A lighting switch operates taillights, park lights, and headlights. A dip switch allows the driver to change the beams from high to low, or vice versa.

Stop lights operate when the brake pedal is depressed.

Turn signals are mounted so they can be seen from the front, rear, and sides of the automobile.

An emergency flasher system operates both front and rear turn signals at the same time.

Other circuits operate courtesy (convenience) lights, reversing lights, and fault indicators.

Incandescent lamps consist of one or more filaments that heat up until they glow. The filament material does not burn because most of the air in the bulb has been replaced by inert gases that stop combustion from occurring.

The power in watts is often marked on the lamp. The power in watts being consumed by the lamp is found by multiplying the voltage to the lamp by the current flowing through it.

Halogen lamps are filled with a halogen gas such as bromine or iodine. They have a much longer life than incandescent lamps and are generally brighter and produce more light per unit of power consumed, but they are very hot in use. The bulbs must be handled carefully because they can be damaged by residue from fingerprints.

All lamps or light bulbs have letters and numbers stamped on them, indicating the power the bulb consumes.

Light emitting diodes (LEDs) are used in automotive applications such as warning indicators and alphanumeric displays.

LED light can be bright red, green, blue, yellow, clear, or white.

LEDs turn on instantly, which can reduce braking response time by 2/10 of a second. This translates to an extra 16 feet (5 meters) of stopping distance at highway speeds.

LEDs can be designed for LED lighting and as LED replacement bulbs for traditional bulb holders.

LEDs pass current flow in only one direction, meaning they are polarity conscious. When an LED is forward biased, current flows through it and it emits light. Thus, when an LED is coupled to an electricity supply, it must be done in the correct polarity.

LEDs are often connected in groups called series strings, which are then connected in parallel to achieve the required amount of light.

LEDs work best when the voltage to them and the current flow through them remains constant at a preset level, either via a resistor or through the use of a voltage regulation circuit (preferred).

Some LED lights are multivoltage, meaning they can work on both 12- and 24-volt systems.

Stop lights are red lights usually incorporated in the taillight cluster. Many vehicles have a higher additional stop light (called a high-level stop lamp) mounted on top of the boot (trunk) lid or on the rear window.

The stop light circuit consists of:
- Battery
- Fusible links and fuses
- Stop light switch and bulbs
- Wiring
- Ground circuit to return current from the filaments to the battery

When the brake pedal is pressed, a switch mounted on the pedal support is closed. Current flows from the battery through the fuse, through the switch, to the brake light filaments, and back to the battery via the ground system.

When the driver releases the pedal, the flow of electrical current stops and the brake lamps are extinguished.

Reversing lights are white lights fitted to the rear of a vehicle.

The reverse light circuit consists of:
- Battery
- Fuses and fusible links
• Ignition switch
• Reversing light switch on the transmission
• Reversing light filaments
• Wiring
• Ground circuit to allow current to return to the battery through the vehicle frame

When the ignition switch is on and the vehicle is in reverse, current flows from the battery, through the ignition switch, to the closed reversing light switch on the transmission.

Electrical current flows across the closed switch to the reversing lights, and then returns to the battery by the earth return system.

Indicators are amber lights on the vehicle’s corners. A column-mounted switch, operated by the driver, directs a pulsing current to the indicator lights on one side of the vehicle or the other.

Indicators continue until the switch is canceled either by the operator or by a canceling mechanism in the switch, which operates after the steering wheel is returned to the straight-ahead position.

The indicator light circuit consists of:
• Battery
• Fusible links and fuses
• Ignition switch
• Flasher unit
• Three-position switch used as the direction indicator switch
• Lights at the front and rear of the vehicle
• Pilot lights mounted in the instrument cluster
• Wiring
• Ground circuit to return the electrical current to the battery

Current from the battery flows through the fusible link to the ignition switch, where it is directed through a fuse to the flasher unit.

The flasher unit uses a timing circuit to pulse the current 60 to 120 times per minute. This current is directed through the indicator switch to the indicator lights at the front and rear of the vehicle on the chosen side, causing the lamps and a pilot light on the instrument cluster to pulsate. The flasher unit also produces a clicking sound to alert the driver that the indicators are in use.

When the indicator switch is returned to the “off” or central position, the timer circuit is switched off.

Most vehicles are equipped with hazard warning lights. This circuit is similar to the indicator lights except that it simultaneously causes a pulsing in all exterior indicator lights and both pilot lights on the instrument panel.

In headlights, two filaments provide for a main and a dip beam function. These must be positioned correctly in relation to the highly polished reflector. This is called focusing and is carried out during manufacture.

The main, or high, beam filament is positioned to project the maximum amount of light forward and parallel to the reflector axis. This light is then shaped by the lens, which is made up of many small glass prisms that bend the light to achieve optimum road illumination.

The dip, or low, beam is placed above and slightly to one side of the main filament. Mounting the dip filament in this position produces a beam of light that is projected downward and toward the curb side.

With this arrangement, the main filament produces the best possible light output while the dip filament gives a downward and dispersed beam.

A semisealed beam headlight uses a replaceable bulb with a prefocus collar, which locates the bulb in the headlight and also controls the correct positioning of the filaments.

A sealed beam headlight is a completely sealed unit. When a filament fails, the whole unit must be replaced.

High-intensity discharge (HID) lights produce extremely bright white or bluish light.

Drivers using HID lights are able to see the road ahead for approximately 300 feet (100 meters), compared to about 200 feet (60 meters) for a halogen system.

HID headlights can be up to three times brighter than halogen lights, are more efficient in converting electrical energy into light energy, have a longer service life, and have a light color that is closer to daylight.

HID lights operate on a gas discharge bulb system and consist of a light, bulb, ballast, and special high-voltage circuitry. They do not use a filament in the bulb.

Driving lights on the front of the vehicle supplement headlights and provide higher intensity illumination over longer distances than standard headlight systems. Vehicle design rules and local regulations specify limitations in relation to the positioning of driving lights.

Most driving lights use quartz halogen bulbs in the 55- to 120-watt range. Reflector quality is extremely important for optimum performance.

Driving lights operate only when the high beam is operating. This safety feature ensures that driving lights turn off when the headlights are dipped from high to low beam.

For safety reasons, a relay and circuit breaker should always be used for driving lights.

Fog lights are used with park lights (not headlights) to increase visibility in poor weather.
For motor vehicles and trailers, two red tail lamps operate when the headlight switch is in the park position and the headlight position. The bulbs are connected in parallel to each other (and to a number plate illumination lamp) so that the failure of one filament will not cause total circuit failure.

Taillights are usually incorporated in a cluster assembly at the rear of the vehicle. Government regulations control the height of the lamps and their brightness.

The park lights, sometimes called clearance lamps, are located at the front of the vehicle and are used at night when the vehicle is parked on the side of the road. In some cases, park lights are incorporated in the headlight assembly.

Park lights operate when the light switch is moved to the first position. For safety reasons, the park lights and taillights continue to operate when the light switch is moved to the headlight position. The bulbs are connected in parallel with each other.

The circuit for the park lights and taillights includes:
- Battery
- Fusible links and fuses
- Park light switch
- Lights at each corner of the vehicle
- Number plate light
- Wiring
- Ground circuit to complete the circuit to the battery through the vehicle frame

When the park light switch is closed, current flows from the battery through the fusible link to the park light switch, where it is fed through the fuse to the front park lights and to the rear tail and number plate lights.

After passing through the filaments, the current path is completed through the frame of the vehicle to the negative battery terminal.

The headlight circuit consists of:
- Battery
- Fusible link and fuses
- Headlight switch and relays
- Dipper switch
- Headlights
- High beam indicator light
- Wiring
- Ground circuit

When the headlights are switched on, current is supplied from the battery, through the fusible link and fuse, and across the closed switch contacts to the dipper switch.

In the dip beam position, electrical current can flow from the dipper switch contacts through the low beam relay winding to ground.

This creates a magnetic field that closes a set of contacts, allowing electrical current to flow from the battery, through the fusible link, to the relay contact. From the closed relay contacts, the current flows to the light filaments and then to ground.

The park lights and taillights are also in operation when the headlights are switched on.

The layout of electrical circuits is shown as diagrams made up of symbols and connecting lines. Refer to the manufacturer’s service manual for details on how to read a particular circuit diagram.

Sensors are integrated into a common wiring harness by combining all the individual systems, where possible, into a multiplexed serial communications network so they can share the information.

Less wire and fewer connections means less chance of dirty connections causing faults.

This system is referred to as a controlled area network bus (CAN-bus) and it uses two thin wires to connect all the control units and their sensors to each other. The output devices are referred to as nodes.

Multiplex networks enable a decreased number of dedicated wires for each function, and therefore a reduction in the number of wires in the wiring harness; reduced system cost and weight; and improved reliability, serviceability, and installation.

Common sensor data—such as vehicle speed and engine temperature—are available on the network; thus data can be shared, thereby reducing the number of sensors.

Functions can be added or modified through software changes.

Other control units can be added to the system by simply connecting them to the network.

A diagnostic tool can be connected to the CAN-bus to assist in diagnosis and fault finding.
Lighting Procedures

Example: Possibly a bad ground on a light? (Operates but very dim)
- The left side headlight is dim with a yellowish beam on both high and low beam. The right side headlight operates normally.
- A yellowish beam indicates that the operating voltage for the left side headlight is low. Using a voltmeter, check the voltage across the headlight filament while it is switched on. Then compare this voltage to the battery voltage.

If the difference in voltages is more than 0.5 volt for a 12-volt system (or 1 volt for a 24-volt system), a voltage drop exists in the circuit.

Measure voltage drop in the headlight supply circuit by placing the red probe on the positive terminal of the battery and the negative probe on the positive supply side of the bulb filament. Ideally it should be 0 volts.

Measure the voltage drop in the ground circuit by placing the red probe on the ground side of the headlight bulb filament and the negative probe on the negative battery terminal. If no fault exists, then the voltage drop should be 0 volts. In this case, the voltage drop is 1.5 volts. This indicates a faulty ground connection. Check headlight ground connections back to the battery for loose or corroded terminals. Repair the ground.

Personal safety includes using personal protective clothing and equipment, such as:
- Work clothing
- Eye protection
- Ear protection
- Hand protection
- Respiratory equipment

A vehicle may have warning lights that will activate only if that circuit is in use. You may need to turn on that circuit to see the warning light.

Instructions for checking peripheral lighting systems:
1. Check instrumentation.
2. Check car horn.
3. Check rear lights.
4. Check front lights.
5. Check interior lights.

Make sure the fuses are in good condition before attempting to change a bulb in a circuit that has more than one bulb, such as the turn signal circuit. If none of the bulbs is working, there may be a bigger problem.

Many light bulbs have more than one filament. These bulbs normally have offset pins to ensure proper locking in the socket. Do not force the bulb in the wrong way.

Some bulbs have a colored glass envelope that enables them to be used with a clear lens. If you replace a bulb of this type, make sure that you replace it with one of the same color.

Instructions for checking and changing an exterior light bulb:
1. Access bulb.
2. Remove bulb.
3. Check bulb holder for corrosion.
4. Insert new bulb.
5. Replace cover and test.

Replace a bulb with one of exactly the same type, or change both lights at once.

Replace a sealed beam unit when one filament has failed or the reflector shows signs of internal blistering.

If both lights are not bright when switched on, start the engine to see if this solves the problem. Also check the ground connection with a DVOM.

Do not touch a halogen bulb with your bare fingers. If you do, clean it with an alcohol-based substance (not gasoline or paraffin).

Instructions for checking and changing a headlight bulb:
1. Check headlight operation.
2. Identify headlight type.
3. Access lamp socket.
4. Remove and replace old bulb.
5. Replace headlight unit and test.

When aiming headlights, check the headlight positioning requirements for your location as well as the specific vehicle.

Instructions for aiming headlights:
1. Check tire pressures.
2. Position the vehicle.
3. Check low beam settings.
4. Check high beam settings.
5. Adjust headlight alignment.