labor force rose from 24 to 38 percent.

- Visas for students and S&E workers have been issued more slowly since the events of September 11, owing to both increased security restrictions and a drop in applications.

- Since the 1980s other countries have increased investment in S&E education and the S&E workforce at higher rates than the United States has. Between 1993 and 1997 the OECD countries increased their number of S&E research jobs 23 percent, more than twice the 11 percent increase in S&E research jobs in the United States. (1)

There is a great need to inspire and encourage students in the United States to pursue careers in science and engineering. In addition, according to reports prepared by National Association for Gifted Children (NAGC), there are approximately 3 million academically gifted children in grades K-12 in the U.S - approximately 6% of the student population. It is emphasized that gifted students are in need of services or activities not normally provided by the school. Besides, the federal government does not provide funding directly to districts specifically for gifted education. Reports highlight the missed opportunities to identify and serve gifted students in the U.S.

PROGRAM DESCRIPTION

Math, Science Olympiad Program (MSOP) is Accord Schools’ unique program that motivates and encourages gifted students for academic studies in grades 6-12. Early math and science training by experts ensures early specialization and solid
scientist background for gifted students. MSOP aims to train student towards prestigious math and science competitions in national and international level. MSOP’s condensed training program helps gifted students to develop their critical and analytical thinking skills while providing a challenging environment for them. Students prepare for the International Olympiads in which a group of 4 to 6 students represent each country. The International Olympiads are the most prestigious and most difficult competitions for high school students.

In this program, along with the regional and national competitions, gifted students will prepare for the following competitions:

- International Mathematics Olympiad (IMO)
- International Olympiad in Informatics (IOI)
- International Physics Olympiad (IPhO)
- International Chemistry Olympiad (IChO)
- International Biology Olympiad (IBO)
- Intel Science Talent Search
- Country and State Science Fairs

**GOALS OF MSOP**

The goals of MSOP are to:

- Enrich gifted students with a more challenging curriculum in sciences
- Provide essential resources and tools for students to excel and reach their full potential
- Empower students to succeed in secondary and post secondary education
- Groom qualified scientists for our community and our nation
- Cultivate an interest in the science fields
- Indoctrinate students with a sense of duty and responsibility to community and nation
- Contribute to meeting our nations’ and world’s future needs through preparing skillful and dedicated citizens and scientists with integrity
MAIN FEATURES OF THE PROGRAM

INDIVIDUALS, NOT A GROUP
A true generalization about gifted students is that every gifted student is unique in his/her abilities and interests and cannot be categorized or evaluated based on generalized criteria. Although Accord encourages group activities and social life among students, every student matters as an individual to Accord mentors and coaches, and will not be categorized or evaluated based on presupposed beliefs.

Accord encourages parents of all students to keep in touch with the teachers/mentors, help motivate the students, keep track of progress and be a part of the academic process.

FLEXIBILITY
Students will take a diagnostic test prior to enrolling in Accord’s MSOP Program, and will be placed in the appropriate program based on their performance level.

TUTORING/MENTORING
To reach the goals of the gifted program (dedicated citizens and scientists with integrity and a sense of duty and responsibility), Accord will encourage its gifted students to contribute to their society. As their knowledge and skills are their most valuable property, and furthermore the best way of learning is teaching: students will use their knowledge to help others better understand lessons. Students will give support to other students in lower grades with in a schedule time that will not impede on the gifted students educational goals. (i.e. a 9th grade student in the second level of the math program will tutor a 7th grader for an hour a week)

COMPONENTS OF THE PROGRAM

MATH
All students are required to complete the 1st and 2nd levels of the Math Program.
**INTERNATIONAL OLYMPIAD**
Students will choose their primary area of study after completing the 1st and 2nd levels of the Olympiad Program.

**SCIENCE PROJECTS**
Students are expected to participate in the county science fair or a nationwide project competition every year.

**ACADEMIC CLUBS**
Students should be enrolled in a club activity related to one of the main areas (i.e. Robotics, Game Programming, Competitive engineering...)

**ELIGIBILITY CRITERIA**
Accord will give a placement test in the first week of the school year. After submitting required documents, the administration review team will review each candidate’s admissions packet; notifications are sent with a letter of acceptance into Accord’s MSOP project.

**STAYING IN ACCORD’S MSOP PROGRAM**
Students will be assessed at the end of every semester based on their performance in every class in order to remain in the highly gifted program. A student MUST:
- Maintain 3.5 or above GPA
- Get all his/her teachers approval
- Be in good standing with his/her institution.

**BENEFITS OF MSOP**
From student, school and social perspectives, Accord’s MSOP has many benefits including the following:
- Early specialization for solid scientist training,
- Teaches scientific methodology to students,
- Provides a challenging environment for gifted students,
- Develops the student interest in Science and Mathematics,
• Gives the ability to use creative problem solving strategies,
• Provides a solid background on advanced topics through an Accord developed math, computer and science curriculum,
• Centralized evaluation of students: motivation by global competition and more reliable ranking of the student,
• Immediate support for students’ weak topics,
• Develops team spirit,
• Easy acceptance from top notch universities,
• Lifelong advantages of learning analytical thinking,
• Prevents from bad habits by keeping students busy with scientific activities,
• Gives the students self-discipline of studying,
• Middle and high school achievements,
• Reduces heavy loads of the teachers with ready-made packages.
SAMPLE PROGRAM

6TH GRADE
- Complete 1st level of Accord’s Math Program (see outline)
- Complete 1st part of 1st level of Accord’s Computer Program (see outline)

COMPETITIONS:
- Math League, MathCounts, AMC-8

SUMMER PROGRAM:
- Accord’s summer camp

7TH GRADE
- Complete 1st part of 2nd level of Accord’s Math Program (the Art of Problem Solving, Volume 1, Basics)
- Complete 2nd part of 1st level of Accord’s Computer Program
- Science Fair Project for County Science Fair

COMPETITIONS:
- Math League, MathCounts, AMC-8, AMC-10, First LEGO League

SUMMER PROGRAM:
- Accord’s summer camp

8TH GRADE
- Complete 2nd part of 2nd level of Accord’s Math Program (the Art of Problem Solving, Volume 2, and Beyond)
- Complete 2nd part of 2nd level of Accord’s Computer Program
- Science Fair Project for County Science Fair

COMPETITIONS:
- Math League, MathCounts, AMC-8, AMC-10, AIME, USACO

SUMMER PROGRAM:
- Accord’s summer camp

9TH GRADE
- Choose primary area of study: Math, Computers, Physics or Biology
- Complete 3rd level of Accord’s Olympiad Preparation Program.
• Participate in the preparation camp of the primary area.
• Robotics Club: FIRST Robotics Competition

Competitions:
• USAMO or USACO or other USA Olympiad.

Summer Program:
• Accord’s summer Olympiad preparation camp

10th Grade
• Participate in the preparation camp of the primary area
• Participate in the International Olympiad, win a medal
• Science Fair Project for County Science Fair
• Calculus

Competitions:
• USAMO or USACO or other USA Olympiad
• IMO or IOI or IPhO or IBO

Summer Program:
• Internship at a high-tech company

11th Grade
• Gold medal at the International Olympiad
• Pass 2 AP tests in math, computer or sciences
• Take a class at a local university
• Participate in the Intel ISEF Project Competition
• SAT

Competitions:
• USAMO or USACO or other USA Olympiad
• IMO or IOI or IPhO or IChO or IBO
• Intel Talent Search

Summer Program:
• Internship at HP Labs, Intel or a related lab

12th Grade
• Gold medal at the international Olympiad
• Pass 2 AP tests in math, computer or sciences
• Take 2 classes at a local university

**Competitions:**
• USAMO or USACO or other USA Olympiad
• IMO or IOI or IPhO or ICHO or IBO

**Summer Program:**
• Mentorship at Accord’s summer camps, Inspire new students
MATH PROGRAM

Accord’s math program involves a high concentration on the AMC’s in math. AMC’s are a series of math contests culminates with the Mathematical Olympiad Summer Program (MOSP), which is a 3-4-week training program for the top qualifying AMC students. It is from this group of truly exceptional students that the USA Team, which will represent the United States at the International Mathematical Olympiad (IMO), are chosen.

Following the 4 weeks Mathematical Olympiad Summer Program (MOSP), the US Team accompanied by their adult leaders, travel to the site of the International Mathematical Olympiad (IMO). There, the most talented high school students from over 80 nations compete in an exceedingly, challenging two day assessment.

1ST LEVEL

Accord’s 1st level Math, Science Olympiad Program curriculum and related materials (are) as described in 6th Grade Program Outline. All homework assignments and class worksheets consist of problems taken from actual math contests.

PRIMARY BOOK:
Accord’s Math, Science Olympiad Program- 1st Level Math Problem Collection (compilation of actual math problems)

ADDITIONAL:
- “Australian Mathematics Competition Books 1, 2, 3” by J Edwards, D King, PJ O’Halloran
- “More Mathematical Challenges” by Tony Gardiner
- “Math Olympiad Contest Problems” by Dr. George Lenchner
- “Algebra” by I.M. Gelfand, Alexander Shen

2ND LEVEL

TEXTBOOKS:
- The Art of Problem Solving, Basics – Vol 1
- The Art of Problem Solving, and Beyond – Vol 2
ADDITIONAL:

- “Challenging Problems in Algebra” by Alfred S. Posamentier, Charles T. Salkind
- “Challenging Problems in Geometry” by Alfred S. Posamentier, Charles T. Salkind
- “Contest Problem Book I thru V: Annual High School Contests of the Mathematical Association of America” by Charles T. Salkind
- “Math Contests High School (Math League)” by Steven R. Conrad, Daniel Flegler

The Art of Problem Solving, Volumes I and II, were written by Sandor Lehoczky and Richard Rusczyk. Their goal was to write the books they wish they’d had when they were students preparing for extracurricular math events.

The Art of Problem Solving contains over 1000 examples and exercises culled from such contests as MATHCOUNTS, the Mandelbrot Competition, the AMC tests, ARML, and Olympiads from around the world.

Although the Art of Problem Solving is widely used by students preparing for mathematics competitions, these two books are not just a collection of tricks. The emphasis on learning and understanding methods rather than memorizing formulas enables students to solve large classes of problems beyond those presented in the book.

Accord expects its gifted students to finish high school mathematics using “The Art of Problem Solving” books in 7th and 8th grades.

3RD LEVEL - (FOR MATH OLYMPIANS):

In the 3rd level of the math program (if students choose to participate in the International Math Olympiads) students are assigned a local high-ranking university tutor and begin preparing for the International Mathematics Olympiad (IMO). Prospective Math Olympians have to prove their proficiency in high school mathematics (Accord’s MSOP, 2nd level) in order to qualify for the 3rd level (IMO preparation). They will be given a diagnostic test prior to enrollment in this competitive and complex mathematics program.

Some of the books they will be learning from are as follow:

- “Winning Solutions” by Edward Lozansky and Cecil Rousseau
- “Mathematical Olympiad Challenges” by Titu Andreescu, Razvan Gelca
- “The USSR Olympiad Problem Book” by D.O. Shklarsky, et al
• “Geometry Revisited” by H. S. M. Coxeter, Samuel L. Greitzer
• “250 Problems in Elementary Number Theory” by Wacław Sierpiński
• “Principles and Techniques in Combinatorics” by Chen Chuan-Chong, Koh Khee-Meng
• “Mathematical Olympiad Treasures” by Titu Andreescu, Bogdan Enescu
• “USA Mathematical Olympiads 1972-1986 - Problems and Solutions” by Murray Klamkin
• “The Art and Craft of Problem Solving” by Paul Zeitz
• “Polynomials” by E.J. Barbeau
• “Problem Solving Through Problems” by Loren C. Larson
• “Mathematical Olympiads, Problems and Solutions from Around the World” by Titu Andreescu and Zuming Feng

INSPIRATIONAL:
• “Count Down: The Race for Beautiful Solutions at the International Mathematical Olympiad” by Steve Olson
• “Who’s who of U.S.A. Mathematical Olympiad participants, 1972-1986: A record of their activities leading up to those that are current” by Nura Dorothea Rains Turner
• “Count Down: Six Kids Vie for Glory at the World’s Toughest Math Competition” by Steve Olson
Accord’s computer program is a long term computer science training for International Olympiads in Informatics (IOI). IOI participants are the most talented high school students from over 80 nations and they compete in an exceedingly, challenging two day assessment.

In the USA, the USA Computer Olympiad (USACO) training gate is an online training system as the first step of IOI. It is composed of various programming problems on different topics and contests throughout the year. Each student participates in one of the four divisions (level1, bronze, silver and gold) according to his/her skills and completion of the problems in each chapter. Then the top students based on their scores in the contests in the gold division are invited to 2 weeks USACO camp to determine the 4 members of IOI team to represent USA.

Accord’s advanced training program is composed of three levels. In the first level, the aim is to introduce computer science basics, improve reasoning abilities, learn basic programming skills and be ready for USACO. In the second level while students solve the problems and progress in the USACO training gate, they will deepen their programming and improve their problem solving skills in computer science. In third level, students start solving problems in the olympiad level.

1st Level

First level of the computer program is a brief introduction to computer science.

Textbook:
- Accord’s MSOP© Computer Science Booklet - 1st Level

Curriculum:
1. Introduction to Computer
2. Basic Programming
   a. Output
   b. Variables
   c. Arithmetic
   d. Input
   e. if-else
   f. Loops
   g. Nested if-else
   h. Nested loops
3. Graph Theory
   a. Nodes, edges, weights
   b. Representation
   c. Path, simple path, cycle
   d. Connected graph
   e. Directed graph
   f. Eulerian path
4. Combinatorics
   a. Counting
   b. Factorial
   c. Basic probability
5. Number Systems
   a. Binary, octal, decimal, hexadecimal
   b. Conversion
   c. Addition, subtraction, multiplication
6. Bits & boolean operators
   a. AND, OR, XOR, NOT, NAND, NOR
   b. Operator precedence
7. Boolean Algebra
   a. Equality rules; commutative, associative, distributive properties
   b. Simplification
   c. Ordered triples
8. Digital Circuits - 4 hours
   a. AND, OR, XOR, NOT, NAND, NOR

2ND LEVEL
This program is designed to prepare students for programming competitions. It consists of two steps. First step includes 6 parts of programming examples in C++. Each part consists of examples and problems based on those examples. Second step is the USACO training gate.

Students are expected to inspect and try the examples in C++. After becoming comfortable with the examples, they should spend quite a lot time on the problems at the end. Proposed time is no more than a week for each topic and 1-5 hours for each problem.

TEXTBOOK:
- Accord’s MSOP® C++ Programming Booklet

CURRICULUM: C++ PROGRAMMING
PART 1 - FLOW CONTROL AND LOOPS

• #include, main(), int, cin, cout
• Commenting on the source code ( //, /* */)
• if-else
• Conditionals (>, <, ==, <=, !=, &&, ||)
• Loops (do-while, while, for)
• Operators (+=, -=, *=, /=, %, %=)

PART 2 - EMBEDDED LOOPS

• Embedded loops
• break and continue

PART 3 - ARRAYS, LOOP-ARRAY RELATION

• Arrays
• Loop-array relation
• Examples on set operations
• #define
• const

PART 4 - MATRICES, FILE INPUT/OUTPUT

• ifstream, ofstream
• Multi-dimensional arrays

PART 5 - VARIABLE TYPES

• Variable types
• String operations
• switch-case
• Arrays with initial values
• ()?:

PART 6 - STRUCT AND FUNCTIONS

• Variable types
• functions, parameter passing
• local/global declarations

3RD LEVEL- (FOR COMPUTER OLYMPIANS):
In the 3rd level of the Computer Olympiad Program (if students choose to advance in computer studies) students prepare for the International Olympiad in Informatics (IOI). Prospective Computer Olympians have to complete the 2nd level or prove their proficiency in C++ to qualify for this high level program. 3rd level curriculum consists of data structures, algorithms and real olympiad problems.

**TEXTBOOK:**
- Accord’s MSOP© Data Structures and Algorithms Booklet

**ADDITIONAL:**

**CURRICULUM: DATA STRUCTURES AND ALGORITHMS**

**A. FUNDAMENTAL ALGORITHMS**
- Sorting
  - Bubble Sort
  - Insertion Sort
  - Selection Sort
  - Quicksort
- Heaps
  - Heapsort
  - Priority Queues

**B. DATA STRUCTURES**
- Fundamental Data Structures
  - Linked-lists
  - Stack
  - Queue
• Trees
  o Binary Trees
  o Traversing
  o n-ary Trees
• Introduction to Graphs

C. Recursion
• Introduction
• Traversing
• Divide-and-Conquer
• Subset
• Permutation
• Combination
• Non-Recursive Applications

D. Graph Algorithms
• Connectivity
  o Union-Find
• Biconnectivity
  o Articulation Point
  o Biconnected Components
• Weighted Graphs
  o Minimum Spanning Tree
  o Shortest Path
  o All Shortest Paths
• Directed Graphs
  o Transitive Closure
  o Topological Sort
  o Strongly Connected Components

E. Search Techniques
• Blind Search Methods
  o Depth First Search + Exhaustive Search
  o Breadth First Search
  o Non-Recursive DFS
  o Depth First Iterative Deepening
  o Greedy Methods + Pruning Techniques
• Informed Search Strategies
  o Best First Search
  o Beam Search
  o Hill Climbing
  o Algorithm of A and A*
• Game Tree Search
F. ADVANCED TOPICS

- Dynamic Programming
  - Knapsack Problem
  - Matrix Chain Product
- Hashing
- Data Compression
  - Huffman Encoding
- Constraint Satisfaction Problems
- Parsing & Grammars
- Geometric Algorithms
  - Elementary Geometric Methods
  - Convex Hull
  - Intersection
- And-Or Graphs
- Finite State Automata
PHYSICS PROGRAM

In the Physics Olympiad Preparation Program (if students choose to participate in the International Physics Olympiads) students are assigned a local high-ranking university tutor and begin preparing for the International Physics Olympiad (IPhO). Prospective Physics Olympians have to prove their proficiency in high school mathematics (Accord’s MSOP, 2nd level) in order to qualify for the Physics Olympiad preparation. They will be given a diagnostic test prior to enrollment in this competitive and complex mathematics program.

CALCULUS

Calculus is not required for the IPhO, however it’s a MUST for a Physics Olympiad contestant.

SYLLABUS

MECHANICS

• Foundation of kinematics of a point mass
• Newton’s laws, inertial systems
• Closed and open systems, momentum and energy, work, power
• Conservation of energy, conservation of linear momentum, impulse
• Elastic forces, frictional forces the law of gravitation, potential energy and work in a gravitational field
• Centripetal acceleration, Kepler’s laws

MECHANICS OF RIGID BODIES

• Statics, center of mass, torque
• Motion of rigid bodies, translation, rotation, angular velocity, angular acceleration, conservation of angular momentum
• External and internal forces, equation of motion of a rigid body around the fixed axis, moment of inertia, kinetic energy of a rotating body
• Accelerated reference systems, inertial forces

HYDROMECHANICS

• Pressure, buoyancy and the continuity law.
**Thermodynamics and Molecular Physics**
- Internal energy, work and heat, first and second laws of thermodynamics
- Model of a perfect gas, pressure and molecular kinetic energy, Avogadro’s number, equation of state of a perfect gas, absolute temperature
- Work done by an expanding gas limited to isothermal and adiabatic processes
- The Carnot cycle, thermodynamic efficiency, reversible and irreversible processes, entropy (statistical approach), Boltzmann factor

**Oscillations and Waves**
- Harmonic oscillations, equation of harmonic oscillation |
- Harmonic waves, propagation of waves, transverse and longitudinal waves, linear polarization, the classical Doppler effect, sound waves
- Superposition of harmonic waves, coherent waves, interference, beats, standing waves

**Electric Charge and Electric Field**
- Conservation of charge, Coulomb’s law
- Electric field, potential, Gauss’ law
- Capacitors, capacitance, dielectric constant, energy density of electric field

**Current and Magnetic Field**
- Current, resistance, internal resistance of source, Ohm’s law, Kirchhoff’s laws, work and power of direct and alternating currents, Joule’s law
- Magnetic field (B) of a current, current in a magnetic field, Lorentz force
- Ampere’s law
- Law of electromagnetic induction, magnetic flux, Lenz’s law, self-induction, inductance, permeability, energy density of magnetic field
- Alternating current, resistors, inductors and capacitors AC-circuits, voltage and current (parallel and series) resonances

**Electromagnetic Waves**
- Oscillatory circuit, frequency of oscillations, generation by feedback and resonance
• Wave optics, diffraction from one and two slits, diffraction grating, resolving power of a grating, Bragg reflection
• Dispersion and diffraction spectra, line spectra of gases
• Electromagnetic waves as transverse waves, polarization by reflection, polarizers
• Resolving power of imaging systems
• Black body, Stefan-Boltzmann law

QUANTUM PHYSICS

• Photoelectric effect, energy and impulse of the photon
• De Broglie wavelength, Heisenberg’s uncertainty principle

RELATIVITY

• Principle of relativity, addition of velocities, relativistic Doppler effect
• Relativistic equation of motion, momentum, energy, relation between energy and mass, conservation of energy and momentum

MATTER

• Simple applications of the Bragg equation
• Energy levels of atoms and molecules (qualitatively), emission, absorption, spectrum of hydrogenlike atoms
• Energy levels of nuclei (qualitatively), alpha-, beta- and gamma-decays, absorption of radiation, half-life and exponential decay, components of nuclei, mass defect, nuclear reactions

TEXTBOOKS

• “Physics” by Serway
• “Physics” by Ohanion

PROBLEM COLLECTIONS

MAIN:
• “Yamanlar Physics Olympiad Preparation Books”
ADDITIONAL

- “Princeton Problems in Physics with Solutions” by Nathan Newbury et al
- “Problems in General Physics” by I. E Irodov
- “MTG’s Physics Olympiad Problems”
- “International Physics Olympiads” by Waldemar Gorzkowski (Polish Acad. Sci.)
- “200 Puzzling Physics Problems” by Peter Gnadig et al
LEVEL 1 MATH ANNUAL PLAN

PART 1: INTRODUCTION TO MATH AND NUMBERS

WEEK 1
- Why do I Bother Learning Math?
- Positive Integers and Four Basic Operations, Negative Integers

SPECIAL ASSIGNMENT
Write a short composition telling what you expect from this class and learning math. Include your three main motivations to learn math.

TEACHING
Motivation to learn Math. Several applications from engineering to astronomy. Real life situations where knowing math really makes a difference. Why you still need to learn math to be a firefighter, a magician or an astronaut. Motivation for introducing numbers. Why and how did mankind come up with them? Positive integers and basic four operations, addition, subtraction, multiplication, division. Why do we need these operations? Negative numbers. Their applications in real life.

GROUP ACTIVITY
Practicing four basic operations on positive integers with a fun game hide and seek with numbers.

SAMPLE PROBLEM
\[ (-1) - (-2) + (-3) - (-4) + ... - (-2004) + (-2005) = ? \]

WEEK 2
- Rational Numbers, Complex and Continued Fractions

TEACHING
Motivation for introducing rational numbers. What are they and how do we use four operations with them? Rational numbers will be introduced. More complex problems involving fractions will be shown. Continued fractions will be introduced.

**GROUP ACTIVITY**

Hide & Seek with rational numbers.

**SAMPLE PROBLEM**

\[
\frac{1}{1 - \frac{1}{1 - \frac{1}{1 - \frac{1}{1 - \frac{1}{2}}}}} = ?
\]

**WEEK 3**

- Decimals and Percents

**TEACHING**

Motivation for introducing decimals and percentages will be given. Several applications like bank statements, interest rates, discounts will be discussed. Four operations using fractions, decimals and percentages will be practiced with lots of problems.

**GROUP ACTIVITY**

In random groups of 3, each group will make up a problem involving fractions, decimals and percentages and ask this problem to another group.

**SAMPLE PROBLEM**

\[
\frac{1.23 \times 0.12}{0.3} + \frac{2.46 \times 1.59}{5.3} = ?
\]
WEEK 4
  • Properties of Four Basic Operations

TEACHING
Priority order of four operations will be explained. Parentheses will be introduced. Commutative, associative properties of four operations will be investigated. Distributive property of multiplication over addition. How to use these properties in problem solving.

GROUP ACTIVITY
In random groups of 3, each group will make up a problem related to the topics covered so far and ask this problem to another group.

SPECIAL ASSIGNMENT
Find the sum 1+2+3+...+100 without using a calculator. Explain how you have got your answer.

SAMPLE PROBLEM
\[
\begin{array}{ccccccccc}
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
\end{array}
\]

WEEK 5
  • Gauss and Telescopic Sums
  • How to prove Gauss’ formula in 10 cool ways!

TEACHING
Gauss’ genius way of finding 1+2+3+...+100 will be explained. Similar expressions, like 1+3+5+...+99, will be calculated using Gauss’ formula. Also telescopic sums will be introduced and several applications of both will be given. Several other similar techniques will be discussed. Assignments from the previous week will be discussed.
**SPECIAL ASSIGNMENT**

Imagine yourself in Gauss’ time where there is no calculator and find another quick way of finding the sum 1+2+3+…+100. (Note: The best solutions will be chosen and rewarded.)

**SAMPLE PROBLEM**

\[
\frac{1}{1\times2} + \frac{1}{2\times3} + \frac{1}{3\times4} + \ldots + \frac{1}{2004\times2005} + \frac{1}{2005} = ?
\]

**WEEK 6**
- Review

**PART 2: HOW TO COUNT WITHOUT COUNTING!**

**WEEK 7**
- Sets, Venn Diagrams
- Counting Problems

**TEACHING**

What is a set? Showing a set in several ways, including Venn Diagrams. Basic operations with sets: Inclusion, intersection, union. Problem Solving via counting elements in a set.

**SAMPLE PROBLEM**

There are 20 students in an advanced math class. In this class, 4 students can speak French and German, 5 can speak German and Spanish, and 6 can speak Spanish and French. If there are only 3 students who can not speak any of these three languages and 3 students who can speak all three languages, how many students can speak exactly one language?

**WEEK 8**
- Permutation and Combinations

**TEACHING**

Number of ways of ordering objects in a line, on a circle, or in a keychain under certain conditions will be discussed. Techniques of counting numbers satisfying some modularity conditions in their decimal representation will be developed.
GROUP ACTIVITY
Divide the students in groups of four or five and ask them to show all possible orderings of the group on a line, or circular table under some given conditions.

SPECIAL ASSIGNMENT
Work on the following problem, and explain your thoughts:

“We go to a house where there are exactly two kids. If a girl opens the door what is the chance that the other kid is also a girl?”

SAMPLE PROBLEM
There are 6 students in a math study group. They sit on a round table to study algebra. If Nancy and Emily wants to sit together, Robert and Christina don’t want to sit next to each other, how many different sitting arrangements are possible?

WEEK 9
• Probability

TEACHING
Definition of probability, universal space, independent events, conditional probability. Applications with coin, dice problems and how to use probability in real life situations.

GROUP ACTIVITY
A real life probability question, assignment problem from the previous week, will be discuss in several groups of 3 students and the groups which agree on a particular answer will discuss their solutions to the problem with other such groups.

SPECIAL ASSIGNMENT
Work on the following problem, and explain your thoughts:

“We have two cards one having both faces blue and the other having one blue and one red faces. We accidentally drop one of the cards and see that the upper face of the card we dropped is blue. What is the chance the lower face of that card is also blue?”

SAMPLE PROBLEM
There are 3 white balls and 7 red balls in a box. A ball is picked randomly and put aside. Then a second ball is picked. If the second ball is red, what s the probability that the first ball was also red?
WEEK 10

- Basic Statistics
- Patterns and Sequences
- Graphs and Diagrams

TEACHING

Patterns in a given sequence of numbers will be investigated. The notions of mean, median, mode of the sequence will be explained. How to convert this information in a graph or diagram in several ways and also how to read the information given in a diagram will be discussed.

SPECIAL ASSIGNMENT

There is a presidential election in an advanced math class of size 20 with three candidates Rafael, Donatello, and Leonardo. Use your imagination to find a possible outcome for the votes of this election and show these results in diagram form.

SAMPLE PROBLEM

What number should be removed from the list so that the average of the remaining numbers is 19?

11, 16, 19, 23, 30

WEEK 11

- Review

PART 3: X IS SCARY? NO MORE!..

WEEK 12

- Introduction to Word Problems.
- The Concept of Variables

TEACHING

What is a variable? How to convert a word problem into an equation with unknowns?

SAMPLE PROBLEM
The mathematician Augustus De Morgan lived in the nineteenth century. He once made the following statement: "I was \(x\) years old in the year \(x^2\)." In what year was De Morgan born?

**Week 13**
- One and Two Unknown Linear Algebra Problems

**Teaching**
First solving linear algebra problems with one unknown will be taught. Students will practice with age, distance, counting problems of this type. Afterwards, solving linear algebra problems with two unknowns will be taught. Several real life applications will be given.

**Sample Problem**
If Michael Jordan has an average of 29 points per game after 100 games, how many points does he need in the remaining 50 games so that he finishes the season with an average of 30 points per game?

**Week 14**
- Functions and Operations
- Graphing Functions

**Teaching**
The concepts: functions and operations, domain, image, graph of a function will be taught. Equation and graph of functions will be explained and converting one form to the other will be discussed.

**Sample Problem**
Suppose that the operation \(^*\) is defined by \(a^*b = 3a - 2b\). What is the result of \((1^*(-2))^*(3^*4)\)?

**Week 15**
- Exponents
- Roots

**Teaching**
Definition and properties of powers, roots, radicals. Basic four operations in exponents and roots.

**Sample Problem**
If \( x = \sqrt{3^2 + 4^2} \), \( y = \sqrt{x^2 + 5^2} \), \( z = \sqrt{y^2 + 10^2} \),

find the value of \( \sqrt{x^2 + y^2 + z^2} \).

**WEEK 16**
- Polynomials
- Solving Quadratic Equations

**Teaching**

**Sample Problem**

\[
\frac{1}{2 + \frac{1}{2 + \frac{1}{2 + \ldots}}} = ?
\]

**WEEK 17**
- Review

**PART 4: NUMBER THEORY - A KINGDOM WHERE NUMBERS RULE!**

**WEEK 18**
- Divisibility, LCM, GCD, Remainder, Euclidean Algorithm

**Teaching**
Division of numbers. Quotient, remainder. Remainder of sums, products. Greatest Common Divisor, Least Common Multiple. Euclidean Algorithm to find GCD.

**Sample Problem**

The least common multiple of two numbers is 105 and the greatest common divisor is 5. What are the possible sums of these two numbers?
Week 19

- Prime Numbers and Unique Factorization

Teaching

What is a prime number? Why is it so commonly used from mathematics to computer science to cryptography? An algorithm to find small prime numbers. Fermat primes, Mersenne primes. Several ways to check if a given number is prime or not. Expressing integers as a product of prime numbers.

Group Activity

Random groups of 3 students will be formed. The groups will give each other three digit numbers and try to factor them into prime numbers.

Sample Problem

How many zeros do we have in the end of the number

$$100! = 1 \times 2 \times 3 \times \ldots \times 100$$

in the usual decimal representation?

Week 20

- Modular Arithmetic
- Chinese Remainder Theorem
- Quadratic Residues

Teaching

Modular Arithmetic makes life easy finding the remainders of large numbers and powers, products, sums. Chinese Remainder Theorem will be introduced and several applications will be given. Quadratic Residues, Jacobi, Legendre symbols will be taught. Quadratic Reciprocity Law will be mentioned. Congruence formulas involving prime numbers like Fermat’s Little theorem, Wilson Theorem will be given.

Sample Problem

What is the smallest positive integer which has remainders 5, 6, 7 when divided by the numbers 11, 13, 15 respectively?
Week 21

- Number Base Arithmetic

Teaching

Decimal number representation of numbers is not the only choice one has. Binary, ternary and other base representations will be introduced and four basic operations will be practiced under these base representations. Some applications will be given.

Sample Problem

A store has four weights and a balance. We are trying to measure the weights of objects weighing 1, 2, 3,…, 40 pounds. What should be the weights of the four objects we use to do this?

Week 22

- Review

Part 5: Geometry, This Is Where I Live!

Week 23

- 0-D Geometry: Points
- 1-D Geometry: Lines
- Length

Teaching

Points are the building blocks of geometry. Lines, rays, and line segments will be discussed.

Sample Problem

A path which is 1 m wide is partly surrounded by a fence shown in the diagram at the right. What is the length of the fence?

Week 24

- 2-D Geometry: Triangles, squares, rectangles, circles, polygons
- Angle

Teaching
Two dimensional geometric shapes will be explored. Interior and exterior angle theorems of polygons will be introduced with proofs.

**Sample Problem**

Prove that the sum of the measures of the exterior angles of a convex polygon is 360°.

**Week 25**

- Area
- Teaching
- Areas of regular and non-regular polygons will be discussed.

**Sample Problem**

What is the area of the shaded region if O is the point of intersection of the diagonals of the smaller square?

![Diagram](image)

**Week 2**

- Similar Triangles

**Teaching**

Similar triangles and relevant theorems will be discussed.

**Sample Problem**

What fraction of the area of the large triangle is shaded?

![Diagram](image)

**Week 27**

- Pythagorean Theorem and Applications

**Teaching**

This is Greek to me!

Pythagorean Theorem will be introduced with proof and its applications to word problems will be explored.
**Class Activity**

Watching a video about Pythagorean Theorem.

**Sample Problem**

Calculate the total length of all of the line segments in the figure below if the sides of the small square in the center each measure 1 cm.

![Figure](image)

**Week 28**

- How to prove Pythagorean Theorem in 10 cool ways!

**Teaching**

Various proofs of Pythagorean Theorem will be introduced. Students will be encouraged to compare and contrast a variety of proofs.

**Sample Problem**

Make a presentation on a proof of Pythagorean Theorem.

**Week 29**

- 3-D Geometry: Rectangular Prisms, Cones, Pyramids; Surface Area; Volume

**Teaching**

Three dimensional figures, their surface areas, and volumes will be explored.

**Sample Problem**

What is the surface area in cm² of the solid figure shown if the cubes measure 1 cm on each side?

**Week 30**

- Review
PART 6: MISCELLANEOUS FUN!

WEEK 31
- Logic Problems

TEACHING
Logic Puzzles, two way tables, problems require thinking outside the box.

SAMPLE PROBLEM
Four married couples were sitting around a circular table.

No man was sitting next to his wife or another man.

Mr. Coster was not sitting next to Mrs. Black.

Mr. Black was not sitting next to Mrs. Dell.

Moving clockwise around the table, the women were seated in the same order of their names as the men.

Mrs. Archer was sitting on the right of Mr. Black.

Who was sitting on the right of Mrs. Coster?

WEEK 32
- Irrational Numbers

TEACHING
Definition of irrational numbers will be given. Existence of them will be proved via using fractions and divisibility with the number $\sqrt{2}$. Several other proofs including a nice geometric one using Pythagorean Theorem will be discussed.

SPECIAL ASSIGNMENT
Similarly show that $\sqrt{3}$ is also irrational. Square roots of which other numbers do you think are irrational?

SAMPLE PROBLEM
Prove that $e = \sum_{k=0}^{\infty} \frac{1}{k!}$ is irrational.

WEEK 33
- Problem Solving
WEEK 34
  • Problem Solving

WEEK 35
  • Problem Solving

WEEK 36
  • Problem Solving