

# **SkillsUSA 2010 Contest Projects**

## **Related Technical Math**

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## 3M 2010 SkillsUSA Related Technical Math

Show all necessary work on the test sheets and record your answers on this sheet

1. 1175
2. 25%
3. 25°
4. 1/10 or .10
5. \$227
6. 24
7. 34.5
8. 1/10 or .06
9. 58.83
10. -1
11. \$96,030
12. 2988.29 pounds
13. 577 or 15.71
14. 32
15. 95.07 units<sup>2</sup>
16. Morse .3355
17. \$188 million/mi
18. 141.30 million
19. 56 songs
20. 6/5
21. 1/3
22. 30
23. log<sub>2</sub> X = 8
24. 7.24 cm
25. 16

26. 6 days 14.70 hr
27. 0.74 or  $\frac{\sqrt{5}}{3}$
28. 32
29. 1/4 or .25
30. 0
31. \$12,629.71
32. 12
33. 67.5° and 112.5
34. 200 Type A; 260 Type B
35. #8
36. 5
37. 5
38. 61%
39. 4/3 or 1.33 units
40. 35 km
41. 5; 3; 1
42. \$4215.12
43. 5°
44. 5 5/6 hr or 5.83 hr
45. 2 1/4 units<sup>2</sup> of 5.25 units<sup>2</sup>
46. 34 songs
47. 141.56 ft
48. 38.20 mm
49. 4.17%
50. 32°

1. Lockheed Martin laid-off 47 workers at a certain plant, which was 4% of their work force. How many workers did they have previous to the lay-off?

$x = \text{total workforce}$

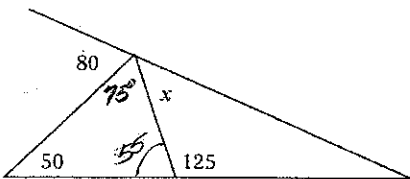
$$\frac{x}{100\%} = \frac{47}{4\%}$$

$$x = 1175$$

2. A 1qt. bottle full of liquid is 10% alcohol, and a 3-qt. bottle full of liquid is 30% alcohol. If the two bottles are combined, what is the percentage of alcohol in the mixture?

$$\frac{.10(1\text{qt}) + .3(3\text{qt})}{1\text{qt} + 3\text{qt}} = \frac{.1\text{qt} + .9\text{qt}}{4\text{qt}}$$
$$= \frac{1}{4} = 25\%$$

3. Find the value of angle  $x$ .



$$80 + 75 + x = 180$$

$$x = 180 - 155$$

$$x = 25^\circ$$

4. Blood groups for a certain sample of people are shown in the table. If one person from the sample of people is randomly selected, what is the probability that he or she has type B blood?

Blood Group	Frequency
O	110
A	64
B	20
AB	6

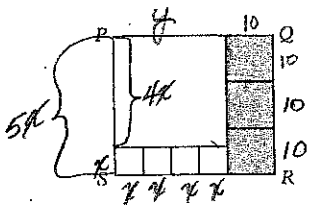
$$\frac{20}{200} = \frac{1}{10} \text{ or } .10$$

5. For a fee, the American Scholarship Search Company helped 28,560 students locate various study grants and fellowships. They collected \$13,623,120 in finder's fees from these students. The company advertised in their literature that they collected a finder's fee of only \$250 per student. On average how much did they overcharge each student?

$$\frac{\$13,623,120}{28,560 \text{ students}} = \$477/\text{student}$$

$$\begin{array}{r} \$477 \\ - 250 \\ \hline \$227 \text{ overcharge student} \end{array}$$

6. Rectangle PQRS is divided into eight squares. The length of each shaded square is 10. What is the length of the side of the largest square?



$$\begin{aligned} PS &= 30 \\ 30 &= 4x + x \\ 30 &= 5x \\ x &= 6 \end{aligned}$$

$$\begin{aligned} y &= 4x \\ &= 4(6) \\ &= 24 \end{aligned}$$

$$QR = 3(10)$$

$$QR = 30 = PS$$

7. Find the third quartile of the following data: ~~12, 15, 42, 37, 61, 14, 14, 9, 25, 32, 32, and 30.~~

9, 12, 14 | 14, 15, 25, 30, 32, 32 | 37, 42, 61

$$Q_2 = \frac{25 + 30}{2} = 27.5$$

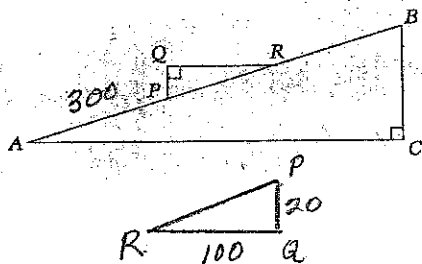
$$Q_3 = \frac{32 + 37}{2} = \frac{69}{2} = 34.5$$

8. A certain medication is known to cure a specific illness for 75% of the people who have the illness. If two people with the illness are selected at random and take the medication, what is the probability that neither will be cured?

$$\left(1 - \frac{3}{4}\right)\left(1 - \frac{3}{4}\right) =$$

$$\left(\frac{1}{4}\right)\left(\frac{1}{4}\right) = \frac{1}{16} \text{ or } .0625 \quad .06$$

9. As shown  $AB = 300$ ,  $PQ = 20$  and  $QR = 100$ . Line  $QR$  is parallel to line  $AC$ . Determine the length of  $BC$ , to the nearest tenth.



$$\frac{BC}{20} = \frac{300}{\sqrt{10,400}}$$

$$BC = \frac{(300)(20)}{\sqrt{10,400}}$$

$$RP = \sqrt{(100)^2 + (20)^2}$$

$$= 58.834$$

$$RP = \sqrt{10,400}$$

$$= 58.83$$

10. For all nonzero numbers  $x$  and  $y$  such that  $x - y = xy$ , find  $\frac{1}{x} - \frac{1}{y}$

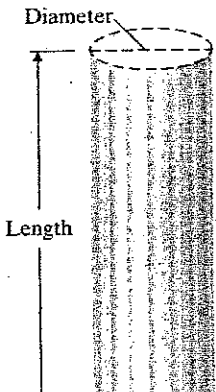
$$\begin{aligned} \frac{1}{x} - \frac{1}{y} &= \\ \frac{y}{xy} - \frac{x}{xy} &= \frac{y-x}{xy} \\ &= \frac{-1(x-y)}{(x-y)} = -1 \end{aligned}$$

11. Wells Fargo has decided to donate their old computers to the Mandan Public Schools. Each computer donated is worth \$120 in tax-deductible dollars. In addition, the computer company supplying the bank with new computers gives a 7% rebate to any customer donating used computers to schools. If sixty new computers are purchased at a list price of \$1850 each and sixty old computers are donated to the Mandan Public Schools, what is the net cost to the bank?

$$\begin{aligned} (100\% - 7\%)(60) \$1850 - 60(\$120) &= \\ \$103,230 - 7200 &= \$96,030 \end{aligned}$$

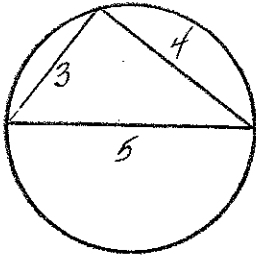
12. Many applied problems involve joint variation. For example, a cylindrical concrete column has a safe load of capacity that varies directly with the diameter raised to the fourth power and inversely with the square of its length. Where  $d$  = diameter and  $l$  = length, the equation

would be of the form  $y = \frac{kd^4}{l^2}$ . Find  $y$  when  $d = 1.5$  feet,  $l = 12$  feet and  $k = 85,000$  pounds



$$\begin{aligned} y &= \frac{85,000 (1.5)^4}{(12)^2} = \frac{85,000 (5.0625)}{144} \\ &= 2988.28125 \\ &= 2988.28 \text{ pounds} \end{aligned}$$

13. A circle is drawn around a triangle with side lengths of 3, 4, and 5. Find the circumference of the circle. Write answer in terms of pi.



$$r = \frac{5}{2} = 2.5$$

$$C = 2r\pi$$

$$C = 2(2.5)\pi$$

$$= 5\pi \text{ or } 15.71$$

14. McKenzie paid \$480 to purchase a certain number of T-shirts for her softball team. Two shirts were slightly damaged, so the vendor gave her 2 extra shirts, effectively decreasing the cost per shirt by \$1. How many shirts (including the 2 extra) did McKenzie receive?

$x$  = number of T-shirts

$$\frac{\$480}{x-2} - \frac{\$480}{x} = \$1$$

$$480x - 480(x-2) = x(x-2)$$

$$480x - 480x + 960 = x^2 - 2x$$

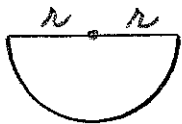
$$0 = x^2 - 2x - 960$$

$$0 = (x-32)(x+30)$$

$$x = 32$$

32

15. The perimeter of the semicircle is 40. Find the area of the semicircle. Round the answer to the nearest thousandth.



$$P = 2r + r\pi$$

$$40 = 2r + 3.142r$$

$$40 = 5.142r$$

$$r = 7.779$$

$$C = \frac{2r\pi}{2}$$

$$C = r\pi$$

$$A = \frac{\pi r^2}{2}$$

$$= \frac{\pi (7.779)^2}{2}$$

$$= 95.07$$

$$= 95.07 \text{ units}^2$$

16. Minnesota Twins players Mauer and Morneau are going into the last day of the season almost tied for the batting title. Morneau has 200 hits in 600 at bats, Mauer Has 199 hits in 600 at bats. On the last day of the season Morneau goes 3 for 5 and Mauer goes 3 for 4. Who wins the batting title and what is their average (round to the nearest ten-thousandth)? Recall batting percentage is determined by dividing the hits by at bats to obtain the batting average in decimal form.

$$\text{Morneau } \frac{200 + 3}{600 + 5} = \frac{203}{605} = .33553$$

$$\text{Mauer } \frac{199 + 3}{600 + 4} = \frac{202}{604} = .33443$$

$$\text{Morneau } .3355$$

17. The London subway system has a staff of 16,000 and accommodates 2.5 million passengers each day. A 1993 expansion of the system extended the system 16 kilometers and cost 2.85 billion British pounds. How many dollars per mile (to the nearest million) will this extension cost? (Use 1 kilometer = 0.62 miles and 1 U. S. dollar = 1.5258 British pounds.)

$$\begin{aligned} \frac{2.85 \times 10^9 \left( \frac{\$1}{1.5258 \$} \right)}{1} &= \frac{\$1,865,183,246}{9.92 \text{ mi}} \\ \frac{\left( \frac{16 \text{ km}}{1} \right) \left( \frac{.62 \text{ mi}}{1 \text{ km}} \right)}{1} &= \frac{\$188,022,504.6}{\text{mi}} \\ &= \$188 \text{ million / mi} \end{aligned}$$

18. The orbit of Venus is an ellipse with the Sun as a focus. If we say that the center of the ellipse is at the origin, an approximate equation for the orbit is:  $\frac{x^2}{5013} + \frac{y^2}{4970} = 1$  where  $x$  and  $y$  are measured in million of miles. Find the greatest possible distance across the ellipse. Round your answer to the nearest million miles. The standard form of an ellipse is:  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$



$$\sqrt{a^2} = \sqrt{5013} = 70.803$$

$$\sqrt{b^2} = \sqrt{4970} = 70.498$$

$$a + b = 141 \text{ million}$$

$$= 141.30 \text{ million}$$

19. Cormac has a collection of 50 songs that are each 3 minutes long and 50 songs that are each 5 minutes long. What is the maximum number of songs from his collection that he can play in 3 hours without repeating a song?

$$\left(\frac{3 \text{ hr}}{1}\right) \left(\frac{60 \text{ min}}{1 \text{ hr}}\right) = 180 \text{ min}$$

50 songs + 6 songs

$$50 \text{ song} \times 3 \text{ min} = \frac{150 \text{ min}}{30 \text{ min}}$$

56 songs

$$\frac{30 \text{ min}}{5 \text{ min}} = 6 \text{ songs}$$

20. If  $\frac{a+b}{a} = 6$  and  $\frac{b+c}{c} = 7$  find the ratio of  $a$  to  $c$ .

$$a\left(\frac{a+b}{a}\right) = 6(a) \quad c\left(\frac{b+c}{c}\right) = 7(c)$$

$$a+b = 6a$$

$$b+c = 7c$$

$$b = 5a$$

$$b = 6c$$

$$5a = 6c$$

$$a = \frac{6c}{5}$$

$$\frac{a}{c} = \frac{6c}{5c}$$

$$\frac{a}{c} = \frac{6}{5}$$

21. Three pennies showing 2 heads and 1 tail are on a table. Two of the coins are selected at random and turned over. What is the probability that all three coins now show the same side?



$$P(3 \text{ tails}) = 0 + \frac{1}{3}$$

$$P(3 \text{ tails}) = \frac{1}{3}$$

22. The sum of three numbers is 98. The first number is  $\frac{2}{3}$  of the second, and the second is  $\frac{5}{8}$  of the third. What is the second number?

$x = \text{the first}$      $y = \text{the second}$      $z = \text{the third}$

$$x = \frac{2}{3}y \quad y = \frac{5}{8}z$$

$$y = \frac{5}{8} \left( \frac{48}{1} \right)$$

$$\frac{2}{3}y + y + z = 98$$

$$\frac{5y}{3} + z = 98$$

$$\frac{49}{24}z = 98$$

$$z = 30$$

$$\left( \frac{5}{3} \right) \left( \frac{5}{8}z \right) + z = 98$$

$$\left( \frac{24}{49} \right) \frac{49}{24}z = \left( \frac{24}{49} \right) 98$$

$$\frac{25}{24}z + \frac{24}{24}z = 98$$

$$z = 48$$

$$30$$

23. If  $\log_b(xy) = 11$  and  $\log_b\left(\frac{x}{y}\right) = 5$ , what is  $\log_b x$ ?

$$\log_b x + \log_b y = 11$$

$$\log_b x - \log_b y = 5$$

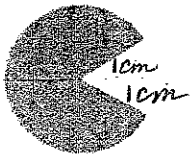
$$\log_b x + \log_b y = 11$$

$$\log_b x - \log_b y = 5$$

$$\hline 2 \log_b x = 16$$

$$\log_b x = 8$$

24. An old video game featured a hungry creature in the form of a sector of a circle with a radius 1 cm. The missing portion, the mouth, has a central angle of 60 degrees. What is the perimeter (in cm) of the creature?



$$P = 2r + \frac{\theta}{360} 2\pi r$$

$$= 2(1\text{cm}) + \left( \frac{300}{360} \right) 2(1)\pi$$

$$= 2\text{cm} + \frac{572\pi}{6}$$

$$= 2\text{cm} + \frac{5\pi}{3}$$

$$= 2\text{cm} + 5.23598$$

$$= 7.24\text{cm}$$

25. Find  $x+y+z$  given that  $\frac{x}{3-x} = \frac{y}{5-y} = \frac{z}{16-z} = 2$

$$\frac{x}{3-x} + \frac{y}{5-y} + \frac{z}{16-z} = 2$$

$$\frac{x+y+z}{3+5+8-(x+y+z)} = 2$$

$$\frac{x+y+z}{24-(x+y+z)} = 2$$

$$x+y+z = 2(24-(x+y+z))$$

$$x+y+z = 48 - 2x - 2y - 2z$$

$$3x+3y+3z = 48$$

$$3(x+y+z) = 48$$

$$x+y+z = 16$$

26. Kay Cobb and her brother Rutherford went on a cruise from San Diego to Miami via the Panama Canal for a distance of 4380 miles. The ship Constellation travels at 24 knots per hour. How many days and hours of sailing would the ship Constellation need to cover the 4380 land miles? 1 knot = 1.15 miles.

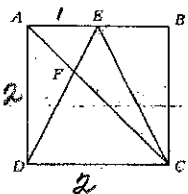
$$24 \text{ knots} \left( \frac{1.15 \text{ mi}}{1 \text{ knot}} \right) = 27.6 \text{ mi/hr}$$

$$\left( \frac{4380 \text{ mi}}{1} \right) \left( \frac{\text{hr}}{27.6 \text{ mi}} \right) = 158.695 \text{ hr}$$

$$\frac{158.695 \text{ hr}}{1} \left( \frac{1 \text{ day}}{24 \text{ hr}} \right) = 6 \text{ days } 14.695 \text{ hr}$$

$$= 6 \text{ days } 14.70 \text{ hr}$$

27. ABCD is a square with an inscribed isosceles triangle EDC such that E is the midpoint of AB. Diagonal AC intersects DE at F. If the area of the square ABCD is 4, find the length of FE.



$$DE = \sqrt{(2)^2 + (1)^2}$$

$$DE = \sqrt{5}$$

$$\triangle FAE \sim \triangle FCD$$

$$\frac{AE}{DC} = \frac{FE}{FD}$$

$$\frac{1}{2} = \frac{FE}{DF}$$

$$DF = 2FE$$

$$ED = EF + DF = \sqrt{5}$$

$$EF + 2EF = \sqrt{5}$$

$$3EF = \sqrt{5}$$

$$EF = \frac{\sqrt{5}}{3}$$

$$EF = .74$$

$$= .74$$

28. If  $n$  is greater than 0 and  $\sqrt[2]{n^2+n^2+n^2+n^2} = 64$ , what is the value of  $n$ ?

$$\sqrt{4n^2} = 64$$

$$2n = 64$$

$$n = 32$$

29. Find all real values of  $x$  such that  $2x + \sqrt{x} - 1 = 0$

$$2x - 1 = -\sqrt{x}$$

$$(2x - 1)^2 = (-\sqrt{x})^2$$

$$4x^2 - 4x + 1 = x$$

$$4x^2 - 5x + 1 = 0$$

$$(4x - 1)(x - 1) = 0$$

$$4x - 1 = 0 \quad x = 1$$

$$\underline{x = \frac{1}{4} \text{ or } .25}$$

Check

$$2\left(\frac{1}{4}\right) + \sqrt{\frac{1}{4}} - 1 \stackrel{?}{=} 0$$

$$\frac{1}{2} + \frac{1}{2} - 1 = 0$$

$$0 = 0$$

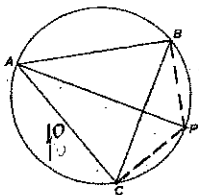
$$x = 1$$

$$2(1) + \sqrt{1} - 1 = 0$$

$$2 + 1 - 1 = 0$$

$$2 \neq 0$$

30. Equilateral triangle  $ABC$  is inscribed in a circle. The angle bisector at  $A$  intersects the circle again at  $P$ . If the length of segment  $AC$  is 10, Find  $AP - (BP + CP)$



$$PC = \frac{10\sqrt{3}}{3}$$

$$BP = \frac{10\sqrt{3}}{3}$$

$$AP = \frac{20\sqrt{3}}{3}$$

$$AP - (BP + CP)$$

$$AP^2 = \sqrt{(10)^2 + \left(\frac{10\sqrt{3}}{3}\right)^2} \quad AP = \sqrt{\frac{400}{3}} = \frac{20\sqrt{3}}{3} - \left(\frac{10\sqrt{3}}{3} + \frac{10\sqrt{3}}{3}\right)$$

$$AP^2 = \sqrt{100 + \frac{100(3)}{9}} = \frac{20}{\sqrt{3}} = \frac{20\sqrt{3}}{3} - \frac{20\sqrt{3}}{3}$$

$$AP^2 = \frac{100 + 100}{3} = \frac{20\sqrt{3}}{3} = 0$$

$$AP = \sqrt{\frac{200 + 100}{3}}$$

31. Suppose that the cost of a college education is increasing 8% per year. The equation  $C(t) = P(1.08)^t$  forecasts the tuition cost in  $t$  years from now and is based on the present cost  $P$  in dollars. How much will a college now charging \$5850 for tuition charge in 10 years?

$$\begin{aligned}
 C(t) &= P(1.08)^{10} \\
 &= 5850(1.08)^{10} \\
 &= 5850(2.158924) \\
 &= \$12,629.71
 \end{aligned}$$

32. Compute the smallest value of  $n$  for which the mean and median of the set

$\{13, 21, 26, 28, 41, n\}$  are equal.

$$13 + 21 + 26 + 28 + 41 + n = 129 + n$$

$$\text{mean} = \frac{129 + n}{6}$$

$$\frac{129 + n}{6} = \frac{47}{2}$$

$$\text{median} = \frac{26 + 28}{2} = \frac{47}{2}$$

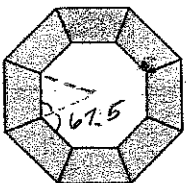
$$129 + n = \left(\frac{47}{2}\right)6$$

$$129 + n = 47(3)$$

$$129 + n = 141$$

$$n = 12$$

33. Eight identical tables shaped as isosceles trapezoids fit together without gaps to make a "round" table. Find the interior angle measures of the trapezoidal tabletops.



$$\frac{360}{8} = 45^\circ$$

$$67.5^\circ; 112.5$$

$$x + x + 45^\circ = 180^\circ$$

$$2x = 180^\circ - 45^\circ$$

$$2x = 135^\circ$$

$$x = 67.5$$

$$\frac{360^\circ - 2(67.5)}{2} = 112.5^\circ$$

34. Electro Electronics makes two types of switching devices. Type A takes 4 minutes to make and requires \$3 worth of materials. Type B takes 5 minutes to make and requires \$5 worth of materials. When the production manager reviewed the latest batch, she found that it took 35 hours to make these switches with a materials cost of \$1900. How many switches of each type were produced for the latest batch?

$$\begin{array}{ll} x = \text{type A} & \text{time} \quad 4x + 5y = 2100 \\ y = \text{type B} & \text{cost} \quad 3x + 5y = 1900 \end{array}$$

$$\begin{array}{r} 4x + 5y = 2100 \\ -3x - 5y = -1900 \\ \hline x = 200 \end{array}$$

$$\begin{array}{l} 3(200) + 5y = 1900 \\ 5y = 1900 - 600 \\ 5y = 1300 \\ y = 260 \\ 200 \text{ Type A} \\ 260 \text{ Type B} \end{array}$$

35. A ticket fee was \$10 but reduced. The number of customers increased by 50%, but the gate receipts increased by only 20%. What was the new price of the ticket?

$$\begin{array}{l} x = \text{new fee} \\ N = \text{original customers} \end{array}$$

$$(100\% + 20\%) \$10 N = (100\% + 50\%) x N$$

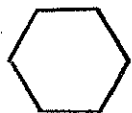
$$1.2(10) N = 1.5 x N$$

$$\frac{1.2(10)N}{1.5N} = \frac{15xN}{1.5N}$$

$$\$8 = x$$

#8

36. If each side of a regular pentagon is  $x^2 + 17$  and each side of a regular hexagon is  $x^2 + 2x$ , for what value or values of  $x$  will the perimeters of the figures be equal?



$$6(x^2 + 2x) = 5(x^2 + 17)$$

$$6x^2 + 12x = 5x^2 + 85$$



$$6x^2 - 5x^2 + 12x - 85 = 0$$

$$x^2 + 12x - 85 = 0$$

$$(x + 17)(x - 5) = 0$$

$$x = 5$$

37. If  $2^x = 15$  and  $15^y = 32$ , find the value of  $xy$ .

$$2^x = 15 \qquad 15^y = 32$$

$$x \log 2 = \log 15 \qquad y \log 15 = \log 32$$

$$x = \frac{\log 15}{\log 2} \qquad y = \frac{\log 32}{\log 15}$$

$$x = 3.9068 \qquad y = 1.2797$$

$$xy = (3.9068)(1.2797) \qquad xy = 5$$

$$= 4.9998$$

38. Ella takes five mathematics tests, each scaled from 0 to 100, and obtains an average of 73%. After her teacher drops one of the test scores, Ella's new average is 76%. What was the score on the test the teacher dropped?

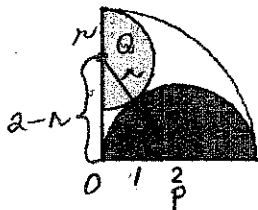
$$5 \times 73 = 365$$

$$4 \times 76 = 304$$


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$$61 \qquad 61\%$$

39. The two semicircles in the figure are tangent to each other. The radius of the quadrant and the diameter of the larger semicircle are each 2. Find the diameter of the smaller circle.



$$(2-r)^2 + (1)^2 = (r+1)^2$$

$$4 - 4r + r^2 + 1 = r^2 + 2r + 1$$

$$5 + r^2 - r^2 - 1 = 2r + 4r$$

$$4 = 6r$$

$$r = \frac{4}{6}$$

$$r = \frac{2}{3}$$

$$\text{Diameter} = 2r$$

$$= 2 \left( \frac{2}{3} \right)$$

$$= \frac{4}{3} \text{ units}$$

$$\approx 1.\bar{3} \text{ units}$$

40. On Monday, Jack drove to work at an average speed of 70 km/h and arrived 1 minute late. On Tuesday, he left at the same time and took the same route. This time he drove at an average speed of 75 km/h and arrived 1 minute early. How long is his route to work?

$$d = rt$$

$$\frac{d}{70} - \frac{d}{75} = \frac{1}{30}$$

$$\frac{d}{70} = t$$

$$75d - 70d = \frac{(70)(75)}{30}$$

$$1 \text{ min} + 1 \text{ min} = 2 \text{ min}$$

$$\left(\frac{1}{3}\right) 5d = \frac{(70)(75)}{30} \left(\frac{1}{3}\right)$$

$$2 \text{ min} \left(\frac{1 \text{ hr}}{60 \text{ min}}\right) = \frac{1}{30} \text{ hr}$$

$$d = 35 \text{ km}$$

41. Every year 28 baseball writers cast votes for first, second, and third place for the Cy Young award the American League award for the best pitcher in the league. How many points were awarded for each first, second, and third place vote? The totals for the top three pitchers in 2009 were:

	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	Total
Zack Greinke	25	3	0	134
Felix Hernandez	2	23	1	80
Justin Verlander	1	0	9	14

$$x = \text{first } y = \text{second } z = \text{third}$$

$$x = 5 \quad y = 3 \quad z = 1$$

$$25x + 3y = 134$$

$$2x + 23y + z = 80$$

$$1x + 9z = 14$$

$$17(25x + 3y) = (134)17$$

$$425x + 51y = 2278$$

$$-425x - 5175y = -17650$$

$$-5124y = -15372$$

$$-9(2x + 23y + z) = 80$$

$$-18x - 207y - 9z = -720$$

$$x + 9z = 14$$

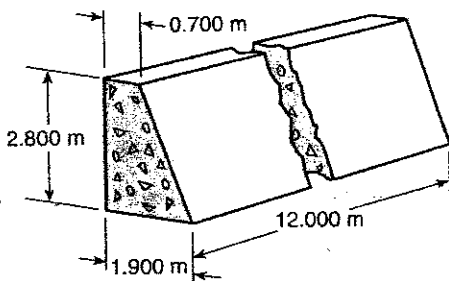
$$y = 3 \quad 5 + 9z = 14$$

$$25(-17x - 207y) = (-706)25$$

$$25x + 3(3) = 134$$

$$25x = 125 \quad x = 5$$

42. A concrete retaining wall is shown. At a cost of \$96.50 per cubic meter, what is the total cost of the concrete wall?



$$V = \left(\frac{1}{2}(b_1 + b_2)h\right)l$$

$$= (.5(1.9 + .7)2.8)12$$

$$= .5(2.6)(2.8)(12)$$

$$= 43.68 \text{ m}^3$$

$$= 43.7 \text{ m}^3$$

$$43.68 \text{ m}^3 \left(\frac{\$96.50}{\text{m}^3}\right) =$$

$$= \$4215.12$$

43. To convert Celsius temperatures to Fahrenheit temperatures quickly without a calculator, some people use this rule of thumb: Double the Celsius reading and add 30 degrees. The correct formula is  $F = \left(\frac{9}{5}\right)C + 32$ . What is the error when the rule of thumb is used at 35 degrees Celsius?

Rule of Thumb

$$2(35) + 30 =$$

$$70 + 30 = 100^\circ$$

Formula

$$F = \left(\frac{9}{5}\right)35 + 32$$

$$= 63 + 32$$

$$= 95^\circ$$

$$100^\circ - 95^\circ = 5^\circ$$

44. Working alone, pump A can fill a pool in 8 hours, while pump B can fill it in 10 hours. The two pumps are turned on at the same time and run until the pool is 75% full. Pump A then stops working, but pump B continues until the pool is filled. How long does it take to fill the empty pool?

Rate of pump A =  $\frac{1}{8}$  hr  
 " " " B =  $\frac{1}{10}$  hr

y = time to complete

$$\frac{1}{10}y = \frac{1}{4}$$

$$y = \frac{10}{4}$$

$$= \frac{5}{2}$$

x = time to fill 75%

$$\left(\frac{1}{8}\right)x + \left(\frac{1}{10}\right)x = \frac{3}{4}$$

$$10x + 8x = \frac{3(8)(10)}{4}$$

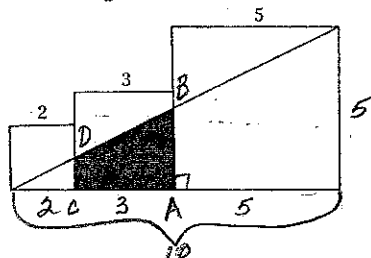
$$18x = 60$$

$$x = \frac{60}{18} = \frac{10}{3} \text{ hr}$$

Total  $\frac{10}{3} + \frac{5}{2} = \frac{20}{6} + \frac{15}{6} = \frac{35}{6}$  hr

$$5\frac{5}{6} \text{ hr}$$

45. Three squares have the dimensions indicated. What is the area of the shaded quadrilateral?



$$\frac{5}{10} = \frac{AB}{5}$$

$$\frac{(5)(5)}{10} = AB$$

$$AB = \frac{25}{10}$$

$$AB = \frac{5}{2}$$

$$\frac{5}{10} = \frac{DC}{2}$$

$$\frac{5(2)}{10} = DC$$

$$\frac{10}{10} = DC$$

$$DC = 1$$

$$A = \frac{1}{2}(b_1 + b_2)h$$

$$= \frac{1}{2}\left(\frac{5}{2} + 1\right)3$$

$$= \frac{1}{2}\left(\frac{7}{2}\right)\left(\frac{3}{1}\right)$$

$$= \frac{21}{4} \text{ units}^2 \text{ or } 5.25 \text{ units}^2$$

$$5.83 \text{ hr}$$

46. The ratio of boys to girls in Mr. Shag's class is 3 to 2. The ratio of boys to girls in Mrs. Bag's class is 4 to 3. If there are 30 students in Mr. Shag's class and 28 students in Mrs. Bag's class, what is the total number of boys in the two classes?

$$\text{Mr. Shag ratio} = \frac{3b}{2g} \quad \frac{3}{5}(30) = 18 \text{ boys}$$

$$\text{Mrs. Bag ratio} = \frac{4b}{3g} \quad \frac{4}{7}(28) = \frac{16 \text{ boys}}{34 \text{ boys}}$$

47. The Buckingham Memorial Fountain in Chicago shoots water from a nozzle within the fountain. The height  $h$ , in feet, of the water above the ground  $t$  seconds after it leaves the nozzle is given by  $h(t) = -16t^2 + 90t + 15, h \geq 15$ . What is the maximum height of the water-spout? Round to the nearest tenth of a foot.

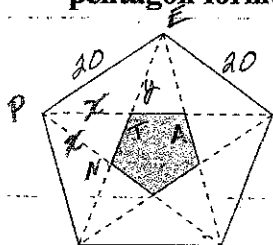
$$h(t) = -16t^2 + 90t + 15 \quad h(2.8125) = -16(2.8125)^2 + 90(2.8125) + 15$$

$$\frac{dh}{dt} = -32t + 90 \quad = -126.5625 + 253.125 + 15$$

$$32t = 90 \quad = 141.5625$$

$$t = 2.8125 \quad = 141.56 \text{ ft}$$

48. If the perimeter of a regular pentagon is 100 mm, what is the perimeter of the regular pentagon formed by connecting the diagonals?



$$\frac{PE}{PN} = \frac{ET}{TA}$$

$$\frac{x+y}{x} = \frac{x}{y}$$

$$y(x+y) = (x)(x)$$

$$xy + y^2 = x^2$$

$$x^2 - xy - y^2 = 0$$

$$x = \frac{y \pm \sqrt{y^2 - 4(-y^2)}}{2}$$

$$x = \frac{y \pm y\sqrt{5}}{2}$$

$$x = y \left( \frac{1 + \sqrt{5}}{2} \right)$$

$$\frac{x+y}{y} = \frac{x}{y} + 1$$

$$= \frac{1 + \sqrt{5}}{2} + 1$$

$$= \frac{3 + \sqrt{5}}{2}$$

$$\frac{100}{2} = \frac{3 + \sqrt{5}}{2} \cdot P$$

$$\frac{200}{3 + \sqrt{5}} = P$$

$$P = 50(3 - \sqrt{5})$$

$$= 38.20 \text{ mm}$$

49. The populations of two cities were equal at the end of 2005. The population of Charboneau decreased by 2.9 percent in 2006, increased by 8.9 percent 2007, and increased by 6.9 percent in 2008. The population of Grassy Butte increased by  $r$  percent each of the three years. If the populations of the towns were equal at the end of 2008, determine the value of  $r$  correct to one decimal place. Given  $A = P\left(1 + \frac{r}{100}\right)^n$

$$A = P\left(1 + \frac{r}{100}\right)^n$$

$$A(1 - .029)(1 + .089)(1 + .069) = P\left(1 + \frac{r}{100}\right)^3$$

$$1.1303809 = \left(1 + \frac{r}{100}\right)^3$$

$$\sqrt[3]{1.1303809} = \sqrt[3]{1 + \frac{r}{100}}$$

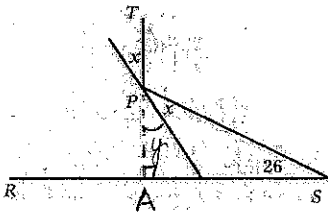
$$1.04169 = 1 + \frac{r}{100}$$

$$.04169 = \frac{r}{100}$$

$$4.169 = r$$

$$4.17\%$$

50. A beam of light shines from point S, reflects off a reflector at point P, and reaches point T so that line PT is perpendicular to line RS. Find the value of  $x$ .



$$\angle x = \angle y$$

The angles of  $\triangle APS = \angle SAP + \angle APS + \angle PSA$

$$180^\circ = 90^\circ + 2x + 26^\circ$$

$$180^\circ = 116^\circ + 2x$$

$$180^\circ - 116^\circ = 2x$$

$$64^\circ = 2x$$

$$x = 32^\circ$$

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