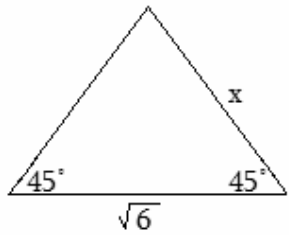


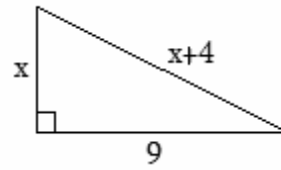
### Question 1

For each question, find the value of  $x$ .

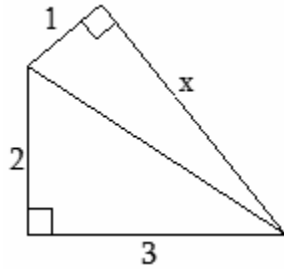
A)



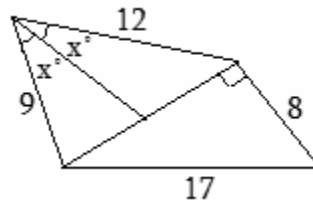
B)



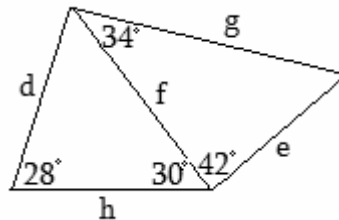
C)



D)



### Question 2



- A) Given the quadrilateral above, find the longest side.
- B) Given the quadrilateral above, find the second longest side.
- C) Given the quadrilateral above, find the second shortest side.
- D) Given the quadrilateral above, find the shortest side.

### Question 3

In  $\triangle ABC$ ,  $D$ ,  $E$ , and  $F$  are the midpoints of  $\overline{AB}$ ,  $\overline{BC}$ , and  $\overline{AC}$ , respectively.

$$AB = \frac{3}{2}x + 2y, \quad BC = 4x - 2, \quad AC = 2x - 2z, \quad DE = -3x + 3y, \quad EF = y + 3z, \quad \text{and}$$

$$DF = x + 3.$$

- A) What is the value of  $x$ ?
- B) What is the value of  $y$ ?
- C) What is the value of  $z$ ?
- D) What is the perimeter of  $\triangle DEF$ ?

### Question 4

A) The equation of the line through  $(3, -4)$  and  $(6, 11)$  is written in the form  $Ax + By = C$ , where  $A$ ,  $B$ , and  $C$  are relatively prime integers, and  $A$  is positive. Find the value of  $A + B + C$ .

B) The equation of the line through  $(-4, 5)$  and parallel to  $3x + 6y = 17$  is written in the form  $Dx + Ey = F$ , where  $D$ ,  $E$ , and  $F$  are relatively prime integers, and  $D$  is positive. Find the value of  $D + E + F$ .

C) The equation of the line through  $(2, -7)$  and perpendicular to the line  $2x - 4y = 7$  is written in the form  $Gx + Hy = I$ , where  $G$ ,  $H$ , and  $I$  are relatively prime integers, and  $G$  is positive. Find the value of  $G + H + I$ .

D) The equation of the perpendicular bisector of  $\overline{JK}$ , with  $J(1, 6)$  and  $K(0, 20)$  is written in the form  $Lx + My = N$ , where  $L$ ,  $M$ , and  $N$  are relatively prime integers, and  $L$  is positive. Find the value of  $L + M + N$ .

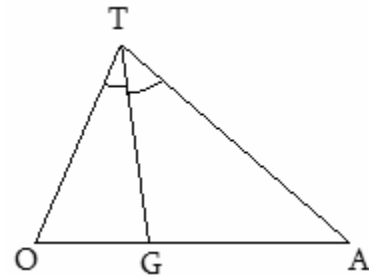
### Question 5

- A) Find the perimeter of a rhombus given diagonals of length  $2\sqrt{5}$  and  $\sqrt{7}$ .
- B) Find the length of the longer side of a rectangle with a diagonal of length  $\sqrt{5}$  and a perimeter of 6.
- C) Find the perimeter of an isosceles trapezoid with median of length 10, base angle measures of  $30^\circ$ , and a height of  $3\sqrt{3}$ .
- D) Find the perimeter of regular hexagon PQRSTU given that the perimeter of  $\triangle PRT$  is 3.

### Question 6

In  $\triangle OAT$ , the angle bisector of  $\angle T$  meets  $\overline{OA}$  at  $G$ ,  
 $OG = \frac{10}{3}$ ,  $GA = \frac{26}{3}$ , and  $OT = 5$ .

- A) What is the length of  $\overline{AT}$ ?
- B) What is the measure of  $\angle GOT$ ?
- C) What is the value of  $\cos(\angle OAT)$  expressed as a fraction in simplest form?
- D) What is the length of  $\overline{GT}$ ?



### Question 7

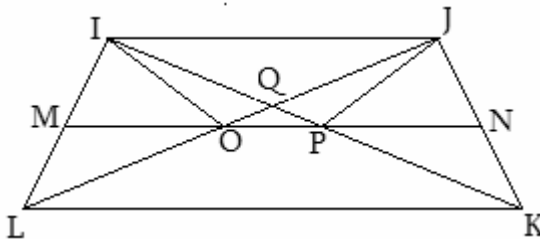
On the Cartesian plane,  $\triangle ABC$  is an equilateral triangle with coordinates  $A(0,0)$ ,  $B(6,0)$ , and  $C(3,3\sqrt{3})$ . The line  $y = x\sqrt{3} - 1$  intersects  $\triangle ABC$  at points  $D(q,r)$  and  $E(s,t)$ , where  $q < s$  and  $r < t$ .

- A) Find the shortest distance between  $\overline{AC}$  and  $\overline{DE}$ .
- B) Find  $m\overline{DE}$  in the form  $\frac{X}{Y}$ .
- C) Find  $q + r + s + t$ .
- D) Find the ratio, in fractional form, between the perimeter of triangle BED and the perimeter of triangle ABC.

### Question 8

Given isosceles trapezoid IJKL with median  $\overline{MN}$  and diagonals  $\overline{JL}$  and  $\overline{IK}$ ,  $\overline{IJ} \parallel \overline{LK}$ ,  $\overline{IJ} = 6$ ,  $\overline{LK} = 16$ , a height of  $5\sqrt{3}$ , and O and P are on  $\overline{MN}$ .

- A) Find the length of  $\overline{MO}$ .
- B) Find the length of  $\overline{OP}$ .
- C) Find the length of  $\overline{JP}$ .
- D) Find the length of  $\overline{PK}$ .



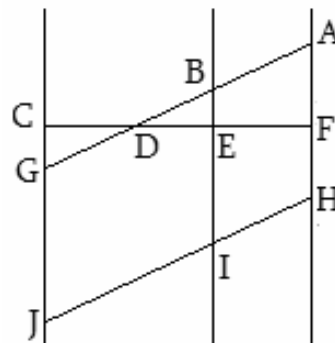
### Question 9

- A) The supplement of the complement of  $\angle A$  is equal to seven times the measure of  $\angle A$ . Find the measure of  $\angle A$ .
- B) The angle measure of  $\angle B$  is  $n^\circ$ , and the angle measure of the complement of  $\angle B$  is  $(36n - 21)^\circ$ . Find the value of  $n$ .
- C)  $m\angle CDE = m\angle FDG = 40^\circ$ , and  $E$ ,  $D$ , and  $F$  are collinear. Find the sum of all possible values of  $m\angle CDG$ .
- D) The angle measures of a right triangle are  $x^\circ$ ,  $(x + y)^\circ$ , and  $(x + 5y)^\circ$  where  $x$  and  $y$  are both positive integers. Find the value of  $\frac{x}{y}$ .

### Question 10

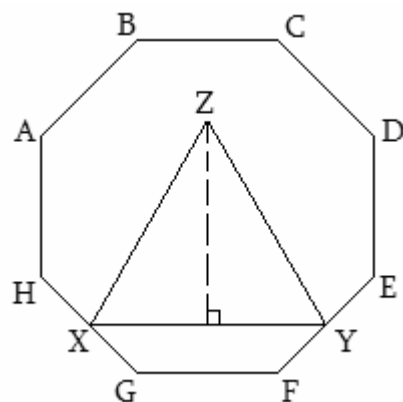
In the figure to the right,  $\overline{CJ} \parallel \overline{BI} \parallel \overline{AH}$ ,  $\overline{AG} \parallel \overline{JH}$ ,  $\overline{CF} \perp \overline{AH}$ ,  $\angle BDE = 30^\circ$ ,  $BE = 3$ , and  $AF = 4$ .

- A) Find  $m\angle EIJ$ .
- B) Find the length of  $\overline{DA}$ .
- C) Find the length of  $\overline{HI}$ .
- D) Find the sum of the angle measures in pentagon  $DEIJG$ .



### Question 11

Given regular octagon  $ABCDEFGH$  with perimeter of 64, where  $X$  is the midpoint of  $\overline{GH}$ ,  $Y$  is the midpoint of  $\overline{EF}$ , and  $\triangle XYZ$  is an equilateral triangle with  $Z$  lying in the interior of octagon  $ABCDEFGH$ .



- A) Find  $m\overline{XY}$ .
- B) Find the shortest distance between the altitude drawn from  $Z$  to side  $\overline{XY}$  of  $\triangle XYZ$ , and  $\overline{DE}$ .
- C) Find the shortest distance between  $\overline{XY}$  and  $\overline{FG}$ .
- D) Find the ratio, in fractional form, of the perimeter of pentagon  $GXZYF$  to the perimeter of octagon  $ABCDEFGH$ .

### Question 12

In the Geometric Zoo, where all animals are extremely geometrically-inclined, a group of animals decided to play a game where they have to use a geometric sentence to guess the measure of an angle. Josef the Jaguar thinks the measure of the angle is equal to the number of diagonals in a dodecagon. Pamela the Penguin thinks the measure of the angle is equivalent to the degree measure of the sum of 5 exterior angles of a regular 36-gon. Alexis the Armadillo thinks the measure of the angle is equal to the perimeter of an equilateral triangle with an altitude of length  $10\sqrt{3}$ . Gina the Giraffe thinks the measure of the angle is equal to the number of degrees in the last remaining angle of a quadrilateral with angle measures of  $113^\circ$ ,  $102^\circ$ , and  $88^\circ$ . The angle is measured with a protractor, and it was observed that one animal was exactly correct, two animals were three degrees off, and one animal was seven degrees off.

- A) Who was correct in guessing the measure of the angle?
- B) Who were three degrees off in guessing the measure of the angle?
- C) Who was seven degrees off in guessing the measure of the angle?
- D) What was the measure of the angle?

### Question 13

Please classify the following statements as either TRUE or FALSE. (Note: The words TRUE or FALSE must be submitted. No points will be given to any single letter responses.)

- A) Co-planar lines that do not intersect must be parallel.
- B) The angle measures of vertical angles must be equivalent.
- C) A proof by induction must begin with a contradiction to the statement trying to be proven.
- D) If the side lengths of two similar triangles are in the ratio 1:2, then the ratio of their perimeters must be 1:6.

### Question 14

Square	Rhombus	Trapezoid
Rectangle	Quadrilateral	Parallelogram

Of the figures that appear in the box above, how many of them can be described by the explanations below?

- A) Must have perpendicular diagonals.
- B) Must have bisecting diagonals.
- C) Must have at least one pair of parallel sides.
- D) Can have all sides of differing lengths.

### Question 15

Given  $\triangle ABC$ , with  $AB = 6$ ,  $BC = 8$ ,  $AC = 4$ , and  $\triangle DEF$ , with  $DE = 3 \cdot AB$ ,  
 $EF = 2 \cdot BC$ ,  $DF = 4 \cdot AC$ ,

- A) Classify  $\triangle ABC$  as equilateral, isosceles, or scalene.
- B) Classify  $\triangle ABC$  as acute, right, or obtuse.
- C) Classify  $\triangle DEF$  as equilateral, isosceles, or scalene.
- D) Classify  $\triangle DEF$  as acute, right, or obtuse.