COURSE TITLE:	**Chemistry for Fire & Hazardous Materials Resp.**	Course No. & Version:	**HAZ006**
TOPIC AREA:	**Hazardous materials**	LEVEL:	**Technician & Officer**
SOURCE:	**Internal**	Course No.	
PRIMARY DOMAIN:	☒ Didactic ☐ Psychomotor ☐ Combination		
DELIVERY METHOD:	75 % Lecture % Hands-on % Distanced 25 % Other: Classroom activities & case studies		
DURATION:	48 Hrs	SCHEDULING:	Can be delivered 6 straight days or any combination of 48 hours.
PROGRAM GOAL:	This program is designed to provide the participant with the capabilities of conducting a thorough hazard-risk assessment of chemicals and other forms of hazardous materials. It is well suited for Hazardous Materials Technicians, fire safety and small quantity generator inspectors, command officers, EMS personnel with hazardous materials responsibilities, law enforcement chemical response teams and bomb technicians.		
TARGET AUDIENCE:	Fire department officers and firefighting personnel preparing to serve in the role of hazardous materials technician. This program assumes a minimum pre-requisite of Hazardous Materials Operational level training prior to attendance.		
COURSE DESCRIPTION:	This 48 hour program focuses on the basic knowledge required to evaluate the potential hazards and behaviors of hazardous chemical substances which are commonly encountered by emergency response personnel. It examines the structure of chemical compounds and the reasons for their behavior when involved in an incident or fire. Topics during the program include: Atomic and molecular structure, salts, non-salts, hydrocarbon compounds, hydrocarbon derivatives, hazards, hazard classifications, fires involving chemicals, products of combustion, common uses and illicit use of chemicals.		
MAX STUDENTS:	30	MAX INST. RATIO:	1:15
STANDARDS MET:	This program meets or exceeds chemistry and chemical hazard/risk assessment related training competencies established by NFPA 472, the HMEP Public Sector Hazardous Materials Training Guidelines and the Florida SERC Training Guidelines.		

APPROVALS

Organization	No. / Date	Conditions
FSFC	PD-3137	Approved for Professional Development

NOTES	References: Bevelacqua, Armando “Hazardous Materials Chemistry”, Delmar **Meyer, Eugene “Chemistry of Hazardous Materials”, Brady** Fire, Frank “Common Sense Approach to Hazardous Materials” Fire Engineering

EDUCATIONAL OBJECTIVES

The students will be able to describe the following basic principles of chemistry.

1. Define chemistry and its importance to fire fighting operations and hazardous materials response.
2. Define matter and identify its three possible states.
3. Identify the units of measure important to the study of chemistry.
4. Identify the common units of temperature measurement and, given appropriate field job aids, demonstrate the ability to convert between the common units of measure.
5. Define pressure, atmospheric pressure and vapor pressure.
6. Identify the difference between endothermic and exothermic reactions.
7. Identify the Nine DOT Hazard Classifications and their subdivisions

The students will be able to analyze physical and chemical properties of compounds and their impact on hazards and risks to responders.

1. Identify the key physical and chemical properties of hazardous materials.
2. Identify how molecular weight, size, and polarity affect these physical properties.
3. Describe the impacts of pH and the concept of acid-base reactions.
4. Describe the pH Scale and relate the concept of “strength” and “concentration” as it relates to corrosive materials.
5. Define specific gravity and vapor density.
6. Given a list of reactions, identify whether each reaction is a chemical or physical reaction.

The students will be able to determine the logical and systematic order of elements using the Periodic Table.

1. Describe parts of the atom, atomic number, atomic structures, and related properties.
2. Identify correct atomic structures to reinforce the concept of sub-orbitals.
3. Identify symbols, names, and atomic numbers of elements with reference to the Periodic Table.
4. Define isotope and identify what constitutes an isotope
5. Name the three most common forms of ionizing radiation and identify their subatomic source.

Given various materials, the students will be able to recognize and identify salts, their bonds, general formulas, names, and hazards.

1. Demonstrate knowledge of ionic bonding by naming salts correctly.
2. Given formulas or names, determine balanced salt formulas.
3. Identify the seven types of potential hazardous salt compounds (binary, oxide, peroxide, hydroxide, oxygenated (oxy salts), cyanide, and ammonium) and their hazards.

4. Given a description of a substance involved in an incident, identify the type of salt and the potential hazards involved.
5. Identify elements and compounds that tend to be water-reactive because of chemical reactivity or physical state.
6. Identify the hazards of oxidizers as individual chemicals when combined with other chemicals, and be able to determine worst-case scenarios.
7. Relate the hazardous salts to their appropriate DOT Hazard Classification.

Given various materials, the students will be able to recognize and identify common inorganic non-salts.

1. Demonstrate knowledge of covalent bonding.
2. Given formulas or structures, determine the identity of inorganic nonsalt compounds.
3. Given a description of a substance involved in an incident, identify the type of inorganic nonsalt and the potential hazards involved.

Given various hydrocarbons, the students will be able to identify the bond type, structure, and hazards of the hydrocarbon.

1. Correctly identify and analyze a hydrocarbon by determining its structure, isomers, bonds, and shape.
2. From formulas, determine whether a particular hydrocarbon compound has a saturated, unsaturated, or aromatic bond.
3. Explain the basic concepts of the International Union of Pure and Applied Chemistry (IUPAC) naming nomenclature.
4. From the carbon hydrogen ratio in the formula, determine whether a particular compound has a straight, branched, or resonant arrangement.
5. Identify specific hydrocarbons given a name, formula, or structure.
6. Correctly identify the potential for, and impacts of, polymerization, decomposition, and slow oxidation reactions.
7. Correctly identify the characteristics of alkene, alkyne, alkane, and aromatic hydrocarbons.
8. Given various hydrocarbon compounds, identify the anticipated DOT Hazard Classification that would be appropriate for that hydrocarbon.

Given various hydrocarbon derivatives, the students will be able to identify the bond type, structure, functional group, and name of the hydrocarbon derivative.

1. Given a diagram, name the structure that represents a specific derivative.
2. Given the name, formula, or structure, identify the functional groups of the hydrocarbon derivatives.
3. From formulas, identify hydrocarbon derivatives and deduce the chemical characteristics that determine their hazardous properties.
4. Identify specific hydrocarbon derivatives given the name, formula, or structure.

The students will be able to analyze thermodynamic properties and their impact on airborne concentration.

1. Describe the concepts expressed by Boyle's Law, Charles Law and the Combined Gas Law.
2. Describe the thermodynamic properties and the associated hazards of compressed and liquefied compressed gases.
3. Describe the thermodynamic properties and the associated hazards of cryogenic materials.

Fire Chemistry

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Morning	**Morning**	**Morning**	**Morning**	**Morning**	
Registration, Welcome Introduction Basic Principles of Chemistry Introduction to Physical and Chemical Properties	Quiz 1: Chemistry Basics Introduction to Compounds & Ionic bonding Naming and general formulas for ionic compounds Binary Salts -- Hazards of binary salts -- Water reactive salts Metal Oxides -- Hazards of metal oxides	Quiz 2: Salt Compounds Covalent bonding Hydrocarbons Alkanes H/C (Parrafins) -- Fuel flamilies -- M.W. and physical states -- Flammable range -- Ignition temperature -- Combustible vs. flammable Cyclo Alkanes and Alkane Isomers	Quiz 3 –Hydrocarbons, Isomers and Aromatics Hydrocarbon Derivatives Part 1 Halogenated H/C -- Chloro-, fluoro- and Bromo-carbons -- Halogenated extinguishing agents Nitrogen Compounds -- Amines, Cyanides and Nitro compounds -- Ideal explosives Ethers, Organic Peroxides Sulfur and mercaptan compounds (thioethers and thiols- and blister agents)	Quiz 4 H/C Derivatives & Meth Labs Hydrocarbon Derivatives Part 2 Principles of polar solvents -- Polarity -- Hydrogen bonding Alcohols Carbonyl Group Compounds -- Ketones -- Aldehydes -- Organic Acids -- Organic esters, phosphoric esters, organophosphates and nerve agents	Quiz 5 H/C Derivatives and Firefighting Inorganic non-salts -- Binary non-salts -- Oxy Acids (e.g. Nitric, sulfuric, phosphoric) -- Acid Gases (HF, HCl, HI) Corrosives -- pH -- Acid/base balance -- Neutralization reactions
Afternoon	**Afternoon**	**Afternoon**	**Afternoon**	**Afternoon**	**Afternoon**
Chemistry, The Elements & Atomic Structure Periodic Table Electron Configuration Hazards -- Water reactive alkali metals -- Diatomic oxidizers -- DOT “Oxidizer” classification Kinetic Molecular Theory	Polyatomic anions Hydroxide salts -- Alkaline corrosive metals Oxidizing salts -- Peroxide salts -- Oxygenated (oxy) salts Cyanide salts Polyatmoic Anions Ammonium salts -- Ammonium nitrate Activity: Salt case studies	Alkenes -- Polyermerization reactions -- Inhibitors and initiators Alkynes -- Acetylene and torch operations Aromatic hydrocarbons Activity: Hydrocarbon case studies	Illict Drug Labs Methamphetamine labs -- P-2-P labs -- Red Phosphorus method -- Ammonia/Alakli metal labs (Nazi method) Other common labs -- GHB Activity: Illicit lab case studies	Flammable materials (Liquids and solids) Fire and Pyrolsis Extinguishing agents -- Halogenated agents -- Dry chemical extinguishing agents Activity: Extinguishment Case Studies	Tabletop application -- Scenario based applications of chemistry
Evening Assignment	**Evening Assignment**	**Evening Assignment**	**Evening Assignment**	**Evening Assignment**	
Atomic Structure Worksheets Read Assigned Units Prepare for Test 1 covering basics	Salts Worksheets Read Assigned Units Prepare for test 2	Hydrocarbon Worksheets Read Assigned Units Prepare for test 3	Hydrocarbon Derivative Worksheets Read Assigned Units Prepare for test 4	Hydrocarbon Derivative Worksheets Read Assigned Units Prepare for test 5	