SAFETY FUNDAMENTALS
SELF-ASSESSMENT

By BCSP
What are the plasma proteins called that are capable of combining chemically with the specific antigens that induced their formation?

A. Interferons  
B. Antibodies  
C. Phagocytic cells  
D. Complement plasma proteins

- An antibody is any of the body globulins that combine specifically with antigens to neutralize toxins, agglutinate bacteria or cells and precipitate soluble antigens. A detailed study of the immune system will provide more information about protecting the body from foreign biological agents.
Which occupational illness is caused by a virus?

A. Hepatitis B
B. Brucellosis
C. Mesothelioma
D. Tuberculosis

Hepatitis B is caused by the Hepatitis B virus. Brucellosis and tuberculosis are caused by bacteria. Mesothelioma is a type of lung cancer almost always associated with exposure to asbestos.
Which are single-celled parasitic organisms that can cause occupational illnesses?

- A. Bacteria
- B. Viruses
- C. RNA
- D. Protozoa

Protozoa are single celled organisms and many are parasitic. Bacteria are single-celled but not parasitic. Viruses do not have all of the components of a cell and RNA (ribonucleic acid) is composed of organic compounds but not composed of cells.
What kind of reaction is evidenced by a fuel and an oxidizer igniting on contact without the need of an outside source of ignition?

- A. Hysteretic
- B. Hygroscopic
- C. Hypergolic
- D. Cryogenic

Hypergolic refers to a fuel that will ignite with an oxidizer but does not require an outside source of ignition.
The installation of a wet-pipe automatic sprinkler system may cause an increase in facility risk when storing which chemical?

- A. Calcium carbide
- B. Benzoly peroxide
- C. Peroxyacetic acid
- D. Potassium permanganate
- All of these chemicals present a serious fire hazard, however, the preferred method of fire control for the last three items is to use water. Calcium carbide with moisture creates corrosive calcium hydroxide and liberates acetylene (ethyne). Acetylene (ethyne), if inhaled can cause depression of the central nervous system and can ignite
What internal organ would exposure to a chemical labeled a nephrotoxin target?

- A. Liver
- B. Brain
- C. Heart
- D. Kidney

A nephrotoxin targets the kidneys. There is other types of agents that target specific organs or have specific detrimental effects on the human body.

- Hemotoxins: target the red blood cells
- Hepatoxins: target the liver
- Neurotoxin: target nerve cells
- Teratogens: target the fetus during pregnancy
- Mutagens: can cause mutations in DNA
- Carcinogens: can cause cancer
Which best defines a chemical’s upper flammability limit?

- A. The maximum temperature at which the chemical can ignite when mixed in air
- B. The maximum flash point at which the chemical can ignite when mixed in air
- C. The minimum proportion of the chemical that can ignite when mixed in air at a certain temperature
- D. The maximum proportion of the chemical that can ignite when mixed in air at a certain temperature

The upper flammability limit (sometimes called the upper explosive limit) is the upper range of a material’s ability to ignite when vaporized and mixed with air, at a certain conditions. Above the upper flammability limit, adding additional amounts of the material (without adding additional amounts of the material) causes the mixture to be too rich and the mixture will not burn. A material ignites only when the mixture is within the material’s flammability range, that is when the volumetric ratio of the mixture in air is within its upper and lower flammability limits.
A glass beaker containing 100 ml of toluene breaks in a small, unvented storage cabinet with a volume of one cubic meter. The ambient temperature of the liquid toluene and the inside of the storage cabinet is 25℃. Assuming toluene can be treated as an ideal gas in its vapor phase, what is the expected concentration (in parts per million) of toluene in the storage cabinet assuming that all of the toluene vaporized and none was lost outside the storage cabinet?

A. 16
B. 180
C. 2000
D. 22000

First, determine how many moles of toluene there are in the beaker. 100 mL toluene x 0.865(SG) = 86.5 g toluene. 86.5 g toluene / 92.13 g/g-mol toluene = 0.939 mol toluene in the beaker. Next, determine the molar volume of 0.939 moles of toluene at 25℃ assuming that it acts as an ideal gas. 25℃ = 298 K.

Finally, determine the concentration per unit volume and plug in all of the data to obtain the concentration in parts per million. Concentration (mg/m³) = (86.5 g/1m³). = 86.5 g x 1000 mg/g = (86 500 mg/1m³). C (ppm) = (86 500 x 22.96) / 92.13. = 21 557 ppm ≈ 22 000 ppm
Which is an agent that is known to be carcinogenic to humans?

- A. Polyvinyl chloride
- B. Sodium vapors
- C. Mercury vapors
- D. Asbestos

Asbestos is the only item from the answer selections that is known to be carcinogenic to humans. There are two well-respected organizations that publish lists related to items that are known human carcinogens. One list is published by the International Agency for Research on Cancer (IARC) and the other is published by the U.S. National Toxicology Program part of the National Institutes of Health.
A lightning bolt is a visible manifestation of the ................................ of a large potential electrical difference between a cloud and another cloud, or the ground.

- A. Equalization
- B. Creation
- C. High current (amperage) nature
- D. High power (wattage) nature

Lightning is an electrical arc produced to equalize the buildup of two opposite charges between two clouds or between a cloud and an object (usually on the ground)
Use one or more of the following equations to assist with answering this question.

\[ I = \frac{E}{R} \quad P = E \cdot I = I^2 \cdot R \quad \frac{1}{R_{\text{parallel}}} = \sum_{i=1}^{n} \frac{1}{R_n} \quad R_{\text{series}} = \sum_{i=1}^{n} R_n \]

What is the power consumed by this direct-current circuit?

- First, Equivalent R = 75 \, \Omega
- Next, Current \, I = E/R = 24 \, \text{V}/75 \, \Omega = 0.32 \, \text{A}
- Finally, use the equation to find the power consumed by the circuit.
- \[ P = EI = 24 \, \text{V} \times 0.32 \, \text{A} = 7.7 \, \text{W} \]

A. 7.7 W
B. 11 W
C. 23 W
D. 230 W
When a ground–fault circuit interrupter (GFCI) detects current leakage to ground in a circuit, how long does it take a typical GFCI to open the circuit and interrupt the current flow?

- A. 0.0002-0.0003 seconds (2-3 microseconds)
- B. 0.002-0.003 seconds (2-3 milliseconds)
- C. 0.02-0.03 seconds (2-3 hundredths of a second)
- D. 0.2-0.3 seconds (2-3 tenths of a second)

Ground-fault circuit interrupters sense current leakage to ground and open the circuit in about 2 hundredths of a second.
That electrical hazard is presented by a 0.75 F capacitor on a de-energized circuit?

A. Latent voltage
B. Latent current
C. Latent power
D. Latent inductance

The term latent means hidden. Capacitors store electric charge and even when the circuit is de-energized a capacitor can release this charge based on the rating of the capacitor when the circuit is closed. A 0.75 F (farad) capacitor is a very large capacitor and if the capacitor is not discharged through a discharge resistor when the circuit is de-energized, there is a high voltage hazard present.
Use one or more of the following equations to assist with answering this question.

\[ I = \frac{E}{R} \quad P = E \cdot I = I^2 \cdot R \quad \frac{1}{R_{\text{parallel}}} = \sum_{i=1}^{n} \frac{1}{R_i} \quad R_{\text{series}} = \sum_{i=1}^{n} R_i \]

Which statement is true?

A. As the total resistance in a circuit increases, power consumption decreases when current flowing through the circuit is held constant.
B. As the total resistance in a circuit increases, the current flowing through the circuit decreases when voltage is held constant.
C. As the voltage in a circuit increases, the current flowing though the circuit decreases when the resistance in the circuit is held constant.
D. As the voltage in a circuit increases, the power consumption decreases when the current flowing through the circuit decreases.

As the total resistance in a circuit increases, the current flowing through the circuit decreases when voltage is held constant. This is the definition of Ohm’s Law.
What hazard is present when a flammable liquid is being transferred from one container into another?

A. Ignition of flammable vapors from auto-ignition
B. Ignition of flammable vapors from reaching the flash point
C. Ignition of flammable vapors from mechanical sparks
D. Ignition of flammable vapors from static electricity

When flammable liquids are being transferred between containers, ignition from static electricity is a hazard that must be controlled through bonding and grounding the containers.
Which is a typical sign of heat syncope?

• A. Red skin
• B. Dry skin
• C. Fainting
• D. Convulsions

Syncope is synonymous with partial or full loss of consciousness (followed by full recovery) due to temporary impairment of blood supply to the brain. Heat syncope is fainting due to overexposure to heat.
When a volcano erupts nearby, what hazard can engulf an entire town with little warning?

- A. Cyclonic event
- B. Lava
- C. Seismic event
- D. Pyroclastic flow

Natural hazards associated with seismic and volcanic activity are important to understand. The pyroclastic flow (also called the pyroclastic density current) is the hot gases and ash that flows down the side of a volcano at very high speeds.
A heat stress standard for continuous work is described below. Wet bulb globe temperature index standards Light work: 30.0°C  Moderate work: 26.7°C. Heavy work: 25.0°C. A cabinet-making crew working outdoors in the open sun is exposed to the following temperatures.

**Outdoors:** Natural wet bulb temperature: 24°C  Dry bulb temperature: 31°C  Globe temperature: 43°C

Management asks a safety professional whether there is any advantage to moving the crew indoors. Temperatures taken inside reveal the following.

**Indoors:** Natural wet bulb temperature: 22°C.  Dry bulb temperature: 25°C.  Globe temperature: 31°C.  Finally, the safety professional finds the following equations for calculating the wet bulb globe temperature index. \( WGBT = 0.7T_{nwb} + 0.3T_g \)

Given all of this information, what is the most appropriate analysis by the safety professional?

A. Outside, only moderate work can be done; while inside, heavy work can be done
B. Outside, only light work can be done; while inside, heavy work can be done
C. Outside, only light work can done; while inside, moderate work can be done
D. Both outside and inside, only moderate work can be done.

First, evaluate the WGBT index for work outdoors. Outdoors (uses the solar load term) \( WGBT = 0.7 \text{ NWB} + 0.2 \text{ GT} + 0.1 \text{ DB} = 28.5°C \). Next, evaluate it for work indoors, Indoors (does not use the solar load term) \( WGBT = 0.7 \text{ NWB} + 0.3 \text{ GT} = 24.7°C \). Finally, evaluate these two indexes against the corporate standards. Outdoors, the WBGT index is calculated at 28.5°C. Since this temperature is above the standard for moderate work (26.7°C) and below the standard for light work (30.0°C), only light work is permitted outdoors. Indoors, the WBGT index is calculated at 24°C. Since this temperature is below the standard for heavy work (25°C), heavy work may be done indoors.
The wavelength of the visible region of the electromagnetic spectrum extends from .................. nanometers

A. 100 to 280
B. 170 to 400
C. 400 to 780
D. 780 to 1400

- The visible portion of the electromagnetic spectrum is from 400 to 780 nm. This is important to know in laser safety, since a person’s aversion reflex (blink/turn-away reflex) is based on the visible spectrum of light. Laser energy entering the eye operating outside these wavelengths will not cause a person to blink or turn away.
Which expression best represents how to calculate the radiation intensity (RI) at a distance (X) from a source of radiation intensity Io?

A. $\text{RI} = \frac{I_0}{X}$

B. $\text{RI} = \frac{I_0}{X^2}$

C. $\text{RI} = \frac{I_0}{X^3}$

D. $\text{RI} = \frac{1}{I_0X^2}$

The correct answer (B) is also called the Inverse Square Law. When the distance an object is from an energy source is doubled, the energy imparted on the object is reduced by one-fourth. This law is applicable to sound energy, ionizing radiation and non-ionizing radiation.
Which is a form of non-ionizing radiation?

• A. Alpha
• B. X-ray
• C. Gamma
• D. Ultraviolet

Ultraviolet radiation is a form of non-ionizing radiation. The other answer selections are all forms of ionizing radiation.
The following octave band noise measurements were collected. Noise levels Collected:

<table>
<thead>
<tr>
<th>Octave Band Center Frequency (Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
<th>8000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound Pressure Level (dB)</td>
<td>115</td>
<td>105</td>
<td>98</td>
<td>95</td>
<td>89</td>
<td>88</td>
<td>95</td>
</tr>
<tr>
<td>A-Weighting Correction</td>
<td>-16</td>
<td>-9</td>
<td>-3</td>
<td>0</td>
<td>+1</td>
<td>+1</td>
<td>-1</td>
</tr>
</tbody>
</table>

The following formula may assist you with this noise problem:

\[ L_{PT} = 10 \cdot \log \left[ \sum_{j=1}^{N} \left(10^{\frac{L_{PT}}{10}}\right) \right] \]

A local hearing conservation regulatory standard permits no employee to be exposed to 85 dBA for more than 8 hours per day on a time-weighted average (with a 3 dB exchange rate). Using the formula shown below, how many hours per day (T) may an employee work without exceeding the local regulatory hearing conservation standard?

\[ T = \frac{8}{\left[\frac{L_{PT} - 85}{3}\right]^2} \]

A. 0.1 hours (6 minutes)
B. 1.2 hours (72 minutes)
C. 4.0 hours (240 minutes)
D. 4.8 hours (288 minutes)

Please see next page
Since all of the noise levels are generated by one machine, the levels are additive. First, add the A-weighting octave bank corrections to the sound pressure level for each octave band. Add each band contribution to calculate the resultant sound pressure level. Next, calculate the total A-weighted sound pressure level using the first formula in the problem.

<table>
<thead>
<tr>
<th>Octave Band Center Frequency</th>
<th>Sound Pressure Level (dB)</th>
<th>A-Weighting Correction</th>
<th>Corrected dB Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>115</td>
<td>-16</td>
<td>99</td>
</tr>
<tr>
<td>250</td>
<td>105</td>
<td>-9</td>
<td>96</td>
</tr>
<tr>
<td>500</td>
<td>98</td>
<td>-3</td>
<td>95</td>
</tr>
<tr>
<td>1000</td>
<td>95</td>
<td>0</td>
<td>95</td>
</tr>
<tr>
<td>2000</td>
<td>89</td>
<td>+1</td>
<td>90</td>
</tr>
<tr>
<td>4000</td>
<td>88</td>
<td>+1</td>
<td>89</td>
</tr>
<tr>
<td>8000</td>
<td>95-16</td>
<td>-1</td>
<td>94</td>
</tr>
</tbody>
</table>

Continued .. next page
Ans of Q 22

- Formula

\[
L = 10 \cdot \log \left( \frac{99}{10} + \frac{96}{10} + \frac{95}{10} + \frac{95}{10} + \frac{90}{10} + \frac{89}{10} + \frac{94}{10} \right) = 10 \cdot 10.35 = 103.5 \text{dBA}
\]

- Finally, using the local regulatory formula for hearing conservation found in the problem, calculate how long an employee may be exposed to a noise of 103.5 dBA

- Formula

\[
T = \frac{8}{\left[ \frac{(103.5-85)}{3} \right]^2}
\]

\[
T = 0.11 \text{hrs} = 6.7 \text{minutes} \approx 6 \text{ minutes}
\]
The maximum frictional force on a body resting on another body is proportional to the:

- A. Resultant of all forces perpendicular to the surfaces in contact and the coefficient of static friction.
- B. Resultant of all forces perpendicular to the surfaces in contact and the coefficient of kinetic friction.
- C. Total area of the surfaces in contact and the coefficient of friction.
- D. Coefficient of static friction and the mass of the bodies

The force of static friction between two surfaces in contact but not in motion, relative to each other, cannot be greater than $N \times f$, where $N$ is the normal (perpendicular) force between the two surfaces and $f$ (coefficient of static friction) is a dimensionless constant that depends on the nature of the pair of surfaces.
When hung on a scale at sea level, the scale indicates that a brick’s mass is 25 kg. When the same brick is submerged in water at sea level and hung on the scale, it indicates that the mass of the brick is 15 kg. What is the specific gravity of the brick?

A. 0.6  
B. 1.6  
C. 2.5  
D. 4.0

\[
\frac{25}{10} = 2.5
\]
A simple, stationary two-leg sling supports a mass of 1500 kg. Member AC is a rigid spreader bar. The two legs of the sling form a 20 degree angle with the horizontal. What is the load in wire rope Member AB, assuming that the load is symmetrical?

![Diagram](image)

Each Leg = \( \frac{1500}{2} = 750 \) Kg

750 Kg = 750 x 9.8 = 7350 N

\[ T_{AB} \times \cos 70 = 7350 \text{ N} \]

\[ T_{AB} = \frac{7350}{\cos(70)} = \frac{7350}{0.342} = 21.5 \text{kN} \]

A. 2.2 kN
B. 4.4 kN
C. 21.5 kN
D. 43.0 kN
The following equation and information may assist you with this question.

$$PV = nRT$$

$$1\ \text{atm} = 101.3\ \text{kPa}$$

$$25^\circ\text{C} = 298\ \text{K}$$

$$R = 0.08205\ \text{L\ 'atm\ 'K}^{-1}\ \text{mol}^{-1}$$

A 50-L cylinder of dry air (average molecular weight of dry air is 28.8 g/g-mol) is filled to 16000 kPa (gauge) at 0°C. What is the mass of dry air in the cylinder?

A. 0.354 kg

$$\frac{16000}{101.3} = 158\text{atm}g + 1 = 159\text{atm}a$$

B. 1.94 kg

$$159\text{atm} \cdot 50\text{L} = n \cdot 0.082 \cdot 273\text{K}$$

C. 10.2 kg

$$n = \frac{159 \cdot 50}{0.082 \cdot 273} = 355\text{g\ moles}$$

D. 14.4 kg

$$355 \cdot 28.8 = 10200\text{g} = 10.2\text{Kg}$$
What is a BLEVE?

- A. Boiling Liquid Expanding Vapor Explosion
- B. Boiling Liquid Exploding Vapor Expansion
- C. Burning Liquid Expanding Vapor Explosion
- D. Burning Liquid Entrained Vapor Explosion

A BLEVE is an acronym (pronounced “Bleh’Vee”) that stands for a Boiling Liquid Expanding Vapor Explosion. These are associated typically with tanks containing liquefied petroleum gas such as rail tank cars containing propane that are on fire.
What is bounded at the upper end by a material’s UFL and bounded at the lower end by the material’s LFL?

• A. The material’s flash point
• B. The material’s flashover range
• C. The material’s autoignition parameters.
• D. The material’s flammability range

A material’s flammability range is bounded on the upper end by the upper flammability limit (UFL) and bounded on the lower end by the lower flammability limit (LFL). These are sometimes called the upper and lower explosive limits, respectively (referred to by their abbreviations UEL and LEL). This flammability range is based on the mixture of the material by volume in air.

• Above the UFL, the mixture is too rich to ignite and below the LFL, the mixture is too lean to ignite. However, it is important to note that the LFL and UFL for a material are determined at a certain baseline temperature, pressure and humidity, therefore, there are variations in these values in the field.
What hazard does compressed oxygen (medical grade, medical use) present when assessing the fire risk in hospital rooms?

A. Compressed oxygen can add fuel to a fire.
B. Compressed oxygen can cause a fire to burn much more intensely.
C. The presence of compressed oxygen reduces the fire risk in a hospital room
D. The presence of compressed oxygen has no effect on the fire risk in a hospital room

Oxygen is an oxidizer and will allow a fire that gets started to burn much more fiercely. Oxygen is not flammable (it is not a fuel) but it significantly increases the severity of a worst-case loss event in a hospital room. Therefore, smoking should not be permitted in rooms where oxygen is being used.
A smoke detector is sensitive to the ............ from a fire.

A. Heat generated  
B. Flashes generated  
C. Products of combustion  
D. Ultraviolet and infrared output  

- Smoke detectors are sensitive to the products of combustion (i.e., smoke) from fire. Sometimes, these products may be invisible to the human eye, but ionizing, photoelectric and combination photoelectric / ionizing smoke detectors can detect these minute smoke particles.  
- The energy from combustion is detected by other types of fire detection apparatus.
To what general class of hydrocarbon is the flammable material acetylene (also called ethyne) cataloged?

- A. Aryl (aromatic, covalently-bound carbon in a ring structure)
- B. Alkane (aliphatic paraffin, single carbon-carbon bond)
- C. Alkane (aliphatic olefin, double carbon-carbon bond)
- D. Alkyne (aliphatic, triple carbon-carbon bond bond)

Acetylene (IUPAC designation: ethyne) is a triple carbon-carbon bond hydrocarbon. It is properly classed as an alkyne.
What is heat produced by the human body called?

- A. Latent heat
- B. Metabolic heat
- C. Enthalpy
- D. Effective heat

The human body metabolizes food using chemical processes and creates energy from these metabolic processes. This energy is the body’s metabolic heat and it can be measured.
From what type of occupational activity is Raynoud’s phenomenon a characteristic sign?

- A. Standing for long periods of time
- B. Sitting for long periods of time
- C. Using vibrating tools
- D. Welding aluminum

Raynaud’s phenomenon is characterized by white knuckles and fingers and can be brought on by exposure to cold or by the use of vibrating tools.
Which typically is considered a repetitive motion disorder?

- A. Atherosclerosis
- B. Amyotrophic lateral sclerosis
- C. Carpal tunnel syndrome
- D. Guillain-Barre syndrome

Carpal tunnel syndrome is a classic repetitive motion disorder. Others include tenosynovitis (also called De Quervain’s disease or trigger finger), epicondylitis (tennis elbow), thoracic outlet syndrome and tendonitis.
Which is a type of workplace violence?

- A. Horseplay
- B. Armed robbery
- C. Death of a colleague
- D. Theft.

Workplace violence is related to the perception of an employee that he or she may be harmed by another person, regardless of the other person’s actual intent, and regardless or whether the other person is an employee. Therefore, an armed robbery is a form of workplace violence.
When designing a presence-sensing, point-of-operation device for a press, what is the minimum distance required from the sensing field to the point-of-operation, assuming a hand speed constant of 63 inches/second (160cm/second) and a stopping time for the press of 0.75 seconds?

A. 31.50 inches (80cm)
B. 47.25 inches (120 cm)
C. 63.00 inches (160 cm)
D. 84.00 inches (214 cm)

Find the minimum safe guarding distance. This problem can be worked two ways—using U.S. customary units or in metric units.

• Metric
  • $D_s = 160 \text{ cm/second} \times T_s$
  • $D_s = 160 \text{ cm} \times 0.75 \text{ seconds} = 120 \text{ cm}$

• U.S. Customary
  • $D_s = 63'' / \text{ second} \times T_s$
  • $D_s = 63 \times 0.75 \text{ seconds} = 47.25''$
What predictive analytical method is designated by the acronym THERP?

A. Circuit redundancy
B. Fault probability
C. Failure modes
D. Human error

The acronym THERP (pronounced "Thurp") stands for Technique for Human Error Rate Prediction. It is a quantitative method for estimating the probability of human error occurring during a process step or sequence of steps.
When should an octave-band analyzer be used?

A. To ensure that equipment is operating properly by detecting a pure tone
B. To ensure that noise energy is being spread equally across the frequency spectrum
C. To determine where the noise energy lies in the frequency spectrum
D. To determine the highest sound pressure level of an integrated noise measurement.

Octave band analyzers are used to understand noise energy across a spectrum of frequencies. The noise energies are then aggregated to quantify the actual noise energy affecting employees.
What is the basic operating principle of a portable combustible gas meter?

A. The measured change in sample gas temperature from heating due to combustion of the sample gas is a combustion chamber

B. The measured change in electrical resistance from heating due to combustion of the sample gas across a Wheatstone bridge

C. The measured change in electrical conductivity of the sample gas due to ion exchange within the combustible gas meter.

D. The measured change in electric potential of the sample gas due to ionization of the sample gas when the sample gas is exposed to a potential difference.

A portable combustible gas meter works from the measured change in resistance occurring due to the heating from combustion of the sample gas across a Wheatstone bridge. The change in resistance is compared against that for the calibration gas and the percent of the lower flammability limit is reported.
The following equation and information may assist you with answering this question.

\[ F = ma = mg \]

\[ \rho_{H_2O} = 1000 \text{ kf/m}^3 = 62.4 \text{ lb/ft}^3 \]

\[ 1 \text{ Pa} = 1 \text{ Nm}^{-2} = 1 \text{ kg m}^{-1}.\text{s}^{-2} = 0.000145 \text{ lb/in}^2 \text{ (psi)} \]

\[ 1 \text{ ft} = 30.48 \text{ cm} = 12 \text{ in} \]

\[ G = 9.81 \text{ m/s}^2 \]

What pressure should be expected at a water sampling port located at the bottom of a water tower that is 50 m high from the sampling port to the highest point within the tank, assuming the water tower is full?

A. 5.1 kPa (0.74 psi)
B. 490 kPa (71 psi)
C. 610 kPa (88 psi)
D. 690 kPa (100 psi)

- The pressure at the bottom of a column of water is based on the height of the water column. The width of the water column is irrelevant.
- This problem can be worked two ways – using U.S. customary units or in metric units.

**Metric**

\[ F = mg \]

\[ = 1000 \text{ kg/m}^3 (50\text{m}) (9.81\text{m/s}^2) \]

\[ = 490500 \text{ kg m}^{-1}.\text{s}^{-2} \]

\[ = 490500 \text{ Pa} \approx 490 \text{ kPa} \]

**U.S. Customary**

\[ F = mg \]

\[ = 62.4 \text{ lb/ft}^3 (164 \text{ ft}) \]

\[ = 10236 \text{ lb/ft}^2 (1 \text{ ft}/12 \text{ in})^2 \]

71 lb/in^2 \approx 71 \text{ psi}
When performing personal monitoring for exposure to an airborne chemical, the sampling device and sampling protocol must be designed so that the employee’s ................ can be inferred from the sample results.

A. Short-term exposure limits
B. Threshold limit values
C. Time-weighted average exposure
D. Permissible exposure limits.

It is essential that exposure data leading to an understanding of the employee’s time-weighted average exposure be obtained.
What class of air sampling device is a Drager-Tube?

- A. Grab sampling device
- B. Data logging device
- C. Integrating air sampling device
- D. Quantitative air sampling device

A Drager-Tube is a grab sampling device. It is a type of colorimetric tube suitable for estimating the exposure level of an airborne material in any one location.
Which type of dry chemical material is most suitable for extinguishing fires fueled by ordinary combustibles such as paper and cardboard?

- A. Sodium chloride
- B. Potassium chloride
- C. Potassium bicarbonate
- D. Ammonium phosphate

Of the four listed dry chemicals, only ammonium phosphate is a listed chemical for using on fires with ordinary combustibles as the fuel.
Which type of sprinkler system is designed primarily to protect properties when there is danger of serious water damage, resulting from damaged automatic sprinklers or broken sprinkler piping?

- A. On/off sprinkler system
- B. Dry pipe system
- C. Preaction system
- D. Dry pipe system equipped with exhauster
- Precaution systems are typically found in environments that have computers or communications equipment, museums or other facilities where an inadvertent discharge of water is a major concern.
What provides the highest degree of safeguarding while not sacrificing utility at the point of operation of a guillotine-type paper cutter?

• A. A gate that encloses the point of operation before the clutch can be actuated.
• B. A pullback device attached to the operator’s hands that moves them from the point of operation before the knife descends.
• C. A fixed-barrier guard that protects the point of operation.
• D. A control that requires the operator to use both hands to engage the clutch.

The stack height of paper being sheared would probably preclude the use of gates enclosing the point of operation and the same would apply to the fixed-barrier guard. Pullback devices require continuous adjustment, therefore, the best selection is a two-hand control device.
Which provides the best protection to employees operating power presses?

- A. Fixed-enclosure guard
- B. Pullback device
- C. Proximity device
- D. Two-hand trip device

The fixed-enclosure guard is in place at all times, except for maintenance or die changing. Pullback devices are subject to stretch and need to be adjusted regularly. Proximity sensors are subject to variability and two-hand trips can be defeated.
Why should a hood guard be used on the abrasive wheel of a floor-stand grinder?

- A. To prevent persons or objects from coming in contact with the revolving abrasive wheel
- B. To contain the fragments of a broken abrasive wheel
- C. To contain the large dust particles (<20 m) so that they can be removed by the local exhaust system
- D. To protect the employee’s eyes from sparks and small particles.

The guard is designed to retain the pieces of the grinding wheel should the grinding wheel break during operation.
The battery in a household smoke detector is almost discharged and the smoke detector chirps every 30 seconds to alert the occupants to replace the battery. What kind of system design does this smoke detector feature represent?

- A. Fail-active
- B. Fail-passive
- C. Fail operational
- D. Fail-tolerant

A fail-active device is one that continues to operate upon detection of a fault condition and actively engages a safety system upon detection of a fault condition (such as a low voltage condition due to the discharged battery). In the case of the smoke detector, the 30 second chirping is the active engaged safety system alerting the occupants of the impending battery failure. A fail-passive device causes the device to fail in a non-working state when a failure or fault is detected. A fail-operational device continues to operate in the event of a failure and no special safety systems are engaged as a result of the fault
The following equation may assist you with answering this question.

\[ Q = VA \]

If the inward centerline face velocity at the inlet of a plain 8 inch (20 cm) diameter exhaust duct is 1000 ft/min (5 m/s), what is the best estimate of the volumetric flow rate?

- A. 350 ft\(^3\)/min (0.16 m\(^3\)/s)
- B. 1400 ft\(^3\)/min (7.1 m\(^3\)/s)
- C. 11900 ft\(^3\)/min (60.4 m\(^3\)/s)
- D. 50300 ft\(^3\)/min (255 m\(^3\)/s)

\[
\pi \left[ \left( \frac{8}{12} \right)^2 \right] = 0.349 \quad 1000 \times 349 = 349 \approx 350
\]
The possibility a welder being engulfed by grain while welding inside a grain hopper is a hazard that should be considered as part the:

- A. Segregation of hazards program
- B. Hot work program.
- C. Hazardous energy control program
- D. Process safety management program.
Which best describes the role of a staff safety professional?

A. Personally investigation most incidents occurring within the organization
B. Retaining direct responsibility for safety performance within the organization
C. Influencing organizational line management to accept accountability for safety performance.
D. Maintaining a wide personal acquaintance with employees at all levels.

The role of a staff safety professional is one of a consultant and influencer. Since safety should be built into line performance, a key role of a safety professional is to influence line management to accept accountability for safety performance.
Which is an essential component of an effective product hazardous condition warning label?

A. How to use the product to cause to hazardous condition to appear
B. How to seek medical attention after coming into contact with the hazardous condition
C. How to avoid coming into contact with the hazard condition
D. How the hazardous condition warning has been acknowledged by the user

- Effective product warning labels:
  - * Identify that there is a hazard
  - * Indicate the level of seriousness
  - * Indicate the likelihood of harm
  - * Explain how to avoid the hazard and
  - * Describe consequences if not heeded.
How are future injuries and property damage caused by unsafe employee actions best reduced?

- A. Reinforcing negative behavior every time it is observed
- B. Building avoidance through positive consequences
- C. Concentrating on a behavior pattern and its underlying causes
- D. Systematically reinforcing positive employee actions and behavior

There are three broad categories of options to affect behavior;
- Modify behavior which can shape the worker behavior through systematically reinforcing the right or desired behavior until the new habit (safe behavior) is formed.
- Change attitudes so the later behavior will follow the new attitude
- Build a psychological environment so that the worker feels more comfortable working safely.
What is most significant when evaluating maintenance operating procedures?

- A. Ensuring that machine energy is zero and will remain so during maintenance
- B. Ensuring that a tagout procedure is described and will be implemented during maintenance
- C. Ensuring that the maintenance procedure has supervisory oversight
- D. Ensuring that there is at least one additional person on-hand to assist in an emergency during maintenance

It is essential that all energy sources are zero and remain that way during maintenance operations. This includes unexpected energy sources such as the kinetic energy (mechanical energy) from engulfment hazards and items that could fall and strike employee, in addition to the usual energy sources such as electricity, high pressure and heat sources.
Before maintaining electrically-powered equipment, an employee opens the electrical circuit powering the equipment and places his personal lock on the circuit breaker to ensure that the circuit remains open while he is performing maintenance on the equipment serviced by that electrical circuit.

What type of control does this describe?

A. Engineering control  
B. Administrative control  
C. Personal control  
D. Personal protection equipment.

- Locking out a circuit is an administrative control (a procedure) since it requires a person to perform the action each time. Engineering controls are permanent fixtures that need no human interaction to operate. Personal protective equipment is worn by employees as a final barrier against coming into contact with a particular
What do safety incentive programs attempt to influence directly?

- A. Employee behaviors
- B. Employee attitudes
- C. Organizational culture
- D. Organizational structure

Employee incentive programs attempt to influence employee behaviors. Incentive programs rarely have any effect on organizational culture or employee attitudes.
Which is the best example of an administrative hazard control?

• A. Requiring all machines to have installed safeguards that automatically prevent employees from coming into contact with the point of operation when the machine is operating.
• B. Requiring employees to use automation machines as designed, including using all installed machine safeguards.
• C. Requiring employees to use SCBA when investigating the source of a high concentration of airborne benzene.
• D. Requiring employees to engage in 10 minutes of cooling rest after 25 minutes of working in direct sun when the temperature is more than 30°C (86°F).

Of the answer selections listed, work rotation is the only administrative hazard control. Requiring employees to use machines as designed is not a formal administrative hazard control per se.
What type of respiratory protection should be selected when the atmosphere is known to be life threatening?

A. Demand flow airline respirator
B. Positive pressure airline respirator
C. Self-contained breathing apparatus
D. Powered, full-facepiece air-purifying respirator

• When the atmosphere is known to be life-threatening, self-contained breathing apparatus should be selected.
Which best describes the term universal precautions?

• A. The use of latex gloves when handling bodily fluids
• B. The use comprehensive infection control procedures including necessary personal protective equipment, sharps management, and contaminated equipment management.
• C. The use of Biohazard Safety Levels 1-4 for the management of airborne or potentially airborne infectious agents in bioresearch institutions.
• D. The use of regulated sharps management program for disposing of needles and other instruments that come into contact with human fluids and potentially infectious agents.

• The term universal precautions is commonly used in the medical field and is related to the comprehensive infection control procedures healthcare organizations use. Universal precautions are not limited to the use of personal protective equipment, but also include sharps management and contaminated equipment management procedures.
What is necessary when working with Class 3B lasers?

- A. Protective eyewear with blast resistance
- B. Protective eyewear with harmonic protection
- C. Protective eyewear with heat resistance
- D. Protective eyewear based on the emitted wavelength

Laser eyewear must be selected with the specific laser wavelength in mind.
What is a quantitative fit test?

• A. A respiratory protection testing protocol
• B. An encapsulating hazardous materials ensemble testing protocol
• C. A statistical test of correlation between two variables.
• D. A fire extinguisher regulator testing system

A quantitative fit test is a respirator fit testing protocol used to determine how well a respirator fits on an individual by measuring the concentration of a benign contaminant gas inside the face piece.
When should full-facepiece respirators be cleaned and inspected?

- A. Before and after each use
- B. Dairy
- C. Weekly
- D. They should be discarded after each use

Non-disposable respirators (such as full-face piece respirator) should be cleaned and inspected before and after each use.
What is necessary when hearing protection is first provided to employees?

- A. Employees should be given a baseline audiogram before being permitted to use hearing protection.
- B. Employees should be enrolled in the hearing conservation program before being permitted to use hearing protection.
- C. Employees should be shown when to use the hearing protection and how to use it.
- D. Employees should be counseled on the temporary nature of the hearing protection.
- It is essential that employees be informed when to use hearing protection (e.g. where hearing protection is required and under what conditions) and how to properly use the hearing protection (including how to obtain replacement hearing protection).
What is a common problem associated with some latex gloves?

• A. A harboring of undesirable bacteria
• B. A high incidence of viral pneumonitis
• C. An allergy or sensitivity to latex
• D. An inability to protect against blood borne infectious agents

Latex allergies are common and employees who are sensitive or allergic to latex should be provided with gloves that contain no latex.
Who is responsible and accountable for ensuring that an employee wears the proper personal protective equipment which at work?

- A. The safety management
- B. The employee
- C. The employee’s union
- D. The employee’s employer

The employee’s employer is responsible and accountable for ensuring that an employee is wearing appropriate personal protective equipment. Though a safety manager may be part of the employer, line supervision should be responsible and accountable for ensuring that personal protective equipment is donned and is the type appropriate for the work.
Which types of glove materials are best for handling containers contaminated with a acid such as hydrochloric acid?

- A. Polyvinyl acetate or polycellulose
- B. Butyl rubber or neoprene
- C. Polyvinyl alcohol or cellulose
- D. Butylamine or acetate

Glove materials such as butyl rubber or neoprene are generally best for handling acids like hydrochloric acid. The other glove materials are particularly poor for corrosive materials.
What is the primary purpose of a training program’s course objectives?

- A. Listing the course content and visual aids
- B. Describing the content of the lesson plan
- C. Outlining the instructional procedure
- D. Describing the intended outcome of instruction

• The course objective describe the outcome of a training session.
Which is a key component in a typical behavioral approach to improving safety?

A. Setting goals
B. Having active safety contests
C. Enforcing disciplinary action programs
D. Writing safety procedures

Setting safety-related performance goals can change behavior if management is willing to routinely check on progress toward fulfilling goals (especially by establishing intermediate objectives by which progress toward meeting the goals can be measured).
Which is considered an advantage of the lecture method of delivering training?

- A. The trainer can address any size group.
- B. Points stressed are those in the instructor’s lesson plan.
- C. Information can be presented quickly as the instructor does not have to allow time for questions.
- D. Background information can be presented to emphasize important ideas.
- A large group can be addressed and a large amount of information can be presented using the lecture method of training
In an emergency resulting from damage due to a meteorological event, what is the first consideration?

A. Turning responsibility over to public agencies  
B. Evacuating personnel and abandoning the system  
C. Terminating normal operations that represent sources of flammable or toxic agents.  
D. Safeguarding personnel and the system.

In any emergency the first consideration is always safeguarding personnel and the system. Evacuation is not always the best way to safeguard personnel (especially in a meteorological event).
Which situation represents the best reason to use resources from outside the organization to implement a new safety performance strategy?

- A. There is poor alignment across levels of management relating the values that support good safety performance.
- B. The safety manager has excellent knowledge, but is not particularly adept in making presentations.
- C. Management has decided to improve the safety performance.
- D. There is considerable concern as to who will train safety professionals.
- External resources may be helpful to bridge the misaligned values related to safety performance. Frequently, the non-biased (Outside) view will help coalesce the thinking across levels of management so that good safety performance values can be agreed to.
What is the most important element to consider when reconstructing a motor vehicle collision?

- A. Vehicle maintenance
- B. Driving records of involved individuals
- C. The possibility of multiple causal factors
- D. The single causal factor
- When investigating any incident it is important to remember that there will a number of causal factors for which there will a number of root causes.
Safety sampling can be a successful method to verify the effectiveness of a safety strategy provided that:

- **A.** The technique is adapted to the operation, a sound basic incident prevention program is in place and the management is familiar with the technique and the technique’s ability to yield actionable information.

- **B.** A sound basic incident prevention program is in place and the disabling injury frequency rate is below the industrial average.

- **C.** A sound basic incident prevention program is in place and the observations are made in a manufacturing environment.

- **D.** The technique is adapted to the organization and only physical conditions are observed.

Safety sampling is a highly effective way to verify that a method or strategy is working, provided that the safety sampling process is understood along with its limitations.
What is the purpose of an audit?

A. To verify inspection points and regulatory compliance
B. To identify management opportunities for behavioral-based system improvements.
C. To affix accountability for detected performance excursions for the purpose of identifying legal liability.
D. To measure and verify performance against established objective performance criteria for the purpose of process improvement.

Audits are designed to measure and verify the actual performance of a system against established criteria so that the system can be improved.
Which is an essential deliverable within a comprehensive root cause analysis report?

A. Recommendations for corrective actions derived from root causes
B. Recommendations for corrective actions derived from findings of employee fault and/or liability
C. Recommendations for corrective actions derived from findings of manager/supervisor fault and/or liability
D. Causal factors associated with unknown events.

If a formal root cause analysis report does not contain recommendations for corrective actions based on the root causes of the incident, the root cause analysis report failed to meet its objective.
76. Ideally, comprehensive audits are conducted by multidisciplinary teams that are:

- A. New to the work and work processes and independent of the line management
- B. New to the work and work processes and organized within the line management
- C. Knowledgeable of the work and work processes and independent of the line management
- D. Knowledgeable of the work and work processes and organized within the line management.

Audit teams should independent of the line management and should have knowledge of the work flow and work processes that they are auditing.
How can a safety professional work best within the organization?

A. As a technical expert to provide management with objective data
B. As a staff advisor to assist staff and management personnel
C. As an administrative associate to determine policy and exercise authority
D. As a line manager with staff members as subordinates.

Safety professionals are best used as advisors to line management, as a staff function. A safety professional should not have line authority, except as appropriate within his or her own chain of command.
What is a purpose of an employee safety and health committee?

A. To write the company’s safety and health policy and procedures
B. To advise management and employees on safety and health issues
C. To measure and evaluate the effectiveness of the incident and loss control system
D. To use specialized knowledge to eliminate causative factors associated with incidents.
E. A key purpose of a well-run safety committee is to advise management and employees on important safety and health issues. Safety committees are excellent tools for enhancing participation in safety
79. How is program evaluation best described?

- A. Determination of unit costs
- B. Presentation of numerical data in tabular form
- C. Measurement of results against accepted criteria
- D. Determination of priorities on a subjective basis

- A program evaluation is similar to an audit. In both causes, results are verified and compared against defined criteria.

- For a program evaluation, the aspect of continuous improvement does not play as significant a role. A program evaluation may not occur on as routine a basis as an audit.
A safety professional has identified a complex problem. What should the safety professional do first to begin solving the problem?

A. Develop an action plan.
B. Set goals for reducing injuries and illnesses.
C. Perform a needs analysis
D. Determine the applicable compliance issues affecting the problem.

• The first step in solving a problem (once the problem has been identified) is to conduct a thorough needs analysis.
Which technique effectively decreases a project's schedule risk without increasing the overall risk?

A. Incorporating slack time into the project’s critical path schedule early in the project planning

B. Decreasing resource allocation to long-lead items

C. Increasing attention to short-term schedule items to ensure they are delivered on-time.

D. Increasing the number of vendors providing critical products and service to ensure that at least one of them will deliver the products and services on-time.

Incorporating slack into a project schedule is an effective way to reduce schedule risk without increasing overall risk, assuming that the slack was incorporated early in the project life cycle.
82. Which risk analysis method is associated with evaluating a task by breaking it down into its successive steps, identifying the hazards and risks associated with each step, and developing a solution for each risk that will eliminate or control its exposures?

A. System safety analysis
B. Job safety analysis
C. Preliminary hazards and task analysis
D. Management oversight and risk tree analysis

This is the classic definition of job safety analysis. Job safety analysis is a tactical risk assessment method.
Which system safety analysis technique uses deductive reasoning?

- System hazard analysis
- Fault tree analysis
- Preliminary hazard analysis
- Operating and support hazard analysis
- Deductive risk assessment techniques use a top-down approach, such as fault-tree analysis. Inductive methods (such as failure mode and effects analysis and event tree analysis) use a bottom-up approach
. Which is the best definition of risk?

• Risk is the combination of the hazard of a defined exposure and its probability of occurrence.
• Risk is the combination of the hazard of a defined exposure and its magnitude of exposure.
• Risk is the combination of the probability of a defined exposure and its hazard.
• Risk is the combination of the severity of a defined exposure with its frequency of occurrence.
• Risk is best defined as the combination of the severity of a defined loss event and its frequency. Hazard and risk are not the same. In addition, the severity of a loss event is not its risk.
85. Which two measurements are most meaningful in determining an organization’s level of safety performance?

- Scheduled safety audits and benchmarking
- Safety inspections and insurance loss ratios
- Safety inspections and recordable injuries
- Safety maintenance repair logs and dispensary cases.
- Safety performance must be measured. To understand the measurements, independent audits based on meaningful criteria must be conducted regularly.
The ISO 14000 series of environmental management systems requires compliant companies to:

A. Recycle airborne and waterborne hazardous waste within the documented guidelines.
B. Adhere to international law related to the collection and disposal of hazardous waste.
C. Eliminate the use of listed toxic and highly toxic hazardous materials.
D. Control and reduce their impacts on the environment.

• The ISO 14000 series of standards is designed for companies to control and reduce their impacts on the environment.
87. The OHSAS 18001 requirements for occupational health and safety management systems fundamentally are designed to help companies that adopt this standard:

A. Improve their occupational health and safety management systems.
B. Identify unknown hazards.
C. Correct root causes and other documented issues.
D. Reduce their incidence rates
E. OHSAS 18001 is designed so that companies that adopt this methodology will improve their occupational health and safety management systems.
New analytical equipment is purchased for $25,000. New information now shows that the operating costs and maintenance will be $600 per year more than the manufacturer anticipated. If the expected life is 8 years and the cost of money is 8% per year (compounded annually), how much should be deducted from the purchase price to compensate for the extra operating costs?

A. $511
B. $3,448
C. $5,183
D. $6,381
89. One or more of the following equations may assist you with answering this question.

\[
F = P \cdot (1 + i)^n \quad P = \frac{(1+i)^n - 1}{i(1+i)^n} \quad A = P \cdot \frac{i(1+i)^n}{(1+i)^n - 1} \\
A = F \cdot \frac{i}{(1+i)^n - 1}
\]

A new safety system can be designed and installed for $2,000,000. Because of this investment, annual property losses are expected to decrease about $195,000 calculated at the end of the first full year the new system was installed. The life of the new safety system is 25 years and the expected interest rate is associated with the cost of money is 8%, compounded annually. What is the net present value of this new safety system?

A. Positive net present value of $82,000
B. Positive net present value of $160,000
C. Negative net present value of $9,000
D. Negative net present value of $190,000
A capital investment of $10,000 was made exactly 5 years ago. This investment was placed in a financial instrument with a 3% annual percentage rate, compounded monthly. When the investment principal and interest proceeds are withdrawn, what is the total return on investment of the initial investment of $10,000?

A. 3.0%
B. 7.4%
C. 11.1%
D. 16.2%
A system may fail if either Component X or Component Y fails. If component X has a probability of failure of 0.50 and component Y has a probability of failure of 0.70, what is system’s overall probability of failure?

- 0.35
- 0.70
- 0.85
- 1.20
The following table shows the weights of a sample of components. The equation shown adjacent to the table may assist you with answering the question.

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What is the sample standard deviation?

- 0.10
- 0.33
- 1.15
- 1.33

\[
S = \sum_{i=1}^{n} \left[ \frac{(X_i - \overline{X})^2}{N - 1} \right]
\]

\[
\overline{X} = \frac{\sum_{i=1}^{n} X_i}{N}
\]

\[
N = 10
\]

Better use calculator
What additional calculation is necessary to determine the upper and lower control limits associated with industrial hygiene sampling calculations?

A. Sampling and analytical error
B. Threshold limit value
C. Lowest effect observable level
• Coefficient of variation
A large heavy construction project lasted exactly 6 years, from the project's wrap-up. Safety professionals conducted weekly inspections of the construction site using the same inspection protocol over the entire 6 year period. Assuming a normal distribution, what is the best estimate of the number of inspections that had inspection scores within plus or minus 1 standard deviation of the mean?

Areas Under the Standard Normal Curve from 0 to $Z$

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When will management most likely give support to a proactive safety effort?

A. When a serious injury or other costly accident has occurred at the company
B. When the prevention of losses relates to the achievement of company objectives
C. When company insurance premiums are increased after a significant loss.
D. When the company’s frequency and severity rates are higher than the industry average

Safety professionals should endeavor to associate loss prevention with meeting company objectives (e.g., meeting mission objectives)
96. What do lagging indicators of safety, health and environmental performance measure?

A. Measures of activities  
B. Measures of outcomes  
C. Measures of behaviors  
D. Measures of culture

- A lagging indicator Measures outcomes. Lagging indicator Measures history and overall performance. It is untrue that lagging indicator are poor measures of performance, but they are predictive measures of safety of performance.
Which is the best example of leading indicator of safety, health and environmental performance?

A. Number of hazardous materials spills reported
B. Number of corrective actions closed from incident reports
C. Number of lost workdays incidents
D. Number of regulatory citations issued

A leading indicator can help to predict safety performance. Therefore, the number of corrective actions resolved from incident reports is predictive (leading) measure of safety performance.
98. How should leading indicators of safety, health and environmental performance best be used in a safety, health and environmental program?

A. Sparingly
B. By trained safety, health and environmental professionals
C. As part of the normal line performance and accountability process
D. As part of an audit program

- Measures of safety performance should be a normal part of the line safety function. Managers should expect subordinate supervisors to carry out their safety-related responsibilities in the same way they carry out their production-related responsibilities.
Which typically is considered a direct cost of an incident?

- Employee out-patient medical care
- Incident investigation costs
- Replacement employee wages
- Replacement employee training costs
- Employee medical care related to an incident is a direct cost. The other items are classified as indirect incident costs.
100. The total direct and indirect costs of a loss total $100,000, How many units sold for $1.00 each must a self-insured company manufacture to recover this cost assuming that the profit margin on each unit is 10%?

- $1.00 x 10% = $0.10 profit per unit
- $100,000 in losses/$0.10 profit per unit
- = 1,000,000 units needed to recover losses