

BCSP CSP® - Quiz Questions with Answers

Domain 1: Advanced Science and Math

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1.

What is the volumetric flow rate of a round duct measuring 10 inches in diameter with a measured flow rate of 462 fpm?

Use the formula: $Q = V \times A$, where V = velocity of the air and A = cross-sectional area of the duct

254 cfm

366 cfm

46 cfm

188 cfm

Correct answer: 254 cfm

The volumetric flow rate, expressed in cubic feet per minute, can be found using the following calculation:

$Q = V \times A$, where V = velocity of the air and A = cross-sectional area of the duct

Find the area of the circle. The diameter is 10 inches, so the radius is 10/2, which is 5 inches or 0.42 feet.

$$A = \pi r^2 = \pi(0.42^2) = 0.1764\pi = 0.55 \text{ sf}$$

$$Q = V \times A = 462 \text{ fpm} \times 0.55 \text{ sf} = 254 \text{ cfm}$$

2.

What is the mode of the following set? {12, 20, 18, 20, 12, 18, 16, 12, 18, 20, 16, 15, 18, 15}

18

12

20

16

Correct answer: 18

The mode in a set of data is the value that occurs most frequently. For example, the mode of the sample set {6, 6, 9, 9, 9, 10, 10, 12, 12, 17, 17, 20} is 9, since it occurs three times.

3.

Determine the amount of force of a 3,200 lb automobile with an acceleration rate of 25 m/s^2 .

Use the formula $F = ma$, where F = amount of force, m = mass (kg), and a = acceleration (m/s^2).

Note: $2.2 \text{ lbs} = 1 \text{ kg}$

36,362.5 N

31,405.5 N

48,003.8 N

24,578.9 N

Correct answer: 36,362.5 N

The amount of force is calculated using the following formula:

$F = ma$, where F = amount of force, m = mass (kg), and a = acceleration (m/s^2)

Convert pounds to kilograms:

$$\text{kg} = 3,200 \text{ lb} \times (\text{kg}/2.2 \text{ lb}) = 1454.5 \text{ kg}$$

$$F = ma = (1454.5 \text{ kg})(25 \text{ m/s}^2)$$

$$F = 36,362.5 \text{ kg} \times \text{m/s}^2 = 36,362.5 \text{ N}$$

4.

What value is calculated using the following equation?

$$\mu = (x_1 + x_2 + \dots + x_n)/n$$

Mean

Mode

Median

Variance

Correct answer: Mean

For a dataset, the mean is the sum of the observations divided by the number of observations. The mean is represented by the Greek letter (μ), which is mu.

The mode of a data sample is the variable that occurs most often in the collection. The median is the middle value in a list of data. The variance can be described as the degree to which the variables in the data set are spread.

5.

A solution contains 10^{-4} ions per liter. What is the pH of this solution?

Use the formula: $pH = -\log|10^{-4}|$

 4 2 8 -4

Correct answer: 4

The pH of a solution is calculated as follows:

$$pH = -\log|10^{-4}|$$

$$pH = -\log|10^{-4}|$$

$$pH = -\log|0.0001|$$

$$pH = -(-4) = 4$$

6.

There are two trains running on the same track, traveling at 30 and 40 miles per hour, respectively. If the slower train starts an hour early while the faster train sits on the track, how long will the faster train take to catch up with the slower train?

3 hours

1 hour

4 hours

2 hours

Correct answer: 3 hours

The time (hours) it takes for the faster train to catch the slower train is x . The slower train left 1 hour earlier than the faster train ($x+1$).

To determine when they meet, determine when $40(x) = 30(x+1)$

Solve for x

$$40x = 30x + 30$$

Subtract $30x$ from both sides.

$$10x = 30$$

Divide both sides by 10.

$$x = 3$$

Substitute to check: $40(3) = 30(3 + 1)$ $120 = 120$.

7.

If $Q' = 4200$ cfm and $G = 1.5$ cfm, what is the steady-state concentration of this gas or vapor?

Use the formula $Q' = G/C$, where Q' = the effective rate of ventilation adjusted for incomplete mixing, G = rate of generation, and C = concentration of gas or vapor in ppm

357 ppm

3400 ppm

2800 ppm

48 ppm

Correct answer: 357 ppm

Steady-state concentration can be calculated using the following formula $Q' = G/C$.

Rearrange the equation to solve for C.

$$Q' = G/C$$

$$C = G/Q'$$

$$C = 1.5 \text{ cfm}/4200 \text{ cfm} = 0.000357$$

To convert this to ppm, multiply by 10^6

$$C = 357 \text{ ppm}$$

The other options are incorrect calculations likely from an error or missed step in your use of the formula.

8.

An object of mass 92 kg rolls down a hill at 9.1 m/s. Calculate the momentum of the object.

Use the formula $p = mv$, where p = momentum, m = mass (kg), and v = velocity (m/s)

837.2 kg x m/s

611.4 kg x m/s

10.1 kg x m/s

922.1 kg x m/s

Correct answer: 837.2 kg x m/s

Calculate momentum by using the following formula:

$$p = mv = (92 \text{ kg})(9.1 \text{ m/s})$$

$$p = 837.2 \text{ kg x m/s}$$

9.

A company has four recordable injury cases and two days away or restricted cases for a total of six cases. The company has a total of 612,884 hours worked for the year. Calculate the total case injury rate (TCIR, also known as total recordable injury rate [TRIR]) for this company.

Use the formula $TCIR/TRIR = (\text{Number of injury or illness cases} \times 200,000) / (\text{Total number of hours worked})$

1.96

2.25

1.57

1.31

Correct answer: 1.96

To determine the company's total case incident rate/total recordable injury rate (TCIR/TRIR), use the following equation:

$TCIR/TRIR = (\text{Number of injury or illness cases} \times 200,000) / (\text{Total number of hours worked})$

$TCIR/TRIR = (6 \times 200,000) / 612,884$

$TCIR/TRIR = 1,200,000 / 612,884 = 1.96$

The company's TCIR/TRIR for the year is 1.96. This rate can be compared to the Bureau of Labor and Statistics' average rating for the company's standard industry code (SIC) category. The constant of 200,000 is based on 100 employees working 2,000 hours/year. This rate states that for every 100 employees, 1.96 of them sustained an injury or illness from a work-related accident.

10.

The molecular weight of hydrogen sulfide is 34. Convert 14.1 ppm of hydrogen sulfide to mg/m^3 .

Use the formula: $\text{mg}/\text{m}^3 = (\text{ppm})(\text{MW})/24.45$, where ppm = parts per million, mg/m^3 = measured mg/m^3 of the contaminant, MW = molecular weight of contaminant, and 24.45 = constant = 1 g-mol

19.6 mg/m^3 23.2 mg/m^3 16.8 mg/m^3 29.5 mg/m^3

Correct answer: 19.6 mg/m^3

To convert from ppm to mg/m^3 , use the following equation:

$$\text{mg}/\text{m}^3 = (\text{ppm})(\text{MW})/24.45$$

$$\text{mg}/\text{m}^3 = (\text{ppm})(\text{MW})/24.45 = [(14.1 \text{ ppm})(34 \text{ g/mol})]/24.45 \text{ g/mol}$$

$$\text{mg}/\text{m}^3 = [(14.1 \text{ ppm})(34 \text{ g/mol})]/24.45 \text{ g/mol} = 479.4 \text{ ppm}/24.45$$

$$\text{mg}/\text{m}^3 = 479.4 \text{ ppm}/24.45 = 19.6 \text{ mg}/\text{m}^3$$

11.

What is the sample variance for the following dataset?

Location # of Incidents

NJ	5
DE	7
NY	12
CT	12

12.67

38

.9

18.67

Correct answer: 12.67

Variance is a measure of the variability of a sample from which the standard deviation is derived. Most scientific calculators will provide a variance as part of a statistical calculation of a data sample.

The equation for sample variance (s^2) is $s^2 = [\Sigma(X-\text{mean})^2]/n-1$.

First, calculate the mean.

$$\text{mean} = (5+7+12+12)/4 = 9$$

Then find $(X-\text{mean})$ and $(X-\text{mean})^2$ for the data points:

Location # of Incidents	$(X-\text{mean})$	$(X-\text{mean})^2$	
NJ	5	-4	16
DE	7	-2	4
NY	12	3	9
CT	12	3	9

Insert into the formula:

$$s^2 = [\Sigma(X-\text{mean})^2]/n-1 = (16 + 4 + 9 + 9)/(4-1)$$

$$s^2 = (38)/3$$

$$s^2 = 12.67$$

The standard deviation, σ , would be equal to the square root of the sample variance or $\sigma = (12.67)^{1/2} = 3.56$

12.

What is the mode of the following set of data?

3, 6, 7, 7, 8, 10, 12, 13, 14

7

8

9

11

Correct answer: 7

The mode is the variable that appears most often in a set of data.

The mean, or average, of the set is 9 (rounded up from 8.9). The range, or difference between the highest and lowest values in the set, is 11. The median is the middle value in a list of data. There are nine values in this set in numerical order, and 8 is the central point (median).

13.

An object of 2 kg is traveling at 76m/s. Calculate the kinetic energy in Joules.

$$5.776 \times 10^3 \text{ J}$$

$$3.801 \times 10^3 \text{ J}$$

$$7.602 \times 10^8 \text{ J}$$

$$1.3432 \times 10^6 \text{ J}$$

Correct answer: $5.776 \times 10^3 \text{ J}$

The equation for Kinetic Energy:

$$KE = 1/2(mv^2)$$

Where:

KE = kinetic energy (N)

m = mass of the object (2kg)

v = speed of the object (velocity) (76m/s)

Solve for KE:

$$KE = (0.5)(2)(76^2)$$

$$KE = 5776 \text{ kg} \times \text{m}^2/\text{s}^2$$

$$KE = 5,776 \text{ J}$$

$$KE = 5.776 \times 10^3 \text{ J}$$

The other answer options are incorrect and are likely from an error or miscalculation in your equation.

14.

Determine the frictional force that results from an object having a coefficient of friction of 0.4 and force of 300N.

120N

210N

60N

80N

Correct answer: 120N

Frictional force resists motion when the surface of one object comes in contact with the surface of another. All objects on Earth have some type of frictional force.

The equation to determine the frictional force is: $F = \mu N$

Where:

F_{fric} = frictional force (which is parallel to the surface)

μ = coefficient of friction

N = force acting on the surface in a direction that is perpendicular to the surface

Solve:

$$F_{fric} = (.4) (300)$$

$$F_{fric} = 120N$$

15.

What is the volume of 2.6 gram-moles (g-mol) of gas at an absolute pressure of 33.2 psi and a temperature of 51°C?

Use the formula $PV = nRT$

30.6 L

14.4L

17.04 L

34.8 L

Correct answer: 30.6 L

Use the formula $PV = nRT$.

Where:

$$n = 2.6 \text{ mol}$$

$$P = 33.2 \text{ psi}$$

$$T = (51 + 273) = 324 \text{ }^\circ\text{K}$$

R_g is the Universal gas constant; it is defined as:

$$R_g = 8.314 \text{ J / mol} \times \text{K}$$

Convert the units for this problem:

$$R_g = 1.206 \text{ L} \times \text{psi / mol} \times \text{K}$$

Plugging everything in:

$$\text{Vol} = n \times R_g \times \text{Temp} / P$$

$$\text{Vol} = (2.6 \text{ mol}) \times (1.206 \text{ L} \times \text{psi / mol} \times \text{K}) (324 \text{ K}) / 33.2 \text{ psi}$$

The units will cancel (psi, mol, K), leaving only liters (L):

$$\text{Vol} = 2.6 \times 1.206 \text{ L} \times 324 / 33.2$$

$$\text{Vol} = 30.6004 \text{ L}$$

$$\text{Vol} = 30.6 \text{ L}$$

The other answer options are incorrect and are likely from an error or miscalculation in your equation.

16.

You work for a large company that has 85 locations around the world. The mean weight of extremely hazardous chemicals used annually at all the sites is 44 pounds. You calculated the standard deviation of this weight between all the sites and found it to be five pounds. What is the margin of error of this data using a confidence interval of 95%?

± 1.1 pounds

± .91 pounds

± 14 pounds

± .88 pounds

Correct answer: ± 1.1 pounds

The confidence interval is the measure of uncertainty there is with a statistic. Confidence intervals are typically stated as a margin of error. The margin of error tells you how confident you would be if you measured the entire population or data set. A confidence interval is the range of values where we are fairly certain our true value lies.

The equation for calculating the confidence interval is: $\bar{x} \pm Z(s/\sqrt{n})$

Where:

\bar{x} = the mean (44 pounds)

z = the chosen Z-value from the table below (a 95% confidence interval has a Z score of 1.960)

s = the standard deviation (5 pounds)

n = is the number of observations (85)

The \bar{x} bar symbol is used in statistics to represent the sample mean of a distribution.

Table of Z-Scores for Commonly Used Confidence Intervals (can be found by searching for "Confidence Intervals" online).

Confidence Interval	Z Score
80%	1.282

85%	1.440
90%	1.645
95%	1.960
99%	2.576
99.5%	2.807
99.9%	3.291

Substitute and solve using the equation: $\bar{x} \pm Z(s/\sqrt{n})$

$$= 44 \pm (1.960)(5/\sqrt{85})$$

$$= 44 \pm (1.960) (5/9.22)$$

$$= 44 \pm (1.960) (.54)$$

$$= 44 \text{ pounds} \pm 1.1 \text{ pounds}$$

This means that there is a 95% level of confidence that the weight of extremely hazardous chemicals used at each site will be between 42.9 and 45.1 pounds each year. The margin of error is ± 1.1 pounds.

17.

What is the mean of the following set of data?

3, 6, 7, 7, 8, 10, 12, 13, 14

9

7

8

11

Correct answer: 9

The mean, or average, of the set of data is 9 (rounded up from 8.9).

The mean is calculated by summing all of the data points (3+6+7+7+8+10+12+13+14=80) and dividing that by the number of data points (in this case, 9). This gives the mean of 8.89, which is rounded up to 9.

The median is the middle value in a list of data. There are nine values in this set of data in numerical order, and 8 is the central point (median) of the data set. Seven is the mode, the variable that occurs most often in a set of data. The range, or difference between the highest and lowest values in the set, is 11.

18.

What is the range of the following set of data?

3, 6, 7, 7, 8, 10, 12, 13, 14

11

8

7

9

Correct answer: 11

$$14 - 3 = 11$$

The range, or difference between the highest and lowest values in the set, is 11.

The median is the middle value in a list of data. There are nine values in this set of data in numerical order, and 8 is the central point, or median, of the dataset; 7 is the mode, which is the variable that occurs most often in a set of data. The mean, or average, of the data is 9 (rounded up from 8.9).

19.

Your supervisor has asked you to calculate how many gallons of wastewater would be generated from pumping the contents of an oily wastewater tank that is 14 feet tall and has a diameter of 72 inches.

2,962 gallons

8,228 gallons

1,773 gallons

1,646 gallons

Correct answer: 2,962 gallons

To calculate the total volume of a vertical cylindrical tank, you need to know the cylinder diameter (or radius) and the cylinder height.

The formula for the volume of a vertical cylinder tank is: $\pi \times \text{radius}^2 \times \text{height}$

or $\pi \times (\text{diameter}/2)^2 \times \text{height}$

Tank height = 14 feet

Tank diameter = 72 inches/12 ft/inch = 6 feet

Volume = $\pi \times (6\text{ft}/2)^2 \times 14\text{ft}$

Volume = $\pi \times (3\text{ft})^2 \times 14\text{ft}$

Volume = $\pi \times 9\text{ft}^2 \times 14\text{ft} = 396\text{ft}^3$

To convert ft^3 to gallons use conversion (gallons = cubic feet \times 7.480519)

$396\text{ft}^3 \times 7.480519\text{gal}/\text{ft}^3 = 2,962$ gallons

The other answer options are incorrect, likely due to an error or miscalculation in your formula.

20.

Your company's Regional Manager asked you to estimate the annual fuel usage of your district's powered industrial trucks (forklifts, personnel lifts, scissor lifts). For the first month of the year, the fuel usage at each of your company locations was 150 gallons, 225 gallons, 350 gallons, 75 gallons, 25 gallons, 175 gallons, 15 gallons, and 9 gallons.

What is the estimated annual fuel consumption in your district?

1,536 gallons/year

1,532 gallons/year

1,636 gallons/year

1,563 gallons/year

Correct answer: 1,536 gallons/year

To estimate the annual fuel consumption for your district, we first need to calculate the mean monthly fuel usage and then extrapolate that to the entire year.

$$\text{Mean } (u) = x_1 + x_2 + \dots x_n / n$$

where x_1, x_2, \dots, x_n are the monthly fuel usage values, and n is the number of locations.

$$\text{Mean } (u) = 150 + 225 + 350 + 75 + 25 + 175 + 15 + 9 = 192$$

$$\text{First, add the fuel usage values: } 150 + 225 + 350 + 75 + 25 + 175 + 15 + 9 = 1,024$$

So, the total fuel usage for the first month is 1,024 gallons. Next, we calculate the mean monthly fuel usage:

$$\text{Mean } (u) = 1,024 / 8 = 128 \text{ gallons}$$

To estimate the annual fuel consumption, we multiply the mean monthly fuel usage by 12:

$$\text{Annual Fuel Consumption} = 128 \text{ gallons per month} \times 12 \text{ months per year}$$

$$\text{Annual Fuel Consumption} = 1,536 \text{ gallons/year}$$

21.

What is used to calculate the significance of observed differences between the means of two samples, as well as determine the difference between two population parameters?

T-test

Spearman's rho

Chi-square statistic

Degrees of freedom

Correct answer: T-test

The t-test is used to calculate the significance of observed differences between the means of two samples, and it can also determine if there is a difference between two population parameters.

The Spearman rank, or rho, examines the correlation between two sets of numbers. The value of rho will be between +1 and -1, where -1 indicates a perfect negative correlation and +1 indicates a perfect positive correlation. If the value is between 0.7 and -0.7, it is considered too weak to be a significant result.

Chi-square statistics are useful in comparing observed distributions to theoretical ones. Degrees of freedom can be described as the number of values that are free to vary.

22.What is the atomic weight of hydrogen phosphate (H_2PO_4)?**96.97 g**

94.97 g

69.97g

65.99 g

Correct answer: 96.97 g

The atomic weight of compounds is determined by adding the atomic weight of individual atoms, remembering to multiply the individual weights by the number of atoms of each present in the compound.

- *Hydrogen: 2 atoms x 1 (atomic weight) = 2*
- *Phosphorous: 1 atom x 30.9738 (atomic weight) = 30.9738*
- *Oxygen: 4 atoms x 15.9994 (atomic weight) = 63.9976*

$$2 + 30.9738 + 63.9976 = 96.9714 \text{ g}$$

Therefore, 1 mol of H_2PO_4 would weigh 96.9714 g.

The other answer options are incorrect and are likely from an error or miscalculation in your equation.

23.

A construction worker is building a wall that requires lifting 8 x 8 x 16 inch cinder blocks, that weigh 38 pounds each, and stacking them on a base that is 18 inches high. The job analysis determined a horizontal multiplier of 1, a vertical multiplier of .85, a distance multiplier of .94, an asymmetric multiplier of .86, and a frequency multiplier of .97.

What would the Lifting Index (LI) be if the cinder blocks were determined to have an object coupling rating of "good"?

1.12

3.4

.112

11.2

Correct answer: 1.12

The Lifting Index (LI) describes the level of physical stress associated with a manual lifting task using the ratio of the load weight over the Recommended Weight Limit (RWL). The Recommended weight Limit (RWL) is defined as the weight that an average healthy worker could lift over a substantial period (e.g., up to eight hours) without an increased risk of lower back pain or injury.

The equation for the Lifting Index is $LI = \text{Object weight}/RWL$

The equation for the Recommended Weight Limit is $RW = LC \times HM \times VM \times DM \times AM \times FM \times CM$

Where:

RWL = Recommended Weight Limit

LC = Load Constant (51)

HM = Horizontal Multiplier (given as 1)

VM = Vertical Multiplier (given as .85)

DM = Distance Multiplier (given as .94)

AM = Asymmetric Multiplier (given as .86)

FM = Frequency Multiplier (given as .97)

CM = Coupling Multiplier (a "good" object coupling has a coupling multiplier of 1)

Solve the recommended weight limit:

$$RWL = 51 \times 1 \times .85 \times .94 \times .86 \times .97 \times 1 = 34$$

Solve the Lifting Index

$$LI = 38/34 = 1.12$$

24.

A dragster is traveling at 25 m/s and then accelerates at a rate of 30 m/s^2 for 6 seconds. How fast is the dragster traveling after these 6 seconds?

Use the formula $v = v_o + at$, where v = velocity, v_o = original velocity at the start of the acceleration, a = acceleration, and t = time (s).

205 m/s

95 m/s

180 m/s

305 m/s

Correct answer: 205 m/s

Solve the equation.

$$v = v_o + at$$

$$v = 25 \text{ m/s} + (30 \text{ m/s}^2)(6 \text{ s})$$

$$v = 25 \text{ m/s} + 180 \text{ m/s} = 205 \text{ m/s}$$

25.

Which of the following reflects the idea that numbers are free to vary in a dataset?

Degrees of freedom

T-test

Spearman's rho

Chi-square statistics

Correct answer: Degrees of freedom

Degrees of freedom can be described as the number of items in a sample that are free to vary. It is equivalent to the number of items in a sample minus one.

The Spearman rank, or rho, is a reflection of the correlation between two sets of numbers. The distance from 1 indicates the correlation between the two variables, creating either a weak or strong correlation. If the number is positive, it may indicate a stronger correlation, whereas a negative number may imply a weaker correlation.

The t-test is used to calculate the significance of observed differences between the means of two samples and can be used to determine a difference between two population parameters.

Chi-square statistics are useful in comparing observed distributions to theoretical ones.

26.

What is Charles' Law?

At constant pressure, the volume occupied by a fixed mass of gas is directly proportional to the absolute temperature

At constant temperature, a fixed mass of gas occupies a volume that is inversely proportional to the pressure exerted upon it

All internal energy is in kinetic form, and any change causes a change in temperature

The ratio of the product of pressure and volume and the absolute temperature of a gas is equal to a constant

Correct answer: At constant pressure, the volume occupied by a fixed mass of gas is directly proportional to the absolute temperature

There are four basic gas laws:

1. **Charles' Law:** At constant pressure, the volume occupied by a fixed mass of gas is directly proportional to the absolute temperature. $V_1/T_1 = V_2/T_2$
 2. **Boyle's Law:** At constant temperature, a fixed mass of gas occupies a volume inversely proportional to the pressure exerted upon it. $P_1V_1 = P_2V_2$
 3. **Ideal Gas Law:** The equation of state for an ideal gas relates pressure, volume, temperature, and a quantity of gas. $PV = nRT$
 4. **Combined Gas Law:** Combining Charles' Law and Boyle's Law, it describes the ratio of pressure and volume and the absolute temperature of a gas. $(P_1V_1)/T_1 = (P_2V_2)/T_2$
-

27.

A semi-truck traveling on the highway loses a tire weighing 110 pounds. The tire rolls off the trailer and continues moving down an incline at a rate of 60 mph. Calculate the momentum of the tire as it travels down the hill.

1340kg m/s

143 kg m/s

314kg m/s

1840kg m/s

Correct answer: 1340kg m/s

Momentum is a measure of the motion of a mass or body that is determined by the product of its mass and velocity.

It is calculated using the formula: $p=mv$

Where:

p = momentum (kg m/s)

m = mass (kg)

v = velocity (m/s)

To solve this problem, convert pounds (lbs) to mass (kg), and mph to meters/second (m/s).

Converting pounds to mass:

$1lb = 2.205kg$

$(1lb/2.205kg) (110lbs) = (.4535lbs/kg)(110lbs) = 50kg$

Convert mph to m/s:

$1mph = 1609 \text{ meters}/3600\text{sec} = .4469\text{m/s}$

$(60\text{mph}) (.4469\text{m/s}/\text{mph}) = 26.8\text{m/s}$

Solve:

$$p = (50\text{kg})(26.8\text{m/s}) = 1340\text{kg m/s}$$

28.

What is heat transfer that does NOT require a physical medium?

Radiation

Conduction

Convection

Adsorption

Correct answer: Radiation

Radiation heat transfer does not require a physical medium. Often referred to as thermal radiation, the heat from the sun is an example of this type of heat transfer.

Conduction is heat transfer by direct contact between two objects (such as a stove-top burner and a pan).

Convection is heat transfer from the movement of a bulk fluid (such as air or water).

Adsorption is not a heat transfer mechanism but rather a surface phenomenon of particulates or gases adhering to filter media.

29.

Which of the following statements is TRUE regarding p-values?

The lower the p-value is, the more statistically significant the result will be

The lower the p-value is, the more likely the result will be

The lower the p-value is, the less significant the result will be

The p-value assumes that the null hypothesis is false

Correct answer: The lower the p-value is, the more statistically significant the result will be

A p-value is a number describing the likelihood of a result occurring by chance (i.e., if the null hypothesis is true). The p-value is expressed as a number between 0 and 1. For example, a p-value below 0.05 represents that there is a <5% chance of an outcome that is random, given the null hypothesis.

The lower the p-value is, the more statistically significant the result will be. The p-value tests the null hypothesis and means nothing regarding the truth of the alternative hypothesis.

30.

Which equation is used to calculate the rate of convective heat transfer?

$$Q = hA(T_s - T_b)$$

$$Q = hA(T_b - T_s).$$

$$Q = hA(T_s/T_b)$$

$$Q = hA(T_s + T_b)$$

Correct answer: $Q = hA(T_s - T_b)$

Convection is the process of thermal energy transfer created by the movement of heated liquid or air. The convective heat transfer rate (Q), is a calculation of the time it takes for the surface temperature (T_s) of a given material to dissipate/transfer its heat through interaction with the fluid/air (T_b). There can be natural convection and forced convection. The rate of convective heat transfer can be calculated using the formula:

$$Q = hA(T_s - T_b)$$

- Q = convective heat transfer rate
 - h = heat transfer coefficient
 - A = surface area of the material where heat is being transferred
 - T_s = surface temperature
 - T_b = temperature of the fluid at bulk temperature
-

31.

For a chemical with a pressure of 390 mm Hg, what would be the concentration at a barometric pressure of 910 mm Hg?

Use the formula $C = (P_v \times 10^6)/P_b$, where C = concentration (ppm), P_v = pressure of chemical (mm Hg), and P_b = barometric pressure (mm Hg)

428,571.4 ppm

986,045.2 ppm

220,076.2 ppm

868,456.0 ppm

Correct answer: 428,571.4 ppm

In order to calculate the vapor or gaseous concentrations, use the following formula:

$$C = (P_v \times 10^6)/P_b$$

Insert the known variables and solve.

$$C = (P_v \times 10^6)/P_b$$

$$C = (390 \text{ mm Hg} \times 10^6)/910 \text{ mm Hg}$$

$$C = 3.9 \times 10^8 \text{ mm Hg}/910 \text{ mm Hg} = 428,571.4 \text{ ppm}$$

32.

Which Standard Gas Law does the following relationship describe?

$$P_1V_1 = P_2V_2$$

Boyle's Law

Ideal Gas Law

Charles Law

General Gas Law

Correct answer: Boyle's Law

Boyles Law describes how the pressure and volume of a gas vary under conditions of constant temperature.

Where: P_1 = the Pressure of a gas @ Time 1

V_1 = the volume of that same gas @ Time 1

P_2 = the pressure of that same gas @ Time 2

V_2 = the volume of that same gas @ Time 2

The Ideal Gas Law $PV = nRT$ describes the relationship for determining the value of any of the measurable characteristics of a gas

Where: P = the pressure of the gas involved

V = the volume of the gas involved

n = the number of moles of the gas involved

Charles Law $V_1/T_1 = V_2/T_2$ describes how the volume and Absolute Temperature of a gas vary under conditions of constant pressure

The General Gas Law $P_1V_1/T_1 = P_2V_2/T_2$

Where: P_1 & P_2 are the pressures of the gas at each of its two states

33.

Force is a quantity measured using an SI unit. What is this unit?

Newton

Joule

Pound

Kilogram

Correct answer: Newton

*Force is a push or a pull changing the state of rest of an object. Force is measured in newtons (N). It is the amount of force required to give 1 kg of mass an acceleration of 1 m/sec² ($F = ma$), so newtons are equivalent to 1 kg*m/s².*

*Joules are used to measure energy (force acting over a distance, or kg*m²/s²), and kilograms are used to measure mass. Pounds can also be a measure of force, but they are the English unit.*

34.

A commercial paint remover contains a liquid mixture with the following characteristics:

Chemical Name	% of chemicals in the mixture	LEL	UEL
Methylene Chloride	73	10.7	17.4
Ethanol	7	3.3	19
Phenol	20	1.8	8.6

What is the calculated Lower Explosive Limit (LEL) and Upper Explosive Limit (UEL) of the mixture?

5% LEL to 14.5% UEL

1.8% LEL to 17.4% UEL

5% LEL to 19% UEL

1.8% LEL to 14.5% UEL

Correct answer: 5% LEL to 14.5% UEL

The Lower Explosive Limit (LEL) is the minimum concentration of a vapor or combustible gas needed to cause combustion in air. Below this concentration, the mixture is too “lean” to ignite. The Upper Explosive Limit (UEL) is the maximum concentration of a vapor or combustible gas that will ignite in the air. Above this concentration, the mixture is too “rich” to burn.

To calculate the LEL and UEL of a mixture, use the following equations:

$$LEL_{\text{Mixture}} = 1 / (f_1 / LEL_1 + f_2 / LEL_2 + f_3 / LEL_3)$$

$$UEL_{\text{Mixture}} = 1 / (f_1 / UEL_1 + f_2 / UEL_2 + f_3 / UEL_3)$$

Where:

f = % of chemicals in the mixture

LEL/UEL = Lower and Upper Explosive limits

$$\text{Solve for LEL of mixture} = 1 / (.73/10.7) + (.07/3.3) + (.2/1.8)$$

$$= 1/ (.068) + (.021) + (.111)$$

$$= 1/ (.2)$$

LEL of mixture = 5%

$$\text{Solve for UEL of mixture} = 1/ (.73/17.4) + (.07/19) + (.2/8.6)$$

$$= 1/ (.042) + (.004) + (.023)$$

$$= 1/ (.069)$$

UEL of mixture = 14.5%

The explosive range of the mixture is 5% LEL to 14.5% UEL.

35.

How is the minimum sample volume (in liters) calculated?

Limit of quantification (LOQ) multiplied by 1,000 divided by the contaminant target concentration

Maximum sample volume

Limit of quantification (LOQ) multiplied by 100 divided by the target concentration

Median sample time

Correct answer: Limit of quantification (LOQ) multiplied by 1,000 divided by the contaminant target concentration

The minimum sample volume is equal to the limit of quantification (LOQ) multiplied by 1,000 (to convert from liters to cubic meters) divided by the contaminant target concentration. LOQ is the concentration level above which quantitative results may be obtained with a certain degree of confidence. Contaminant target concentration is an estimate of the airborne concentration of the contaminant being tested. It is necessary to determine the minimum and maximum volumes of air to collect in order to have a statistically valid sample.

The maximum sample volume is equal to the maximum analyte per sample times 1,000 divided by the contaminant target concentration. Median sample time is a fabricated term.

36.

What is the weight of water?

8.34 lb/gal

62.4 lb/gal

16.68 lb/gal

3.87 lb/gal

Correct answer: 8.34 lb/gal

Water weighs 8.34 lb/gal. There are 7.48 gallons per cubic foot; therefore, 1 cubic foot of water will weigh 62.4 lb ($8.34 \text{ lb/gal} \times 7.48 \text{ gal/ft}^3 = 62.4 \text{ lb/ft}^3$).

In metric units, the weight of water is 9.8 kN per cubic meter.

37.

An employee is working 2 feet away from a dose field that is reading 550 mr/hr. What would be the dose rate for the employee if they moved their work site to a distance of 5 feet?

88 mr/hr

5500 mr/hr

22 mr/hr

440 mr/hr

Correct answer: 88 mr/hr

The radiation dose received is inversely proportional to the square of the distance. The greater the distance from the source, the less the dose to the individual.

To calculate the dose at a distance, use the following equation:

$$I_2 = (I_1) [(D_1)^2 / (D_2)^2]$$

Where:

I_1 = intensity at distance 1 (550 mr/hr)

I_2 = intensity at distance 2 (Solve)

D_1 = distance at location 1 (2 ft)

D_2 = distance at location 2 (5 ft)

Solve for I_2 :

$$I_2 = (550 \text{ mr/hr}) [(2 \text{ ft})^2 / (5 \text{ ft})^2]$$

$$I_2 = (550 \text{ mr/hr}) [(4) / (25)]$$

$$I_2 = (550 \text{ mr/hr}) (.16) = 88 \text{ mr/hr at 5 feet}$$

38.

The radioactive half-life of cadmium is 13.6 years. Which of the following is an accurate explanation of what this means?

It takes 13.6 years for half of the atoms in cadmium to change into a different isotope.

In 13.6 years, cadmium will have crystallized into a harder, more sustainable substance.

It takes 13.6 years to create one atom of cadmium.

Every 13.6 years, half of the atoms in cadmium are regenerated.

Correct answer: It takes 13.6 years for half of the atoms in cadmium to change into a different isotope.

The half-life of a radioactive element is the time for half of the atoms of that substance to decay into another nuclear form. Cadmium has a half-life of 13.6 years. In this length of time, half of the atoms will change. Half-lives can range from fractions of a second to billions of years, depending on the substance.

The half-life refers to radioactive decay, not physical changes such as crystallization or increased stability.

Half-life is about the decay of existing atoms, not the creation of new atoms.

Regeneration implies a process of renewal, which is not applicable in the context of radioactive decay.

39.

Calculate the mean of near misses for a company with the following number of near misses at various locations: 15, 10, 15, 21, 31, 28.

20

15

120

24

Correct answer: 20

The mean is also the average and is the sum of observations divided by the number of observations.

$$\text{mean} = (x_1 + x_2 + \dots + x_n) / n$$

$$\text{mean} = (15 + 10 + 15 + 21 + 31 + 28) / 6$$

$$\text{mean} = 120 / 6$$

$$\text{mean} = 20$$

The other answer options are incorrect and likely from an error or miscalculation in your equation.

40.

There are three resistors valued respectively at 5 Ω , 7 Ω , and 10 Ω in a parallel circuit. What is the total resistance of the circuit?

Use the formula: $1/R_{parallel} = 1/R_1 + 1/R_2 + 1/R_n$

2.27

0.44

1.89

0.05

Correct answer: 2.27

In a parallel circuit, the total resistance is calculated as follows:

$$1/R_{parallel} = 1/R_1 + 1/R_2 + 1/R_n$$

$$1/R_{parallel} = 1/5 + 1/7 + 1/10$$

$$1/R_{parallel} = 0.2 + 0.14 + 0.1 = 0.44$$

$$R_{parallel} = 1/0.44 = 2.27$$

41.

Which type of research study compares data collected from a large number of participants from various demographical backgrounds at a single point in time?

Cross-sectional study

Cohort study

Case-control study

Ames testing

Correct answer: Cross-sectional study

A cross-sectional study observes variable data across a large subset of the population at the same time, such as memory in different age groups.

Cohort studies observe people over a long period of time. The participants share similar characteristics, such as demographics or occupations.

A case-control study compares a group of people who have a condition or disease (case) to a similar group that does not (control). Researchers study aspects of both groups, looking for factors that might correlate to the disease, such as family, medical history, or lifestyle.

Ames testing is a procedure to determine whether or not a chemical is a mutagen.

42.

Which of the following is useful in comparing observed distributions to theoretical ones in a set of variables?

Chi-square statistics

T-test

Spearman's rho

Degrees of freedom

Correct answer: Chi-square statistics

Chi-square statistics are useful in comparing observed distributions to theoretical ones in a set of variables. The chi-square can be used to evaluate the independence of two variables within a dataset.

Degrees of freedom can be described as the number of scores that are free to vary and indicate the independence of score values.

The Spearman rank, or rho, is an assessment of correlation between two sets of numbers. The distance from 1 implies the correlation between the two variables, creating either a weak or strong correlation. If the number is positive, it may indicate a stronger correlation, whereas a negative number may imply a weaker correlation.

The t-test is used to calculate the significance of observed differences between the means of two samples and can be used to determine a difference between two population parameters.

43.

You have forgotten the numbers for a combination lock. Assuming the combination consists of three numbers (0-9), how many possible permutations are there?

Use the formula $n^r = n \times n \times \dots n$, where n^r = permutation when repetition is allowed and n = the number of possibilities to choose from.

1,000

999

729

825

Correct answer: 1,000

To calculate permutations with repetition, simply multiply the data points using the formula below:

$$n^r = n \times n \times \dots n$$

Solve:

$$n^r = n \times n \times n$$

$$n^r = 10 \times 10 \times 10$$

$$n^r = 1,000 \text{ permutations}$$

44.

What is the estimated power density at 200 ft for 15,000 W transmitted through an antenna with a gain of 12?

Use the formula $W = (GP)/(4\pi r^2)$. Remember to convert watts into milliwatts and feet into centimeters.

0.385 mW/cm²

0.0285 mW/cm²

0.000342 mW/cm²

1.345 mW/cm²

Correct answer: 0.385 mW/cm²

Use the following formula to calculate power density:

$$W = (GP)/(4\pi r^2)$$

Where:

W = power density (mW/cm²)

G = gain

P = antenna power (mW)

A = effective antenna area (cm²)

π = wavelength (cm)

r = distance from antenna (cm)

Convert watts to milliwatts:

$$15,000 \text{ W} \times 1,000 \text{ mW/W} = 15,000,000 \text{ mW}$$

Convert feet to centimeters:

$$200 \text{ feet} \times 12 \times 2.54 = 6,096 \text{ cm}$$

Solve:

$$W = (GP)/(4\pi r^2) = (12)(15,000,000)/((4)(3.14)(6096)^2)$$

$$W = 0.385 \text{ mW/cm}^2$$

The other answer options are incorrect and would likely be from an error or miscalculation in your formula.

45.

A force of 125 N is required to compress an automobile suspension spring 0.36 m. Determine the potential energy of the spring.

Use the formula $PE_{\text{elastic}} = (kx^2)/2$, where PE = potential energy (elastic, J), k = spring constant (N/m), and x = amount of compression (distance in meters)

22.49 J

8.1 J

18.4 J

14.2 J

Correct answer: 22.49 J

Elastic potential energy is stored in elastic materials as the result of their stretching or compressing. The equation to determine elastic potential energy is:

To solve this problem, we first need to determine the spring constant (k). We know that $F = 125 \text{ N}$ when $x = 0.36 \text{ m}$. Since $F = kx$, then $k = f/x$.

- $k = (125 \text{ N}) / (0.36 \text{ m})$
- $k = 347.22 \text{ N/m}$

We can now plug k into the PE equation.

- $PE_{\text{elastic}} = (kx^2)/2 = ((347.22 \text{ N/m}) \times (0.36 \text{ m})^2)/2$
- $PE_{\text{elastic}} = ((347.22 \text{ N/m}) \times (0.1296 \text{ m}))/2$

Meters will cancel from the bottom, and you will be left with:

- $22.49 \text{ N} \times \text{m} = 22.49 \text{ J}$
- $PE_{\text{elastic}} = 22.49 \text{ J}$

All other answer options are likely from an error or miscalculation in your equation.

46.

What describes the statistical term "variance"?

The degree to which the variables in a dataset are spread

The middle value in a list of data in numerical order

The correlation between variables

The probability of obtaining a result like the one observed

Correct answer: The degree to which the variables in a dataset are spread

- **Variance:** *the degree to which the variables in a dataset are spread out from the mean*
 - **Median:** *the middle value in a list of data in numerical order*
 - **Correlation coefficient:** *an equation used to calculate a correlation between variables*
 - **P-value:** *the probability of obtaining a result like the one observed*
-

47.

A round ball is balanced on the edge of a cliff. The ball weighs 4.0 kg and is balanced at a height of 8 m above the earth's surface. What is the potential energy (PE) of the object?

Use the formula $PE = mgh$, where $PE =$ potential energy (J), $m =$ mass of the object (kg), $g =$ gravitational acceleration of the earth (9.8 m/s^2), and $h =$ height above earth's surface (m).

313.6 J

68.3 J

412.9 J

244.8 J

Correct answer: 313.6 J

Potential energy exists whenever an object that has mass has a position within a force field.

The equation to determine potential energy is:

$$PE = mgh = (4.0 \text{ kg})(9.8 \text{ m/s}^2)(8 \text{ m})$$

$$PE = 313.6 \text{ kg(m}^2\text{/s}^2) = 313.6 \text{ J}$$

48.

A melted material moves at a speed of 75 feet per minute. How far does the material move in 10 seconds?

Use the formula $v = d/t$, where v = velocity, d = distance, and t = time

12.5 feet

1.25 feet

7.5 feet

0.75 feet

Correct answer: 12.5 feet

The equation to determine velocity is $v = d/t$.

Rearrange the terms to solve for d .

$$v = d/t$$

$$d = vt$$

Convert feet per minute to feet per second.

$$75 \text{ ft/min} \times 1 \text{ min}/60 \text{ sec} = 1.25 \text{ feet/sec}$$

$$d = vt = (1.25 \text{ ft/sec})(10 \text{ sec}) = 12.5 \text{ feet}$$

49.

What is the lifting index for a lifting task where a box weighs 12 kgs with a recommended weight limit of 15 kgs?

0.8

1.25

3

1.5

Correct answer: 0.8

The lifting index, part of the NIOSH Lifting Equation, provides a relative estimate of the level of physical stress associated with a particular lifting task.

Lifting index (LI) = Load weight/Recommended weight limit

Here, $12/15 = 0.8$ LI

NIOSH recommends that single or multiple lifting tasks should have a (composite) lifting index lower than 1.0.

50.

What is the MOST common illness that may result from exposure to waterborne pathogens in the United States?

Otitis externa (swimmer's ear)

Pseudomonas septicemia (sepsis)

Pneumonia

Legionnaires' Disease

Correct answer: Otitis externa (swimmer's ear)

Otitis externa (swimmer's ear) is where the outer ear canal becomes infected due to water remaining in the ears. The remaining water creates an environment that encourages the growth of bacteria that can infect the ear from the eardrum out to the ear canal.

*While most of the hospitalizations and deaths are caused by nontuberculous mycobacterial infections, such as *Pseudomonas* septicemia (sepsis), pneumonia, and Legionnaires' Disease, they are not as common as swimmer's ear. These germs can grow in drinking water distribution systems, grow inside the pipes of homes and buildings, or be introduced by contaminated water entering the water table during flooding events, sewage overflows, or from agricultural run-off.*

51.

112 millimeters equals how many inches?

*Note: 1 inch = 25.4 millimeters***4.4 in**

2.5 in

4.1 in

1.6 in

*Correct answer: 4.4 in**Given: 1inch/25.4mm* *$(112\text{mm})(1\text{inch}/25.4\text{mm}) = \text{inches}$* *$(112/25.4) = \text{inches (mm cancel)}$* *$112/25.4 = 4.4 \text{ inches}$* *The other answer options are incorrect and are likely from an error or miscalculation in your equation.*

52.

If an object places stress of 45 lbs/in² on a 10 in² surface, what is the resulting force?

450 lbs

45 lbs

4.5 lbs

201 lbs

Correct answer: 450 lbs

Pressure and force are related. You can calculate one if you know the other by using the formula:

pressure = force (F) / area (A)

- *psi = pressure (or stress) in pounds per square inch*
- *A = the area to which the force is applied (in²)*
- *F = force*

Solve for F

If $psi = F/A$, then $F = psi \times A$

Therefore:

$$F = 45 \text{ lbs/in}^2 \times 10 \text{ in}^2$$

$$F = 450 \text{ lbs}$$

53.

You took a sound measurement at three feet from a shredding machine and got a reading of 95dBA. Calculate the sound level in the general area of the shop 14 feet away from the operation.

To calculate the sound level at a distance from a measured sound reading, use the following equation:

$$dB_1 = dB_0 + 20\log_{10}(d_0/d_1)$$

82dBA

80dBA

87dBA

90dBA

Correct answer: 82dBA

To calculate the sound level at a distance from a measured sound reading, use the following equation:

$$dB_1 = dB_0 + 20\log_{10}(d_0/d_1)$$

Where:

dB_0 = original sound-level measurement (95dBA)

dB_1 = calculated sound-level measurement at another distance (solve)

d_0 = original distance where the noise measurement was taken (3 feet)

d_1 = second distance you would like to calculate the sound level reading for (14 feet)

Solve:

$$dB_1 = 95dBA + 20\log_{10}(3/14)$$

$$dB_1 = 95dBA + 20\log_{10}(.214)$$

$$dB_1 = 95dBA + 20(-.669)$$

$$dB_1 = 95\text{dBA} + (-13.4)$$

$$dB_1 = 81.6 \text{ (round up)}$$

$$dB_1 = 82\text{dB at 14 feet}$$

The other answer options are incorrect and would likely include an error or mistake in your formula.

54.

-40 °C is equal to how many degrees Kelvin?

233 K

0 K

313 K

273 K

Correct answer: 233 K

To convert degrees Celsius to degrees Kelvin, add 273.

$$-40\text{ }^{\circ}\text{C} + 273 = 233\text{ K}$$

55.

Which type of biological hazard is a LEADING cause of concern for the health and safety of the workforce?

Bloodborne pathogens

Waterborne pathogens

Bacterial infection

Fungal diseases

Correct answer: Bloodborne pathogens

The Occupational Safety and Health Administration (OSHA) implemented the Bloodborne Pathogens Standard (29 CFR 1910.1030) to reduce the potential for occupational illnesses related to biological hazards. Bloodborne pathogens include exposure to viral infections as a result of human-to-human contact with bodily fluids, accidental contact through the skin by puncture, and exposure to infected animals. HIV, Hepatitis B, and Hepatitis C are some of the more common viral diseases to which healthcare workers could be exposed.

Waterborne pathogens can occur in underdeveloped countries with poorly maintained sanitation and water supplies. They can also be found in wastewater treatment plants, breaks in aging infrastructure, and sewer spills and overflows. Some pathogens of concern include; E. coli, enterococci, and fecal coliform.

Bacterial infections can occur from working with animals and livestock in the agricultural business, exposure to contaminated individuals in the health care field, and working in sanitation. Some of the more common bacterial exposures at work include staphylococcus aureus (staph infection), salmonella, and escherichia coli (E. coli).

Fungal diseases can occur in workers who work outside in the soil, such as agricultural workers, or any occupation that digs in the dirt and inhales dust. Aspergillus, candidiasis, and coccidioidomycosis are some of the more common fungal diseases that workers can be exposed to.

56.

Your employer designed a new storage facility and wants you to determine the emitted concentration of a contaminant that will be stored inside. The ventilation provides eight air changes every hour with a volumetric flow rate of 3000 cubic feet per minute (cfm). The contaminant emits at a rate of 1.5 cfm. Calculate the concentration in parts per million (ppm) of the contaminant in the storage area when the ventilation is operating.

Use the following equation $C = G/Q (1 - e^{-Nt/60})$

60ppm

75ppm

42ppm

120ppm

Correct answer: 60ppm

Use the following equation to calculate the concentration of a contaminant using air changes per hour:

$$C = G/Q (1 - e^{-Nt/60})$$

Where:

C = concentration at a given time (ppm) (Solve)

G = rate of generation of contaminant (cfm) (1.5)

Q = flow rate (cfm) (3000)

t = time (in h) (1)

N = number of room air changes (8)

Solve:

$$C = 1.5/3000 (1 - e^{-8(1)/60})$$

$$C = .0005 (1 - e^{-.13}) \text{ (enter +/- .13 } e^x \text{ on calculator)}$$

$$C = .0005 (1 - .88)$$

$$C = .0005 (.12)$$

$$C = .00006 \times 10^6 \text{ (multiply } X 10^6 \text{ to convert to ppm)}$$

$$C = 60\text{ppm}$$

The other answer options are incorrect and are likely from an error or miscalculation in your equation.

57.

An over-the-road truck driver working for your company is traveling at 54 m/s when he notices that the traffic light is red. The truck driver reduces his speed at a rate of -10 m/s^2 . He continues this deceleration for 96 m before the light changes to green and he begins to accelerate. At the point of acceleration, what is the velocity?

Use the formula $v^2 = v_o^2 + 2as$, where $v^2 = \text{final velocity}$, $v_o = \text{initial velocity}$, $a = \text{acceleration of the object (m/s)}$, and $s = \text{displacement of the object (change in position is normally described in distance from original position)}$

31.6 m/s

14.7 m/s

26.4 m/s

18.8 m/s

Correct answer: 31.6 m/s

The formula for calculating terminal velocity is:

$$v^2 = v_o^2 + 2as$$

Calculate the truck driver's velocity by inserting the known variables, as follows:

$$v^2 = (54 \text{ m/s})^2 + 2(-10 \text{ m/s}^2)(96 \text{ m})$$

Solve:

$$v^2 = 2916 \text{ m/s}^2 + 2(-960 \text{ m})$$

$$v^2 = 2916 \text{ m/s}^2 + -1920 \text{ m} = 996 \text{ m/s}^2$$

$$\sqrt{v^2} = \sqrt{996 \text{ m/s}}$$

$$v = 31.6 \text{ m/s}$$

58.

There are many applications for nanotechnology, such as using carbon nanotube materials in cleaning up oil spills, medical imaging agents, and in the fabrication of microchip semiconductors for electronic products. How big is a nanometer?

A billionth of a meter: $1 \text{ nm} = 10^{-9} \text{ m}$

A trillionth of a meter: $1 \text{ nm} = 10^{-12} \text{ m}$

A millionth of a meter: $1 \text{ nm} = 10^{-6} \text{ m}$

A thousandth of a meter: $1 \text{ nm} = 10^{-3} \text{ m}$

Correct answer: A billionth of a meter: $1 \text{ nm} = 10^{-9} \text{ m}$.

Nanotechnology relates to the control, manipulation, and understanding of matter between 1 to 100 nanometers in size.

59.

A force is acting at 45° with the horizontal on an object displaced 4m along the horizontal direction. The normal force on the surface is 350N, and the coefficient of friction is 0.4. Calculate the work done by the force.

Use the formula $W = Fs \times \cos\theta$, where W = amount of work done on or to an object (in joules or newtons) ($1 \text{ J} = 1 \text{ N} \times 1 \text{ m}$), F = magnitude of force (N), s = displacement (m), and θ = angle between the directions of force and displacement

395.9 N

21.5 N

176.6 N

99.0 N

Correct answer: 395.9 N

In order to determine the amount of work done on an object by a force applied at an angle, use the following formula:

$$W = Fs \times \cos\theta$$

Where:

W = amount of work done on or to an object (in joules or newtons) ($1 \text{ J} = 1 \text{ N} \times 1 \text{ m}$)

F = magnitude of force (N)

s = displacement (m)

θ = angle between the directions of force and displacement

Determine the amount of force based on the friction coefficient of 0.4:

$$F_{\text{friction}} = 350 \text{ N}(0.4) = 140 \text{ N}$$

Insert into the modified work equation:

$$W = Fs \times \cos\theta = (140 \text{ N})(4 \text{ m})(\cos 45^\circ)$$

Solve:

$$W = (560 \text{ N} \times \text{m})(0.707)$$

$$W = 395.9 \text{ N}$$

60.

What frictional force results from an object having a coefficient of friction of 0.28 and 400 N?

Use the formula $F = \mu N$, where F = frictional force (parallel to the surface), μ = coefficient of friction, and N = force acting on the surface in a direction that is normal (perpendicular) to the surface (N)

112 N

64 N

182 N

104 N

Correct answer: 112 N

Solve the equation.

$$F = \mu N = (0.28)(400 \text{ N})$$

$$F = 112 \text{ N}$$

61.

Which gas law states that when the pressure exerted by a gas is reduced, the volume increases?

Boyle's law

Charles's law

Ideal gas law

Dalton's law

Correct answer: Boyle's law

Boyle's law uses the following calculation:

$P_1V_1 = P_2V_2$, where P = pressure exerted and V = volume of the gas.

Therefore, this calculation states that a fixed mass of gas occupies a volume inversely proportional to the pressure exerted upon it. In other words, when the pressure is reduced, the volume increases.

Charles's law states that at constant pressure, the volume occupied by a fixed mass of gas is directly proportional to the absolute temperature. It is written as $(V_1)/(T_1) = (V_2)/(T_2)$.

The ideal gas law states that all internal energy is in kinetic energy form and any change causes a change in temperature. It is written as $PV = nRT$. It can be derived by combining Boyle's law and Charles's law and utilizing Avogadro's number.

Dalton's law states that chemicals will present themselves in proportions that are small whole numbers.

62.

Which of the following statements is TRUE?

The lower the p-value is, the less likely the result occurred by chance

The lower the p-value is, the more likely the result occurred by chance

The lower the p-value is, the less significant the result

The p-value assumes that the null hypothesis is false

Correct answer: The lower the p-value is, the less likely the result occurred by chance

The p-value is a probability associated with the test statistic. It measures the chance of getting a result at least as strongly if the null hypothesis is true. To test the population mean, the farther out a test statistic is, the smaller the p-value will be, making it less likely for the results to have occurred and giving more evidence to reject the null hypothesis.

The lower the p-value is, the more likely the result is statistically significant.

The other answer options are inaccurate descriptions of a p-value.

63.

What is 50 m/s (meters per second) in mph (miles per hour)?

111.85 mph

122.75 mph

236.32 mph

310.97 mph

Correct answer: 111.85 mph

First, convert meters per second to feet per second.

$$50 \text{ m/s} \times 3.281 \text{ ft/m} = 164.05 \text{ ft/s}$$

Then, convert feet per second to feet per mile.

$$164.05 \text{ ft/s} \times 3,600 \text{ s/h} \times 1 \text{ mi}/5,280 \text{ ft} = 111.85 \text{ mi/h, or mph}$$

(We know there are 3600 s/h by calculating $60 \text{ s/min} \times 60 \text{ min/hr} = 3600 \text{ s/hr.}$)

Another conversion is $1 \text{ m/s} = 2.237 \text{ m/h}$

$$50 \text{ m/s} \times 2.237 \text{ mi/h (per 1 m/s)} = 50 \times 2.237 \text{ mi/h} = 111.85 \text{ mi/h}$$

64.

Which major part of the ear is used for hearing?

Cochlea

Pinna

Stapes

Eustachian tube

Correct answer: Cochlea

The cochlea, or the inner ear, is the main element for hearing. The cochlea is a fluid-filled coil that has two chambers. Sound energy travels through the oval window (base of the cochlea) to the distant end of the coil (apex). The waves travel through one chamber and reflect through the second chamber to the round window.

The pinna is the ear lobe. It gathers sound waves and directs them toward the external auditory canal and onto the eardrum.

The stapes is a bone of the middle ear.

The eustachian tube equalizes pressure between the middle and outer ear.

65.

What is a reflection of the correlation between two sets of numbers?

Spearman's rank coefficient of correlation

T-test

Chi-square statistic

Degrees of freedom

Correct answer: Spearman's rank coefficient of correlation

Spearman's rank coefficient of correlation (also referred to as Spearman's rho, referring to the pronunciation of the 17th letter of the Greek alphabet [P]), is a reflection of the correlation between two sets of numbers. The distance from 1 implies the relative strength or weakness of the correlation between the two variables. If the number is positive, it may indicate a stronger correlation, whereas a negative number may imply a weaker correlation.

A t-test is used to calculate the significance of observed differences between the means of two samples. It can be used to determine a difference between two population parameters.

The chi-square statistic is useful in comparing observed distributions to theoretical ones. Degrees of freedom can be described as the number of scores that are free to vary.

66.

What statement BEST describes the purpose of using Pareto Analysis?

To focus efforts on the problems that offer the greatest potential for improvement

To analyze the majority of the issues that are identified

To show which items you are wasting time working on

To provide good visual data to superiors

Correct answer: To focus efforts on the problems that offer the greatest potential for improvement

Pareto analysis is a technique that is used to evaluate and prioritize the most significant items among a large list of data. This process can assist the safety professional when performing risk assessment, hazard analysis, and problem-solving. The technique employs the 80-20 rule, which states that about 80% of the problems or effects are produced by about 20% of the causes.

Analyzing the majority of issues that are identified is incorrect because Pareto Analysis specifically focuses on identifying the few critical issues (the vital few) that have the greatest impact, rather than analyzing the majority of issues.

Showing which items you are wasting time working on is misleading as Pareto Analysis is used to identify the most significant issues to focus on, not specifically to highlight wasted efforts.

While Pareto Analysis can produce visual charts that are useful, its primary purpose is to identify key problems for improvement, not just to provide visual data.

67.

Given that $C_e = 0.704$ and $SP = 0.25$ in wg, what is the airflow velocity of the system?

Use the formula $V = 4005 C_e \sqrt{SP_h}$, where $V =$ velocity of air (fpm), $C_e =$ coefficient of entry loss and $SP_h =$ static pressure of the hood (in wg)

1410 fpm

2140 fpm

864 fpm

1250 fpm

Correct answer: 1410 fpm

Calculate the airflow velocity and account for the coefficient of entry loss by using the following formula:

$$V = 4005 C_e \sqrt{SP_h} = (4005)(0.704) \sqrt{(0.25)}$$

$$V = (2820)(0.5) = 1410 \text{ fpm}$$

68.

Your company made an investment of \$75,000 in safety training software that is estimated to prevent \$45,000 in injury fees per year. If the payment plan has an annual interest rate of 8%, what will be the predicted value of the product after 2 years?

\$80,245

\$65,721

\$35,721

\$60,245

Correct answer: \$80,245

The time value of money can be predicted using the following equation:

$$P = F (1+i)^{-n}$$

Where:

P = present worth of money (principal) (solve)

F = future worth (or savings) (\$45,000)

i = annual interest rate (APR) (.08)

-n = number of years (2)

Year 2:

$$P = \$45,000 (1 + .08)^{-2}$$

$$P = \$45,000 (1.08)^{-2}$$

$$P = \$45,000 (.8573)$$

$$P = \$38,579$$

After the end of year two, the value of the investment is equal to:

$$(\$41,666 + \$38,579) = \$80,245$$

69.

An object weighs 12.8 N. What is the object's mass?

Use the formula $W = mg$, where W = amount of work done on or to an object due to gravity, m = mass (kg), and g = gravity (9.8 m/s^2) (constant)

1.3 kg

2.6 kg

0.8 kg

2.2 kg

Correct answer: 1.3 kg

The weight of an object can be determined using the following formula:

$W = mg$, where W = amount of force on an object due to gravity, m = mass (kg), and g = gravity (9.8 m/s^2) (constant on earth)

Rearrange the equation to solve for m .

$$W = mg$$

$$m = W/g$$

$$m = W/g = 12.8 \text{ N}/9.8 \text{ m/s}^2, \text{ and } 1 \text{ N} = 1 \text{ kg} \times \text{m/s}^2$$

Simplifying, $m = 1.3 \text{ kg}$

70.

Given a chemical with a vapor pressure of 390 mm Hg and a barometric pressure of 910 mm Hg, what is the concentration percentage?

Use the formula $C_{\text{percentage}} = (P_v \times 100)/P_b$, where $C_{\text{percentage}}$ = concentration percentage, P_v = pressure of chemical (mm Hg), and P_b = barometric pressure (mm Hg)

42.86%

39.98%

31.77%

45.05%

Correct answer: 42.86%

The formula for calculating the concentration of vapors as a percentage is:

$$C_{\text{percentage}} = (P_v \times 100)/P_b$$

Insert the known variables and solve.

$$C_{\text{percentage}} = (P_v \times 100)/P_b$$

$$C_{\text{percentage}} = (390 \text{ mm Hg} \times 100)/910 \text{ mm Hg}$$

$$C_{\text{percentage}} = 39,000 \text{ mm Hg}/910 \text{ mm Hg}$$

$$C_{\text{percentage}} = 42.86\%$$

71.

Kinetic energy is typically measured in which unit?

Joules

Newtons

 ft/s^2

Ohms

Correct answer: Joules

*Kinetic energy, the energy of motion, is typically measured in joules. The joule—the SI unit of energy, heat, or amount of work—is defined as the amount of work when 1 newton (N) is displaced by 1 meter in the direction of the force, or 1 N*m.*

Since $1 \text{ N} = 1 \text{ kg}\cdot\text{m}/\text{s}^2$, a joule can also be expressed as $1 \text{ joule} = 1 \text{ N}\cdot\text{m} = 1 \text{ kg}\cdot\text{m}^2/\text{s}^2$.

Newtons are the SI unit used to measure force, ft/s^2 is a measure of acceleration, and Ohms are a measure of electrical resistance.

72.

What is the minimum number of air samples to collect if the employee group size is 12?

10

12

15

24

Correct answer: 10

The number of samples collected will depend on the number of workers performing the task. Enough samples should be taken to determine with a 90% confidence level that at least one of the samples taken will capture the highest 10% of exposure received.

For employee group sizes up to 7, take one sample for each employee. As the number of workers performing the task increases, the number of samples increases based on a probability expression table created by NIOSH in accordance with the NIOSH Occupational Exposure Sampling Strategy Manual-Technical Appendix A.

73.

You own a safety consultant company that borrowed \$50,000 from a lender for a new Safety Management System (SMS) software suite. The loan carries an interest rate of 2.5% compounded every four months (three times a year) for five years. What will the entire cost of the loan be to your company?

Use the following formula $F = P (1 + i/n)^{nt}$

\$56,600

\$51,200

\$58,560

\$51,580

Correct answer: \$56,650

The equation used to calculate compound interest is:

$$F = P (1 + i/n)^{nt}$$

Where:

F = future value of the loan

P = initial loan amount (\$50,000)

i = interest rate (in decimal) (0.025)

n = number of times per year interest is compounded (3)

t = number of years invested (5)

Solve:

$$F = \$50,000 (1 + .025/3)^{(3)/(5)}$$

$$F = \$50,000 (1 + .0083)^{15} = (1.0083)^{15}$$

$$F = \$50,000 (1.132)$$

$$F = \$56,600$$

Therefore, the five-year loan cost would be \$56,600.

The other answer options are incorrect and would likely be from an error or miscalculation in your formula.

74.

What is the weight, in newtons (N), of an object on earth with a mass of 4.5 kg?

Use the formula $W = mg$

44.1 N

22.3 N

56.9 N

32.2 N

Correct answer: 44.1 N

The weight of an object can be determined using the following formula:

$W = mg$

- W = amount of work done on or to the weight of an object due to gravity
- m = mass (kg)
- g = gravity (9.8 m/s^2) (constant)

$$W = mg = (4.5 \text{ kg})(9.8 \text{ m/s}^2)$$

$$W = 44.1 \text{ kg} \times \text{m/s}^2 = 44.1 \text{ Newtons (N)}$$

75.

A box is sitting on the floor. A force of 310 N is applied horizontally to the side of the box, and the box is moved horizontally by 11.5 m. What is the amount of work done?

Use the formula $W = Fs$, where W = work done on or to a system (usually in joules or newton-meters, $1 \text{ J} = 1 \text{ N} \times 1 \text{ m}$), F = magnitude of the force (N), and s = displacement (m).

3,565 J

2,110 J

4,096 J

2,695 J

Correct answer: 3,565 J

When a force (F) acting on an object causes displacement (s) in a direction different from the one along where the force acts, the work done is calculated as $W = Fs$.

Solve the equation:

$$W = Fs = (310 \text{ N})(11.5 \text{ m})$$

$$W = 3,565 \text{ N} \times \text{m} = 3,565 \text{ J}$$

76.

What is used to calculate the significance of observed differences between the means of two samples?

A t-test

A chi-square statistic

Degrees of freedom

Spearman rank

Correct answer: A t-test

The t-test is used to calculate the significance of observed differences between the means of two samples. It is also used to tell if there is a difference between two population parameters; a larger t-score indicates that the groups are different, while a smaller t-score indicates that they are similar.

The chi-square statistic is useful in comparing actual versus theoretical (or modeled) data. Degrees of freedom can be described as the number of values that are free to vary when estimating statistical values. The Spearman rank, or rho, is an indication of the correlation between two sets of numbers.

77.

In a normal distribution, what percentage of the dataset falls within one standard deviation of the mean?

68% of the dataset

95.45% of the dataset

99.73% of the dataset

100% of the dataset

Correct answer: 68% of the dataset

Data can typically be plotted on a bell curve, which is a normal distribution with a single peak. In a bell curve, half of the data points are on the left side, and half of the data points are on the right side of the curve. Standard deviation values are marked on either side of the mean, which is in the center of the curve. One standard deviation is equal to 68% of the dataset.

Two standard deviations are equal to 95.45% of the dataset. Three standard deviations are equal to 99.73% of the dataset. There is no number of standard deviations equal to 100% of the dataset, as no set of data is perfect.

78.

Which category of hazardous waste generator would your company be classified as if it creates 300 lbs of hazardous waste per month?

Small Quantity Generator (SQG)

Large Quantity Generator (LQG)

Conditionally Exempt Small Quantity Generator (CESQG)

Acute Quantity Generator (AQG)

Correct answer: Small Quantity Generator (SQG)

The EPA classifies hazardous waste generators based on the amount of hazardous waste they accumulate per month.

Small Quantity Generator (SQG) generates >100kg (220 lb) to ≤ 1000kg (2,200 lb) per month with a maximum storage amount of ≤6000kg (13,200 lb)

Large Quantity generator (LQG) generates >1000kg (2,200 lb) per month with no maximum storage amount

Conditionally Exempt Small Quantity Generator (CESQG) generates ≤100kg (220 lb) per month with a maximum storage amount of ≤1000kg (2,220 lb)

Acute Quantity Generator is not an EPA Category of hazardous waste generator

All hazardous waste generators are required to send their hazardous waste to a permitted company, landfill, or Treatment, Storage, and Disposal Facility (TSDF).

79.

A tank contains 80% air and 20% nitrogen. What is the oxygen content of the tank?

16.8%

21%

23%

15.6%

Correct answer: 16.8%

Air consists of approximately 21% oxygen, 78% nitrogen, and 1% other (0.95 argon and 0.04 carbon dioxide).

If the tank had only 80% air, take 80% of 21%. This is done by multiplying percentages: $0.8 \times 0.21 = 0.168 = 16.8\%$

80.

Which of the following statements is FALSE?

Protons do not have a charge

Shells with a complete number of valence electrons are considered to be inert

Ionic bonds are formed when two atoms exchange electrons

Each electron shell contains a limited number of electrons

Correct answer: Protons do not have a charge

Protons are positively charged. Neutrons are neutrally charged. Electrons are negatively charged. Protons and neutrons are found in the nucleus.

The remaining answers are all correct statements.

81.

Organic compounds all contain which element?

Carbon

Nitrogen

Oxygen

Sodium

Correct answer: Carbon

Organic chemistry is the study of carbon and its interactions with other elements. Organic compounds all contain carbon.

While many organic compounds contain nitrogen, it is not a defining element of all compounds.

Oxygen is present in many organic compounds, such as alcohols and carboxylic acids, but it is not a necessary component of all organic compounds.

Sodium is not a common component of organic compounds and is more associated with inorganic chemistry.

82.

What is the time-weighted average (TWA) for an employee exposed to ethyl alcohol at 1300 ppm for 2 h, 750 ppm for 3 h, and 1125 ppm for 3 h?

1028 ppm

865.625 ppm

8825 ppm

6925 ppm

Correct answer: 1028 ppm

The TWA is the concentration of a chemical that an employee is exposed to for a specified period. The OSHA permissible exposure limit (PEL) and ACGIH threshold limit value (TLV) are both calculated for TWAs of 8 hours.

The TWA can be calculated using the formula:

$$TWA = (C_1T_1)+(C_2T_2)+...(C_nT_n)/total\ hours\ worked$$

In this example,

$$TWA = (1300\ ppm \times 2\ h)+(750\ ppm \times 3\ h)+(1125\ ppm \times 3\ h)/8\ h$$

$$TWA = (2600\ ppm)+(2250\ ppm)+(3375\ ppm)/8\ h$$

$$TWA = (8225\ ppm)/8\ h$$

$$TWA = 1028\ ppm$$

83.

A truck driver, traveling at a velocity of 40 m/s, is approaching a traffic light when it turns yellow. They apply the brakes to decelerate at a rate of -10.0 m/s^2 , coming to a complete stop in 4 seconds.

What is the distance traveled from the time they apply the brakes until they come to a complete stop?

Use the following equation $s = v_0t + [(at^2)/2]$

80 m

160 m

240 m

90 m

Correct answer: 80 m

Calculate displacement for this problem, which is a change in the position of an object. The equation is:

$$s = v_0t + [(at^2)/2]$$

- *s = displacement*
- *v₀ = initial velocity*
- *t = time*
- *a = acceleration*

Substitute the problem:

$$s = (40 \text{ m/s} \times 4\text{s}) + [(-10.0\text{m/s}^2 \times 4\text{s}^2)/2]$$

$$s = 160 \text{ m} + [-160 \text{ m}/2]$$

$$s = 160 \text{ m} + (-80 \text{ m})$$

$$s = 80 \text{ m}$$

The other answer options are incorrect and are likely from an error or miscalculation in your formula.

84.

What is the median of the following dataset?

3, 6, 7, 7, 8, 10, 12, 13, 14

8

7

9

11

Correct answer: 8

The median is the middle value in a list of data. There are nine values in this set of data in numerical order, and 8 is the central point.

The mode is 7, which is the variable that occurs most often in a set of data. The mean, or average, of the set of data is 9 (rounded up from 8.9). The range, or difference between the highest and lowest values in the set, is 11.

85.

Kinetic energy is typically measured in what unit?

Joules

Newton

ft/s²

Ohms

Correct answer: Joules

Kinetic energy, the energy of motion, is typically measured in joules. Joules are 1 kg x m²/s².

86.

Determine the kinetic energy of a 575 kg roller coaster car moving at a speed of 17.6 m/s.

Use the formula $KE = (1/2)(mv^2)$, where KE = kinetic energy (J), m = mass of the object, and v = speed of the object (velocity).

89,056 J

66,178 J

104,008 J

75,137 J

Correct answer: 89,056 J

The basic equation to determine kinetic energy is written as:

$$KE = (1/2)(mv^2) = (1/2)(575 \times 17.6^2)$$

$$KE = (1/2)(178,112)$$

$$KE = 89,056 \text{ kg} \times (\text{m/s})^2 = 89,056 \text{ J}$$

Recall that $J = \text{kg} \times \text{m}^2/\text{s}^2$.
