

# BCSP ASP - Quiz Questions with Answers

## Domain 1: Advanced Sciences and Math

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1.

Given 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, insert the known variables and solve.

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

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

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

2.

Which equation is used by insurance companies to determine an experience modification rate (EMR)?

$$\text{EMR} = (\text{adjusted actual losses} + \text{ballast}) / (\text{expected losses} + \text{ballast})$$

$$\text{EMR} = (\text{adjusted actual losses} - \text{ballast}) / (\text{expected losses} - \text{ballast})$$

$$\text{EMR} = \text{adjusted actual losses} / \text{expected losses}$$

$$\text{EMR} = (\text{adjusted actual losses} + \text{ballast})(\text{expected losses} + \text{ballast})$$

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*Correct answer:  $\text{EMR} = (\text{adjusted actual losses} + \text{ballast}) / (\text{expected losses} + \text{ballast})$*

*Insurance companies that provide workers' compensation coverage now use an additional multiplier known as the EMR to assist in the determination of the cost of workers' compensation costs. It is calculated by dividing the sum of adjusted actual losses and ballast by the sum of expected losses and ballast.*

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**3.**

What is the volume of 2.6 mol of gas at a pressure of 33.2 psi and a temperature of 324K?

Use the formula  $PV = nRT$ .

**30.6 L**

3.6 L

17.04 L

34.8 L

Correct answer: 30.6 L

Solve using the Ideal Gas Law equation:

$$PV = nRT$$

Where:

Pressure (P) = 33.2 psi

Volume (V) = (solve)

Number of molecules or moles (n) = 2.6 mol

Universal gas constant (R) = 8.314J/mol x K (converts to 1.206L x psi/mol x K using the Value Gas Constant table of page 203 of the reference)

Temperature = 324 K

Insert values:

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

Solve for V:

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

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

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

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

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

4.

Which of the following statements is TRUE?

**The lower the p-value, the less likely the result**

The lower the p-value, the more likely the result

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

The p-value assumes that the null hypothesis is false

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*Correct answer: The lower the p-value, the less likely the result*

*The p-value is defined as the probability of obtaining a result as extreme as the one observed, assuming that the null hypothesis is true. The lower the p-value, the less likely the result, so the more "significant" the result.*

*A p-value of 0.05, for example, represents a 5% chance of an outcome that is extreme, given the null hypothesis.*

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**5.**

You take a sound level measurement five feet from a noise source, and the result is 95 dBA. What is the noise level measurement from 12 feet away?

**87.4 dBA**

90.1 dBA

85.3 dBA

86.1 dBA

*Correct answer: 87.4 dBA*

*Solve using the equation  $dB_1 = dB_0 + 20 \log_{10}(d_0 / d_1)$ .*

$$dB_1 = 95 \text{ dBA} + 20 \log_{10}(5 / 12)$$

$$dB_1 = 95 \text{ dBA} + 20(-0.38)$$

$$dB_1 = 95 \text{ dBA} + (-7.60)$$

$$dB_1 = 87.4 \text{ dBA}$$

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6.

Cs-137 has an initial activity of 6050 GBq/g. What would be the activity after 13 years of decay, given a half-life of 30.0 years?

**4480.61 GBq/g**

1222.70 GBq/g

3253.89 GBq/g

5230.43 GBq/g

Correct answer: 4480.61 GBq/g

Radioactive decay can be calculated by:

$$N_t = N_0 e^{-\lambda t}$$

$$N_{13y} = 6050 \text{ GBq/g} \times e^{-(0.693/30.0y)13}$$

$$N_{13y} = 6050 \text{ GBq/g} \times 0.7406$$

$$N_{13y} = 4480.61 \text{ GBq/g}$$

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7.

Your employer has purchased a tract of land for \$220,000. What would be the value of this land in 10 years, assuming an APR of 11%?

Use the formula  $F = P(1 + i)^n$ , where  $F$  = future value of the money,  $P$  = present value of the money (principal),  $i$  = interest rate (annual percentage rate [APR]), and  $n$  = number of years (in this case, number of years invested).

**\$624,800**

\$275,900

\$458,100

\$832,600

Correct answer: \$624,800

Calculate the future value of money using the known variables:

$$F = P(1 + i)^n$$

$$F = \$220,000(1 + 0.11)^{10}$$

$$F = \$220,000(1.11)^{10}$$

$$\text{Note that } (1.11)^{10} = 2.8394 = 2.84$$

$$F = \$220,000(2.84)$$

$$F = \$624,800$$

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8.

A Reynolds number with a value of 1500 denotes what type of flow?

**Laminar flow**

Turbulent flow

Cannot be determined

Computational flow

*Correct answer: Laminar flow*

*The Reynolds number is a dimensionless number that is used to determine flow conditions in a pipe or along flat surfaces. It is calculated by multiplying the density of the fluid or air, the diameter of the duct or pipe or area of a surface, and the velocity of the fluid or air movement, and then dividing by the viscosity of the fluid or density of the air. Reynolds numbers below 2000 typically indicate a laminar or non-turbulent flow. Reynolds numbers between 2000 and 4000 indicate a changing or transitional flow, and Reynolds numbers greater than 4000 suggest a turbulent flow.*

*Turbulence is a measure of how much a fluid mixes as it flows.*

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9.

What does the following equation calculate?

$VP + h_e$ , where  $VP$  = duct velocity pressure and  $h_e$  = overall hood entry loss

Static pressure of the hood

Coefficient of entry loss

Velocity of air

Static pressure of the fan

*Correct answer: Static pressure of the hood*

*The static pressure of the hood ( $SP_h$ ) is calculated using the following equation:*

*$|SP_h| = VP + h_e$ , in which the value of the static pressure is always positive.*

*The coefficient of entry loss is calculated by dividing the duct velocity pressure by the static pressure of the hood and taking the square root. The velocity of air is calculated by multiplying 4,005 by the coefficient of entry loss and the square root of the static pressure of the hood. The static pressure of the fan is calculated by subtracting the duct velocity pressure and incoming static pressure from the outgoing static pressure.*

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**10.**

A box on the floor has a force of 350N applied horizontally to the side of the box and the box is moved 10 meters in a horizontal direction. Calculate the amount of work that is accomplished.

**3,500J**

35J

3,050J

2,500J

*Correct answer: 3,500J*

*The equation for calculating the amount of work accomplished is:*

$$W = Fs$$

*Where:*

*W = the work accomplished in Joules or Newtons (1 J = 1 N × 1 m)*

*F = magnitude in Newtons (N)*

*s = displacement in a horizontal direction in meters (m)*

*Solve for W:*

$$W = (350N) (10m)$$

$$W = 3,500J$$

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**11.**

Given a velocity pressure of 0.35", determine the velocity of air.

Use the formula  $V = 4005\sqrt{VP}$ , where  $V$  = velocity (fpm) and  $VP$  = velocity pressure ( $H_2O$ ).

**2363 fpm**

1578 fpm

3985 fpm

2839 fpm

Correct answer: 2363 fpm

Airflow velocity is used to capture contaminants and overcome cross-drafts, transportation of contaminants through the duct, and balancing of "losses" in the system and in the discharge of the contaminant from the stack. This is described as the "magnitude" of the system, which is a function of the velocity pressure. This relationship is written mathematically as:

$$V = 4005\sqrt{VP}$$

Insert the known variables and solve.

$$V = 4005\sqrt{VP}$$

$$V = 4005\sqrt{0.35}$$

$$V = 4005(0.59) = 2363 \text{ fpm}$$

**12.**

What is the weight, in Newtons (N), of an object on earth that has 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 ( $[9.8 \text{ m/s}^2]$ [constant])

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

$$W = 44.1 \text{ Newtons}$$

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**13.**

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 5

Correct answer: 4

The pH of a solution is calculated as follows:

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

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

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

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**14.**

In toxicology, chemical interactions are often described in non-balanced mathematical equations. Which equation represents an antagonistic effect?

$$2 + 2 = 0$$

$$2 + 2 = 10$$

$$2 + 2 = 4$$

$$2 + 0 = 10$$

Correct answer:  $2 + 2 = 0$

*Antagonism occurs when two substances seem to balance each other, eliminating the toxic effects of one or both of the substances. Mathematically, this is described as  $2 + 2 = 0$ .*

*Additive effects occur when two substances interact but have the same anticipated effect. Mathematically, this is described as  $2 + 2 = 4$ .*

*Synergism occurs when two substances have a greater-than-anticipated effect. Mathematically, this is described as  $2 + 2 = 10$ .*

*Potentiation occurs when a normally non-toxic substance becomes toxic in the presence of another substance. Mathematically, this is described as  $2 + 0 = 10$ .*

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**15.**

Calculate the wet bulb globe temperature Index (WBGT) for outdoor conditions with a solar load if the wet-bulb temperature is 92 °F, the globe temperature is 99 °F, and the dry-bulb temperature is 84 °F.

Use the formula  $WBGT = 0.7 WB + 0.2 GT + 0.1 DB$ , where  $WB$  = wet-bulb temperature,  $DB$  = dry-bulb temperature, and  $GT$  = globe temperature.

**93°**

98°

87°

101°

Correct answer: 93°

For outdoor conditions with a solar load, WBGT is calculated as:

$$WBGT = 0.7 WB + 0.2 GT + 0.1 DB$$

Insert the known variables and solve.

$$WBGT = 0.7 WB + 0.2 GT + 0.1 DB$$

$$WBGT = (0.7)(92) + (0.2)(99) + (0.1)(84)$$

$$WBGT = 64.4 + 19.8 + 8.4 = 92.6^\circ \text{ or } 93^\circ$$

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16.

An employee is working about two feet from a source of radiation which measures 220 mrem/hr. If the employee worked five feet from the source, what would the dose rate be?

**35.2 mrem/hr**

3.52 mrem/hr

1375 mrem/hr

576 mrem/hr

*Correct answer: 35.2 mrem/hr*

*The dose received by employees is inversely proportional to distance. To calculate the dose at a distance, use the Inverse Square Law:*

$$I_2 = I_1[(d_1)^2 / (d_2)^2]$$

*Where:*

*$I_1$  = intensity at distance 1 (220mrem/hr)*

*$I_2$  = intensity at distance 2 (value looking to solve)*

*$d_1$  or  $d_2$  = distance at location 1 or 2 ( $d_1$  = 2 feet,  $d_2$  = 5 feet)*

*Solve for  $I_2$ :*

$$I_2 = 220 \text{ mrem/hr}[(2)^2 / (5)^2]$$

$$I_2 = 220 \text{ mrem/hr}(4 / 25)$$

$$I_2 = 220 \text{ mrem/hr} (.16)$$

$$I_2 = 35.2 \text{ mrem/hr}$$


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**17.**

A company has 249 employees who worked a total of 500,500 hours, and the company experienced 18 recordable incidents. What would the incident rate be?

**7.19**

9.34

5.35

6.99

*Correct answer: 7.19*

*The OSHA injury and illness incident rate (IR) is calculated by:*

*IR = (number of injuries and illnesses x 200,000) / employee hours worked*

*IR = 18 x 200,000 / 500,500*

*IR = 7.19*

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**18.**

Company A had a total of 6 OSHA recordable cases, and 3 of them were lost-time cases in 2020. The total employee hours worked was 150,000 hours in 2020. What is the total recordable injury rate for Company A in 2020?

**8.00**

4.00

2.67

6.00

*Correct answer: 8.00*

*The equation to calculate the total recordable injury rate is:*

*# of recordable injuries \* 200,000 / total work hours*

*$(6 * 200,000) / 150,000 = 8.00$*

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**19.**The formula  $\pi \times d$  is used to calculate what?**The circumference of a circle**

The area of a circle

The diameter of a circle

The radius of a circle

*Correct answer: The circumference of a circle*

*The circumference of a circle is found by multiplying  $\pi$  by the diameter ( $d$ ) of the circle.*

*In many ventilation-related problems, you will need to calculate the area of a circle but will only be given the circumference. You can use this formula to solve the diameter by rearranging to get:*

*$(C) / (\pi) = d$ , where  $C$  is the circumference of the circle*

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**20.**

The total cost of a loan paid over five years is \$67,600. The interest rate is 6%. What was the original amount of the loan without interest?

Use the formula  $I = pni$ , where  $I$  = the amount of interest paid,  $p$  = principal (amount borrowed),  $n$  = number of years (or period), and  $i$  = interest rate.

**\$52,000**

\$49,000

\$58,000

\$62,000

Correct answer: \$52,000

To calculate simple interest, use the following equation:

$$I = pni$$

Since the total cost equals the principal added to the amount of interest paid, set up an equation in terms of  $p$ :

$$\text{Total cost} = I + p = pni + p$$

Solve for  $p$ .

$$pni + p = p(5)(.06) + p = \$67,600$$

$$0.3p + p = \$67,600$$

$$1.3p = \$67,600$$

$$p = \$52,000$$

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**21.**

Calculate the voltage for a DC circuit with the following data:

 $(I = 0.8 \text{ A}, 4 \Omega)$ Use the formula  $V = IR$ , where  $V = \text{volts}$ ,  $I = \text{current (A)}$ , and  $R = \text{resistance of the circuit } (\Omega)$ .**3.2 V**

3.6 V

2.3 V

6.4 V

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*Correct answer: 3.2 V**The voltage of a circuit can be calculated using the following equation:*

$$V = IR$$

$$V = IR = (0.8 \text{ A})(4 \Omega) = 3.2 \text{ V}$$

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22.

To calculate the experience modification rate, what is the accurate definition of BALLAST?

**An amount added to both the numerator and the denominator of the experience modification rate (EMR) formula to reduce the differences between large credits and large debits**

A figure determined by multiplying the payrolls in each applicable classification of the insured employees by an expected loss ratio factor

A factor that limits excess losses

A comparison of actual losses with expected losses

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*Correct answer: An amount added to both the numerator and the denominator of the experience modification rate (EMR) formula to reduce the differences between large credits and large debits*

*Ballast is an amount added to both the numerator and the denominator of the EMR formula, reducing differences between large credits and large debits. The result is that all modifications come closer to a modification factor of 1.0, also known as "unity modification."*

*Expected losses are calculated by multiplying the payrolls in each applicable classification of the insured employees by an expected loss ratio factor published for each classification in each state. Adjusted actual losses are determined by a formula that has a stabilizing effect on the results and limits excess losses. There is no component of the EMR formula that compares actual losses with expected losses.*

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**23.**

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 (N),  $m$  = mass of the object, and  $v$  = speed of the object (velocity).

**89,056 m/s<sup>2</sup>**66,178 m/s<sup>2</sup>104,008 m/s<sup>2</sup>75,137 m/s<sup>2</sup>

Correct answer: 89,056 m/s<sup>2</sup>

The basic equation to determine kinetic energy is written as:

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

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

$$KE = 89,056 \text{ m/s}^2$$

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**24.**Solve for  $x$  in the following equation:  $(-3)x + 4 = 25$ 

$x = -7$

$x = 7$

$x = 6$

$x = -6$

Correct answer:  $x = -7$

When solving an equation for  $x$ , you want to get  $x$  alone. In this problem, subtract 4 from both sides of the equation.

$$(-3)x + 4 = 25$$

$$(-3)x = 21$$

Then divide both sides by  $(-3)$ :

$$x = -7$$

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**25.**

Two slings were used to hold a billboard weighing 1,000 lbs at a 45-degree angle. What is the sling load force if the load factor at 45 degrees is 1.414?

**707 lbs**

636 lbs

730 lbs

841 lbs

*Corrective answer: 707 lbs*

*The load factor is determined by the leg angle of the triangle. The slings are angled at the same point and hold a billboard at each end. As the sling force increases, the sling angle decreases.*

*Sling load force = (load weight/2) \* load factor*

*(1000 lb/2) \* 1.414 = 707 lbs*

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26.

What is the OSHA requirement for the minimum fall clearance distance?

6 feet

4 feet

3.5 feet

10 feet

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*Correct answer: 6 feet*

*The OSHA requirement for the minimum fall clearance distance is 6 feet. The minimum fall clearance distance is the distance between the anchorage point and the lower level to ensure that a worker doesn't contact the lower level during a fall.*

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**27.**

Which bond occurs when electrons are shared between two atoms in a molecule?

**Covalent bond**

Ionic bond

Valence bond

Electron bond

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*Correct answer: Covalent bond*

*There are two types of chemical bonds:*

- *Covalent bonds occur when electrons are shared between two atoms in a molecule.*
  - *Ionic bonds form when two atoms exchange electrons.*
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28.

Which of the following is an accurate definition of antagonism?

**When combined, two chemicals interfere with each other**

The combined effect of two chemicals is equal to the sum of each chemical acting independently

The combined effect of two chemicals is much greater than the sum of the effect of each agent acting independently

One substance does not have a toxic effect on a certain organ system, but with another chemical, the combination of the two is greater

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*Correct answer: When combined, two chemicals interfere with each other*

*Various chemicals react differently with other chemicals, and they also have varying effects on humans and animals in these combinations. These effects can be described as additive, antagonistic, synergistic, or potentiating. Antagonistic effects occur when two chemicals interfere with each other when combined.*

*When the combined effect of the chemicals is equal to the sum of each chemical acting independently, it is an additive effect. When the combined effect of two chemicals is much greater than the sum of the effect of each agent acting independently, it is a synergistic effect. The potentiating effect is when one substance does not have a toxic effect on a certain organ system; however, when it combines with another chemical, it makes the combination of the two greater.*

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**29.**

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

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

**1,000**

45

550

825

Correct answer: 1,000

To calculate permutations with repetition, simply multiply the data points as described in the formula below:

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

Solve.

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

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

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

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**30.**

If  $C_e = 0.715$  and  $SP = 0.4$  "wg, what is the airflow velocity of the system?

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

**1804 fpm**

722 fpm

1208 fpm

2174 fpm

Correct answer: 1804 fpm

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

$$V = 4005C_e\sqrt{SP_h}$$

Insert the known variables and solve.

$$V = 4005C_e\sqrt{SP_h}$$

$$V = (4005)(0.715)\sqrt{0.4}$$

$$V = 2864(0.63) = 1804 \text{ fpm}$$

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**31.**

An instructor wants to compare two groups of students by evaluating the average test scores of the groups. What is the best statistical tool for testing the differences between the means of the two data sets?

**Student t-test**

Chi-square

Degrees of freedom

P-value

*Correct answer: Student t-test*

*The student t-test is specifically designed to determine if there is a significant difference between the means of two groups, which can help the instructor understand whether any differences observed are likely due to chance or if they represent a true difference in performance.*

*A chi-square test is primarily used for categorical data to test the relationship between two categorical variables, not for comparing means of continuous data.*

*P-value is an outcome of statistical tests, including the t-test, that tells you the probability that your observed data could occur under the null hypothesis. It is not a test but rather a component of the result from statistical tests.*

*Degrees of freedom is a concept used in statistical analyses to specify the number of independent pieces of information in a sample. While important for calculating test statistics like those in the t-test, it is not a test itself.*

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**32.**

An employee has been exposed to 75% of the permissible exposure to noise, measured by a noise dosimeter. What is the Time-Weighted Average (TWA) expressed in a sound pressure level?

**88 dBA**

90 dBA

83 dBA

82 dBA

*Correct answer: 88 dBA*

*To convert noise dosimetry readings, into a Time-Weighted Average (TWA), use the following equation:*

*$TWA = 16.61 \log_{10}(D / 100) + 90$ , where  $D$  is the measured dose.*

*$TWA = 16.61 \log_{10}(75 / 100) + 90$*

*$TWA = (16.61)(-0.125) + 90$*

*$TWA = (-1.999) + 90$*

*$TWA = 88 \text{ dBA}$*

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**33.**

In toxicology, chemical interactions are often described in non-balanced mathematical equations. Which equation represents an additive effect?

$$2 + 2 = 4$$

$$2 + 2 = 10$$

$$2 + 0 = 10$$

$$2 + 2 = 0$$

Correct answer:  $2 + 2 = 4$

Additive effects occur when two substances interact but have the same anticipated effect. Mathematically, this is described as  $2 + 2 = 4$ .

Synergism occurs when two substances have a greater-than-anticipated effect. Mathematically, this is described as  $2 + 2 = 10$ .

Potentiation occurs when a normally non-toxic substance becomes toxic in the presence of another substance. Mathematically, this is described as  $2 + 0 = 10$ .

Antagonism occurs when two substances seem to balance each other, eliminating the toxic effects of one or both of the substances. Mathematically, this is described as  $2 + 2 = 0$ .

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**34.**

Your company has purchased an investment building. If the purchase price is \$1,200,000 today, and the APR is expected to be 7%, what will the value of the building be in 20 years?

**\$4,644,000**

\$24,000,000

\$2,568,000

\$3,600,000

Correct answer: \$4,644,000

Calculate the future value of money using the following equation:

$$F = P(1 + i)^n$$

- $F$  = future value of the money
- $P$  = present value of the money (principal)
- $i$  = interest rate (annual percentage rate [APR])
- $n$  = number of years (in this case, the number of years invested)

Insert the known variables and solve.

$$F = \$1,200,000(1 + 0.07)^{20}$$

$$F = \$1,200,000(1.07)^{20} = \$1,200,000(3.87) = \$4,644,000$$

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**35.**

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  $-10 \text{ m/s}^2$ . He continues this deceleration for 96 m before the light changes to green, and then he begins to accelerate. At the point of acceleration, what is the velocity?

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

31.6 m/s

24.4 m/s

36.9 m/s

18.8 m/s

Correct answer: 31.6 m/s

**The formula for calculating terminal velocity is written as:**

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

**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 the equation.**

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

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

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

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


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**36.**

The velocity of a vehicle is 115 m/s. Convert to miles per hour.

**257.25 mph**

112.75 mph

236.32 mph

310.97 mph

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*Correct answer: 257.25 mph*

*Convert meters per second to feet per second.*

$$115 \text{ m/s} \times 3.281 \text{ ft/m} = 377.3 \text{ ft/s}$$

*Convert feet per second to feet per mile.*

$$377.3 \text{ ft/s} \times 3,600 \text{ s/h} \times \text{mi}/5,280 \text{ ft} = 257.25 \text{ mph}$$

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**37.**

The company you work for is interested in implementing a new training program. You are asked to determine the return on investment (ROI) of this program to your company. Which of the following could you use to find the ROI?

**Cost-benefit analysis**

Training suitability analysis

Context analysis

Work analysis

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*Correct answer: Cost-benefit analysis*

*Cost-benefit analyses are conducted to determine the return on investment to the company, from the original investment in training costs. These can help organizations and companies decide whether to spend time, money, and energy on certain resources.*

*Training suitability analysis assesses the task, job, or project that is performed in order to determine whether training is the desired (or only) solution to performance problems. Context analysis is performed to determine the desired training needed by the organization. Work analysis focuses on the desired skill and performance requirements of the job being done.*

---

**38.**

There are two noise sources immediately adjacent to one another, each producing a sound level of 85 dB. What is the sum of the sound levels?

**88 dB**

170 dB

0 dB

173 dB

*Correct answer: 88 dB*

*The difference between the two noise sources is 3 dB (88 dB - 85 dB). According to the Decibel Addition Table, when there is a difference of 0 dB between two sound levels, then 3 dB should be added. Therefore, 85 dB + 3 dB = 88 dB.*

---

**39.**

A dragster is traveling at 25 m/s and then accelerates at a rate of  $30 \text{ m/s}^2$  for six seconds. How fast is the dragster traveling after six 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

45 m/s

305 m/s

Correct answer: 205 m/s

Velocity can be calculated as follows:

$$v = v_o + at$$

Solve the equation.

$$v = v_o + at$$

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

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

---

**40.**

There is a round ball balanced on the edge of a cliff. Imagine that 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 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 ( $9.8 \text{ m/s}^2$ ), and  $h$  = height above the 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.

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

$$PE = 313.6 \text{ J}$$

---



41.

The radioactive half-life of cadmium is 13.6 years. What does this mean?

**It takes 13.6 years for half of the atoms in cadmium to disintegrate into another nuclear form**

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 disintegrate into another nuclear form*

*The half-life of a radioactive element is the time it takes for one-half of the atoms of that substance to disintegrate into another nuclear form; cadmium has a half-life of 13.6 years. In this length of time, half of the atoms will disintegrate. Half-lives can range from fractions of a second to many billions of years depending on the radionuclide.*

---

42.

If the concentration of hydronium ions in a solution is  $3 \times 10^{-4}$ , what is the pH of the solution?

**3.52**

.003

3

7

Correct answer: 3.52

To calculate pH, use the equation  $pH = -\log [H^+]$ .

$H^+$  is the hydronium ion. Take the negative log of the concentration of this value to get the pH.

$$pH = -\log [H^+]$$

$$pH = \log(3 \times 10^{-4})$$

$$pH = 3.52$$

---

43.

What equation is extremely useful when solving load calculation problems involving a right triangle?

**Pythagorean equation**

Half-Life equation

Differential equation

Quadratic equation

*Correct answer: Pythagorean equation*

*The Pythagorean equation is commonly used in load calculations encountered in safety and health to determine the length of any side of a right triangle. It is also used to solve for the degree of any angle within a triangle. The remaining equations are unrelated to solving for a load calculation with a triangle.*

*Pythagorean equation:  $a^2+b^2=c^2$*

---

**44.**

What is the median of the following set of data?

3, 6, 7, 7, 8, 10, 12, 13, and 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.*

*7 is the mode, 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 from 8.9). The range, or difference between the highest and lowest values in the set, is 11.*

---

**45.**

A person is working under a moderate workload in an environment of 31.1 °C (88 °F). For every 15 minutes of work, how long should the worker be able to rest?

**45 minutes**

30 minutes

15 minutes

5 minutes

*Correct answer: 45 minutes*

*According to the Permissible Heat Exposure Threshold Limit Value, a worker in moderate conditions of 31.1 °C (88 °F) should be permitted a work/rest regimen of 25% work and 75% rest each hour. Since 15 minutes is 25% of one hour, 45 minutes is 75% of one hour.*

---

**46.**

Which term is used to describe the total amount of electrical force that drives the flow between two points?

**Voltage**

Current

Resistance

Circuit

*Correct answer: Voltage*

*Voltage describes the total amount of electrical force that drives the current between two points, measured in volts.*

*Current is the flow of electric charge or the rate of flow of electric charge, measured in amperes.  
Resistance is a measure of the opposition to the flow of steady electrical current, measured in ohms.*

---

47.

The amount of work done on an object is 12.8 N. What is the object's weight?

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 ( $9.8 \text{ m/s}^2$  constant).

**1.3 kg**

2.6 kg

0.8 kg

2.2 kg

Correct answer: 1.3 kg

Rearrange the equation to solve for  $m$ .

$$W = mg$$

$$m = W / g$$

$$m = W / g = 12.8 \text{ N} / 9.8 \text{ m/s}^2$$

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

---

**48.**

A cubic yard of soil can weigh 2,000 pounds. If a dump truck is hauling 17 cubic yards, how much does the soil in the dump truck weigh?

**34,000 pounds**

2,000 pounds

17,000 pounds

30,000 pounds

*Correct answer: 34,000 pounds*

*Each cubic yard of soil weighs 2,000 pounds. If the truck holds 17 cubic yards, find the total weight by multiplying 2,000 pounds by 17.*

*$17 \times 2,000 \text{ pounds} = 34,000 \text{ pounds}$*

---



**49.**

Which ventilation systems are designed to control contaminants at the source before a mixture with breathing air occurs?

**Local ventilation**

Dilution ventilation

General ventilation

Capture ventilation

---

*Correct answer: Local ventilation*

*Ventilation is divided into three basic categories: general, dilution, and local. Local (exhaust) ventilation systems are designed to control contaminants at the source before a mixture of breathing air occurs. It is used to control the following:*

- *highly toxic substances*
  - *single-source emissions*
  - *direct worker exposures*
-

**50.**

Which of the following is an accurate description of the wind chill factor?

**The number of calories lost during one hour from a square meter of a surface kept at 91.4 °F**

The number of calories gained during one hour from a square meter of a surface kept at 91.4 °F

The number of calories lost during one hour from a square meter of a surface kept at 98.6 °F

The number of calories lost during one hour from a square foot of a surface kept at 91.4 °F

---

*Correct answer: The number of calories lost during one hour on a square meter of a surface kept at 91.4 °F*

*The wind chill factor is defined as the number of calories lost during one hour on a square meter of a surface kept at 91.4 °F. NOAA's Wind Chill Chart shows the wind chill factor at various wind speeds and temperatures.*

---

**51.**

An employee has been monitored using a noise dosimeter, and they have been exposed to 64% of the permissible exposure. What is the time-weighted average, expressed at a sound pressure level?

Use the formula  $TWA = 16.61 \log_{10} (D / 100) + 90$ , where  $TWA =$  time-weighted average and  $D =$  measured dose.

**86.84 dBA**

62.06 dBA

98.36 dBA

70.48 dBA

Correct answer: 86.84 dBA

In order to convert noise dosimetry readings into a TWA, use the following formula:

$$TWA = 16.61 \log_{10} (D / 100) + 90$$

Insert the known variables and solve:

$$TWA = 16.61 \log_{10} (64 / 100) + 90$$

$$TWA = 16.61 \log_{10} (0.64) + 90$$

$$TWA = (16.61)(-0.19) + 90$$

$$TWA = -3.16 + 90 = 86.84 \text{ dBA}$$

---

**52.**

In toxicology, chemical interactions are often described in non-balanced mathematical equations. Which equation shows potentiation?

$$2 + 0 = 10$$

$$2 + 2 = 10$$

$$2 + 2 = 0$$

$$2 + 2 = 4$$

Correct answer:  $2 + 0 = 10$

*Potentiation occurs when a normally non-toxic substance becomes toxic in the presence of another substance. Mathematically, this is described as  $2 + 0 = 10$ .*

*Synergism occurs when two substances have a greater-than-anticipated effect. Mathematically, this is described as  $2 + 2 = 10$ .*

*Antagonism occurs when two substances seem to balance each other, eliminating the toxic effects of one or both substances. Mathematically, this is described as  $2 + 2 = 0$ .*

*Additive effects occur when two substances interact but have the same anticipated effect. Mathematically, this is described as  $2 + 2 = 4$ .*

---

**53.**

112 millimeters equals how many inches?

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

2.7 inches

44.1 inches

1.06 inches

*Correct answer: 4.4 inches**1 inch = 25.4 millimeters**Set up a ratio to solve for x.*

$$x / 1 = 112 / 25.4$$

$$112 = 25.4x$$

$$x = 112 / 25.4 = 4.4 \text{ inches}$$

---

**54.**

In the equation used to calculate the radiation heat transfer rate, what does  $\epsilon$  represent?

**Emissivity**

Energy

Electrical charge

Exchange of heat

---

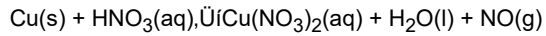
*Correct answer: Emissivity*

*The equation used to calculate the radiation heat transfer rate is  $Q/A = \epsilon\sigma T^4$ , where  $Q/A$  = heat flux (energy/time area),  $A$  = area of heat transfer,  $\epsilon$  = emissivity of radiating body,  $\sigma$  = Stefan-Boltzmann constant, and  $T$  = absolute temperature.*

---

**55.**

After balancing the following equation, which number will be placed in front of  $\text{Cu}(\text{NO}_3)_2$ ?

**Three**

Two

One

Four

*Correct answer: Three*

*When writing a chemical formula, professionals must remember the Law of Conservation, which states that matter can be neither created nor destroyed. Therefore, the number of atoms on one side of the equation must equal those on the opposite side.*

*The balanced equation is:*



**56.**

Which of the following is NOT a *leading* indicator for a health and safety program?

**Employee satisfaction**

Near-miss

Hazard reporting

Inspection frequency

---

*Correct answer: Employee satisfaction*

*A leading indicator measures the effectiveness of control systems through the inputs and conditions before the fact. Leading indicators are actionable and preventative, while lagging indicators are outputs of a system and are retrospective.*

*Near-miss, hazard reporting, and inspection frequency are all leading indicators of a health and safety program. Employee satisfaction is a lagging indicator.*

---



**57.**

What is the specific gravity of water?

**One**

Two

Sixteen

Thirty-two

---

*Correct answer: One*

*Specific gravity is the ratio of the weight of a substance to the weight of water. That value is useful to know whether something will float or sink. Water, since it is the base case, will have a specific gravity of 1.0.*

---

58.

A group of students just completed a final examination. The mean score was 81.5%, with a standard deviation of 7.1. One student scored 84.2%. Assuming a standard distribution, what percentage of students scored higher than this student on the exam?

Use the formula  $z = (X^2 - \mu) / \sigma$ , where  $z = \text{score}$ ,  $X^2 = \text{chi-square value}$ ,  $\mu = \text{mean score}$ , and  $\sigma = \text{standard deviation}$ .

35.2%

28.4%

21.9%

15.5%

Correct answer: 35.2%

This question requires the z-score to find the answer. The z-score is calculated using the following equation:

$$z = (X^2 - \mu) / \sigma$$

Where:

$z = \text{the Z score (solve)}$

$X^2 = \text{the chi-square value (provided as the one student's score of 84.2\%)}$

$\mu = \text{mean score (81.5\%)}$

$\sigma = \text{standard deviation (7.1)}$

Solve for z:

$$z = (X^2 - \mu) / \sigma$$

$$z = (84.2 - 81.5) / 7.1$$

$$z = 2.7 / 7.1$$

$$z = 0.38$$

Using the table of normal distribution (provided on page 384 of reference), determine the area under the curve associated with a z-score of 0.38. A z-score of 0.38 represents a probability content of 0.6480. To calculate the total number of persons taking the exam that scored higher than 84.2%, subtract the total area from the whole.

$$1 - 0.6480 = 0.352$$

Multiply by 100 to find a percentage.

$$0.352 \times 100 = 35.2\%$$

Therefore, 35.2% of the people taking the examination scored higher than 84.2%.

**59.**

Find the volume (in liters) of a room that is 10 m by 10 m by 10 m.

**1,000,000 liters**

1,000 liters

10,000 liters

100,000 liters

*Correct answer: 1,000,000 liters*

*A cubic meter is equal to 1,000 liters. A room that is 10 m by 10 m by 10 m would be 1,000 cubic meters. To convert to liters, multiply by 1,000.*

$$1,000 \times 1,000 = 1,000,000$$

---

**60.**

A certain element has a half-life of 12 years. If there are 50 grams in the beginning, how many will remain after 36 years?

**6.25 grams**

12.5 grams

25 grams

0 grams (i.e., only a negligible amount)

*Correct answer: 6.25 grams*

*36 years is equal to three half-lives. Each half-life will reduce the remaining amount by one-half.*

- 50 grams, after 12 years, will leave 25 grams (first half-life)*
- 25 grams, after 12 years, will leave 12.5 grams (second half-life, 24 years total)*
- 12.5 grams, after 12 years, will leave 6.25 grams (third half-life, 36 years total)*

*For the ASP exam, half-life calculations can be expected to be complete half-life values (i.e., a multiple of the half-life); for example, 36 is a multiple of 12.*

---

61.

Which effect of exposure to more than one chemical is BEST represented by  $2 + 0 = 10$ ?

Potentiating effect

Additive effect

Antagonistic effect

Synergistic effect

*Correct answer: Potentiating effect*

*Various chemicals react differently with other chemicals and also have varying effects on humans and animals in these varying combinations. These effects can be described as additive, antagonistic, synergistic, or potentiating. The potentiating effect is when one substance does not have a toxic effect on a certain organ system; however, when it combines with another chemical, it makes the combination of the two greater ( $2 + 0 = 10$ ).*

*The combined effect of the chemicals being equal to the sum of each chemical acting independently is an additive effect ( $2 + 2 = 4$ ). Antagonistic effects occur when two chemicals interfere with each other when combined ( $3 + -2 = 1$ ). The combined effect of two chemicals being much greater than the sum of the effect of each agent acting independently is the synergistic effect ( $2 + 2 = 10$ ).*

---

62.

Kinetic energy is typically measured in what unit?

**Joules**

Newton's

Ft/s<sup>2</sup>

Ohms

*Correct answer: Joules*

*Kinetic energy, the energy of motion, is typically measured in joules. The conversion factor is 1 joule = 1 kg x m/s<sup>2</sup>.*

---

**63.**

Energy increases quickly based on the height of a fall. This is because kinetic energy is calculated by  $E = (1/2)(m)(V^2)$ . What is the energy (in joules) of a 75 kg man falling at 9 meters per second?

**3037.5 J**

337.5 J

6075 J

675 J

*Correct answer: 3037.5 J*

*If a 75 kg man is falling at 9 m/sec, you can calculate the energy by inserting  $m = 75$  kg and  $V = 9$  m/sec into the equation:*

$$E = (1/2)(m)(V^2) = (1/2)(75 \text{ kg})([9 \text{ m/sec}]^2) = (1/2)(75 \text{ kg})(81 \text{ [m}^2\text{] / [sec}^2\text{]}) = 3037.5 \text{ J.}$$

---

**64.**

The kinetic energy of a 1 kg object falling off a cliff is  $76,000 \text{ m/s}^2$ . Convert the kinetic energy to joules.

*Note: 1 joule =  $1 \text{ kg} \times \text{m/s}^2$ .*

**$7.60 \times 10^4 \text{ J}$**

$3.80 \times 10^{-3} \text{ J}$

$7.60 \times 10^8 \text{ J}$

$7.60 \times 10^2 \text{ J}$

*Correct answer:  $7.60 \times 10^4 \text{ J}$*

*The conversion factor is 1 joule =  $1 \text{ kg} \times \text{m/s}^2$ . Therefore, in this question, there are  $7.60 \times 10^4 \text{ J}$  (joules) of kinetic energy.*

---



**65.**

What is the sum of the interior angles in a triangle?

**180 degrees**

90 degrees

270 degrees

360 degrees

*Correct answer: 180 degrees*

*The sum of the three interior angles in a triangle will always equal 180 degrees. If all three sides are of equal length, the angles will be the same (an equilateral triangle) at 60 degrees each. If two sides are the same, two of the angles will be the same.*

*Right triangles are common in safety; they have one angle that is exactly 90 degrees. This means that the other two angles must both be smaller than 90 degrees and must total 90 degrees when added. The longest side will always be opposite from the largest angle.*

---

**66.**

Determine the amount of force of a 3,200-lb automobile with an acceleration rate of  $25 \text{ m/s}^2$ .

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

**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:

$$F = ma$$

Convert pounds to kilograms.

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

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

$$F = 36,362.5 \text{ N}$$

---

67.

6.2 L of an ideal gas is contained at 3.0 atm and 37°C. How many moles (note-moles were converted from gram-moles) of this gas are present?

**0.73 mol**

2.62 mol

0.007 mol

3.16 mol

Correct answer: 0.73 mol

The equation for this is  $PV = nRT$ , where:

- $P$  = absolute pressure (3 atm)
- $V$  = volume (6.2 liters)
- $T$  = temperature (310 Kelvin)
- $n$  = number of molecules (moles) (converted from gram-moles)
- $R$  = universal gas constant

Using the Board of Certified Safety Professionals (BCSP) Universal Gas Constant Value examination reference sheet on page 203. Since the volume ( $V$ ) is in liters, the temperature in kelvin, the moles in grams, and the pressure in atm, the universal gas constant (or  $R$  value) would be .08205. Insert this value into the equation for the universal gas constant.

First, convert 37 °C to Kelvin for temperature ( $T$ ):

$$T = ^\circ\text{C} + 273$$

$$T = 37^\circ\text{C} + 273$$

$$T = 310 \text{ K}$$

Since you are solving for moles, rearrange the equation to solve for  $n$ :

$$n = PV / RT$$

$$n = (3.0 \text{ atm} \times 6.2 \text{ L}) / (0.08205 \text{ L atm/mol K} \times 310 \text{ K})$$

$$n = 0.73 \text{ mol}$$

---

**68.**

Three resistors are valued respectively at 5  $\Omega$ , 7  $\Omega$ , and 10  $\Omega$  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

3.05

Correct answer: 2.27

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

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

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

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

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

---

**69.**

What method (or calculation) could a safety manager use to determine if there's a correlation between the injury rates in a machine shop and the results of safety audits of machining operations at that shop?

**Spearman's Rank Coefficient**

T-test

Chi-square statistic

Degrees of freedom

*Correct answer: Spearman's Rank Coefficient*

*Spearman's Rank Coefficient of Correlation is a reflection of the correlation between two sets of numbers. The distance from 1 implies the strength or weakness of a correlation between the two variables. If the number is positive, it indicates a stronger correlation, whereas a negative number implies a weaker correlation.*

*A t-test is used to calculate the significance of observed differences between the means of two samples, and it can be used to determine whether there is 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.*

---

**70.**

A right triangle has a hypotenuse that is five feet long. The short side of the triangle is three feet long. How long is the missing side?

**Four feet**

Three feet

Two feet

Six feet

*Correct answer: Four feet*

*To find the length of a right triangle's side, use the Pythagorean Theorem. This states that  $a^2 + b^2 = c^2$  where  $c$  is the hypotenuse.*

*In this case,  $3^2 + b^2 = 5^2$*

*After we rearrange it, we get  $b^2 = 25 - 9 = 16$*

*The square root of 16 is 4, which is the answer.*

---

71.

The area of a circle is found by using which formula?

$$\pi \times r^2$$

$$\pi \times d^2$$

$$\pi \times r$$

$$\pi (r^2) / 4$$

Correct answer:  $\pi \times r^2$

The area of a circle is calculated by multiplying pi ( $\pi$ ) by the square of the radius ( $r^2$ ).

In some texts, the radius is replaced by the diameter. The radius can be found by dividing the diameter by 2 ( $d / 2 = r$ ).

---

72.

Calculate the volume of a sphere with a radius of six inches.

**902 cubic inches**

14.82 cubic inches

90.21 cubic inches

678 cubic inches

*Correct answer: 902 cubic inches**The formula for finding the volume of a sphere is  $V = (4/3)\pi(r^3)$ .**Where:**V = volume (solve)* *$\pi = (3.14)$* *r = straight line from the center of a circle or sphere to the circumference (6 inches)**Note:  $r^3$  will provide an answer in cubic inches**Input values and solve for V:*

$$V = (4/3)(3.14)(6^3)$$

$$V = (1.33)(3.14)(216 \text{ cubic inches})$$

$$V = 902 \text{ cubic inches}$$

---



**73.**

Company A had a total of 5 OSHA recordable cases in 2019 and 3 recordable cases in 2020. The total employee hours worked was 150,000 hours in 2020. What is the total recordable injury rate for Company A in 2020?

**4.00**

6.67

2.67

3.00

*Correct answer: 4.00*

*The equation used to calculate the total recordable injury rate is:*

*# of recordable injuries \* 200,000 / total work hours*

*$(3 * 200,000) / 150,000 = 4.00$*

---

**74.**

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 a result of their stretching or compressing. To solve this problem, determine the spring constant ( $k$ ). We know that  $F = 125$  N when  $x = 0.36$  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, leaving the following:

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

**75.**

Which of the following is the sound power reference level?

 **$10^{-12}$  W** $10^{-6}$  W $10^{10}$  W $10^3$  W

*Correct answer:  $10^{-12}$  W*

*The sound power of a source is expressed in terms of its sound power level, and it is written as Lw or PWL. It is helpful to memorize the sound power reference level, which is  $10^{-12}$  W.*

---

**76.**

Calculate the wind chill for the following:

- Wind speed = 35 mph
- Temperature = 15°F

Use the formula wind chill ( $^{\circ}\text{F}$ ) =  $35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$ , where  $T$  = air temperature ( $^{\circ}\text{F}$ ) and  $V$  = wind speed (mph).

-7

0

4

-2

Correct answer: -7

To calculate the wind chill, the following formula can be used:

$$\text{Wind chill } (^{\circ}\text{F}) = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Insert the known variables and solve.

$$\text{Wind chill } (^{\circ}\text{F}) = 35.74 + 0.6215(15) - 35.75(35^{0.16}) + 0.4275(15)(35^{0.16})$$

$$\text{Wind chill } (^{\circ}\text{F}) = 35.74 + 9.32 - 35.75(1.77) + 0.4275(15)(1.77)$$

$$\text{Wind chill } (^{\circ}\text{F}) = 45.06 - 63.28 + 11.35 = -6.87, \text{ or } -7$$


---

**77.**

The equation  $Q = VA$  is used to calculate which of the following?

**Volumetric flow rate**

Total pressure

Velocity pressure

Air changes per hour

---

*Correct answer: Volumetric flow rate*

*In industrial hygiene and engineering, Q denotes flow rate. The volumetric flow rate (Q) is equal to the area (A) of the duct, multiplied by the velocity (V) of the air.*

*Total pressure is denoted by TP. Velocity pressure is denoted by VP. The number of air changes per hour is denoted by N.*

---

**78.**

Radioactive substances have what specific activity?

**>70 Bq/g**

&lt;70 Bq/g

&gt;90 Bq/g

&lt;90 Bq/g

Correct answer: >70 Bq/g

*The United States Department of Transportation identifies hazardous materials, specifically for transportation purposes, into nine different classifications. Class 7 is radioactive materials, which are substances that have a specific activity of >70 Bq/g (Becquerels per gram).*

---

**79.**

The cost to refit one of your company's processing lines would require \$75,000. You are asked to calculate the total cost of the project if the interest rate is 5.5% annually and the loan is repaid in three years. What is the total cost of the project?

Use the formula  $I = pni$ , where  $I$  = the amount of interest paid,  $p$  = principal (amount borrowed),  $n$  = number of years (or period), and  $i$  = interest rate.

**\$87,375**

\$12,375

\$99,275

\$75,000

Correct answer: \$87,375

To calculate simple interest, insert the known variables and solve.

$$I = pni$$

$$I = (\$75,000)(3 \text{ years})(0.055 \text{ per year})$$

$$I = \$12,375$$

To find the total project cost, add the principal amount to the amount of interest paid ( $I$ ).

$$\text{Total cost} = \$75,000 + \$12,375 = \$87,375$$

---

80.

Which of the following is NOT a *direct* cost of an incident?

Accident investigation

Legal fees

Worker's compensation payment

Medical bills

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*Correct answer: Accident investigation*

*The direct cost of an incident is attributed directly to the result of the injury. These costs include legal fees, worker's compensation payments, medical bills, therapy, etc.*

*The indirect costs of an incident are expenses that a company has to endure due to the incident. These costs include time lost by employees, accident investigations, material damage, production losses, etc.*

---



81.

What is used to determine the return to a company from the original investment in preventive costs?

**Cost-benefit analysis**

Cost of risk

Content analysis

Time value of money

---

*Correct answer: Cost-benefit analysis*

*Cost-benefit analysis is conducted to determine the return on investment to a company from the original investment in preventive costs.*

---

**82.**

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

**10**

12

15

24

*Correct answer: 10*

*When collecting air samples, you must determine the number of samples to collect depending on the employee group size. For each employee, one sample should be collected up until the employee group size is eight, and then only seven samples are required. Once the employee group size is 11 or 12, only 10 samples need to be collected.*

---

83.

What is the correct formula for the volume of a cylinder?

$$\pi \times r^2 h$$

$$\pi \times d \times h$$

$$\pi \times d^2 h$$

$$\pi \times r \times h$$

Correct answer:  $\pi \times r^2 h$

The volume of a cylinder is calculated by finding the area of a circle ( $\pi r^2$ ) and multiplying that value by the height ( $h$ ) of the cylinder.

---

**84.**

Where is the following equation used to measure wet bulb globe temperature (WBGT)?

$$WBGT = 0.7WB + 0.2GT + 0.1DB$$

**Outdoors with solar load**

Outdoors without solar load

Indoors without solar load

Indoors with solar load

*Correct answer: Outdoors with solar load*

*Outdoors with a solar load, WBGT is calculated as  $WBGT = 0.7WB + 0.2GT + 0.1DB$ , where WB = wet-bulb temperature, DB = dry-bulb temperature, and GT = globe temperature.*

*The equation  $WBGT = 0.7WB + 0.3GT$  is used to measure the WBGT indoors or outdoors without solar load. There is no solar load indoors.*

---

85.

Which of the following is the MOST common leading indicator?

**Number of near-misses**

Number of safety observations

Number of participants in safety programs

Number of inspections

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*Correct answer: Number of near-misses*

*A leading indicator measures the effectiveness of control systems through the inputs and conditions before the fact. Leading indicators are actionable and preventative, while lagging indicators are outputs of a system and are retrospective.*

*The most common leading indicator is the number of near-misses. The number of safety observations is hazards reported by employees, the number of participants in a safety program is worker participation, and the number of inspections is inspections conducted over time.*

---

86.

What is NOT a measure of central tendency?

**Variance**

Mean

Median

Mode

*Correct answer: Variance*

*Central tendency is a statistical value that gives the general tendency for the center of a data group. Measures of central tendency are:*

- *Mean*
- *Median*
- *Mode*

*Variance is a measure of dispersion. It is the degree to which the variables in the data set are spread, indicating how far from the mean the variables are.*

---

87.

In toxicology, chemical interactions are often described in non-balanced mathematical equations. Which equation represents a synergistic effect?

$$2 + 2 = 10$$

$$2 + 2 = 0$$

$$2 + 0 = 10$$

$$2 + 2 = 4$$

Correct answer:  $2 + 2 = 10$

*Synergism occurs when two substances have a greater-than-anticipated effect. Mathematically, this is described as  $2 + 2 = 10$ .*

*Potentiation occurs when a normally non-toxic substance becomes toxic in the presence of another substance. Mathematically, this is described as  $2 + 0 = 10$ .*

*Antagonism occurs when two substances seem to balance each other, eliminating the toxic effects of one or both of the substances. Mathematically, this is described as  $2 + 2 = 0$ .*

*Additive effects occur when two substances interact but have the same anticipated effect. Mathematically, this is described as  $2 + 2 = 4$ .*

---

88.

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

233 K

0 K

-40 K

-145 K

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*Correct answer: 233 K*

*To convert degrees Celsius to degrees Kelvin, add 273°.*

*-40 °C + 273° = 233 K*

---



89.

One standard deviation is equal to which of the following?

**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 graph of a normal distribution with a single peak. The bell curve demonstrates that 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%, as no set of data is perfect.*

---

**90.**

The values of resistors in a parallel circuit are 9, 12, 15, 18, and 20  $\Omega$ . What is the total resistance of this parallel circuit?

**2.7 $\Omega$** .37 $\Omega$ 2.85 $\Omega$ .35 $\Omega$ 

Correct answer: 2.7 $\Omega$

The equation for total resistance in a parallel circuit:

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

Insert values and solve

$$1/R_{\text{parallel}} = 1/9\Omega + 1/12\Omega + 1/15\Omega + 1/18\Omega + 1/20\Omega$$

$$1/R_{\text{parallel}} = .11\Omega + .08\Omega + .07\Omega + .06\Omega + .05\Omega$$

$$1/R_{\text{parallel}} = .37\Omega$$

Solve for  $R_{\text{parallel}}$

$$R_{\text{parallel}} = 1/.37\Omega$$

$$R_{\text{parallel}} = 2.7\Omega$$

---

**91.**

Determine the frictional force that 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, N),  $\mu$  = 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

The formula for determining the frictional force is:

$$F = \mu N$$

Solve the equation.

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

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

---

**92.**

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

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

**1.96**

2.25

1.57

3.02

Correct answer: 1.96

To determine the company's TCIR, use the following equation:

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

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

$$TCIR = 1,200,000 / 612,884 = \sim 1.96$$

The company's TCIR for the year is 1.96. This rate can be compared to the Bureau of Labor and Statistics' average rating for the particular Standard Industry Code category. The constant of 200,000 is based on 100 employees working 2,000 hours per year. Therefore, this rate states that for every 100 employees, 1.96 have sustained an injury or illness as a result of a work-related accident.

For perspective, a TCIR of 1.96 is lower than the average TCIR for all private industries for the year 2020, which was 2.7 (see Bureau of Labor Statistics "Total nonfatal work injuries and illnesses, by year, private industry").

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**93.**

Calculate the wet bulb globe temperature index (WBGT) for indoor conditions with no solar load if the wet-bulb temperature is 85 °F and the globe temperature is 95 °F.

Use the formula  $WBGT = 0.7 WB + 0.3 GT$ , where  $WB$  = wet-bulb temperature and  $GT$  = globe temperature.

**88°**

102°

96°

80°

Correct answer: 88°

For indoor and outdoor conditions with no solar load, WBGT is calculated as:

$$WBGT = 0.7 WB + 0.3 GT$$

Insert the known variables and solve.

$$WBGT = 0.7 WB + 0.3 GT$$

$$WBGT = (0.7)(85) + (0.3)(95)$$

$$WBGT = 59.5 + 28.5 = 88°$$

---

**94.**

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.

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

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

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

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

---

95.

The molecular weight of hydrogen sulfide is 34. Convert 14.1 ppm of hydrogen sulfide to  $\text{mg}/\text{m}^3$ .

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

**19.6  $\text{mg}/\text{m}^3$** 23.2  $\text{mg}/\text{m}^3$ 16.8  $\text{mg}/\text{m}^3$ 29.5  $\text{mg}/\text{m}^3$ 

Correct answer: 19.6  $\text{mg}/\text{m}^3$

To convert from ppm to  $\text{mg}/\text{m}^3$ , use the following equation:

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

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

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

---

96.

Methyl Ethyl Ketone (MEK) is evaporating from a container at a rate of 1.5 pints every hour. Calculate the actual ventilation rate (Q) needed to control the generation for liquid solvent (MEK) to a PEL of 200ppm with a Specific Gravity (SG) of 0.81, a Molecular Weight (MW) of 72.11, and a ventilation design constant (K) of 4.

**2263.42 cfm**

1810.7 cfm

2532.95 cfm

2001.48 cfm

Correct answer: 2263.42 cfm

The primary purposes for using ventilation are to (1) maintain an adequate oxygen supply, (2) control hazardous concentrations of chemicals, (3) remove odors, (4) control temperature and humidity, and (5) remove contaminants at the source, before they enter the workplace. By understanding how to use and control ventilation, the safety professional can successfully eliminate or greatly reduce any concentration of contaminants in the air.

In order to calculate the rate of generation of potentially harmful contaminants (such as volatile organic compounds) found in liquid solvents, and the required ventilation flow needed to control them below required exposure limits, we utilize the following equation, which accounts for incomplete mixing of the contaminant with the air.

The equation for the actual ventilation rate (Q) of generation for liquid solvents:

$$Q = 403 \times 10^6 \times SG \times ER \times K / MW \times C$$

Where:

Q = actual ventilation rate (cfm)

SG = specific gravity of the volatile liquid (given .81)

ER = evaporation rate of the liquid (pints/min) (given 1.5 pints/60min)

K = design constant which allows for incomplete mixing of contaminant with air (1-10) (given 4)

MW = molecular weight of liquid (given 72.11)

C = desired concentration of gas or vapor at time t in ppm (normally the PEL or TVL of the contaminant) (given a PEL of 200ppm)

Insert given values and solve:

$$Q = (403 \times 10^6 \times 0.81 \times [1.5 \text{ pints} / 60 \text{ minutes}] \times 4) / (72.11 \times 200)$$

$$Q = (403 \times 10^6 \times .81 \times [.025] \times 4 / 14,422)$$

$$Q = 32,643,000 / 14,422$$

$$Q = 2263.42 \text{ cfm}$$



**97.**

A 6-foot man is working from the second story of a building while being attached to an overhead anchor point, using the D-ring on his harness that is attached to a 6-foot lanyard. OSHA's maximum allowable deceleration distance is 3.5 feet.

Assuming the safety factor is 3 feet, calculate the maximum total free fall distance for this man?

**18.5 feet**

15 feet

12 feet

15.5 feet

*Correct answer: 18.5 feet*

*The maximum total free fall distance is the maximum vertical distance a falling employee may travel, including the lifeline device and the maximum allowable deceleration distance by OSHA.*

*Maximum total free fall distance (overhead anchor point) = length of the lanyard + height of the person + safety factor + allowable deceleration*

*Maximum total free fall distance = 6 ft + 6 ft + 3 ft + 3.5 ft*

*Maximum total free fall distance = 18.5 feet*

---

**98.**

Calculate the static pressure of a fan, given the following information:

- $SP_{out} = 1.6$  "wg
- $SP_{in} = 0.5$  "wg
- $VP_{in} = 0.7$  "wg

Use the formula  $SP_{fan} = SP_{out} - SP_{in} - VP_{in}$ .**0.4 "wg**

0.2 "wg

0.6 "wg

0.8 "wg

*Correct answer: 0.4 "wg**In order to calculate the static pressure of the fan ( $SP_{fan}$ ), use the following formula:*

$$SP_{fan} = SP_{out} - SP_{in} - VP_{in}$$

*Insert the known variables and solve.*

$$SP_{fan} = SP_{out} - SP_{in} - VP_{in}$$

$$SP_{fan} = 1.6 - 0.5 - 0.7$$

$$SP_{fan} = 0.4 \text{ "wg}$$

---

**99.**

Which of the following is considered a leading indicator?

**Number of near-misses**

Incident rate

Lost time

Direct costs of incidents

*Correct answer: Number of near-misses**Safety indicators are designed to measure performance in order to identify problem areas, stimulate action, document management efforts, and reinforce improvements in behavior.**Near-misses are the most common leading indicator. When people report near-misses, they are more actively engaged in safety day-to-day. The more an individual reports near-misses, the better they are at identifying hazards.*

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**100.**

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

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*Correct answer: Boyle's law*

*Boyle's law uses the 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. The ideal gas law states that all internal energy is in kinetic energy form, and any change causes a change in temperature. Dalton's law states that chemicals will present in proportions that are small whole numbers.*

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