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 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, entering freshmen are expected to have completed three years of college preparatory coursework (Algebra I, Geometry, and Algebra II or an equivalent course sequence). Although not required for admission to the CSU, a fourth year of mathematics is advisable, especially for students planning to pursue majors in technical fields. A Precalculus 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 another course, such as 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 ELM requirement.*

The Entry Level Mathematics Requirement

The ELM placement test 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 placement test unless they have demonstrated proficiency in mathematics on the CSU's Early Assessment Program (EAP) in mathematics, 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:

- placement in the "Ready for CSU college-level mathematics courses" category on the Early Assessment Program (EAP) taken in conjunction with the 11th grade California Standards Test in High School Mathematics or Algebra II
- placement in the "Ready for CSU college-level mathematics courses - Conditional" category on the Early Assessment Program (EAP) taken in conjunction with the 11th grade California Standards Test in High School Mathematics or Algebra II PLUS successful completion of a CSU-approved math or appropriate math-related course or activity taken before enrolling at a CSU campus
- a score of 550 or above on the mathematics portion of the College Board SAT Reasoning Test
- a score of 550 or above on a College Board SAT Subject Test in Mathematics (level 1 or level 2)
- 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 Mathematics examination (Calculus AB or Calculus BC)
- 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.

Description of the ELM Placement Test

The ELM placement test reflects the desire of the CSU mathematics and mathematics education community to assess mathematical skills needed in CSU General Education (GE) programs in quantitative reasoning, and to serve the needs of entering students planning both quantitative and nonquantitative courses of study.

The ELM placement test described here made its debut at the March 23, 2002 administration. 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.

Content

The ELM placement test is predicated on the idea that students are responsible for mastering the content of three years of high school mathematics. The test places a major emphasis on working with numbers and data, the connections between algebra and geometry, and problem solving. The test provides geometric formulas for reference in support of its purpose to assess understanding of mathematical concepts and problem-solving skills, rather than recall of facts.

Table 1 on the following page contains a list of the topics covered by the ELM 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

The ELM placement test contains 50 multiple-choice questions, 45 of which will be scored and 5 of which will be field tested for possible use on future tests. Students will be allotted 90 minutes to complete the test.

Calculators Not Allowed

Calculators are not allowed for the ELM placement test. The placement test is designed to emphasize quantitative reasoning and problem solving rather than computation.

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 and estimate square roots
- ✓ Represent and understand the data presented in tables, pie charts, bar and line graphs, histograms, and other formats for presenting data visually used in print and electronic media
- ✓ Interpret and calculate the arithmetic mean
- ✓ Interpret and calculate the median
- ✓ Make estimates and predictions 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

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. The ELM scores are reported on a scale of 0 to 80. All scores are reported as even numbers on this scale, and the passing scaled score is 50.

The ELM test 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.

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 CSU 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.
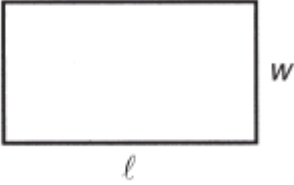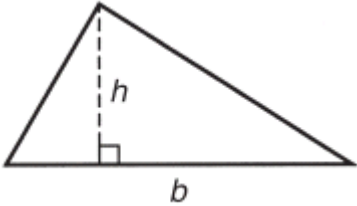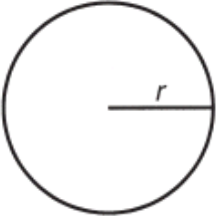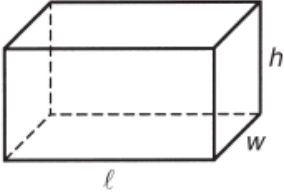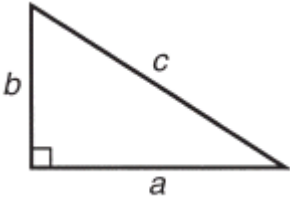
Sample Problems

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

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. These formulas are presented in Table 2 on , and are included in each test booklet.

The pages that follow contain problems representative of the topics covered on the ELM placement test. The problems are arranged by the topic clusters listed in Table 1 on . The answers to these questions can be found on .

Table 2: Geometry Reference Formulas

Rectangle 	Area $= \ell w$ Perimeter $= 2\ell + 2w$
Triangle 	Area $= \dfrac{1}{2} bh$
Circle 	Area $= \pi r^2$ Circumference $= 2\pi r$
Rectangular Solid 	Volume $= \ell w h$
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. The sale price of Kathy's new coat 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

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 pilots of an airline have signed a new two-year contract. For the first year of the new contract, current salaries will be reduced by 25 percent. For the second year, these reduced salaries will be further reduced by 10 percent. What percent of their current salaries will the pilots earn during the second year of the new contract?

(A) 35%   (B) 65%   (C) 67.5%   (D) 72.5%   (E) 75%

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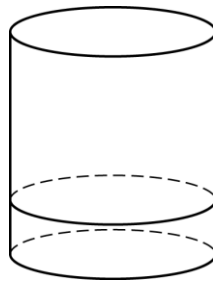
9.   The figure above shows a right circular cylindrical vessel that is exactly one-quarter full. If 7 liters of liquid are added, the vessel will be exactly three-fifths full. What is the total capacity of the vessel, in liters?

(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. The number of atoms of platinum (Pt) in the universe is estimated to be 1.4 times the number of atoms of silicon (Si) in the universe. The number of atoms of silver (Ag) in the universe is estimated to be 0.33 times the number of atoms of silicon in the universe. Based on these estimates, the number of atoms of platinum in the universe is approximately how many times the number of atoms of silver in the universe?

(A) 0.24   (B) 0.46   (C) 1.07   (D) 1.73   (E) 4.24

---

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. Over the last thirty years, the speed of microprocessors has become approximately 4 times faster every 3 years. Based on this information, microprocessors made today are approximately how many times as fast as microprocessors made 9 years ago?

(A) $4?3$　　(B) 3^4　　(C) 4^2　　(D) 4^3　　(E) $\left(\dfrac{4}{3}\right)^3$
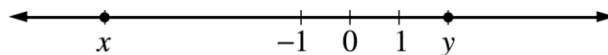
18. Which of the following must be true about the numbers x and y graphed on the number line above?

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

```
      A  B      C         D       E
←———┼——┼—•—•—┼——•—┼——•—┼——•—→
    0  1  2  3  4  5  6  7  8  9  10
```
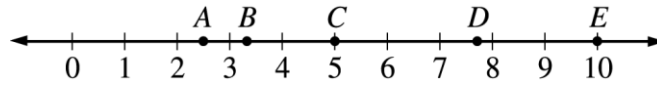
19. Which point on the number line above could represent $\sqrt{10}$?
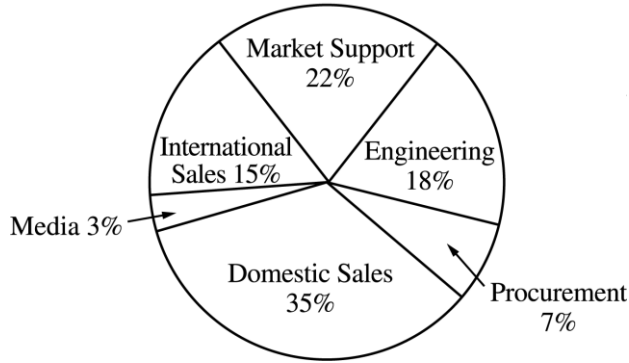
(A) *A*   (B) *B*   (C) *C*   (D) *D*   (E) *E*

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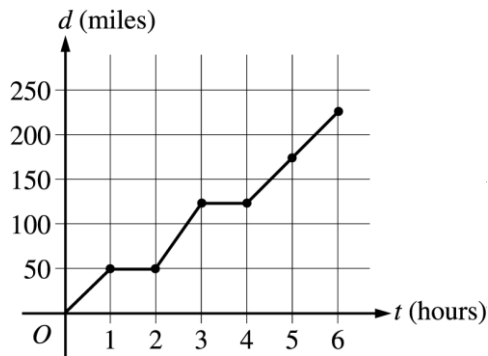
22. In the graph above, d represents the distance, in miles, that a motorist has traveled after t hours on the road. How many hours did it take the motorist to travel 200 miles?

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

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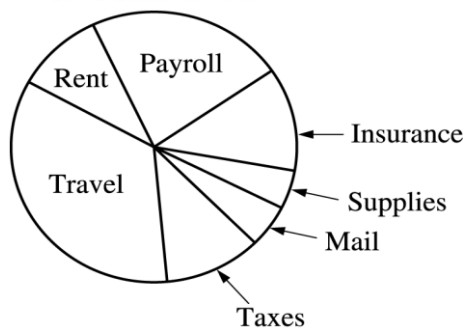
23. Which of the categories shown in the graph above accounts for approximately one-third of Company X's expenses?

(A) Insurance   (B) Payroll   (C) Rent   (D) Travel   (E) Taxes
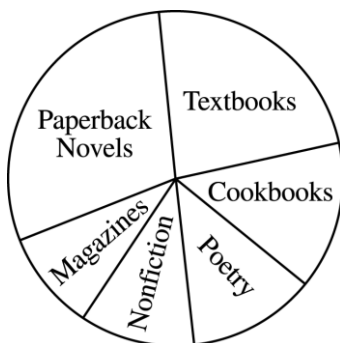
24. The circle graph above represents the percent of total revenue a publisher receives from various types of publications. Of the following, which best approximates the percent of total revenue that is derived from textbooks and cookbooks?

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

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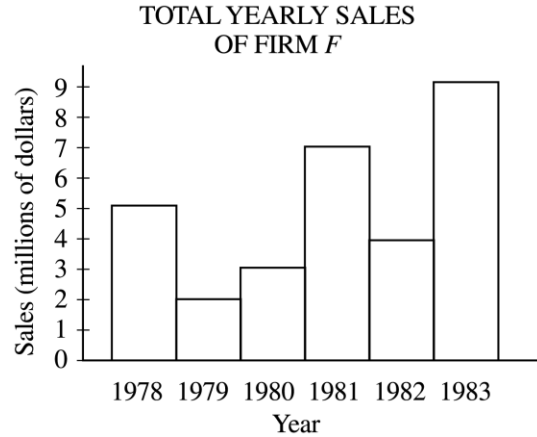
25.   The graph above shows the yearly sales for Firm *F*. What is the average (arithmetic mean)
of the yearly sales of Firm *F* for the three-year period from 1979 through 1981, in millions
of dollars?

(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 was the recorded high temperature on the fifth day if the average (arithmetic mean)
high temperature was $85°$ for the five days?

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

27.   As a scooter salesman, Gerardo keeps track of how many scooters he sells each week. In
his first four weeks on the job, he sold 9, 4, 7, and 6 scooters. In his fifth week, he sold k
scooters. If the median number of scooters sold per week for the five weeks is equal to 7,
which of the following must be true?

(A) $k \leq 4$ (B) $k \leq 7$ (C) $k \geq 7$ (D) $k \leq 9$ (E) $k \geq 9$

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. Abraham's physics class has 40 students, and his class had an average (arithmetic mean) score of 75 on the midterm. Anita's physics class has 20 students, and her class had an average score of 81 on the same midterm. What was the average score of all the students in both physics classes on the midterm?

(A) 77   (B) 77.5   (C) 78   (D) 78.5   (E) 79

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

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

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) $a^4b^2c^5$

15

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. The average price of gas increased by 10 percent during one year. If x represents the average price of gas at the beginning of the year and if y represents the average price of gas at the end of the year, which of the following is true?

    (A) $x = 0.1y$ (B) $y = 0.1x$ (C) $y = x + 0.1$
    (D) $y = 1.1x$ (E) $x = 1.1y$

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. $-2r\left(3r^2 - 2rs\right) =$

    (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. $\left(3x^3y\right)\left(-2x^2y^3\right) =$

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

---

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

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

---

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

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

---

50. Mei 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 Mei 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) $-\dfrac{1}{2}$ (B) $-\dfrac{1}{4}$ (C) $\dfrac{1}{2}$ (D) $\dfrac{3}{4}$ (E) 2

18

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 $-\dfrac{1}{2}$?

(A)

(B)

(C)

(D)

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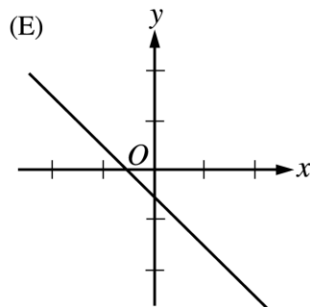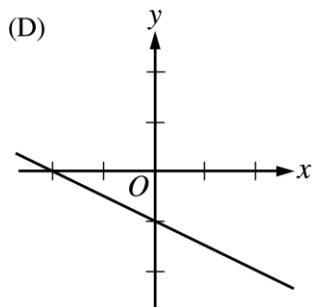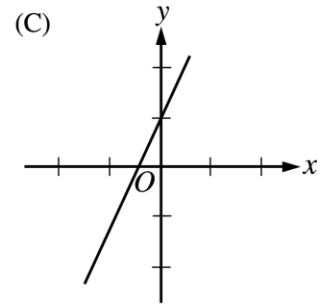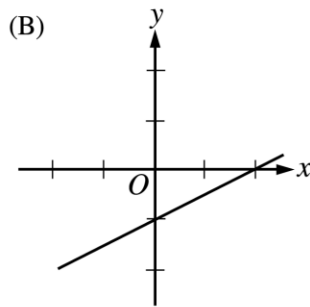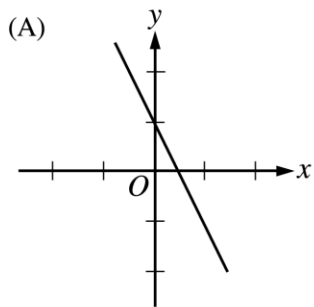
55. If the point $(2, 4)$ is on the line $y = 6x + b$, then $b =$

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

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

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

---

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

(A) $x \ge -\dfrac{1}{3}$ (B) $x \ge 1$ (C) $x \le -\dfrac{1}{3}$ (D) $x \le \dfrac{1}{3}$ (E) $x \le 1$

---

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) $130\dfrac{2}{3}$ (D) $133\dfrac{1}{3}$ (E) 160

WEATHER BALLOON TEMPERATURES

Height	Temperature (°C)
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. $\dfrac{2}{3x} - \dfrac{1}{x} =$

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

---

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

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

---

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

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

---

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

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

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

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

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?

(A) 1   (B) 2   (C) 4   (D) 8   (E) 48
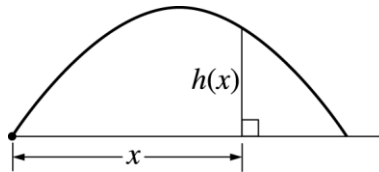
73. A golf ball is hit so that when it is directly above a point that is x feet from the golfer, it is $h(x) = 30x - \dfrac{1}{10}x^2$ feet above the ground. How far from the golfer will the ball hit the ground?

(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 $|x - 2| \le 3$?

(A) $\;$ −6 −5 −4 −3 −2 −1 0 1 2 3 4 5 6

(B) $\;$ −6 −5 −4 −3 −2 −1 0 1 2 3 4 5 6

(C) $\;$ −6 −5 −4 −3 −2 −1 0 1 2 3 4 5 6

(D) $\;$ −6 −5 −4 −3 −2 −1 0 1 2 3 4 5 6

(E) $\;$ −6 −5 −4 −3 −2 −1 0 1 2 3 4 5 6

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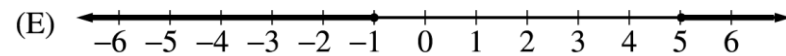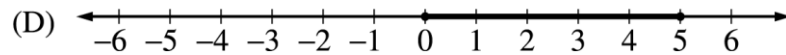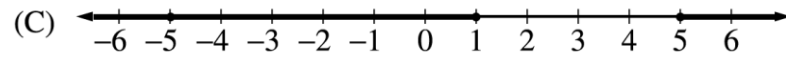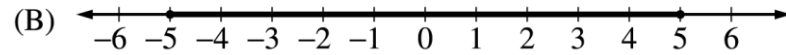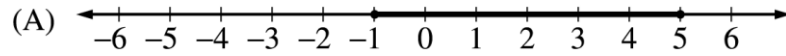
75. What are all values of x for which $|2x - 3| = 5$?

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

---

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

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

---

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

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

24

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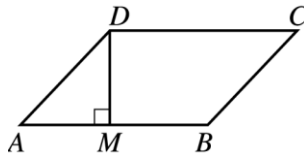
78. In parallelogram *ABCD* above, $AM = MB$, $BC = \sqrt{2}$, and $DC = 2$. What is the area of *ABCD* ?

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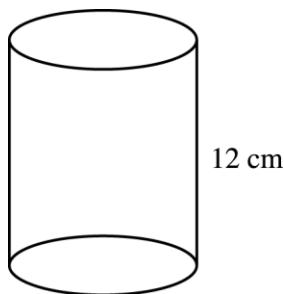
81. The cylinder shown above has a base area of 25π square centimeters and a height of 12 centimeters. What is its volume, in cubic centimeters?

(A) $\dfrac{25\pi}{12}$ (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. In the picture above, the perimeter of the starfish is 30 centimeters. This original picture is to be enlarged in both dimensions to an image that is similar to the original picture. If the area of the enlarged image is 9 times the area of the original picture, what is the perimeter in centimeters of the starfish in the enlarged image?

(A) 30   (B) 90   (C) 180   (D) 270   (E) 2,430

84. 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, in inches, of the scoop for Paul's helping?

(Hint: The volume of a sphere with radius r is $\frac{4}{3}pr^3$.)

(A) $\sqrt[3]{\frac{1}{2}}$ (B) 1   (C) $\frac{1}{2}$ (D) $2\left(\sqrt[3]{\frac{1}{2}}\right)$ (E) 2
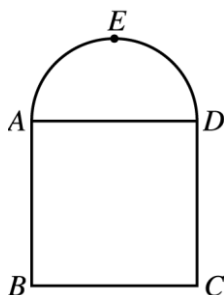
85. The figure above consists of semicircle AED and square ABCD. If the length of a side of the square is 12 feet, how many square feet are enclosed by the semicircle?

(A) 6π (B) 12π (C) 18π (D) 36π (E) 72π
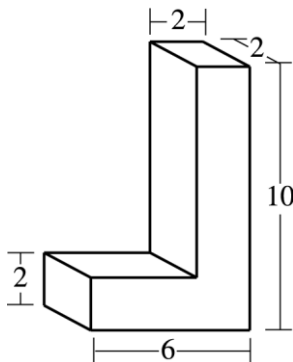
86. In the figure above, two rectangular solids meet to form the L-shaped solid. What is the volume of the solid?

(A) 48   (B) 56   (C) 64   (D) 120   (E) 480
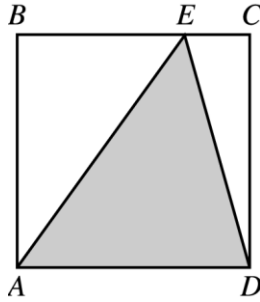
87. The area of square *ABCD* in the figure above is 64. What is the area of the shaded triangle *AED* ?

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

88. 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) $2\sqrt{2}$
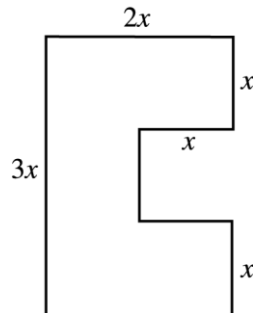
89. What is the perimeter of the figure above, if all intersecting line segments meet at right angles?

(A) 6*x*   (B) 8*x*   (C) 10*x*   (D) 11*x*   (E) 12*x*
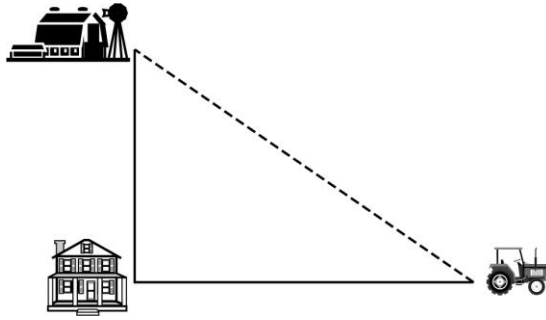
90.	In the figure above, John's barn is 200 yards due north of his house and his tractor is 300 yards due east of his house. How many yards must he walk to go directly from his tractor to his barn if he walks in a straight line?

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

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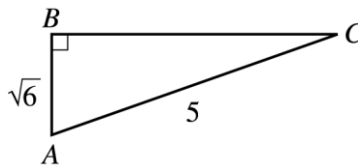
92.	In right triangle *ABC* above, *BC* =

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

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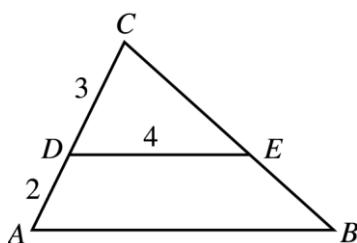
93. In the figure above, if $DE \parallel AB$, what is the length of AB ?

(A) $\dfrac{3}{20}$ (B) $\dfrac{8}{3}$ (C) $\dfrac{15}{4}$ (D) 6   (E) $\dfrac{20}{3}$
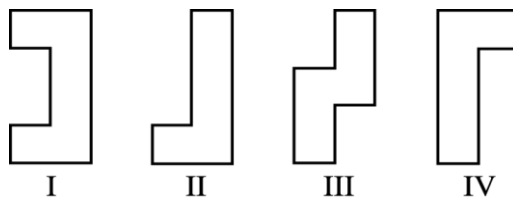
94. Which of the figures above are congruent?

(A) I and II   (B) I and III   (C) I and IV   (D) II and III   (E) II and IV
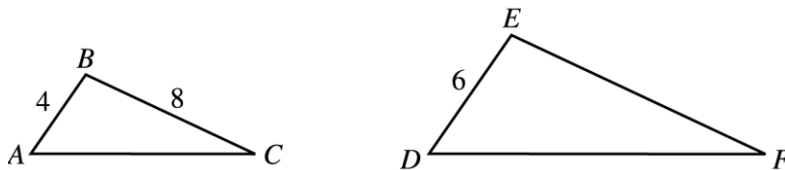
95. Triangles *ABC* and *DEF* in the figure above are similar. What is the length of *EF* ?

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

96. 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

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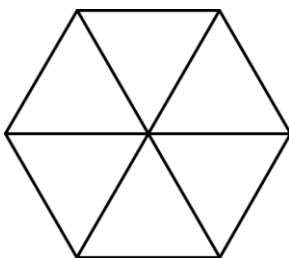
98. A regular hexagon is formed from 6 equilateral triangles, as shown in the figure above. If each triangle has perimeter 4, then the perimeter of the hexagon is

(A) 8   (B) 16   (C) 24   (D) $\dfrac{4\sqrt{3}}{3}$ (E) $8\sqrt{3}$
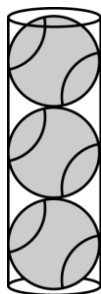
99. Three spherical balls, each 2 inches in diameter, fit snugly inside the cylindrical can shown above. What is the volume of the can in cubic inches?

(A) 3π (B) 4π (C) 6π (D) 12π (E) 24π

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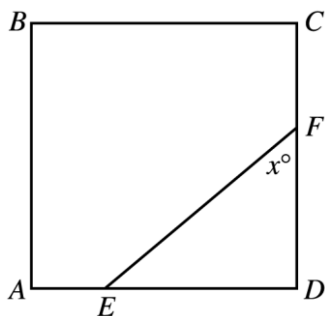
100. In square *ABCD* above, the measure of $\angle AEF = 140°$. What is the value of x ?

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

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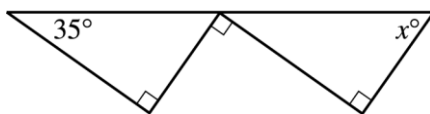
101. In the figure above, what is the value of x ?

(A) 25   (B) 35   (C) 45   (D) 55   (E) 65
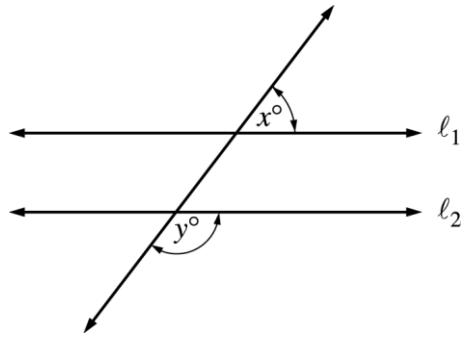
102. In the figure above, ℓ_1 is parallel to ℓ_2 and $y = 127$. What is the value of x ?

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

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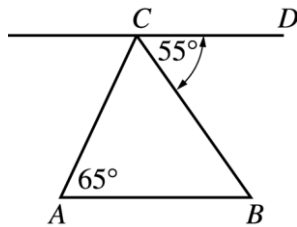
103. In the figure above, *CD* is parallel to *AB*. What is the measure of $\angle ACB$?

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

Coordinate Geometry and Graphing
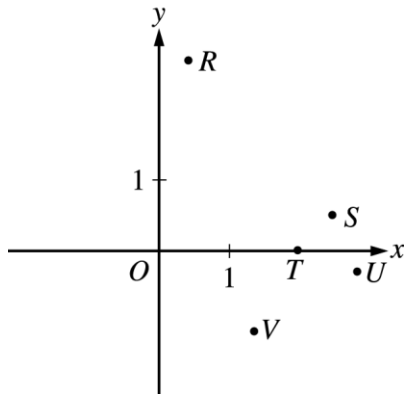
104. If $a < b,$ which point in the figure above could have coordinates (a, b) ?

    (A) *R*   (B) *S*   (C) *T*   (D) *U*   (E) *V*
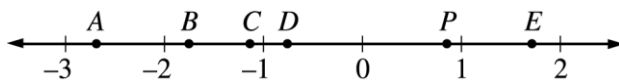
105. If x is the coordinate of point *P* shown on the number line above, which of the following points has coordinate $-2x$?

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

−3   7
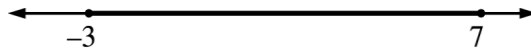
106. Which of the following represents all values of x in the interval graphed on the number line above?

(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) $7 \leq x \leq -3$

107. 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) $(2, 11)$

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

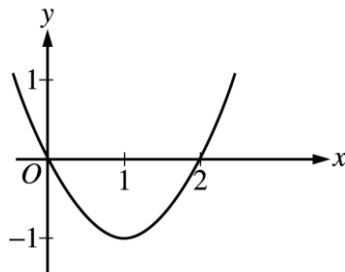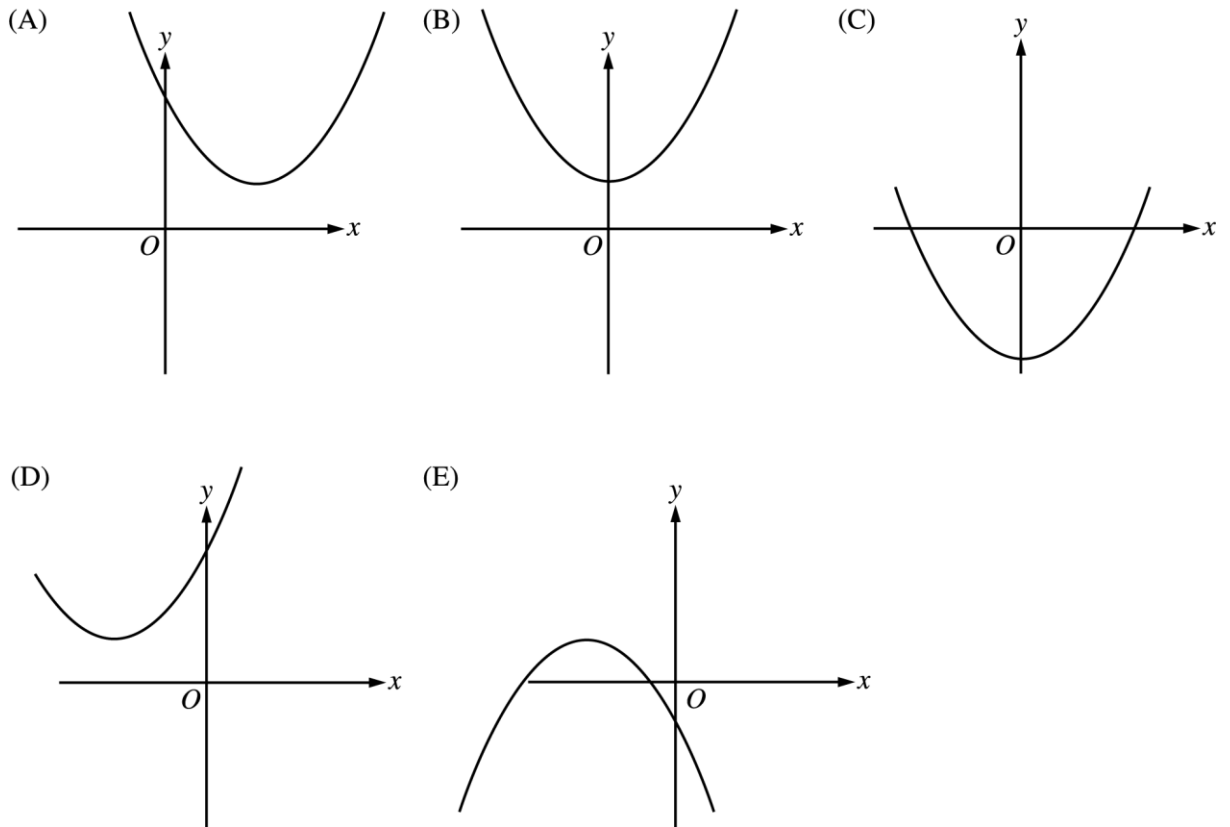(A) -1 (B) 0   (C) 1   (D) 3   (E) 5
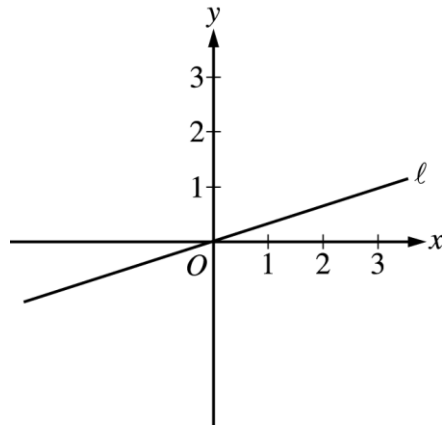
109. Which of the following is an equation of line ℓ in the figure above?

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

110. Which of the following could be the graph of $y = 3x + 2$?
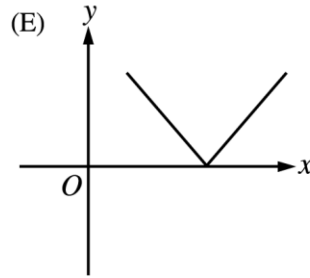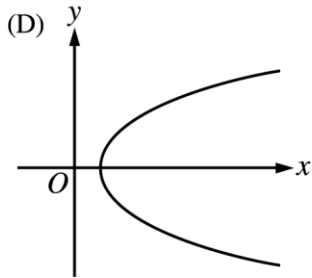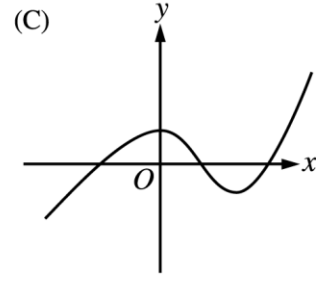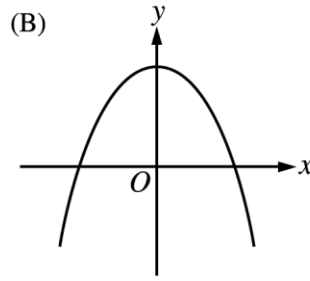
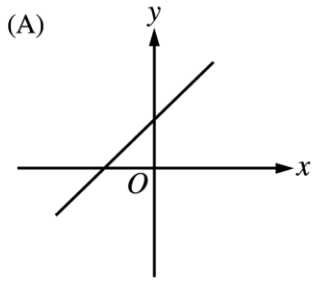(A)

(B)

(C)

(D)

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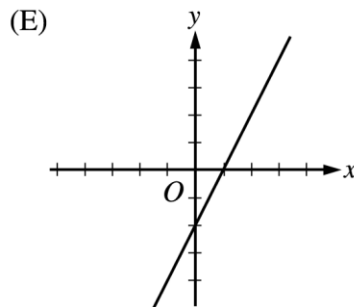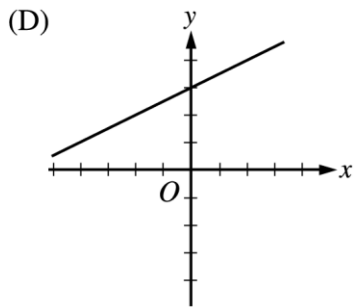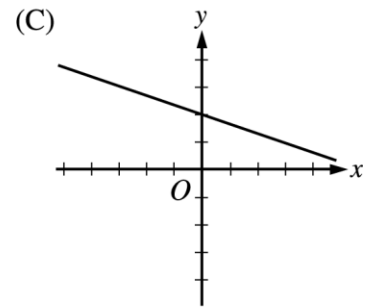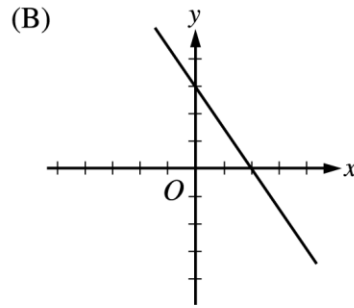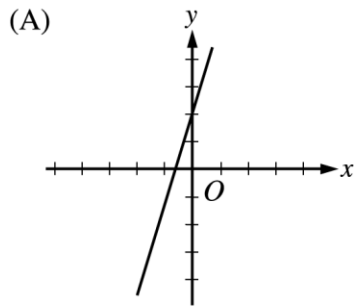
111. Which of the following could be the graph of $y = (x - 2)^2 + 1$?

(A)

(B)

(C)

(D)

(E)

112. 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 $x > 2$

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

(A)

(B)

(C)

(D)

(E)

---

114. 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

---

115. 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) $\left(\dfrac{7}{2}, \dfrac{7}{2}\right)$ (E) $\left(\dfrac{3}{2}, \dfrac{5}{2}\right)$

Answers to Sample Problems

1. A	30. A	59. C	88. A
2. C	31. E	60. B	89. E
3. D	32. E	61. B	90. C
4. D	33. D	62. C	91. B
5. B	34. D	63. E	92. B
6. C	35. C	64. D	93. E
7. E	36. A	65. D	94. E
8. B	37. D	66. D	95. D
9. B	38. D	67. B	96. C
10. C	39. A	68. E	97. B
11. E	40. E	69. E	98. A
12. C	41. D	70. E	99. C
13. D	42. A	71. D	100. D
14. A	43. B	72. B	101. D
15. C	44. A	73. E	102. C
16. C	45. C	74. A	103. C
17. D	46. A	75. C	104. A
18. B	47. D	76. E	105. B
19. B	48. A	77. A	106. D
20. E	49. E	78. A	107. A
21. C	50. B	79. D	108. C
22. D	51. D	80. C	109. B
23. D	52. C	81. E	110. A
24. C	53. A	82. E	111. A
25. B	54. D	83. B	112. E
26. C	55. B	84. D	113. A
27. C	56. D	85. C	114. D
28. C	57. A	86. B	115. B
29. B	58. D	87. E	