



# Automotive Technologies

## 47.0600.00

### Embedded Math Credit Crosswalk

The Automotive Technologies program has been recognized by the Arizona State Board of Career and Technical Education (CTE) as being eligible for consideration by local governing boards to grant 1 credit of 4<sup>th</sup>-year high school math. This document is the result of a committee analysis completed in April 2023.

Automotive Standards	AZ Math Standards	Reasoning/Rationale
<b>STANDARD 1.0 PERFORM ENGINE SERVICES—GENERAL</b>		
1.1 Research vehicle service information including fluid type, service precautions and procedures, technical service bulletins, and recalls		Volumes - incongruity
1.2 Identify vehicle systems, including advanced driver assistance systems (ADAS)		
1.3 Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed		
1.4 Verify operation of the instrument panel engine warning indicators		Visual and metered calculations in decimals
1.5 Inspect engine assembly for fuel, oil, coolant, and other leaks		
1.6 Explain the various gaskets, seals, and sealers and their removal and application procedures for engine covers		
1.7 Explain procedures for verifying engine mechanical timing	<b>QR.NR.3</b> Understand and compare magnitudes of numbers utilizing real-world context. Understand the importance and impact of unit selection.	Dial indicators – timing relationship to units (mm or std)
1.8 Inspect engine and transmission mounts		
1.9 Identify service precautions related to service of the internal combustion engine of a hybrid electric vehicle		
1.10 Explain the components and configuration of the cylinder head and valve train	<b>QR.NR.1</b> Represent quantities, using equivalent forms when appropriate, to investigate and describe quantitative and geometric relationships and solve problems in real-world contexts.	Compression ratios compared to cylinder head Fuel and air ratios Valve train geometry - rocker arm length and angle -determine distance of open valve

	<b>G.G-C.B.5</b> Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector. Convert between degrees and radians.	Calculate angle ratios and proportions on the face of the valves - if off, will not seal Engine size conversions Gear differential ratios for slope Cam - analyzing angle values degrees open and lift, finding arc length and calculating
1.11 Explain the components and configurations of engine block assembly		
1.12 Explain the function of lubrication and cooling system components and configurations		
1.13 Perform engine oil and filter change; use proper fluid type per manufacturer specification; reset maintenance reminder as required		
1.14 Perform cooling system pressure test to identify leaks; check coolant condition and level; inspect and test pressure cap; determine necessary action		Flow rates -gallons/min Temperature Oil pumps - PSI
1.15 Explain causes of engine overheating		Timing - temperature
1.16 Inspect, replace, and/or adjust drive belts, tensioners, and pulleys; check pulley and belt alignment		
1.17 Inspect and test coolant; drain and recover coolant; flush and refill cooling system; use proper fluid type per manufacturer specification; bleed air as required		
1.18 Explain procedures for removing, inspecting, and replacing thermostat and gasket/seal		
1.19 Explain the procedure to perform common fastener and thread repair to include proper torquing		
<b>Automotive Standards</b>	<b>AZ Math Standards</b>	<b>Reasoning/Rationale</b>
<b>STANDARD 2.0 PERFORM AUTOMATIC TRANSMISSION AND TRANSAXLE SERVICES—GENERAL</b>		
2.1 Research vehicle service information including fluid type, service precautions and		

procedures, technical service bulletins, and recalls		
2.2 Identify vehicle systems, including advanced driver assistance systems (ADAS)		
2.3 Explain automatic transmission and transaxle components and configurations		
2.4 Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed	<b>A2.F-TF.B.5</b> Create and interpret sine, cosine and tangent functions that model periodic phenomena with specified amplitude, frequency, and midline.	Numbers and patterns freeze frame data - interpret sine waves amplitude and time
2.5 Inspect transmission fluid condition and level, and check for leaks in a transmission or a transaxle equipped with a dipstick		
2.6 Inspect transmission fluid condition and level, and check for leaks in a transmission or a transaxle not equipped with a dipstick	<b>A1.F-IF.C.9</b> Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).	Temp and level on a linear graph compare graphs from scan tools and service manual
2.7 Explain transmission/transaxle gear reduction/multiplication operation using driving, driven, and held member (power flow) principles	<b>QR.CR.2</b> Compare, reason and communicate about proportional and non-proportional models utilizing real-world contexts.	Ratios solve for missing parts - planetary gear set
2.8 Explain hydraulic principles (Pascal's Law) in a transmission/transaxle	<b>QR.CR.3</b> Identify, create, and use appropriate models for bivariate data sets (i.e. linear, exponential) to estimate solutions for contextual questions, identify patterns and identify how changing parameters affect the models.	Find unknowns e/ir
2.9 Inspect, adjust, and/or replace external manual valve shift linkage, transmission range sensor/switch, and/or park/neutral position switch	<b>A1.F-IF.C.9</b> Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).	Measurement – compare data points to the manual's graph
2.10 Explain procedures to drain and replace fluid and filter(s) to include proper fluid type per manufacturer specification		

2.11 Explain relearn procedure		
2.12 Inspect, replace and/or align power train mounts		
2.13 Describe the operational characteristics of a continuously variable transmission (CVT)	<p><b>A1.F-LE.A.2</b> Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or input/output pairs.</p> <p><b>A1.F-IF.B.4</b> For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Include problem-solving opportunities utilizing real-world context. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).</p>	Engine input and transmission output ratios- create linear graphs of engine rpm compared to transmission output rpm
2.14 Describe the operational characteristics of a hybrid vehicle drive train	<p><b>QR.NR.2</b> Reason, model, and communicate with and about percentages (change, incorrect, deceptive, relative and absolute).</p>	Ohm's law and electricity Resistance, voltage, and amperage diagnostics Time, charge rates digital wave or sine graph Percentage of voltage (read and calculate)
<b>Automotive Standards</b>	<b>AZ Math Standards</b>	<b>Reasoning/Rationale</b>
<b>STANDARD 3.0 PERFORM MANUAL DRIVE TRAIN AND AXLE SERVICES—DRIVE SHAFT, HALF SHAFTS, UNIVERSAL JOINTS AND CONSTANT VELOCITY (CV) JOINTS (FRONT, REAR, ALL WHEEL AND 4-WHEEL DRIVE)</b>		
3.1 Research vehicle service information including fluid type, service precautions and procedures, technical service bulletins, and recalls		Convert inch pounds and foot pounds
3.2 Identify vehicle systems, including advanced driver assistance systems (ADAS)		
3.3 Describe manual drive train components and configuration		

3.4 Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed	<b>A1.S-ID.A.1</b> Represent real-value data with plots for the purpose of comparing two or more data sets.	Freeze frame data graphing and time points - scatter plot Compare actual to high-performance data Sensor dependent -standard deviation and linear curves
3.5 Check fluid condition; check for leaks		
3.6 Drain and refill manual transmission/transaxle; use proper fluid type per manufacturer specification		
3.7 Check and adjust clutch master cylinder fluid level; check for leaks; use proper fluid type per manufacturer specification		
3.8 Describe the operational characteristics of an electronically controlled manual transmission/transaxle		
3.9 Inspect, remove, and/or replace bearings, hubs, and seals		
3.10 Inspect, service, and/or replace shafts, yokes, boots, and universal/CV joints		
3.11 Check for leaks at drive assembly and transfer case seals; check vents; check fluid level; use proper fluid type per manufacturer specification		
3.12 Inspect differential housing; check for leaks; inspect housing vent		
3.13 Explain procedures to adjust differential housing fluid level; use proper fluid type per manufacturer specification		
3.14 Inspect and replace drive axle wheel studs		
3.15 Identify concerns related to variations in tire circumference and/or final drive ratios	<b>QR.NR.4</b> Use and justify estimation skills, and know why, how, and when to estimate results. Assess and justify the reasonableness of estimations using the context and comparisons to other known values.	Diameter, circumference, gear ratios for rpm Tire sizing aspect ratios – calculate the ratio of height and width

Automotive Standards	AZ Math Standards	Reasoning/Rationale
<b>STANDARD 4.0 PERFORM SUSPENSION AND STEERING SYSTEM SERVICES—GENERAL</b>		
4.1 Research vehicle service information including fluid type, service precautions and procedures, technical service bulletins, and recalls		
4.2 Identify vehicle systems, including advanced driver assistance systems (ADAS)		
4.3 Describe suspension and steering system components and configurations		Front-end angles
4.4 Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed	<b>A1.S-ID.A.1</b> Represent real-value data with plots for the purpose of comparing two or more data sets.	Freeze frame data graphing and time points - scatter plot Compare actual to high-performance data Sensor dependent -standard deviation and linear curves Similar math as in 43.4
4.5 Disable and enable supplemental restraint system (SRS); verify indicator lamp operation		
4.6 Inspect rack and pinion steering gear inner tie rod ends (sockets) bellows boots		
4.7 Inspect power steering fluid level and condition		
4.8 Flush, fill, and bleed power steering system using proper fluid type per manufacturer specification		
4.9 Inspect for power steering fluid leakage		
4.10 Remove, inspect, replace, and/or adjust power steering pump drive belt		
4.11 Inspect and replace power steering hoses and fittings		
4.12 Inspect pitman arm, relay (centerlink/intermediate) rod, idler arm, mountings, and steering linkage damper		Precision measurement - dial indicators and comparing data (actual to desired) Plot performance in a graph
4.13 Inspect tie rod ends (sockets), tie rod sleeves, and clamps (non-rack and pinion)		Precision measurement - dial indicators and comparing data (actual to desired)

		Plot performance in a graph
4.14 Describe an electric power steering system		
4.15 Inspect upper and lower control arms, bushings, and shafts		Precision measurement - dial indicators and comparing data (actual to desired) Plot performance in a graph
4.16 Inspect and replace rebound/jounce bumpers		
4.17 Inspect track bar, strut rods/radius arms, and related mounts and bushings		Precision measurement - dial indicators and comparing data (actual to desired) Plot performance in a graph
4.18 Inspect upper and lower ball joints (with or without wear indicators)		Precision measurement - dial indicators and comparing data (actual to desired) Plot performance in a graph
4.19 Inspect suspension system coil springs and spring insulators		
4.20 Inspect torsion bars and mounts		
4.21 Inspect and/or replace front/rear stabilizer bar (sway bar) bushings, brackets, and links		
4.22 Inspect, remove and/or replace strut assembly, strut coil spring, insulators, and upper strut bearing mount		
4.23 Inspect suspension system leaf spring(s), spring insulators (silencers), shackles, brackets, bushings, center pins/bolts, and mounts		
4.24 Inspect components of electronically controlled suspension systems	<b>A1.F-IF.C.7</b> Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).	Graph actual v desired tolerance Parabolic graph
4.25 Inspect, remove, and/or replace shock absorbers; inspect mounts and bushings		
4.26 Inspect front and rear wheel bearings		Precision measurement - dial indicator

<p>4.27 Describe the function of electronically controlled suspension and steering systems and components (e.g., active suspension and stability control)</p>	<p><b>A1.F-IF.C.7</b> Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).</p>	<p>Graph actual v desired tolerance Parabolic graph Similar math as in 4.24</p>
<p>4.28 Perform pre-alignment inspection; measure vehicle ride height</p>		
<p>4.29 Describe four-wheel alignment angles (camber, caster, and toe) and effects on vehicle handling/tire wear</p>	<p><b>QR.NR.2</b> Reason, model, and communicate with and about percentages (change, incorrect, deceptive, relative and absolute). <b>G.G-C.B.5</b> Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector. Convert between degrees and radians.</p>	<p>Percentages of 90-degree angles (half circles) Change in ride height will change length of toe angle (arc in a half circle)</p>
<p>4.30 Inspect tire condition/age; identify tire wear patterns; check for correct tire size, application (service-class, load and speed ratings), and air pressure as listed on the tire information placard/label</p>		
<p>4.31 Rotate tires according to manufacturer's recommendation including vehicles equipped with tire pressure monitoring systems (TPMS)</p>		
<p>4.32 Dismount, inspect, and remount tire on wheel (with/without TPMS); balance wheel and tire assembly</p>		
<p>4.33 Inspect tire and wheel assembly for air loss; determine necessary action</p>		
<p>4.34 Repair tire following tire manufacturer approved procedure</p>		
<p>4.35 Describe indirect and direct tire pressure monitoring systems (TPMS); calibrate/relearn system; verify operation of instrument panel lamps</p>	<p><b>A1.A-CED.A.1</b> Create equations and inequalities in one variable and use them to solve problems. Include problem-solving opportunities utilizing real-world</p>	<p>Pressure v temperature Create linear graphs - equation of the line Evaluate points along the line</p>



	context. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).	
4.36 Explain the steps required to remove and replace sensors (per OEM/sensor manufacturer) in a tire pressure monitoring system (TPMS)		
4.37 Perform Road Force balance/match mounting	<b>QR.NR.1</b> Represent quantities, using equivalent forms when appropriate, to investigate and describe quantitative and geometric relationships and solve problems in real-world contexts.	Calculate tire circumferences - 2D and 3D Force of energy and angles - calculate the weight, air pressure, height, and diameter of the tire
Automotive Standards	AZ Math Standards	Reasoning/Rationale
STANDARD 5.0 PERFORM BRAKE SYSTEM SERVICES—GENERAL		
5.1 Research vehicle service information including fluid type, service precautions and procedures, technical service bulletins, and recalls		
5.2 Identify vehicle systems, including advanced driver assistance systems (ADAS)		
5.3 Identify brake system components and configuration		
5.4 Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed	<b>A1.S-ID.A.1</b> Represent real-value data with plots for the purpose of comparing two or more data sets.	Freeze frame data graphing and time points - scatter plot, standard deviation and linear curves Compare actual to high-performance data Similar math as in 4.4
5.5 Describe procedure for performing a road test to check brake system operation including an anti-lock brake system (ABS)	<b>QR.NR.1</b> Represent quantities, using equivalent forms when appropriate, to investigate and describe quantitative and geometric relationships and solve problems in real-world contexts.	Distance traveled over time - ratio Measurements taken for speed Calculate distance to stop Compare to brake material specs
5.6 Install wheel and torque lug nuts		
5.7 Explain hydraulic principles (Pascal's law)	<b>A1.A-REI.B.3</b> Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. <b>A1.A-CED.A.4</b> Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <i>For example,</i>	Ohms Law Understanding equations - find an unknown given two knowns using area, volume, energy in and out Solve for variables

	<i>rearrange Ohm's law <math>V = IR</math> to highlight resistance <math>R</math>.</i>	
5.8 Describe proper brake pedal height, travel, and feel		
5.9 Check master cylinder for external leaks and proper operation		
5.10 Inspect brake lines, flexible hoses, and fittings for leaks, dents, kinks, rust, cracks, bulging, wear, and loose fittings/supports		
5.11 Explain procedures for selecting, handling, storing, and filling brake fluids to proper level; use proper fluid type per manufacturer specification		
5.12 Describe components of hydraulic brake warning light system		
5.13 Explain procedures for bleeding and/or replacing fluid in the brake system		
5.14 Test brake fluid for contamination		
5.15 Explain the removal, cleaning, and inspecting of a brake drum including measuring the brake drum diameter		Precision tools
5.16 Explain the procedures for refinishing brake drums including final drum measurement and diameter; compare with specification		Precision tools
5.17 Explain the removal, cleaning, inspecting, and/or replacement of brake shoes, springs, pins, clips, levers, adjusters/self-adjusters, other related brake hardware, and backing support plates; lubrication and reassembling		
5.18 Explain procedures for inspecting wheel cylinders for leaks and proper operation; remove and replace as needed		
5.19 Explain procedures for preadjusting brake shoes and parking brake; installing brake drums or drum/hub assemblies and		

wheel bearings; making final checks and adjustments		
5.20 Remove and clean caliper assembly; inspect for leaks and damage/wear		
5.21 Inspect caliper mounting and slides/pins for proper operation, wear, and damage		
5.22 Remove, inspect, and/or replace brake pads and retaining hardware		Precision tools
5.23 Lubricate and reinstall caliper, brake pads, and related hardware; seat brake pads against rotor and inspect for leaks		
5.24 Clean and inspect rotor and mounting surface, measure rotor thickness, thickness variation, and lateral runout; determine necessary action		Precision tools
5.25 Remove and reinstall/replace rotor		
5.26 Refinish rotor on vehicle; measure final rotor thickness and compare with specification		Precision tools
5.27 Explain procedures to refinish rotor off vehicle; measuring final rotor thickness and comparing with specification		Precision tools
5.28 Retract and re-adjust caliper piston on an integral parking brake system		Precision tools
5.29 Measure brake pad wear; determine necessary action		Precision tools
5.30 Explain the procedure to burnish/break-in replacement brake pads according to manufacturer's recommendation		
5.31 Check brake pedal travel with, and without, engine running to verify proper power booster operation		
5.32 Describe the components of the brake power assist system (vacuum/hydraulic/electric)		
5.33 Remove, clean, inspect, repack/replace, and install wheel bearings; remove and install		

bearing races; replace seals; install hub and adjust bearings		
5.34 Check parking brake system components for wear, binding, and corrosion; clean, lubricate, adjust and/or replace as necessary		
5.35 Check parking brake operation (including electric parking brakes); and parking brake indicator light system operation		
5.36 Check operation of brake stop light system		Basic math
5.37 Describe the electronic brake control system components and function (ABS, TCS, ESC)	<p><b>A2.F-IF.B.4</b> For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Include problem-solving opportunities utilizing a real-world context. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.</p> <p>Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root and piecewise-defined functions.</p>	<p>Interpret speed sensor in a sine wave graph</p> <p>Automotive scope pattern- scan tool (line graph) plot data on a graph and determine voltage v time failure</p> <p>Slopes and peaks (trig functions) on a graph</p>
5.38 Describe the operation of a regenerative braking system		
5.39 Inspect wheel studs and describe procedures for replacement		
<b>Automotive Standards</b>	<b>AZ Math Standards</b>	<b>Reasoning/Rationale</b>
<b>STANDARD 6.0 PERFORM ELECTRICAL/ELECTRONIC SYSTEM SERVICES—GENERAL</b>		
6.1 Research vehicle service information including fluid type, service precautions and procedures, technical service bulletins, and recalls		
6.2 Identify vehicle systems and electrical/electronic system components and configurations,		

including advanced driver assistance systems (ADAS)		
6.3 Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed	<b>QR.SPR.3:</b> Represent numerical summaries and visual displays of real-world data to make informed decisions. Reason, communicate, and describe strengths, limitations, and fallacies of various displays. <i>Encompasses P.S-IC.B.6</i>	Freeze Frame graphs with sine waves. and percentages Residual graphs - highs and lows mapped to the spec
6.4 Describe electrical/electronic series, parallel, and series-parallel circuits using principles of electricity (Ohm's Law)	<b>A1.A-CED.A.4</b> Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <i>For example, rearrange Ohm's law <math>V = IR</math> to highlight resistance <math>R</math>.</i>	Ohms Law
6.5 Demonstrate proper use of a digital multimeter (DMM) when measuring source voltage, voltage drop (including grounds), current flow, and resistance		Voltage drop formula
6.6 Demonstrate knowledge of the causes and effects from shorts, grounds, opens, and resistance problems in electrical/electronic circuits	<b>QR.NR.3</b> Understand and compare magnitudes of numbers utilizing real-world context. Understand the importance and impact of unit selection.	Ohms law - comparison of current circuit data Solve for variables, E over IR, $E/I=R$
6.7 Use fused jumper wires to check operation of electrical circuits per service information		
6.8 Use wiring diagrams to trace electrical/electronic circuits		
6.9 Measure key-off battery drain (parasitic draw)	<b>QR.SPR.3</b> Represent numerical summaries and visual displays of real-world data to make informed decisions. Reason, communicate, and describe strengths, limitations, and fallacies of various displays. <i>Encompasses P.S-IC.B.6</i>	Using voltage and amperage to make decisions Plot data -as voltage drops, the numbers change with resistance in the circuits Choose level of accuracy - use units to solve problems
6.10 Inspect and test fusible links, circuit breakers, and fuses; determine necessary action		
6.11 Repair and/or replace connectors, terminal ends, and wiring of electrical/electronic systems		
6.12 Perform battery state-of-charge test; determine necessary action	<b>QR.SPR.3</b> Represent numerical summaries and visual displays of real-world data to make informed decisions. Reason, communicate, and describe strengths, limitations, and fallacies of various displays. <i>Encompasses P.S-IC.B.6</i>	Linear graph - similar to parasitic draw

6.13 Confirm proper battery capacity, size, type, and application for vehicle; perform battery capacity and load test	<b>QR.CR.2</b> Compare, reason and communicate about proportional and non-proportional models utilizing real-world contexts.	Voltage drain over time-data is variable - temperature impacts readings Linear graph -incorporate variance to the midline
6.14 Maintain or restore electronic memory functions as recommended by manufacturer		
6.15 Inspect and clean battery; fill battery cells (if applicable); check battery cables, connectors, clamps, and hold-downs		
6.16 Perform battery charging according to manufacturer's recommendations		
6.17 Explain procedures for jump-starting a vehicle using jumper cables and a booster battery or an auxiliary power supply		
6.18 Identify electrical/electronic modules, security systems, radios, and other accessories that require reinitialization or code entry after reconnecting vehicle battery		
6.19 Perform starter current draw test; determine necessary action	<b>QR.CR.2</b> Compare, reason and communicate about proportional and non-proportional models utilizing real-world contexts.	Loading a starter Similar math as in 6.13
6.20 Perform starter circuit voltage drop tests; determine necessary action	<b>QR.SPR.3</b> Represent numerical summaries and visual displays of real-world data to make informed decisions. Reason, communicate, and describe strengths, limitations, and fallacies of various displays. <i>Encompasses P.S-IC.B.6</i> <b>QR.CR.2</b> Compare, reason and communicate about proportional and non-proportional models utilizing real-world contexts.	Comparing data Similar math as in 6.12
6.21 Inspect and test starter relays and solenoids; determine necessary action		
6.22 Describe the removal and installation of a starter in a vehicle		
6.23 Explain the operation of an automatic idle-stop/start-stop system		
6.24 Perform charging system output test; determine necessary action	<b>QR.SPR.3</b> Represent numerical summaries and visual displays of real-world data to make informed	Comparing data Similar math as in 6.20

	<p>decisions. Reason, communicate, and describe strengths, limitations, and fallacies of various displays. <i>Encompasses P.S-IC.B.6</i></p> <p><b>QR.CR.2</b> Compare, reason and communicate about proportional and non-proportional models utilizing real-world contexts.</p>	
6.25 Explain removal/replacement procedures for generator (alternator) drive belts; check pulleys and tensioners for wear; check pulley and belt alignment		
6.26 Remove, inspect, and/or reinstall generator (alternator)		
6.27 Perform charging circuit voltage drop tests; determine necessary action	<p><b>A1.A-CED.A.4</b> Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <i>For example, rearrange Ohm's law <math>V = IR</math> to highlight resistance <math>R</math>.</i></p> <p><b>QR.NR.3</b> Understand and compare magnitudes of numbers utilizing real-world context. Understand the importance and impact of unit selection.</p>	<p>Ohms law Drop test: evaluate and compare voltage and amperage</p>
6.28 Inspect interior and exterior lamps and sockets including headlights and auxiliary lights (fog lights/driving lights); replace as needed		
6.29 Aim headlights		
6.30 Describe vehicle comfort, convenience, access, safety, and related systems operation		
6.31 Describe the operation of keyless entry/remote-start systems		
6.32 Describe procedures for disabling and enabling for supplemental restraint system (SRS); verify indicator lamp operation		
6.33 Verify windshield wiper and washer operation; replace wiper blades		

Automotive Standards	AZ Math Standards	Reasoning/Rationale
<b>STANDARD 7.0 PERFORM HEATING, VENTILATION AND AIR CONDITIONING (HVAC) SYSTEM SERVICES—GENERAL</b>		
7.1 Research vehicle service information including fluid type, service precautions and procedures, technical service bulletins, and recalls		
7.2 Identify vehicle systems, including advanced driver assistance systems (ADAS)		Basic math: 3d patterns/axis draw arcs to find center line (focal point) ex. SpringerLink on how to square solving the angle on a triangle (height and distance)
7.3 Describe heating, ventilation and air conditioning (HVAC) components and configuration		
7.4 Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed	<b>QR.SPR.3</b> Represent numerical summaries and visual displays of real-world data to make informed decisions. Reason, communicate, and describe strengths, limitations, and fallacies of various displays. <i>Encompasses P.S-IC.B.6</i>	Freeze frame data graphs Similar math as in 7.4
7.5 Explain the steps of an A/C performance test including connections, pressure gauges, identifying refrigerant, and coagulin	<b>QR.CR.2</b> Compare, reason and communicate about proportional and non-proportional models utilizing real-world contexts.	Air conditioning temperature and pressure chart Ambient temp v temp of freon relationship Compare gauge data - altitude v vacuum
7.6 Describe abnormal operating noises in the A/C system		
7.7 Visually inspect A/C components for signs of leaks		
7.8 Interpret heating and air conditioning problems		
7.9 Inspect and replace A/C compressor drive belts, pulleys, and tensioners; determine necessary action		
7.10 Inspect A/C condenser for airflow restrictions; determine necessary action		Surface area cooling calculation Measure airflow change across the condenser (cubic feet)
7.11 Inspect evaporator housing condensation drain; determine necessary action		
7.12 Inspect engine cooling and heater systems hoses and pipes; determine necessary action		



7.13 Inspect HVAC system ducts, doors, hoses, cabin filters, and outlets		
7.14 Identify the source of HVAC system odors		
7.15 Demonstrate the need to recover, recycle, and handle refrigerants using proper equipment and procedures	<p><b>QR.CR.2</b> Compare, reason and communicate about proportional and non-proportional models utilizing real-world contexts.</p> <p><b>QR.SPR.3</b> Represent numerical summaries and visual displays of real-world data to make informed decisions. Reason, communicate, and describe strengths, limitations, and fallacies of various displays. <i>Encompasses P.S-IC.B.6</i></p>	<p>ASE freon - temp pressure relationships</p> <p>Compare readings to baseline spec</p> <p>Similar math as in 6.12</p>
Automotive Standards	AZ Math Standards	Reasoning/Rationale
STANDARD 8.0 PERFORM ENGINE PERFORMANCE SERVICES – GENERAL		
8.1 Research vehicle service information including fluid type, service precautions and procedures, technical service bulletins, and recalls		
8.2 Identify vehicle systems, including advanced driver assistance systems (ADAS)		<p>Basic math: 3d patterns/axis draw arcs to find center line (focal point) ex. SpringerLink on how to square solving the angle on a triangle (height and distance)</p> <p>Similar math as in 7.2</p>
8.3 Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed	<p><b>QR.SPR.3</b> Represent numerical summaries and visual displays of real-world data to make informed decisions. Reason, communicate, and describe strengths, limitations, and fallacies of various displays. <i>Encompasses P.S-IC.B.6</i></p>	<p>Freeze Frame</p> <p>Similar math as in 7.4</p>
8.4 Demonstrate understanding of proper engine cooling system operation	<p><b>A1.A-CED.A.1</b> Create equations and inequalities in one variable and use them to solve problems. Include problem-solving opportunities utilizing real-world context.</p> <p>Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).</p>	<p>Create equations and inequalities to determine gallons/min (fluid flow) and surface area</p> <p>Thermostat/coolant/pump/radiator airflow/fan power</p>
8.5 Describe camshaft timing including engines equipped with	<p><b>QR.NR.4</b> Use and justify estimation skills, and know why, how, and when to estimate results. Assess and justify the reasonableness of</p>	<p>Ratios - circumferences- degrees - radius</p> <p>Determine how rocker arms are operating (opening and closing)</p>

Standards used in this Crosswalk: AZ Math Standards ALG2, Geo, Quant Reasoning revised 2018 and CTE Automotive Technologies revised in 2022

variable valve timing (VVT) and/or variable lift systems	estimations using the context and comparisons to other known values. <b>QR.CR.2</b> Compare, reason and communicate about proportional and non-proportional models utilizing real-world contexts.	Determine the shape of the load on rocker arms ratio and degrees VVTI - Timing of valve opening and frequency ex. toyota variable valve timing use the graph to determine how far the shift is and is it shifting in the right spot
8.6 Explain computerized control system components and configurations		
8.7 Explain ignition system components and configurations		
8.8 Describe the removal and replacement of spark plugs and the inspection of secondary ignition components for wear and damage		
8.9 Describe fuel, air induction, and exhaust system components and configurations		
8.10 Explain fuel filter(s) replacement(s) where applicable		
8.11 Inspect, service, or replace air filters, filter housings, and intake duct work		
8.12 Inspect integrity of the exhaust manifold, exhaust pipes, muffler(s), catalytic converter(s), resonator(s), tail pipe(s), and heat shields; determine necessary action		
8.13 Inspect condition of exhaust system hangers, brackets, clamps, and heat shields; determine necessary action		
8.14 Explain procedures to check and refill diesel exhaust fluid (DEF)		
8.15 Describe emission control system components and configurations		
8.16 Inspect, test, and service positive crankcase ventilation (PCV) filter/breather, valve, tubes, orifices, and hoses; perform necessary action		

Automotive Standards	AZ Math Standards	Reasoning/Rationale
<b>STANDARD 9.0 PERFORM AUTOMOTIVE SHOP AND SAFETY TASKS</b>		
9.1 Exhibit general shop safety rules and procedures		
9.2 Utilize safe procedures for handling of tools and equipment		
9.3 Demonstrate proper placement of floor jacks and jack stands		
9.4 Demonstrate proper procedures for safe lift operation		
9.5 Utilize proper ventilation procedures for working within the lab/shop area		
9.6 Identify marked safety areas		
9.7 Identify the location and the types of fire extinguishers and other fire safety equipment		
9.8 Demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment		
9.9 Identify the location and use of eye wash stations		
9.10 Identify the location of the posted evacuation routes		
9.11 Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities		
9.12 Wear appropriate clothing for lab/shop activities		
9.13 Secure hair and jewelry for lab/shop activities		
9.14 Demonstrate awareness of the safety aspects of supplemental restraint systems (SRS), electronic brake control systems		
9.15 Identify vehicle systems which pose a safety hazard during service due to high voltage (i.e., hybrid/electric drivetrain, lighting systems, ignition systems, A/C systems, injection systems, etc.)		

9.16 Locate and demonstrate knowledge of material safety data sheets (SDS)		
9.17 Identify tools and their usage in automotive applications		
9.18 Identify SAE and metric designation		
9.19 Demonstrate safe handling and use of appropriate tools including torque wrenches		
9.20 Demonstrate proper cleaning, storage, and maintenance of tools and equipment		
9.21 Demonstrate proper use of precision measuring tools (i.e., micrometer, dial-indicator, dial-caliper, etc.)		
9.22 Identify information necessary and the service requested on a repair order		
9.23 Identify purpose and demonstrate proper use of fender covers, mats, seat, and steering wheel covers		
9.24 Perform a vehicle walk-around inspection; identify and document existing vehicle conditions (i.e., body-, paint- and/or windshield damage, etc.)		
9.25 Perform a vehicle multi-point inspection and complete a vehicle inspection report		
9.26 Demonstrate use of the three C's (concern, cause, and correction)		
9.27 Ensure vehicle is prepared to return to customer per school/company policy (i.e., floor mats, steering wheel cover, etc.)		