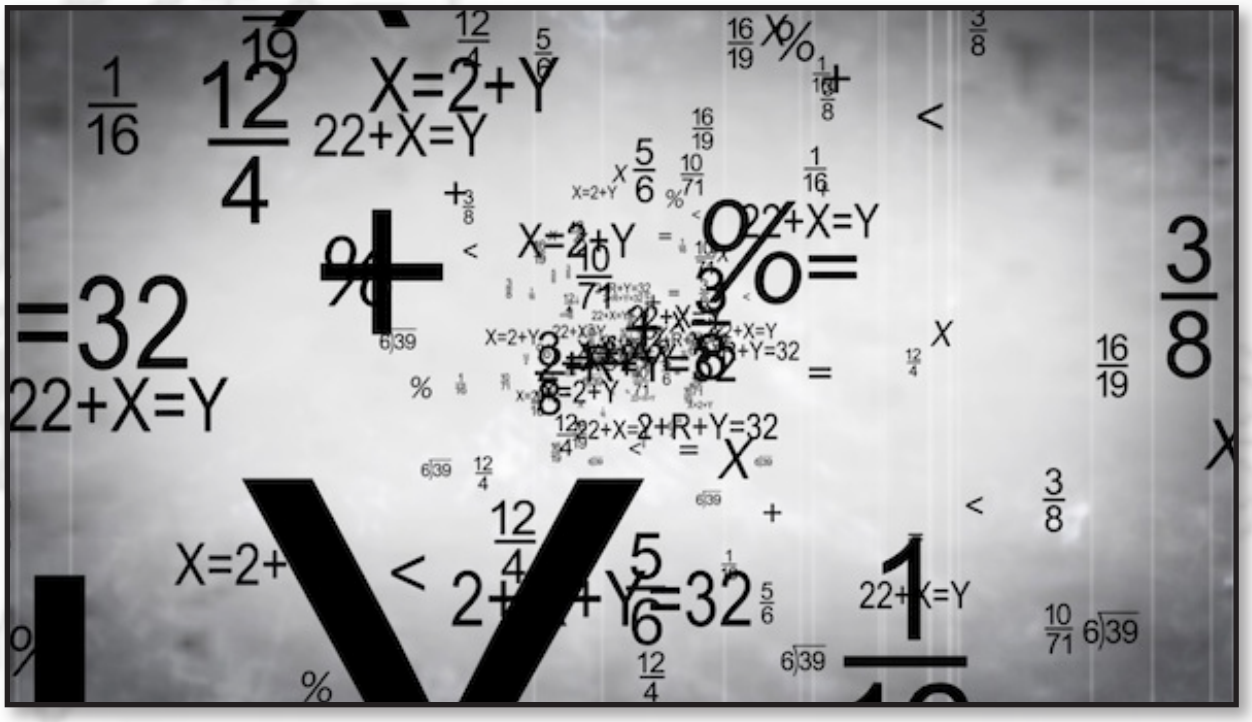
Math Review

Scenarios and Problems
Student Guide



Module 9: Use of Formulas

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Use of Formulas and Equations (Lineworker)

Scenario

The line crew is using a block and a rope to lift a load up to the top of a pole. The block is rigged to the cross arm on the pole, and the cross arm is held on by bolts.

Samyra, a lineman working on the ground, sees Barry, the head linesman, and asks, “Hey, Barry, we have the block and rope ready to make this lift up the pole, but we are not sure if that bolt in the cross arm is going to shear.”

“Okay, well the shearing stress is equal to the load divided by the cross sectional area of the bolt. That gives us this formula,” Barry says as he writes down the information and shows it to Samyra.

Samyra sees that Barry has written X pounds / 0.2485 square inches = 805 pounds per square inch. If X represents the maximum load, what is the maximum weight of the load the crew can pick up?

A. 400 lbs
B. 200 lbs
C. 3,239 lbs
D. 50 lbs

The line crew is lifting a load to the top of a pole
Courtesy National Parks Service, image is in the public domain

Problems

Translating practical problems into useful mathematical expressions where X represents the unknown

The line crew is calculating the load resulting from a customer adding an air conditioning unit to their building. The air conditioner uses 1,750 watts of power and over a period of time the crew determines that the air conditioner used 9,625 watt-hrs. Which calculation would provide the number of hours (X) that the air conditioner was used?

A. 1,750 watts / X hrs = 9,625 watt-hrs
B. 1,750 watts * X hrs = 9,625 watt-hrs
C. 1,750 watts / 9,625 watt-hrs = X hrs
D. 1,750 watts * 9,625 watt-hrs = X hrs

The crew is verifying the power factors for a customer with a maximum load of 4,000 W true power. The crew determines that the kVA apparent power (kilo volt-amp actual) is 4,600 kVA. The power factor equation is the true power divided by the apparent power. Which calculation provides the power factor (PF) of the transformer?

A. 4,600 kVA * 4,000 W = PF
B. 4,600 kVA / 4,000 W = PF
C. 4,000 W / 4,600 kVA = PF
D. 4,000 kW * PF = 4,600 kVA

The line crew has reported to a manufacturing location to investigate a customer's complaint about dimming lights. The crew determined that the apparent power (volt-amperes) being used by the customer is 22,000 volt-amperes. The crew must calculate the amps load by dividing 22,000 volt-amperes by the system voltage, which is 220 volts. Which calculation would the crew use?

A. 22,000 volt-amperes / 220 volts = X
B. 22,000 volt-amperes * 220 volts = X
C. 220 volts / 22,000 volt-amperes = X
D. 22,000 volt-amperes = 0.220 volts * X

Solving Simple Algebraic Equations

The line crew just received an emergency call that a car has hit a pole and people are trapped in the car. The crew is 20.85 miles from the event and they have 30 minutes to get to it. To determine the speed the crew has to drive the formula is: 0.5 hours * X = 20.85 miles, where X is the speed. What is the minimum speed that the crew could travel and still reach the accident site within 30 minutes? (Round to the nearest whole number.)

A. 45 mph
B. 42 mph
C. 60 mph
D. 21 mph

The line crew has determined that the watts loss due to resistance in the line going to a business is 950 watts. The amps in the line equal 12 amps. What is the ohms of resistance in the line using the following calculation: 950 watts = 12^2 amps * X, where "X" is the ohms of resistance?

A. 6.6 ohms
B. 66 ohms
C. 39.6 ohms
D. 0.66 ohms

Determining Slope, Midpoint, and Distance

The line crew is working in a trench installing an underground system. The trench is 6 feet deep. The Occupational Safety and Health Administration (OSHA) requires that for the type of soil the crew is working in, the slope of the trench side walls must be at least 1.5 feet back for every 1 feet of depth. How far back does the crew need to slope the trench so they can work the installation safely?

A. 6 ft
B. 12 ft
C. 9 ft
D. 18 ft

The line crew is setting poles and pulling wire from a substation for a new subdivision. Twelve poles are used. The first pole is set 150 feet from the substation and the rest of the poles are 150 feet apart. How many feet of wire does the crew have to pull to get to the mid-span of the 12 poles?

A. 900 ft
B. 825 ft
C. 300 ft
D. 1,200 ft

Use of Formulas and Equations (Plant Operator)

Scenario

Coal Cars
Courtesy Energy Information Agency, image is in the public domain

“How much coal did we receive today?” Carlos asks Sara, a plant operator.

“Looks like we are right at 9,400 tons for the day from the 75 cars that were offloaded,” Sara responds.

“That seems high. We usually average about 116 tons per train car, right?”

“Correct. They used the newer train cars today, so I think they were able to get more in than usual, but I am not sure.”

What was the average amount of coal in tons per train car for the most recent shipment?

A. 154.67 tons
B. 125.33 tons
C. 81.03 tons
D. 78.57 tons

Problems

Translating practical problems into useful mathematical expressions where X represents the unknown

Used resin from a water purification system is collected and stored in small metal drums. If a total of 56 drums are ready for shipment and 8 drums can be stacked on each pallet, which calculation below would determine how many pallets are needed if X represents the number of pallets?

A. 8 drums per pallet * X pallets = 56 drums
B. 8 drums per pallet + X pallets = 56 drums
C. 56 drums * X pallets = 8 drums per pallet
D. 56 drums * 8 drums per pallet = X pallets

If make-up water is produced at a rate of 50 gallons/minute and a 2,000-gallon tank needs to be filled, which calculation below would determine how many minutes will it take if X represents minutes?

A. 50 gallons/minute * 2,000 gallons = X minutes
B. 50 gallons/minute * X minutes = 2,000 gallons
C. 2,000 gallons – 50 gallons/minute = X minutes
D. 2,000 gallons * X minutes = 50 gallons/minute

In each coal delivery, a train with 80 cars averaging 30 tons of coal per car arrives every day at 4 AM. Which calculation below would determine how much coal is delivered every day if X represents the tons of coal?

A. 4 tons per car * 80 cars = X tons
B. 80 cars + 30 tons per car = X tons
C. 80 cars * 30 tons per car = X tons
D. 30 tons per car * X tons = 80 cars

Solving Simple Algebraic Equations

A train with 50 cars delivers 1,650 tons of coal to a coal power plant. If Sara is trying to determine the average amount of coal delivered per train car, she can use the following formula: 50 * X = 1,650. What is the average amount of coal in tons per train car?

A. 30 tons
B. 33 tons
C. 35 tons
D. 32 tons

Sara, who works at a nuclear plant which operates at a constant output, is trying to determine the power level, in Megawatts (MW), that the plant produces each hour. The total plant output for the day is 12,000 MW-h. She uses the following formula to calculate the power level of the plant: 24 hrs * X = 12,000 MW-h. What is the power level?

A. 50 MW
B. 500 MW
C. 1,500 MW
D. 120 MW

A coal plant uses 15 tons of coal per hour to fuel the furnaces. If a coal silo contained 500 tons of coal, how much coal is left after 15 hours of operation? Mark used the following equation to determine the remaining coal: 15 tons/hour * 15 hour + X = 500 tons.

A. 530 tons
B. 470 tons
C. 225 tons
D. 275 tons

Determining Slope, Midpoint, and Distance

After a maintenance period, large plants are heated to operating temperature in stages. These stages can include a waiting period called a soak, and the soak allows piping and equipment time to heat and expand evenly. If a plant can be linearly heated from 50° F to 1,500° F in the span of eight hours, at what temperature should the soak occur if the procedure calls for the soak at the heating span's midpoint?

A. 750° F
B. 4 hrs
C. 775° F
D. 1,550° F

The auger for the coal deliveries takes coal from the delivery bin 150 feet away to a silo and dumps the coal into the silo from the top at 75 feet elevation. What is the slope of the auger?

A. 2 ft
B. 168 ft
C. 1/2 ft
D. 225 ft

A conveyer that leads to the furnace hopper runs from the feed point 40 feet horizontally and up 30 feet vertically. If a conveyor ran directly from the feed point to the top of the hopper, what would be its length?

A. 70 ft
B. 10 ft
C. 50 ft
D. 35 ft

Use of Formulas and Equations (Pipefitter/Pipelayer/ Welder)

Scenario

"The last of the pipe will be installed today, correct?" Leona, the head of the gas crew, asks her crew.

"Looks that way," Jarred, a crewmember, responds.

"Excellent. Have you figured out how much back fill we are going to need in this trench?"

"Yeah, looks like we'll need 1,920 cubic feet."

"Okay, but I'll need that number in yards instead of feet since our trucks haul fill material by the cubic yard."

The gas crew is installing the last of the piping
Courtesy FERC, image is in the public domain

Using a conversion factor of 1 cubic yard to 27 cubic feet, which calculation below would give Leona the correct amount of fill material in cubic yards, where X is cubic yards?

A. X yds^3 = 1,920 ft^3 / 27
B. X yds^3 = 1,920 ft^3 * 27
C. X yds^3 = 27 / 1,920 ft^3
D. X yds^3 / 1,920 ft^3 = 27

Problems

Translating practical problems into useful mathematical expressions where X represents the unknown

The gas crew is taking materials out of the warehouse for a major pipe replacement job planned for the upcoming week. The crew has 36 meters ready for replacement with 4 meters on each pallet. Which equation determines the number of pallets, where the number of pallets is X?

A. 4 meters per pallet * X pallets = 36 meters
B. 4 meters per pallet / X pallets = 36 meters
C. 36 meters * 4 meters per pallet = X pallets
D. X pallets / 4 meters per pallet = 36 meters

The gas crew is working on a major highway. The job requires that the crew place traffic cones out to warn motorist of the construction activity. The length of the work zone is 50 feet leading up to the trucks, 100 feet around the construction zone, and 20 feet to allow the cars to get back in their lane. The total work zone is 170 feet. The crew has 10 cones. Which calculation would be used to calculate the distance between the cones?

A. 170 ft * X ft between = 10 cones
B. X ft between = 170 ft / 10 cones
C. 10 cones = X ft between / 170 ft
D. 170 ft * 10 cones = X ft between

Solving Simple Algebraic Equations

The gas crew just received an emergency call that a car has hit the side of a house, snapping off a gas meter and causing a gas leak. The crew is 11.5 miles from the event and they have 15 minutes, or 0.25 hours, to get to it. To determine the speed the crew has to drive, the formula is: 0.25 hours * X = 11.5 miles, where X is the speed. What is the minimum speed the crew could travel and still reach the accident site within 15 minutes?

A. 33 mph
B. 46 mph
C. 37 mph
D. 66 mph

The gas crew is using a small crane and a rope sling to lift a 1,500-pound load of pipes off a flatbed truck. The two rope slings are at a 45° angle coming off the single crane hook. The crew needs to know the total pounds of lift the two slings must provide. The calculation is 1,500 pounds = X / 1.414, where X is the weight to be lifted. How many pounds of lift must the two ropes provide?

A. 3,000 lbs
B. 2,121 lbs
C. 1,500 lbs
D. 1,750 lbs

The gas crew is doing a liquid pressure test on a new piping system. The crew has to calculate the amount of water necessary to fill the pipe. The calculation is length of the pipe multiplied by the radius of the pipe squared times π (3.14), which equals the volume of the pipe in cubic feet. This amount is then multiplied by 7.4 gallons of water in a cubic foot. Their pipe is 8 feet long pipe with a 0.25-foot radius, so the formula is 8 feet * $(0.25 \text{ feet})^2$ * 3.14 * 7.4 gallons/cubic feet = X, where X is the amount of water needed to fill the pipe. What is X?

A. 47.7 gallons
B. 1.57 gallons
C. 32.5 gallons
D. 11.6 gallons

Determining Slope, Midpoint, and Distance

The gas crew is working in a trench installing an underground piping system. The trench is 6 feet deep. The Occupational Safety and Health Administration (OSHA) requires that for the type of soil the crew is working in, the sides of the trench must have a slope of 1.5 feet of slope for every 1 foot of trench depth. How far back does the crew need to slope the trench so they can work the installation safely?

A. 6 ft
B. 12 ft
C. 9 ft
D. 18 ft

Darryl, a welder, is reconditioning some weld rod that had gotten damp. The rod has to be heated in an oven until it is completely dried and ready for reuse. The E-60 rod has to be heated at 700° F for 1 hour. The current oven temperature is 250° F. The welder has turned the oven temperature to 700° F. What would be the mid-point in the heating process?

A. 500° F
B. 700° F
C. 350° F
D. 475° F

The gas crew is laying out a new residential piping system. The Class 4 piping system has to be at least 220 feet from the nearest building with four or more stories. There are four-story buildings on both sides of the pipe installation project that are 605 feet apart. What is the distance to the piping system if it is installed at the midpoint between the buildings?

A. 300 ft
B. 220 ft
C. 385 ft
D. 302.5 ft

Use of Formulas and Equations (Technician)

Scenario

"What did the crew determine on the load for that new air conditioner unit, Randall?" George, a journeyman electrician, asks.

"Looks like the energy usage was 9,625 watt-hours," Randall responds.

"Okay, looks like the unit's power is 1,750 watts. How many hours was the air conditioner used?"

Which calculation would provide the number of hours (X) that the air conditioner was used?

A. 1,750 watts / X hrs = 9,625 watt-hrs
B. 1,750 watts * X hrs = 9,625 watt-hrs
C. 1,750 watts / 9,625 watt-hrs = X hrs
D. 1,750 watts * 9,625 watt-hrs = X hrs

George's crew has calculated the load for a new building AC unit
Courtesy Achim Hering via Wikemediacommons, image licensed under Creative Commons

Problems

Translating practical problems into useful mathematical expressions where X represents the unknown

Nicolette, an instrument and control technician, is checking a solenoid controlled valve. The valve is energized from 24 volts DC and the solenoid draws a current of 4 amps. Nicolette must calculate the solenoid resistance in ohms by dividing the system voltage by the system amperage. Which calculation would provide the solenoid resistance (X) in ohms?

A. 24 volts * X ohms = 4 amps
B. 24 volts * 4 amps = X ohms
C. X ohms = 24 volts / 4 amps
D. X ohms = 4 amps / 24 volts

Lionel, an instrument and control technician, needs to add a relay to control a remote load. The relay has a coil resistance of 100 ohms. Lionel measures the DC voltage across the energized relay coil and finds it measures 22 volts. Lionel needs to calculate the solenoid power dissipation in watts by dividing the voltage squared (22 x 22 = 484) by the resistance. Which calculation would provide the solenoid coil power dissipation (X) in watts?

A. 484 volts / 100 ohms = X watts
B. X watts = 100 ohms / 484 volts
C. 484 volts * 100 ohms = X watts
D. 44 volts / 100 ohms = X watts

Solving Simple Algebraic Equations

George, a journeyman electrician, has determined that the power (wattage) loss due to resistance in the line going to a business is 950 watts. The current (amps) in the line equals 12 amps. What is the resistance (ohms) in the line using the following calculation: 950 watts = 12^2 amps * X, where X is the resistance in ohms?

A. 6.6 ohms
B. 66 ohms
C. 39.6 ohms
D. 0.66 ohms

Charlotte, an electrician, has determined the power loss in an energized solenoid controlled valve is 40 watts at a DC voltage across the solenoid of 22 volts. What is the resistance of the solenoid using the following calculation: 40 watts = 22^2 / X, where X is the resistance in ohms?

A. 121 ohms
B. 12.1 ohms
C. 1.21 ohms
D. 1.82 ohms

Determining Slope, Midpoint, and Distance

After a maintenance period, large plants are heated to operating temperature in stages. These stages can include a waiting period called a soak, and the soak allows piping and equipment time to heat and expand evenly. If a plant can be linearly heated from 50° F to 1,500° F in the span of eight hours, at what temperature should the soak occur if the procedure calls for the soak at the heating span's midpoint?

A. 750° F
B. 4 hrs
C. 775° F
D. 1,550° F

The auger for the coal deliveries takes coal from the delivery bin 150 feet away to a silo and dumps the coal into the silo from the top at 75 feet elevation. What is the slope of the auger?

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A. 70 ft
B. 10 ft
C. 50 ft
D. 35 ft