Entry Level Mathematics

ELM Problem Book

Numbers and Data

Algebra

Geometry

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2002 Edition

An Aid to Preparation for
The California State University
Entry Level Mathematics (ELM) Examination

Table of Contents

Introduction

All students in the CSU are required to take college-level courses in mathematics or quantitative reasoning in order to graduate. It is important that all students arrive at the university with the necessary entry-level mathematics skills. If, on entry, a student is found to need additional work in college preparatory subjects and is placed in appropriate remedial coursework, *such remedial coursework will not count toward credit for graduation.*

In order to ensure that students entering the university are ready to take courses in mathematics or quantitative reasoning, freshmen must complete three years of college-preparatory coursework (Algebra I, Geometry, and Algebra II). Although not required for admission to the CSU, a fourth year of precalculus mathematics is advisable, especially for students planning to pursue majors in technical fields. This fourth-year course is a prerequisite to the freshman calculus courses required in most technical curricula. Students who do not intend to major in technical fields in college may choose a course in statistics and probability in their senior year of high school. *All students are encouraged to take mathematics in their senior year of high school, since students whose last math course was completed in the junior year or earlier often have difficulties with the required college-level mathematics courses and with the Entry Level Mathematics (ELM) requirement.*

The Entry Level Mathematics Requirement

The ELM placement examination assesses entry-level mathematics skills that the CSU expects entering students to have acquired in three years of rigorous college-preparatory mathematics coursework. Such courses must include the topics covered in elementary and intermediate algebra and two- and three-dimensional geometry, whether offered in traditional or integrated mathematics courses.

All entering students must take the ELM unless they have demonstrated proficiency in mathematics on the SAT, ACT, or Advanced Placement exams (see list below) prior to placement in appropriate university mathematics coursework. This is the ELM requirement. Those who are not exempt must take the ELM placement test prior to enrollment in the CSU. Failure to comply with this requirement will prevent the student from enrolling in the university. Specific policies regarding retesting and placement are determined by each campus. Exemptions from the placement test are given only to those students who can present proof of one of the following:

- A score of 550 or above on the mathematics section of the College Board SAT I: Reasoning Test[1]
- A score of 550 or above on Mathematics Level IC or IIC of the College Board SAT II: Mathematics Test[1]
- A score of 23 or above on the ACT Mathematics Test taken October 1989 or later
- A score of 3 or above on the College Board Advanced Placement Calculus AB or Calculus BC examination
- A score of 3 or above on the College Board Advanced Placement Statistics examination
- Completion and transfer to the CSU of a college course that satisfies the requirement in quantitative reasoning, provided such a course was completed with a grade of C or better

[1] NOTE: The College Board SAT and Achievements Tests became the SAT I and SAT II, respectively, beginning March 1994. A new, "recentered" scoring scale has been in effect since April 1995. If you took the SAT before April 1995, contact the campus Admissions and Records Office or Test Office for appropriate exemption scores.

Description of the Modified ELM Placement Test

The ELM placement test reflects the desire of the CSU mathematics and mathematics education community to build a placement test that assesses mathematical skills needed in campus General Education (GE) programs in quantitative reasoning and to serve the needs of entering students planning both quantitative and nonquantitative courses of study. The placement test was developed over a two-year period by a committee of CSU mathematics professors, mathematics education professors, and chairs of mathematics departments. It differs in several important respects from the ELM placement test that has been in place since January 1999.

The ELM placement test described here will be administered for the first time at the March 23, 2002, systemwide administration. Following are some of the ways in which it differs from its ELM predecessor.

Content
In content, the main difference between the current ELM and its predecessor is one of emphasis. There is more emphasis on working with numbers and data, the connections between algebra and geometry, and problem solving. There is less emphasis on working pure algebra problems. The test provides the major geometric formulae for reference because its purpose is to assess understanding of mathematical concepts and problem-solving skills rather than recall of facts and equations.

The actual topics covered by the current ELM are not very different from those that have been the basis of the placement test since 1992. A few topics have been deleted, but no topics have been added. The placement test is still predicated on the idea that students are responsible for mastering the content of three years of high school mathematics.

Table 1 contains a list of the topics covered by the placement test and shows the proportion of the test devoted to each of the three major content areas: Numbers and Data, Algebra, and Geometry.

Timing
In the past, students were given 75 minutes to complete the ELM, which contained 65 multiple-choice questions. Beginning with the March 23, 2002, administration, the ELM will contain 50 multiple-choice questions. Students will be allotted 90 minutes to complete the test.

Calculators Not Allowed
Beginning with the March 23, 2002, administration, calculators will not be allowed for the ELM placement test. The questions on the ELM do not require involved computation. Rather, the placement test includes problems that emphasize quantitative reasoning and problem solving.

Table 1: CSU ELM Topics

NUMBERS AND DATA (approximately 35%)

- ✓ Carry out basic arithmetic calculations
- ✓ Understand and use percent in context
- ✓ Compare and order rational numbers expressed as fractions and/or decimals
- ✓ Solve problems involving fractions and/or decimals in context
- ✓ Interpret and use ratio and proportion in context
- ✓ Use estimation appropriately
- ✓ Evaluate the reasonableness of a solution to a problem
- ✓ Evaluate and estimate square roots
- ✓ Represent and understand data presented graphically (including pie charts, bar and line graphs, histograms, and other formats used in print and electronic media for presenting data visually)
- ✓ Calculate and understand the arithmetic mean
- ✓ Calculate and understand the median
- ✓ Make estimates and predictions based on data
- ✓ Distinguish between reasonable and unreasonable claims based on data

ALGEBRA (approximately 35%)

- ✓ Evaluate and interpret algebraic expressions
- ✓ Simplify algebraic expressions
- ✓ Express relationships among quantities using variables
- ✓ Use properties of exponents
- ✓ Perform polynomial arithmetic (add, subtract, multiply, divide, and factor)
- ✓ Perform arithmetic operations involving rational expressions
- ✓ Solve linear equations (with both numerical and literal coefficients)
- ✓ Solve systems of linear equations in two unknowns
- ✓ Solve linear inequalities
- ✓ Solve problems in context that are modeled by linear equations
- ✓ Solve quadratic and rational equations (with both numerical and literal coefficients; real solutions only)
- ✓ Solve problems in context that are modeled by quadratic equations
- ✓ Solve equations involving absolute value (in one variable)
- ✓ Solve inequalities involving absolute value (in one variable)
- ✓ Find and use slopes and intercepts of lines
- ✓ Use constant and average rates to solve problems in context (using appropriate units)

GEOMETRY (approximately 30%)

- ✓ Find the perimeter, area, or volume of geometric figures (including triangles, quadrilaterals, rectangular parallelepipeds, circles, cylinders, and combinations of these figures)
- ✓ Calculate the ratio of corresponding geometric measurements of similar figures (e.g., if the perimeters are in a 3:2 ratio, the areas are in a 9:4 ratio)
- ✓ Use the Pythagorean Theorem
- ✓ Use properties of congruent or similar geometric objects
- ✓ Solve geometric problems using the properties of basic geometric figures (including triangles, quadrilaterals, polygons, and circles)
- ✓ Determine angles in the plane (using properties of intersecting lines, parallel lines, and perpendicular lines)
- ✓ Identify and plot points on the number line
- ✓ Identify and plot points in the coordinate plane
- ✓ Plot points on the graph of a function determined by an algebraic expression
- ✓ Graph linear functions in one variable
- ✓ Graph quadratic functions in one variable
- ✓ Relate basic information about a function to features of its graph (e.g., linearity, positivity or negativity, increasing or decreasing)
- ✓ Find the length or midpoint of a line segment in the coordinate plane

Scores on the ELM Placement Test

As noted previously, the ELM placement test consists of 50 multiple-choice questions. The reported score will be based on 45 of these questions. The remaining 5 questions are being field tested for possible use on future tests. **Beginning with the March 23, 2002, administration, score reporting for the ELM will employ a scale of 0-80.** All scores will be reported as even numbers on this scale. The passing scaled score on the ELM is 50, reported on a scale of 0-80.

The ELM is reviewed regularly, and new editions are developed several times each year. Therefore, the questions on one edition of the test will not be identical to those on another. However, steps are taken to ensure that each edition represents the same level of difficulty. The inevitable slight differences in difficulty between one edition of the test and another are accommodated through the statistical practice of equating the scores to the ELM scale. A scaled score earned by taking any given ELM test administered on or after March 23, 2002, indicates the same level of proficiency as the same scaled score earned by taking any other given ELM test administered on or after March 23, 2002.

It is extremely important to note that a scaled score earned on the ELM placement test before the March 23, 2002, administration cannot be compared to a scaled score earned by taking the ELM placement test on or after March 23. This is due to the changes incorporated in the ELM administered beginning March 23, 2002: disallowing the use of calculators, giving students more time to take the test, decreasing the number of test questions, and changing the emphasis of what the test measures. To discourage comparisons, the CSU mathematics and mathematics education professors who modified the ELM revised the ELM scale: the 0-80 scale replaces the 100-700 scale that has been in use since the mid-1980's. The score that determines proficiency on the new scale was recommended by a panel of expert judges chosen from faculty in mathematics and related departments throughout the CSU.

Subscores

Starting with score reporting for the March 23, 2002, test, students will receive three scaled subscores—one for each content area (Numbers and Data, Algebra, and Geometry)—as well as a total scaled score. The subscores will be represented graphically as score ranges on the 0-80 scale. The score of 50, which indicates proficiency, is indicated by a vertical line on this scale. Figure 1, on the next page, shows a sample student score report.

How the ELM Placement Test is Used

The ELM placement test must be taken by all nonexempt students before they can enroll in the CSU. Students receiving a total scaled score of 50 or above may enroll directly in a baccalaureate quantitative reasoning course. Students receiving a total scaled score below 50 are typically required to take remedial coursework. Campuses have the option of permitting students who score below 50 to take the ELM placement test again after self-study or a tutorial.

The subscores are intended to provide guidance in determining the nature of the remediation that best meets a student's needs. However, it is essential to bear in mind that the subscores are less reliable than the total scaled score. The total scaled score is based on all 45 scored test questions while the subscores are based only on subsets of roughly 12 to 18 questions each. To signal the fact that the subscores are less reliable than the total score, they are represented as ranges rather than as single numbers. Only the total score is reliable enough to be represented as a single number.

In addition, subscores are shown as ranges to discourage interpretations of "passing" or "failing" one of the content areas covered by the ELM. A student can demonstrate proficiency on ELM as

a whole, but the student should not be thought of as "failing" Numbers and Data or "passing" Algebra. In other words, placement decisions should be based on the total score; however, subscores may identify areas of particular need.

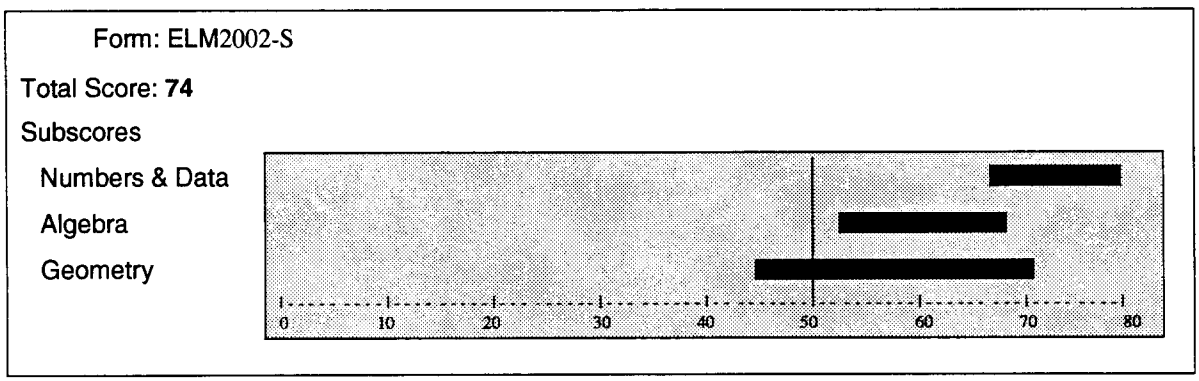
So what DO the subscores show? A given student's subscores tell us about that student's performance in the three content areas relative to the performance of other students who took the examination. Thus, a subscore range completely to the left of the cut score marker on the 0-80 axis indicates that a student's performance in that content area ranks with the overall performance of students whose total score is below the cut score. Conversely, a subscore range completely to the right of the cut score marker on the 0-80 scale suggests that a student's performance in the corresponding content area ranks with the overall performance of students whose total score is above the cut score. It is quite possible that a student scoring above the cut score on the test as a whole will rank with fellow test takers whose total score is below the cut score in a particular content area. It is important to remember that the total score is the most important and reliable guide: students who score above the cut score are ready for the first GE mathematics course, even if their performance in the three content areas is uneven. By the same token, a student who ranks with the proficient test takers in a given subscore area but whose total score is below the cut score will benefit from some remedial instruction.

A subscore range that straddles the cut-score marker is harder to interpret than one that is entirely to one side of that marker. Typically, students with a total score near the cut score (either "passing" or "failing") will have subscores straddling the cut-score marker. The "passing" students in this group are ready for the first GE course; those whose total score is below the cut score can probably benefit from general review in all three content areas before proceeding to the first GE course.

Students whose total score is well below the cut score probably stand to benefit from more intensive help in all the content areas. If all three subscore ranges are to the left of the cut-score marker, this is almost certainly the case.

The most important caveat to bear in mind is not to overinterpret the subscore ranges. The subscore ranges can provide useful information in thinking about what kind of remediation a given student needs, but interpreting them is an art as much as it is a science. Each student presents an individual case. When in doubt, remember that the total score is the most reliable indicator.

Figure 1: Sample ELM Score Report

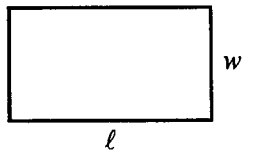
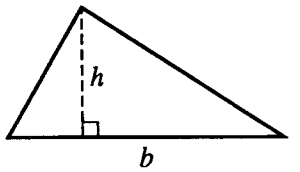
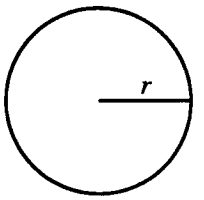
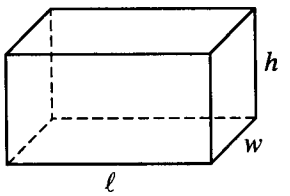
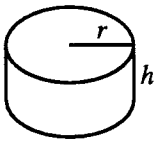
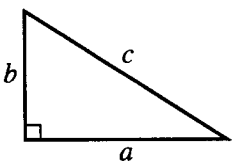


Sample Problems

This book has been developed to help students prepare for the CSU Entry Level Mathematics (ELM) examination. It is *not* a text, but rather a compilation of problems in the topic areas that are covered on the ELM exam. Many of the problems have appeared on previous ELM exams, and they illustrate the various levels of difficulty and the style of the problems that appear on the exam.

The test provides a page of Geometry Reference Formulas because its purpose is to assess understanding of mathematical concepts and problem-solving skills rather than recall of facts and equations. These formulas are presented in Table 2 on page 7, and are included in each ELM test booklet.

The pages that follow contain problems representative of the topics covered on the Entry Level Mathematics (ELM) test. The problems are arranged by the topic clusters listed in Table 1 on page 3. The answers to these questions can be found on page 41.

Table 2: Geometry Reference Formulas	
Rectangle 	Area = ℓw Perimeter = $2\ell + 2w$
Triangle 	Area = $\frac{1}{2}bh$
Circle 	Area = πr^2 Circumference = $2\pi r$
Rectangular Solid 	Volume = ℓwh
Right Circular Cylinder 	Volume = $\pi r^2 h$
Pythagorean Theorem 	$c^2 = a^2 + b^2$

Number Sense

1. A theater has 25 rows, each with 12 seats. At a certain performance there were, on average, 3 empty seats per row. What was the attendance at that performance?

   (A) 225 (B) 264 (C) 297 (D) 300 (E) 375

---

2. There are 45 people coming to a picnic at which hot dogs will be served. Hot dogs come in packages of 8 that cost $2.50 each, and hot dog rolls come in packages of 10 that cost $2.00 each. If enough hot dogs and hot dog rolls will be purchased so that each person can have at least one hot dog in a roll, what is the minimum that can be spent on hot dogs and hot dog rolls?

   (A) $20.50 (B) $22.50 (C) $25.00 (D) $27.00 (E) $29.50

---

3. A P-model car costs 15 percent more than a V-model car. If the V-model costs $7,000, what is the cost of the P-model?

   (A) $5,950 (B) $7,105 (C) $8,005 (D) $8,050 (E) $8,500

---

4. The sale price of a photography book is 20 percent off the list price. If the sale price of the book is $10, what is the list price?

   (A) $7.50 (B) $8.00 (C) $12.00 (D) $12.50 (E) $14.00

---

5. The operating budget of the Western Robotics Company was $300 million last year. If the operating budget this year is 12 percent less than last year, what is this year's operating budget, in millions of dollars?

   (A) 36 (B) 264 (C) 274 (D) 288 (E) 336

---

6. The sale price of Kathy's new briefcase was reduced 30% from the original price of \$80. What was the sale price of the briefcase?

(A) \$30 (B) \$40 (C) \$50 (D) \$56 (E) \$104

---

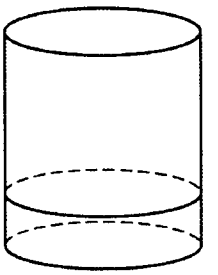
7. Which of the following numbers is between 3.74 and $3\frac{4}{5}$?

(A) $3\frac{9}{10}$ (B) 3.72 (C) 3.82 (D) $3\frac{1}{2}$ (E) $3\frac{3}{4}$

0.12 0.018 0.04 0.004

8. In which of the following are the four decimals above listed in order from greatest to least?

(A)	0.12	0.018	0.04	0.004
(B)	0.12	0.04	0.018	0.004
(C)	0.018	0.12	0.004	0.04
(D)	0.018	0.004	0.12	0.04
(E)	0.04	0.004	0.12	0.018



9. The figure above shows a right circular cylindrical vessel that is exactly one-quarter full. If 7 liters of liquid are added, the vessel will be exactly three-fifths full. What is the total capacity of the vessel, in liters?

(A) 14 (B) 20 (C) 21 (D) $\frac{9\pi}{20}$ (E) 21π

---

10. Marshall is making corn bread. His recipe calls for $3\frac{1}{2}$ cups of cornmeal, but he wants to make only half the amount given in the recipe. How many cups of cornmeal should he use?

(A) $1\frac{1}{4}$ (B) $1\frac{1}{2}$ (C) $1\frac{3}{4}$ (D) 5 (E) 7

---

11. Maria worked in a library. She was paid at the rate of \$6.00 per hour. If she worked from 10:30 A.M. to 4:45 P.M. on Tuesday, how much money did she earn?

(A) \$30.00 (B) \$33.00 (C) \$34.50 (D) \$36.00 (E) \$37.50

---

12. A certain medicine is prescribed in an amount proportional to a patient's body weight. If a patient weighing 70 kilograms requires 210 milligrams of this medicine, then the amount of medicine required for a patient weighing 80 kilograms is

(A) 220 mg (B) 230 mg (C) 240 mg (D) 250 mg (E) 290 mg

---

13. Joel mixed 3 tablespoons of plant fertilizer with 2 liters of water. In order to obtain the same ratio of fertilizer to water, how many tablespoons of fertilizer must he mix with 5 liters of water?

(A) $3\frac{1}{3}$ (B) 6 (C) 7 (D) $7\frac{1}{2}$ (E) 8

---

14. How many dollars will x pens cost if 5 such pens cost y dollars?

(A) $\frac{xy}{5}$ (B) $\frac{5}{xy}$ (C) $5xy$ (D) $\frac{y}{5x}$ (E) $\frac{x}{5y}$

ENROLLMENT AT CENTRAL COLLEGE

Freshmen	1,816
Sophomores	1,473
Juniors	1,431
Seniors	1,298

15. According to the table above, which of the following best approximates the total enrollment at Central College?

(A) 1,800 + 1,400 + 1,400 + 1,200
(B) 1,800 + 1,400 + 1,400 + 1,300
(C) 1,800 + 1,500 + 1,400 + 1,300
(D) 1,900 + 1,500 + 1,400 + 1,300
(E) 1,900 + 1,500 + 1,500 + 1,300

---

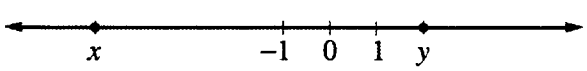
16. In a music class of 30 students, there are 6 more females than males. How many females are in the class?

(A) 6 (B) 12 (C) 18 (D) 24 (E) 36

---

17. A roast is to be cooked 20 minutes for each pound of weight. If a roast weighing 7 pounds needs to be ready for dinner at 6:00 P.M., which of the following would be the best time to put the roast into the oven?

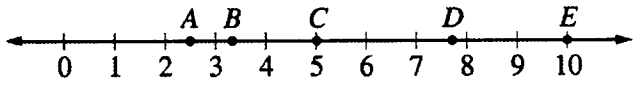
(A) 2:30 P.M. (B) 3:00 P.M. (C) 3:30 P.M. (D) 4:00 P.M. (E) 4:30 P.M.



18. Which of the following must be true about the numbers x and y graphed on the number line above?

I. $x + y > 0$
II. $y - x > 0$
III. $xy > 0$

(A) I only (B) II only (C) III only (D) II and III only (E) I, II, and III



19. Which point on the number line above could represent $\sqrt{10}$?

(A) *A* (B) *B* (C) *C* (D) *D* (E) *E*

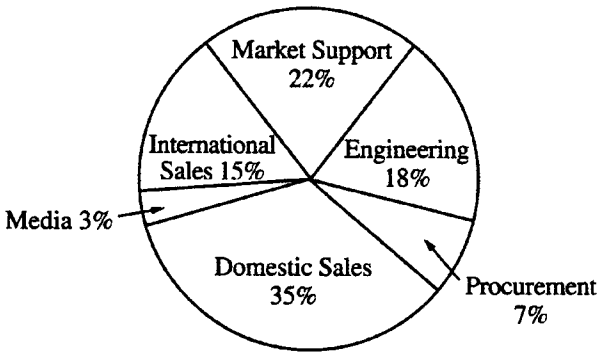
---

20. $\sqrt{24}$ is a number between

(A) 0 and 1 (B) 1 and 2 (C) 2 and 3 (D) 3 and 4 (E) 4 and 5

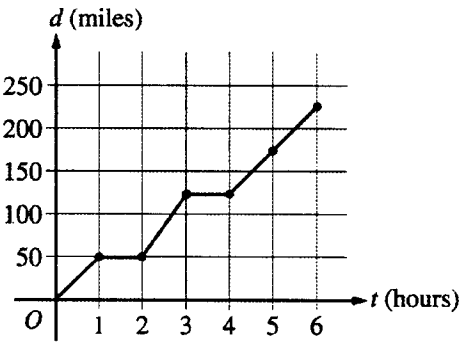
Data Analysis

ANNUAL BUDGET BY DEPARTMENT



21. The circle graph above shows the annual budget for the Heavy Equipment Company. If the total budget is $50,000,000, what amount is budgeted for the market support and engineering departments combined?

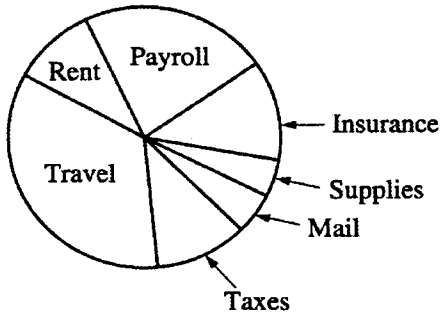
(A) $11 million (B) $18 million (C) $20 million
(D) $22 million (E) $25 million



22. In the graph above, d represents the distance, in miles, that a motorist has traveled after t hours on the road. How many hours did it take the motorist to travel 200 miles?

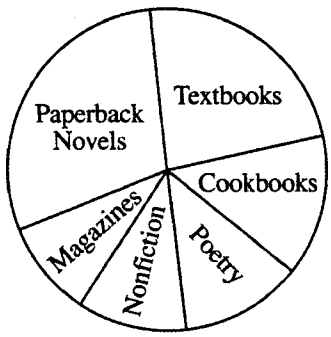
(A) 4.0 (B) 4.5 (C) 5.0 (D) 5.5 (E) 6.0

MONTHLY EXPENSES
OF COMPANY *X*



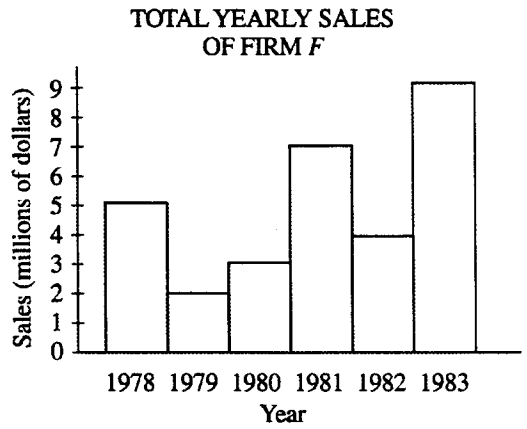
23. Which of the categories shown in the graph above accounts for approximately one-third of Company *X*'s expenses?

(A) Insurance (B) Payroll (C) Rent (D) Travel (E) Taxes



24. The circle graph above represents the percent of total revenue a publisher receives from various types of publications. Approximately what percent of total revenue is derived from textbooks and cookbooks?

(A) 10% (B) 25% (C) 35% (D) 50% (E) 65%



25. The graph above shows the yearly sales for Firm *F*. What is the average (arithmetic mean) of the yearly sales of Firm *F* for the three-year period from 1979 through 1981, in millions of dollars?

(A) 3 (B) 4 (C) 5 (D) 6 (E) 7

---

26. The recorded high temperatures on four successive days were 94°, 85°, 77°, and 86°. What must the recorded high temperature be on the fifth day in order to have an average (arithmetic mean) high temperature of 85° for the five days?

(A) 76° (B) 80° (C) 83° (D) 86° (E) 88°

HISTORY TEST SCORES

Test 1	82
Test 2	71
Test 3	93
Test 4	88
Test 5	86

27. Danielle's scores on 5 history tests are given in the table above. What is the median of Danielle's scores?

(A) 82 (B) 84 (C) 86 (D) 88 (E) 93

ANNUAL COST OF WATER PER HOUSEHOLD IN 5 COMMUNITIES

Ashville	$696
Buckview	$557
Centerville	$268
Deerfield	$156
Elmwood	$434

28. What is the median annual cost of water per household in the 5 communities listed in the table above?

(A) $156 (B) $268 (C) $434 (D) $557 (E) $696

---

29. An investment company advertised that last year its clients, on average, made a profit of 9%. Which of the following claims can legitimately be made, based on that information?

(A) All of their clients made a profit of at least 9% last year.
(B) At least one of their clients made a profit of at least 9% last year.
(C) Some of their clients will make a profit of at least 9% this year.
(D) All of their clients will make a profit of at least 9% this year.
(E) If a person becomes one of their clients, that person will make a profit of at least 9% each year.

---

30. In a study of pain relievers, 50 people were given product *A* and all but 3 experienced relief. In the same study, 25 people were given product *B* and all but 2 experienced relief. Which of the following claims is most reasonable based on the data?

(A) Product *B* is better, because only 2 failed to get relief.
(B) Product *B* is better, because only 8% failed to get relief.
(C) Product *B* is better, because only 2% failed to get relief.
(D) Product *A* is better, because only 6% failed to get relief.
(E) Product *A* is better, because only 3% failed to get relief.

Algebra I

31. If $x = -1$ and $y = 6$, then $x^2 + 3xy =$

(A) 19 (B) 17 (C) 16 (D) −16 (E) −17

---

32. If $t = -2$, then $3t^2 - 5t - 6 =$

(A) −28 (B) −8 (C) −4 (D) 8 (E) 16

---

33. If $b = 6$ and $h = 10$, then $\frac{1}{2}bh =$

(A) 8 (B) 15 (C) 16 (D) 30 (E) 60

---

34. $\frac{4r^3s^5}{10r^8s^6} =$

(A) $\frac{2r^5s}{5}$ (B) $\frac{2r^{11}s^{11}}{5}$ (C) $\frac{2s}{5r^5}$ (D) $\frac{2}{5r^5s}$ (E) $\frac{1}{6r^5s}$

---

35. $(a^2c^3)(ab^2c) =$

(A) ab^2c^2 (B) $a^2b^2c^3$ (C) $a^3b^2c^4$ (D) $a^3b^3c^4$ (E) $a^4b^2c^5$

---

36. $\left(27a^{12}b^{6}\right)^{\frac{1}{3}} =$

(A) $3a^4b^2$ (B) $9a^4b^2$ (C) $9a^{12}b^6$ (D) $81a^{12}b^6$ (E) $81a^{36}b^{18}$

---

37. $16^{-\frac{1}{2}} =$

(A) -8 (B) -4 (C) $\frac{1}{8}$ (D) $\frac{1}{4}$ (E) 256

---

38. A thermostat is set at a temperature T that is neither less than $68°$ nor greater than $78°$. Which of the following inequalities describes all values of T?

(A) $68° \leq T$
(B) $68° < T < 78°$
(C) $68° \leq T < 78°$
(D) $68° < T \leq 78°$
(E) $68° \leq T \leq 78°$

---

39. This year José earned 3 times as much money as he earned last year. If José earned T dollars this year and he earned L dollars last year, which of the following equations represents the relationship between T and L?

(A) $3L = T$ (B) $\frac{L}{3} = T$ (C) $T \times L = 3$ (D) $\frac{L}{3} = \frac{T}{3}$ (E) $\frac{L}{3} = \frac{3}{T}$

---

40. $\left(y^2 - 3y + 6\right) - \left(3y^2 + 4y - 5\right) =$

(A) $-2y^2 + y - 11$ (B) $-2y^2 + y + 1$ (C) $-2y^2 + y + 11$
(D) $-2y^2 - 7y + 1$ (E) $-2y^2 - 7y + 11$

---

41. $-2r(3r^2 - 2rs) =$

(A) $6r^3 + 4rs$ (B) $6r^3 - 4r^2s$ (C) $-6r^3 + 2rs$
(D) $-6r^3 + 4r^2s$ (E) $-6r^3 - 4r^2s$

---

42. $(x - 6)(3x - 4) =$

(A) $3x^2 - 22x + 24$ (B) $3x^2 - 22x - 24$ (C) $3x^2 - 18x + 24$
(D) $3x^2 - 14x - 24$ (E) $3x^2 - 14x + 24$

---

43. One factor of $x^2 + 2x - 8$ is

(A) $x - 1$ (B) $x - 2$ (C) $x - 4$ (D) $x - 6$ (E) $x - 8$

---

44. $(3x^3y)(-2x^2y^3) =$

(A) $-6x^5y^4$ (B) $-6x^6y^3$ (C) xy^{-2} (D) x^6y^3 (E) $6x^5y^3$

---

45. $\frac{4 + 8x}{2} =$

(A) $4x$ (B) $6x$ (C) $2 + 4x$ (D) $2 + 8x$ (E) $4 + 4x$

---

46. $x^{-2} =$

(A) $\frac{1}{x^2}$ (B) $\sqrt{x}$ (C) $-x^2$ (D) $x^{\frac{1}{2}}$ (E) $x^{-\frac{1}{2}}$

---

47. If $2az - 5z = 2$, then $z =$

(A) $-\frac{2}{3a}$ (B) $\frac{2+5a}{2a}$ (C) $\frac{1}{a-5}$ (D) $\frac{2}{2a-5}$ (E) $7 - 2a$

---

48. If $4x - 1 = 5x + 3$, then $x =$

(A) -4 (B) $-\frac{4}{9}$ (C) $\frac{2}{9}$ (D) $\frac{4}{9}$ (E) 2

---

49. If $3x - d = c$, then $x =$

(A) $c + d - 3$ (B) $d + \frac{c}{3}$ (C) $\frac{d-c}{3}$ (D) $\frac{c-d}{3}$ (E) $\frac{c+d}{3}$

---

50. Ma-li can paint a certain room in about 5 hours, and Alicia can paint the same room in about 4 hours. Approximately how many hours would it take Ma-li and Alicia to paint that room if they worked together?

(A) 1 (B) 2 (C) 4 (D) 5 (E) 9

---

51. Mario paddled his canoe upstream for 3 hours. When he turned around and paddled back to his starting point, it took him only 1 hour. If the river flows at a speed of 3 miles per hour, how fast could Mario paddle his canoe in still water?

(A) 1 mile per hour (B) 2 miles per hour (C) 3 miles per hour
(D) 6 miles per hour (E) 9 miles per hour

---

52. What is the slope of the line through the points $(2, 2)$ and $(4, 3)$?

(A) $-\frac{1}{2}$ (B) $-\frac{1}{4}$ (C) $\frac{1}{2}$ (D) $\frac{3}{4}$ (E) 2

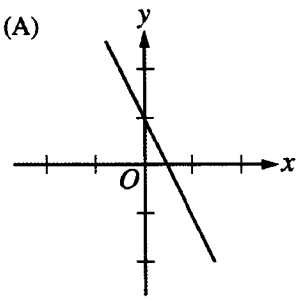
---

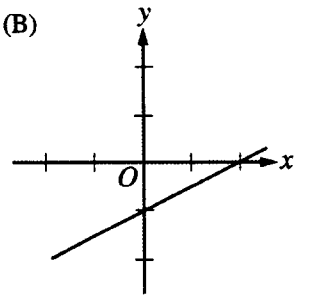
53. Which of the following lines is parallel to the line with equation $2y + 4x = 3$?

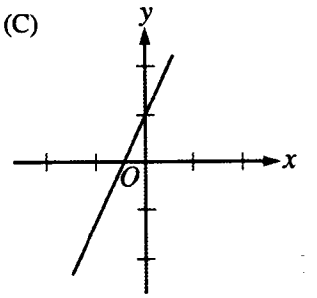
(A) $y + 2x = 3$ (B) $y - 2x = 3$ (C) $2y - 4x = 3$
(D) $-2y + 4x = 3$ (E) $4y + 2x = 3$

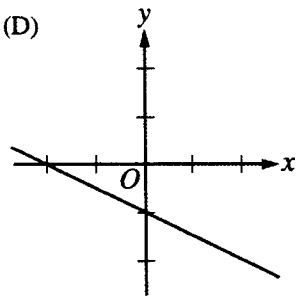
---

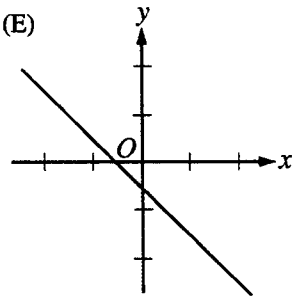
54. Which of the following is the graph of a line with a slope of $-\frac{1}{2}$?

(A)


(B)


(C)


(D)


(E)


---

55. If the point $(2, 4)$ is on the line $y = 6x + b$, then $b =$

(A) -22 (B) -8 (C) 12 (D) 16 (E) 26

---

56. $-3x < 5$ is equivalent to

(A) $x < -15$ (B) $x < -\frac{5}{3}$ (C) $x > -15$ (D) $x > -\frac{5}{3}$ (E) $x > -\frac{3}{5}$

---

57. $1 - 2x \leq 2 + x$ is equivalent to

(A) $x \geq -\frac{1}{3}$ (B) $x \geq 1$ (C) $x \leq -\frac{1}{3}$ (D) $x \leq \frac{1}{3}$ (E) $x \leq 1$

---

58. A car travels 80 miles on 3 gallons of gas. At the same rate (in miles per gallon), how many miles will the car be expected to travel on 5 gallons of gas?

(A) 48 (B) 130 (C) $130\frac{2}{3}$ (D) $133\frac{1}{3}$ (E) 160

WEATHER BALLOON TEMPERATURES

Height	Temperature
1,000 feet	23°
2,000 feet	20°
3,000 feet	17°

59. A weather balloon is released and as it rises in the air it records the temperature, in degrees Celsius, as shown in the table above. If the temperature continues to decrease at a constant rate, the temperature at 5,500 feet will be

(A) 12.5° (B) 11° (C) 9.5° (D) 8° (E) 6.5°

Algebra II

60. If $a = -2$, then $|5 - a| - |a - 8| =$

(A) -13 (B) -3 (C) 7 (D) 13 (E) 17

---

61. For $x > 0$, $\sqrt{4x^2} + \sqrt{9x^2} =$

(A) $\sqrt{13}x$ (B) $5x$ (C) $13x$ (D) $5x^2$ (E) $13x^2$

---

62. $\sqrt{100x^{36}} =$

(A) $100x^{18}$ (B) $50x^{18}$ (C) $10x^{18}$ (D) $50x^6$ (E) $10x^6$

---

63. If $f(x) = 3x^2 - 4x + 1$, then $f(-2) =$

(A) -19 (B) -5 (C) -3 (D) 5 (E) 21

---

64. A factor of $4a^2 - 9b^2$ is

(A) $4a + 9b$ (B) $4a - 9b$ (C) $3a + 2b$ (D) $2a + 3b$ (E) $a - b$

---

65. One factor of $18x^2 - 32$ is

(A) $9x - 32$ (B) $9x - 16$ (C) $3x - 2$ (D) $3x + 4$ (E) $9x + 4$

---

66. $\frac{2}{3x} - \frac{1}{x} =$

(A) $\frac{1}{3}$ (B) $\frac{1}{2x}$ (C) $\frac{1}{3x}$ (D) $-\frac{1}{3x}$ (E) $-\frac{2}{3x^2}$

---

67. $\left(1 + \frac{1}{a}\right)\left(\frac{a}{a^2 - 1}\right) =$

(A) 1 (B) $\frac{1}{a - 1}$ (C) $\frac{a + 1}{a - 1}$ (D) $\frac{2}{a^2 - 1}$ (E) $\frac{a^2}{a^2 - 1}$

---

68. $\frac{t^2 - t}{3} + \frac{1}{3t} =$

(A) $\frac{t - 1}{9}$ (B) $\frac{t^3 - t^2}{9}$ (C) $\frac{9}{t - 1}$ (D) $t - 1$ (E) $t^3 - t^2$

---

69. If $\frac{4}{2x - 2} = \frac{1}{x + 1}$, then $x =$

(A) 1 (B) $\frac{1}{3}$ (C) -1 (D) $-\frac{3}{2}$ (E) -3

---

70. One solution of the equation $(2x - 9)(5x + 2) = 0$ is

(A) $-\frac{9}{2}$ (B) $-\frac{5}{2}$ (C) $\frac{2}{9}$ (D) $\frac{2}{5}$ (E) $\frac{9}{2}$

---

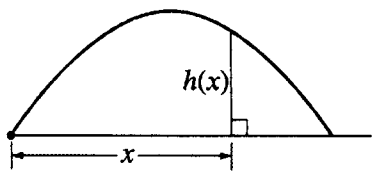
71. If $\sqrt{x - 1} = 4$, then $x =$

(A) 3 (B) 9 (C) 15 (D) 17 (E) 25

---

72. An apple falling from a tree is h feet above the ground t seconds after it begins to fall, where $h = 64 - 16t^2$. After how many seconds will the apple hit the ground $(h = 0)$?

(A) 1 (B) 2 (C) 4 (D) 8 (E) 48

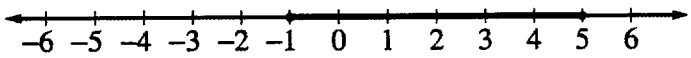


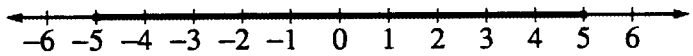
73. A golf ball is hit so that when it is directly above a point that is x feet from the golfer, it is $h(x) = 30x - \frac{1}{10}x^2$ feet above the ground. How far from the golfer will the ball hit the ground?

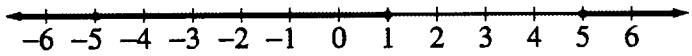
(A) 100 feet (B) 150 feet (C) 200 feet (D) 250 feet (E) 300 feet

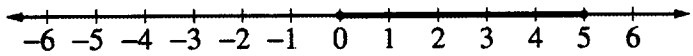
---

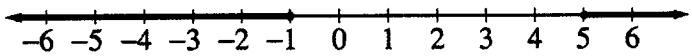
74. Which of the following graphs represents all values of x such that $|x - 2| \leq 3$?

(A) 

(B) 

(C) 

(D) 

(E) 

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75. What are all values of x for which $|2x - 3| = 5$?

(A) $x = -5$ and $x = 5$ (B) $x = -2$ and $x = 8$ (C) $x = -1$ and $x = 4$
(D) $x = 1$ and $x = -4$ (E) $x = 2$ and $x = 4$

---

76. If $3x + 5y = 4$ and $x = 3 - 2y$, then $y =$

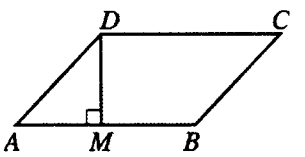
(A) -13 (B) -5 (C) $-\frac{5}{3}$ (D) $\frac{13}{3}$ (E) 5

---

77. If $\begin{cases} 4x - 3y = 17 \\ 2x + 5y = -11, \end{cases}$ then $y =$

(A) -3 (B) -2 (C) $\frac{7}{5}$ (D) 3 (E) $\frac{13}{3}$

Measurement Geometry



78. In parallelogram $ABCD$ above, $AM = MB$, $BC = \sqrt{2}$, and $DC = 2$. What is the area of $ABCD$?

(A) 2 (B) 4 (C) $\sqrt{2}$ (D) $2\sqrt{2}$ (E) $4 + 2\sqrt{2}$

---

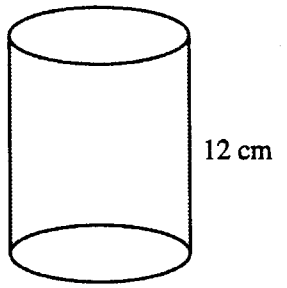
79. What is the area of a circle whose circumference is 10π ?

(A) 5 (B) 25 (C) 5π (D) 25π (E) 100π

---

80. The base of a rectangular solid is a square with side of length 3 feet. If the height of the rectangular solid is 5 feet, what is the volume of the solid, in cubic feet?

(A) 15 (B) 30 (C) 45 (D) 60 (E) 135



81. The cylinder shown above has a base area of 25π square centimeters and a height of 12 centimeters. What is its volume, in cubic centimeters?

(A) $\frac{25\pi}{12}$ (B) $25\pi - 12$ (C) $25\pi + 12$ (D) 250π (E) 300π

---

82. If each edge of a cube is doubled in length, then the volume of the cube is multiplied by a factor of

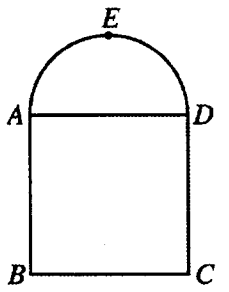
(A) 2 (B) 3 (C) 4 (D) 6 (E) 8

---

83. An automatic ice-cream scoop serves spherical helpings of ice cream. The scoop can be adjusted to serve helpings from 1 inch in diameter to 2 inches in diameter. If Tim orders a scoop with a 2-inch diameter, and if Paul wants only half as much ice cream as Tim, what should be the diameter of the scoop for Paul's helping?

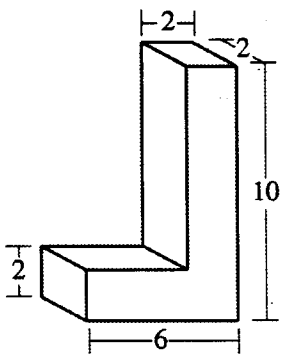
(Hint: The volume of a sphere is $V = \frac{4}{3}\pi r^3$ where r is the radius of the sphere.)

(A) $\sqrt[3]{\frac{1}{2}}$ (B) 1 (C) $\frac{1}{2}$ (D) $2\left(\sqrt[3]{\frac{1}{2}}\right)$ (E) 2



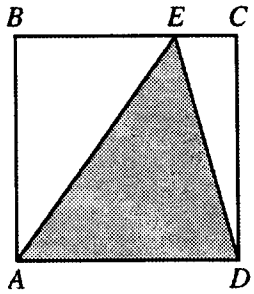
84. The figure above consists of semicircle *AED* and square *ABCD*. If the length of a side of the square is 12 feet, what is the number of square feet enclosed by the semicircle?

(A) 6π (B) 12π (C) 18π (D) 36π (E) 72π



85. In the figure above, two rectangular solids meet to form the L-shaped solid. What is the volume of the solid?

(A) 48 (B) 56 (C) 64 (D) 120 (E) 480



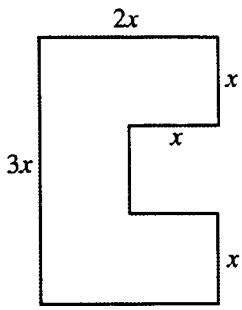
86. The area of square *ABCD* in the figure above is 64. What is the area of the shaded triangle *AED* ?

(A) 16 (B) 24 (C) 28 (D) 30 (E) 32

---

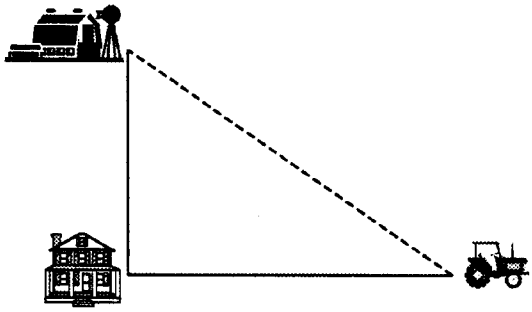
87. A stack of three cubes of the same size has a volume of 24 cubic inches. What is the length, in inches, of an edge of one of the cubes?

(A) 2 (B) $\frac{8}{3}$ (C) 3 (D) 8 (E) $2\sqrt{2}$



88. What is the perimeter of the figure above, if all intersecting line segments meet at right angles?

(A) $6x$ (B) $8x$ (C) $10x$ (D) $11x$ (E) $12x$



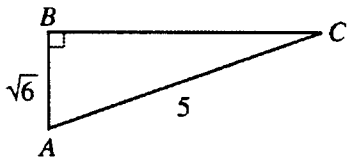
89. In the figure above, John's barn is 200 yards due north of his house and his tractor is 300 yards due east of his house. How many yards must he walk to go directly from his tractor to his barn if he walks in a straight line?

(A) $10\sqrt{13}$ (B) $\sqrt{500}$ (C) $100\sqrt{13}$ (D) 400 (E) 500

---

90. The lengths of the two longer sides of a right triangle are 7 and 9, respectively. What is the length of the shortest side?

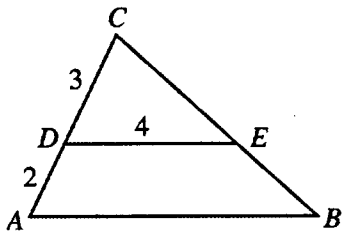
(A) 2 (B) $4\sqrt{2}$ (C) $\sqrt{130}$ (D) 16 (E) 32



91. In right triangle ABC above, $BC =$

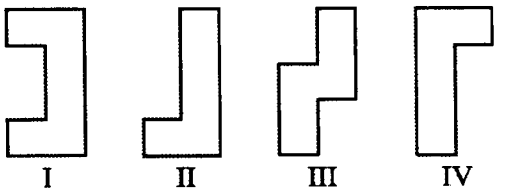
(A) $5 - \sqrt{6}$ (B) $\sqrt{19}$ (C) $\sqrt{31}$ (D) $5 + \sqrt{6}$ (E) 4

Plane Geometry



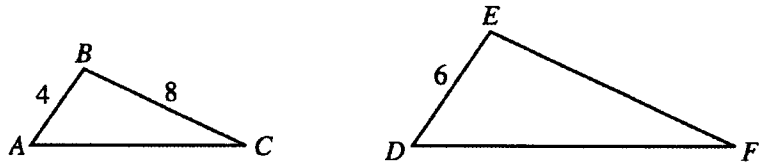
92. In the figure above, if $DE \parallel AB$, what is the length of AB ?

(A) $\frac{3}{20}$ (B) $\frac{8}{3}$ (C) $\frac{15}{4}$ (D) 6 (E) $\frac{20}{3}$



93. Which two of the figures above are congruent?

(A) I and II (B) I and III (C) I and IV (D) II and III (E) II and IV



94. Triangles ABC and DEF in the figure above are similar. What is the length of EF ?

(A) 4 (B) 6 (C) 8 (D) 12 (E) 16

---

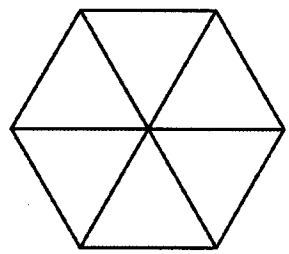
95. A rectangular garden has a perimeter of 28 yards. The width of the garden is 6 yards less than its length. What is the area of the garden, in square yards?

(A) 132 (B) 48 (C) 40 (D) 36 (E) 12

---

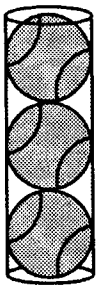
96. If the circumference of circle A is twice the circumference of circle B and the radius of circle A is 4, what is the radius of circle B ?

(A) 1 (B) 2 (C) $2\sqrt{2}$ (D) 2π (E) 8



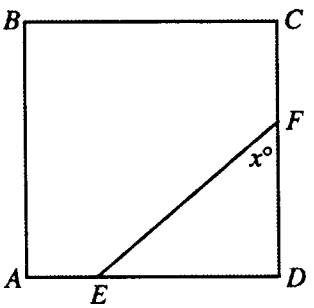
97. A regular hexagon is formed from 6 equilateral triangles, as shown in the figure above. If each triangle has perimeter 4, then the perimeter of the hexagon is

(A) 8 (B) 16 (C) 24 (D) $\frac{4\sqrt{3}}{3}$ (E) $8\sqrt{3}$



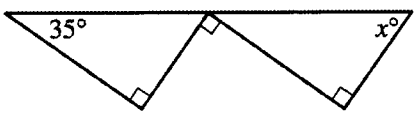
98. Three spherical balls, each 2 inches in diameter, fit snugly inside the cylindrical can shown above. The volume of the can is

(A) 3π (B) 4π (C) 6π (D) 12π (E) 24π



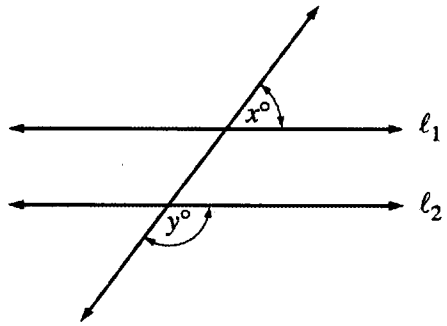
99. In square $ABCD$ above, the measure of $\angle AEF = 140°$. What is the value of x ?

(A) 30 (B) 40 (C) 45 (D) 50 (E) 60



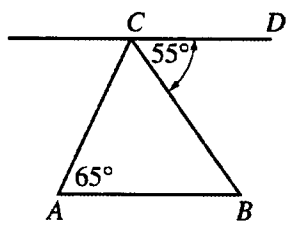
100. In the figure above, what is the value of x ?

(A) 25 (B) 35 (C) 45 (D) 55 (E) 65



101. In the figure above, ℓ_1 is parallel to ℓ_2 and $y = 127$. What is the value of x ?

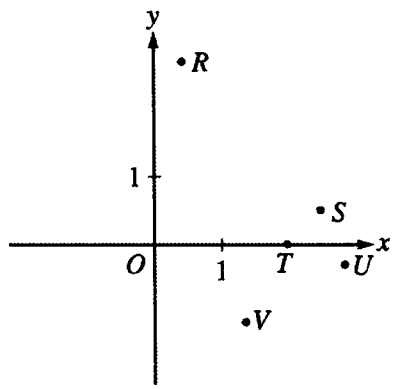
(A) 37 (B) 45 (C) 53 (D) 60 (E) 63



102. In the figure above, CD is parallel to AB. What is the measure of $\angle ACB$?

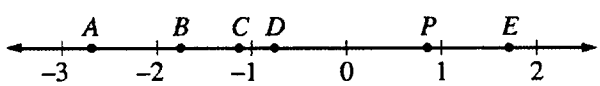
(A) 25° (B) 35° (C) 60° (D) 120° (E) 125°

Coordinate Geometry and Graphing



103. If $a < b$, which point in the figure above could have coordinates (a, b) ?

(A) R (B) S (C) T (D) U (E) V



104. If x is the coordinate of point P shown on the number line above, which of the following points has coordinate $-2x$?

(A) A (B) B (C) C (D) D (E) E

105. Which of the following represents all values of x in the interval graphed on the number line above?

(A) $x \leq -3$ and $x \leq 7$
(B) $x \geq -3$ and $x \geq 7$
(C) $x \leq -3$ or $x \geq 7$
(D) $-3 \leq x \leq 7$
(E) $7 \leq x \leq -3$

---

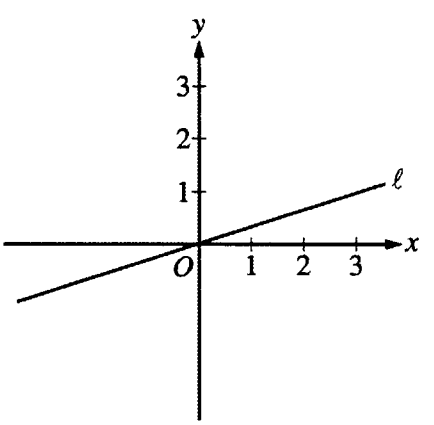
106. Which of the following points is NOT on the graph of $y = x^2 + 7$?

(A) $(0, -7)$ (B) $(0, 7)$ (C) $(-1, 8)$ (D) $(1, 8)$ (E) $(2, 11)$

---

107. If a and b are the two solutions to $x^2 - x - 2 = 0$, then $a + b =$

(A) -1 (B) 0 (C) 1 (D) 3 (E) 5



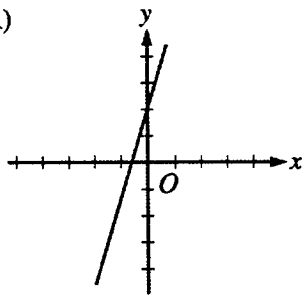
108. Which of the following is an equation of line ℓ in the figure above?

(A) $y = \frac{1}{3}$ (B) $y = \frac{1}{3}x$ (C) $y = 3x$ (D) $y = -\frac{1}{3}x$ (E) $y = -3x$

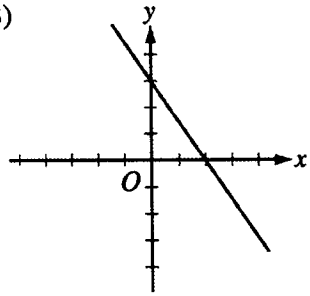
---

109. Which of the following could be the graph of $y = 3x + 2$?

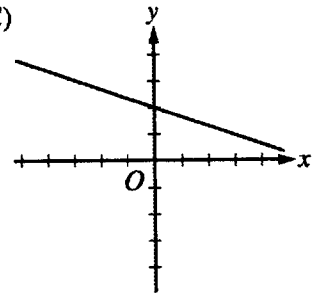
(A)



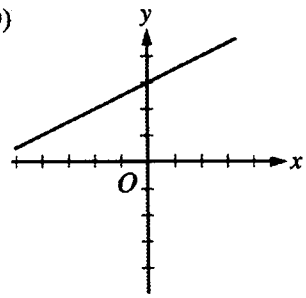
(B)



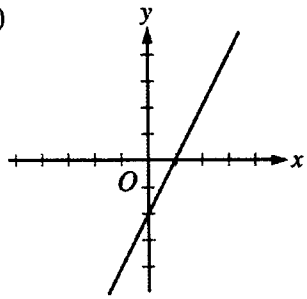
(C)



(D)

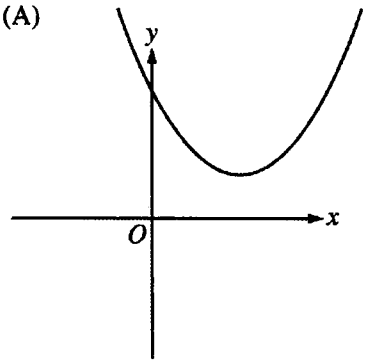


(E)

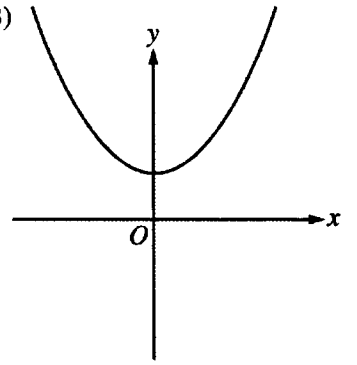


110. Which of the following could be the graph of $y = (x - 2)^2 + 1$?

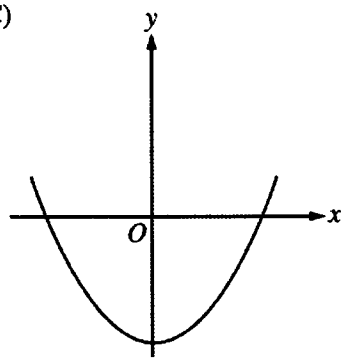
(A)



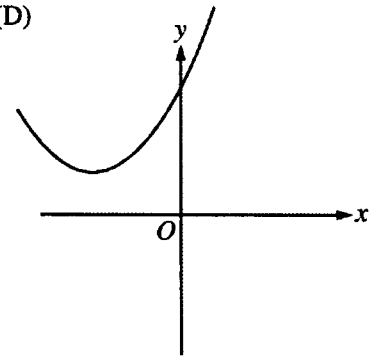
(B)



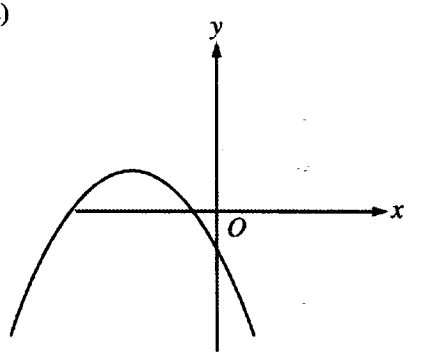
(C)

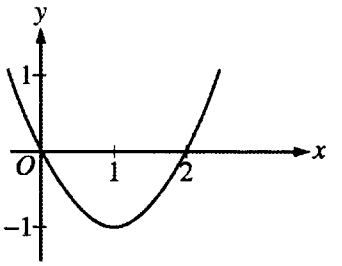


(D)



(E)





111. The figure above shows the graph of $y = f(x)$. What are all values of x for which $f(x) > 0$?

(A) $x < 0$ (B) $x > 1$ (C) $x > 2$ (D) $0 < x < 2$ (E) $x < 0$ or $x > 2$

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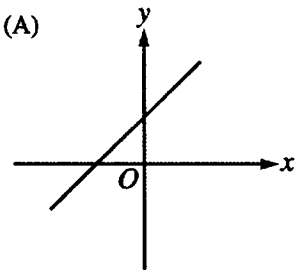
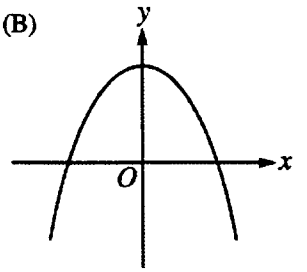
112. Which of the following is the graph of a linear function?

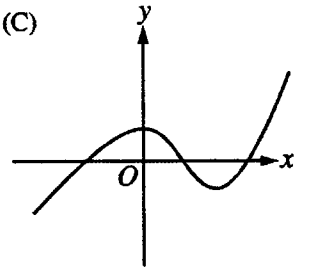
(A)



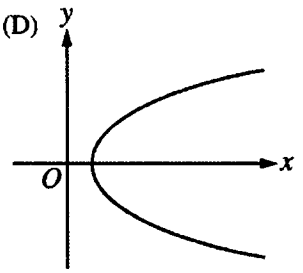
(B)



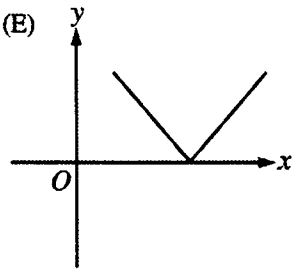
(C)



(D)



(E)



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113. If the distance between the points $(x, 11)$ and $(1, -1)$ is 13, then which of the following could be a value of x ?

(A) 2 (B) 4 (C) 5 (D) 6 (E) 12

---

114. In the coordinate plane, which of the following is the midpoint of the line segment with endpoints $(2, 5)$ and $(6, 1)$?

(A) $(8, 6)$ (B) $(4, 3)$ (C) $(4, 4)$ (D) $\left(\frac{7}{2}, \frac{7}{2}\right)$ (E) $\left(\frac{3}{2}, \frac{5}{2}\right)$

Answers to Questions

1. A	30. D	59. C	88. E
2. C	31. E	60. B	89. C
3. D	32. E	61. B	90. B
4. D	33. D	62. C	91. B
5. B	34. D	63. E	92. E
6. D	35. C	64. D	93. E
7. E	36. A	65. D	94. D
8. B	37. D	66. D	95. C
9. B	38. E	67. B	96. B
10. C	39. A	68. E	97. A
11. E	40. E	69. E	98. C
12. C	41. D	70. E	99. D
13. D	42. A	71. D	100. D
14. A	43. B	72. B	101. C
15. C	44. A	73. E	102. C
16. C	45. C	74. A	103. A
17. C	46. A	75. C	104. B
18. B	47. D	76. E	105. D
19. B	48. A	77. A	106. A
20. E	49. E	78. A	107. C
21. C	50. B	79. D	108. B
22. D	51. D	80. C	109. A
23. D	52. C	81. E	110. A
24. C	53. A	82. E	111. E
25. B	54. D	83. D	112. A
26. C	55. B	84. C	113. D
27. C	56. D	85. B	114. B
28. C	57. A	86. E	
29. B	58. D	87. A	

Table of Contents

Introduction

All students in the CSU are required to take college-level courses in mathematics or quantitative reasoning in order to graduate. It is important that all students arrive at the university with the necessary entry-level mathematics skills. If, on entry, a student is found to need additional work in college preparatory subjects and is placed in appropriate remedial coursework, *such remedial coursework will not count toward credit for graduation.*

In order to ensure that students entering the university are ready to take courses in mathematics or quantitative reasoning, freshmen must complete three years of college-preparatory coursework (Algebra I, Geometry, and Algebra II). Although not required for admission to the CSU, a fourth year of precalculus mathematics is advisable, especially for students planning to pursue majors in technical fields. This fourth-year course is a prerequisite to the freshman calculus courses required in most technical curricula. Students who do not intend to major in technical fields in college may choose a course in statistics and probability in their senior year of high school. *All students are encouraged to take mathematics in their senior year of high school, since students whose last math course was completed in the junior year or earlier often have difficulties with the required college-level mathematics courses and with the Entry Level Mathematics (ELM) requirement.*

The Entry Level Mathematics Requirement

The ELM placement examination assesses entry-level mathematics skills that the CSU expects entering students to have acquired in three years of rigorous college-preparatory mathematics coursework. Such courses must include the topics covered in elementary and intermediate algebra and two- and three-dimensional geometry, whether offered in traditional or integrated mathematics courses.

All entering students must take the ELM unless they have demonstrated proficiency in mathematics on the SAT, ACT, or Advanced Placement exams (see list below) prior to placement in appropriate university mathematics coursework. This is the ELM requirement. Those who are not exempt must take the ELM placement test prior to enrollment in the CSU. Failure to comply with this requirement will prevent the student from enrolling in the university. Specific policies regarding retesting and placement are determined by each campus. Exemptions from the placement test are given only to those students who can present proof of one of the following:

- A score of 550 or above on the mathematics section of the College Board SAT I: Reasoning Test[1]
- A score of 550 or above on Mathematics Level IC or IIC of the College Board SAT II: Mathematics Test[1]
- A score of 23 or above on the ACT Mathematics Test taken October 1989 or later
- A score of 3 or above on the College Board Advanced Placement Calculus AB or Calculus BC examination
- A score of 3 or above on the College Board Advanced Placement Statistics examination
- Completion and transfer to the CSU of a college course that satisfies the requirement in quantitative reasoning, provided such a course was completed with a grade of C or better

[1] NOTE: The College Board SAT and Achievements Tests became the SAT I and SAT II, respectively, beginning March 1994. A new, "recentered" scoring scale has been in effect since April 1995. If you took the SAT before April 1995, contact the campus Admissions and Records Office or Test Office for appropriate exemption scores.

Description of the Modified ELM Placement Test

The ELM placement test reflects the desire of the CSU mathematics and mathematics education community to build a placement test that assesses mathematical skills needed in campus General Education (GE) programs in quantitative reasoning and to serve the needs of entering students planning both quantitative and nonquantitative courses of study. The placement test was developed over a two-year period by a committee of CSU mathematics professors, mathematics education professors, and chairs of mathematics departments. It differs in several important respects from the ELM placement test that has been in place since January 1999.

The ELM placement test described here will be administered for the first time at the March 23, 2002, systemwide administration. Following are some of the ways in which it differs from its ELM predecessor.

Content

In content, the main difference between the current ELM and its predecessor is one of emphasis. There is more emphasis on working with numbers and data, the connections between algebra and geometry, and problem solving. There is less emphasis on working pure algebra problems. The test provides the major geometric formulae for reference because its purpose is to assess understanding of mathematical concepts and problem-solving skills rather than recall of facts and equations.

The actual topics covered by the current ELM are not very different from those that have been the basis of the placement test since 1992. A few topics have been deleted, but no topics have been added. The placement test is still predicated on the idea that students are responsible for mastering the content of three years of high school mathematics.

Table 1 contains a list of the topics covered by the placement test and shows the proportion of the test devoted to each of the three major content areas: Numbers and Data, Algebra, and Geometry.

Timing

In the past, students were given 75 minutes to complete the ELM, which contained 65 multiple-choice questions. Beginning with the March 23, 2002, administration, the ELM will contain 50 multiple-choice questions. Students will be allotted 90 minutes to complete the test.

Calculators Not Allowed

Beginning with the March 23, 2002, administration, calculators will not be allowed for the ELM placement test. The questions on the ELM do not require involved computation. Rather, the placement test includes problems that emphasize quantitative reasoning and problem solving.

Table 1: CSU ELM Topics

NUMBERS AND DATA (approximately 35%)

- ✓ Carry out basic arithmetic calculations
- ✓ Understand and use percent in context
- ✓ Compare and order rational numbers expressed as fractions and/or decimals
- ✓ Solve problems involving fractions and/or decimals in context
- ✓ Interpret and use ratio and proportion in context
- ✓ Use estimation appropriately
- ✓ Evaluate the reasonableness of a solution to a problem
- ✓ Evaluate and estimate square roots
- ✓ Represent and understand data presented graphically (including pie charts, bar and line graphs, histograms, and other formats used in print and electronic media for presenting data visually)
- ✓ Calculate and understand the arithmetic mean
- ✓ Calculate and understand the median
- ✓ Make estimates and predictions based on data
- ✓ Distinguish between reasonable and unreasonable claims based on data

ALGEBRA (approximately 35%)

- ✓ Evaluate and interpret algebraic expressions
- ✓ Simplify algebraic expressions
- ✓ Express relationships among quantities using variables
- ✓ Use properties of exponents
- ✓ Perform polynomial arithmetic (add, subtract, multiply, divide, and factor)
- ✓ Perform arithmetic operations involving rational expressions
- ✓ Solve linear equations (with both numerical and literal coefficients)
- ✓ Solve systems of linear equations in two unknowns
- ✓ Solve linear inequalities
- ✓ Solve problems in context that are modeled by linear equations
- ✓ Solve quadratic and rational equations (with both numerical and literal coefficients; real solutions only)
- ✓ Solve problems in context that are modeled by quadratic equations
- ✓ Solve equations involving absolute value (in one variable)
- ✓ Solve inequalities involving absolute value (in one variable)
- ✓ Find and use slopes and intercepts of lines
- ✓ Use constant and average rates to solve problems in context (using appropriate units)

GEOMETRY (approximately 30%)

- ✓ Find the perimeter, area, or volume of geometric figures (including triangles, quadrilaterals, rectangular parallelepipeds, circles, cylinders, and combinations of these figures)
- ✓ Calculate the ratio of corresponding geometric measurements of similar figures (e.g., if the perimeters are in a 3:2 ratio, the areas are in a 9:4 ratio)
- ✓ Use the Pythagorean Theorem
- ✓ Use properties of congruent or similar geometric objects
- ✓ Solve geometric problems using the properties of basic geometric figures (including triangles, quadrilaterals, polygons, and circles)
- ✓ Determine angles in the plane (using properties of intersecting lines, parallel lines, and perpendicular lines)
- ✓ Identify and plot points on the number line
- ✓ Identify and plot points in the coordinate plane
- ✓ Plot points on the graph of a function determined by an algebraic expression
- ✓ Graph linear functions in one variable
- ✓ Graph quadratic functions in one variable
- ✓ Relate basic information about a function to features of its graph (e.g., linearity, positivity or negativity, increasing or decreasing)
- ✓ Find the length or midpoint of a line segment in the coordinate plane

Scores on the ELM Placement Test

As noted previously, the ELM placement test consists of 50 multiple-choice questions. The reported score will be based on 45 of these questions. The remaining 5 questions are being field tested for possible use on future tests. **Beginning with the March 23, 2002, administration, score reporting for the ELM will employ a scale of 0-80.** All scores will be reported as even numbers on this scale. The passing scaled score on the ELM is 50, reported on a scale of 0-80.

The ELM is reviewed regularly, and new editions are developed several times each year. Therefore, the questions on one edition of the test will not be identical to those on another. However, steps are taken to ensure that each edition represents the same level of difficulty. The inevitable slight differences in difficulty between one edition of the test and another are accommodated through the statistical practice of equating the scores to the ELM scale. A scaled score earned by taking any given ELM test administered on or after March 23, 2002, indicates the same level of proficiency as the same scaled score earned by taking any other given ELM test administered on or after March 23, 2002.

It is extremely important to note that a scaled score earned on the ELM placement test before the March 23, 2002, administration cannot be compared to a scaled score earned by taking the ELM placement test on or after March 23. This is due to the changes incorporated in the ELM administered beginning March 23, 2002: disallowing the use of calculators, giving students more time to take the test, decreasing the number of test questions, and changing the emphasis of what the test measures. To discourage comparisons, the CSU mathematics and mathematics education professors who modified the ELM revised the ELM scale: the 0-80 scale replaces the 100-700 scale that has been in use since the mid-1980's. The score that determines proficiency on the new scale was recommended by a panel of expert judges chosen from faculty in mathematics and related departments throughout the CSU.

Subscores

Starting with score reporting for the March 23, 2002, test, students will receive three scaled subscores—one for each content area (Numbers and Data, Algebra, and Geometry)—as well as a total scaled score. The subscores will be represented graphically as score ranges on the 0-80 scale. The score of 50, which indicates proficiency, is indicated by a vertical line on this scale. Figure 1, on the next page, shows a sample student score report.

How the ELM Placement Test is Used

The ELM placement test must be taken by all nonexempt students before they can enroll in the CSU. Students receiving a total scaled score of 50 or above may enroll directly in a baccalaureate quantitative reasoning course. Students receiving a total scaled score below 50 are typically required to take remedial coursework. Campuses have the option of permitting students who score below 50 to take the ELM placement test again after self-study or a tutorial.

The subscores are intended to provide guidance in determining the nature of the remediation that best meets a student's needs. However, it is essential to bear in mind that the subscores are less reliable than the total scaled score. The total scaled score is based on all 45 scored test questions while the subscores are based only on subsets of roughly 12 to 18 questions each. To signal the fact that the subscores are less reliable than the total score, they are represented as ranges rather than as single numbers. Only the total score is reliable enough to be represented as a single number.

In addition, subscores are shown as ranges to discourage interpretations of "passing" or "failing" one of the content areas covered by the ELM. A student can demonstrate proficiency on ELM as

a whole, but the student should not be thought of as “failing” Numbers and Data or “passing” Algebra. In other words, placement decisions should be based on the total score; however, subscores may identify areas of particular need.

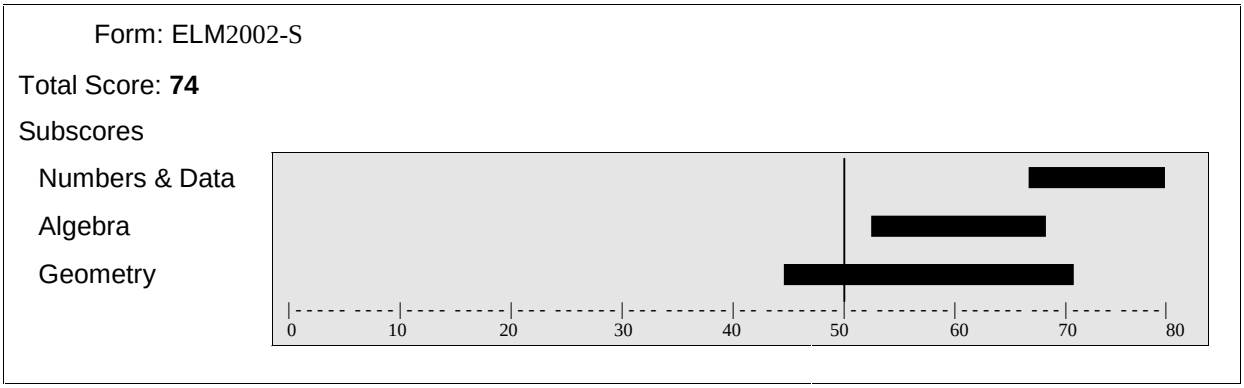
So what DO the subscores show? A given student’s subscores tell us about that student’s performance in the three content areas relative to the performance of other students who took the examination. Thus, a subscore range completely to the left of the cut score marker on the 0-80 axis indicates that a student's performance in that content area ranks with the overall performance of students whose total score is below the cut score. Conversely, a subscore range completely to the right of the cut score marker on the 0-80 scale suggests that a student’s performance in the corresponding content area ranks with the overall performance of students whose total score is above the cut score. It is quite possible that a student scoring above the cut score on the test as a whole will rank with fellow test takers whose total score is below the cut score in a particular content area. It is important to remember that the total score is the most important and reliable guide: students who score above the cut score are ready for the first GE mathematics course, even if their performance in the three content areas is uneven. By the same token, a student who ranks with the proficient test takers in a given subscore area but whose total score is below the cut score will benefit from some remedial instruction.

A subscore range that straddles the cut-score marker is harder to interpret than one that is entirely to one side of that marker. Typically, students with a total score near the cut score (either “passing” or “failing”) will have subscores straddling the cut-score marker. The “passing” students in this group are ready for the first GE course; those whose total score is below the cut score can probably benefit from general review in all three content areas before proceeding to the first GE course.

Students whose total score is well below the cut score probably stand to benefit from more intensive help in all the content areas. If all three subscore ranges are to the left of the cut-score marker, this is almost certainly the case.

The most important caveat to bear in mind is not to overinterpret the subscore ranges. The subscore ranges can provide useful information in thinking about what kind of remediation a given student needs, but interpreting them is an art as much as it is a science. Each student presents an individual case. When in doubt, remember that the total score is the most reliable indicator.

Figure 1: Sample ELM Score Report

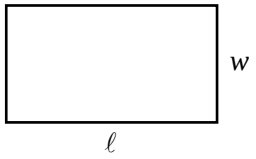
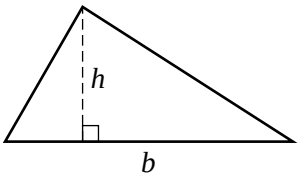
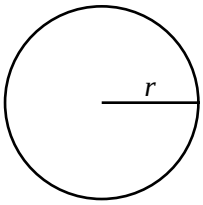
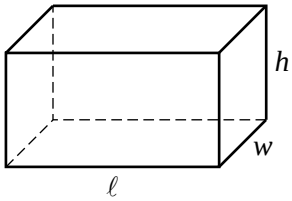
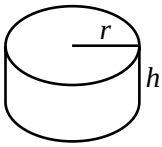
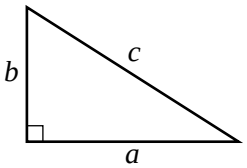


Sample Problems

This book has been developed to help students prepare for the CSU Entry Level Mathematics (ELM) examination. It is *not* a text, but rather a compilation of problems in the topic areas that are covered on the ELM exam. Many of the problems have appeared on previous ELM exams, and they illustrate the various levels of difficulty and the style of the problems that appear on the exam.

The test provides a page of Geometry Reference Formulas because its purpose is to assess understanding of mathematical concepts and problem-solving skills rather than recall of facts and equations. These formulas are presented in Table 2 on page 7, and are included in each ELM test booklet.

The pages that follow contain problems representative of the topics covered on the Entry Level Mathematics (ELM) test. The problems are arranged by the topic clusters listed in Table 1 on page 3. The answers to these questions can be found on page 41.

Table 2: Geometry Reference Formulas	
Rectangle 	Area $= \ell w$ Perimeter $= 2\ell + 2w$
Triangle 	Area $= \frac{1}{2} bh$
Circle 	Area $= \pi r^2$ Circumference $= 2\pi r$
Rectangular Solid 	Volume $= \ell wh$
Right Circular Cylinder 	Volume $= \pi r^2 h$
Pythagorean Theorem 	$c^2 = a^2 + b^2$

Number Sense

1. A theater has 25 rows, each with 12 seats. At a certain performance there were, on average, 3 empty seats per row. What was the attendance at that performance?

   (A) 225 (B) 264 (C) 297 (D) 300 (E) 375

---

2. There are 45 people coming to a picnic at which hot dogs will be served. Hot dogs come in packages of 8 that cost $2.50 each, and hot dog rolls come in packages of 10 that cost $2.00 each. If enough hot dogs and hot dog rolls will be purchased so that each person can have at least one hot dog in a roll, what is the minimum that can be spent on hot dogs and hot dog rolls?

   (A) $20.50 (B) $22.50 (C) $25.00 (D) $27.00 (E) $29.50

---

3. A P-model car costs 15 percent more than a V-model car. If the V-model costs $7,000, what is the cost of the P-model?

   (A) $5,950 (B) $7,105 (C) $8,005 (D) $8,050 (E) $8,500

---

4. The sale price of a photography book is 20 percent off the list price. If the sale price of the book is $10, what is the list price?

   (A) $7.50 (B) $8.00 (C) $12.00 (D) $12.50 (E) $14.00

---

5. The operating budget of the Western Robotics Company was $300 million last year. If the operating budget this year is 12 percent less than last year, what is this year's operating budget, in millions of dollars?

   (A) 36 (B) 264 (C) 274 (D) 288 (E) 336

---

6. The sale price of Kathy's new briefcase was reduced 30% from the original price of \$80. What was the sale price of the briefcase?

(A) \$30 (B) \$40 (C) \$50 (D) \$56 (E) \$104

---

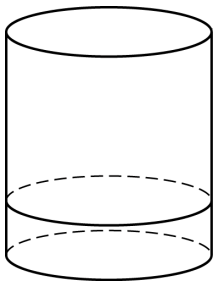
7. Which of the following numbers is between 3.74 and $3\frac{4}{5}$?

(A) $3\frac{9}{10}$ (B) 3.72 (C) 3.82 (D) $3\frac{1}{2}$ (E) $3\frac{3}{4}$

0.12 0.018 0.04 0.004

8. In which of the following are the four decimals above listed in order from greatest to least?

(A)	0.12	0.018	0.04	0.004
(B)	0.12	0.04	0.018	0.004
(C)	0.018	0.12	0.004	0.04
(D)	0.018	0.004	0.12	0.04
(E)	0.04	0.004	0.12	0.018



9. The figure above shows a right circular cylindrical vessel that is exactly one-quarter full. If 7 liters of liquid are added, the vessel will be exactly three-fifths full. What is the total capacity of the vessel, in liters?

(A) 14 (B) 20 (C) 21 (D) $\frac{9\pi}{20}$ (E) 21π

---

10. Marshall is making corn bread. His recipe calls for $3\frac{1}{2}$ cups of cornmeal, but he wants to make only half the amount given in the recipe. How many cups of cornmeal should he use?

(A) $1\frac{1}{4}$ (B) $1\frac{1}{2}$ (C) $1\frac{3}{4}$ (D) 5 (E) 7

---

11. Maria worked in a library. She was paid at the rate of \$6.00 per hour. If she worked from 10:30 A.M. to 4:45 P.M. on Tuesday, how much money did she earn?

(A) \$30.00 (B) \$33.00 (C) \$34.50 (D) \$36.00 (E) \$37.50

---

12. A certain medicine is prescribed in an amount proportional to a patient's body weight. If a patient weighing 70 kilograms requires 210 milligrams of this medicine, then the amount of medicine required for a patient weighing 80 kilograms is

(A) 220 mg (B) 230 mg (C) 240 mg (D) 250 mg (E) 290 mg

---

13. Joel mixed 3 tablespoons of plant fertilizer with 2 liters of water. In order to obtain the same ratio of fertilizer to water, how many tablespoons of fertilizer must he mix with 5 liters of water?

(A) $3\frac{1}{3}$ (B) 6 (C) 7 (D) $7\frac{1}{2}$ (E) 8

---

14. How many dollars will x pens cost if 5 such pens cost y dollars?

(A) $\frac{xy}{5}$ (B) $\frac{5}{xy}$ (C) $5xy$ (D) $\frac{y}{5x}$ (E) $\frac{x}{5y}$

ENROLLMENT AT CENTRAL COLLEGE

Freshmen	1,816
Sophomores	1,473
Juniors	1,431
Seniors	1,298

15. According to the table above, which of the following best approximates the total enrollment at Central College?

(A) 1,800 + 1,400 + 1,400 + 1,200
(B) 1,800 + 1,400 + 1,400 + 1,300
(C) 1,800 + 1,500 + 1,400 + 1,300
(D) 1,900 + 1,500 + 1,400 + 1,300
(E) 1,900 + 1,500 + 1,500 + 1,300

---

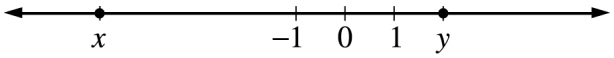
16. In a music class of 30 students, there are 6 more females than males. How many females are in the class?

(A) 6 (B) 12 (C) 18 (D) 24 (E) 36

---

17. A roast is to be cooked 20 minutes for each pound of weight. If a roast weighing 7 pounds needs to be ready for dinner at 6:00 P.M., which of the following would be the best time to put the roast into the oven?

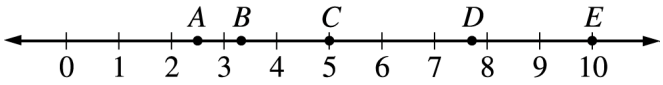
(A) 2:30 P.M. (B) 3:00 P.M. (C) 3:30 P.M. (D) 4:00 P.M. (E) 4:30 P.M.



18. Which of the following must be true about the numbers x and y graphed on the number line above?

I. $x + y > 0$
II. $y - x > 0$
III. $xy > 0$

(A) I only (B) II only (C) III only (D) II and III only (E) I, II, and III



19. Which point on the number line above could represent $\sqrt{10}$?

(A) *A* (B) *B* (C) *C* (D) *D* (E) *E*

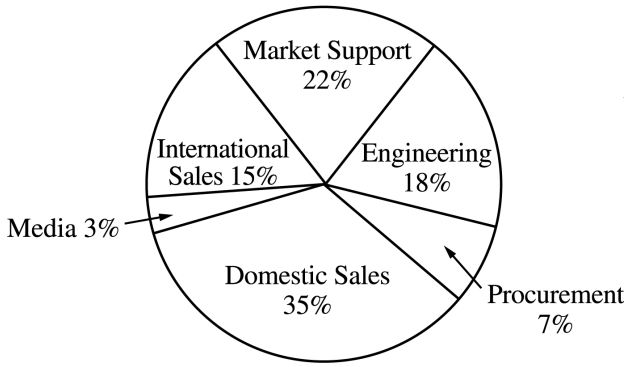
---

20. $\sqrt{24}$ is a number between

(A) 0 and 1 (B) 1 and 2 (C) 2 and 3 (D) 3 and 4 (E) 4 and 5

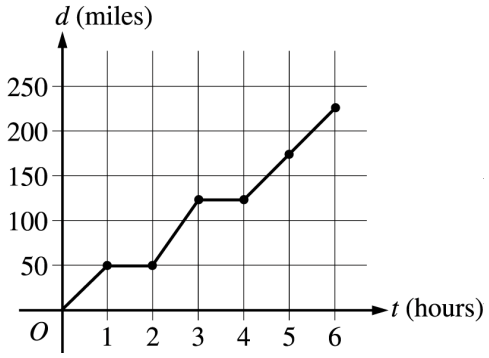
Data Analysis

ANNUAL BUDGET BY DEPARTMENT



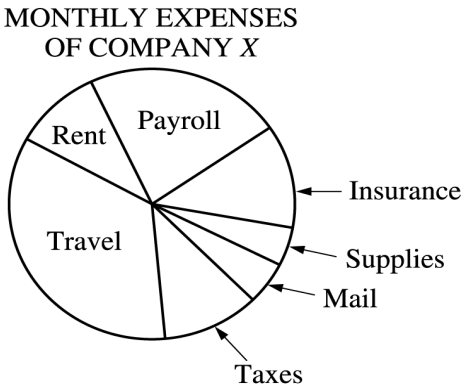
21. The circle graph above shows the annual budget for the Heavy Equipment Company. If the total budget is $50,000,000, what amount is budgeted for the market support and engineering departments combined?

(A) $11 million (B) $18 million (C) $20 million
(D) $22 million (E) $25 million



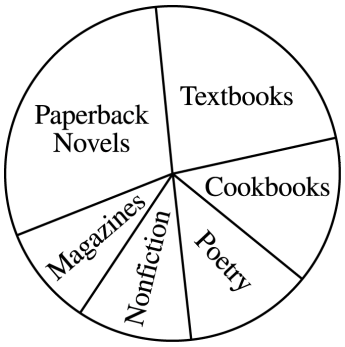
22. In the graph above, d represents the distance, in miles, that a motorist has traveled after t hours on the road. How many hours did it take the motorist to travel 200 miles?

(A) 4.0 (B) 4.5 (C) 5.0 (D) 5.5 (E) 6.0



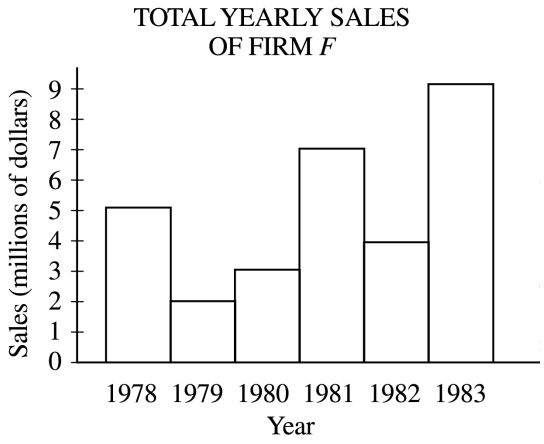
23. Which of the categories shown in the graph above accounts for approximately one-third of Company *X*'s expenses?

(A) Insurance (B) Payroll (C) Rent (D) Travel (E) Taxes



24. The circle graph above represents the percent of total revenue a publisher receives from various types of publications. Approximately what percent of total revenue is derived from textbooks and cookbooks?

(A) 10% (B) 25% (C) 35% (D) 50% (E) 65%



25. The graph above shows the yearly sales for Firm *F*. What is the average (arithmetic mean) of the yearly sales of Firm *F* for the three-year period from 1979 through 1981, in millions of dollars?

(A) 3 (B) 4 (C) 5 (D) 6 (E) 7

---

26. The recorded high temperatures on four successive days were $94°$, $85°$, $77°$, and $86°$. What must the recorded high temperature be on the fifth day in order to have an average (arithmetic mean) high temperature of $85°$ for the five days?

(A) $76°$ (B) $80°$ (C) $83°$ (D) $86°$ (E) $88°$

HISTORY TEST SCORES

Test 1	82
Test 2	71
Test 3	93
Test 4	88
Test 5	86

27. Danielle's scores on 5 history tests are given in the table above. What is the median of Danielle's scores?

(A) 82 (B) 84 (C) 86 (D) 88 (E) 93

ANNUAL COST OF WATER PER HOUSEHOLD IN 5 COMMUNITIES

Ashville	$696
Buckview	$557
Centerville	$268
Deerfield	$156
Elmwood	$434

28. What is the median annual cost of water per household in the 5 communities listed in the table above?

(A) $156 (B) $268 (C) $434 (D) $557 (E) $696

---

29. An investment company advertised that last year its clients, on average, made a profit of 9%. Which of the following claims can legitimately be made, based on that information?

(A) All of their clients made a profit of at least 9% last year.
(B) At least one of their clients made a profit of at least 9% last year.
(C) Some of their clients will make a profit of at least 9% this year.
(D) All of their clients will make a profit of at least 9% this year.
(E) If a person becomes one of their clients, that person will make a profit of at least 9% each year.

---

30. In a study of pain relievers, 50 people were given product *A* and all but 3 experienced relief. In the same study, 25 people were given product *B* and all but 2 experienced relief. Which of the following claims is most reasonable based on the data?

(A) Product *B* is better, because only 2 failed to get relief.
(B) Product *B* is better, because only 8% failed to get relief.
(C) Product *B* is better, because only 2% failed to get relief.
(D) Product *A* is better, because only 6% failed to get relief.
(E) Product *A* is better, because only 3% failed to get relief.

Algebra I

31. If $x = -1$ and $y = 6$, then $x^2 + 3xy =$

(A) 19 (B) 17 (C) 16 (D) −16 (E) −17

---

32. If $t = -2$, then $3t^2 - 5t - 6 =$

(A) −28 (B) −8 (C) −4 (D) 8 (E) 16

---

33. If $b = 6$ and $h = 10$, then $\frac{1}{2}bh =$

(A) 8 (B) 15 (C) 16 (D) 30 (E) 60

---

34. $\frac{4r^3s^5}{10r^8s^6} =$

(A) $\frac{2r^5s}{5}$ (B) $\frac{2r^{11}s^{11}}{5}$ (C) $\frac{2s}{5r^5}$ (D) $\frac{2}{5r^5s}$ (E) $\frac{1}{6r^5s}$

---

35. $\left(a^2c^3\right)\left(ab^2c\right) =$

(A) ab^2c^2 (B) $a^2b^2c^3$ (C) $a^3b^2c^4$ (D) $a^3b^3c^4$ (E) $a^4b^2c^5$

---

36. $\left(27a^{12}b^{6}\right)^{\frac{1}{3}} =$

(A) $3a^4b^2$ (B) $9a^4b^2$ (C) $9a^{12}b^6$ (D) $81a^{12}b^6$ (E) $81a^{36}b^{18}$

---

37. $16^{-\frac{1}{2}} =$

(A) -8 (B) -4 (C) $\frac{1}{8}$ (D) $\frac{1}{4}$ (E) 256

---

38. A thermostat is set at a temperature T that is neither less than $68°$ nor greater than $78°$. Which of the following inequalities describes all values of T?

(A) $68° \le T$
(B) $68° < T < 78°$
(C) $68° \le T < 78°$
(D) $68° < T \le 78°$
(E) $68° \le T \le 78°$

---

39. This year José earned 3 times as much money as he earned last year. If José earned T dollars this year and he earned L dollars last year, which of the following equations represents the relationship between T and L?

(A) $3L = T$ (B) $\frac{L}{3} = T$ (C) $T \times L = 3$ (D) $\frac{L}{3} = \frac{T}{3}$ (E) $\frac{L}{3} = \frac{3}{T}$

---

40. $\left(y^2 - 3y + 6\right) - \left(3y^2 + 4y - 5\right) =$

(A) $-2y^2 + y - 11$ (B) $-2y^2 + y + 1$ (C) $-2y^2 + y + 11$
(D) $-2y^2 - 7y + 1$ (E) $-2y^2 - 7y + 11$

---

41. $-2r(3r^2 - 2rs) =$

(A) $6r^3 + 4rs$ (B) $6r^3 - 4r^2s$ (C) $-6r^3 + 2rs$
(D) $-6r^3 + 4r^2s$ (E) $-6r^3 - 4r^2s$

---

42. $(x - 6)(3x - 4) =$

(A) $3x^2 - 22x + 24$ (B) $3x^2 - 22x - 24$ (C) $3x^2 - 18x + 24$
(D) $3x^2 - 14x - 24$ (E) $3x^2 - 14x + 24$

---

43. One factor of $x^2 + 2x - 8$ is

(A) $x - 1$ (B) $x - 2$ (C) $x - 4$ (D) $x - 6$ (E) $x - 8$

---

44. $(3x^3y)(-2x^2y^3) =$

(A) $-6x^5y^4$ (B) $-6x^6y^3$ (C) xy^{-2} (D) x^6y^3 (E) $6x^5y^3$

---

45. $\dfrac{4 + 8x}{2} =$

(A) $4x$ (B) $6x$ (C) $2 + 4x$ (D) $2 + 8x$ (E) $4 + 4x$

---

46. $x^{-2} =$

(A) $\dfrac{1}{x^2}$ (B) $\sqrt{x}$ (C) $-x^2$ (D) $x^{\frac{1}{2}}$ (E) $x^{-\frac{1}{2}}$

---

47. If $2az - 5z = 2$, then $z =$

(A) $-\frac{2}{3a}$ (B) $\frac{2+5a}{2a}$ (C) $\frac{1}{a-5}$ (D) $\frac{2}{2a-5}$ (E) $7 - 2a$

---

48. If $4x - 1 = 5x + 3$, then $x =$

(A) -4 (B) $-\frac{4}{9}$ (C) $\frac{2}{9}$ (D) $\frac{4}{9}$ (E) 2

---

49. If $3x - d = c$, then $x =$

(A) $c + d - 3$ (B) $d + \frac{c}{3}$ (C) $\frac{d-c}{3}$ (D) $\frac{c-d}{3}$ (E) $\frac{c+d}{3}$

---

50. Ma-li can paint a certain room in about 5 hours, and Alicia can paint the same room in about 4 hours. Approximately how many hours would it take Ma-li and Alicia to paint that room if they worked together?

(A) 1 (B) 2 (C) 4 (D) 5 (E) 9

---

51. Mario paddled his canoe upstream for 3 hours. When he turned around and paddled back to his starting point, it took him only 1 hour. If the river flows at a speed of 3 miles per hour, how fast could Mario paddle his canoe in still water?

(A) 1 mile per hour (B) 2 miles per hour (C) 3 miles per hour
(D) 6 miles per hour (E) 9 miles per hour

---

52. What is the slope of the line through the points $(2, 2)$ and $(4, 3)$?

(A) $-\frac{1}{2}$ (B) $-\frac{1}{4}$ (C) $\frac{1}{2}$ (D) $\frac{3}{4}$ (E) 2

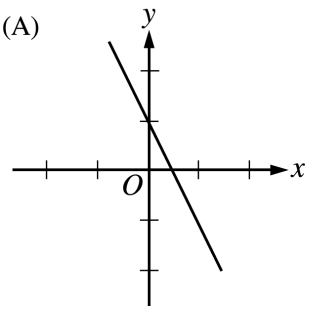
---

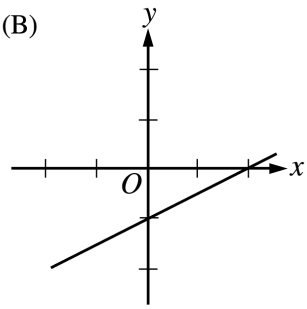
53. Which of the following lines is parallel to the line with equation $2y + 4x = 3$?

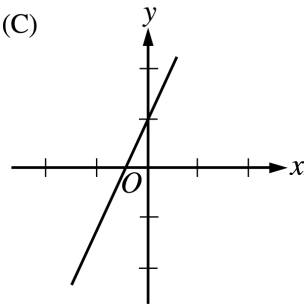
(A) $y + 2x = 3$ (B) $y - 2x = 3$ (C) $2y - 4x = 3$
(D) $-2y + 4x = 3$ (E) $4y + 2x = 3$

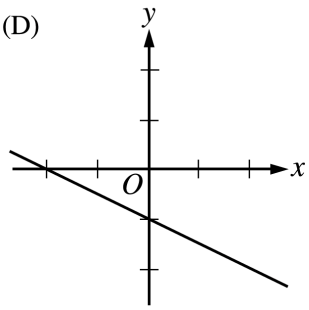
---

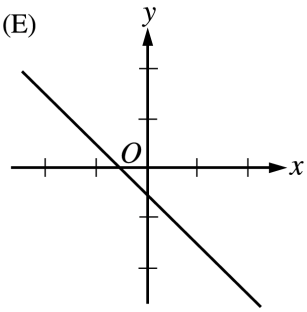
54. Which of the following is the graph of a line with a slope of $-\frac{1}{2}$?

(A)


(B)


(C)


(D)


(E)


---

55. If the point $(2, 4)$ is on the line $y = 6x + b$, then $b =$

(A) -22 (B) -8 (C) 12 (D) 16 (E) 26

---

56. $-3x < 5$ is equivalent to

(A) $x < -15$ (B) $x < -\frac{5}{3}$ (C) $x > -15$ (D) $x > -\frac{5}{3}$ (E) $x > -\frac{3}{5}$

---

57. $1 - 2x \leq 2 + x$ is equivalent to

(A) $x \geq -\frac{1}{3}$ (B) $x \geq 1$ (C) $x \leq -\frac{1}{3}$ (D) $x \leq \frac{1}{3}$ (E) $x \leq 1$

---

58. A car travels 80 miles on 3 gallons of gas. At the same rate (in miles per gallon), how many miles will the car be expected to travel on 5 gallons of gas?

(A) 48 (B) 130 (C) $130\frac{2}{3}$ (D) $133\frac{1}{3}$ (E) 160

WEATHER BALLOON TEMPERATURES

Height	Temperature
1,000 feet	23°
2,000 feet	20°
3,000 feet	17°

59. A weather balloon is released and as it rises in the air it records the temperature, in degrees Celsius, as shown in the table above. If the temperature continues to decrease at a constant rate, the temperature at 5,500 feet will be

(A) 12.5° (B) 11° (C) 9.5° (D) 8° (E) 6.5°

Algebra II

60. If $a = -2$, then $|5 - a| - |a - 8| =$

(A) -13 (B) -3 (C) 7 (D) 13 (E) 17

---

61. For $x > 0$, $\sqrt{4x^2} + \sqrt{9x^2} =$

(A) $\sqrt{13}x$ (B) $5x$ (C) $13x$ (D) $5x^2$ (E) $13x^2$

---

62. $\sqrt{100x^{36}} =$

(A) $100x^{18}$ (B) $50x^{18}$ (C) $10x^{18}$ (D) $50x^6$ (E) $10x^6$

---

63. If $f(x) = 3x^2 - 4x + 1$, then $f(-2) =$

(A) -19 (B) -5 (C) -3 (D) 5 (E) 21

---

64. A factor of $4a^2 - 9b^2$ is

(A) $4a + 9b$ (B) $4a - 9b$ (C) $3a + 2b$ (D) $2a + 3b$ (E) $a - b$

---

65. One factor of $18x^2 - 32$ is

(A) $9x - 32$ (B) $9x - 16$ (C) $3x - 2$ (D) $3x + 4$ (E) $9x + 4$

---

66. $\frac{2}{3x} - \frac{1}{x} =$

(A) $\frac{1}{3}$ (B) $\frac{1}{2x}$ (C) $\frac{1}{3x}$ (D) $-\frac{1}{3x}$ (E) $-\frac{2}{3x^2}$

---

67. $\left(1 + \frac{1}{a}\right)\left(\frac{a}{a^2 - 1}\right) =$

(A) 1 (B) $\frac{1}{a - 1}$ (C) $\frac{a + 1}{a - 1}$ (D) $\frac{2}{a^2 - 1}$ (E) $\frac{a^2}{a^2 - 1}$

---

68. $\frac{t^2 - t}{3} \div \frac{1}{3t} =$

(A) $\frac{t - 1}{9}$ (B) $\frac{t^3 - t^2}{9}$ (C) $\frac{9}{t - 1}$ (D) $t - 1$ (E) $t^3 - t^2$

---

69. If $\frac{4}{2x - 2} = \frac{1}{x + 1}$, then $x =$

(A) 1 (B) $\frac{1}{3}$ (C) -1 (D) $-\frac{3}{2}$ (E) -3

---

70. One solution of the equation $(2x - 9)(5x + 2) = 0$ is

(A) $-\frac{9}{2}$ (B) $-\frac{5}{2}$ (C) $\frac{2}{9}$ (D) $\frac{2}{5}$ (E) $\frac{9}{2}$

---

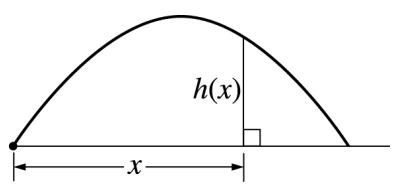
71. If $\sqrt{x - 1} = 4$, then $x =$

(A) 3 (B) 9 (C) 15 (D) 17 (E) 25

---

72. An apple falling from a tree is h feet above the ground t seconds after it begins to fall, where $h = 64 - 16t^2$. After how many seconds will the apple hit the ground $(h = 0)$?

(A) 1 (B) 2 (C) 4 (D) 8 (E) 48

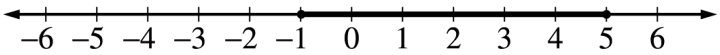


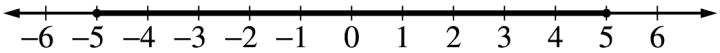
73. A golf ball is hit so that when it is directly above a point that is x feet from the golfer, it is $h(x) = 30x - \frac{1}{10}x^2$ feet above the ground. How far from the golfer will the ball hit the ground?

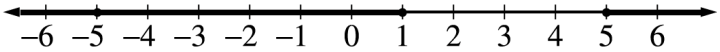
(A) 100 feet (B) 150 feet (C) 200 feet (D) 250 feet (E) 300 feet

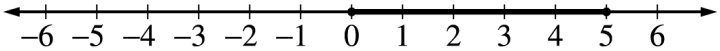
---

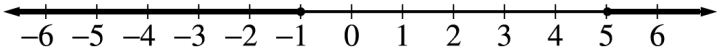
74. Which of the following graphs represents all values of x such that $|x - 2| \leq 3$?

(A) 

(B) 

(C) 

(D) 

(E) 

---

75. What are all values of x for which $|2x - 3| = 5$?

(A) $x = -5$ and $x = 5$ (B) $x = -2$ and $x = 8$ (C) $x = -1$ and $x = 4$
(D) $x = 1$ and $x = -4$ (E) $x = 2$ and $x = 4$

---

76. If $3x + 5y = 4$ and $x = 3 - 2y$, then $y =$

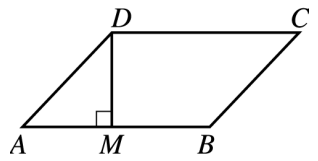
(A) -13 (B) -5 (C) $-\frac{5}{3}$ (D) $\frac{13}{3}$ (E) 5

---

77. If $\begin{cases} 4x - 3y = 17 \\ 2x + 5y = -11, \end{cases}$ then $y =$

(A) -3 (B) -2 (C) $\frac{7}{5}$ (D) 3 (E) $\frac{13}{3}$

Measurement Geometry



78. In parallelogram $ABCD$ above, $AM = MB$, $BC = \sqrt{2}$, and $DC = 2$. What is the area of $ABCD$?

(A) 2 (B) 4 (C) $\sqrt{2}$ (D) $2\sqrt{2}$ (E) $4 + 2\sqrt{2}$

---

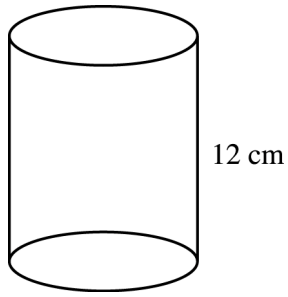
79. What is the area of a circle whose circumference is 10π ?

(A) 5 (B) 25 (C) 5π (D) 25π (E) 100π

---

80. The base of a rectangular solid is a square with side of length 3 feet. If the height of the rectangular solid is 5 feet, what is the volume of the solid, in cubic feet?

(A) 15 (B) 30 (C) 45 (D) 60 (E) 135



81. The cylinder shown above has a base area of 25π square centimeters and a height of 12 centimeters. What is its volume, in cubic centimeters?

(A) $\frac{25\pi}{12}$ (B) $25\pi - 12$ (C) $25\pi + 12$ (D) 250π (E) 300π

---

82. If each edge of a cube is doubled in length, then the volume of the cube is multiplied by a factor of

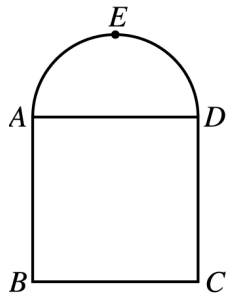
(A) 2 (B) 3 (C) 4 (D) 6 (E) 8

---

83. An automatic ice-cream scoop serves spherical helpings of ice cream. The scoop can be adjusted to serve helpings from 1 inch in diameter to 2 inches in diameter. If Tim orders a scoop with a 2-inch diameter, and if Paul wants only half as much ice cream as Tim, what should be the diameter of the scoop for Paul's helping?

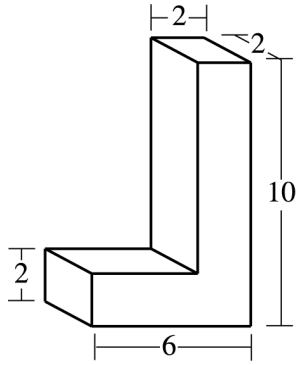
(Hint: The volume of a sphere is $V = \frac{4}{3}\pi r^3$ where r is the radius of the sphere.)

(A) $\sqrt[3]{\frac{1}{2}}$ (B) 1 (C) $\frac{1}{2}$ (D) $2\left(\sqrt[3]{\frac{1}{2}}\right)$ (E) 2



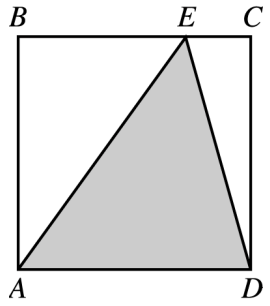
84. The figure above consists of semicircle *AED* and square *ABCD*. If the length of a side of the square is 12 feet, what is the number of square feet enclosed by the semicircle?

(A) 6π (B) 12π (C) 18π (D) 36π (E) 72π



85. In the figure above, two rectangular solids meet to form the L-shaped solid. What is the volume of the solid?

(A) 48 (B) 56 (C) 64 (D) 120 (E) 480



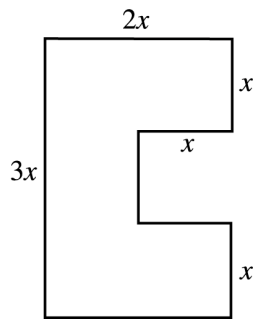
86. The area of square *ABCD* in the figure above is 64. What is the area of the shaded triangle *AED* ?

(A) 16 (B) 24 (C) 28 (D) 30 (E) 32

---

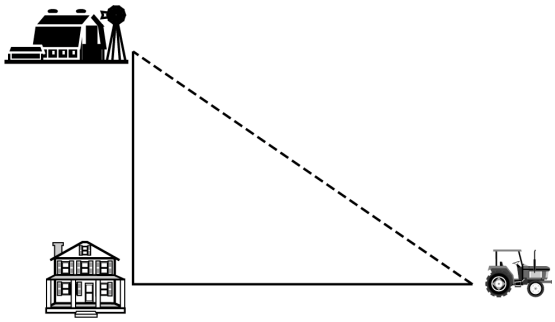
87. A stack of three cubes of the same size has a volume of 24 cubic inches. What is the length, in inches, of an edge of one of the cubes?

(A) 2 (B) $\frac{8}{3}$ (C) 3 (D) 8 (E) $2\sqrt{2}$



88. What is the perimeter of the figure above, if all intersecting line segments meet at right angles?

(A) $6x$ (B) $8x$ (C) $10x$ (D) $11x$ (E) $12x$



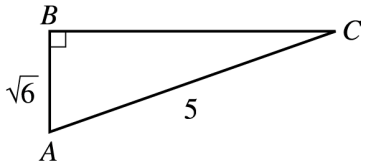
89. In the figure above, John's barn is 200 yards due north of his house and his tractor is 300 yards due east of his house. How many yards must he walk to go directly from his tractor to his barn if he walks in a straight line?

(A) $10\sqrt{13}$ (B) $\sqrt{500}$ (C) $100\sqrt{13}$ (D) 400 (E) 500

---

90. The lengths of the two longer sides of a right triangle are 7 and 9, respectively. What is the length of the shortest side?

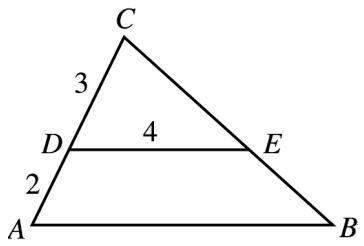
(A) 2 (B) $4\sqrt{2}$ (C) $\sqrt{130}$ (D) 16 (E) 32



91. In right triangle *ABC* above, $BC =$

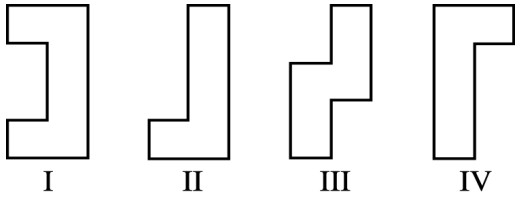
(A) $5 - \sqrt{6}$ (B) $\sqrt{19}$ (C) $\sqrt{31}$ (D) $5 + \sqrt{6}$ (E) 4

Plane Geometry



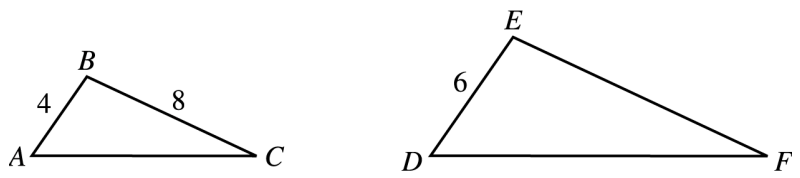
92. In the figure above, if $DE \parallel AB$, what is the length of AB ?

(A) $\frac{3}{20}$ (B) $\frac{8}{3}$ (C) $\frac{15}{4}$ (D) 6 (E) $\frac{20}{3}$



93. Which two of the figures above are congruent?

(A) I and II (B) I and III (C) I and IV (D) II and III (E) II and IV



94. Triangles *ABC* and *DEF* in the figure above are similar. What is the length of *EF* ?

(A) 4 (B) 6 (C) 8 (D) 12 (E) 16

---

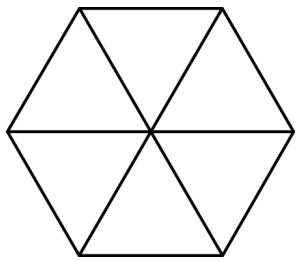
95. A rectangular garden has a perimeter of 28 yards. The width of the garden is 6 yards less than its length. What is the area of the garden, in square yards?

(A) 132 (B) 48 (C) 40 (D) 36 (E) 12

---

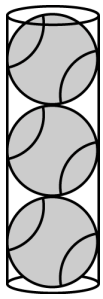
96. If the circumference of circle *A* is twice the circumference of circle *B* and the radius of circle *A* is 4, what is the radius of circle *B* ?

(A) 1 (B) 2 (C) $2\sqrt{2}$ (D) 2π (E) 8



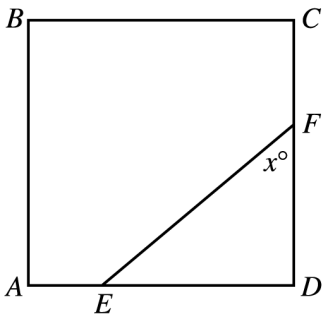
97. A regular hexagon is formed from 6 equilateral triangles, as shown in the figure above. If each triangle has perimeter 4, then the perimeter of the hexagon is

(A) 8 (B) 16 (C) 24 (D) $\frac{4\sqrt{3}}{3}$ (E) $8\sqrt{3}$



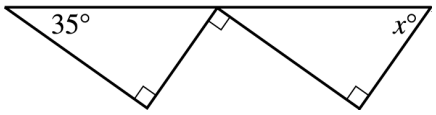
98. Three spherical balls, each 2 inches in diameter, fit snugly inside the cylindrical can shown above. The volume of the can is

(A) 3π (B) 4π (C) 6π (D) 12π (E) 24π



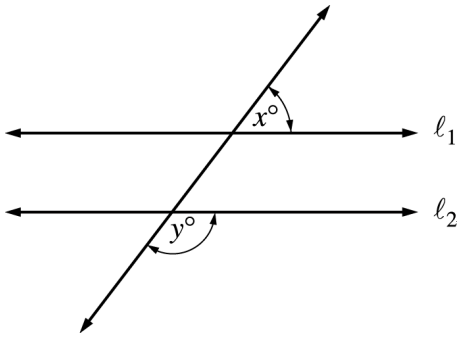
99. In square *ABCD* above, the measure of $\angle AEF = 140°$. What is the value of x ?

(A) 30 (B) 40 (C) 45 (D) 50 (E) 60



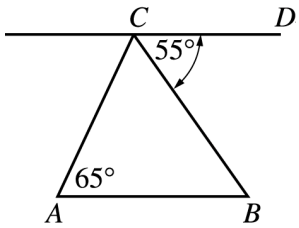
100. In the figure above, what is the value of x ?

(A) 25 (B) 35 (C) 45 (D) 55 (E) 65



101. In the figure above, ℓ_1 is parallel to ℓ_2 and $y = 127$. What is the value of x ?

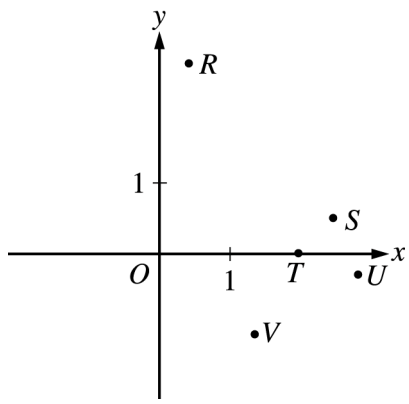
(A) 37 (B) 45 (C) 53 (D) 60 (E) 63



102. In the figure above, CD is parallel to AB. What is the measure of $\angle ACB$?

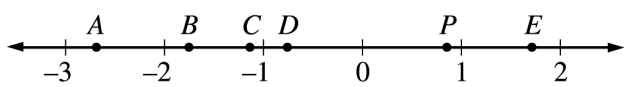
(A) 25° (B) 35° (C) 60° (D) 120° (E) 125°

Coordinate Geometry and Graphing



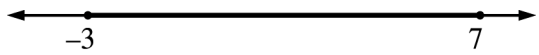
103. If $a < b$, which point in the figure above could have coordinates (a, b) ?

(A) R (B) S (C) T (D) U (E) V



104. If x is the coordinate of point P shown on the number line above, which of the following points has coordinate $-2x$?

(A) A (B) B (C) C (D) D (E) E



105. Which of the following represents all values of x in the interval graphed on the number line above?

(A) $x \le -3$ and $x \le 7$
(B) $x \ge -3$ and $x \ge 7$
(C) $x \le -3$ or $x \ge 7$
(D) $-3 \le x \le 7$
(E) $7 \le x \le -3$

---

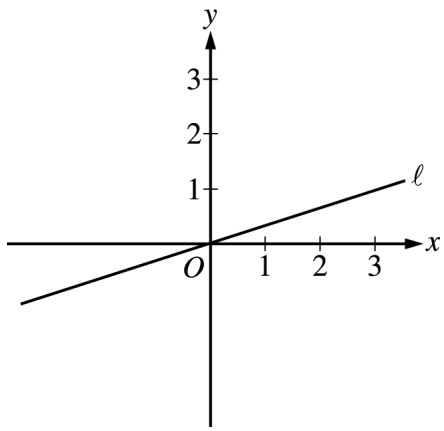
106. Which of the following points is NOT on the graph of $y = x^2 + 7$?

(A) $(0, -7)$ (B) $(0, 7)$ (C) $(-1, 8)$ (D) $(1, 8)$ (E) $(2, 11)$

---

107. If a and b are the two solutions to $x^2 - x - 2 = 0$, then $a + b =$

(A) -1 (B) 0 (C) 1 (D) 3 (E) 5



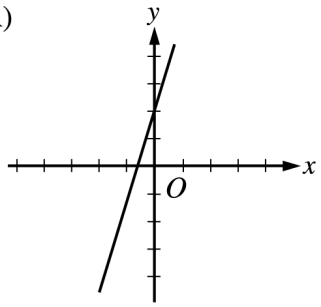
108. Which of the following is an equation of line ℓ in the figure above?

(A) $y = \frac{1}{3}$ (B) $y = \frac{1}{3}x$ (C) $y = 3x$ (D) $y = -\frac{1}{3}x$ (E) $y = -3x$

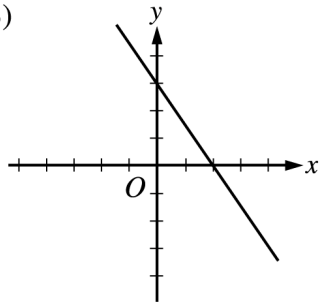
---

109. Which of the following could be the graph of $y = 3x + 2$?

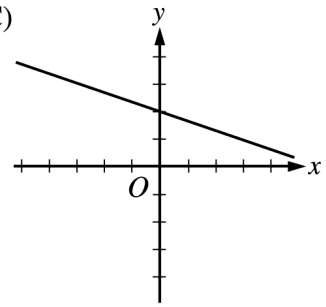
(A)



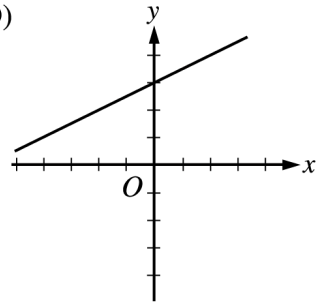
(B)



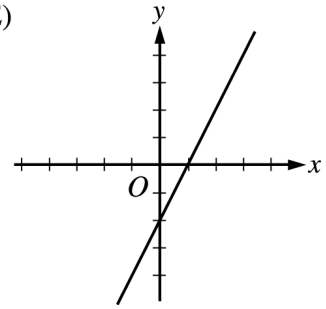
(C)



(D)

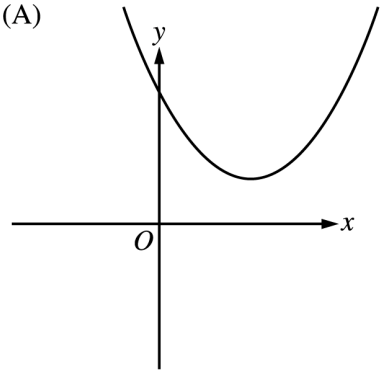


(E)

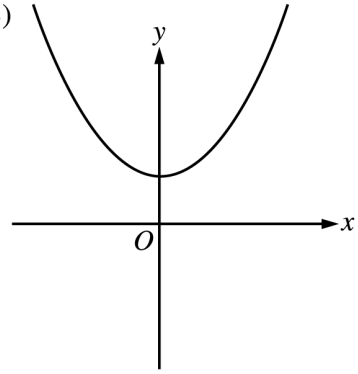


110. Which of the following could be the graph of $y = (x - 2)^2 + 1$?

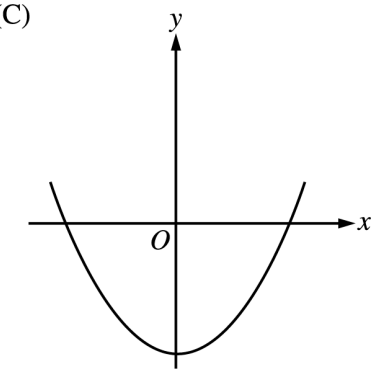
(A)



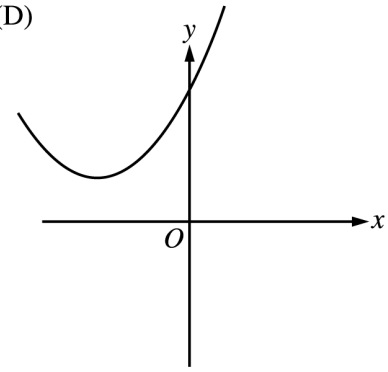
(B)



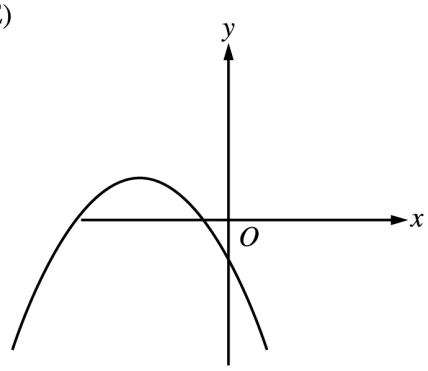
(C)

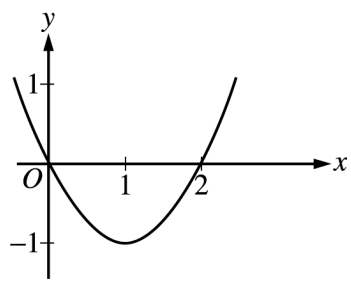


(D)



(E)





111. The figure above shows the graph of $y = f(x)$. What are all values of x for which $f(x) > 0$?

(A) $x < 0$ (B) $x > 1$ (C) $x > 2$ (D) $0 < x < 2$ (E) $x < 0$ or $x > 2$

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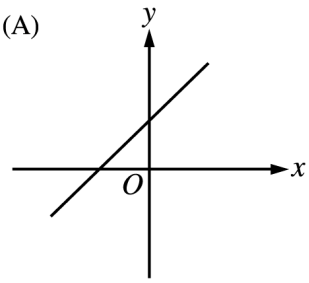
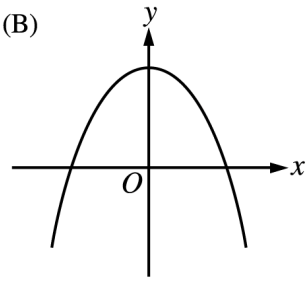
112. Which of the following is the graph of a linear function?

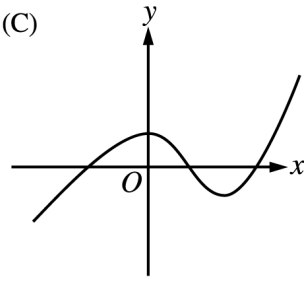
(A)



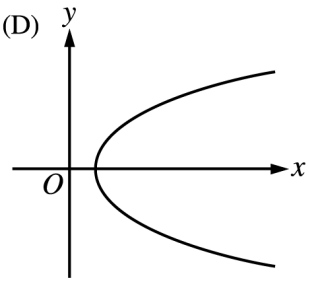
(B)



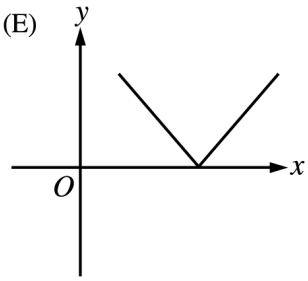
(C)



(D)



(E)



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113. If the distance between the points $(x, 11)$ and $(1, -1)$ is 13, then which of the following could be a value of x ?

(A) 2 (B) 4 (C) 5 (D) 6 (E) 12

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114. In the coordinate plane, which of the following is the midpoint of the line segment with endpoints $(2, 5)$ and $(6, 1)$?

(A) $(8, 6)$ (B) $(4, 3)$ (C) $(4, 4)$ (D) $\left(\frac{7}{2}, \frac{7}{2}\right)$ (E) $\left(\frac{3}{2}, \frac{5}{2}\right)$

Answers to Questions

1. A	30. D	59. C	88. E
2. C	31. E	60. B	89. C
3. D	32. E	61. B	90. B
4. D	33. D	62. C	91. B
5. B	34. D	63. E	92. E
6. D	35. C	64. D	93. E
7. E	36. A	65. D	94. D
8. B	37. D	66. D	95. C
9. B	38. E	67. B	96. B
10. C	39. A	68. E	97. A
11. E	40. E	69. E	98. C
12. C	41. D	70. E	99. D
13. D	42. A	71. D	100. D
14. A	43. B	72. B	101. C
15. C	44. A	73. E	102. C
16. C	45. C	74. A	103. A
17. C	46. A	75. C	104. B
18. B	47. D	76. E	105. D
19. B	48. A	77. A	106. A
20. E	49. E	78. A	107. C
21. C	50. B	79. D	108. B
22. D	51. D	80. C	109. A
23. D	52. C	81. E	110. A
24. C	53. A	82. E	111. E
25. B	54. D	83. D	112. A
26. C	55. B	84. C	113. D
27. C	56. D	85. B	114. B
28. C	57. A	86. E	
29. B	58. D	87. A	