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| **TEXAS CTE LESSON PLAN**[www.txcte.org](http://www.txcte.org) |
| **Lesson Identification and TEKS Addressed** |
| **Career Cluster** | Law, Public Safety, Corrections, and Security |
| **Course Name** | Firefighter I |
| **Lesson/Unit Title** | Extinguishing Properties of Water |
| **TEKS Student Expectations** | **130.334. (c) Knowledge and Skills**(10) The student describes the characteristics of water as it relates to fire extinguishing potential.(A) The student is expected to explain the law of thermodynamics as it relates to specific heat, latent heat, and heat flow(B) The student is expected to compare the advantages and disadvantages of water as an extinguishing agent |
| **Basic Direct Teach Lesson**(Includes Special Education Modifications/Accommodations and one English Language Proficiency Standards (ELPS) Strategy) |
| **Instructional Objectives** |

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| The student will be able to: |
| 1. Describe the physical characteristics of water |
| 2. Explain the Law of Specific Heat, the Law of Latent Heat of Vaporization, |
| and the Law of Heat Flow |
| 3. Compare the advantages and disadvantages of water as an |
| extinguishing agent |

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| **Rationale** |

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| Understanding the extinguishing characteristics of water, and the efficiency in |
| which it extinguishers fire, is important for understanding strategies in which it |
| will be applied. The primary way in which water extinguishes fire is by cooling |
| (absorbing heat from the fire), but water can also be used to smother a fire by |
| diluting or excluding oxygen. This happens as water vaporizes and is |
| converted to steam. |

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| **Duration of Lesson** | 2 hours |
| **Word Wall/Key Vocabulary***(ELPS c1a,c,f; c2b; c3a,b,d; c4c; c5b) PDAS II(5)* |  |
| **Materials/Specialized Equipment Needed** | * Extinguishing Properties of Water Handout
* Extinguishing Properties of Water Handout Key
* Extinguishing Properties of Water Quiz
* Extinguishing Properties of Water Quiz Key
* The Extinguishing Properties of Water Checklist
* Discussion Rubric
* Fire service equipment as needed for skills demonstration
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| **Anticipatory Set**(May include pre-assessment for prior knowledge) |

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| Engage the students in discussion relating the extinguishing characteristics of |
| water as they apply to the tactical and strategic decisions involved in fighting |
| fires. Decisions regarding direct aggressive interior attack or using water to |
| protect exposures are often made in relation to water’s availability, the stage of |
| the fire, and the safety of fire personnel and civilians. How and when water is |
| used as an agent can have a positive or negative effect on the outcome at an |
| emergency scene. Use the Discussion Rubric to assess the students’ |
| understanding. |

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| **Direct Instruction \*** |

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| I. Physical Characteristics of Water |
| A. Water exists in one of three physical states: |
| 1. Solid – as ice. Water freezes at 32°F or 0°C |
| 2. Liquid – between the temperatures of 32°F and 212°F (0–100°C) |
| 3. Gas – as invisible water vapor. Water vaporizes at 212°F or 100°C |
| B. Water weighs 8.33 pounds per gallon |
| C. Water expands to 1700 times its original volume when converted to |
| steam at 212°F |
| II. The Law of Specific Heat |
| A. Specific Heat is the measurement of the heat-absorbing capacity of a |
| substance. Water is noncombustible and can also absorb large |
| amounts of heat |
| B. The ratio of the amount of heat required to raise the temperature of a |
| unit of mass of a substance by one unit of temperature to the amount of |
| heat required to raise the temperature of a similar mass of a referencematerial, usually water, by the same amount |

C. In SI, specific heat is the temperature required to raise the temperature of 1 gram of water 1 degree C (1 calorie)D. In the customary system, specific heat is the temperature required to raise the temperature or 1 pound of water 1 degree F (1 BTU/British Thermal Unit)E. A BTU is the standard measurement used to show the amount of energy that a fuel has as well as the amount of output of any heat-generating device1. The Law of Latent Heat of Vaporization
	1. Latent heat is the amount of heat energy absorbed or released during a change of state (solid<->liquid<->gas). The energy that is required to change a substance from a liquid state to a gaseous state is called Latent Heat of Vaporization
	2. Complete vaporization does not occur immediately upon water reaching its boiling point at 212°F. The temperature must remain constant until the entire volume of water is converted
	3. The smaller the water droplet or particle, and the larger the number of them (the greater the surface area), the more rapidly the conversion to steam will occur
	4. Water will expand to 1700 times its original volume upon complete conversion to steam
	5. Specific heat is relative to the Law of Latent Heat of Vaporization because, as water is used to cool the fire, it absorbs energy (BTUs) in the process
	6. Through this heat absorption, the fire is effectively controlled by cooling the fuel below its ignition temperature, and making an interior fire attack possible because there is now a tenable work environment
	7. Converting water to steam is how an indirect fire attack is conducted
	8. The Law of Latent Heat of Vaporization is important in firefighting because the temperature of the water is not increased beyond 212°F during the absorption of 970 BTU’s for every pound of water converted to steam

IV. Law of Heat FlowA. Heat flows from hot to cold. The 2nd law of thermodynamics – heat flows spontaneously from a hot to a cold body* + 1. For heat to be transferred from one body to another, the two bodies must be at different temperatures
		2. Heat moves from warm or hot objects to cooler objects
		3. The rate at which the heat transfer occurs is dependent upon the temperature difference between the two objects, and the conductivity of the materials involved. The greater the difference, the greater the transfer rate over time
1. Advantages of Water as an Extinguishing Agent
2. Water is readily available, and is not cost prohibitive (it is considered to be expensive)

B. Water has greater heat absorbing capability (higher specific heat) than most all other common extinguishing agentsC. Water takes a relatively large amount of heat to completely convert to steam (high latent heat of vaporization)D. Water can be used in many different forms or ways:1. As a solid stream
2. As a broken stream
3. From a fog nozzle as a
	1. Straight stream
	2. Narrow pattern fog stream
	3. Wide pattern fog stream

VI. Disadvantages of Water as an Extinguishing Agent A. Water has high surface tensionB. Water can react readily with some materials like combustible metalsC. Water allows radiant heat to pass through itD. Water freezes at 32°FE. Water readily conducts electricity*Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:** NONE
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| **Guided Practice \*** | Have the students review the Extinguishing Properties of Water Checklist. Upon completion of the skills review, students are to complete the skills under the supervision of an instructor. Use the Extinguishing Properties of Water Checklist for assessment*Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*NONE |
| **Independent Practice/Laboratory Experience/Differentiated Activities \*** | After discussing the extinguishing properties of water, have the students read about Fire Streams, then complete the Extinguishing Properties of Water Handout. Students may work individually, as partners, or in small groups. Use the Extinguishing Properties of Water Handout KeyInstruction can be differentiated by use of an oral exam, skill demonstration, or written testing. When a student has met the minimum standard to be considered competent in the didactic phase of instruction, as well as the tactile learning phase, it should be recorded.*Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*NONE |
| **Lesson Closure** |  |
| **Summative/End of Lesson Assessment \***  | Extinguishing Properties of Water Quiz and KeyExtinguishing Properties of Water Handout KeyExtinguishing Properties of Water ChecklistDiscussion Rubric*Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*NONE |
| **References/Resources/****Teacher Preparation** | 0135151112, *Essentials of Firefighting* (5thEdition), International Fire Service Training Association (IFSTA) |
| **Additional Required Components** |
| **English Language Proficiency Standards (ELPS) Strategies** |  |
| **College and Career Readiness Connection[[1]](#footnote-1)** | IV. ListeningB. Listen effectively in informal and formal situations1. Listen critically and respond appropriately to presentations.
2. Listen actively and effectively in one-on-one situations
3. Listen actively and effectively in group discussions.
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| **Recommended Strategies** |
| **Reading Strategies** |  |
| **Quotes** |  |
| **Multimedia/Visual Strategy****Presentation Slides + One Additional Technology Connection** |  |
| **Graphic Organizers/Handout** |  |
| **Writing Strategies****Journal Entries + 1 Additional Writing Strategy** |  |
| **Communication****90 Second Speech Topics** |  |
| **Other Essential Lesson Components** |
| **Enrichment Activity**(e.g., homework assignment) | For enrichment, students will participate in hose deployment and fire stream selection during manipulative training. |
| **Family/Community Connection** |  |
| **CTSO connection(s)** | SkillsUSA |
| **Service Learning Projects** |  |
| **Lesson Notes** |  |

1. Visit the Texas College and Career Readiness Standards at <http://www.thecb.state.tx.us/collegereadiness/CRS.pdf>, Texas Higher Education Coordinating Board (THECB), 2009. [↑](#footnote-ref-1)