

Contestant Number _____

2017 SkillsUSA

Related Technical Math Test

INSTRUCTIONS

Please place your contestant number at the top of this page and on the first page of the test. Do all necessary work on the test sheets and place the answers on the answer sheet. Remember to include the correct units on your answers.

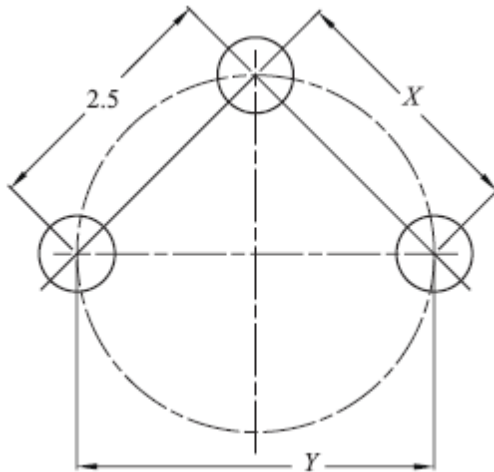
You may use any type of calculator and the given formula sheet. Use the calculator value for π . Round your answers to the nearest tenth or cent unless otherwise directions are given. Place the answers on the answer sheet.

In the event of a tie: The judges will determine the winner by the reasoning and overall quality of the work shown to solve the problems.

You will have two hours to complete the test.

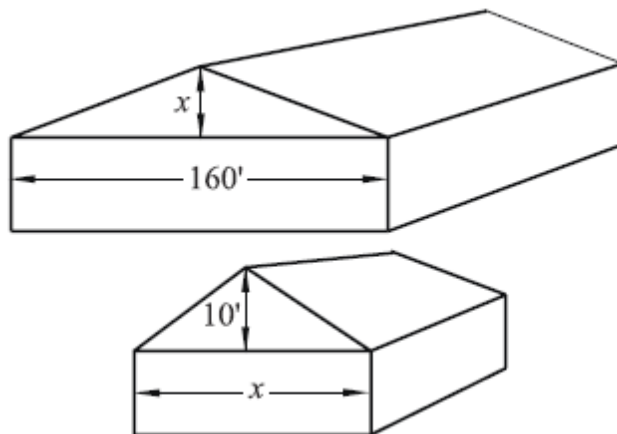
- 1) The walls of a house are to be covered with insulation board. The actual area is 2604 square feet. How many 8 foot by 4 foot insulation boards must be ordered to allow for 7% waste?

- 2) In the figure shown below, solve for dimension X , a chord of the circle, and Y , the circle's diameter. Dimensions are in centimeters.

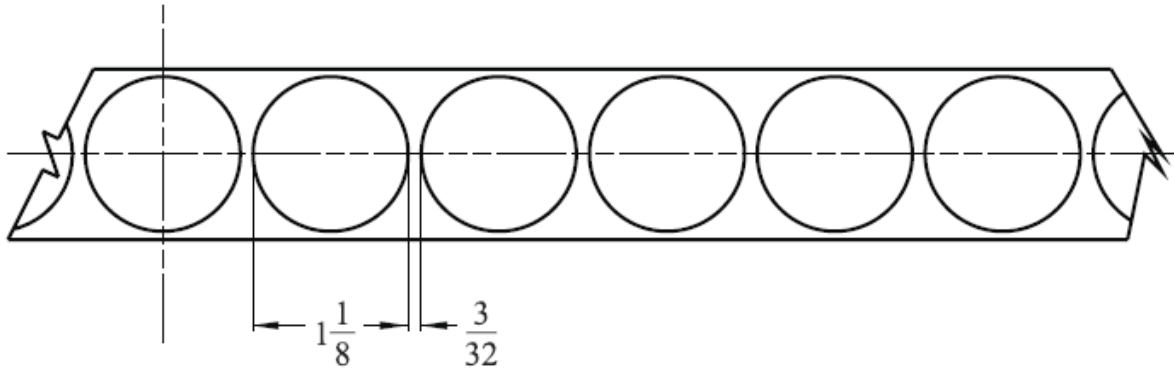


- 3) A person standing 120 feet from the base of a smokestack finds that the angle of elevation (the angle a line from the eye to the object makes with the horizontal) is 50° . If the person's eye is 5 feet 8 inches from the ground, what is the height of the stack? Round to the thousandths place.

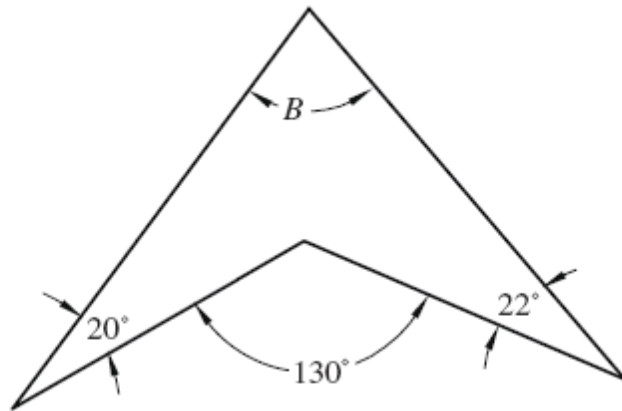
- 4) An equally pitched roof has both sides at the same angle with the horizontal. Two buildings have equally pitched roofs as shown below. The span of the first roof is 160 ft and the vertical height of the second roof is 10 ft. What is the span of the second roof if its span equals the vertical height of the first roof?



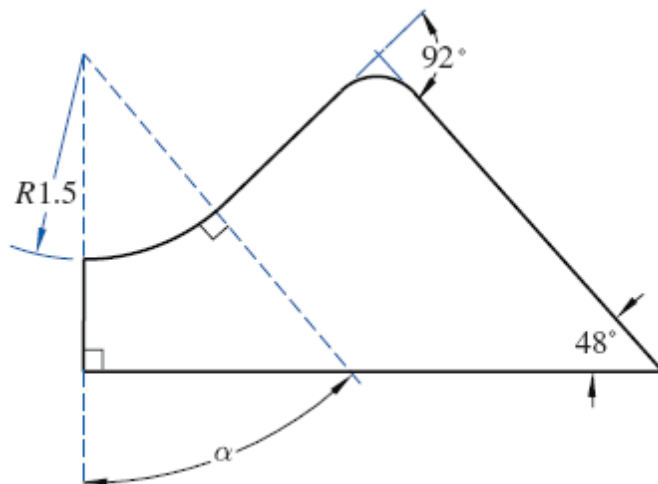
- 5) Determine the number of discs that can be blanked from a 24-foot roll of #18-gauge cold rolled steel if each blank is $1\frac{1}{8}$ inches in diameter and there is a $\frac{3}{32}$ -inch web between each disc.



6) Solve for angle B in the polygon shown below.



7) For the molding gauge shown below, solve for angle α .



- 8) The currents (measured in Amperes) running through an electrical system are given by the following system of equations. Solve the system to find the currents (I_1 , I_2 , and I_3) in this circuit.

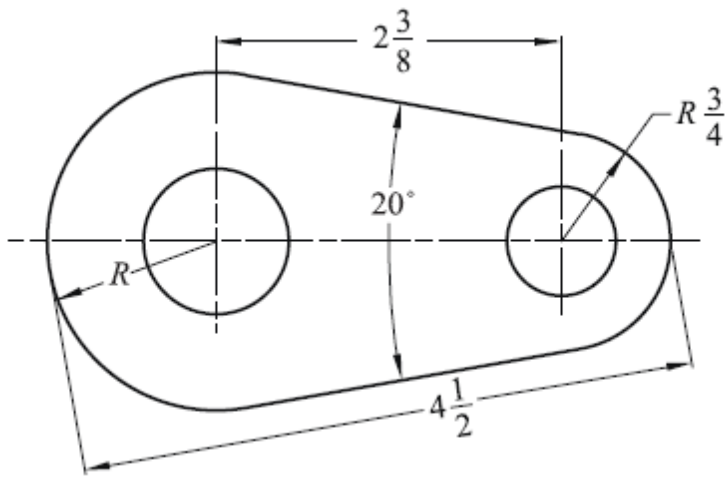
$$2I_1 - I_2 + I_3 = 0.850$$

$$-I_1 + 2I_2 + 3I_3 = 4.450$$

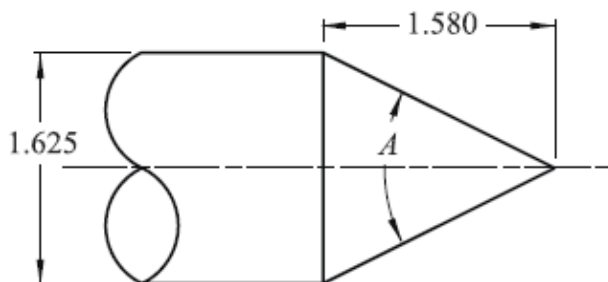
$$I_1 + 2I_2 + 5I_3 = 7.550$$

9) Solve the roots of the quadratic equation: $x^2 - 4x + 2 = 0$.

10) Determine the length of radius R in the figure below. Dimensions are in inches.

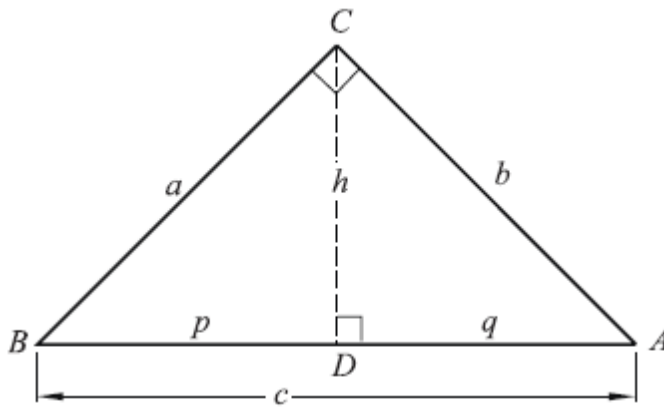


11) Determine angle A. The dimensions shown are in inches.

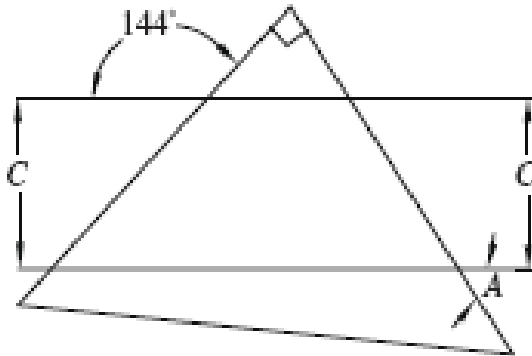


- 12) Suppose that the mean starting salary of welders in a specific region is \$37,480 with a standard deviation of \$1,400 and that salaries follow a normal distribution. Approximately what percentage of the salaries will be between \$34,680 and \$40,280?

- 13) In the figure shown below, solve for a and h when $p = 2$ and $q = 6$.

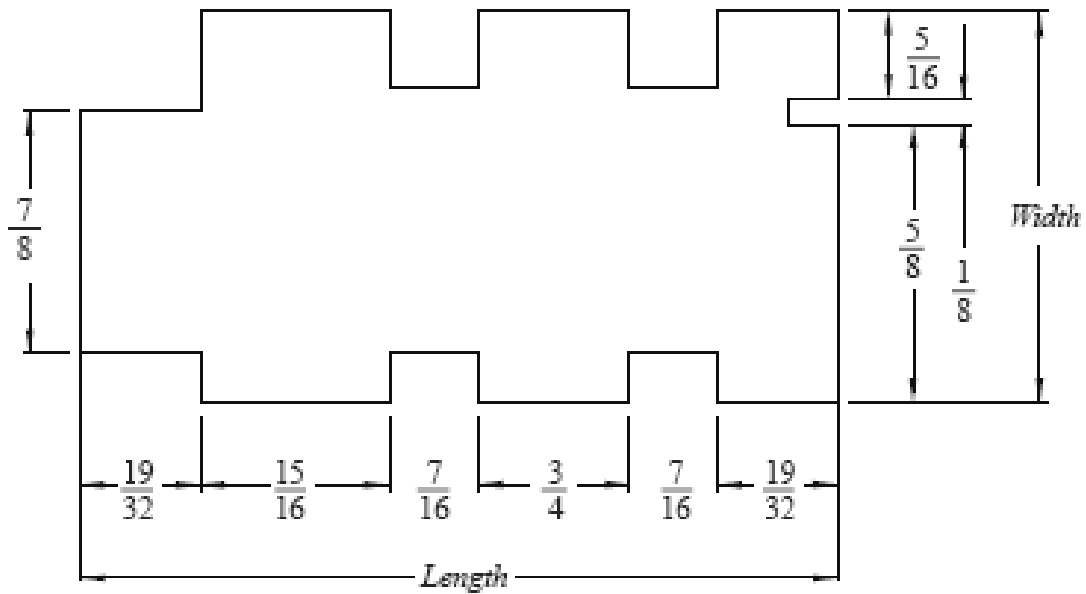


14) In the figure shown below, solve for $\angle A$. Note that the two lines are parallel.

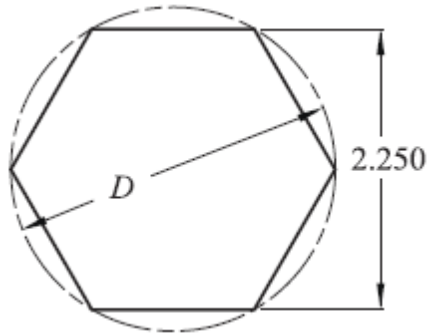


15) The lifting capacity of a cable is proportional to the area of its cross section. If a cable 1.5 inches in diameter will lift 10,000 pounds, what will a cable 6.25 inches in diameter lift?

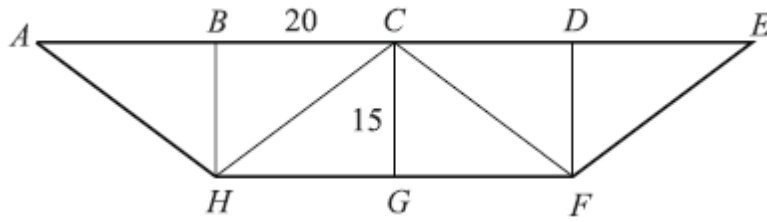
- 16) The dimensions of the detail shown below are given in inches. Determine the indicated length and width.



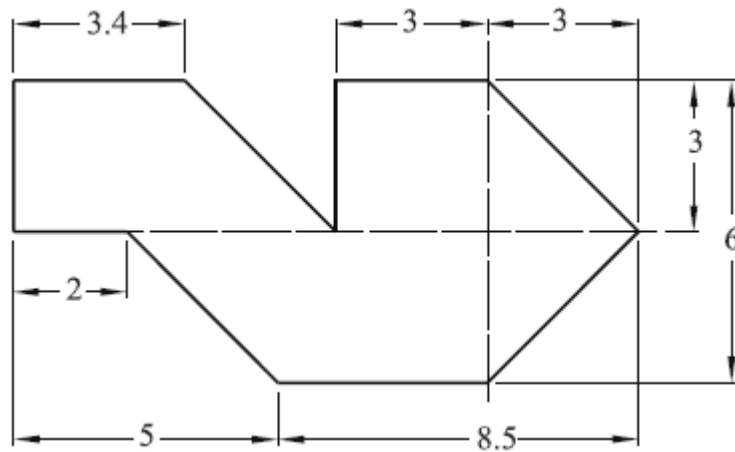
- 17) Determine the diameter of the circle circumscribed around the hexagon shown below. Dimensions are in centimeters. Round to the thousandths place.



18) The principal dimensions of a truss are provided in the figure below. Calculate $\angle CHG$ and the length of HC. All dimensions are in feet.



19) What is the perimeter of the blank shown below? Dimensions are in inches.



20) The foundation of a building required 346 cubic yards of concrete. The concrete was hauled in buggies holding 9 cubic feet each. How many loads were required to pour the foundation?

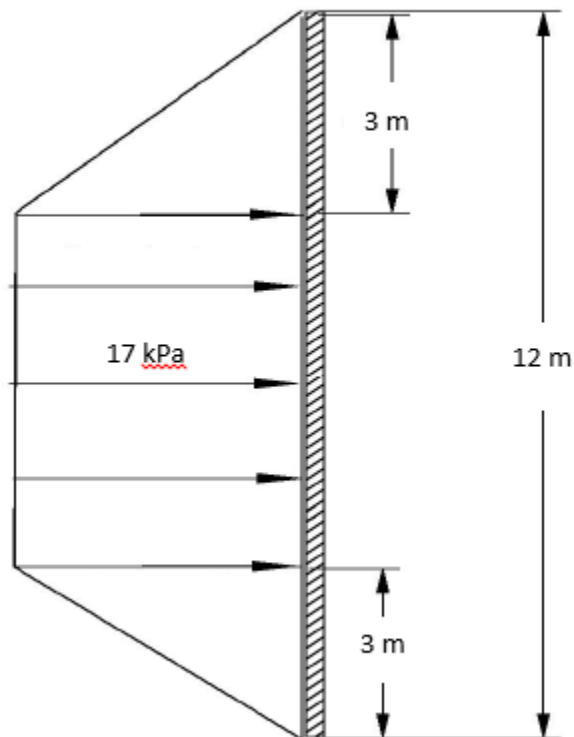
21) A fair coin is tossed 3 times. What is the probability that all three tosses will land tail side up?

22) Solve for x in the expression: $3(x + 2y) = 2(5x - y)$.

- 23) A population of 600 transistors contains transistors from three lots. The transistors are categorized by lot and by whether they pass an electrical test, with the results shown in the table below. If a transistor is chosen at random from the population, what is the probability that the transistor is from Lot A and passes the electrical test?

| LOT | PASS | FAIL |
|-----|------|------|
| A | 88 | 12 |
| B | 165 | 35 |
| C | 260 | 40 |

- 24) A 12 meter foundation is temporarily supported with a brace subjected to pressure as illustrated in the figure shown below. What is the total force (in Newtons) per meter exerted on the wall?



25) Let E be the event that a new car requires engine work under warranty and let T be the event that the car requires transmission work under warranty. Suppose that $P(E) = 0.10$, $P(T) = 0.02$, and $P(E \text{ and } T) = 0.01$. Find the probability that the car needs work on either the engine, the transmission, or both.

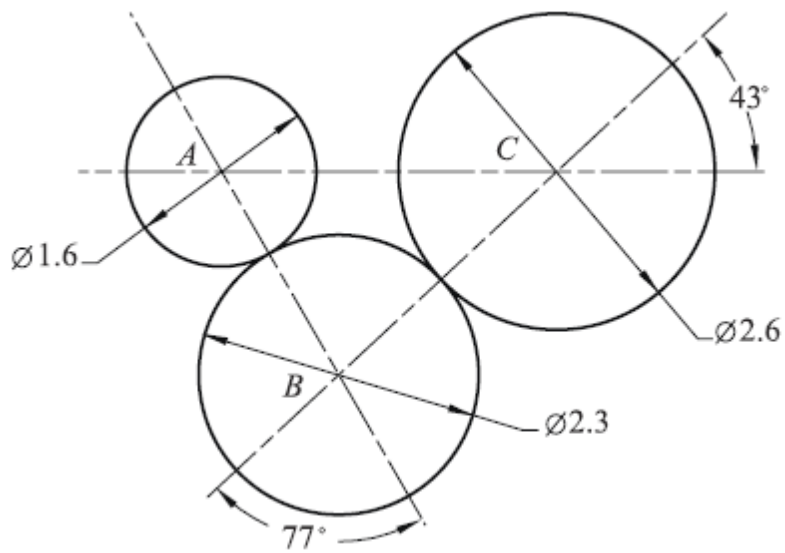
26) A sphere is cut from a cube 20 inches on an edge. What is the minimum amount of waste in cubic inches?

27) A 10 pound weight is placed at one end of a 12 foot pole. A 6 pound weight is placed at the other end. At what distance from the 10 pound weight should a fulcrum be placed to balance the pole?

28) To test the flow of coolant through a radiator with a 2 inch diameter passage, a flow of 5 gallons was recorded in 4 minutes. Find the velocity in feet per second of the flow through the radiator.

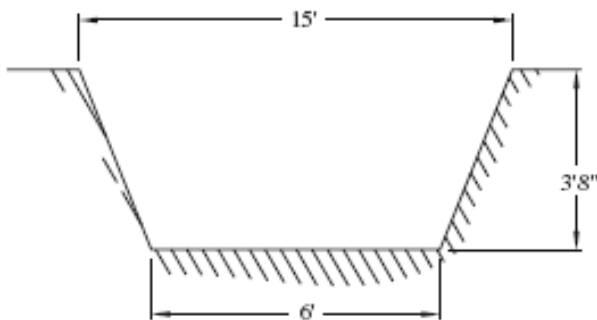
29) The local hardware store sells custom-colored paint. A certain orange color needed to match the color on a piece of machinery consists of 1.5 parts red paint and 2 parts yellow paint. How many gallons of red and how many gallons of yellow paint are needed to make 28 gallons of orange paint?

- 30) Three gears mesh as shown below. Find the distance between points A and C.
Dimensions are in centimeters.



- 31) A special laminated wooden beam is made up of two pieces of planking, each $1\frac{5}{8}$ inch thick, and three pieces of lumber, each $\frac{13}{16}$ inch thick. What is the thickness of the beam?

- 32) Calculate the cross-sectional area of the storm drain shown below. Give answer in square meters (round to the hundredths place).



33) A news story reported the number of calories in hamburgers from a sample of six fast-food restaurants as 250, 290, 230, 310, 310, and 350. Find the sample standard deviation for number of calories (round answer to tenths place).

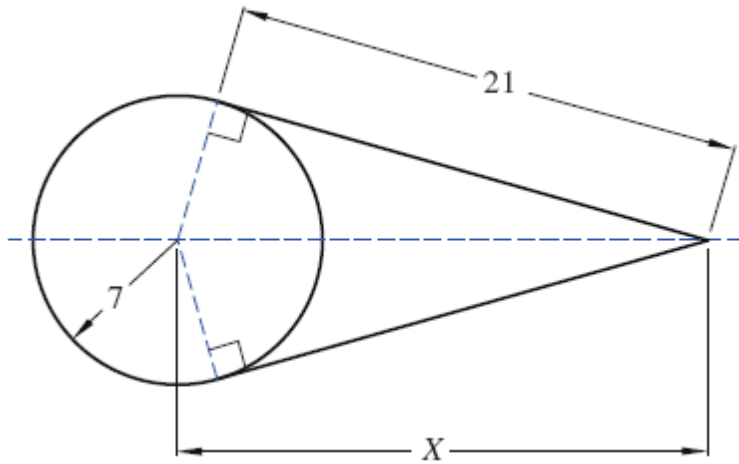
34) The elongation of a guy wire varies directly with small loads. What is the elongation of the guy wire when the load is 2500 N if a load of 400 N causes an elongation of 8 mm?

35) As part of an experiment on perception and memory, colored balls are randomly picked from a jar. At the start of the experiment, the jar contains 5 red balls, 6 green balls, and 8 white balls. When a ball is selected, the color of the ball is noted and the ball is replaced in the jar. Find the probability of selecting two green balls. Round to three decimal places.

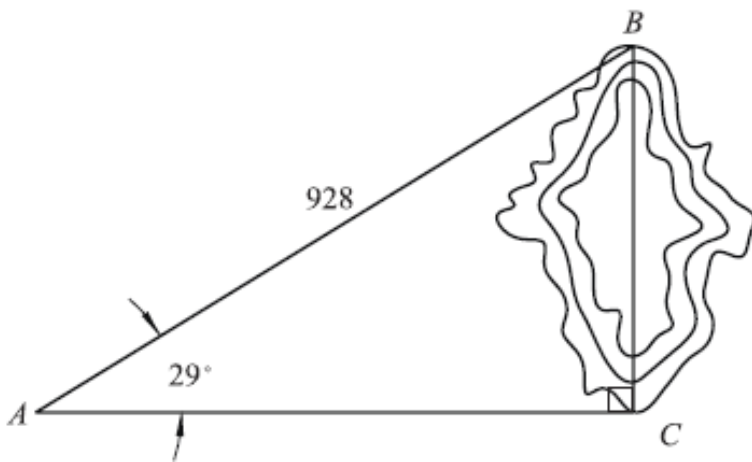
36) Flow Q in gallons per minute (gpm) through a pipe with inside diameter d in inches and flow velocity V in feet per second is given by the formula $Q = 2.44d^2V$. How many gpm of water are discharged from a 1.5-inch inside diameter pipe if the flow velocity is 10 feet per second? Round to the tenths place.

37) The Perseid meteor shower occurs every year in August. Suppose on a typical evening an average of 5 meteors can be spotted every 10 minutes. Find the probability that fewer than 3 will be spotted during a 10 minute interval (round to the ten-thousandths place).

38) In the figure below solve for X . Dimensions are in feet.



39) A builder wishes to measure a pond. Right triangle ACB is constructed as shown in the figure below. If $AB = 928$ feet and $\angle A$ is 29° , find the distance between point B and C .



40) A contractor estimates that 10,032 cement blocks are needed for a job. How many additional blocks must be ordered to provide for 12% scrap and damage?

41) The weather in Plain City is dry most of the time, but it can be quite rainy in the spring. The rainiest month of the year is April. The table below shows the annual rainfall in Plain City, in inches, for each April from 1982 to 1992. Find the 25th percentile for the data.

| YEAR | RAINFALL |
|------|----------|
| 1982 | 0.7 |
| 1983 | 4.37 |
| 1984 | 5.21 |
| 1985 | 1.23 |
| 1986 | 3.21 |
| 1987 | 2.56 |
| 1988 | 1.89 |
| 1989 | 3.36 |
| 1990 | 5.01 |
| 1991 | 0.56 |
| 1992 | 2.31 |

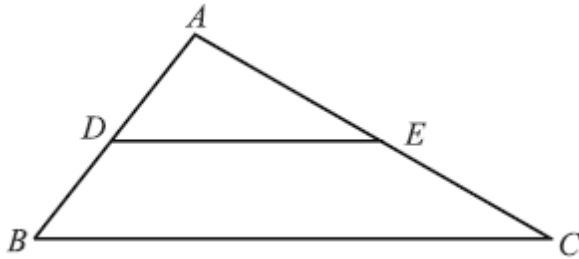
42) Solve for x : $(\sqrt{x+3})^3 - 2 = 6$

43) The formula for the sum of the separate resistances in a parallel circuit containing 3 resistors is: $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$. What size resistor is needed for R3 if R1 = 2 ohms, R2 = 6 ohms, and the total circuit resistance is 1.33 ohms? Round answer to the tenths place.

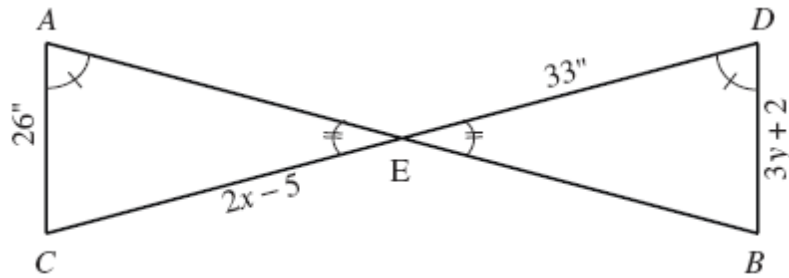
44) Irradiance is a measure of the sun's power available at the surface of the earth and it averages 1000 watts per square meter. If we use a typical crystalline solar cell rated at 15% efficiency, how many solar panels measuring 65 inches by 39 inches are needed to produce 500 kw in full sun?

- 45) The lowest possible sound that can be heard is called the threshold of hearing. The sound level at the threshold of hearing is: $10^{-12} \frac{W}{m^2}$. Determine the intensity of sound in units of dB for an office setting when no one is speaking if the sound the level is measured to be $10^{-7} \frac{W}{m^2}$.

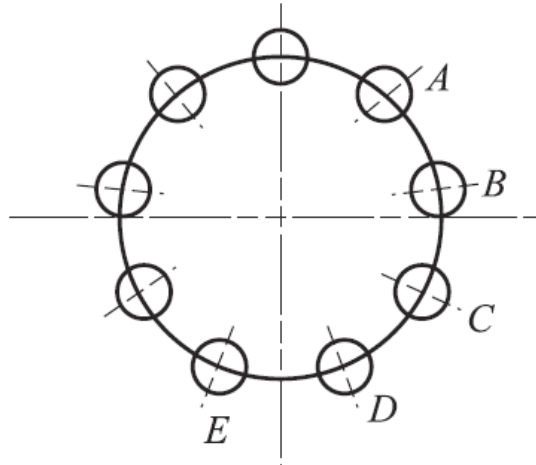
- 46) In triangle ABC shown in Figure 18.8, segments DE and BC are parallel, DA = 4 inches, AB = 8 inches, DE = 10 inches. Solve for length of side BC.



- 47) In the figure below, $\angle CAE \cong \angle DBE$, $AE = EB$, and angle $\angle AEC \cong \angle DEB$. CE is given as $2x - 5$ and BD as $3y + 2$. Using geometric principles and algebra, solve for x and y .



- 48) Nine holes are equally spaced around the 7.125-inch diameter bolt circle shown in the figure below. Find the chordal distance between holes *A* and *B*. Round answer to thousandths place.



49) If the radius of a circle is doubled, by what factor is the area multiplied?

50) Calculate the weighted mean for the grade sheet shown below.

| | HOMEWORK | QUZZES | TESTS | FINAL |
|---------------|-----------------|---------------|--------------|--------------|
| GRADE | 90 | 72 | 80 | 95 |
| WEIGHT | 0.2 | 0.15 | 0.3 | 0.35 |

Date _____

Contestant Number _____

Answer sheet for 2017 SkillsUSA Related Technical Math Test

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

13. _____

14. _____

15. _____

16. _____

17. _____

18. _____

19. _____

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45. _____

46. _____

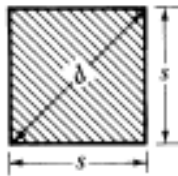
47. _____

48. _____

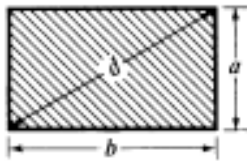
49. _____

50. _____

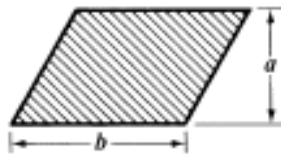
Plane Figures

Square:

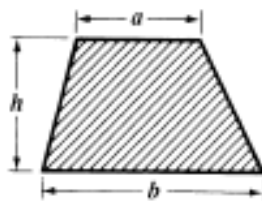
$$\begin{aligned}\text{Area} = A &= s^2 = \frac{1}{2}d^2 \\ s &= 0.7071d = \sqrt{A} \\ d &= 1.414s = 1.414\sqrt{A}\end{aligned}$$

Rectangle:

$$\begin{aligned}\text{Area} = A &= ab = a\sqrt{d^2 - a^2} = b\sqrt{d^2 - b^2} \\ d &= \sqrt{a^2 + b^2} \\ a &= \sqrt{d^2 - b^2} = A + b \\ b &= \sqrt{d^2 - a^2} = A + a\end{aligned}$$

Parallelogram:

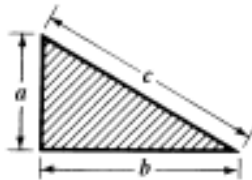
$$\begin{aligned}\text{Area} = A &= ab \\ a &= A + b \\ b &= A + a\end{aligned}$$

Note: The dimension a is measured at right angles to line b .*Trapezoid:*

$$\text{Area} = A = \frac{(a+b)h}{2}$$

Note: In Britain, this figure is called a *trapezium* and the one below it is known as a *trapezoid*, the terms being reversed.*Example:* Side $a = 23$ meters, side $b = 32$ meters, and height $h = 12$ meters. Find the area.

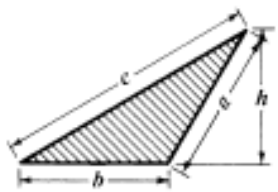
$$A = \frac{(a+b)h}{2} = \frac{(23+32)12}{2} = \frac{55 \times 12}{2} = 330 \text{ square meters}$$

Right-Angled Triangle:

$$\begin{aligned}\text{Area} = A &= \frac{ab}{2} \\ c &= \sqrt{a^2 + b^2} \\ a &= \sqrt{c^2 - b^2} \\ b &= \sqrt{c^2 - a^2}\end{aligned}$$


Acute-Angled Triangle:

$$\begin{aligned}\text{Area} = A &= \frac{bh}{2} = \frac{b}{2} \sqrt{a^2 - \left(\frac{a^2 + b^2 - c^2}{2b}\right)^2} \\ \text{If } S &= \frac{1}{2}(a+b+c), \text{ then} \\ A &= \sqrt{S(S-a)(S-b)(S-c)}\end{aligned}$$

Obtuse-Angled Triangle:


$$\text{Area} = A = \frac{bh}{2} = \frac{b}{2} \sqrt{a^2 - \left(\frac{c^2 - a^2 - b^2}{2b}\right)^2}$$

If $S = \frac{1}{2}(a + b + c)$, then

$$A = \sqrt{S(S-a)(S-b)(S-c)}$$
Circle:


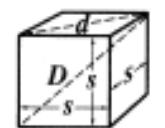
$$\text{Area} = A = \pi r^2 = 3.1416 r^2 = 0.7854 d^2$$

$$\text{Circumference} = C = 2\pi r = 6.2832 r = 3.1416 d$$

$$r = \frac{C}{6.2832} = \frac{\sqrt{A + 3.1416}}{0.564} = 0.564 \sqrt{A}$$

$$d = \frac{C}{3.1416} = \frac{\sqrt{A + 0.7854}}{1.128} = 1.128 \sqrt{A}$$

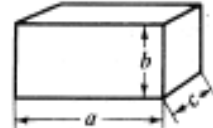
Length of arc for center angle of $1^\circ = 0.008727d$
 Length of arc for center angle of $n^\circ = 0.008727nd$

Solids*Cube:*



$$\text{Diagonal of cube face} = d = s\sqrt{2}$$

$$\text{Diagonal of cube} = D = \sqrt{\frac{3d^2}{2}} = s\sqrt{3} = 1.732s$$

$$\text{Volume} = V = s^3$$

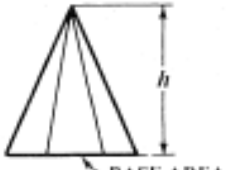
$$s = \sqrt[3]{V}$$
Square Prism:


$$\text{Volume} = V = abc$$

$$a = \frac{V}{bc} \quad b = \frac{V}{ac} \quad c = \frac{V}{ab}$$
Prism:


$V = \text{volume}$
 $A = \text{area of end surface}$
 $V = h \times A$

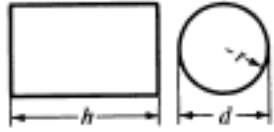
The area A of the end surface is found by the formulas for areas of plane figures on the preceding pages. Height h must be measured perpendicular to the end surface.

Pyramid:


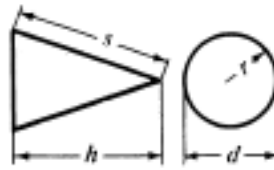
$$\text{Volume} = V = \frac{1}{3}h \times \text{area of base}$$

If the base is a regular polygon with n sides, and $s = \text{length of side}$, $r = \text{radius of inscribed circle}$, and $R = \text{radius of circumscribed circle}$, then:


$$V = \frac{nsrh}{6} = \frac{ns}{6} \sqrt{R^2 - \frac{s^2}{4}}$$

Cylinder:


Volume = $V = 3.1416r^2h = 0.7854d^2h$
 Area of cylindrical surface = $S = 6.2832rh = 3.1416dh$
 Total area A of cylindrical surface and end surfaces:
 $A = 6.2832r(r+h) = 3.1416d(\frac{1}{2}d+h)$

Cone:


Volume = $V = \frac{3.1416r^2h}{3} = 1.0472r^2h = 0.2618d^2h$
 Conical surface area = $A = 3.1416r\sqrt{r^2+h^2} = 3.1416rs$
 $= 1.5708ds$
 $s = \sqrt{r^2+h^2} = \sqrt{\frac{d^2}{4}+h^2}$

Sphere:


Volume = $V = \frac{4\pi r^3}{3} = \frac{\pi d^3}{6} = 4.1888r^3 = 0.5236d^3$
 Surface area = $A = 4\pi r^2 = \pi d^2 = 12.5664r^2 = 3.1416d^2$
 $r = \sqrt[3]{\frac{3V}{4\pi}} = 0.6204\sqrt[3]{V}$

U.S. Liquid Measure*1 U.S. gallon =*

- 0.13368 cubic foot
- 231** cubic inches
- 128** U.S. fluid ounces
- 4** U.S. quarts
- 8** U.S. pints
- 0.8327 British Imperial gallon
- 3.785411784** liters

1 quart =

- 2** U.S. pints
- 8** U.S. gills
- 32** U.S. fluid ounces
- 57.75** cubic inches
- 0.9463529 liters

1 pint =

- 4** U.S. gills
- 16** U.S. fluid ounces
- 28.875** cubic inches
- 473.176** milliliters

1 gill =

- 1/2** cup = **4** U.S. fluid ounces
- 7.21875** cubic inches
- 118.29** milliliters

Other:

1 board foot = 1 ft x 1 ft x 1 in

1 square meter = 1550 square inches

Quadratic formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$$P(X = x) = e^{-\lambda} \frac{\lambda^x}{x!}$$

$$\#dB = 10 \log \left(\frac{I}{I_0} \right)$$

$$s = \sum_{i=1}^n \frac{(x_i - \frac{\sum x}{n})^2}{n-1}$$