

# **Mine Foreman Training**

## **Mine Gases – Unit 3**

**Power Point Program and Training**  
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# Properties of Air



**Air is a mixture of gases forming the atmosphere that surrounds the earth.**



**Air is made up of oxygen, nitrogen, carbon dioxide, argon and other rare gases.**



**The essential  
function of air is to  
support life and  
combustion.**



**Air consists of the following gases:**

**oxygen ( $O_2$ ) – 20.93%**

**nitrogen ( $N_2$ ) – 78.10%**

**carbon dioxide ( $CO_2$ ) – 0.03%**

**argon (A) – 0.94%**



**The specific gravity of a gas is the weight of the gas compared to the same volume of air.**



**For the purpose of comparing the weight of other gases to the weight of air, the specific gravity of air is taken as one (1.000)**





# **Intake air in the mine is air which:**

**(1) has not passed through the last working place of a split or by the unsealed entrances to abandoned workings**

**(2) by analysis contains not less than 19.5% oxygen nor more than 0.5% carbon dioxide**

**(3) does not contain any dangerous quantities of flammable gas or any harmful amounts of poisonous gas or dust**



**Dangerous or injurious atmospheres are most likely to be found in unventilated , abandoned areas or idle working places.**



**Before a worker is sent into an abandoned or idle place, a certified foreman must check the place for ventilation, roof conditions, and other dangers as required by a pre-shift examination.**



**When the temperature of air increases, the capacity to absorb moisture increases. Therefore, the changes in weather conditions outside the mine do effect conditions in the mine.**



**When the temperature of the air outside the mine is cooler than the air inside the mine, (mine air is normally 60 degrees) it will travel in the mine and as it rises in temperature, it will absorb the moisture and dry out the mine.**



**As cooler outside air travels through the intake entries, it rises in temperature, absorbs moisture and tends to dry out the mine.**



**When the temperature of the air outside the mine is warmer than the air inside the mine, (mine air is normally 60 degrees) it will decrease in temperature as it travels in the mine and it will deposit moisture in the mine.**



**As warmer outside air travels through the intake entries, it cools, loses its ability to retain moisture, and causes moisture to be deposited in the mine.**





**Air used to ventilate a mine may mix with methane, carbon dioxide, or other gases, lose oxygen by absorption or combustion , and either absorb or deposit moisture.**



**When the air pressure going into the mine increases, the volume of a gas decreases and when the air pressure going into the mine decreases, the volume of the gas increases.**



**A barometer is an instrument used for determining the pressure of the atmosphere.**



**A barometer is read in inches of mercury and each inch of barometer reading is equivalent to a pressure of 0.491 pounds per square inch (psi) of atmospheric pressure.**



**A change in the volume of a gas is directly proportional to the change in absolute temperature and is inversely proportional to the change in absolute pressure.**



**Diffusion of gases means mixing or blending with each other when they come in contact.**



**Light gases diffuse (mix or blend) more rapidly with heavy gases than with other light gases.**



**Gases will not separate or stratify once they have been diffused or mixed.**





**A body of methane is easier to remove than a body of carbon dioxide because methane is lighter than carbon dioxide and diffuses more readily.**



# Properties of Oxygen



**The element in air that is essential for life is oxygen.**



**Oxygen is a tasteless, odorless, colorless gas that supports life and combustion.**



**The hemoglobin of the blood carries oxygen to all parts of the body.**



**Oxygen combines with the carbon contained in waste products in the body and forms carbon dioxide (CO<sub>2</sub>)**



**When people are deprived of the normal content of oxygen in the air, breathing becomes faster and deeper as the deficiency increases .**



**Dizziness, rapid heartbeat, and headache occur when air contains as little as 16% oxygen.**

**Atmospheres with less than 16% oxygen are dangerous and persons entering such atmospheres should enter only when wearing adequate protective equipment which supplies oxygen.**





**An atmosphere in which the oxygen content is less than 16% is called “blackdamp”.**



**The specific gravity (weight) of oxygen is 1.105.**



**The minimum percentage of oxygen that must be present in active mine workings at all times is 19.5%.**



**Oxygen makes up about one-fifth (20.93%) of the earth's atmosphere.**



**The percentage of oxygen decreases while passing through a coal mine because it is absorbed by coal, breathed by men, and consumed by oxidation with other materials.**



**When oxygen is confined in the presence of coal in an underground mine, part of the oxygen combines with carbon to form carbon dioxide, but the greater part is absorbed by the coal.**



**Oxygen can be detected by use of oxygen detectors and by chemical analysis.**



**When abandoned mines or abandoned parts of active mines are penetrated, the machinery shall be stopped and tests for oxygen deficiency and explosive gases shall be made by a person qualified to use the approved instruments.**





**Gas tests shall be made at the mouth of auger holes.**



**When gas tests show oxygen deficiency or the presence of explosive gases, the equipment shall not be operated until the condition is corrected.**



**Black damp or oxygen deficiency will usually be found in auger holes at surface mining operations.**



# Properties of Methane



**Methane (CH<sub>4</sub>) is a potentially explosive gas that is naturally formed from the decay of matter and it is frequently encountered in coal mining operations.**



**Methane is made up  
of carbon and  
hydrogen (CH<sub>4</sub>)**



**The specific gravity  
or weight of methane  
is 0.555.**



**Methane is liberated from coal and adjoining roof and floor strata.**





**Methane is found in all underground coal mines and may also be detected at some surface coal mines, as well as in enclosed areas such as silos, bins, hoppers, and reclaim tunnels**



**Methane is usually found along the roof, in high places, in the vicinity of working faces, in dead ends above falls, in sealed areas, and abandoned workings.**



**Methane is not explosive by itself because it does not contain oxygen which is required to support combustion.**



**The explosive range of methane is between 5% and 15%. However, the explosive range of methane may be lower than 5% when coal dust is in suspension.**



**There can be no explosion when the percentage of methane is greater than 15%, because the amount of oxygen present is insufficient for rapid combustion to occur.**



**When the methane content is less than 5%, with no coal dust in suspension, an explosion will not occur because the heat, liberated by combustion, is dissipated into the surrounding air at a sufficiently rapid rate to prevent flame propagation.**



**The percentage of methane that will produce maximum explosive force is 10%.**



**The approximate ignition  
temperature of methane is  
1200° F.**





**“Fire damp” is an explosive mixture of methane and air.**



**When the percentage of oxygen is below 12%, a methane-air mixture will not explode.**



**Coal dust is more easily ignited in the presence of methane and the force of the explosion is greater.**



**Coal dust in suspension lowers the explosive limit of methane. In other words, it is possible to have an explosion with less than 5% methane if coal dust is present in the air.**



**Methane expands from 17 to 34 times its normal volume when ignited, depending on the amount of coal dust present.**



**Methane can be detected by use of methane detectors and testers, a flame safety lamp, or by chemical analysis.**



**Checks for methane should be made at surface mines. The checks should be made at auger holes, in reclaim tunnels, under coal stockpiles, in coal bins, and in silos.**



**When checking for methane in a reclaim tunnel underneath a coal stockpile, the test should be made near the roof of the tunnel, especially at coal discharge and transfer points.**





**When checking for methane in silos, the test should be made at the top and bottom of silos.**

**Before welding, cutting, or soldering is performed near auger holes, a test for the presence of methane must be made.**

**Methane gas will most likely  
be encountered above a  
pillar fall.**



**Methane gas can be found at surface mines in auger holes, in coal that is processed or stored at tipples, and in coal in open pits.**



**The maximum allowable concentration of methane at a surface mine area is 1.0%.**



**All auger mining machines should be provided with an approved methane detection device.**



**All highwall mining machinery shall be equipped with a methane monitor and be maintained in a permissible condition.**



**All surface mines should  
have an approved methane  
detection device.**





# Properties of Carbon Dioxide



**Carbon dioxide (CO<sub>2</sub>) is a colorless, odorless gas formed by the chemical combination of carbon and oxygen.**



**Lung ventilation increases as carbon dioxide increases. When 5% carbon dioxide is present, lung ventilation increases 300%, breathing becomes labored, and continued exposure is injurious.**



**Carbon dioxide is formed in a mine by combustion, breathing of workers, decay of vegetable and animal matter, oxidation of coal, and chemical action of acid water on carbonates.**



**The specific gravity of  
carbon dioxide is 1.529.**



**Carbon dioxide is the product of complete combustion.**



**Carbon dioxide will ordinarily be found near the floor and in dip workings or in poorly ventilated places.**



**Carbon dioxide can be detected with carbon dioxide detectors or by chemical analysis.**





# Properties of Carbon Monoxide



**Carbon monoxide (CO) is a colorless, odorless, tasteless, combustible, and poisonous gas.**



**Carbon monoxide is an extremely poisonous gas.**



**Carbon monoxide can be detected by carbon monoxide detectors and by chemical analysis.**



**Carbon monoxide is the product of incomplete combustion (combustion with an insufficiency of oxygen).**



**Carbon monoxide will most likely be found in coal mines when there is a mine fire or after an explosion, or when it is produced in smaller quantities by diesel emissions.**



**Internal combustion engines  
produce carbon monoxide.**



**The principal poisonous gas produced by explosives is carbon monoxide.**





**Carbon monoxide causes injury to life by combining with the hemoglobin of the blood and excluding oxygen.**



**200 parts per million  
(0.02%) of carbon monoxide  
will produce symptoms in  
several hours**



**When breathed, carbon monoxide reduces the capacity of the blood to carry sufficient oxygen. Symptoms include drowsiness, headache, imbalance, mental confusion, and burning eyes.**



**Carbon monoxide in quantities of 0.2% - 0.3% (2000-3000 ppm) will produce unconsciousness in 30 minutes.**



**The maximum amount of CO that can be present in the mine atmosphere of active workings is .005% (50ppm).**



**Carbon monoxide is  
poisonous because the blood  
absorbs carbon monoxide  
300 times more readily than  
it does oxygen.**



**Small quantities of carbon monoxide are injurious because it accumulates in the blood.**



**The specific gravity (weight)  
of carbon monoxide is 0.967.**





**The percentage of saturation of the blood with carbon monoxide which is necessary to cause death is 60%-70%**



**Only 0.1% of carbon monoxide in the atmosphere will result in approximately 65% saturation of the blood.**



**0.2% of carbon monoxide present in the atmosphere will result in approximately 80% saturation of the blood.**



**Carbon monoxide is explosive over a wide range. Its range of explosibility is from 12.5% - 74%.**



**The percentage of carbon monoxide required for maximum explosive violence is 32% - 36%.**



**The ignition temperature of carbon monoxide is 1190° F.**



**The most dangerous feature of carbon monoxide is its poisonous character.**



# Properties of Nitrogen





**Nitrogen is a tasteless,  
odorless, colorless gas  
which will neither  
support life nor  
combustion.**



**The specific gravity  
of nitrogen is 0.967.**



**Nitrogen is not combustible. It is in the air we breathe, in fact, it makes up 78.10 percent of the air we breathe.**



# Properties of Hydrogen Sulfide



**Hydrogen sulfide is a poisonous, combustible, colorless gas having a sweetish taste and an odor like rotten eggs.**



**Hydrogen sulfide can be detected by its odor.**



**Hydrogen sulfide can be detected by a hydrogen sulfide detector or by paper dipped in acetate of lead, which will turn black immediately on exposure to hydrogen sulfide.**



**The specific gravity  
(weight) of hydrogen  
sulfide is 1.191.**





**The range of explosibility of hydrogen sulfide is 4.3% - 46% and the most violent explosive percentage is 14%.**



**Hydrogen sulfide is  
extremely poisonous even in  
small amounts.**



**The ignition temperature of hydrogen sulfide is 655° F.**



**Hydrogen sulfide is extremely poisonous in small amounts, even in as little 0.5%. It smells like rotten eggs and is injurious to the eyes. Anyone smelling the odor should retire to fresh air, out of the smell without delay, because very small percentages will destroy the senses of taste and smell before quantities are encountered which might prove fatal.**



# Properties of Nitrogen Dioxide



**Nitrogen dioxide ( $\text{NO}_2$ ) is an extremely poisonous gas frequently formed by the burning of high explosives and in small amounts by diesel equipment.**



**High explosives containing nitroglycerin and nitro-substitution compounds give off nitrogen dioxide when burned.**



**Nitrogen dioxide ( $\text{NO}_2$ ) is  
non – combustible.**





**The most NO<sub>2</sub> that can be present in mine air of active workings is .0003% (3ppm)**



**Extremely low concentrations,  
approximately 0.01% (100ppm)  
will be fatal.**



**Nitrogen dioxide can be detected by a  $\text{NO}_2$  detector, chemical analysis, or by using a paper soaked in a solution of starch and potassium iodide, which will turn blue when exposed to nitrogen dioxide.**



**Nitrogen dioxide is extremely irritating to the nostrils and eyes and relatively small quantities may cause death even after apparent recovery.**



# Properties of Sulfur Dioxide



**Sulfur dioxide (SO<sub>2</sub>) is a colorless, suffocating, irritating, and poisonous gas.**



**Sulfur dioxide (SO<sub>2</sub>) is formed in the mine by burning coal containing pyrites or by diesel exhaust emissions.**



**The specific gravity of sulfur dioxide ( $\text{SO}_2$ ) is 2.263 and it is extremely poisonous even in small amounts.**





**Sulfur dioxide is fatal in percentages of 0.05% (500ppm) or more.**



**Sulfur dioxide can be detected by sense of smell and its effect on the air passages or by chemical analysis.**



**Sulfur dioxide is extremely irritating and suffocating and is intolerable to breathe.**



**Sulfur dioxide is not combustible  
so it will not burn or explode.**



# Properties of Hydrogen



**Hydrogen ( $H_2$ ) is a colorless, odorless, tasteless gas that is formed by mine fires , explosions, and by charging batteries.**



**Hydrogen is explosive over a wide range which is 4.1% to 74%.**



**Hydrogen is the lightest of all gases, with a specific gravity of 0.070 and its ignition temperature is 935° F.**





**Hydrogen can be detected by  
detectors or by chemical analysis.**



# Properties of Water Vapor ( $\text{H}_2\text{O}$ )



**Water vapor is water in a gaseous state and is found in all mine air and its specific gravity is 0.625.**



**The most important condition affecting the humidity of air is temperature.**



**When moisture is added to the weight of air the air becomes lighter since water vapor is lighter than the constituents of air which it displaces.**



**Humidity is the degree to which the air is saturated with moisture.**



**Hot air will hold more  
moisture than cold air.**



# Diesel Exhaust





**Before diesel-powered machinery can be taken into an underground coal mine in the Commonwealth of Kentucky written approval must be obtained from the OMSL.**



**Diesel powered equipment used in an underground coal mine shall be restricted to haulageways and working places where positive (controlled flow) ventilation is maintained.**



**In addition to the amount of air required by the Kentucky Mining Law, at least 6,000 cfm of air shall be provided for each diesel unit used in a working section of a mine.**



**The air for ventilating coal mines where diesel machines are used shall contain not less than 20.5%, by volume, of oxygen (dry basis) and not more than 1.00%, by volume, of methane.**



**Black smoke shall not be permitted in diesel exhaust.**



# Gas Detection



**All gases in coal mines  
can be detected by an  
appropriate gas detector  
or by analysis.**



**Coal companies use different makes and brands of detectors. Some will detect only one gas and some are multi – detectors. Follow the manufacturer’s recommendation and instruction for use, charging, and calibration of the detector being used at your mine.**





**It is your company's responsibility to provide you with all necessary training and information to properly use the gas detection devices being used at your mine. It is your responsibility to make sure that the gas detection devices that you use in performing your duties as mine foreman, be properly charged and calibrated and working properly.**



**Flame safety lamps can be used to detect for the presence of methane and oxygen deficiency, as a “back-up” means only.**



**There are occasions to determine the percentages, volume, and cubic feet of methane and air in a split of air.**



To find the *percentage (%)* of methane when the cubic feet of methane and the total volume of air are known, divide the cubic feet of methane by the volume.



**Example: if a mine liberates 600 cfm of methane in a split and has a volume of air equal to 80,000 cfm, what is the percentage of methane being liberated? Answer : divide the cubic feet of methane by the volume of air ( $600 / 80,000 = .0075 = 0.75\%$ )**



**To find the *cubic feet of methane* when the percentage of methane and the total volume of air are known, multiply the volume by the percentage.**



**Example: if the total volume of an air split in a mine is 80,000 cfm, and the percentage of methane in the split is .75%, how many cubic feet of methane are in the split? Answer : multiply the total volume of air by the percentage of methane in the split (80,000 times .75% or .0075 = 600 cfm)**



**To find the total volume of air when the percentage and the cubic feet of methane are given, divide the cubic feet of methane by the percentage.**





**Example: if a mine liberates 600 cfm of methane, how many cubic feet of air will be required per minute to keep the methane content to 0.75%?**

**Answer : divide the volume of methane by the percentage of methane (600 cfm / .75% = 600 / .0075 = 80,000 cfm)**



# Oral Gas Exam



**What is the essential  
function and weight of air?**



**Answer: to support life and combustion and the specific gravity of air is 1.00.**



**What gases are in the normal air that we breathe and in what percentages?**



<b>Oxygen (O<sub>2</sub>)</b>	<b>20.93%</b>
<b>Nitrogen (N<sub>2</sub>)</b>	<b>78.10%</b>
<b>Carbon Dioxide (CO<sub>2</sub>)</b>	<b>0.03%</b>
<b>Argon and other rare gases</b>	<b>0.94%</b>



**What is meant by the  
specific gravity of a gas?**



**Answer: the weight of the gas compared to the same volume of air.**





**What is considered as  
intake air in a mine?**



# **Answer: Intake air in the mine is air which:**

- (1) has not passed through the last working place of a split or by the unsealed entrances to abandoned workings**
- (2) by analysis contains not less than 19.5% oxygen nor more than 0.5% carbon dioxide**
- (3) does not contain any dangerous quantities of flammable gas or any harmful amounts of poisonous gas or dust**



**What is considered an unsafe mine atmosphere?**



**Answer: one which contains a harmful amount of poisonous gas or a dangerous amount of flammable gas, or one which contains less than 19.5% oxygen and more than 0.5% carbon dioxide.**



**Where are dangerous or injurious atmospheres most likely to be found in mines?**



**Answer: Dangerous or injurious atmospheres are most likely to be found in unventilated , abandoned areas or idle working places.**



**What precaution should be observed before a worker is sent into an abandoned or idle place?**



**Answer: Before a worker is sent into an abandoned or idle place, a certified foreman must check the place for ventilation, roof conditions, and other dangers as required by a pre-shift examination.**





**What effect does temperature have upon the amount of moisture which can be absorbed by air?**



**Answer: When the temperature of air increases, the capacity to absorb moisture increases. Therefore, the changes in weather conditions outside the mine do effect conditions in the mine.**



**What effect does a low outside temperature (below 60° F) have upon the dampness of a mine?**



**When the temperature of the air outside the mine is cooler than the air inside the mine, (mine air is normally 60 degrees) it will travel in the mine and as it rises in temperature, it will absorb the moisture and dry out the mine.**



**What effect does a high outside temperature (above 60° F) have upon the dampness of a mine?**



**Answer:** When the temperature of the air outside the mine is warmer than the air inside the mine, (mine air is normally 60 degrees) it will decrease in temperature as it travels in the mine and it will deposit moisture in the mine.



**What is meant by the diffusion of gases?**



**Diffusion of gases means mixing or blending with each other when they come in contact.**





**How does the diffusion rate  
of gases vary?**



**Light gases diffuse (mix or blend) more rapidly with heavy gases than with other light gases.**



**Will diffused gases  
separate from a mixture  
because of their difference  
in weight?**



**Answer: Gases will not separate or stratify once they have been diffused or mixed.**



**Which is easier to remove,  
a body of methane or a  
body of carbon dioxide?**



**A body of methane is easier to remove than a body of carbon dioxide because methane is lighter than carbon dioxide and diffuses more readily.**



**What element in air is essential for life?**



# Oxygen





**How does the body receive oxygen?**



**The hemoglobin of the blood carries oxygen to all parts of the body.**



**What is blackdamp?**



**An atmosphere in which the oxygen content is less than 16% is called “blackdamp”.**



**What is the specific gravity  
of oxygen?**



**Answer: 1.105**



**What is the minimum percentage of oxygen that can be present in mine air in active workings?**



**Answer: 19.5%**





**Why does the percentage of oxygen decrease while passing through a coal mine?**



**The percentage of oxygen decreases while passing through a coal mine because it is absorbed by coal, breathed by men, and consumed by oxidation with other materials.**



**What changes occur to oxygen in an atmosphere confined in the presence of coal?**



**When oxygen is confined in the presence of coal in an underground mine, part of the oxygen combines with carbon to form carbon dioxide, but the greater part is absorbed by the coal.**



**How may oxygen be detected?**



**Oxygen can be detected by use of oxygen detectors and by chemical analysis.**



**When abandoned mines or abandoned parts of active mines are penetrated, what action shall be taken?**



**When abandoned mines or abandoned parts of active mines are penetrated, the machinery shall be stopped and tests for oxygen deficiency and explosive gases shall be made by a person qualified to use the approved instruments.**





**What instrument can be used to detect for low oxygen deficiency?**



**Oxygen can be detected by use of oxygen detectors and by chemical analysis.**



**What is methane (CH<sub>4</sub>)?**



**Methane (CH<sub>4</sub>) is a potentially explosive gas that is naturally formed from the decay of matter and it is frequently encountered in coal mining operations.**



**What is the composition of methane (CH<sub>4</sub>)?**



**Methane is made up  
of carbon and  
hydrogen (CH<sub>4</sub>)**



**What is the specific gravity  
of methane ( $\text{CH}_4$ )?**



**Answer: .555**





**What is the source of methane (CH<sub>4</sub>) in coal mines?**



**Methane is liberated from coal and adjoining roof and floor strata.**



**In what areas of  
underground mines is  
methane usually found?**



**Methane is usually found along the roof, in high places, in the vicinity of working faces, in dead ends above falls, in sealed areas, and abandoned workings.**



**Why is methane not  
explosive by itself?**



**Methane is not explosive by itself because it does not contain oxygen which is required to support combustion.**



**What is the explosive  
range of methane?**



**The explosive range of methane is between 5% and 15%. However, the explosive range of methane may be lower than 5% when coal dust is in suspension.**





**Why can there be no explosion when the percentage of methane is greater than 15?**



**There can be no explosion when the percentage of methane is greater than 15%, because the amount of oxygen present is insufficient for rapid combustion to occur.**



**What is the percentage of methane required for maximum explosive force?**



**Answer: 10%**



**What is the approximate  
ignition temperature of  
methane?**



**Answer: 1200°F.**



# What is fire damp?



**“Fire damp” is an explosive mixture of methane and air.**





**What is the percentage of oxygen below which no explosion of a methane-air mixture can occur?**



**Answer: 12%**



**What effect does the presence of methane have upon the explosibility of coal dust?**



**Coal dust is more easily ignited in the presence of methane and the force of the explosion is greater.**



**What effect does coal dust in the air have upon the range of explosibility of methane?**



**Coal dust in suspension lowers the explosive limit of methane. In other words, it is possible to have an explosion with less than 5% methane if coal dust is present in the air.**



# How can methane be detected?



**Methane can be detected by use of methane detectors and testers, a flame safety lamp, or by chemical analysis.**





**What dangerous gas is most likely to be encountered above a pillar fall?**



**Answer: Methane**



**What is the maximum allowable concentration of methane at a surface mine area?**



**Answer: 1.0%**



**What is carbon dioxide  
(CO<sub>2</sub>)?**



**Carbon dioxide (CO<sub>2</sub>) is a colorless, odorless gas formed by the chemical combination of carbon and oxygen.**



**What is the specific gravity  
of carbon dioxide (CO<sub>2</sub>)?**



**Answer: 1.529**





**Is carbon dioxide (CO<sub>2</sub>)  
explosive?**



**Answer: No**



**What is carbon monoxide  
(CO)?**



**Carbon monoxide (CO) is a colorless, odorless, tasteless, combustible, and poisonous gas.**



**What effect does carbon monoxide (CO) have on life?**



**Carbon monoxide is an extremely poisonous gas.**



**What is the source of carbon monoxide (CO)?**



**Carbon monoxide is the product of incomplete combustion (combustion with an insufficiency of oxygen).**





**How can carbon  
monoxide be detected?**



**Carbon monoxide can be detected by carbon monoxide detectors and by chemical analysis.**



**When can carbon  
monoxide most likely to  
be found in underground  
mines?**



**Carbon monoxide will most likely be found in coal mines when there is a mine fire or after an explosion, or when it is produced in smaller quantities by diesel emissions.**



**What else can produce  
carbon monoxide?**



# Internal combustion engines



**What is the principal  
poisonous gas produced  
by explosives?**



# Carbon monoxide





**How does carbon  
monoxide cause injury to  
life?**



**Carbon monoxide causes injury to life by combining with the hemoglobin of the blood and excluding oxygen.**



**How are persons affected  
by breathing CO?**



**When breathed, carbon monoxide reduces the capacity of the blood to carry sufficient oxygen. Symptoms include drowsiness, headache, imbalance, mental confusion, and burning eyes.**



**What is the maximum amount of CO that can be present in the mine atmosphere of “active workings”?**



**Answer: .005% (50 ppm)**



**Why is carbon monoxide  
poisonous?**



**Carbon monoxide is  
poisonous because the blood  
absorbs carbon monoxide  
300 times more readily than  
it does oxygen.**





**Why are small quantities  
of carbon monoxide  
injurious?**



**Small quantities of carbon monoxide are injurious because it accumulates in the blood.**



**What is the specific gravity of carbon monoxide ?**



**Answer: 0.967**



**What percentage of saturation of the blood from carbon monoxide is necessary to cause death?**



**Answer: 60% -70%**



**Is carbon monoxide  
explosive?**



**Yes, carbon monoxide is explosive over a wide range.**





**What is the range of  
explosibility of carbon  
monoxide?**



**Answer: 12.5% -74%**



**What is the most dangerous feature of carbon monoxide?**



**Its poisonous character.**



**What is hydrogen sulfide?**



**Hydrogen sulfide is a poisonous, combustible, colorless gas having a sweetish taste and an odor like rotten eggs.**



**What is the specific gravity of hydrogen sulfide?**



**Answer: 1.191**





**What mine gas can be detected by its odor?**



**Answer: Hydrogen Sulfide**



**Is hydrogen sulfide  
poisonous?**



**Answer: Yes, it is  
extremely poisonous even  
in small amounts.**



**What is nitrogen dioxide  
(NO<sub>2</sub>)?**



**Nitrogen dioxide (NO<sub>2</sub>) is an extremely poisonous gas frequently formed by the burning of high explosives and in small amounts by diesel equipment.**



**What amount of nitrogen dioxide ( $\text{NO}_2$ ) will be fatal?**



**Extremely low concentrations,  
approximately 0.01% (100ppm)  
will be fatal.**





**What are the first effects  
of nitrogen dioxide (NO<sub>2</sub>)  
on a person?**



**Nitrogen dioxide is extremely irritating to the nostrils and eyes and relatively small quantities may cause death even after apparent recovery.**



**What is sulfur dioxide  
(SO<sub>2</sub>)?**



**Sulfur dioxide (SO<sub>2</sub>) is a colorless, suffocating, irritating, and poisonous gas.**



**What is the specific  
gravity of sulfur dioxide  
(SO<sub>2</sub>)?**



**Answer: 2.263**



**Is sulfur dioxide ( $\text{SO}_2$ )  
combustible?**



**Answer: No, it will not  
burn or explode.**





**What is hydrogen (H<sub>2</sub>)?**



**Hydrogen (H<sub>2</sub>) is a colorless, odorless, tasteless gas that is formed by mine fires , explosions, and by charging batteries.**



**How is hydrogen ( $H_2$ )  
formed in a mine?**



**Hydrogen ( $H_2$ ) is formed by mine fires, explosions, and by charging batteries.**



**Is hydrogen ( $H_2$ )  
explosive?**



**Hydrogen is explosive over a wide range which is 4.1% to 74%.**



**What is the most important condition affecting the humidity of air?**



**The most important condition affecting the humidity of air is temperature.**





**What is humidity?**



**Humidity is the degree to which the air is saturated with moisture.**



**Which will hold the most moisture, hot or cold air?**



**Answer: Hot air**



**Under what provisions can diesel equipment be used underground in the Commonwealth of Kentucky?**



**Before diesel-powered machinery can be taken into an underground coal mine in the Commonwealth of Kentucky written approval must be obtained from the OMSL.**



**Where can diesel equipment be used in underground coal mines?**



**Diesel powered equipment used in an underground coal mine shall be restricted to haulageways and working places where positive (controlled flow) ventilation is maintained.**





**What quantity of ventilating air must be present where diesel equipment is used in underground coal mines?**



**In addition to the amount of air required by the Kentucky Mining Law, at least 6,000 cfm of air shall be provided for each diesel unit used in a working section of a mine.**



**What substance shall not be present in diesel exhaust?**



# Black smoke



**How are gases detected in underground coal mines?**



**All gases in coal mines  
can be detected by an  
appropriate gas detector  
or by analysis.**



**How is methane gas detected in underground coal mines?**



**Coal companies use different makes and brands of detectors. Some will detect only one gas and some are multi – detectors. Follow the manufacturer’s recommendation and instruction for use, charging, and calibration of the detector being used at your mine.**





**Are flame safety lamps still used  
for gas detection?**



**Flame safety lamps can be used to detect for the presence of methane and oxygen deficiency, as a “back-up” means only.**



**If the total volume of an air split in a mine is 60,000 cfm, and the percentage of methane in the split is .75%, how many cubic feet of methane are in the split?**



**Answer : multiply the total volume of air by the percentage of methane in the split (60,000 times .75% or .0075 = 450cfm)**



**A mine liberates 500 cfm of methane in a split and has a volume of air equal to 40,000 cfm, what is the percentage of methane being liberated?**



**Answer : divide the cubic feet of methane by the volume of air (500 / 40,000 = 0.0125 or 1.25%)**



**A mine liberates 400 cfm of methane, how many cubic feet of air will be required per minute to keep the methane content to 0.50%?**



**Answer : divide the volume of methane by the percentage of methane (400 cfm / .50% = 400 / .0050 = 80,000 cfm)**





# End of Unit 3