

What students will learn

When they have finished the Electrics module, students should be able to:

- Know the main parts of an electric ignition system
- Choose the right spark plugs for their engine
- Clean, check and set the gap on spark plugs
- Clean and check HT leads and plug caps
- Check for sparks

Things you need before you start

Information

You will need ideas and information on:

What type of spark plugs are common in engines locally
– and where to get them from

The makers codes for common plugs (NGK, Denso,
Champion, Bosch etc)

Plug gap sizes for the engines your students will work on

Materials

Examples to show students:

Engines: outboard motors, mower, brush cutter

Dismantled engine showing magneto and flywheel

Used spark plugs – showing deposits and electrode wear

HT leads and caps

Tools or equipment

If students don't have their own engines, you may need to provide suitable engines to work on.

Students will need tools and equipment to check, clean and gap spark plugs:

Spark plug spanner, feeler gauge/gap setting tool, wire brush.

Electrics - Activity

The activities in this module require the students to collect information about the ignition parts for the engines they are working on.

The students then carry out the maintenance checks and adjustments on spark plugs and then check, clean – or replace – HT leads and plug caps.

Ideally, students should use their own engines for this activity. It would be useful for them to carry out the maintenance tasks on other types of engine and equipment as well.

Students should work together in small groups to answer the questions and carry out the maintenance tasks.

The module

The workbook sections for this module are:

Introduction – the parts of an ignition system

Magneto

Spark plugs

HT leads and plug caps.

Timing the spark

On-off switch

Maintenance

HT leads and caps

Spark plugs

Fault finding

Copies of the workbook sections are included in your manual here as well as in the Student Workbook.

You need to work through each section with the students, talking about the ignition parts and showing the students what to do – and what they should NOT do.

Remember
The workbooks are not designed to be used by the students learning on their own.

Electrics introduction -tutor notes

Use these notes for an introduction at the beginning of the Electrics module.

To start the module, talk to the students generally about the main things they will learn and what they will do:

- Ignition parts, and what they need for their engines
- special things they should know about
- maintenance and checks
- fault finding.

Explain

Explain that the in module:

- They will be learning about engines with simple magneto ignition systems – and **no other** electrics. This course does not cover engines with electric starters, batteries, generators or other electrical parts.
- You will talk about each of these things – and show them what to do and how to work on their engines.
- They will collect information about THEIR engine, and
- Finally, they will get to carry out checks, change/clean plugs etc.

Talk about

The worksheet diagram of the main parts of an ignition system and how the parts connect.

In addition

Talk about -

- The need for advice and assistance
- It is **very** important that students understand the limits of what they learn on this course. Here they learn only about simple, small – scale checks and maintenance jobs such as changing and setting plugs.
- Bigger jobs **need expert knowledge and skill and equipment** to dismantle, repair and adjust. For example, servicing a magneto or setting the ignition timing.

Make sure students understand that they need expert assistance for any larger or safety related work.

Magneto

Work with students through each part of the workbook notes.

Talk about - magnetos

- Rotating magnets and electrical coils. As the magnets turn with the engine they 'induce' an electrical current in the coils.

The current is controlled by various electronic devices.

The magnets are usually attached to the flywheel on the engine crankshaft. The coils and electronics inside or behind the flywheel.

Note – you are not expected to explain the magneto working in any detail – just explain where the parts are – and that they produce high voltage electricity for the spark.

- The magneto is hard to get at without special tools to remove the flywheel. Most newer engines have magnetos that need no regular maintenance anyway. Advise students to leave any work on a magneto to experts.
- The key (Woodruff key) that holds the flywheel in the right place on the crankshaft. If this is worn or broken, it changes the point when the spark is made. The key can also break or shear – for example, if a mower blade hits a large rock.

Show

Examples of magneto on two or three engines. An engine with the flywheel exposed – or removed – would be good for students to see. Show the woodruff key on the crankshaft.

Help students to find the magneto on their engine.

Talk about

- Older engines used to have a set of 'points' in the magneto. The points switched the current to the spark plug(s) at exactly the right moment in the cycle. They needed regular cleaning and careful setting. Their job is done now by electronic switches which need no regular attention.
- If you have **older engines with mechanical 'points'** still in use locally, explain these to students and show them how to check/clean the points.

Spark plugs

Talk about -

- What spark plugs do – ignite the fuel inside the engine.
- The parts of a plug
 - use the cutaway diagram and description on the worksheet
 - show some actual spark plugs
- Spark plugs are simple pieces of equipment – but they have a very hard life.
 - In a 4-stroke engine running at 3000 rpm (revs per minute) the plug has to spark at about 25 times every second! (that's 50 times per second in a 2-stroke).
 - The temperature in the exploding fuel at the tip of the plug can get to 3000°C.
- Plugs should last for many hundreds of hours running if they are regularly looked after.

Talk about - types of plug

Work through the worksheet explaining:

- Many different types of plug
 - Thread diameter and reach
 - Seating
 - Heat range

Show examples of each type

Talk about – plug number codes

- Plug makers have different codes
- Codes printed on your own plug examples

The worksheet gives two cross reference codes between NGK and Champion makes:

NGK BPZ8H–N-10 and Champion L78YC - for many Mercury Outboards

NGK BR6S and Champion RJ8C for many Briggs and Stratton motors

Show

Students other makers spark plugs that are the same as your examples.

Talk about

Where students can buy spark plugs in your area and who sells the different makes (NGK, Denso, Champion, Bosch etc)

Talk about – using the right plug

When they fit a new plug, don't just replace the plug with the same number as the old one in the engine. Someone might have used the wrong one in the past! Check.

Use the plug recommended by the engine maker (or recommended by the spark plug makers for their exact engine make/model/age).

If an older engine has spark plug(s) that keep fouling up with deposits, a spark plug with the next higher number in the heat range may cure the problem. Do not go more than **one** step.

Student activity

Help students find out which spark plug is the right one for their engine from:

- Engine makers operator manual
- Or – it might be written on the engine somewhere
- Or – spark plug makers reference book
- Or – from the engine supplier/dealer

Get them to complete the first part of the activity where they write down information about the spark plugs for their engine.

Spark plug maintenance

Work through the worksheet. Explain and show how to:

- remove plugs from the engine
 - use a plug spanner – take care not to break insulator
- check condition - show examples:
 - what a used plug tip should look like
 - what lots of white or black/oily deposits can mean
 - when to clean a plug – or when it should be replaced
 - show students the Autolite Technical Chart at the back of this Electrics module. Work through this with them and compare your examples with those in the pictures.
- Clean plugs
 - Scrape and wire brush
- Check and set electrode gaps
 - Use types of feeler gauge or wire gauge
 - Bend end electrode
 - Care not to damage insulator round the centre electrode

- Refit the plugs

Do up hand tight and then **no more than a quarter turn maximum** with a plug spanner

Too loose and it will leak

Too tight and you can easily damage the cylinder head – if aluminium.

Student activity

Get them to complete the second part of the activity where they remove, check, clean and gap the plug(s) on their own engine.

Plug leads and caps

Work with students through the workbook notes.

Talk about -

- The purpose of plug leads (sometimes called HT or High Tension leads) – to carry the high volt electricity form the magnet to the spark plug
- The purpose of the plug cap – to connect to the plug firmly and to keep water, dirt – and hands- away from the electrical connections
- Safety – it is possible to get a shock from a lead when the engine is running, especially if the leads are damp/wet or dirty. Take care when touching them.

Show

- Where the leads are connected on one or two engines.
- Examples of different leads and caps
- How to remove and replace the lead from the spark plug (twist and pull cap, not the lead)
- How to clean and check them for damage.

Explain

- Water is the enemy of HT ignitions. Especially salt water
- The spark will “track” easily on a wet surface and not go through the spark plug
- Keep all parts clean and as dry as you can
- Spray with CRC or WD40 if you have it.

Timing the spark

Talk about

- For an engine to start and run properly, the spark plug must 'spark' at exactly the right point in the engine's cycle. In most engines that point is just before top dead centre (b.t.d.c) as the piston reaches the top of its stroke.
- The timing has to be exactly right for the engine to start and run well.

Most engines automatically change their timing to suit different engine speeds.

Explain

Timing of the spark is fixed by:

- Where the magnets on the flywheel magneto are fixed and the position of the flywheel on the crankshaft. The fly wheel position is set by the Woodruff key-way. Students could look for wear and damage – or the key shearing.
- The position of the contact points and their gap on older engines
- The position of the electronic 'switch device' in the magneto on newer engines

The contact points and electronic switch positions are adjustable – but you need special timing lights, gauges and tools to set it right. This is outside the scope of this course.

Show students where adjustments and timing marks are on their engines – but advise them **not** to make changes without expert help and the right information for their engine.

On/Off switch

Talk about the purpose of the switch

- To stop the engine when it is running

And for safety

- To make sure the engine won't start – when turning parts during maintenance
- To stop the engine in a emergency lanyard kill-switch if you fall overboard (outboard motors)
- Make sure students understand the importance of wearing the lanyard to the switch – and regularly check that the switch **does** work! When they see their boat disappearing over the horizon – it is much **too** late!

Show examples of switches, where they are on the engine, how they work

Help students with the activity

They check, clean and refit spark plugs, HT and caps.

Ignition – fault finding

Work with students through the separate fault finding worksheet.

Explain and show students the steps to check for sparks at the plug and how to find out which part is faulty.