Starting Systems

State a major safety precaution when removing or working around a starting motor…

…Always unhook the battery ground before attempting to remove the starter motor.
Starting Systems

Identify the following components

Armature
Commutator
Brushes
Pole Shoe
Field Coil
The Armature is a rotating electromagnet.
Brushes transfer electrons from the stationary field coils to the spinning armature.
Field Coils are Stationary Electromagnets
Pole Shoes concentrate the stationary magnetic field
Starting Systems

Identify the following components
- Starter housing or frame
- Bushings
- Starter Drive Pinion
- Over-running clutch
Armature spins in replaceable bushings located at both ends of the starter housing.
Bushings will wear out and should always be replaced if replacing brushes or rebuilding starter motor.
Starter drive pinion uses an over-running clutch. This allows the starter gear to drive the flywheel and then spin freely once the engine starts.
bendix or over-running clutch - the construction of this gear protects the Armature from being spun by the engine flywheel.
Starter Diagnosis
Damage to drive pinion means flywheel teeth may be worn also. Always inspect entire flywheel as damaged ring gear will cause noisy starter (stripped gears) and requires removal of engine or transmission to replace.
Worn out bushings...

Will slow the starter and increase amp draw
Worn or Dry Armature shaft will INCREASE amp flow
Burned commutator bars restrict the amp flow
Worn out brushes
DECREASE amp flow
There will be more questions...

...On the test....

...than I am covering here.

Read your book...

and complete starter Labs
Test the Starting System

Check Cranking RPM

Check Cranking Volts

Check Cranking Amps
Low Cranking RPM

A slow turning starter will pull extra amps

Could be caused by tight motor
(New Engines)

Can be caused by advanced timing
(recheck with ignition turned off)
Cranking Volts

Power is required to turn motor

\[ P = I \times E \]

Low volts will cause high amps
Low Cranking Volts

Cranking volts at battery should be over 10V

Load test battery if low cranking volts

Excessive amp draw can cause low cranking volts in a good battery
High Cranking Amps

Check voltage drop across STARTER MOTOR

If Battery cranking volt is 1/2 volt more than Starter volt drop diagnose battery cables and connections
If cranking volts are within 1/2 volt of battery…

Insure motor turns freely

Insure ignition does not cause slow turning motor

Replace Starter Motor
(assuming there are excessive amps)
These are only rough maximum cranking amps. Actual amps will depend on starter design!

**Common Cranking Amps**

- 4 Cylinder gasoline
  - 150 amps
- 6 Cylinder gasoline
  - 200 amps
- 8 Cylinder gasoline
  - 250 amps
Before you install the rebuilt starter

Bench test the replacement

It may save you a starter R & R
Starting Systems

Understand the operation of the two starting circuits

#1 Starter Control Circuit

#2 Starter Motor Circuit
Starter Relays

Understand the function of the Pull In solenoid windings….

…and the hold in solenoid windings

More electrical power is needed to pull in the solenoid (and engage the starter pinion gear with the flywheel)

Once the solenoid is ON the pull in windings lose their ground and that power is now available to the starter motor
Starter Solenoids

Predict the effect of an open circuit in the solenoid pull in windings….

….and the solenoid hold in windings

The following 2 pictures show how an open hold in winding will cause the starter to rapidly click OFF and ON

This same symptom happens with a low power (dead) battery
If volts are over 10 volts while cranking, a clicking starter is caused by a bad solenoid on the starter motor
Starter Control

Identify variations in starter control circuits

There are many variations and starter controls.

For non-cranking starters always study the wiring diagram to help you decide how to diagnose the system.
Test the Starting System

Test cranking RPM
Test Cranking Volts
Test Cranking Amps

For a routine test of the starting circuit always pay attention to Cranking RPM (should not sound slow – over 200 RPM) Cranking Volts (Should always stay above 10 Volts Cranking Amps (less is better as long as RPM is good)