

AUTOMOTIVE TECHNOLOGIES COURSE OF STUDY Grades 11-12

Subject Code
170302

Lancaster City Schools
345 E. Mulberry Street
Lancaster, Ohio 43130

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Automotive Technologies
Lancaster City Schools

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Lancaster City Schools

The Vision

A community focused on student achievement

The Mission

To prepare students of all ages to meet academic, social, civic, cultural, and employment needs of the 21st Century

Lancaster City Schools Educational Philosophy

The School Board believes in the dignity and uniqueness of each student and recognizing their inherent differences, endeavors to provide a broad curriculum enabling students to reach their maximum potentials.

Success in education necessitates a curriculum that considers multiple learning styles and which encompasses a variety of teaching methods.

Mental and emotional development begins at birth and continues throughout life. Each of our schools must strive to create an atmosphere which fosters healthy and productive attitudes toward education and which encourages a life-long interest in learning.

The Lancaster City Schools are committed to:

1. teaching 21st century skills pertaining to reading, writing, mathematics, historical perspective, scientific inquiry, technology, arts, culture, health and wellness, social and vocational areas to meet or exceed a mastery level so that students continue intellectual growth and development;
2. providing experiences which enable students to develop critical thinking, reasoning, problem solving and decision making skills;
3. stimulating creativity, encouraging personal enrichment,
4. and providing approaches to wellness that enable students to define their individuality;
5. fostering attitudes of acceptance and respect for the ideas, beliefs and goals of others;
6. fostering attitudes of social responsibility so that every student contributes to their community in a positive way;

Our ultimate goal is to generate graduates of the Lancaster City Schools who, as adults, will stand confidently, participate fully, learn continually and contribute meaningfully to our world.

Lancaster City Schools Goals and Objectives

The goal of this school system is to accept responsibility for the development of each child into an adult who can stand confidently, participate fully, learn continually and contribute meaningfully to our world.

To achieve the desired goal, five equally important objectives with desired outcomes will be incorporated into our curriculum planning:

1. To ensure that each student develops mastery in academic skills.
2. To ensure that each student develops the capacity to recognize and analyze current and future challenges and opportunities.
3. To ensure the development of meaningful interpersonal relationships among students, staff and the community.
4. To ensure that staff, students and parents are afforded maximum feasible participation in the development and evaluation of programs and policies that meet the educational needs of all stakeholders.
5. To ensure maximum efficiency in the allocation of human and material resources.

Automotive Technologies Program Philosophy

We believe Automotive Technologies is a two-year program of classroom instruction, lab experience, and work in the field of interactive media. Automotive Technologies places students on a seamless pathway to a two year college, a four year degree, or an entry level position at a dealership/repair facility.

We believe Automotive Technologies fosters the development of fully functioning individuals who take actions that better their family, their workplace, and society.

We believe Automotive Technologies assists students in developing skills to solve problems, relate positively to others, and manage resources, and balance work and family life.

We believe the major responsibility for Automotive Technologies rests with the Lancaster City Schools Board of Education. The Automotive Technologies instructor carries out its instructions, with support from the community through an advisory board and from Lancaster High School through the Career and Technical Department chairperson and the Assistant Principal.

We believe the major responsibility of the Automotive Technologies instructor is to guide each student as they learn and practice skills needed to function in society, in the workplace, and in higher education. The Automotive Technologies instructor must be aware of all trends in the field and must teach students to meet current industry standards. The Automotive Technologies instructor must follow ethical codes of the school district, the high school, and the classroom.

2015 NATEF Automobile Accreditation Auto Service Technician (AST)

I. ENGINE REPAIR

A. General: Engine Diagnosis; Removal and Reinstallation (R & R)

1. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction. P-1
2. Research applicable vehicle and service information, such as internal engine operation, vehicle service history, service precautions, and technical service bulletins. P-1
3. Verify operation of the instrument panel engine warning indicators. P-1
4. Inspect engine assembly for fuel, oil, coolant, and other leaks; determine necessary action. P-1
5. Install engine covers using gaskets, seals, and sealers as required. P-1
6. Remove and replace timing belt; verify correct camshaft timing. P-1
7. Perform common fastener and thread repair, to include: remove broken bolt, restore internal and external threads, and repair internal threads with thread insert. P-1
8. Inspect, remove and replace engine mounts. P-2
9. Identify hybrid vehicle internal combustion engine service precautions. P-3
10. Remove and reinstall engine in an OBDII or newer vehicle; reconnect all attaching components and restore the vehicle to running condition. P-3

I. ENGINE REPAIR

B. Cylinder Head and Valve Train Diagnosis and Repair

1. Remove cylinder head; inspect gasket condition; install cylinder head and gasket; tighten according to manufacturer's specifications and procedures. P-1
2. Clean and visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition. P-1

- | | |
|---|-----|
| 3. Inspect pushrods, rocker arms, rocker arm pivots and shafts for wear, bending, cracks, looseness, and blocked oil passages (orifices); determine necessary action. | P-2 |
| 4. Adjust valves (mechanical or hydraulic lifters). | P-1 |
| 5. Inspect and replace camshaft and drive belt/chain; includes checking drive gear wear and backlash, end play, sprocket and chain wear, overhead cam drive sprocket(s), drive belt(s), belt tension, tensioners, camshaft reluctor ring/tone-wheel, and valve timing components; verify correct camshaft timing. | P-1 |
| 6. Establish camshaft position sensor indexing. | P-1 |

I. ENGINE REPAIR

C. Engine Block Assembly Diagnosis and Repair

- | | |
|---|-----|
| 1. Remove, inspect, or replace crankshaft vibration damper (harmonic balancer). | P-2 |
|---|-----|

I. ENGINE REPAIR

D. Lubrication and Cooling Systems Diagnosis and Repair

- | | |
|--|-----|
| 1. Perform cooling system pressure and dye tests to identify leaks; check coolant condition and level; inspect and test radiator, pressure cap, coolant recovery tank, and heater core and galley plugs; determine necessary action. | P-1 |
| 2. Identify causes of engine overheating. | P-1 |
| 3. Inspect, replace, and adjust drive belts, tensioners, and pulleys; check pulley and belt alignment. | P-1 |
| 4. Inspect and test coolant; drain and recover coolant; flush and refill cooling system with recommended coolant; bleed air as required. | P-1 |
| 5. Inspect, remove, and replace water pump. | P-2 |
| 6. Remove and replace radiator. | P-2 |
| 7. Remove, inspect, and replace thermostat and gasket/seal. | P-1 |
| 8. Inspect and test fan(s) (electrical or mechanical), fan clutch, fan shroud, | P-1 |

and air dams.

- 9. Perform oil pressure tests; determine necessary action. P-1
- 10. Perform engine oil and filter change. P-1
- 11. Inspect auxiliary coolers; determine necessary action. P-3
- 12. Inspect, test, and replace oil temperature and pressure switches and sensors. P-2

ER Tasks	
P-1	20
P-2	6
P-3	3
	29

II. AUTOMATIC TRANSMISSION AND TRANSAXLE

A. General: Transmission and Transaxle Diagnosis

- 1. Identify and interpret transmission/transaxle concern, differentiate between engine performance and transmission/transaxle concerns; determine necessary action. P-1
- 2. Research applicable vehicle and service information fluid type, vehicle service history, service precautions, and technical service bulletins. P-1
- 3. Diagnose fluid loss and condition concerns; determine necessary action. P-1
- 4. Check fluid level in a transmission or a transaxle equipped with a dipstick. P-1
- 5. Check fluid level in a transmission or a transaxle not equipped with a dipstick. P-1
- 6. Perform stall test; determine necessary action. P-3
- 7. Perform lock-up converter system tests; determine necessary action. P-3
- 8. Diagnose transmission/transaxle gear reduction/multiplication concerns using driving, driven, and held member (power flow) principles. P-1
- 9. Diagnose pressure concerns in a transmission using hydraulic principles (Pascal's Law). P-2

II. AUTOMATIC TRANSMISSION AND TRANSAXLE

B. In-Vehicle Transmission/Transaxle Maintenance and Repair

- 1. Inspect, adjust, and replace external manual valve shift linkage, transmission range sensor/switch, and park/neutral position switch. P-2
- 2. Inspect for leakage; replace external seals, gaskets, and bushings. P-2
- 3. Inspect, test, adjust, repair, or replace electrical/electronic components and circuits including computers, solenoids, sensors, relays, terminals, connectors, switches, and harnesses. P-1
- 4. Drain and replace fluid and filter(s). P-1
- 5. Inspect, replace and align powertrain mounts. P-2

II. AUTOMATIC TRANSMISSION AND TRANSAXLE

C. Off-Vehicle Transmission and Transaxle Repair

- 1. Remove and reinstall transmission/transaxle and torque converter; inspect engine core plugs, rear crankshaft seal, dowel pins, dowel pin holes, and mating surfaces. P-1
- 2. Inspect, leak test, and flush or replace transmission/transaxle oil cooler, lines, and fittings. P-1
- 3. Inspect converter flex (drive) plate, converter attaching bolts, converter pilot, converter pump drive surfaces, converter end play, and crankshaft pilot bore. P-2
- 4. Describe the operational characteristics of a continuously variable transmission (CVT). P-3
- 5. Describe the operational characteristics of a hybrid vehicle drive train. P-3

AT Tasks	
P-1	10
P-2	5
P-3	4
	19

III. MANUAL DRIVE TRAIN AND AXLES

A. General: Drive Train Diagnosis

- 1. Identify and interpret drive train concerns; determine necessary action. P-1

2. Research applicable vehicle and service information, fluid type, vehicle service history, service precautions, and technical service bulletins. P-1
3. Check fluid condition; check for leaks; determine necessary action. P-1
4. Drain and refill manual transmission/transaxle and final drive unit. P-1

III. MANUAL DRIVE TRAIN AND AXLES

B. Clutch Diagnosis and Repair

1. Diagnose clutch noise, binding, slippage, pulsation, and chatter; determine necessary action. P-1
2. Inspect clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots, and springs; perform necessary action. P-1
3. Inspect and replace clutch pressure plate assembly, clutch disc, release (throw-out) bearing and linkage, and pilot bearing/bushing (as applicable). P-1
4. Bleed clutch hydraulic system. P-1
5. Check and adjust clutch master cylinder fluid level; check for leaks. P-1
6. Inspect flywheel and ring gear for wear and cracks; determine necessary action. P-1
7. Measure flywheel runout and crankshaft end play; determine necessary action. P-2

III. MANUAL DRIVE TRAIN AND AXLES

C. Transmission/Transaxle Diagnosis and Repair

1. Inspect, adjust, and reinstall shift linkages, brackets, bushings, cables, pivots, and levers. P-2
2. Describe the operational characteristics of an electronically-controlled manual transmission/transaxle. P-3

III. MANUAL DRIVE TRAIN AND AXLES

D. Drive Shaft and Half Shaft, Universal and Constant-Velocity (CV) Joint Diagnosis and Repair

1. Diagnose constant-velocity (CV) joint noise and vibration concerns; determine necessary action. P-1
2. Diagnose universal joint noise and vibration concerns; perform necessary action. P-2
3. Inspect, remove, and replace front wheel drive (FWD) bearings, hubs, and seals. P-1
4. Inspect, service, and replace shafts, yokes, boots, and universal/CV joints. P-1
5. Check shaft balance and phasing; measure shaft runout; measure and adjust driveline angles. P-2

III. MANUAL DRIVE TRAIN AND AXLES

E. Drive Axle Diagnosis and Repair

1. Ring and Pinion Gears and Differential Case Assembly

1. Clean and inspect differential housing; check for leaks; inspect housing vent. P-2
2. Check and adjust differential housing fluid level. P-1
3. Drain and refill differential housing. P-1
4. Inspect and replace companion flange and pinion seal; measure companion flange runout. P-2

2. Drive Axles

1. Inspect and replace drive axle wheel studs. P-1
2. Remove and replace drive axle shafts. P-1
3. Inspect and replace drive axle shaft seals, bearings, and retainers. P-2
4. Measure drive axle flange runout and shaft end play; determine necessary action. P-2

III. MANUAL DRIVE TRAIN AND AXLES

F. Four-wheel Drive/All-wheel Drive Component Diagnosis and Repair

- 1. Inspect, adjust, and repair shifting controls (mechanical, electrical, and vacuum), bushings, mounts, levers, and brackets. P-3
- 2. Inspect front-wheel bearings and locking hubs; perform necessary action(s). P-3
- 3. Check for leaks at drive assembly seals; check vents; check lube level. P-3
- 4. Identify concerns related to variations in tire circumference and/or final drive ratios. P-3

MD Tasks	
P-1	17
P-2	8
P-3	5
	30

IV. SUSPENSION AND STEERING

A. General: Suspension and Steering Systems

- 1. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins. P-1

IV. SUSPENSION AND STEERING

B. Steering Systems Diagnosis and Repair

- 1. Disable and enable supplemental restraint system (SRS). P-1
- 2. Remove and replace steering wheel; center/time supplemental restraint system (SRS) coil (clock spring). P-1
- 3. Diagnose steering column noises, looseness, and binding concerns (including tilt mechanisms); determine necessary action. P-2
- 4. Diagnose power steering gear (non-rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine necessary action. P-2
- 5. Diagnose power steering gear (rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine necessary action. P-2
- 6. Inspect steering shaft universal-joint(s), flexible coupling(s), collapsible column, lock cylinder mechanism, and steering wheel; perform necessary P-2

action.

7. Remove and replace rack and pinion steering gear; inspect mounting bushings and brackets. P-2
8. Inspect rack and pinion steering gear inner tie rod ends (sockets) and bellows boots; replace as needed. P-2
9. Determine proper power steering fluid type; inspect fluid level and condition. P-1
10. Flush, fill, and bleed power steering system. P-2
11. Inspect for power steering fluid leakage; determine necessary action. P-1
12. Remove, inspect, replace, and adjust power steering pump drive belt. P-1
13. Remove and reinstall power steering pump. P-2
14. Remove and reinstall press fit power steering pump pulley; check pulley and belt alignment. P-2
15. Inspect and replace power steering hoses and fittings. P-2
16. Inspect and replace pitman arm, relay (centerlink/intermediate) rod, idler arm and mountings, and steering linkage damper. P-2
17. Inspect, replace, and adjust tie rod ends (sockets), tie rod sleeves, and clamps. P-1
18. Identify hybrid vehicle power steering system electrical circuits and safety precautions. P-2
19. Inspect electric power-assisted steering. P-3

IV. SUSPENSION AND STEERING

C. Suspension Systems Diagnosis and Repair

1. Diagnose short and long arm suspension system noises, body sway, and uneven ride height concerns; determine necessary action. P-1
2. Diagnose strut suspension system noises, body sway, and uneven ride height concerns; determine necessary action. P-1

- | | |
|--|-----|
| 3. Inspect, remove and install upper and lower control arms, bushings, shafts, and rebound bumpers. | P-3 |
| 4. Inspect, remove and install strut rods and bushings. | P-3 |
| 5. Inspect, remove and install upper and/or lower ball joints (with or without wear indicators). | P-2 |
| 6. Inspect, remove and install steering knuckle assemblies. | P-3 |
| 7. Inspect, remove and install short and long arm suspension system coil springs and spring insulators. | P-3 |
| 8. Inspect, remove and install torsion bars and mounts. | P-3 |
| 9. Inspect, remove and install front stabilizer bar (sway bar) bushings, brackets, and links. | P-3 |
| 10. Inspect, remove and install strut cartridge or assembly, strut coil spring, insulators (silencers), and upper strut bearing mount. | P-3 |
| 11. Inspect, remove and install track bar, strut rods/radius arms, and related mounts and bushings. | P-3 |
| 12. Inspect rear suspension system leaf spring(s), bushings, center pins/bolts, and mounts. | P-1 |

IV. SUSPENSION AND STEERING

D. Related Suspension and Steering Service

- | | |
|---|-----|
| 1. Inspect, remove, and replace shock absorbers; inspect mounts and bushings. | P-1 |
| 2. Remove, inspect, and service or replace front and rear wheel bearings. | P-1 |
| 3. Describe the function of the power steering pressure switch. | P-3 |

IV. SUSPENSION AND STEERING

E. Wheel Alignment Diagnosis, Adjustment, and Repair

- | | |
|---|-----|
| 1. Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, and steering return concerns; determine necessary | P-1 |
|---|-----|

action.

2. Perform pre-alignment inspection and measure vehicle ride height; perform necessary action. P-1
3. Prepare vehicle for wheel alignment on alignment machine; perform four-wheel alignment by checking and adjusting front and rear wheel caster, camber; and toe as required; center steering wheel. P-1
4. Check toe-out-on-turns (turning radius); determine necessary action. P-2
5. Check SAI (steering axis inclination) and included angle; determine necessary action. P-2
6. Check rear wheel thrust angle; determine necessary action. P-1
7. Check for front wheel setback; determine necessary action. P-2
8. Check front and/or rear cradle (subframe) alignment; determine necessary action. P-3
9. Reset steering angle sensor P-2

IV. SUSPENSION AND STEERING

F. Wheels and Tires Diagnosis and Repair

1. Inspect tire condition; identify tire wear patterns; check for correct tire size and application (load and speed ratings) and adjust air pressure; determine necessary action. P-1
2. Diagnose wheel/tire vibration, shimmy, and noise; determine necessary action. P-2
3. Rotate tires according to manufacturer's recommendations. P-1
4. Measure wheel, tire, axle flange, and hub runout; determine necessary action. P-2
5. Diagnose tire pull problems; determine necessary action. P-2
6. Dismount, inspect, and remount tire on wheel; balance wheel and tire assembly (static and dynamic). P-1

- | | |
|--|-----|
| 7. Dismount, inspect, and remount tire on wheel equipped with tire pressure monitoring system sensor. | P-2 |
| 8. Inspect tire and wheel assembly for air loss; perform necessary action. | P-1 |
| 9. Repair tire using internal patch. | P-1 |
| 10. Identify and test tire pressure monitoring system (indirect and direct) for operation; verify operation of instrument panel lamps. | P-2 |
| 11. Demonstrate knowledge of steps required to remove and replace sensors in a tire pressure monitoring system. | P-1 |

SS Tasks	
P-1	22
P-2	22
P-3	11
	55

V. BRAKES

A. General: Brake Systems Diagnosis

- | | |
|--|-----|
| 1. Identify and interpret brake system concerns; determine necessary action. | P-1 |
| 2. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins. | P-1 |
| 3. Describe procedure for performing a road test to check brake system operation; including an anti-lock brake system (ABS). | P-1 |
| 4. Install wheel and torque lug nuts. | P-1 |

V. BRAKES

B. Hydraulic System Diagnosis and Repair

- | | |
|--|-----|
| 1. Diagnose pressure concerns in the brake system using hydraulic principles (Pascal's Law). | P-1 |
| 2. Measure brake pedal height, travel, and free play (as applicable); determine necessary action. | P-1 |
| 3. Check master cylinder for internal/external leaks and proper operation; determine necessary action. | P-1 |
| 4. Remove, bench bleed, and reinstall master cylinder. | P-1 |

- | | |
|---|-----|
| 5. Diagnose poor stopping, pulling or dragging concerns caused by malfunctions in the hydraulic system; determine necessary action. | P-3 |
| 6. Inspect brake lines, flexible hoses, and fittings for leaks, dents, kinks, rust, cracks, bulging, and wear; check for loose fittings and supports; determine necessary action. | P-1 |
| 7. Replace brake lines, hoses, fittings, and supports. | P-2 |
| 8. Fabricate brake lines using proper material and flaring procedures (double flare and ISO types). | P-2 |
| 9. Select, handle, store, and fill brake fluids to proper level. | P-1 |
| 10. Inspect, test, and/or replace components of brake warning light system. | P-3 |
| 11. Identify components of brake warning light system. | P-2 |
| 12. Bleed and/or flush brake system. | P-1 |
| 13. Test brake fluid for contamination. | P-1 |

V. BRAKES

C. Drum Brake Diagnosis and Repair

- | | |
|--|-----|
| 1. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging or pedal pulsation concerns; determine necessary action. | P-1 |
| 2. Remove, clean, inspect, and measure brake drum diameter; determine necessary action. | P-1 |
| 3. Refinish brake drum and measure final drum diameter; compare with specifications. | P-1 |
| 4. Remove, clean, and inspect brake shoes, springs, pins, clips, levers, adjusters/self-adjusters, other related brake hardware, and backing support plates; lubricate and reassemble. | P-1 |
| 5. Inspect wheel cylinders for leaks and proper operation; remove and replace as needed. | P-2 |
| 6. Pre-adjust brake shoes and parking brake; install brake drums or drum/hub assemblies and wheel bearings; perform final checks and | P-2 |

adjustments.

V. BRAKES

D. Disc Brake Diagnosis and Repair

1. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging, or pulsation concerns; determine necessary action. P-1
2. Remove and clean caliper assembly; inspect for leaks and damage/wear to caliper housing; determine necessary action. P-1
3. Clean and inspect caliper mounting and slides/pins for proper operation, wear, and damage; determine necessary action. P-1
4. Remove, inspect, and replace pads and retaining hardware; determine necessary action. P-1
5. Lubricate and reinstall caliper, pads, and related hardware; seat pads and inspect for leaks. P-1
6. Clean and inspect rotor; measure rotor thickness, thickness variation, and lateral runout; determine necessary action. P-1
7. Remove and reinstall rotor. P-1
8. Refinish rotor on vehicle; measure final rotor thickness and compare with specifications. P-1
9. Refinish rotor off vehicle; measure final rotor thickness and compare with specifications. P-1
10. Retract and re-adjust caliper piston on an integrated parking brake system. P-3
11. Check brake pad wear indicator; determine necessary action. P-2
12. Describe importance of operating vehicle to burnish/break-in replacement brake pads according to manufacturer's recommendations. P-1

V. BRAKES

E. Power-Assist Units Diagnosis and Repair

1. Check brake pedal travel with, and without, engine running to verify proper power booster operation. P-2
2. Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster. P-1
3. Inspect vacuum-type power booster unit for leaks; inspect the check-valve for proper operation; determine necessary action. P-1
4. Inspect and test hydraulically-assisted power brake system for leaks and proper operation; determine necessary action. P-3
5. Measure and adjust master cylinder pushrod length. P-3

V. BRAKES

F. Miscellaneous (Wheel Bearings, Parking Brakes, Electrical, Etc.) Diagnosis and Repair

1. Diagnose wheel bearing noises, wheel shimmy, and vibration concerns; determine necessary action. P-3
2. Remove, clean, inspect, repack, and install wheel bearings; replace seals; install hub and adjust bearings. P-1
3. Check parking brake cables and components for wear, binding, and corrosion; clean, lubricate, adjust or replace as needed. P-2
4. Check parking brake operation and parking brake indicator light system operation; determine necessary action. P-1
5. Check operation of brake stop light system. P-1
6. Replace wheel bearing and race. P-2
7. Inspect and replace wheel studs. P-1
8. Remove and reinstall sealed wheel bearing assembly. P-2

V. BRAKES

G. Electronic Brake, Traction and Stability Control Systems Diagnosis and Repair

		BR Tasks	
1.	Identify and inspect electronic brake control system components; determine necessary action.	P-1	P-1 33
2.	Identify traction control/vehicle stability control system components.	P-3	P-2 10
3.	Describe the operation of a regenerative braking system.	P-3	P-3 8 51

VI. ELECTRICAL/ELECTRONIC SYSTEMS

A. General: Electrical System Diagnosis

- | | | |
|-----|---|-----|
| 1. | Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins. | P-1 |
| 2. | Demonstrate knowledge of electrical/electronic series, parallel, and series-parallel circuits using principles of electricity (Ohm’s Law). | P-1 |
| 3. | Demonstrate proper use of a digital multimeter (DMM) when measuring source voltage, voltage drop (including grounds), current flow and resistance. | P-1 |
| 4. | Demonstrate knowledge of the causes and effects from shorts, grounds, opens, and resistance problems in electrical/electronic circuits. | P-1 |
| 5. | Check operation of electrical circuits with a test light. | P-1 |
| 6. | Check operation of electrical circuits with fused jumper wires. | P-1 |
| 7. | Use wiring diagrams during the diagnosis (troubleshooting) of electrical/electronic circuit problems. | P-1 |
| 8. | Diagnose the cause(s) of excessive key-off battery drain (parasitic draw); determine necessary action. | P-1 |
| 9. | Inspect and test fusible links, circuit breakers, and fuses; determine necessary action. | P-1 |
| 10. | Inspect and test switches, connectors, relays, solenoid solid state devices, and wires of electrical/electronic circuits; determine necessary action. | P-1 |

- 11. Replace electrical connectors and terminal ends. P-1
- 12. Repair wiring harness. P-3
- 13. Perform solder repair of electrical wiring. P-1

VI. ELECTRICAL/ELECTRONIC SYSTEMS

B. Battery Diagnosis and Service

- 1. Perform battery state-of-charge test; determine necessary action. P-1
- 2. Confirm proper battery capacity for vehicle application; perform battery capacity test; determine necessary action. P-1
- 3. Maintain or restore electronic memory functions. P-1
- 4. Inspect and clean battery; fill battery cells; check battery cables, connectors, clamps, and hold-downs. P-1
- 5. Perform slow/fast battery charge according to manufacturer's recommendations. P-1
- 6. Jump-start vehicle using jumper cables and a booster battery or an auxiliary power supply. P-1
- 7. Identify high-voltage circuits of electric or hybrid electric vehicle and related safety precautions. P-3
- 8. Identify electronic modules, security systems, radios, and other accessories that require re-initialization or code entry after reconnecting vehicle battery. P-1
- 9. Identify hybrid vehicle auxiliary (12v) battery service, repair, and test procedures. P-3

VI. ELECTRICAL/ELECTRONIC SYSTEMS

C. Starting System Diagnosis and Repair

- 1. Perform starter current draw tests; determine necessary action. P-1
- 2. Perform starter circuit voltage drop tests; determine necessary action. P-1

3. Inspect and test starter relays and solenoids; determine necessary action. P-2
4. Remove and install starter in a vehicle. P-1
5. Inspect and test switches, connectors, and wires of starter control circuits; determine necessary action. P-2
6. Differentiate between electrical and engine mechanical problems that cause a slow-crank or a no-crank condition. P-2

VI. ELECTRICAL/ELECTRONIC SYSTEMS

D. Charging System Diagnosis and Repair

1. Perform charging system output test; determine necessary action. P-1
2. Diagnose (troubleshoot) charging system for causes of undercharge, no-charge, or overcharge conditions. P-1
3. Inspect, adjust, or replace generator (alternator) drive belts; check pulleys and tensioners for wear; check pulley and belt alignment. P-1
4. Remove, inspect, and re-install generator (alternator). P-1
5. Perform charging circuit voltage drop tests; determine necessary action. P-1

VI. ELECTRICAL/ELECTRONIC SYSTEMS

E. Lighting Systems Diagnosis and Repair

1. Diagnose (troubleshoot) the causes of brighter-than-normal, intermittent, dim, or no light operation; determine necessary action. P-1
2. Inspect interior and exterior lamps and sockets including headlights and auxiliary lights (fog lights/driving lights); replace as needed. P-1
3. Aim headlights. P-2
4. Identify system voltage and safety precautions associated with high-intensity discharge headlights. P-2

VI. ELECTRICAL/ELECTRONIC SYSTEMS

F. Gauges, Warning Devices, and Driver Information Systems Diagnosis and Repair

1. Inspect and test gauges and gauge sending units for causes of abnormal gauge readings; determine necessary action. P-2
2. Diagnose (troubleshoot) the causes of incorrect operation of warning devices and other driver information systems; determine necessary action. P-2

VI. ELECTRICAL/ELECTRONIC SYSTEMS

G. Horn and Wiper/Washer Diagnosis and Repair

1. Diagnose (troubleshoot) causes of incorrect horn operation; perform necessary action. P-1
2. Diagnose (troubleshoot) causes of incorrect wiper operation; diagnose wiper speed control and park problems; perform necessary action. P-2
3. Diagnose (troubleshoot) windshield washer problems; perform necessary action. P-2

VI. ELECTRICAL/ELECTRONIC SYSTEMS

H. Accessories Diagnosis and Repair

1. Diagnose (troubleshoot) incorrect operation of motor-driven accessory circuits; determine necessary action. P-2
2. Diagnose (troubleshoot) incorrect electric lock operation (including remote keyless entry); determine necessary action. P-2
3. Diagnose (troubleshoot) incorrect operation of cruise control systems; determine necessary action. P-3
4. Diagnose (troubleshoot) supplemental restraint system (SRS) problems; determine necessary action. P-2
5. Disable and enable an airbag system for vehicle service; verify indicator lamp operation. P-1
6. Remove and reinstall door panel. P-1

- | | |
|--|-----|
| 7. Check for module communication errors (including CAN/BUS systems) using a scan tool. | P-2 |
| 8. Describe the operation of keyless entry/remote-start systems. | P-3 |
| 9. Verify operation of instrument panel gauges and warning/indicator lights; reset maintenance indicators. | P-1 |
| 10. Verify windshield wiper and washer operation, replace wiper blades. | P-1 |

EE Tasks	
P-1	34
P-2	13
P-3	5
	52

VII. HEATING AND AIR CONDITIONING

A. General: A/C System Diagnosis and Repair

- | | |
|--|-----|
| 1. Identify and interpret heating and air conditioning problems; determine necessary action. | P-1 |
| 2. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins. | P-1 |
| 3. Performance test A/C system; identify problems. | P-1 |
| 4. Identify abnormal operating noises in the A/C system; determine necessary action. | P-2 |
| 5. Identify refrigerant type; select and connect proper gauge set; record temperature and pressure readings. | P-1 |
| 6. Leak test A/C system; determine necessary action. | P-1 |
| 7. Inspect condition of refrigerant oil removed from A/C system; determine necessary action. | P-2 |
| 8. Determine recommended oil and oil capacity for system application. | P-1 |
| 9. Using a scan tool, observe and record related HVAC data and trouble codes. | P-3 |

VII. HEATING AND AIR CONDITIONING

B. Refrigeration System Component Diagnosis and Repair

1. Inspect and replace A/C compressor drive belts, pulleys, and tensioners; determine necessary action. P-1
2. Inspect, test, service or replace A/C compressor clutch components and/or assembly; check compressor clutch air gap; adjust as needed. P-2
3. Remove, inspect, and reinstall A/C compressor and mountings; determine recommended oil quantity. P-2
4. Identify hybrid vehicle A/C system electrical circuits and service/safety precautions. P-2
5. Determine need for an additional A/C system filter; perform necessary action. P-3
6. Remove and inspect A/C system mufflers, hoses, lines, fittings, O-rings, seals, and service valves; perform necessary action. P-2
7. Inspect A/C condenser for airflow restrictions; perform necessary action. P-1
8. Remove, inspect, and reinstall receiver/drier or accumulator/drier; determine recommended oil quantity. P-2
9. Remove, inspect, and install expansion valve or orifice (expansion) tube. P-1
10. Inspect evaporator housing water drain; perform necessary action. P-1
11. Determine procedure to remove and reinstall evaporator; determine required oil quantity. P-2

VII. HEATING AND AIR CONDITIONING

C. Heating, Ventilation, and Engine Cooling Systems Diagnosis and Repair

1. Inspect engine cooling and heater systems hoses; perform necessary action. P-1
2. Inspect and test heater control valve(s); perform necessary action. P-2
3. Determine procedure to remove inspect, and reinstall heater core. P-2

VII. HEATING AND AIR CONDITIONING

D. Operating Systems and Related Controls Diagnosis and Repair

- 1. Inspect and test A/C-heater blower motors, resistors, switches, relays, wiring, and protection devices; perform necessary action. P-1
- 2. Diagnose A/C compressor clutch control systems; determine necessary action. P-2
- 3. Diagnose malfunctions in the vacuum, mechanical, and electrical components and controls of the heating, ventilation, and A/C (HVAC) system; determine necessary action. P-2
- 4. Inspect and test A/C-heater control panel assembly; determine necessary action. P-3
- 5. Inspect and test A/C-heater control cables, motors, and linkages; perform necessary action. P-3
- 6. Inspect A/C-heater ducts, doors, hoses, cabin filters, and outlets; perform necessary action. P-1
- 7. Identify the source of A/C system odors. P-2
- 8. Check operation of automatic or semi-automatic heating, ventilation, and air-conditioning (HVAC) control systems; determine necessary action. P-2

VII. HEATING AND AIR CONDITIONING

E. Refrigerant Recovery, Recycling, and Handling

- 1. Perform correct use and maintenance of refrigerant handling equipment according to equipment manufacturer’s standards. P-1
- 2. Identify and recover A/C system refrigerant. P-1
- 3. Recycle, label, and store refrigerant. P-1
- 4. Evacuate and charge A/C system; add refrigerant oil as required. P-1

HA Tasks	
P-1	17
P-2	14
P-3	4
	35

VIII. ENGINE PERFORMANCE

A. General: Engine Diagnosis

1. Identify and interpret engine performance concerns; determine necessary action. P-1
2. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins. P-1
3. Diagnose abnormal engine noises or vibration concerns; determine necessary action. P-3
4. Diagnose the cause of excessive oil consumption coolant consumption, unusual exhaust color, odor, and sound; determine necessary action. P-2
5. Perform engine absolute (vacuum/boost) manifold pressure tests; determine necessary action. P-1
6. Perform cylinder power balance test; determine necessary action. P-2
7. Perform cylinder cranking and running compression tests; determine necessary action. P-1
8. Perform cylinder leakage test; determine necessary action. P-1
9. Diagnose engine mechanical, electrical, electronic, fuel, and ignition concerns; determine necessary action. P-2
10. Verify engine operating temperature; determine necessary action. P-1
11. Verify correct camshaft timing. P-1

VIII. ENGINE PERFORMANCE

B. Computerized Controls Diagnosis and Repair

1. Retrieve and record diagnostic trouble codes, OBD monitor status, and freeze frame data; clear codes when applicable. P-1
2. Access and use service information to perform step-by-step (troubleshooting) diagnosis. P-1
3. Perform active tests of actuators using a scan tool; determine necessary action. P-2

4. Describe the importance of running all OBDII monitors for repair verification. P-1

VIII. ENGINE PERFORMANCE

C. Ignition System Diagnosis and Repair

1. Diagnose (troubleshoot) ignition system related problems such as no-starting, hard starting, engine misfire, poor drivability, spark knock, power loss, poor mileage, and emissions concerns; determine necessary action. P-2
2. Inspect and test crankshaft and camshaft position sensor(s); perform necessary action. P-1
3. Inspect, test, and/or replace ignition control module, powertrain/engine control module; reprogram as necessary. P-3
4. Remove and replace spark plugs; inspect secondary ignition components for wear and damage. P-1

VIII. ENGINE PERFORMANCE

D. Fuel, Air Induction, and Exhaust Systems Diagnosis and Repair

1. Check fuel for contaminants; determine necessary action. P-2
2. Inspect and test fuel pumps and pump control systems for pressure, regulation, and volume; perform necessary action. P-1
3. Replace fuel filter(s). P-1
4. Inspect, service, or replace air filters, filter housings, and intake duct work. P-1
5. Inspect throttle body, air induction system, intake manifold and gaskets for vacuum leaks and/or unmetered air. P-2
6. Inspect and test fuel injectors. P-2
7. Verify idle control operation. P-1
8. Inspect integrity of the exhaust manifold, exhaust pipes, muffler(s), catalytic converter(s), resonator(s), tail pipe(s), and heat shields; perform necessary action. P-1

- 9. Inspect condition of exhaust system hangers, brackets, clamps, and heat shields; repair or replace as needed. P-1
- 10. Perform exhaust system back-pressure test; determine necessary action. P-2
- 11. Check and refill diesel exhaust fluid (DEF). P-3

VIII. ENGINE PERFORMANCE

E. Emissions Control Systems Diagnosis and Repair

- 1. Diagnose oil leaks, emissions, and drivability concerns caused by the positive crankcase ventilation (PCV) system; determine necessary action. P-3
- 2. Inspect, test, and service positive crankcase ventilation (PCV) filter/breather cap, valve, tubes, orifices, and hoses; perform necessary action. P-2
- 3. Diagnose emissions and drivability concerns caused by the exhaust gas recirculation (EGR) system; determine necessary action. P-3
- 4. Inspect, test, service, and replace components of the EGR system including tubing, exhaust passages, vacuum/pressure controls, filters, and hoses; perform necessary action. P-2
- 5. Inspect and test electrical/electronically-operated components and circuits of air injection systems; perform necessary action. P-3
- 6. Inspect and test catalytic converter efficiency. P-2
- 7. Inspect and test components and hoses of the evaporative emissions control system; perform necessary action. P-1
- 8. Interpret diagnostic trouble codes (DTCs) and scan tool data related to the emissions control systems; determine necessary action. P-3

EP Tasks	
P-1	19
P-2	12
P-3	7
	38

P-1	172
P-2	90
P-3	47
REQUIRED SUPPLEMENTAL TASKS	26
REQUIRED SUPPLEMENTAL TASKS	335

**Grand Total -
Tasks**

Shop and Personal Safety

1. Identify general shop safety rules and procedures.
2. Utilize safe procedures for handling of tools and equipment.
3. Identify and use proper placement of floor jacks and jack stands.
4. Identify and use proper procedures for safe lift operation.
5. Utilize proper ventilation procedures for working within the lab/shop area.
6. Identify marked safety areas.
7. Identify the location and the types of fire extinguishers and other fire safety equipment; demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment.
8. Identify the location and use of eye wash stations.
9. Identify the location of the posted evacuation routes.
10. Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities.
11. Identify and wear appropriate clothing for lab/shop activities.
12. Secure hair and jewelry for lab/shop activities.
13. Demonstrate awareness of the safety aspects of supplemental restraint systems (SRS), electronic brake control systems, and hybrid vehicle high voltage circuits.
14. Demonstrate awareness of the safety aspects of high voltage circuits (such as high intensity discharge (HID) lamps, ignition systems, injection systems, etc.).
15. Locate and demonstrate knowledge of material safety data sheets (MSDS).

Tools and Equipment

1. Identify tools and their usage in automotive applications.
2. Identify standard and metric designation.
3. Demonstrate safe handling and use of appropriate tools.

4. Demonstrate proper cleaning, storage, and maintenance of tools and equipment.

5. Demonstrate proper use of precision measuring tools (i.e. micrometer, dial-indicator, dial-caliper).

Preparing Vehicle for Service

1. Identify information needed and the service requested on a repair order.

2. Identify purpose and demonstrate proper use of fender covers, mats.

3. Demonstrate use of the three C's (concern, cause, and correction).

4. Review vehicle service history.

5. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.

Preparing Vehicle for Customer

1. Ensure vehicle is prepared to return to customer per school/company policy (floor mats, steering wheel cover, etc.).

Pupil Evaluation Methods

Formative

- Observation
- Homework
- Quizzes
- Skill checks
- Class work-individual or group
- Clinical

Summative

- Chapter tests
- Projects
- Unit tests
- Research papers
- Non- linguistic representations
- Abstracts
- Case studies

Diagnostic

- Pre-assessment
- Post-assessment

APPENDIX A: Common Core Literacy Standards for Auto Technology

ENGLISH LANGUAGE ARTS WITH HISTORY AND SOCIAL STUDIES English Language Arts Standards » Reading: Literature » Grade 11-12

The CCR anchor standards and high school grade-specific standards work in tandem to define college and career readiness expectations—the former providing broad standards, the latter providing additional specificity.

Key Ideas and Details:

CCSS.ELA-LITERACY.RI.11-12.1

Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

CCSS.ELA-LITERACY.RI.11-12.2

Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

CCSS.ELA-LITERACY.RI.11-12.3

Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Craft and Structure:

CCSS.ELA-LITERACY.RI.11-12.4

Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

CCSS.ELA-LITERACY.RI.11-12.5

Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.

CCSS.ELA-LITERACY.RI.11-12.6

Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness or beauty of the text.

Integration of Knowledge and Ideas:

CCSS.ELA-LITERACY.RI.11-12.7

Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

CCSS.ELA-LITERACY.RI.11-12.8

Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., *The Federalist*, presidential addresses).

CCSS.ELA-LITERACY.RI.11-12.9

Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including *The Declaration of Independence*, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

Range of Reading and Level of Text Complexity:

CCSS.ELA-LITERACY.RI.11-12.10

By the end of grade 11, read and comprehend literary nonfiction in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

By the end of grade 12, read and comprehend literary nonfiction at the high end of the grades 11-CCR text complexity band independently and proficiently.

English Language Arts Standards » Reading: Informational Text » Grade 11-12

The CCR anchor standards and high school grade-specific standards work in tandem to define college and career readiness expectations—the former providing broad standards, the latter providing additional specificity.

Key Ideas and Details:

CCSS.ELA-LITERACY.RL.11-12.1

Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

CCSS.ELA-LITERACY.RL.11-12.2

Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.

CCSS.ELA-LITERACY.RL.11-12.3

Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure:

CCSS.ELA-LITERACY.RL.11-12.4

Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)

CCSS.ELA-LITERACY.RL.11-12.5

Analyze how an author's choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.

CCSS.ELA-LITERACY.RL.11-12.6

Analyze a case in which grasping a point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas:

CCSS.ELA-LITERACY.RL.11-12.7

Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)

CCSS.ELA-LITERACY.RL.11-12.8

(RL.11-12.8 not applicable to literature)

CCSS.ELA-LITERACY.RL.11-12.9

Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity:

CCSS.ELA-LITERACY.RL.11-12.10

By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11-CCR text complexity band independently and proficiently.

English Language Arts Standards » Writing » Grade 11-12

The CCR anchor standards and high school grade-specific standards work in tandem to define college and career readiness expectations—the former providing broad standards, the latter providing additional specificity.

Text Types and Purposes:

CCSS.ELA-LITERACY.W.11-12.1

Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

CCSS.ELA-LITERACY.W.11-12.1.A

Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.

CCSS.ELA-LITERACY.W.11-12.1.B

Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.

CCSS.ELA-LITERACY.W.11-12.1.C

Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

CCSS.ELA-LITERACY.W.11-12.1.D

Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

CCSS.ELA-LITERACY.W.11-12.1.E

Provide a concluding statement or section that follows from and supports the argument presented.

CCSS.ELA-LITERACY.W.11-12.2

Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

CCSS.ELA-LITERACY.W.11-12.2.A

Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

CCSS.ELA-LITERACY.W.11-12.2.B

Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

CCSS.ELA-LITERACY.W.11-12.2.C

Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

CCSS.ELA-LITERACY.W.11-12.2.D

Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.

CCSS.ELA-LITERACY.W.11-12.2.E

Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

CCSS.ELA-LITERACY.W.11-12.2.F

Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

CCSS.ELA-LITERACY.W.11-12.3

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

CCSS.ELA-LITERACY.W.11-12.3.A

Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.

CCSS.ELA-LITERACY.W.11-12.3.B

Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.

CCSS.ELA-LITERACY.W.11-12.3.C

Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).

CCSS.ELA-LITERACY.W.11-12.3.D

Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.

CCSS.ELA-LITERACY.W.11-12.3.E

Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing:

CCSS.ELA-LITERACY.W.11-12.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)

CCSS.ELA-LITERACY.W.11-12.5

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1-3 up to and including grades 11-12 here.)

CCSS.ELA-LITERACY.W.11-12.6

Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge:

CCSS.ELA-LITERACY.W.11-12.7

Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CCSS.ELA-LITERACY.W.11-12.8

Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

CCSS.ELA-LITERACY.W.11-12.9

Draw evidence from literary or informational texts to support analysis, reflection, and research.

CCSS.ELA-LITERACY.W.11-12.9.A

Apply grades 11-12 Reading standards to literature (e.g., "Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics").

CCSS.ELA-LITERACY.W.11-12.9.B

Apply grades 11-12 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., The Federalist, presidential addresses]").

Range of Writing:

CCSS.ELA-LITERACY.W.11-12.10

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

English Language Arts Standards » Speaking & Listening » Grade 11-12

Comprehension and Collaboration:

CCSS.ELA-LITERACY.SL.11-12.1

Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

CCSS.ELA-LITERACY.SL.11-12.1.A

Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

CCSS.ELA-LITERACY.SL.11-12.1.B

Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

CCSS.ELA-LITERACY.SL.11-12.1.C

Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

CCSS.ELA-LITERACY.SL.11-12.1.D

Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

CCSS.ELA-LITERACY.SL.11-12.2

Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

CCSS.ELA-LITERACY.SL.11-12.3

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas:

CCSS.ELA-LITERACY.SL.11-12.4

Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

CCSS.ELA-LITERACY.SL.11-12.5

Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

CCSS.ELA-LITERACY.SL.11-12.6

Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11-12 Language standards 1 and 3 here for specific expectations.)

English Language Arts Standards » Language » Grade 11-12

Conventions of Standard English:

CCSS.ELA-LITERACY.L.11-12.1

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

CCSS.ELA-LITERACY.L.11-12.1.A

Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.

CCSS.ELA-LITERACY.L.11-12.1.B

Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.

CCSS.ELA-LITERACY.L.11-12.2

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

CCSS.ELA-LITERACY.L.11-12.2.A

Observe hyphenation conventions.

CCSS.ELA-LITERACY.L.11-12.2.B

Spell correctly.

Knowledge of Language:

CCSS.ELA-LITERACY.L.11-12.3

Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

CCSS.ELA-LITERACY.L.11-12.3.A

Vary syntax for effect, consulting references (e.g., Tufte's Artful Sentences) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.

Vocabulary Acquisition and Use:

CCSS.ELA-LITERACY.L.11-12.4

Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11-12 reading and content, choosing flexibly from a range of strategies.

CCSS.ELA-LITERACY.L.11-12.4.A

Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.

CCSS.ELA-LITERACY.L.11-12.4.B

Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).

CCSS.ELA-LITERACY.L.11-12.4.C

Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.

CCSS.ELA-LITERACY.L.11-12.4.D

Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

CCSS.ELA-LITERACY.L.11-12.5

Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

CCSS.ELA-LITERACY.L.11-12.5.A

Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.

CCSS.ELA-LITERACY.L.11-12.5.B

Analyze nuances in the meaning of words with similar denotations.

CCSS.ELA-LITERACY.L.11-12.6

Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

English Language Arts Standards » History/Social Studies » Grade 11-12

Key Ideas and Details:

CCSS.ELA-LITERACY.RH.11-12.1

Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.

CCSS.ELA-LITERACY.RH.11-12.2

Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.

CCSS.ELA-LITERACY.RH.11-12.3

Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain.

Craft and Structure:

CCSS.ELA-LITERACY.RH.11-12.4

Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

CCSS.ELA-LITERACY.RH.11-12.5

Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.

CCSS.ELA-LITERACY.RH.11-12.6

Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence.

Integration of Knowledge and Ideas:

CCSS.ELA-LITERACY.RH.11-12.7

Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

CCSS.ELA-LITERACY.RH.11-12.8

Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.

CCSS.ELA-LITERACY.RH.11-12.9

Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

Range of Reading and Level of Text Complexity:

CCSS.ELA-LITERACY.RH.11-12.10

By the end of grade 12, read and comprehend history/social studies texts in the grades 11-CCR text complexity band independently and proficiently.

English Language Arts Standards » Science & Technical Subjects » Grade 11-12

Key Ideas and Details:

CCSS.ELA-LITERACY.RST.11-12.1

Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

CCSS.ELA-LITERACY.RST.11-12.2

Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

CCSS.ELA-LITERACY.RST.11-12.3

Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure:

CCSS.ELA-LITERACY.RST.11-12.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

CCSS.ELA-LITERACY.RST.11-12.5

Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

CCSS.ELA-LITERACY.RST.11-12.6

Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas:

CCSS.ELA-LITERACY.RST.11-12.7

Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CCSS.ELA-LITERACY.RST.11-12.8

Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

CCSS.ELA-LITERACY.RST.11-12.9

Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity:

CCSS.ELA-LITERACY.RST.11-12.10

By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

English Language Arts Standards » Writing » Grade 11-12

Text Types and Purposes:

CCSS.ELA-LITERACY.WHST.11-12.1

Write arguments focused on discipline-specific content.

CCSS.ELA-LITERACY.WHST.11-12.1.A

Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

CCSS.ELA-LITERACY.WHST.11-12.1.B

Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

CCSS.ELA-LITERACY.WHST.11-12.1.C

Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

CCSS.ELA-LITERACY.WHST.11-12.1.D

Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

CCSS.ELA-LITERACY.WHST.11-12.1.E

Provide a concluding statement or section that follows from or supports the argument presented.

CCSS.ELA-LITERACY.WHST.11-12.2

Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

CCSS.ELA-LITERACY.WHST.11-12.2.A

Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

CCSS.ELA-LITERACY.WHST.11-12.2.B

Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

CCSS.ELA-LITERACY.WHST.11-12.2.C

Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

CCSS.ELA-LITERACY.WHST.11-12.2.D

Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

CCSS.ELA-LITERACY.WHST.11-12.2.E

Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

CCSS.ELA-LITERACY.WHST.11-12.3

(See note: not applicable as a separate requirement)

Production and Distribution of Writing:

CCSS.ELA-LITERACY.WHST.11-12.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-LITERACY.WHST.11-12.5

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

CCSS.ELA-LITERACY.WHST.11-12.6

Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge:

CCSS.ELA-LITERACY.WHST.11-12.7

Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CCSS.ELA-LITERACY.WHST.11-12.8

Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

CCSS.ELA-LITERACY.WHST.11-12.9

Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing:

CCSS.ELA-LITERACY.WHST.11-12.10

Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Note:

Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Mathematical Practices

CCSS.Math.Practice.MP1 Make sense of problems and persevere in solving them.

CCSS.Math.Practice.MP2 Reason abstractly and quantitatively.

CCSS.Math.Practice.MP3 Construct viable arguments and critique the reasoning of others.

CCSS.Math.Practice.MP4 Model with mathematics.

CCSS.Math.Practice.MP5 Use appropriate tools strategically.

CCSS.Math.Practice.MP6 Attend to precision.

CCSS.Math.Practice.MP7 Look for and make use of structure.

CCSS.Math.Practice.MP8 Look for and express regularity in repeated reasoning.

Number and Quantity » The Real Number System

Extend the properties of exponents to rational exponents.

CCSS.MATH.CONTENT.HSN.RN.A.1

Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5(1/3)^3$ to hold, so $(5^{1/3})^3$ must equal 5.

5.CCSS.MATH.CONTENT.HSN.RN.A.2

Rewrite expressions involving radicals and rational exponents using the properties of exponents. Use properties of rational and irrational numbers.

CCSS.MATH.CONTENT.HSN.RN.B.3

Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Number and Quantity

Reason quantitatively and use units to solve problems.

CCSS.MATH.CONTENT.HSN.Q.A.1

Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

CCSS.MATH.CONTENT.HSN.Q.A.2

Define appropriate quantities for the purpose of descriptive modeling.

CCSS.MATH.CONTENT.HSN.Q.A.3

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Number and Quantity » The Complex Number System

Perform arithmetic operations with complex numbers.

CCSS.MATH.CONTENT.HSN.CN.A.1

Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.

CCSS.MATH.CONTENT.HSN.CN.A.2

Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

CCSS.MATH.CONTENT.HSN.CN.A.3

(+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

Represent complex numbers and their operations on the complex plane.

CCSS.MATH.CONTENT.HSN.CN.B.4

(+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.

CCSS.MATH.CONTENT.HSN.CN.B.5

(+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3}i)^3 = 8$ because $(-1 + \sqrt{3}i)$ has modulus 2 and argument 120° .

CCSS.MATH.CONTENT.HSN.CN.B.6

(+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

Use complex numbers in polynomial identities and equations.

CCSS.MATH.CONTENT.HSN.CN.C.7

Solve quadratic equations with real coefficients that have complex solutions.

CCSS.MATH.CONTENT.HSN.CN.C.8

(+) Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$.

CCSS.MATH.CONTENT.HSN.CN.C.9

(+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

Number and Quantity » Vector & Matrix Quantities

Represent and model with vector quantities.

CCSS.MATH.CONTENT.HSN.VM.A.1

(+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., \mathbf{v} , $|\mathbf{v}|$, $\|\mathbf{v}\|$, v).

CCSS.MATH.CONTENT.HSN.VM.A.2

(+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

CCSS.MATH.CONTENT.HSN.VM.A.3

(+) Solve problems involving velocity and other quantities that can be represented by vectors.

Perform operations on vectors.

CCSS.MATH.CONTENT.HSN.VM.B.4

(+) Add and subtract vectors.

CCSS.MATH.CONTENT.HSN.VM.B.4.A

Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

CCSS.MATH.CONTENT.HSN.VM.B.4.B

Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

CCSS.MATH.CONTENT.HSN.VM.B.4.C

Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w , with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

CCSS.MATH.CONTENT.HSN.VM.B.5

(+) Multiply a vector by a scalar.

CCSS.MATH.CONTENT.HSN.VM.B.5.A

Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$.

CCSS.MATH.CONTENT.HSN.VM.B.5.B

Compute the magnitude of a scalar multiple cv using $\|cv\| = |c|v$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).

Perform operations on matrices and use matrices in applications.

CCSS.MATH.CONTENT.HSN.VM.C.6

(+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

CCSS.MATH.CONTENT.HSN.VM.C.7

(+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

CCSS.MATH.CONTENT.HSN.VM.C.8

(+) Add, subtract, and multiply matrices of appropriate dimensions.

CCSS.MATH.CONTENT.HSN.VM.C.9

(+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.

CCSS.MATH.CONTENT.HSN.VM.C.10

(+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.

CCSS.MATH.CONTENT.HSN.VM.C.11

(+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.

CCSS.MATH.CONTENT.HSN.VM.C.12

(+) Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Geometry » Congruence

Experiment with transformations in the plane

CCSS.MATH.CONTENT.HSG.CO.A.1

Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

CCSS.MATH.CONTENT.HSG.CO.A.2

Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

CCSS.MATH.CONTENT.HSG.CO.A.3

Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

CCSS.MATH.CONTENT.HSG.CO.A.4

Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

CCSS.MATH.CONTENT.HSG.CO.A.5

Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

CCSS.MATH.CONTENT.HSG.CO.B.6

Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

CCSS.MATH.CONTENT.HSG.CO.B.7

Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

CCSS.MATH.CONTENT.HSG.CO.B.8

Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

CCSS.MATH.CONTENT.HSG.CO.C.9

Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

CCSS.MATH.CONTENT.HSG.CO.C.10

Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180° ; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

CCSS.MATH.CONTENT.HSG.CO.C.11

Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Make geometric constructions

CCSS.MATH.CONTENT.HSG.CO.D.12

Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

CCSS.MATH.CONTENT.HSG.CO.D.13

Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Geometry » Similarity, Right Triangles, & Trigonometry

Understand similarity in terms of similarity transformations

CCSS.MATH.CONTENT.HSG.SRT.A.1

Verify experimentally the properties of dilations given by a center and a scale factor:

CCSS.MATH.CONTENT.HSG.SRT.A.1.A

A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

CCSS.MATH.CONTENT.HSG.SRT.A.1.B

The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

CCSS.MATH.CONTENT.HSG.SRT.A.2

Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

CCSS.MATH.CONTENT.HSG.SRT.A.3

Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems involving similarity

CCSS.MATH.CONTENT.HSG.SRT.B.4

Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

CCSS.MATH.CONTENT.HSG.SRT.B.5

Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

CCSS.MATH.CONTENT.HSG.SRT.C.6

Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

CCSS.MATH.CONTENT.HSG.SRT.C.7

Explain and use the relationship between the sine and cosine of complementary angles.

CCSS.MATH.CONTENT.HSG.SRT.C.8

Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

Apply trigonometry to general triangles

CCSS.MATH.CONTENT.HSG.SRT.D.9

(+) Derive the formula $A = \frac{1}{2} ab \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

CCSS.MATH.CONTENT.HSG.SRT.D.10

(+) Prove the Laws of Sines and Cosines and use them to solve problems.

CCSS.MATH.CONTENT.HSG.SRT.D.11

(+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Circles

Understand and apply theorems about circles

CCSS.MATH.CONTENT.HSG.C.A.1

Prove that all circles are similar.

CCSS.MATH.CONTENT.HSG.C.A.2

Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

CCSS.MATH.CONTENT.HSG.C.A.3

Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

CCSS.MATH.CONTENT.HSG.C.A.4

(+) Construct a tangent line from a point outside a given circle to the circle.

Find arc lengths and areas of sectors of circles

CCSS.MATH.CONTENT.HSG.C.B.5

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.

Expressing Geometric Properties with Equation

Translate between the geometric description and the equation for a conic section

CCSS.MATH.CONTENT.HSG.GPE.A.1

Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

CCSS.MATH.CONTENT.HSG.GPE.A.2

Derive the equation of a parabola given a focus and directrix.

CCSS.MATH.CONTENT.HSG.GPE.A.3

(+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

Use coordinates to prove simple geometric theorems algebraically

CCSS.MATH.CONTENT.HSG.GPE.B.4

Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.

CCSS.MATH.CONTENT.HSG.GPE.B.5

Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

CCSS.MATH.CONTENT.HSG.GPE.B.6

Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

CCSS.MATH.CONTENT.HSG.GPE.B.7

Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*

Geometry » Geometric Measurement & Dimension

Explain volume formulas and use them to solve problems

CCSS.MATH.CONTENT.HSG.GMD.A.1

Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

CCSS.MATH.CONTENT.HSG.GMD.A.2

(+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

CCSS.MATH.CONTENT.HSG.GMD.A.3

Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

Visualize relationships between two-dimensional and three-dimensional objects

CCSS.MATH.CONTENT.HSG.GMD.B.4

Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Modeling with Geometry

Apply geometric concepts in modeling situations

CCSS.MATH.CONTENT.HSG.MG.A.1

Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*

CCSS.MATH.CONTENT.HSG.MG.A.2

Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*

CCSS.MATH.CONTENT.HSG.MG.A.3

Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Statistics & Probability » Interpreting Categorical & Quantitative Data

Summarize, represent, and interpret data on a single count or measurement variable

CCSS.MATH.CONTENT.HSS.ID.A.1

Represent data with plots on the real number line (dot plots, histograms, and box plots).

CCSS.MATH.CONTENT.HSS.ID.A.2

Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

CCSS.MATH.CONTENT.HSS.ID.A.3

Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

CCSS.MATH.CONTENT.HSS.ID.A.4

Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

Summarize, represent, and interpret data on two categorical and quantitative variables

CCSS.MATH.CONTENT.HSS.ID.B.5

Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

CCSS.MATH.CONTENT.HSS.ID.B.6

Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

CCSS.MATH.CONTENT.HSS.ID.B.6.A

Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

CCSS.MATH.CONTENT.HSS.ID.B.6.B

Informally assess the fit of a function by plotting and analyzing residuals.

CCSS.MATH.CONTENT.HSS.ID.B.6.C

Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

CCSS.MATH.CONTENT.HSS.ID.C.7

Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

CCSS.MATH.CONTENT.HSS.ID.C.8

Compute (using technology) and interpret the correlation coefficient of a linear fit.

CCSS.MATH.CONTENT.HSS.ID.C.9

Distinguish between correlation and causation.

Statistics & Probability » Making Inferences & Justifying Conclusions

Understand and evaluate random processes underlying statistical experiments

CCSS.MATH.CONTENT.HSS.IC.A.1

Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

CCSS.MATH.CONTENT.HSS.IC.A.2

Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model? Make inferences and justify conclusions from sample surveys, experiments, and observational studies

CCSS.MATH.CONTENT.HSS.IC.B.3

Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

CCSS.MATH.CONTENT.HSS.IC.B.4

Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

CCSS.MATH.CONTENT.HSS.IC.B.5

Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

CCSS.MATH.CONTENT.HSS.IC.B.6

Evaluate reports based on data.

Statistics & Probability » Conditional Probability & the Rules of Probability

Understand independence and conditional probability and use them to interpret data

CCSS.MATH.CONTENT.HSS.CP.A.1

Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").

CCSS.MATH.CONTENT.HSS.CP.A.2

Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.

CCSS.MATH.CONTENT.HSS.CP.A.3

Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

CCSS.MATH.CONTENT.HSS.CP.A.4

Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.

CCSS.MATH.CONTENT.HSS.CP.A.5

Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

Use the rules of probability to compute probabilities of compound events.

CCSS.MATH.CONTENT.HSS.CP.B.6

Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.

CCSS.MATH.CONTENT.HSS.CP.B.7

Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model.

CCSS.MATH.CONTENT.HSS.CP.B.8

(+) Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$, and interpret the answer in terms of the model.

CCSS.MATH.CONTENT.HSS.CP.B.9

(+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Statistics & Probability » Using Probability to Make Decisions

Calculate expected values and use them to solve problems

CCSS.MATH.CONTENT.HSS.MD.A.1

(+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.

CCSS.MATH.CONTENT.HSS.MD.A.2

(+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.

CCSS.MATH.CONTENT.HSS.MD.A.3

(+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.

CCSS.MATH.CONTENT.HSS.MD.A.4

(+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?

Use probability to evaluate outcomes of decisions

CCSS.MATH.CONTENT.HSS.MD.B.5

(+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.

CCSS.MATH.CONTENT.HSS.MD.B.5.A

Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.

CCSS.MATH.CONTENT.HSS.MD.B.5.B

Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.

CCSS.MATH.CONTENT.HSS.MD.B.6

(+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).

CCSS.MATH.CONTENT.HSS.MD.B.7

(+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).