

# Course: Transportation Systems

Grade Level: 9-12

Time:	Standards:	Topics:	Essential Questions:	Content and Skills (What the Students Will Know And Be Able To Do):	Specific Assessments:	Resources:
2 weeks	MST 3 MST 4 MST 5 MST 6	Boats, Flotation & Displacement	What makes a boat float? How is density related to buoyancy? How do boats made from heavy materials (steel) float?	Use a balance to determine an object's mass. Using geometry calculate an object's volume. Calculate density ( $\rho$ ) given mass and volume. Determine the buoyancy of an object in water and calculate the maximum payload it can carry without sinking	Worksheets	
1 week	MST 5	Different Boat designs and functions	What are the different types of boat designs? What functions do they serve? What are the advantages and disadvantages of each?	Identify different boat designs. Choose a given design based upon the intended function. Explain the pros and cons of each design.	Worksheets, Quiz	
2 weeks	MST 1 MST 3 MST 5	Barge Design	What is the best design for a cargo barge? What materials will lend themselves to ship building?	Design a model barge and determine its overall volume. Build the model with available materials and produce a water tight prototype. Use a balance to determine the model's mass. Calculate the buoyancy of the model and determine the maximum theoretical payload. Test their models and determine the actual maximum payload.	Hands-on Partnered Project	
2 weeks	MST 1 MST 5	Speed boat Design	What is the best design for a speed boat? What materials will lend themselves to aerodynamic ship building?	Design a model speed boat with an onboard electric motor Build the model with available materials and produce a water tight prototype. Use a balance to determine the model's mass. Using timers determine the boats average time to run a 10ft course and then calculate the boat's average speed.	Hands-on Partnered Project	

3 weeks	MST 5 MST 7	Boater Safety	<p>What are terminology of boating and what do those terms mean?</p> <p>What are the different classifications of boats according to NY?</p> <p>What are the types of Personal Flotation Devices (PFD) and what are the rules governing the number, placement and use on a boat?</p> <p>What other equipment is required to be present and operational on a boat?</p> <p>What procedures should be followed before going out on a boat?</p> <p>What precautions should be made for different types of emergencies?</p> <p>What are the general navigation rules for a boat?</p> <p>What are the specific rules for night time, docking &amp; mooring, anchoring, and locks?</p> <p>What are the different navigation markers and what does each mean?</p> <p>What rules and laws apply to</p>	<p>Know terms that are used to name/describe the parts of a boat.</p> <p>Know the various boat classes as identified by length.</p> <p>Identify types of boat hulls and their characteristics.</p> <p>Know what is a Hull Identification Number and what it indicates.</p> <p>Know State boat registration regulations, requirements, allowances and procedures .</p> <p>Know the various types of Personal Flotation Devices (PFDs) and their characteristics, as well as the state regulations regarding PFDs on a boat.</p> <p>Know the various types of fire extinguishers for boats, and how to maintain them.</p> <p>Know the navigation light requirements for different types and sizes of boats.</p> <p>Know how to check the weather forecast during trip preparation and monitor the weather while out on the water.</p> <p>Know the severe-weather terminology used by NOAA.</p> <p>Know how to prepare for foul weather, and what to do when a storm hits.</p> <p>Perform proper engine and general boat maintenance.</p> <p>Know the trailer classes, proper towing and trailering methods and regulations.</p>	Worksheets, Quizzes, State Licensing Exam	State provided activities, worksheets, and Exams
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2 weeks	MST 3 MST 4	Force, Torque, Work & Energy	<p>What the SI and Imperial units for Force, distance, Torque, Work, &amp; Energy?</p> <p>What does the formula <math>W=F \cdot d</math> mean?</p> <p>What does the formula <math>T=F \times d</math> mean, and what is the difference between and dot and cross vector?</p> <p>How are Energy and Work related?</p>	<p>Use proper units when referring to Force, distance, Torque, Work and Energy in the SI or Imperial system of measures.</p> <p>Calculate Work given the force and distance.</p> <p>Calculate Torque given the force and distance.</p> <p>Understand the relationship between Work and Energy.</p>	Worksheets, Quiz

3 weeks	MST 1 MST 3 MST 4 MST 5 MST 6	Mousetrap Car	<p>How is energy stored in a mousetrap?</p> <p>How do you calculate potential energy stored in elastic objects?</p> <p>How do the principles of torque, energy and work apply to a mousetrap?</p> <p>How does a transmission take force and torque and transfer it to the wheels?</p>	<p>Understand how the torsional spring in a mousetrap stores energy.</p> <p>Use Hooke's Law (<math>F=-k*x</math>) and the associated Energy equation (<math>PE=1/2*k*x^2</math>) to determine the energy available in the spring.</p> <p>Determine the initial torque available from the spring and how the distance from the spring affects the available force.</p> <p>Design a mousetrap car that incorporates either a fixed, variable, or continuously variable transmission to transfer the energy from the mousetrap to the drive wheels of the vehicle.</p>	Hands-on Individual Project	
2 week	MST 4 MST 5	Internal Combustion Engines	<p>What elements/conditions must exist for an internal combustion engine to work?</p> <p>What is the difference between a 2 stroke and a 4 stroke engine?</p> <p>What does a camshaft and valves do in a 4 stroke engine and ports do in a 2 stroke engine?</p>	<p>Understand the how fuel, air, compression, ignition, timing, and exhaust are all needed for an internal combustion engine to function.</p> <p>Be able to identify and explain the differences between a 4 stroke engine and a two stroke engine along with the benefits and drawbacks of each.</p>	Worksheets, Quizzes,	

4 weeks	MST 5 MST 7	Small Engine Disassembly, Reassembly & Repair	<p>What is the ratio of oil to gasoline in a 2 stroke engine?</p> <p>How are the fuel tank and air filter attached to the carburetor?</p> <p>How is a carburetor adjusted?</p> <p>How is the head attached to the block and what function does a head gasket perform?</p> <p>What is the bore and stroke of a cylinder and how is the displacement of an engine calculated?</p>	<p>Properly mix oil and gasoline for a 2 stroke engine such as for a lawnmower, trimmer, or chainsaw.</p> <p>Identify and disassemble the air and fuel systems of a small engine.</p> <p>Identify the parts and functions of a carburetor and adjust the air to fuel mixture to achieve optimum engine operation.</p> <p>Know what the head is and how to remove and replace it properly.</p> <p>Know what the head gasket does and how to install one.</p> <p>Identify and measure the bore and the stroke of a cylinder and using the formula for the volume of a cylinder <math>V = h \cdot r^2 \cdot \pi</math> calculate the displace of an engine.</p>	Worksheets, Hands-on practical examinations	
2 weeks	MST 5 MST 7	Car Systems	<p>What functions do the fuel, electrical, air, powertrain, braking, and computer systems perform?</p>	<p>Identify and explain the systems and components of the fuel (fuel tank, fuel filter, and injectors/carburetor), electrical (battery, alternator, distributor, ignition wires, and spark plugs), air (air filter and carburetor/fuel injector), powertrain (cylinders, crankshaft, transmission, driveshaft, differential/CV joints), braking (master cylinder, brake lines, drum brakes &amp; shoes, disc brakes &amp; rotors &amp; pads), and computer systems)</p>	Worksheets, Hands-on practical examinations	

3 weeks	MST 5 MST 7	Car Maintenance	<p>How does one check the oil level in a car?</p> <p>How do you change the oil and oil filter?</p> <p>How does one check the transmission fluid level in a car?</p> <p>How do you refill washer fluid?</p> <p>How do you check and refill brake fluid?</p> <p>How do you check and refill engine coolant?</p> <p>What do you do if a light is burnt out?</p> <p>How do you replace windshield wipers?</p>	<p>Check the oil level in an engine and know when to and how to change the oil in a car along with the accompanying oil filter.</p> <p>Know how to check the transmission fluid level in a car.</p> <p>Know where the washer fluid reservoir is, how to read it, and how to refill it.</p> <p>Check and refill the master cylinder with brake fluid and know the difference between the different types of brakes fluids and their properties.</p> <p>Know the function of engine coolant and how to check and refill the reservoir.</p> <p>How to safely remove and replace a burnt out and/or broken light in the headlights, tail lights, brake lights, parking lights, or in the cabin of a vehicle.</p> <p>Replace windshield wipers.</p>	Worksheets, Hands-on practical examinations	
3 weeks	MST 5 MST 7	Car Repair	<p>How do you inspect and if needed replace ignition wires and spark plugs?</p> <p>How do you test and replace a car battery?</p> <p>How do you check and replace an air filter?</p> <p>How do you change a tire?</p> <p>How do you inspect and replace brake rotors and pads (disc brakes)?</p> <p>How do you inspect brake drums and shoes (drum brakes)?</p>	<p>Identify, inspect and replace ignition wires and spark plugs.</p> <p>Use a multimeter to test a car battery's open voltage as well as its voltage while cranking.</p> <p>Remove and replace a car battery and connect it correctly to the electrical system.</p> <p>Check and replace an air filter.</p> <p>Use a jack to raise a car, remove a wheel and change a tire.</p> <p>Inspect and determine if brake rotors, pads, drums, or shoes need to be replaced and replace them if need be.</p>	Worksheets, Hands-on practical examinations	

1 week	MST 3 MST 4 MST 5	Bernoulli's Equation, Newton's Laws, Gas compression, and Flight	<p>What are Newton's Laws of motion?</p> <p>What is Bernoulli's Principle?</p> <p>How do Gases such as the atmosphere behave in subsonic conditions?</p> <p>How do these 3 principles combine to allow aerodynamic lift?</p>	<p>Understand and use Newton's 3 laws of motion.</p> <p>Understand and use Bernoulli's Principle.</p> <p>Understand the compressible nature of gasses in subsonic flow.</p> <p>Explain how these 3 principles combine to give wings lift based on their shape and angle of attack.</p>	Worksheet	
2 weeks	MST 1 MST 5	Paper glider construction & Testing	<p>What are the control surfaces on a plane what direction does each control?</p> <p>What combination of control surfaces are used to execute a turn?</p>	<p>Understand what the vertical tail is and explain how it controls yaw.</p> <p>Understand what the horizontal tail is and explain how it controls pitch.</p> <p>Understand what ailerons are and explain how they control roll.</p> <p>Alter the control surfaces of their glider to execute a turn without the glider nose diving or going into a flat spin.</p>	Hands-on Individual Project	
2 weeks	MST 1 MST 5	Foam glider Design	<p>What are the different types of wing design, and what are the benefits and drawbacks of each?</p> <p>What is the aerodynamic center and the center of gravity and what is the relationship between them on a plane?</p>	<p>Identify and explain the different types of NACA wings and what functions and roles each of them serves.</p> <p>Be able to choose a wing profile based on the low speed nature of a glider.</p> <p>Design a fuselage and tail section that takes into account the placement of the aerodynamic center and the center of gravity.</p> <p>Build, test, and revise as needed a foam glider.</p>	Hands-on Individual Project	
1 week	MST 3 MST 4	Force, Impulse, Pressure, & Kinetic and Potential Energy	<p>How are Force, Time and Impulse related to each other?</p> <p>What is Potential Energy and how is it determined?</p> <p>What is Kinetic Energy and how is it determined?</p>	<p>Explain what Impulse is and use the equation <math>I=F*t</math> to calculate it.</p> <p>Explain what potential energy is and know how to use the equation <math>PE=m*g*h</math>.</p> <p>Explain what kinetic energy is and know how to use the equation <math>KE=1/2*m*v^2</math>.</p>	Worksheet, Quiz	

1 week	MST 1 MST 3 MST 4 MST 5 MST 6	Pneumatic Rockets	<p>What are pneumatics?</p> <p>What is the relationship between Force, Pressure and Area?</p> <p>How do you calculate how much Energy is being put into the rocket?</p> <p>What is the top speed and height of a rocket, given the energy?</p> <p>Does the theoretical and the actual maximum height vary and why?</p>	<p>Understand the principles and workings of pneumatic systems.</p> <p>Understand and be able to use the formula <math>P=F/A</math> to determine the force exerted on the rockets.</p> <p>Calculate the Work/Energy put into the rocket using the formula <math>W=F \cdot d</math>.</p> <p>Determine the rocket's initial maximum velocity with the formula <math>KE=1/2 \cdot m \cdot v^2</math> and the theoretical maximum height (neglecting air resistance) using the formula <math>PE=m \cdot g \cdot h</math>.</p> <p>Determine the actual maximum height of the rocket using trigonometry.</p>	Hands-on Individual Project	
2 weeks	MST 1 MST 3 MST 4 MST 5 MST 6	Model Rockets	<p>What are the chemicals in rocket engines and why do they react the way they do?</p> <p>How is Impulse related to rocket engines?</p> <p>What are the different rocket engine sizes and how are they classified?</p>	<p>Understand what an exothermic reaction is and how it relates to the constituents of rocket fuel and its behavior.</p> <p>Describe how the amount of Impulse in a rocket engine determines the flight characteristics of the rocket its placed inside of.</p> <p>Know the different types of rocket fuel, the sizing categories for model rocket use, and be able to determine the correct size engine for a given rocket.</p>	Hands-on Individual Project	
3 weeks	MST 4 MST 5 MST 7	Space Travel and the future of the technology	<p>What challenges do craft find in space?</p> <p>What are the different types of spacecraft and engines?</p> <p>How far is to other planets and solar systems?</p>	<p>Understand the factors that affect space travel such as weightlessness, radiation, air/water recycling, and temperature regulation.</p> <p>Understand the principles behind, convential rockets, nuclear rockets, ionic drive and solar sails.</p> <p>Understand the vast distance between earth and other planets and the number of light years between our solar system and others.</p>	Worksheets	