National Certificate in Motor Industry (Automotive Body)

Collision Repair

Workshop engineering, tools and equipment

Study guide

I-CAR NEW ZEALAND

mito

NATIONAL CERTIFICATE IN MOTOR INDUSTRY (AUTOMOTIVE BODY)

Collision Repair

Acknowledgements

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Contents

Welcome to Workshop engineering, tools and equipment

Welcome to Workshop engineering, tools and equipment. There are many tools and items of equipment needed to run a modern collision repair or refinishing business. They range from hand tools like spanners and screwdrivers, to small equipment items like floor jacks, to large expensive spray/bake booths.

The key to making the best use of any tool or item of equipment is training in its correct and safe operation. It can take years to learn how to use every possible tool and piece of equipment safely and maintain it properly. In this study guide you will look at the common tools and equipment items that are used in the motor industry.

You will start by looking at various hand tools and pieces of workshop equipment and how to maintain them. You will then move into looking at different types of measuring equipment used for general engineering tasks and other types of workshop tools and equipment used in the motor industry. The study guide will then take you into the maintenance and safety aspects of tools and equipment.

Power tools will also be discussed, as well as different metals, plastics, fastening systems, drilling, and finally threading.

An electronic version of this study guide with direct links to I-CAR material can be accessed at https://elearning.mito.org.nz. If you are unable to log in, email elearning@mito.org.nz for assistance. Make sure you provide your name and MITO ID number.

You will probably be familiar with these areas from the work you have been doing. This study guide gives you a chance to check how you work and make sure you are ready for your assessments.

Unit standard	Description	Level	Credits
21669 (v4)	Demonstrate knowledge of hand tools and workshop equipment for motor industry applications	2	2
21670 (v3)	Demonstrate knowledge of general engineering tasks in the motor industry	2	3
21693 (v2)	Demonstrate knowledge of tools and equipment used in the collision repair industry	2	3
21714 (v2)	Demonstrate knowledge of fastening systems used in the motor industry	2	2

Your study resources

Here are the resources you will need to complete this package:

- this study guide
- your assessment book
- selected parts of I-CAR courses TRM-02, STS-01, PLA-03, WRK-01, REF-01.

How to use this study guide

This study guide contains a range of tools to help you with your learning.

Sections

This study guide is divided into sections, or smaller chunks of information.
The contents page tells you the titles of all the sections and subsections.

Icons

This study guide uses several standard icons, which are explained below.

	**References to I-CAR** Sometimes you will need to refer to information in the I-CAR text. The study guide will include this I-CAR icon, followed by the topic in the I-CAR text you should look at. Click on the topic and it will take you to the correct spot in the textbook (you need to be logged into the LMS to access them). In some cases specific search terms are suggested to help you zero in on relevant material.
	**Workplace link** You may also like to undertake your own research to learn more about the subject as it relates specifically to your own workplace.
	**Theory assessment preparation** This material will prepare you for your theory assessment.
	**Web research** There is a wealth of information on the internet. Information provided with this icon will give you some useful tips on where to look.

How you will be assessed

Make sure you read the 'Theory assessment preparation' boxes in this study guide. They will help you understand what will be covered in the assessment.

- This is a theory training package, so you will need to answer questions to show that you have the knowledge required.
- There is one open book and one closed book assessment to complete for this training package.

Use your experience

As an apprentice, you will learn so much from actually doing your job in your workplace.

As you start your study for this package, remember to take some time to think about what you already know about the topics. You'll learn better if you build on your prior knowledge.

This study guide includes activities to help you learn by doing things. Most apprentices are practical people, so you'll get the best out of your study time if you use these opportunities to actively learn the topics.

If you need help

- Check your MITO training folder.

  It contains information to answer many questions you might have about this programme, so check there first.

- Talk to your distance learning tutor.

  The email and freephone numbers to contact your training provider are in your training folder.

- Ask experienced technicians in your workshop.

  Your workmates will be able to answer many questions you may have about how the learning in this training package applies to your work situation.

- Check with your MITO ITA.

  Your MITO ITA is another person you can contact for assistance.

Qualification pathway

Refer below to see where this training package fits in your programme. Before you start this package, you should have completed, or been credited with, all the training packages listed above it on the chart.

Collision Repair L3 and L4	Refinishing L3 and L4
Powering through	Powering through
Workshop safety	Workshop safety
Workshop engineering, tools and equipment	**Workshop engineering, tools and equipment**
General workplace requirements	General workplace requirements
Minor panel repair	Paint preparation
Paint preparation	Minor panel repair
Vehicle trim and glazing	Detailing and grooming
Body exterior – bolted on	Spray equipment and VOCs
Electrical and electronics	Vehicle trim and glazing
Damage analysis	Electrical and electronics
Drivetrain, steering, suspension and brakes	Paint mixing, colour matching and application
Welding	Foams, adhesives and corrosion protection
Foams, adhesives and corrosion protection	QA, law and warranty
Plastic repair	Estimate and quote
Body exterior – welded and bonded	
Measuring	
Structural repair	
QA, law and warranty	
Restraints	
Aluminium	
Estimate and quote	

Overview

Welcome to the learning pathway for Workshop engineering, tools and equipment. Below is your guide to the material and the resources you will be working through.

Section	Overview
1. Hand tools	Covers the main hand tools commonly used in the automotive industry.
2. Workshop equipment	Describes the equipment commonly used within most workshop environments.
3. General engineering measuring equipment	Describes the different types of measuring equipment – such as tape measures, vernier callipers and torque wrenches – used in the automotive industry.
4. Maintenance	Discusses the value of properly maintaining tools and equipment.
5. Using tools safely	Outlines appropriate ways to handle automotive tools. Safety is one of the most important requirements in the automotive industry.
6. Power tools	Guides a user on the different types of power and pneumatic tools used in automotive working environments.
7. Metals	Discusses ferrous metals, non-ferrous metals and heat treatment of metals.
8. Plastics	Outlines the uses of plastic or composite materials on a vehicle.
9. Fastening systems	Looks at common types of fastening systems in the automotive industry. Methods, purposes and principles are just a few of the topics discussed in this section.
10. Drilling	Discusses drilling equipment and relevant information – drilling safety, drill maintenance, and drilling concepts.
11. Threading	Covers different types of threading, as well as common processes and procedures involved.

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1. Hand tools

This section checks that you can properly describe how to operate commonly used hand tools. Using them properly includes making sure that you:

- use them in the most efficient way
- don't damage any components
- don't hurt yourself or others.

You will already be familiar with using a variety of hand tools in the workshop. As you review this section make sure you find out more about any hand tools you are not so familiar with. When you complete the assessment you will be asked about the full range of hand tools covered here.

Start by completing this exercise to review what you already know about hand tools.

(If you are reading this study guide online, you can print this table out or write your own notes.)

Activity 1

Complete the table to make your own notes about hand tools and what they are used to do.

Start with the tools you have used or have seen others use. Highlight any you are not sure about.

Tool	What it looks like	What it's used for
Adjustable wrenches		
Allen keys		
Bars		
Chisels		
Dolly		
Files		
Hacksaws		
Hammers		

Tool	What it looks like	What it's used for
Inspection mirrors		
Magnets		
Pliers		
Punches		
Riveters		
Screwdrivers		
Socket sets		
Spanners		
Wire brushes		

If there are tools you are not familiar with, try the following activities.

Workplace link

Ask your supervisor or a senior technician to show you examples of the tools you are not familiar with and show you how to use this tool.

Web research

Do an internet search using the name of the tool. You may wish to use some words to narrow the results down to tools that are used for working on vehicles (e.g. collision repair tools – dolly).

Figure 1.1: Hammers and dollies are available in a variety of styles

Image from I-CAR STS01 p24

Activity 2

The following is a list of tool descriptions for the tools listed in Activity 1. Write the name of the tool beside the description.

Tool name	Description
	A hand tool usually with a wooden handle and two different striking faces on the head made for delivering blows to an object.
	Often a long handle with a magnetic end used to hold or pick up ferrous items.
	A tool with a shaped tip that fits into the head of a screw, allowing it to be turned.
	Hand tool with open or ring-shaped ends used to turn a nut or bolt.
	Used to force or pry things apart.
	A hardened steel shaft hit by a hammer to leave a mark, make a hole, or force something into place.
	Small mirror, often with a long handle, used to help see in awkward places.
	Used with a hammer to cut through metal.
	Different sized sockets driven by a range of hand pieces to turn nuts and bolts.
	A hexagonal shaft that fits inside a recessed hexagonal hole in a bolt or stud.
	A long hardened steel hand tool with sharp teeth along its face used to remove material.
	A tool for inserting or setting rivets.
	A hand tool with pivoting jaws, usually used for holding, cutting or squeezing items.
	Spanner with an adjustable jaw used to turn nuts and bolts.
	A handsaw (usually with a replaceable blade) used to cut metal.
	Hand tool with wooden or plastic handle and steel bristles used to clean a surface.
	A solid, shaped piece of metal which is held on one side of a vehicle panel while a hammer is being used on the other side of the panel.

Go to the answer section at the back of this guide to check your answers.

Workplace link

You should always be familiar with the manufacturer specifications and your own company's requirements. They help prevent damage and injury. Check what information your workplace has about the special requirements for the use of the following tools and note them below.

Air operated DA sander:

MIG welder:

Theory assessment preparation

Can you describe hand tools, their uses and the procedures for using them in accordance with manufacturer specifications and company requirements?

If not, review:

Study guide:

- Section 1 – Hand tools.

2. Workshop equipment

In this section we will review some other equipment used in the workshop. Again, you will already be familiar with a number of these equipment items.

We will cover the following categories:

- lifting, supporting and straightening equipment (hoists, jacks and stands)
- engine hoists
- inspection and diagnostic equipment
- cleaning, dismantling, repairing and assembling equipment
- other workshop equipment.

Lifting, supporting and straightening equipment

You need to be familiar with how to use vehicle hoists, jacks and stands. Collision repair workshops also have hydraulic equipment used for straightening damaged vehicles.

You need to be fully trained in how to correctly use any hoists that are installed at your workshop.

There are two main types of hoists used in automotive workshops – in-ground hoists and floor-mounted hoists.

In-ground hoist

Here is an example of an in-ground hoist.

Figure 2.1: In-ground hoist

The cylinder comes up out of ground to lift the hoist. As you can see from the picture, this hoist is set into the floor of the workshop. In-ground hoists are becoming less common but they are still used in some workshops.

Floor-mounted hoists

There are a range of floor-mounted hoists available. These sit on the floor level of the workshop.

Drive-on four-post hoist

Figure 2.2: Drive-on four-post hoist

The vehicle is driven up the ramps onto the hoist while the hoist runways are down on the ground. Once the vehicle is on the hoist, it is raised up.

Two-post hoist

Figure 2.3: Two-post hoist

The vehicle is driven into the correct position underneath the hoist. The arms swing out and are placed at the correct lifting points on the vehicle body. The vehicle can then be raised.

Scissor hoist

The vehicle is driven onto the hoist. The vehicle is then raised on the scissor platform.

Figure 2.4: Scissor hoist

Safety precautions for all hoists

You must make sure that the hoist safety locking system or safety latch is engaged before working under the vehicle.

The hydraulic system used to raise the hoist up could fail at an unexpected time and drop the vehicle on the technician working below it.

Hydraulic jacks and stands

Figure 2.5: Hydraulic jacks and stands

http://tradetools.co.nz/products/3475380

Hydraulic jacks are used to raise the vehicle and stands are used to support the vehicle when it is raised.

Safe use of hydraulic jacks

- Check the lifting capacity of the jack – it needs to be sufficient to lift the vehicle.
- Ensure the vehicle is on level and stable ground – you may need to use something (e.g. sheet of plywood) underneath the jack.
- Place chocks around the other wheels of the vehicle.
- Identify the correct lifting point(s) on the vehicle.
- Operate the jack following manufacturer instructions.
- Install stands before working underneath the vehicle.

Web research

For more information about using hoists and jack stands, do your own internet search using the keywords 'safe use of vehicle hoist' or 'safe use of hydraulic jacks'.

You can also check the following web resources:

http://www.hse.gov.uk/pubns/indg434.pdf

http://www.slideshare.net/WRDSB/ontap-vehicle-lift-safety

http://www.wikihow.com/Use-Jack-Stands.

Workplace link

Ask your supervisor to coach you on correct use of the hoists, hydraulic jacks and jack stands that are used at your workplace.

Portable hydraulic body jacks

Collision repair workshops also use specialist hydraulic body jacks to straighten out accident damage areas.

Porta Power was the brand name of the first portable hydraulic body jack and its accessories. Panel beating tool and equipment manufacturers Porter Ferguson Ltd gave the equipment the name Porta Power and, although many companies manufacture portable hydraulic body jack equipment, the majority of the trade still refers to them as a porta power.

The following diagram illustrates a portable hydraulic body jack.

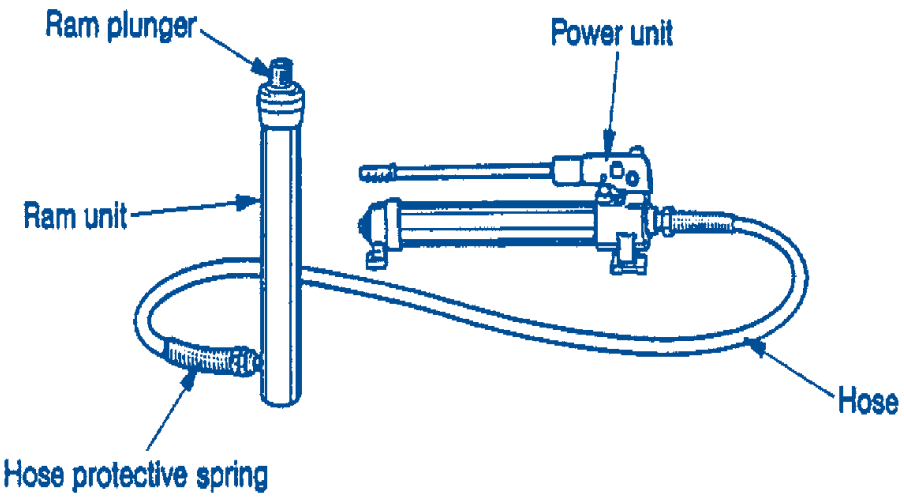

Figure 2.6: Body jack

Basically a hydraulic body jack consists of a hydraulic pump and a ram unit connected by a flexible hose. When the pump handle is operated it extends the ram by the hydraulic pressure created.

The purpose of hydraulic rams is to provide the corrective force required to straighten out accident damage areas on a motor body. Hydraulic body jacks can be used in conjunction with other body alignment equipment and if you study Figure 2.7, you will see a hydraulic jack is being used to push the hinged arm (damage dozer) that is pulling on the chain attached to the vehicle's body.

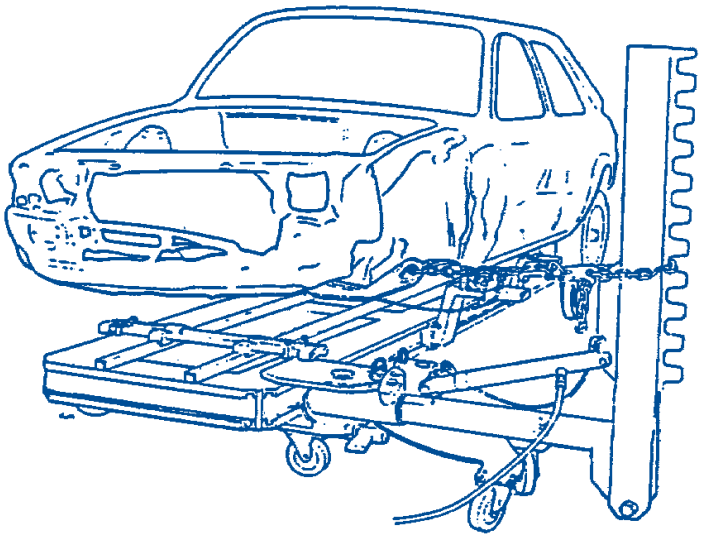

Figure 2.7: Body alignment machine

Hydraulic body jacks can also be used on their own to supply portable force inside a vehicle body, as shown in Figure 2.8.

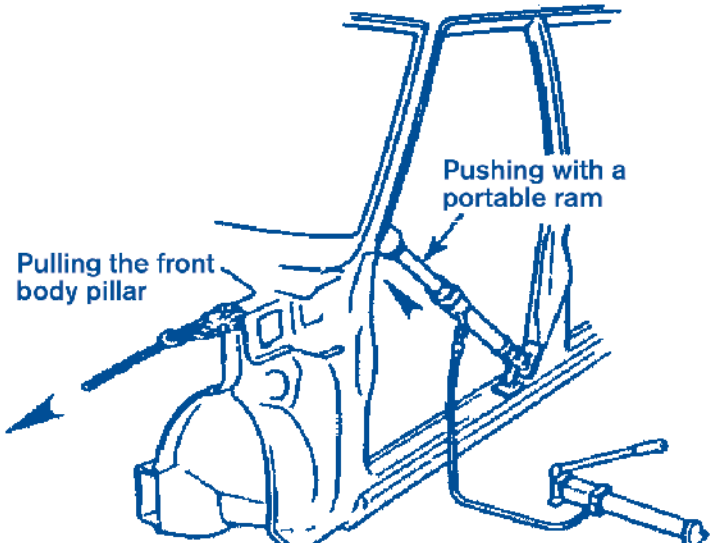

Figure 2.8: Using a hydraulic body jack

Portable hydraulic body jack kits are supplied with extension tubes and end attachments, as shown in Figure 2.9.

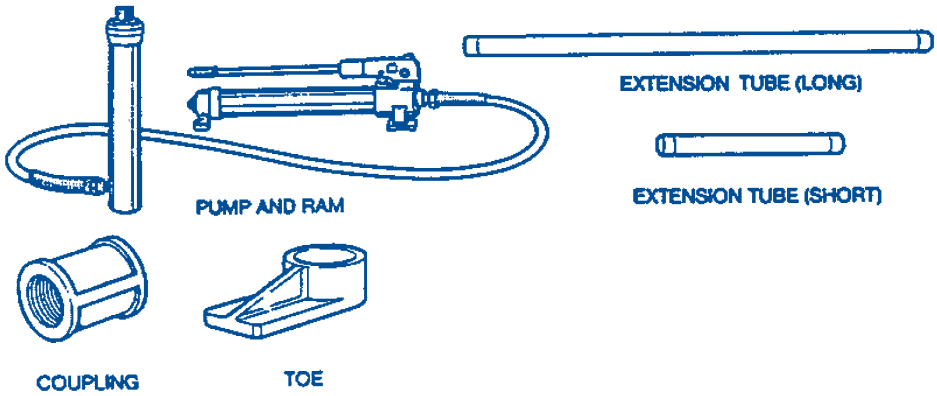

Figure 2.9: Portable jack kit

Portable hydraulic jacks are heavy for their size and care should be taken when lifting/positioning hydraulic body jacks to avoid serious back injuries.

Engine hoists

The engine hoist illustrated in Figure 2.10 is used to remove, replace and transport (around the workshop) major mechanical components of motor vehicles which are removed to gain access for structural repairs.

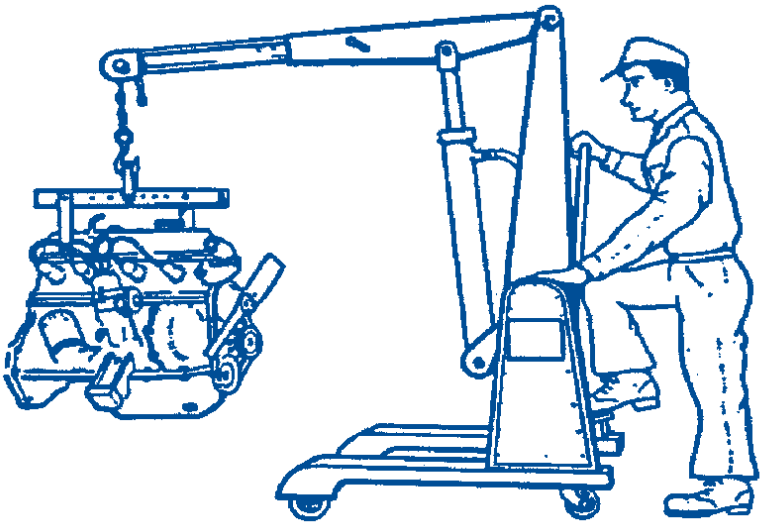

Figure 2.10: Portable lifting hoist

Activity 3

(If you are reading this study guide online, you can print this table out or write your own notes.) Review the photos in the table below and check that you can:

1. name the item
2. say what it is used for.

Equipment item	Name and use
	
	
	
	
	
	

Go to the answer section at the back of this guide to check your answers.

Inspection and diagnostic equipment

This equipment includes:

- inspection lights
- floor creepers
- fault finding and diagnostic equipment (electronic or computer-based)
- multimeter.

Inspection lights are used to provide more light so you can see what you're doing when you are working on a vehicle. There are a wide range of different types of inspection light available.

Floor creepers are the wheeled platforms that vehicle technicians can lie down on when they work underneath a vehicle.

Electronic fault-finding and diagnostic equipment includes **scan tools** which are used to diagnose faults in a vehicle's engine and systems.

Many collision repair workshops use vehicle body measurement systems to identify damage to vehicle chassis and body. These systems can be manual and/or computer controlled. In an electronic system, sensors are used to take measurements and the information is fed back to the system.

Figure 2.11: Scan tool

Multimeters are used to test vehicle wiring and electronic systems for correct operation or to identify faults

Web research

Supplier and equipment manufacturer websites contain many different examples of inspection lights, floor creepers, scan tools, vehicle body measurement systems and multimeters.

To see some examples, enter the name of the equipment into your web browser and search for images of the equipment.

Activity 4

Write the correct tool name next to each description in the table below.
Work through this section again if you are not sure of the correct answers.

Tool name	Description
	An electric meter used to measure volts, amps and ohms.
	Low flat trolley with wheels used for lying on underneath vehicles.
	Handheld electric light used to direct light to specific areas.
	Electronic or computer-based equipment used to read component outputs.

Cleaning, dismantling, repairing and assembling equipment

Activity 5

The following photos include some pieces of equipment you might use for workshop tasks. Write down the names of each piece of equipment and briefly describe their uses in the table below.

If you are reading this online, you can print out this page and the next and write in the table. Or you can make your own notes on a separate page.

Image	Tool name	Use
	1.	
	2.	
	3.	
	4.	
	5.	

Image	Tool name	Use
	6.	
	7.	
	8.	
	9.	
	10.	
	11.	

Go to the answer section at the end of this study guide to check your answers.

Other workshop equipment

Activity 6

Draw lines to correctly match the pieces of equipment in the left column to the most appropriate use in the right column in the table below.

Equipment	Use
Air compressor	Gas or electric equipment used to join metals or plastics using heat.
Extractors	Straight steel bar and flat cast iron plate used to check if components are flat.
Buff	Pump used to provide air pressure to tools and equipment.
Soldering equipment	Hard copy or electronic service information used to provide technical information to the technician.
Straight edge and surface plate	Hardened steel shafts used to remove broken studs or bolts.
Welding equipment	Soldering iron and flux core solder used to join electrical wires and connectors.
Workshop manuals and service information	Electric or air tool used to turn a polishing wheel or buffing pad.

Go to the answer section at the end of this study guide to check your answers.

Theory assessment preparation

Can you describe the uses of the tools and equipment mentioned in this section?

If not, review:

Study guide:

- Section 2 – Workshop equipment.

Look at each different piece of equipment that is in your workplace and talk about how it is used with your supervisor or senior technicians.

3. General engineering measuring equipment

Measuring equipment may include any tool used to measure length, time, distance, speed or intensity. Measuring equipment may also be used to indicate, record or regulate the volume of substances — such as the flow of a gas or an electric current, or the volume of oil. Many tools, for example feeler gauges, are designed to measure very fine tolerances. They sometimes need to be made of flexible or fragile material. Often, an inaccurate measurement can have very significant consequences, so pay special attention to the care and maintenance of measuring equipment.

Measuring equipment commonly used for general workshop engineering includes:

- measuring tape or ruler
- torque wrench
- feeler and gap gauges
- dial test indicators
- vernier callipers
- micrometers.

Some of this measuring equipment is used more by general automotive technicians when working on vehicle engines.

Measuring tape

Measuring tapes and rulers are useful when you need to measure length or width and need measurements to millimetres.

Torque wrench

A torque wrench allows you to tighten a bolt or fastening to a pre-set level of tightness. Many vehicle manufacturers specify torque wrenches must be used when replacing panels and putting components together.

This video shows a collision repair technician using a torque wrench during panel replacement.

Video:

- TRM-02: Using a torque wrench.

Torque wrenches need to be calibrated from time to time to ensure they are accurate.

Feeler gauges and gap gauges

These gauges are used to measure clearance or gap between two surfaces. Feeler gauges usually have a number of blades of different thicknesses, and are useful when you are trying to work out how much of a gap there is. There are also specially designed gauges or 'gap tools' for some tasks (e.g. checking a spark plug gap).

Keep feeler gauges clean and lightly oiled to prevent rust. The thickness of the blades can be checked with a micrometer if needed.

Figure 3.1: Feeler gauge and gap gauges

Dial test indicator

A dial test indicator is used to make precision measurements. It can measure accurately down to 0.01mm.

Dial test indicators are used by automotive technicians to check shafts or flywheels for run-out. The shape of the shaft or wheel needs to be very symmetrical so that the component will operate correctly.

Figure 3.2: Dial test indicator

When measuring run-out, the technician finds out how much the component differs from the perfectly symmetrical shape. The dial test indicator has a moving plunger at the end of the tip. The dial test gauge is fixed in place with the plunger held against the surface of the component. As the component is moved, the dial test gauge display will show where there is any variation.

Vernier caliper

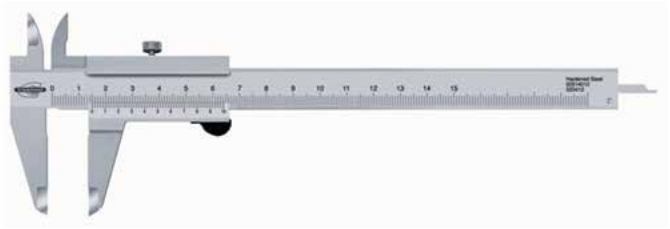

Figure 3.3: Vernier caliper

This is a tool which also provides very accurate measurements. It can be used to measure outside dimension, inside dimension and depth. You could use it to find the dimensions of a pipe, or how deep a drilled hole is.

The big jaws are used to measure outside dimension like this:

Figure 3.3a: Outside dimension

The smaller jaws are used to measure inside dimension.

Figure 3.3b: Inside dimension

The probe on the end of the Vernier calliper can be used to measure depth.

Figure 3.3c: Depth

Micrometer

Micrometers can provide very precise measurements.

There are three types of micrometers. These are used to take similar types of measurements to the Vernier caliper above. They can be used to measure engine components when a high degree of accuracy is needed.

- **Outside micrometers** take outside dimension measurements (e.g. shaft, bearing).
- **Inside micrometers** take inside dimension measurements (e.g. diameter of a hole).
- **Depth micrometers** take depth measurements (e.g. depth of a hole or slot).

Store micrometers in their box to protect them. They should be zeroed before they are used.

Web research

For more information and images of micrometers, check the following web resource:

https://en.wikipedia.org/wiki/Micrometer.

Activity 7

Here is a list of jobs that can be done with the measuring tools we have just covered.

Note down all the measuring tools you think could be used for each of the jobs. Some tools can be used for more than one job.

Job	Tool name
Measuring the size of a hole	
Making a mounting bracket	
Checking brake disks for run-out and thickness	
Setting a nut to the correct tightness	
Setting a tappet clearance	

Go to the answer section at the end of this study guide to check your answers.

Workplace link

There will be manufacturer instructions and workplace procedures that say what you have to do to keep measuring instruments well maintained and safe.

For two measuring tools used in your workplace (e.g. torque wrench, micrometer):

- find the instructions or procedures for looking after the tool
- note down one thing you should do to keep each of the measuring tools in good condition.

Measuring tool 1:

Measuring tool 2:

Theory assessment preparation

Can you describe the uses for each of the measuring tools discussed in this section?

Can you describe the procedures for keeping measuring instruments in a safe condition to ensure accurate use?

If not, review:

Study guide:

- Section 3 – General engineering measuring equipment

Video:

- TRM02 – Using a torque wrench.

Discuss with your workplace supervisor.

4. Maintenance

Regular maintenance helps keep tools and equipment in good working order and is the key to them operating correctly and safely. Maintenance is also critical to equipment lasting as long as it is expected to.

Some large items of equipment (for example, air compressors, chassis measuring systems and paint bake ovens) are huge investments by a motor body repair business owner. Correct use and maintenance is essential to this equipment lasting years before it needs replacing. The manufacturers of large items of equipment usually ensure the equipment is suitable for the work expected of it, and they often make sure the installation of the equipment is done correctly before it is used and any warranty is given on it.

Often in the first year (or more) manufacturers provide a system of warranty checks to ensure the equipment is operating correctly. This is done to support the manufacturer and to make sure the manufacturer does not find themselves in a situation where a new machine is damaged and they have to replace it.

Tool maintenance is also an important part of personal safety. For example, electrical current can travel across wet or oily surfaces. Keeping power tools clean and dry and keeping cords and plugs in good condition reduces the risk of electrocution.

Workshops usually have systems for ensuring maintenance happens as it should. This includes tagging systems for damaged tools and schedules for completing maintenance in accord with manufacturer specifications.

Storage

How tools and equipment are stored is also important. Many tools have surfaces, threads or parts that can be damaged if they are not handled correctly. Having a well organised workshop with an appropriate home for every tool is a central part of maintenance.

Workplace link

Talk with your supervisor and other technicians about why they need to maintain tools. Identify four reasons why tool maintenance is an important part of your job.

Workplace link

Choose three pieces of equipment from the following list that are used in your workshop.

- Air riveter or spray gun
- Hoist or jack
- Vehicle alignment equipment
- Welding equipment
- Air compressor
- Paint oven

For each one you choose:

1. find the relevant manufacturers specifications or maintenance schedule
2. talk to the person responsible for doing the maintenance. Work through the process so that you have a clear understanding of the steps in the equipment maintenance.

Here are some maintenance suggestions for a variety of hand tools you will come across in the workshop.

Tool	Maintenance
Adjustable wrench	Keep clean and oil the adjusting screw periodically. Replace if the jaws are worn.
Allen key	Keep oiled to avoid rusting and replace when worn. It may pay to wear gloves if the bolts are very tight. Use only as recommended.
Bars	Regrind the ends if they become worn (wearing safety goggles). Do not heat.
Chisels	Keep sharp and grind off any mushrooming on the striking end.
Files	Protect from touching other tools and clean with a file card.
Hacksaw	Replace worn or cracked blades and ensure they are well tensioned.
Hammer	Ensure the handle is secure and in good condition. Replace it if it becomes cracked. Sand or file the striking surface to keep it smooth and true.
Inspection mirror	Keep the mirror surface clean and stored away from other tools that might break the glass.
Magnet	Be careful not to drop this as the sharp knocks can reduce the magnetic strength.
Pliers	Adjust the pivot nut as required, keep clean and oil to avoid rust. Replace if the jaws or pivot are worn. Use only as recommended.

Tool	Maintenance
Punch	Regrind both ends if they are worn. May need to be replaced if bent.
Riveters	Keep clean and adjusted as required. Use only as recommended. In some cases the rivet jaws can be replaced when they become worn.
Screwdrivers	Regrind the tip if it becomes worn (wearing safety goggles). Do not use it as a punch, lever or chisel.
Socket sets	Keep these cleaned, oiled and well organised so you can always find the right size. Only use as recommended.
Spanner	Keep clean and replace if the jaws spread or become worn.
Wire brush	Lightly oil to avoid rusting.

Power and air tool maintenance

Power and air tools are covered in more detail in Section 6 – Power tools.

Most workshops will have a maintenance procedure for power and air tools. Electrical tools will often be tested on a regular basis and safety tagged. Air tools depend on a good compressed air supply, so the compressor needs to be maintained too.

Like hand tools, air and power tools should be kept clean and stored in the correct place.

If an air or electrical tool is damaged make sure that it is fixed or replaced before someone else uses it.

Activity 8

The table below lists some tools. Note down at least two procedures you should follow to keep each of these tools in good working conditions. You can write in the space provided or make your notes elsewhere.

Tip: Think about cleaning, lubrication, air or power supply, storage and access and any specific requirements for the tool.

Tool	Procedures to follow
Adjustable wrenches or spanners	
Air chisel	

Tool	Procedures to follow
Files	
Hacksaws	
Panel hammers	
Paint spray gun	
Screwdrivers	
Electric angle grinder	

If you are unsure of the maintenance of any tools, you can find the information from:

- the I-CAR courses you have access to
- your supervisor.

Theory assessment preparation

Can you explain the importance of taking care of and maintaining tools and equipment according to manufacturer specifications?

Can you describe how to clean, lubricate, and store all common workshop tools and equipment:

- for easy access
- without damage and loss
- in accordance with manufacturer specifications and company requirements?

Can you describe the procedures to keep the workshop hand tools listed below maintained in a safe working condition in accordance with manufacturer specifications and company requirements?

- Adjustable wrenches
- Chisels
- Files
- Hacksaws
- Hammers
- Punches
- Screwdrivers
- Spanners

If not, review:

Study guide:

- Section 4 – Maintenance.

5. Using tools safely

Motor vehicle maintenance and repair is one of the most common work activities worldwide. Workshops around the country service or repair thousands of vehicles every day. It is vital that tool safety and related procedures are adhered to and practiced in any automotive work environment. Tool safety has already been discussed extensively in the Workshop safety study guide. Refer back to this material if you need to as you complete this section.

You also have the following sources of information available to you:

- tool manufacturer instructions
- tool user guides and any other supporting information
- your workplace practices and/or common workplace practices.

Web research

You can find information at http://www.usingtools.com.

You can also conduct your own web research to find safe use techniques for a variety of tools.

Activity 9

Choose two tools from the following list. For each one, describe the safety procedure you should follow related to each of the points in the table below. You can print this page and write in the table or draw a similar table to fill in if you're reading this online.

- Angle grinder
- Electric drill
- Hammer and chisel

Step	Tool name: _____	Tool name: _____
Checking prior to use		
During use		
Personal safety		
Safety of others		
Vehicle safety		
Preventing damage to tools and equipment		

Power and air supply equipment

The following equipment and systems play an important role in ensuring tool and equipment safety:

- transformers
- isolating switches
- compressed air
- air lines and systems.

Transformers

A transformer is a simple electrical machine most commonly used to change voltage levels from one value to another and reduce the risk of electrocution when using electric tools. As always, refer to manufacturer and company instructions and wear suitable workplace clothing and safety equipment before use. Keep power leads clear of the work area and don't overload the tool. Do not use a transformer where water is present unless approved by manufacturer instructions.

Isolating switches

Figure 5.1: Isolating switch

Isolating switches, sometimes called residual current devices (RCDs), are used as a safety switch when using power tools and extension leads. As mentioned above, always check manufacturer and company instructions and equip yourself with suitable workplace clothing and safety equipment before using any type of electrical tool. Put the switch near or beside the wall socket so that the long lead from the transformer to the tool is also isolated. Leads should be of the correct type and always be in good condition.

Air lines and systems

Being able to detect incorrect assembly of air line componentry and/or damage and leaks in the air lines and connections ensures the system will function as designed.

Often poor air powered tool operation and/or efficiency is blamed on the tool itself. There is nothing more embarrassing than if the air powered tool supplier's representative is called in and finds an air supply fault as the cause, at your cost.

All workshop air systems should include filtering and lubricators that function correctly, or the air tools can be damaged as a result.

Remember to:

- drain impurities from the air line regularly because the dirt and moisture that may be in the air line can damage your air tools
- lubricate air tools according to the tool manufacturer recommendation to avoid premature wear of the parts
- roll up air lines after use and hang them in a safe place.

Web research

Answer the questions below about using compressed air.

Here is a selection of websites that provide further information:

http://www.dol.govt.nz/workplace/knowledgebase/item/1479

http://safetytoolboxtopics.com/General/compressed-air-safety.html

http://ingersollrandcompressorparts.wikidot.com/10-tips-for-maintaining-your-air-compressor

1. Can compressed air penetrate your clothes and skin?

2. What safety equipment should you use when working with air tools and equipment?

3. How do you complete a safety check on your compressor?

4. What may happen to your air tools if you get water and dirt in the air lines?

5. What effect can excessive air pressure have when you are using a paint spray gun?

References to I-CAR

The following I-CAR resources also include references to compressed air.

REF01:

Module 2 – Compressed air

WKR01:

Module 5 – Repair facility safety.

You should also review:

- tool user guides and any other supporting information
- workshop safety guides and related information
- your workplace practices and/or common workplace practices.

Theory assessment preparation

Are you able to describe the safety procedures for using and maintaining common tools (that is, checking prior to use, checking during use, personal safety, safety of others, vehicle safety, no damage to tools and equipment)?

Can you identify relevant safety precautions for transformers, isolating switches, compressed air, air line and systems?

If not, review:

Study guide:

- Section 5 – Using tools safely

Workshop safety (previous training package).

6. Power tools

Purpose and use of power tools

Power tools help you complete jobs faster and more efficiently and they generally reduce the level of manual labour required to complete a task.

A power tool is a tool operated by a motor that requires electricity or compressed air in order to function. Power tools are categorised as being immobile or portable. When a power tool is portable this usually means that it is handheld. You need to be familiar with leads, plugs and the following power tools:

- grinders
- disk sanders
- dual-action sanders
- orbital sanders
- random-action sanders
- chisels
- saws
- polishers
- wire brushes and attachments
- electric transformers
- heat guns
- air riveters
- staplers
- ratchets.
- air guns
- air hoses and connections
- transformers
- oil lubricators
- rotary sanders
- drills

Workplace link

If you are unfamiliar with any of these tools, ask your supervisor to show you one and give you an explanation of its safe use.

Also find the manufacturer specifications for two of the following tools, and check that you are using each as you are supposed to.

- MIG welder
- Plasma cutter
- Paint spray gun
- DA sander
- Polisher

Power tool attachments

Workplace link

Refer to the following list of attachments and consumable items for tools and equipment.

Note any attachments that are used in your workplace.

- Sanding disks
- Abrasive papers
- Polishing attachments
- Wire brushes
- Abrasive finishing attachments
- Cleaning attachments
- Buffing disks
- Fibre and nylon disks
- Drills
- Glass cutters
- Saw attachments

If an attachment is not currently being used in your workplace, try a web search using the name of the item to find examples.

Theory assessment preparation

Can you describe the following tools and equipment and their uses?

- Drills
- Grinders
- Polishers
- Sanders
- Screwdrivers
- Wrenches
- Sockets

Can you identify the following tool attachments?

- Sanding disks
- Abrasive papers
- Polishing attachments
- Wire brushes
- Abrasive finishing attachments
- Cleaning attachments
- Buffing disks
- Fibre and nylon disks
- Drills
- Glass cutters and saw attachments

If not, review:

Study guide:

- Section 6 – Power tools

And:

Gain more practical experience using power and air tools in the workplace.

Discuss using and maintaining power tools with your supervisor.

7. Metals

This section deals with metals used in the automotive industry. It also investigates the purposes, processes and automotive applications of heat treatment of metals.

The following table lists the ferrous and non-ferrous metals you should be familiar with. For each one, you need to know where and why it is used.

Ferrous metals	Non-ferrous metals
Mild steel	Aluminium
High-strength steel	Chromium
Galvanised steel	Lead
Cast iron	Copper
Spring steel	Zinc
High-speed steel	Tin
Stainless steel	Brass
Ultra-high-strength steel	Bronze
High-strength, low-alloy steel	Solder

Ferrous metals

Ferrous metals contain iron. They may be pure iron, or they may be alloys of iron and other elements. For example, steel is an alloy of iron and carbon. Mixing other metals with iron gives the metal different properties. It can affect strength, cutting power, weight and flexibility. Because of this, different metals perform different roles in vehicle construction and repair applications.

References to I-CAR

Review:

STS01:

- Module 1 – Damage analysis – Steel characteristics.

Why use ferrous metals?

When reviewing the I-CAR material above note down the main reasons for using mild steel and high-strength steel. You can make your notes on a printed copy of this page or on a separate piece of paper.

Ferrous metal	Reasons for use
1. Mild steel	
2. High-strength steel	

Galvanised

Galvanised sheet is mild steel dipped in molten zinc. It gives the ultimate corrosion resistance but the molted (crater-like) surface does not paint easily. It is ideal for inner strengthening motor vehicle panels (such as inner sill plates).

Electrogalvanised

Electrogalvanised sheet has had a zinc coating applied by an electroplating process. This gives a smooth, corrosion-resistant coating. It is a good sheet for fabricating corrosion-resistant panels that will be painted afterwards (for example when repairing rust patches).

Cast iron

Cast iron contains about 3% carbon. It is brittle and will break if struck a hard blow. It is strong in compression but poor in tensile strength (the resistance offered by a material to breaking by being pulled apart).

Modifying cast iron with heat treatment produces malleable cast iron. In this form cast iron is used for motor vehicle parts such as engine blocks.

Aluminium castings are replacing cast iron castings in the modern motor vehicle because aluminium is cheaper than it once was and is lighter and easier to machine than cast iron.

Spring steel

Spring steel is steel with carbon added to it that has been hardened by heat treatment, then tempered (softened) by heat treatment just enough to give it spring qualities. It is used for all types of motor vehicle springs, from suspension springs to door handle retaining spring clips.

Stainless steel

When chromium is added to steel so it makes up more than 11–12% of the compound, the resulting material shows excellent resistance to many forms of corrosion. The chromium combines with oxygen from the atmosphere to form a microscopically thin layer of chromium on the surface.

Stainless steel is used for motor vehicle bodywork trim (e.g. window screen and door mouldings). In polished form stainless is not only corrosion-resistant but also attractive.

High-speed steel

High-speed steel (HSS) is used mostly in the manufacture of cutting tools (such as power saw blades) and machine bits. The advantage of HSS is that it can stand high temperatures without losing its hardness. This is particularly important in devices that spin at speed as they come into contact with material. Because it stays strong at high temperatures, it cuts faster than high carbon steel, hence the name.

High-strength low-alloy steel (HSLA)

HSLA has a yield strength of up to 100,000 PSI. Its strength is due mainly to the addition of special chemical elements. HSLA steel is the second generation of high-strength steels.

It is used in the same structural load carrying areas as HSS, as well as bumper brackets and so on. Motor vehicle bodies constructed using it are even lighter and stronger than the first generation of HSS motor vehicle bodies.

It is not used for external body panels like HSS because, although it is reworkable, it is even more heat sensitive than HSS and a lot harder. This does not make panel repairs very easy to carry out.

HSLA steel is also used for suspension parts like pressed steel bottom suspension arms.

Where are ferrous metals used?

For each ferrous metal in the table below, identify two places where it is used on a vehicle. If you are unsure of where a metal is used, check the information above or talk to your workshop supervisor. If you are reading this online, you might like to print this page and write the information on the table.

Ferrous metals	Uses
HSS	1. 2.
HSLA	1. 2.
Cast iron	1. 2.
Spring steel	1. 2.
Stainless steel	1. 2.

Non-ferrous metals

Non-ferrous metals do not have iron as their basic ingredient.

Copper

Copper is a pure metal and is the oldest metal known to man. It is easily identified by its rich reddish brown colour. Copper is a good conductor of electricity, second only to silver, and also has excellent anti-corrosion qualities. Copper is used for electrical wiring and some radiator parts.

Aluminium

Aluminium is lighter than steel and easy to manufacture. Pure aluminium is somewhat soft and weak. Strength is increased by adding small amounts of other metals such as copper, manganese, zinc and magnesium. Some of the aluminium alloys (mixtures) that have been developed are stronger than steel. Aluminium alloys are lighter than most other commercially available metals.

Aluminium's lightness and easy shaping make it an ideal metal for motor vehicle bodywork and it has been used for this purpose right from the start of motor vehicle manufacturing, mainly for luxury high-performance vehicles.

Some modern vehicle manufacturers (Honda, Audi and Jaguar, to name a few) are producing vehicles with as much aluminium as possible to achieve not only performance gains, but also economy and recycling advantages. Coachbuilders use aluminium to make vehicle bodies and doors such as the one shown in Figure 7.1.

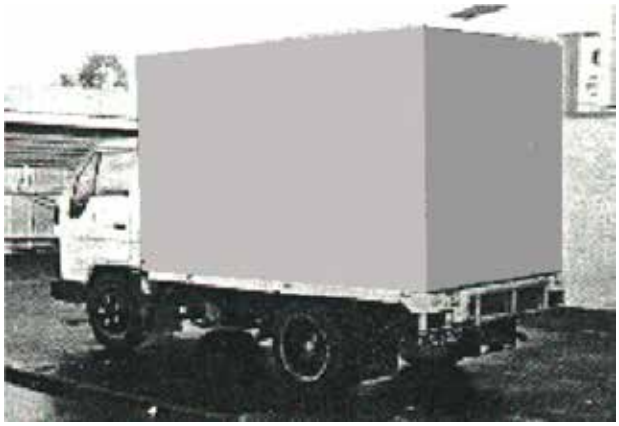

Figure 7.1: Example of aluminium vehicle body

Lead

Lead is a bluish grey metal but has a silvery lustre when newly cut. It is a heavy metal, very pliable (easy to bend) and soft. The plasticity of lead is very high and it can be worked like clay. Its plasticity increases when it is heated. Pure lead is used in automotive lead acid batteries.

By alloying (mixing) tin with lead, solder is produced. Solder is used to join electrical connections, and in some vehicles solder is used to fill body panel joins on weld on panels.

Zinc

Zinc is a bluish-white crystalline metal that is brittle. Zinc has excellent anticorrosion qualities and is used as a protective coating on steel and iron. Most modern vehicle manufacturers use zinc-coated/galvanised underbody panels to avoid rusting of structural body components and the consequent weakening of the vehicle.

Tin

Tin is a soft, shiny, silvery metal that is rarely used except as an alloying agent (in solder.)

Chromium

Chromium is an extremely hard metal with a very bright finish and excellent corrosion resistance. The very first vehicles had their bumpers painted but when the paint was scratched off the steel underneath would start to rust. Adding a layer of chrome over a steel bumper gives a hard scratch-resistant coating that looks good. Anything that got handled a lot (for example door handles) got chromed to give a durable finish. Manufacturers mainly use chrome nowadays for decoration to help vehicle name plates/emblems contrast well against the vehicle paintwork.

Brass

Brass is an alloy (a mixture) of copper and zinc. It is bright yellow and one of the more important alloys of copper. The proportion of copper to zinc varies depending on the use of the metal. Commercial brass contains about 90% copper and 10% zinc.

Brass is used in motor vehicles for electrical connections and as a filler rod in oxygen/acetylene weld brazing operations on some body panel joins (seams).

Bronze

Bronze is another alloy with copper as the main ingredient. It is composed of copper and tin and is reddish gold in colour. Bronze is harder than brass and is also more expensive. Bronze has natural self-lubricating qualities and is used in motor vehicles for shaft and pin bushings. Most oxygen/acetylene welding equipment valves and regulator threads are made of brass or bronze to avoid the need and danger of lubricating them with oil or grease. Also there is no risk of sparking from bronze or brass.

Where are non-ferrous metals used?

Use the information from the last two pages and note at least one use of each of the following types of non-ferrous metal. You might like to print out this page and make notes in the table if you are reading on screen.

Non-ferrous metals	Common uses
Aluminium	
Chromium	
Lead	
Copper	
Zinc	
Tin	
Brass	
Bronze	
Solder	

Heat treatment and the effect of heat on metals

Heat plays a very big part in the production of metal. Without heat, metal cannot be melted and formed.

You need to know about the effects of heat on metal and when you are able to use heat during a repair. For example, in a unibody:

- heat used on a panel after it has been originally formed in the factory can have drastic effects on the strength of the panel
- the amount and duration of heat applied to a panel during the repair process must not exceed manufacturer recommendations
- heating HSS structural parts beyond manufacturer recommendations will cause permanent damage.

The aim of any accident repair is to restore the vehicle to its pre-accident condition.

The heat treatment processes you will find out about in this part of the course change the structure of metals in different ways. They must be used with care – applying too much heat can change the way the panel will react during an accident and place the vehicle occupants at risk.

Web research

For an overview of heat treatment processes, check these web references:

http://www.efunda.com/processes/heat_treat/introduction/heat_treatments.cfm

https://en.wikipedia.org/wiki/Heat_treating.

Next research the following processes by entering the key words into either www.efunda.com or www.wikipedia.org:

- metal hardening
- metal case hardening.

Now find out more about the 'softening' heat treatments, again by entering the key words into efunda or wikipedia:

- annealing
- tempering
- normalising.

Tips: Use the American spelling 'normalizing' on efunda. You may need to add the word metal to your search to get the right results.

Activity 10

Use the information from your web research to note down the purpose and process for each heat treatment technique in the table below.

Purpose	Heat treatment type	Process
	Hardening	
	Case hardening	
	Tempering	

Purpose	Heat treatment type	Process
	Annealing	
	Normalising	

Go to the answer section at the end of this study guide to check your answers.

Theory assessment preparation

Can you explain the common uses and reasons for using ferrous metals?

Can you explain the common uses and reasons for using non-ferrous metals?

Can you describe the purpose, process, and automotive application of heat treatment on metals?

If not, review:

Study guide:

- Section 7 – Metals

STS01:

- Module 1 – Damage analysis – Steel characteristics.

Web references:

- www.wikipedia.org
- www.efunda.com.

8. Plastics

Plastics have been increasingly used in motor vehicles as new forms have been developed. They now offer great strength as well as being light. They are also more flexible than many metals. However, each type has its own special properties. In order to repair plastics you have to be able to correctly identify their uses.

References to I-CAR

Review the following I-CAR material for information about plastics.

PLA03:

- Module 1 – Plastic identification and repair considerations.

Types of plastics

Plastics that are commonly used in vehicles fall into two main categories.

Thermoplastics

Most of these are flexible, although some, like acrylonitrile butadiene styrene (ABS), which is often used for grills, are rigid. Thermoplastics can be plastic welded and reshaped with the assistance of heat. One of the most commonly used thermoplastics in motor vehicles is polypropylene (PP), which belongs to a group of plastics called olefins. These olefins, when sanded, smear and have a wax-like look and feel. Polypropylene is designed to absorb minor collision damage.

Thermosetting plastics

These are generally rigid plastics that are stronger and more resistant to heat than thermoplastics. They cannot be welded as they tend to burn rather than melt. These types of plastics can only be repaired using adhesives and include some polyesters, phenolics and most polyurethanes.

Note that some plastics, for example polyurethane, have both thermoplastic and thermosetting plastic variants.

International Standards Organisation codes

There are a number of kinds of plastic used on vehicles.

The type of plastic is indicated by an International Standards Organisation (ISO) code, which is usually an abbreviation of the plastic's full name. Some of these codes are:

- ABS (acrylonitrile butadiene styrene)
- PE (polyethylene)
- PP (polypropylene)
- PVC (polyvinyl chloride)
- PA (polyamide [nylon])
- PMMA (polymethyl methacrylate [acrylic])
- TPUR (thermoplastic polyurethane)

Which plastics are used where?

These different plastics are used in many parts of the vehicle. Figures 8.1 and 8.2 show the different types of plastics used and whereabouts on the vehicle they may be used.

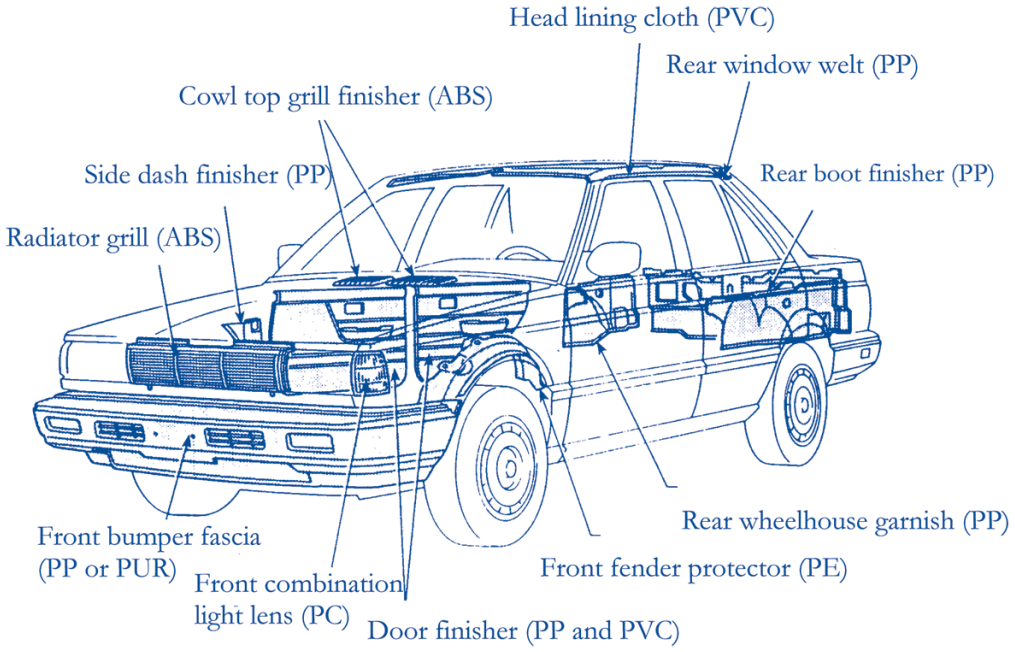

Figure 8.1: Types of plastic used for different components (front view)

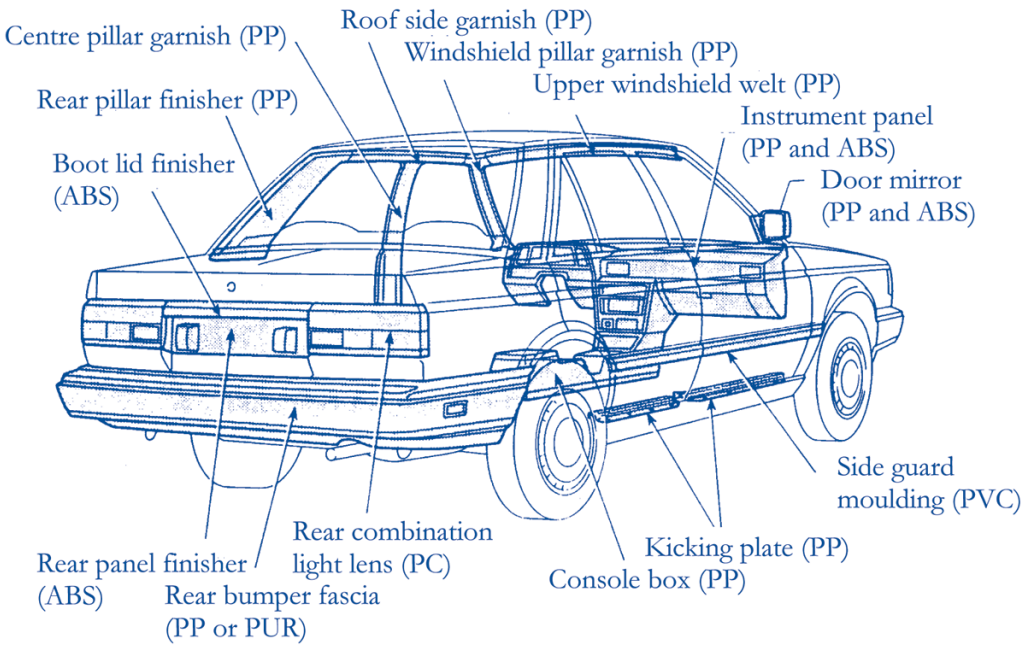

Figure 8.2: Types of plastic used for different components (rear view)

This table shows examples of some uses of the plastics that are covered in your assessment for this package.

ISO Symbol (code)	Chemical (common) name	Examples of use
ABS	Acrylonitrile butadiene styrene	Dash components, grilles, hubcaps, trim mouldings, armrest supports, consoles, tail lamp housings, badges.
PA	Polyamide (Nylon)	Radiator tanks, pump impellers, gears and bushes, headlamp bezels, exterior trim finish parts, fuel filler door, mirrors, plastic engine parts.
PE	Polyethylene	Anti-slip mat, car covers, inner fender panels, valances, spoilers, interior trim panels.
PMMA	Polymethyl methacrylate (Acrylic)	A clear acrylic resin used for instrument and tail lamp lenses, protective covers – e.g. headlight covers, weathershields.
PS	Polystyrene	Sheet or molded polystyrene is a low cost solid plastic. Uses include licence plate holders and solid packaging.
TPU	Thermoplastic urethane	Rear lights and brake lamps, bumper covers, soft filler panels, gravel deflectors, sill panel covers.

Identifying plastics used on vehicles

Identifying plastics on vehicles has become easier for the repairer thanks to the ISO code. This code is often stamped on the underside of the plastic components, as shown in figure 8.3, making identification simpler. In cases where no ISO code has been marked, manufacturer data sheets on plastic parts can be obtained through the franchise dealers' parts departments. There are also a number of tests that can be used.

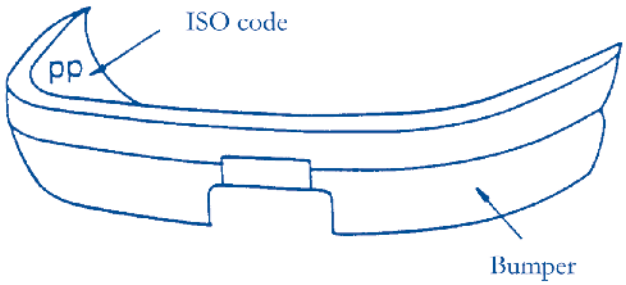

Figure 8.3: ISO code inside bumper indicates type of plastic used

Web research

You can find references about plastic at www.wikipedia.org, or by doing an internet search on the particular plastic.

Theory assessment preparation

Are you able to identify the uses of plastic or composite material on a vehicle?

If not, review:

PLA03:

- Module 1 – Plastic identification and repair considerations

Study guide:

- Section 8 – Plastics

Web reference:

- http://www.wikipedia.org.

9. Fastening systems

Fasteners are used to secure and fasten:

- metal parts
- trim
- sealing rubbers
- plastic.

They may also be used to secure wiring, glass and other components on a vehicle.

Methods for securing components

There are three main methods for securing components:

- bonding (including weld bonding, using adhesives and rivet bonding)
- mechanical (including bolts, rivets and clinches)
- welding (including squeeze-type resistance spot welding [STRSW], gas metal arc [GMA (MIG welding)], flux-cored arc welding, MIG brazing and laser welds).

Your choice of method depends on the type of material being secured and the purpose it fulfils.

References to I-CAR

The following I-CAR materials cover the mechanical and bonding fastening methods.

Mechanical fastening

TRM02:

- Module 1 – Hardware.

Bonding

ADH01:

- Module 2 – Attachment processes.

Welding is covered in detail in your later training packages.

There are hundreds of different types of fasteners used to assemble motor vehicles. Each type is designed to do a specific task, and to stand up to varied conditions during the operational life of the vehicle.

Figure 9.1 below shows some of these components.

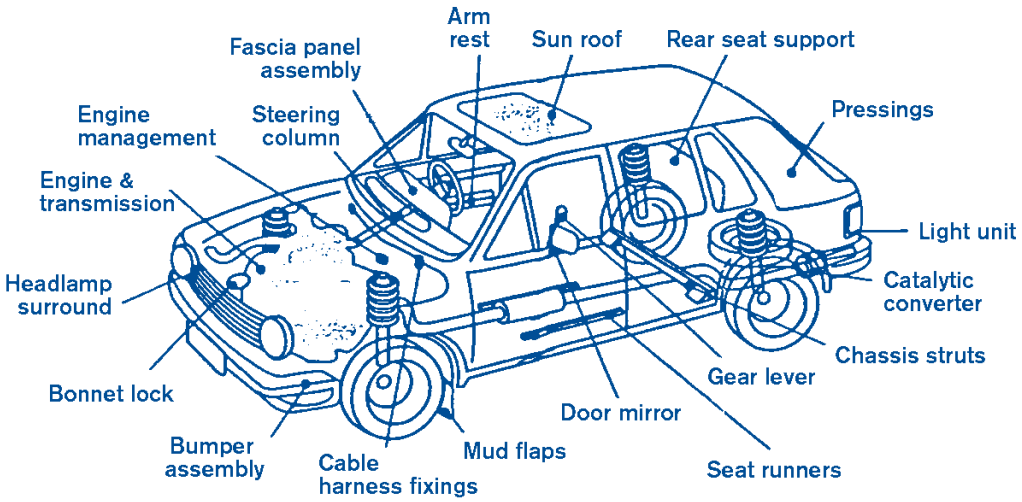

Figure 9.1: Components to be fastened

Metal parts

Metal parts include motors, gearboxes, suspension and steering components, body panels, electrical components, fuel tanks, radiators, mouldings and so on. To secure metal parts, you should use a combination of fastening systems, including bolts and nuts, screws, studs, metal clips, plastic clips, welding and adhesives. These fasteners are designed to secure metal parts in their respective positions accurately and firmly and to withstand complex loading stresses as the vehicle moves through a variety of conditions, speeds and climates.

Trim materials

Trim materials include carpets, seating, upholstery, door trims, bootliners and mouldings. A combination of fastening systems is used here also. The bigger parts such as seats are secured with bolts to floors and frames, while other parts are secured by clips, screws and adhesives. Most upholstery is designed for removal to give access to panels and areas when repairs are to be undertaken.

Rubber and plastic

The most common rubber and plastic components are grilles, bumpers, interior and exterior trim, dashboards, door and bootlid rubbers, weather strips, and mouldings. Again, a combination of fastening systems is used to secure these components to the vehicle body. For instance, bolts secure the bumper to the body, clips hold the bumper ends in place and adhesive secures moulding in position on the bumper.

Figure 9.2 shows examples of fastening systems used on a front guard.
The exploded view shows the vast range of fasteners to be found in just one type of assembly.

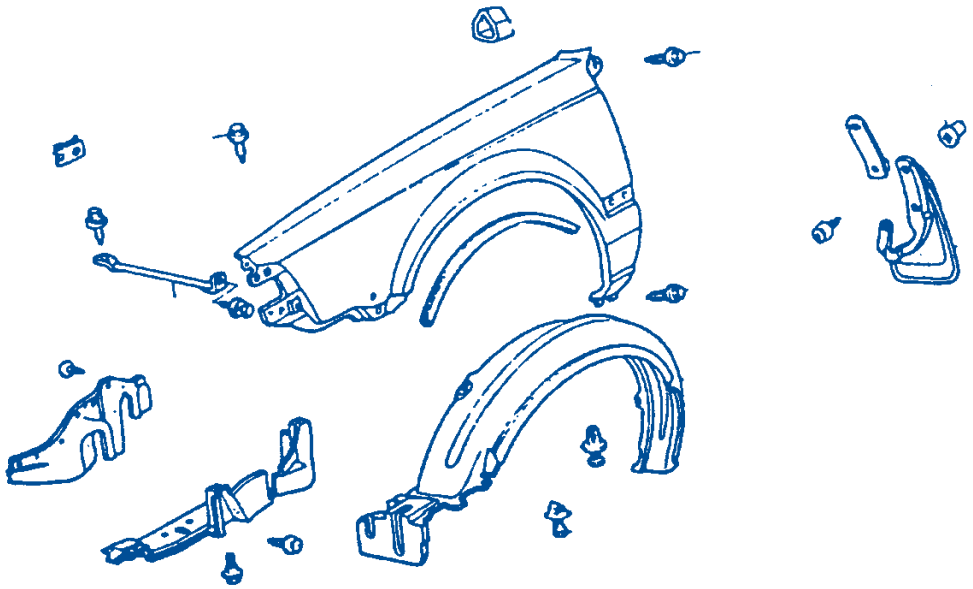

Figure 9.2: Left front guard and fasteners (bolts and clips)

How fastening systems work

The following types of fastening systems should be familiar to you:

- adhesives
- bolts
- cable ties (plastic ties)
- clamps
- double-sided tape
- keys
- lock wire
- nuts
- pins
- plastic and metal body clips
- rivets
- screws
- studs.

Adhesives

Adhesives are compounds that fix or join two items together. Due to their strength and flexibility of use, some current types of adhesives are becoming widely used within the construction and automotive industries. In the automotive industry, they are used in many different situations. They may be single-component or two-component systems.

Contact adhesive

This is used for securing upholstery or interior trim, some door sealing rubbers and so on. Contact adhesives are used in motor vehicle assembly for bonding materials together. The materials can be the same or similar, or dissimilar – for example, fastening rubber to steel or plastic to wood.

Contact adhesives are usually 'solvent-borne', which means that the adhesive in its unused state has a high content of solvent. This solvent keeps the adhesive in a semi-liquid form until it is exposed to air. Once exposed to air the solvent evaporates and the adhesive thickens, forming a bond between the materials being glued.

The range of materials that can be bonded using contact adhesive is considerable and includes:

- some rubbers (polyurethane foam)
- metals
- formica
- carpets
- cloth-backed vinyl
- fibreglass
- some plastics
- weather strips
- noise deadening materials.

F2 is one example of a high performance water-resistant contact adhesive. It has a high bond strength, is very durable and flexible, and is simple to use.

Before you apply adhesive to a surface you must thoroughly clean it. Contact adhesive is applied to the two surfaces to be bonded and left to dry for up to 15 minutes. Once it is tack-free the two surfaces can be placed together, forming an instant bond. Tack-free means that the adhesive does not transfer to your finger. If you touch the adhesive and it sticks to your finger, you must allow more drying time.

Polyurethane adhesives (urethane)

Polyurethane is used in a variety of adhesive types. Urethane adhesives are used for bonding body panels, bonding and sealing windscreens and seam sealing. They can be single pack or two pack types. Two pack types are supplied with automatic mixing nozzles or in separate containers that require hand mixing. Urethane adhesives may be used for:

- joining panels to frames, bonnets, boot lids, doors and roof (metal to metal)
- sealing and bonding windscreens
- gap sealing (joins in bodywork)
- bonding bumper parts (plastic to plastic, steel to plastic).

One-component systems

Polyurethane has a limited shelf life that relies on the adhesive being completely sealed from the air. Once it is exposed to air the curing action commences. Curing time varies depending on the type of job and the strength rating that the adhesive is designed for. Strength and flexibility also vary, affecting what you will use a particular polyurethane adhesive for.

Two-component systems

Two pack urethane adhesives are packaged in separate tubes or containers which must be measured and mixed manually. One container holds the resin and the other the hardener. Careful measurement and mixing is very important with these packaging systems. Other products are packaged in a dual pack – side by side tubes with a mixing nozzle to ensure a proper mix of the two components.

Epoxy adhesives

Epoxy adhesives are used for applications when maximum strength is required. They can be used to:

- bond panels to the vehicle body
- bond other body part components that need structural integrity
- bond mechanical parts.

Manufacturers often use adhesives in combination with other attachment methods – for example, rivet bonding or weld bonding. Epoxy adhesives utilise the two-component system. Two different chemicals are mixed together, creating a chemical reaction which usually produces heat and starts the setting process.

With all adhesives, cleanliness is a must and manufacturer instructions must be rigidly adhered to when bonding components together.

Isocyanate-based adhesives

Used for bonding rubber to metal and some plastics. These adhesives use an isocyanate base and range from superglue type adhesives to polyurethanes with isocyanates added. The general use of isocyanate adhesives in motor vehicles is to bond rubber to rubber, metal to metal, metal to rubber and sometimes plastic to rubber. As with polyurethane adhesives, exposure to air or atmosphere starts the curing or setting process.

Note:

Virtually all modern synthetic adhesives are potential health hazards. Some give off toxic fumes which are harmful to lungs and eyes. The chemicals used in the manufacture of adhesives are harmful to the skin and eyes if contact is made.

Activity 11

1. Draw lines matching the descriptions in column A to the appropriate adhesive types in column B.
2. Draw lines matching the uses in Column C to the appropriate adhesive types in column B.

A. Description	B. Adhesive type	C. Uses
Packed in separate tubes, one for the resin and the other for the hardener	**Contact adhesives**	Different strengths or flexibility depending on usage, for example windscreens or panels
Can range from superglue type adhesives to polyurethane with isocyanates added	**Urethane adhesives**	Mainly used for securing moulding, badges and lettering
Solvent-borne adhesive	**Epoxy adhesives**	Used for securing upholstery or interior trim
Can be single-component type or two-component type, cover a wide range of uses and a variety of types	**Isocyanate adhesives**	Used for bonding rubbers to metal and some plastics
Some body parts are bonded using these types of adhesives and various mechanical parts are secured by the same method	**Double-sided tape**	Used for bonding panels to vehicle bodies and for bonding components requiring structural integrity
Made of neoprene foam and has an adhesive coating on both sides	**Single pack adhesives**	Used for sealing windscreens, gap sealing and bonding bumper parts
Limited shelf time, life dependant on adhesive being completely sealed from the air	**Two pack adhesives**	Used where a high-strength, chemically-cured bond is required

Go to the answer section at the end of this study guide to check your answers.

Keys, plastic clips and cable ties

Fastening keys

Keys are a type of fastening system used to lock components onto shafts. The key fits into a keyway – a slot cut into the shaft or pulley. As the key locks into the keyway slot it effectively locks the two components together. Care must be taken to ensure that the two parts are perfectly aligned when the key is inserted.

Clips

A range of clips is used to attach vehicle trim components to other parts. Many of these clips are plastic and some are metal. They are often single-use fasteners and may need to be replaced.

This video from I-CAR TRM03 shows a technician removing interior door trim. Look for how the clips are used to fasten the door trim. You may have removed and replaced a number of clips yourself, so think about other places you have seen these types of fasteners used.

Video:

- TRM03 – Removing interior door trim panels.

Cable ties

Cable ties are used to keep bundles of wires together and for a range of other purposes.

If you need more information about cable ties, you can carry out an internet search. Try https://en.wikipedia.org.

Working with threaded fasteners (nuts, studs and bolts)

Thread types

The most common thread types are:

- metric
- Unified National Fine (UNF)
- Unified National Coarse (UNC).

Being able to distinguish the different types is critical. Combining nuts and bolts from different thread types will result in damaged fittings.

References to I-CAR

Review the following parts of TRM02 for information on this topic.

TRM02:

- Module 1 – Hardware.

TRM02 Videos:

- Using thread pitch and measuring gauges
- Using a torque wrench.

Torque wrenches

Tightening threaded fasteners to the correct torque is very important. If they are over-tightened they can damage the material they are securing, break, stretch or become difficult to remove. If they are not tightened enough they may come loose. Using a torque wrench takes the guesswork out of tightening threaded fasteners.

Vehicle manufacturers provide torque specifications that must be complied with to meet warranty requirements and help ensure occupant safety.

Locking devices

Locking devices are designed to do what you would expect, stop things from coming loose.

Mechanical locking devices

The range of mechanical locking devices used to assemble and repair motor vehicles is wide and varied. They include flat washers, spring washers, star type washers, retaining clips and pins as shown in Figure 9.3.

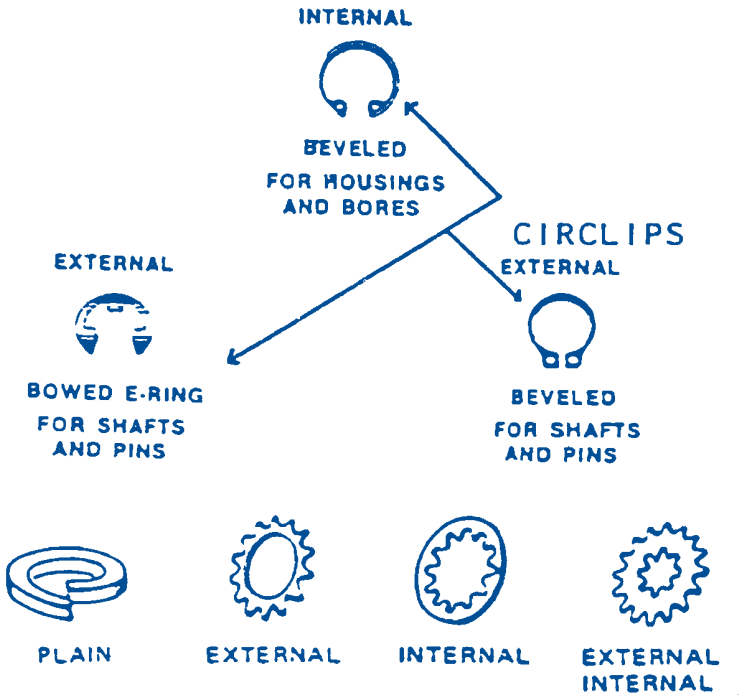

Figure 9.3: Mechanical locking devices

Lockwire (also known as safety wire)

Lockwire works in a similar way to plastic ties. A small length of wire is threaded through parts and then crimped to secure them together. It is designed to stop items like nuts and bolts from coming loose, but also stops them from falling onto the road (or racetrack) if they do fail. Care should be taken to ensure that the lockwire is trimmed off and does not protrude and catch in other pieces of equipment.

Figure 9.4: Lockwire

Chemical locking devices

Chemicals may also be used as a locking agent. They can be of two-part variety, which when mixed together chemically set and lock the fastener tight, or a one-part type that sets when exposed to the atmosphere. One such type has a brand name LocTite and is shown in Figure 9.5. This is a commonly used chemical locking agent in New Zealand.

Figure 9.5: Chemical locking agent

Theory assessment preparation

Can you describe the purpose of fastening systems?

If not, review:

Study guide:

- Section 9 – Fastening systems.

Can you describe the principles of how fastening systems work?

If not, review:

TRM02:

- Module 1 – Hardware

Study guide:

- Section 9 – Fastening systems.

Are you able to identify thread types (including metric, UNF and UNC)?

If not, review:

TRM02:

- Module 1 – Hardware

Video:

- Removing and installing – Hardware and interior trim.

Can you describe the different types of adhesives as well as their uses?

If not, review:

Study guide:

- Section 9 – Fastening systems – Adhesives.

Can you describe plastic fastening systems and their uses?

If not, review:

Study guide:

- Section 9 – Fastening systems – Keys, clips and cable ties.

Can you describe methods of securing components?

If not, review:

Study guide:

- Section 9 – Fastening systems – Keys, clips and cable ties.

Can you describe the method and importance of tightening fasteners to the correct torque?

If not, review:

TRM02:

- Module 1 – Hardware.

Theory assessment preparation

Are you able to identify the different types of automotive fasteners?

If not, review:

TRM02:

- Module 1 – Hardware

Study guide:

- Section 9 – Fastening systems.

Can you describe how locking devices are used to retain components (that is, mechanical and chemical)?

Can you describe different locking devices and their uses (such as locking washers, clips, pins, lock wire, chemical and lock nuts)?

If not, review:

TRM02:

- Module 1 – Hardware

Study guide:

- Section 9 – Fastening systems – Mechanical and chemical locking devices.

Can you describe pop rivets and their uses?

If not, review:

TRM02:

- Module 1 – Hardware.

10. Drilling

Which tool to use?

Whether you use a hand drill, a handheld power drill or a drill press to drill a hole depends on the type of drilling job to be carried out.

Hand drills are generally only used to resize carburettor fuel and air bleed jets. The drills are very small, usually 0.4mm to 1.5mm, so must be very carefully turned by hand.

If the hole is being drilled into the vehicle body or component, an electric or air powered handheld (or portable) drill is used. Most drilling in the collision repair industry is performed using a handheld power drill.

Range of drilling equipment

Drill press

A drill press is a fixed style of drill that may be mounted on a stand or bolted to the floor, or most commonly, to a workbench.

If the hole is to be drilled into a component removed from the vehicle or prior to its assembly onto the vehicle, a drill press is the better method. In coachbuilding, for example, as much drilling as possible is done on a drill press because:

- drilling holes at a perfect 90° is assured on a drill press. This is especially important in thicker/harder materials because they do not distort like sheet metals do during the tightening process. Any non-square holes drilled will result in a fastener not sitting square
- drilling holes using a drill press is a lot faster, especially when drilling multiple holes
- greater accuracy is possible when using a drill press
- there is less chance of operator fatigue, especially when drilling multiple holes.

Handheld power drills

Handheld power drills come in many different sizes and are used for removing pop rivets, spot welds, drilling holes for pop rivets, plug welds, badges, or self-tapping screws. Cordless drills may be used where there is no power supply available.

Because most drilling is done on thinner (say 3mm and under) metals, drilling the hole at 90° is not as important because the thinner metal distorts during the tightening operation, ensuring the bolt head sits square to its mounting surface.

Cutting fluid

Cutting fluids are supplied to:

- lubricate the drill lips, which assist chip (drilling swarf) formation and flow
- cool the lips of the drill, the chips and the work being drilled
- wash away the chips from the lips, which minimises the possibility of clogged flutes in the twist drill
- improve the finish of the drilled holes.

A copious flow of cutting fluid must be directed to reach the cutting lips. This increases the life of the drill by preventing overheating and softening of the lips and by minimising the tendency of the chips to weld to the faces of the flutes. The cooling also prevents the work from warping due to overheating. It is desirable that the cutting fluid used should inhibit corrosion of the work and the drill.

Soluble (water-thinned) oil is a suitable cutting fluid for most common metals.

Cooling is only required for thicker material or continuous drilling (for example, drilling out spot welds). It is not often used in the collision repair industry but a squeeze bottle of soluble oil may be used to apply a few drops of cutting fluid into the drill flutes. This cuts drilling time in half and makes the drill last twice as long.

What drill type or types would you use in the each of the following situations?

Situation	Drill type
Plug weld holding boot pan to chassis rail	1. Drill press ☐ 2. Handheld power drill ☐ 3. Use cutting fluid? Yes/no
Make a heavy steel bracket with many different holes	1. Drill press ☐ 2. Handheld power drill ☐ 3. Use cutting fluid? Yes/no
Drill pop rivet holes on a front panel	1. Drill press ☐ 2. Handheld power drill ☐ 3. Use cutting fluid? Yes/no
Drill out a broken stud in an alternator bracket that has been removed from the engine	1. Drill press ☐ 2. Handheld power drill ☐ 3. Use cutting fluid? Yes/no

Choosing the right drill bit

The first thing you should check is the material you are drilling. Drill bits are designed for different types of material. The most common drill bit types are:

- wood
- metal
- masonry.

In addition to the material being drilled, you will also need to know the hole size (and therefore the drill size).

Web research

The internet link http://en.wikipedia.org/wiki/drill_bit provides good reference information.

Workplace link

Find examples of each type of drill bit in your workshop. Are there other types of drills that are not listed here?

Drill speed is an important consideration. It is affected by the size of the hole and the type of material. A drilling speed chart compares drill sizes and metals to show the proper speed. Find the drill speed chart in your workshop, and use it to complete the table below. The first two have been done for you.

Drill size	Material	Drill speed
10mm	Aluminium	1800 rpm
8mm	Mild steel	830 rpm
1.5mm	HSS	
3mm	Copper	
5mm	Cast iron	

Drilling the hole

Sharpening a drill

Drill sharpening is a highly skilled operation, which you will have to learn. It is best learnt by observing a detailed demonstration, then practicing.

A twist drill can be successfully sharpened on a bench grinder.

Set-up

A suitable set-up would include using a small bench grinder with an abrasive wheel 32A.46.K.VBE on one end with a wheel of similar type but finer grit 60 on the other.

First check that the surfaces of the wheels are running true and they are dressed clean, then make sure the tool rests are adjusted correctly and tightened.

Establishing the cutting angle

Hold the drill level at the correct angle as shown in Figure 10.1.

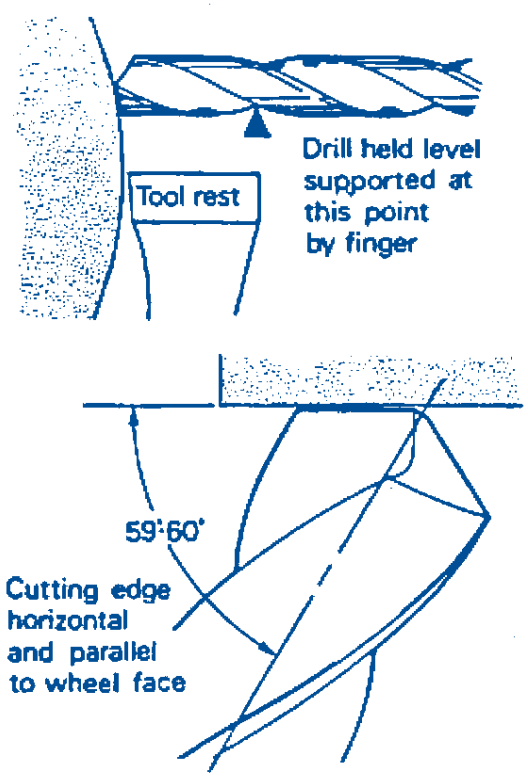

Figure 10.1: Establishing drill angle

Twist it until one cutting edge is horizontal and parallel to the wheel face.

Swing the shank of the drill slightly downwards and to the left. Roll the drill to the right by turning it between the thumb and finger as you swing the hand down, as shown in Figure 10.2.

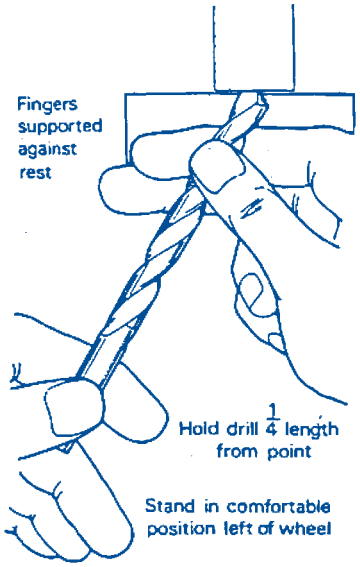

Figure 10.2: Holding drill angle

When sharpening the drill, watch the cutting edge against the wheel. Notice that as the shank swings down, the cutting edge will come slightly upwards and away from the wheel face, as shown in Figure 10.3.

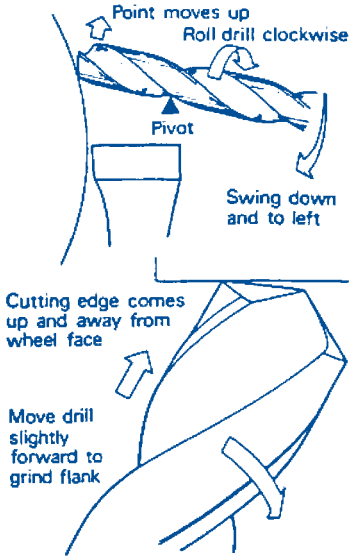

Figure 10.3: Cutting edge angle

Apply a slight forward motion to your hands. This will bring the flank of the point against the wheel to produce lip clearance.

Co-ordinate these three movements of swinging down, twisting clockwise and forward as shown in Figure 10.3. These movements are only slight. If they are performed correctly they will produce a cutting edge that has the correct lip clearance and cutting angle.

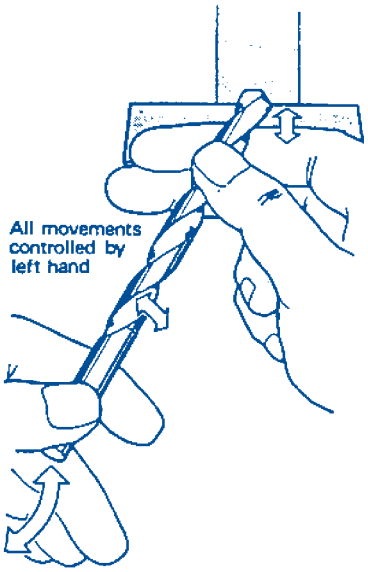

Figure 10.4: Obtain cutting angles

Obtain equal cutting angles

To obtain equal angles, move the drill back and clear of the wheel face. Turn the drill over without moving the position. This presents the second edge to the wheel face at the same angle as the first cutting edge.

Proceed to sharpen the second cutting edge using the same amount of drill movement as before.

When these actions are carried out carefully the drill will be sharpened with equal cutting angles. The lip clearance will be correct and equal.

Checking angles

Use a drill-sharpening gauge as shown in Figure 10.5 to check that the cutting angle is correct (118° for mild steel), the cutting edges are of equal length and the lip clearances are equal and correct (about 12°).

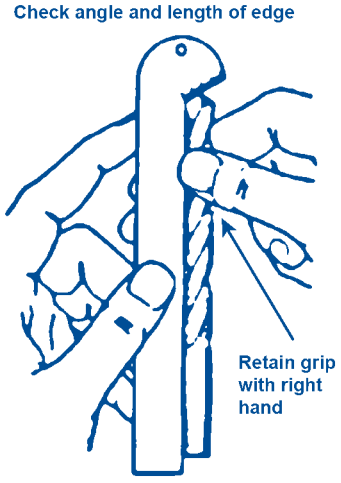

Figure 10.5: Drill sharpening guage

Testing a drill after sharpening

To check the drill has been sharpened correctly, drill a hole in a scrap piece of steel 10mm thick. A drill that has been sharpened correctly will produce evenly curled chips from its cutting edges and require only moderate pressure.

When the hole has been drilled, take the drill bit out of the drill machine and try it in the hole. If the drill fits without play, the cutting edges and angles are equal, as shown in Figure 10.6.

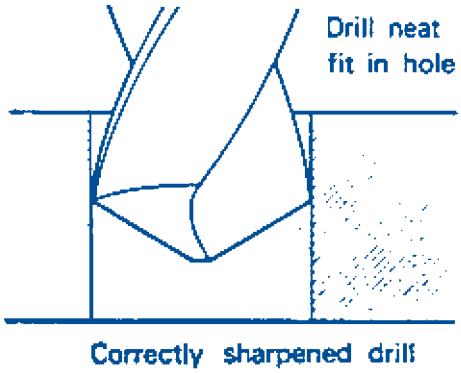

Figure 10.6: Correctly sharpened drill

Any looseness of the drill in the hole indicates the cutting edges and angles are not equal, as shown in Figure 10.7.

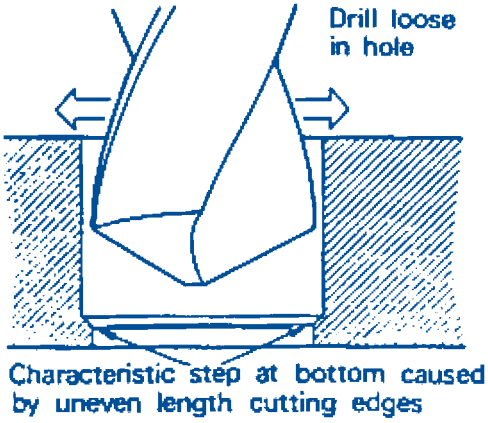

Figure 10.7: Incorrectly sharpened drill

These are important points to remember for the drilling procedure.

- Sharpen a drill on a bench grinder.
- When sharpening drills, hold them correctly with a slight rolling movement and grind as little as possible from the drill.
- Use a drill-sharpening gauge to check the cutting angle of the drill is correct.
- Always test the drill after sharpening.
- When drilling always select the correct size drill for the job.
- Always use safety clothing and equipment.

Space has been provided below for you to write a summary of the steps you should take when sharpening twist drills. Complete the activity by filling in the space.

Centre punching and pilot holes

Before a hole is drilled in the material, the centre point should be marked on the work piece. After marking the centre point it should be centre punched as shown in Figure 10.8. Centre punching creates a slight crater in the surface of the material to align the drill point with.

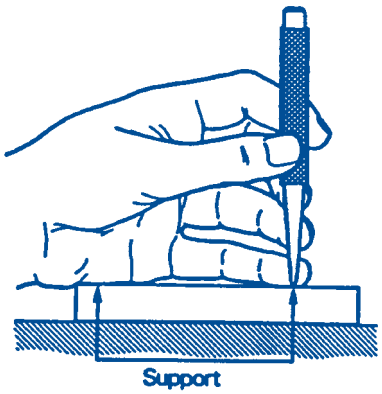

Figure 10.8: Centre punch and drill size

It is very important when using centre punches that you hold the punch at 90° to the work being marked, or when you strike the punch with a hammer it will move sideways slightly.

If you drill holes using centre punched points that have not been marked using the punch at 90°, not only will the hole not be in the correct position, but the drill might break. This occurs especially when using a very small drill because it's able to slip out of the uneven side of the crater when pressure is applied to it. Also, if the drill slips and it is a painted surface it will cause a bad scratch.

Provided you do it correctly, centre punching ensures the centre line of the drill aligns itself with the centre point of the position where you wish to drill the hole.

When you drill large holes it is advisable to drill a pilot hole first. Pilot holes allow the dead centre of the drill bit to be placed into the pilot hole, making it easy to align the drill accurately. They also make the drilling operation go more smoothly and keep the drill cooler.

To decide what size diameter pilot drill to use for a given drill, measure the width of the web of the dead centre of the drill, as shown in Figure 10.9.

Figure 10.9: Centre punch and drill size

Select the next closest drill larger than the width of the web as your pilot drill. When carrying out drilling operations the objective is to remove the maximum amount of metal in a given time without having to re-sharpen the drill too often. This requires that:

- you use a drill sharpened to suit the metal being drilled
- you use the correct combination of speed, feed and cutting (or cooling fluid) if required.

In the motor body industry most drilling operations are light duty (with the possible exception of some coachbuilding situations). In collision repair we now have specialised drills and drilling machines for spot weld drilling. For most other drilling operations, common 59° angle carbon steel drills are used. When it comes to drilling speeds, we tend to get by using two-speed drills and run small diameter drills at the faster speed and larger diameter drills on the slower speed.

Use the correct pressure

The correct pressure (or feed) is the rate that the drill advances into the work. Inspect the condition of a drill to decide if it is being fed properly. Figure 10.10 shows the effect of excessive pressure.

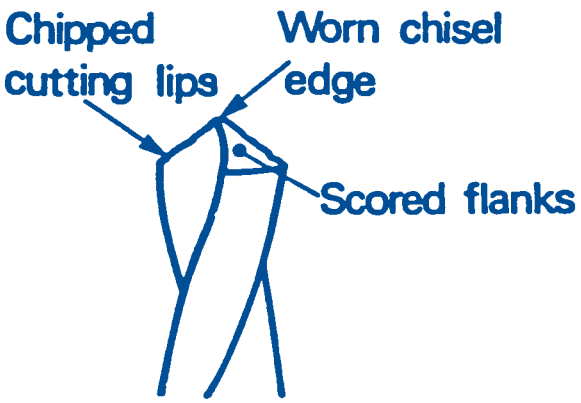

Figure 10.10: Effects of excessive feed/pressure

With too little feed, the drill scrapes rather than cuts and it chatters and quickly dulls the cutting lips.

The smaller the diameter of the drill, the less feed pressure must be used. Conversely, the larger the diameter of the drill, the more feed pressure must be used.

Also remember, the smaller the diameter of a drill the faster the drill speed required. Conversely, the larger the diameter drill, the slower the drill speed required.

Getting it right

If you see any of the following problems, the job has not been done properly:

- damage to an adjacent area
- burrs in the hole
- a rough finish
- signs of overheating
- drill breakage.

Safety when drilling

Personal safety when using drills

- Wear suitable clothing such as overalls, safety glasses, safety boots, aprons and leather gloves.
- Always ensure the workspace is well lit and kept clear, clean and tidy.
- Always tie long hair back or tuck hair up under a close-fitting cap when using a drill machine.
- Make sure none of your clothing is loose or it can catch on the drill. Roll up or button up your sleeves.
- Never attempt to remove drill cuttings whilst the drill is still operating. Their long sharp corkscrew shape can catch onto you, ripping at your fingers and twisting them around the drill.
- Let the drill stop of its own accord after the power is turned off. Do not try to stop it with your hand.
- Always clamp work to the drill press table and never hold the work with your hand. If the drill catches, the work will be flung out at you, and if you hold work with your hand you will be twisted around the drill.

Machine and equipment safety when using drills

- Before using a new drill press always take the time to get to know the machine's controls and functions.
- Always replace belt guards after setting speeds and do not operate any drill press without a belt guard.
- Never leave the chuck key in the drill chuck as it can be flung out at such speed that it can cause serious damage and/or injury.
- Use a brush or piece of wood to remove cuttings around the work (after the drill has stopped), not your hands. The cuttings are hot and sharp.

Safety of others when using drills

- Wipe up any cutting fluid that has spilled onto the floor.
- Sometimes it is a good idea that you inform others nearby that you will be using the drilling equipment (only so others are aware that you are working within a close proximity).

Tool safety when using drills

- Always refer to manufacturer instructions and/or user guides before using tools.
- Adhere to workplace or common workplace practices when using automotive tools.
- Always use the correct tool for the job.
- Maintain and clean workplace tools so that they are in good working condition.
- Put tools back in their original location when finished with them.
- Ensure you use tools in an appropriate manner and for the purpose that they were designed for.

Theory assessment preparation

Can you identify twist drills and describe how to sharpen them?

Can you describe the range and applications of drilling equipment (including hand drill, drill press, cutting fluid and handheld power drill)?

If not, review:

Study guide:

- Section 10 – Drilling.

Are you able to explain how to select twist drills?

Can you describe the procedures and standards for drilling holes in determined positions?

Are you able to explain safety procedures when using drilling equipment?

If not, review:

Study guide:

- Section 10 – Drilling

Web reference:

- http://en.wikipedia.org/wiki/drill_bit.

11. Threading

Cutting new internal or external threads and repairing damaged threads is not a common task in the collision repair industry. However, on the odd occasions that you need to do this, it must be done right.

References to I-CAR

Start by reviewing the TRM02 I-CAR video 'Repairing threads'. This shows a technician using a die nut and a rethreading tap.

Video:

- TRM02 – Repairing threads.

Web research

Check the following website for more information about taps, dies and die nuts:

https://en.wikipedia.org/wiki/Tap_and_die#Die_nut

You also need to understand how to use a thread file – this is another tool that can be used to repair the threads on bolts.

Carry out your own web search using the words 'thread restoring file' or 'thread repair file'. Check the images to see examples of different types of these files. You may also want to watch some video clips demonstrating how these files are used.

Workplace link

Ask an experienced technician to show you how to use taps, dies, die nuts and thread repair files.

Now answer the following questions.

Briefly describe when you would use:

- Taps and dies

- Thread file or die nut

How do you decide which tap or die you should use for a particular situation?

Complete the table below by listing the main steps in cutting an external and internal thread.

Internal thread-cutting procedure	External thread-cutting procedure

There are four things to look for when checking the quality of your work.

- You should not have done any damage to equipment or adjacent areas.
- The thread should be parallel to the axis.
- The thread should be square to the plane.
- The thread should be full in depth and shape.

Theory assessment preparation

Can you describe types of hand threading tools and their application?

Can you describe how to select taps and dies?

Can you describe the procedures and standards to cut internal and external threads?

If not, review:

TRM02:

- Module 2 – Hardware removal and restoration

Video:

- TRM02 – Repairing threads.

Complete your own internet research.

Ask someone to show you how to use these tools.

Answer section

Section 1 – Hand tools

Activity 2 answers

Tool name	Description
Hammer	A hand tool, usually with a wooden handle and two different striking faces on the head; made for delivering blows to an object.
Magnet	Often a long handle with a magnetic end used to hold or pick up ferrous items.
Screwdriver	A tool with a shaped tip that fits into the head of a screw allowing it to be turned.
Spanner	Hand tool with open or ring-shaped ends used to turn a nut or bolt.
Bar	Used to force or pry things apart.
Punch	A hardened steel shaft hit by a hammer to leave a mark, make a hole, or force something into place.
Inspection mirror	Small mirror, often with a long handle, used to help see in awkward places.
Chisel	Used with a hammer to cut through metal.
Socket set	Different sized sockets driven by a range of hand pieces to turn nuts and bolts.
Allen keys	A hexagonal shaft that fits inside a recessed hexagonal hole in a bolt or stud.
File	A long hardened steel hand tool with sharp teeth along its face used to remove material.
Riveting tool	A tool for inserting or setting rivets.
Pliers	A hand tool with pivoting jaws, usually used for holding, cutting or squeezing items.
Adjustable wrench	Spanner with an adjustable jaw used to turn nuts and bolts.
Hacksaw	A handsaw (usually with a replaceable blade) used to cut metal.
Wire brush	Hand tool with wooden or plastic handle and steel bristles used to clean a surface.
Dolly	A solid, shaped piece of metal which is held on one side of a vehicle panel while a hammer is being used on the other side of the panel.

Activity 3 answers

Equipment item	Name and use
	*Hydraulic jack – used to lift vehicles*
	*Engine hoist – used to lift and transport heavy components*
	*In-ground hoist – used to lift vehicle so technician can work underneath it*
	*Four-post hoist – used to lift vehicle so technician can work underneath it*
	*Two-post hoist – used to lift vehicle so technician can work underneath it*
	*Scissor hoist – used to lift vehicle so technician can work on it*

Section 2 – Workshop equipment

Activity 5 answers

Tool name	Use
1. Water blaster	Wash down vehicles and components
2. Baking soda	Neutralise spilt battery acid
3. Angle grinder	Grind off bolt and rivet heads
4. Ratchet, socket and parts tray	Remove and store nuts and bolts
5. Protective cover	Protect the surrounding area when working
6. Slide hammer set	Pull out and reshape bent panels
7. Clamp and vice grips	Hold items when realigning, welding or gluing
8. Grease gun	Lubricate suspension and steering joints
9. Hydraulic press	Press components together, like fitting a bearing to a housing
10. Wheel alignment equipment	Check the steering and suspension geometry
11. Workbench and vice	Hold components while they are being dismantled and assembled

Activity 6 answers

Equipment	Use
Air compressor	Gas or electric equipment used to join metals or plastics using heat.
Extractors	Straight steel bar and flat cast iron plate used to check if components are flat.
Buff	Pump used to provide air pressure to tools and equipment.
Soldering equipment	Hard copy or electronic service information used to provide technical information to the technician.
Straight edge and surface plate	Hardened steel shafts used to remove broken studs or bolts.
Welding equipment	Soldering iron and flux core solder used to join electrical wires and connectors.
Workshop manuals and service information	Electric or air tool used to turn a polishing wheel or buffing pad.

Section 3 – General engineering measuring equipment

Activity 7 answers

Job	Tool name
Measuring the size of a hole	Gap gauges or vernier callipers
Making a mounting bracket	Vernier callipers or tapes
Checking brake disks for run-out and thickness	Dial test indicators and micrometers or vernier callipers
Setting a nut to the correct tightness	Torque wrenches
Setting a tappet clearance	Feeler gauges

Section 7 – Metals

Activity 7 answers

Hardening is when metal (usually steel or cast iron) is heated to cherry red then quickly cooled. Hardening is done to increase the strength and wear properties of metals. Most HSSs have required some form of hardening, usually following by tempering. Suspension springs are one example.

Case hardening is the process of hardening the surface of a metal by infusing elements like carbon into the material's surface, forming a thin layer of a harder alloy. Used on automotive parts that are subject to high pressures and sharp impacts. Often used on gears and engine camshafts.

Tempering is a heat treatment technique for metals and alloys. It is done immediately after quench hardening. Vehicle suspension springs must be tempered after the hardening process.

Annealing is a process that produces conditions by heating and maintaining a suitable temperature, and then cooling. Used to induce softness, relieve internal stresses, refine the structure and improve cold working properties. Sheet steel used to press out exterior panels has generally been annealed.

Normalising is a form of annealing that involves heating the steel to just above its upper critical point. It is soaked for a short period, then allowed to cool in air. Normalising is used to refine grains which have been deformed through cold work, and can improve properties and toughness of the steel. Brackets and suspension parts are often made from steel that has been normalised.

Section 9 – Fastening systems

Activity 11 answers

A. Description	B. Adhesive Type	C. Uses
Packed in separate tubes, one for the resin and the other for the hardener	**Contact adhesives**	Different strengths or flexibility depending on usage, for example windscreens or panels
Can range from superglue type adhesives to polyurethane with isocyanates added	**Urethane adhesives**	Mainly used for securing moulding, badges and lettering
Solvent-borne adhesive	**Epoxy adhesives**	Used for securing upholstery or interior trim
Can be single-component type or two-component type; cover a wide range of uses and a variety of types	**Isocyanate adhesives**	Used for bonding rubbers to metal and some plastics
Some body parts are bonded using these types of adhesives and various mechanical parts are secured by the same method	**Double-sided tape**	Used for bonding panels to vehicle bodies and for bonding components requiring structural integrity
Made of neoprene foam and has an adhesive coating on both sides	**Single pack adhesives**	Used for sealing windscreens, gap sealing and bonding bumper parts
Limited shelf time, life dependant on adhesive being completely sealed from the air	**Two pack adhesives**	Used where a high-strength, chemically-cured bond is required

Prepare for your theory assessment

Now that you have worked through the learning material for all the sections, you will need to complete your theory assessment. Use the table below to check what you will be assessed on. For further preparation go back to the material and the resources listed and study this material again before starting the theory assessment.

What you have to do	Where is this covered?
Describe hand tools, their uses and the procedures for using them	Study guide: ▪ Section 1 – Hand tools
Describe the uses of the tools and equipment covered in Section 2	Study guide: ▪ Section 2 – Workshop equipment
Describe the uses for each of the measuring tools discussed in Section 3 Describe the procedures for keeping measuring instruments in a safe condition to ensure accurate use	Study guide: ▪ Section 3 – General engineering measuring tools Video: ▪ Using a torque wrench
Explain the importance of taking care of and maintaining tools and equipment according to manufacturer specifications Describe procedures to clean, lubricate, and store all common workshop tools and equipment for easy access, and without damage or loss, in accordance with manufacturer specifications and company requirements Describe the procedures to keep workshop hand tools maintained in a safe working condition in accordance with manufacturer specifications and company requirements	Study guide: ▪ Section 4 – Maintenance Workplace learning
Describe the safety procedures for using and maintaining common tools (checking prior to use, during use, personal safety, safety of others, vehicle safety, no damage to tools and equipment) Identify the relevant safety precautions for the following power and air supply equipment: transformers, isolating switches, compressed air, air line and systems	Study guide: ▪ Section 5 – Using tools safely Workshop safety (previous training package) REF01: Module 2 – Compressed air WKR01: Module 5 – Repair facility safety Workplace learning

What you have to do	Where is this covered?
Describe the following tools and equipment and their uses: drills, grinders, polishers, sanders, screw-drivers, wrenches, and sockets Identify the following attachment tools in use in your workplace: sanding disks, abrasive papers, polishing attachments, wire brushes, abrasive finishing attachments, cleaning attachments, buffing disks, fibre and nylon disks, drills, glass cutters and saw attachments Describe the purpose of using power tools and their operation	Study guide: ▪ Section 6 – Power tools Workplace learning
Explain the common uses of and reasons for using ferrous metals Explain the common uses of and reasons for using non-ferrous metals Describe the purpose, process, and automotive application of heat treatment on metals	Study guide: ▪ Section 7 – Metals STS01: ▪ Module 1 – Damage analysis – Steel characteristics Web references: ▪ www.wikipedia.org ▪ www.efunda.com
Identify the uses of plastic or composite material on a vehicle	PLA03: ▪ Module 1 – Plastic identification and repair considerations Study guide: ▪ Section 8 – Plastics
Describe the purpose of fastening systems Describe the principles of how fastening systems work Identify thread types (including metric, UNF and UNC) Describe the different types of adhesives and their uses Describe plastic fastening systems and their uses	Study guide: ▪ Section 9 – Fastening systems TRM02: ▪ Module 1 – Hardware Videos: ▪ Using thread pitch and measuring gauges ▪ Using a torque wrench

What you have to do	Where is this covered?
Describe methods of securing components Describe the method of using torque fasteners and explain their importance Identify the different types of automotive fasteners Describe how locking devices are used to retain components (that is, mechanical and chemical) Describe different locking devices and their uses (including locking washers, clips, pins, lock wire, chemical and lock nuts) Describe pop rivets and their uses	Study guide: ▪ Section 9 – Fastening systems TRM02: ▪ Module 1 – Hardware
Describe the range and applications of drilling equipment (including hand drill, drill press, cutting fluid and handheld power drill) Identify twist drills and describe how to sharpen them	Study guide: ▪ Section 10 – Drilling
Explain how to select twist drills Describe the procedures and standards for drilling holes in determined positions Explain safety procedures when using drilling equipment	Study guide: ▪ Section 10 – Drilling Internet research Workplace learning
Describe types of hand threading tools and their application Describe how to select taps and dies Describe the procedures and standards to cut internal and external threads	Study guide: ▪ Section 11 – Threading TRM02: ▪ Module 2 – Hardware removal and restoration Video: ▪ Repairing threads

Notes

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