



SECOND EDITION

AUTOMOTIVE TECHNICIAN TRAINING

THEORY



INSTITUTE OF THE
MOTOR INDUSTRY

TOM DENTON • HAYLEY PELLIS

ROUTLEDGE



Automotive Technician Training: Theory

Automotive Technician Training is the definitive student textbook for automotive engineering. It covers all the theory and technology sections that students need to learn in order to pass levels 1, 2 and 3 automotive courses. It is recommended by the Institute of the Motor Industry and is ideal for courses and exams run by other awarding bodies. This revised edition overhauls the coverage of general skills and advanced diagnostic techniques. It also includes a new chapter about electric and hybrid vehicles and advanced driver-assistance systems, along with new online learning activities.

Unlike current textbooks on the market, this takes a blended-learning approach, using interactive features that make learning more enjoyable and effective. It is ideal to use on its own but when linked with IMI eLearning online resources, it provides a comprehensive package that includes activities, video footage, assessments and further reading. Information and activities are set out in sequence to meet teacher and learner needs, as well as qualification requirements.

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Second Edition

Tom Denton and Hayley Pells

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Preface

This second edition of *Automotive Technician Training* (ATT) is aimed at students who are taking a course in automotive technology or are interested in learning for themselves about this fascinating industry. Like the previous edition it is an ideal companion to the IMI eLearning but we have also included more activities and the book now works as a standalone package too.

I am delighted to be partnering on this book with my friend and colleague Hayley Pells, a multi award winning owner of a highly respected service and repair business, Avia Autos, in Bridgend, South Wales.

Comments, suggestions and feedback are always welcome at my website: www.tomdenton.org. On this site, you will also find lots of **free** online resources to help with your studies. Several other books are available too:

- ▶ *Automobile Mechanical and Electrical Systems*
- ▶ *Automobile Electrical and Electronic Systems*
- ▶ *Advanced Automotive Fault Diagnosis*
- ▶ *Electric and Hybrid Vehicles*
- ▶ *Alternative Fuel Vehicles*
- ▶ *Automated Driving and Driver Assistance Systems*

We never stop learning, so I hope you find automotive technology as interesting as I still do.

It is a privilege to work with my friend and inspiration Tom Denton, a highly respected technical author and experienced automotive engineer. Working within the automotive industry has proved to me how the skills learned at the beginning of a career can be transferred to numerous aspects of work and personal life.

I run my own workshop which you can see at <https://aviaautos.com>. Here we communicate with our motorists as well as our business clients; we also offer insight and information about our environment and how we continue to learn and engage with further education as a team.

I wish you every success with your journey, and hope this learning enables you to increase your opportunity to enjoy our sector.



Tom



Hayley

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Over the years many people have helped in the production of my books. I am therefore very grateful to the following companies who provided information and/or permission to reproduce photographs and/or diagrams:

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Honda	Porsche	

If I have used any information, or mentioned a company name that is not listed here, please accept my apologies and let me know so it can be rectified as soon as possible.

How to use this book



After successful completion of this chapter you will be able to show you have achieved these outcomes:

- Understand the various icons and symbols and structure used in this book and online
- Understand how to use the learning activities and other features

1.1 Introduction 1

1.1.1 Start here E 1

Introduction The associated IMI eLearning is recommended and can be used in conjunction with this book:



<https://elearning.theimi.org.uk>

However, it is not essential and the book is also a great standalone learning package. There are also some additional support materials here:



<https://www.tomdenton.org>

Qualification levels This book contains all the theory/technology content for automotive study at levels 1, 2 and 3. The materials are presented as chapters, subjects and then sections. Each section (lesson) is marked as follows:

- E** – study only these sections if working on an Entry level qualification
- 1** – study only these sections if working on a level 1 qualification
- 2** – study these sections and those marked level 1 (unless done previously) if working on a level 2 qualification
- 3** – study these sections and those marked level 1 and level 2 (unless done previously) if working on a level 3 qualification
- 123** – if a section is marked with more than one number, then study the level you are working on in detail and skim read the higher level

Title Most of the paragraphs of text in this book with start with a title in bold as shown here! This is the title that you will see on the associated eLearning screen if you are using it. All the activities in this book can be carried out using features on the interactive website. Paper and pencils will work too in most cases so you can still work if you don't have internet access.



When you see this icon, it means that the associated image, video or sound is available in the eLearning or other online sources. You should refer to this to, for example, add labels or complete the diagrams as necessary.

Learning activities are included for each section (lesson). The answers to these activities can be written directly in the book, on a separate notebook or, perhaps even better, as a document or in an electronic notebook. An overview of each activity is outlined below.

Activity sheets are available that match the learning activities, together with some real-world examples. These really help with the learning process and guide you through the activities. Access them and the interactive tools here:



<https://www.tomdenton.org>

Note: The activities suggested after each section are recommended but you can choose different ones. Remember, the more you do the more you will learn.

1.1.2 Learning activities E 1

Information search Looking in other textbooks or in a library is an effective way to see the subject explained differently. Perhaps even better is to use the online search options on the interactive site



Use a library or the web search tools to further examine the subject in this section

Media search Searching online for images, animations and videos is an excellent way to see other ways of how something works.



Use the media search tools to look for pictures and videos relating to the subject in this section

Bullets Three great tools for keeping notes electronically are Evernote, Microsoft OneNote and Google docs. My

favourite currently is OneNote but I find all these tools easy to work with and they can be used online or offline, they also sync to or from a smartphone. Using any word processor is fine – as is using a pen!



Look back over the previous section and write out a list of the key bullet points from this section

Sketch Making a simple sketch to help you remember how a component or system works is a good way to learn. You can use a pencil or the online features or any drawing program – even word processors have quite good drawing tools built in.



Make a simple sketch to show how one of the main components or systems in this section operates

Word cloud A word cloud shows the most common words in a block of text in a larger font. It is a wonderful way to focus in on the important aspects of a learning screen or paragraph of text. There are a few different options available on the interactive site.



Create a word cloud for one or more of the most important screens or blocks of text in this section

Word puzzles Crossword and wordsearch puzzles are an effective way to learn new important words and the associated technologies. A good method is to work in pairs so you each create a puzzle and then swap and try to complete the answers. Hint: Use the eLearning glossary where you can copy the words and definitions (clues!). About 20 words is a good puzzle. Or construct a wordsearch grid using some key words from this section. About 10 words in a 12x12 grid is ideal. Use the online interactive tools for this activity.



Construct a crossword or wordsearch puzzle using important words from this section

Mind map A mind map can be created with pen and paper or on the whiteboard. There are also some great online tools to do this.



Create a mind map to illustrate the features of a key component or system

Information wall An information wall can be created with pen and paper or on the whiteboard. There are also some great online tools to do this. Alternatively, a flip chart or post-it notes on the wall work well.



Create an information wall to illustrate the features of a key component or system

Presentation Preparing and making a presentation to your classmates or workmates is a terrific way to learn about something new because you must study it in detail first. It can be a bit nerve-racking at first but is also good fun so don't worry. There are some great online tools for this or you can use PowerPoint (or similar) to prepare some slides you then explain in more detail.



Using images and text, create a short presentation to show how a component or system works

1.1.3 Visible thinking

Introduction Visible thinking is a method of teaching that encourages learning through observation. It is a way to encourage students to use thinking skills they have already developed outside the classroom. The routines help to promote a deeper understanding of how we think and allow for better learning. Several different routines are highlighted below and these are suggested in various places throughout the book. Teachers can help guide students but it is equally possible for a learner to use the routines directly. The routines outlined below are described as if used by a teacher.



Select a routine from section 1.13 and follow the process to study a component or system

Think-pair-share The think-pair-share routine involves posing a question to learners, asking them to take a few minutes of thinking time. After this they share their thoughts with a partner. It can be used when solving a problem, before a repair routine is started or after reading a section in this book. After discussing as a pair they then share with the whole class.

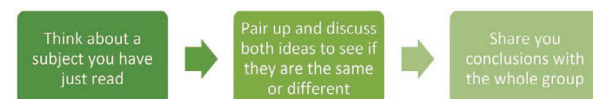


Figure 1.1 Think-pair-share

1 How to use this book

Compass points This routine works well to explore various sides and viewpoints of a proposition or idea prior to taking a stand or expressing an opinion on it. For example, a new idea about a subject can be proposed; a new type of EV battery for instance. The learners can then put their thoughts into four compass-point categories. You can use a whiteboard, flipchart, post-it notes or an electronic equivalent. Whatever works and whatever you have to hand is fine.

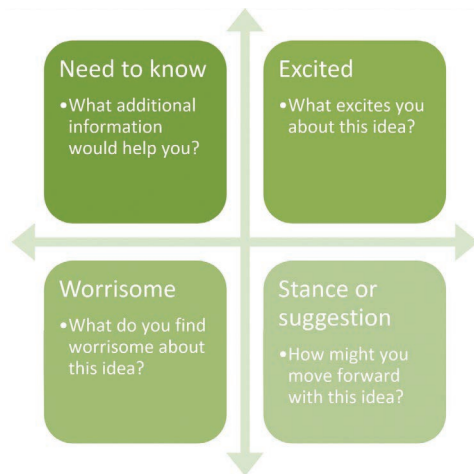


Figure 1.2 Compass points

What makes you say that? This thinking routine asks learners to describe something such as a component or how a system works, and then support their interpretation with evidence. It can be adapted for use with almost any subject and is useful for gathering information on students' general concepts when introducing a new topic.



Figure 1.3 What makes you say that?

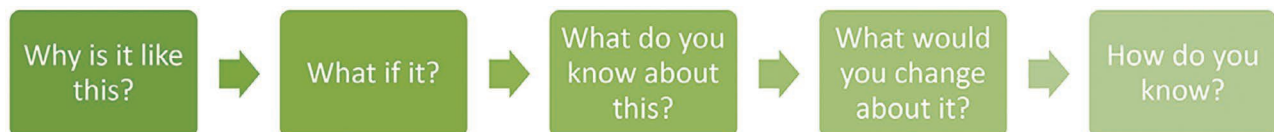


Figure 1.6 Question starts

3-2-1 bridge This routine is used to record initial thoughts, ideas, questions and understandings about a given topic. After reading an article or watching a video, students are then asked to rethink their initial

I used to think but now I think This routine captures a change of opinion or perspective from what a student used to think to what they now think. It enables students to reflect on their learning, be willing to consider different ideas and to be able to acknowledge when their opinion has changed. It gives students the opportunity to reflect on why their thinking may have changed.



Figure 1.4 I used to think but now I think

I noticed this, but why? This is good for thinking further about something you have been examining in the workshop. For example, you may notice the wires connecting a starter motor are much thicker than those connected to the lights. Ask yourself why? It is also a good way to understand how a component works.



Figure 1.5 I noticed this, but why?

Question starts This is a graphic information organiser with spaces for questions which begin: why, what, how or similar. It is a visual guide to help students dig deeper into a question or topic and reach a better understanding.

opinions after learning more about the topic. The idea is for bridges to be built between ideas when new information is obtained.



Figure 1.7 3-2-1 bridge

Think-puzzle-explore This routine works well at the start of a new topic taking what students already know while opening up new areas of interest. What does a student think about the topic? What puzzles them or what unresolved questions are in their minds? What and how can they explore more about the topic?



Figure 1.8 Think-puzzle-explore

Connect-extend-challenge The connect-extend-challenge routine helps students make connections between new and previous knowledge. It then acts as a guide as to how to further develop their interest. Recording students' ideas and using them at a later time can also be useful for reflecting on their understanding.

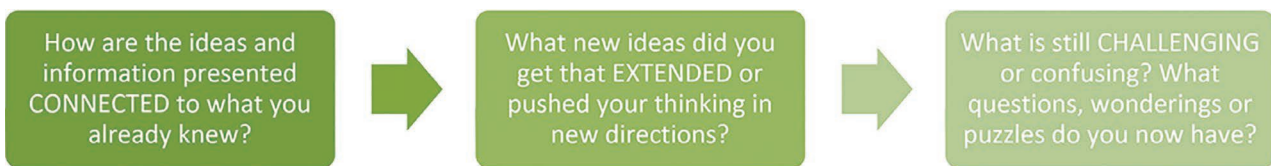


Figure 1.9 Connect-extend-challenge

1.2 Summary

In this chapter we have looked at some of the key features of this book that make learning more effective as well as more fun. There are lots of

different learning activities to try out. Good luck with your studies and I hope you find this book useful.

Remember, get involved in your learning and interact, you will learn much more!

Remember, this book is designed to be used with other resources such as IMI eLearning. For this reason you will find some images do not have all the parts named or an image may be mentioned in the text that is not in the book. This is intentional and you should research the answers and add details in the textbook or in your notes – it is a good way to learn. There is more support on the website that includes additional images and interactive features: www.tomdenton.org

Working safely



After successful completion of this chapter you will be able to show you have achieved these objectives:

- Understand the correct personal and vehicle protective equipment to be used within the automotive environment.
- Understand effective housekeeping practices in the automotive environment.
- Understand key health and safety requirements relevant to the automotive environment.
- Understand about hazards and potential risks relevant to the automotive environment.
- Understand personal responsibilities.

2.1 Personal and vehicle protection

2.1.1 Personal protective equipment ①

Personal protective equipment (PPE) such as safety clothing, is very important to protect yourself. Some people think it is clever or tough not to use protection. They are very sad and will die or be injured long before you! Some things are obvious such as when holding a hot or sharp exhaust you would likely be burnt or cut, others such as breathing in brake dust or working in a noisy area do not produce immediately noticeable effects but could affect you later in life. Fortunately the risks to workers are now quite well understood and we can protect ourselves before it is too late.



Figure 2.1 Eye protection and gloves in use



Figure 2.2 Protective clothing for spot welding

PPE In the following table, we have listed a number of items classed as PPE (Personal Protective Equipment) together with suggested uses. You will see that the use of most items is plain common sense.

Equipment	Notes	Suggested usage or examples of where used
Ear defenders	Must meet appropriate standards	When working in noisy areas or using an air chisel
Face mask	For individual personal use only	Dusty conditions. When cleaning brakes or if preparing bodywork
High visibility clothing	Fluorescent colours such as yellow or orange	Working in traffic such as when on a breakdown
Leather apron	Should be replaced if it is holed or worn thin	When welding or working with very hot items
Leather gloves	Should be replaced when they become holed or worn thin	When welding or working with very hot items and also if handling sharp metalwork
Life jacket	Must meet current standards	Use when attending vehicle breakdowns on ferries!
Overalls	Should be kept clean and be flameproof if used for welding	These should be worn at all times to protect your clothes and skin. If you get too hot just wear shorts and a T-shirt underneath
Rubber or plastic apron	Replace if holed	Use if you do a lot of work with battery acid or with strong solvents
Rubber or plastic gloves	Replace if holed	Gloves must always be used when using degreasing equipment
Safety shoes or boots	Strong toecaps are recommended	Working in any workshop with heavy equipment
Safety goggles	Keep the lenses clean and prevent scratches	Always use goggles when grinding or when any risk of eye contamination. Cheap plastic goggles are much easier to come by than new eyes
Safety helmet	Must meet current standards	Under-vehicle work in some cases
Welding goggles or welding mask	Check the goggles are suitable for the type of welding. Gas welding goggles are NOT good enough when arc welding	You should wear welding goggles or use a mask even if you are only assisting by holding something



Create an information wall to illustrate the features of a key component or system

2 Working safely

2.1.2 Vehicle safety 1

Vehicle safety and the associated regulations can be very complicated. However, for our purposes we can consider the issue across two main areas:

1. Construction of the vehicle

Before a vehicle can be constructed, a prototype has to be submitted for type approval. When awarded, this means the vehicle has passed very stringent tests and that it meets all current safety requirements. Different countries have different systems, which means some modifications to a car may be necessary if it is imported or exported. The European Union (EU) has published many 'directives' which each member country must incorporate into its own legislation. This has helped to standardise many aspects. In the UK the 'Road Vehicles (Construction & Use) Regulations 1986', is the act which ensures certain standards are met. If you become involved in modifying a vehicle, e.g. for import, you may need to refer to the details of this act. Other countries have similar legislation.

Many other laws exist relating to the motor vehicle and the environment – these are about emissions and pollution. Environmental laws change quite often and it will be important to keep up to date.

The Department of Transport states that all vehicles over three years old must undergo a safety check which ensures the vehicle continues to meet the current legislation. First set up by the Ministry of Transport, it continues to be known as the MOT test. This test now includes checks relating to environmental laws.



Create a word cloud for one or more of the most important screens or blocks of text in this section

2. Driving and operating the vehicle

To drive a vehicle on the road you must have an appropriate driving licence, insurance, the vehicle must be taxed and it must be in safe working order.

2.1.3 Moving loads 1

Injuries in a workshop are often due to incorrect lifting or moving of heavy loads. In motor vehicle workshops, heavy and large components, like engines and gearboxes, can cause injury when being removed and refitted.



Figure 2.3 Heavy load – correct lifting method

A few simple precautions will prevent you from injuring yourself, or others:

- ▶ never try to lift anything beyond your capability – get a mate to help. The amount you can safely lift will vary but for any more than you feel comfortable with, you should get help.
- ▶ whenever possible use an engine hoist, a transmission jack or a trolley jack.
- ▶ lift correctly, using the legs and keeping your back straight.
- ▶ when moving heavy loads on a trolley, get help and position yourself so you will not be run over if you lose control.

The ideal option in all cases is simply to avoid manual handling where possible.



Figure 2.4 Engine crane (Source: Blue-Point)



Use the media search tools to look for pictures and videos relating to the subject in this section

2.2 Housekeeping

2.2.1 Working environment 1

There are three main reasons for keeping your workshop and equipment clean and tidy:

- 1 It makes it a safer place to work.
- 2 It makes it a better place to work.
- 3 It gives a better image to your customers.

Servicing and fixing motor vehicles is in some cases a dirty job. But if you clean up after any dirty job then you will find your workshop a much more pleasant place to work.

- ▶ The workshop and floor should be uncluttered and clean to prevent accidents and fires as well as maintaining the general appearance.
- ▶ Your workspace reflects your ability as a technician. A tidy workspace equals a tidy mind equals a tidy job, which equals a tidy wage when you are qualified.
- ▶ Hand tools should be kept clean as you are working. You will pay a lot of money for your tools; look after them and they will look after you in the long term.
- ▶ Large equipment should only be cleaned by a trained person or a person under supervision. Obvious

Material	Purpose	Notes
Detergent	Mixed with water for washing vehicles, etc. Also used in steam cleaners for engine washing, etc.	Some industrial detergents are very strong and should not be allowed in contact with your skin.
Solvents	To wash away and dissolve grease and oil, etc. The best example is the liquid in the degreaser or parts washer which all workshops will have.	NEVER use solvents such as thinners or fuel because they are highly flammable. Suitable PPE should be used, for example gloves, etc. They may attack your skin. Many are flammable. The vapour given off can be dangerous. Serious problems if splashed into eyes. Read the label.
Absorbent granules	To mop up oil and other types of spills. They soak up the spillage after a short time and can then be swept up.	Most granules are a chalk or clay type material which has been dried out.

precautions are to ensure equipment cannot be operated while you are working on it and only use appropriate cleaning methods. For example, would you use a bucket of water or a brush to clean down an electric pillar drill? I hope you answered 'the brush'!

In motor vehicle workshops, many different cleaning operations are carried out. This means a number of different materials are required. It is not possible to mention every brand name here so I have split the materials into three different types. It is important to note that the manufacturer's instructions printed on the container must be followed at all times.



Look back over the previous section and write out a list of the key bullet points from this section

2.2.2 Equipment maintenance 1

The cleaning and maintenance of equipment plays a big part in good housekeeping. This includes large equipment such as ramps, hoists, etc. to small hand tools. Always remember that no one should clean, maintain or use large equipment unless they have had sufficient training or are working under the supervision of an experienced and qualified person.



Figure 2.5 Hand tools

Hand tools are expensive so do look after them and in the long term they will look after you. Technicians need to learn and be aware of the following points regarding equipment:

- ▶ select and use equipment for basic hand tool maintenance activities
- ▶ storing hand tools safely and accessibly
- ▶ how to report faulty or damaged work tools and equipment
- ▶ safety when cleaning and maintaining work tools and equipment.

2 Working safely

It is important to store hand tools safely. Any hand tool left lying around can be a potential hazard to the unsuspecting person or could cause damage to a customer's vehicle. Always make sure that hand tools are stored correctly in either a tool box or in the designated place. If you think that you are probably going to need a particular tool in due course, and don't want to put it back, then be aware of where you place it. Obviously you will want it handy but at the same time you need to think of safety.

Safety also applies to the tool you are using. Don't put it down in a place where it can be damaged. Wherever you store or place a hand tool, think of the following points:

- ▶ safety of yourself and others
- ▶ protection of the customer's vehicle
- ▶ protection of other tools and workshop equipment
- ▶ protection of the tool itself.

From time to time tools and equipment will develop faults or get damaged, however careful you are with them. If you find any damage to equipment it is your duty as a technician to report it or see if it has already been reported.



Figure 2.6 Taking care

Don't leave it to someone else or assume that it must have been spotted by one of your colleagues. It is quite likely that it hasn't.

Does your workshop have a procedure for reporting faulty equipment? Does it need to be written on a report form for instance? Who is the appropriate person to report this fault to? Your supervisor or perhaps another member of staff? Whoever and however, it needs to be done quickly. Delay could possibly make the fault worse but, more importantly, if it needs to be used then work will

be held up. Would this fault be a potential safety issue? This is obviously a very important point to consider. Report it immediately so the problem can be fixed.

In the previous section I mentioned the importance of working safely when cleaning or maintaining equipment. It is important to remember that you must never clean or maintain equipment without adequate training or supervision from a qualified and competent person. Even if you are asked, politely say 'no' and explain why. It is quite likely that the person who asked you to do the task is unaware that you do not have the relevant experience.



Create a mind map to illustrate the features of a key component or system

2.3 Health and safety

2.3.1 Introduction 1

Health and safety law is designed to protect you. In the UK the health and safety executive (HSE) is the enforcement and legislative body set up by the government. The HSE has a very helpful website where you can get all the latest information – including a document specially developed for the motor industry. The address is: www.hse.gov.uk



Figure 2.7 UK HSE logo

Health and Safety Executive (HSE) The HSE's emphasis is on preventing death, injury and ill health in Great Britain's workplaces. However, they do have the authority to come down hard on people who put others at risk, particularly where there is deliberate flouting of the law. Since 2009, HSE has published new versions of its approved health and safety poster and leaflet. The new versions are modern, eye-catching and easy to read. They set out in simple terms, using numbered lists of basic points, what employers and workers must do and tell you what to do if there is a problem.

Employers must ensure that they are displaying the latest versions of the posters. When updates are issued then there is usually a period of time where use of older materials is allowed but it is essential that employers check this.

Employers have a legal duty under the Health and Safety Information for Employees Regulations (HSIER) to display the poster in a prominent position in each workplace or provide each worker with a copy of the equivalent leaflet outlining British health and safety laws.

Employers must meet certain criteria **but** health and safety is the responsibility of **everyone** in the workplace. The reason for the poster and the leaflets is to make everybody aware of this.



Use a library or the web search tools to further examine the subject in this section

Health and Safety Law
What you need to know

All workers have a right to work in places where risks to their health and safety are properly controlled. Health and safety is about stopping you getting hurt at work or ill through work. Your employer is responsible for health and safety, but you must help.

What employers must do for you

- 1 Decide what could harm you in your job and the precautions to stop it. This is part of risk assessment.
- 2 In a way you can understand, explain how risks will be controlled and tell you who is responsible for this.
- 3 Consult and work with you and your health and safety representatives in protecting everyone from harm in the workplace.
- 4 Free of charge, give you the health and safety training you need to do your job.
- 5 Free of charge, provide you with any equipment and protective clothing you need, and ensure it is properly looked after.

What you must do

- 6 Provide ticks, washing facilities and drinking water.
- 7 Provide adequate first aid facilities.
- 8 Report injuries, diseases and dangerous incidents at work to our Incident Contact Centre: 0845 300 9923
- 9 Hire insurance that covers you in case you get hurt at work or ill through work. Display a hard copy or electronic copy of the current insurance certificate where you can easily read it.
- 10 Work with any other employers or contractors sharing the workplace or providing employees (such as agency workers), so that everyone's health and safety is protected.

If there's a problem

- 1 If you are worried about health and safety in your workplace, talk to your employer, supervisor or health and safety representative.
- 2 You can also look at our website for general information about health and safety at work.
- 3 If, after talking with your employer, you are still worried, phone our helpline. We can put you in touch with the local enforcing authority for health and safety, and the Employment Medical Advisory Service. You don't have to give your name.

HSE helpline:
0845 345 0055
HSE website:
www.hse.gov.uk

Fire safety
You can get advice on fire safety from the Fire and Rescue Services or your workplace fire officer.

Employment rights
Find out more about your employment rights at:
www.direct.gov.uk

Your health and safety representative
Other health and safety contacts

HSE
Health and Safety Executive

Figure 2.8 Health and Safety Law poster (Source: HSE)

2.3.2 Regulations and laws 1

There are a number of rules and regulations you need to be aware of. Always check the details for the country in which you work. The following table lists some important areas for the UK.

Title	Rules and regulations
HSE	The Health and Safety Executive is the national independent watchdog for work-related health, safety and illness in the UK. They are an independent regulator and act in the public interest to reduce work-related death and serious injury across Great Britain's workplaces. Other countries have similar organisations.
HASAW	The Health and Safety at Work Act 1974, also referred to as HASAW, HASAWA or HSW, is the primary piece of legislation covering occupational health and safety in the United Kingdom. The Health and Safety Executive is responsible for enforcing the Act and a number of other Acts and Statutory Instruments relevant to the working environment.
COSHH	Control of Substances Hazardous to Health is the law that requires employers to control substances that are hazardous to health such as solvents.
RIDDOR	The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR), place a legal duty on employers, self-employed people and people in control of premises to report work-related deaths, major injuries or over-three-day injuries, work-related diseases, and dangerous occurrences (near-miss accidents).
Provision and Use of Work Equipment Regulations 1998 (PUWER)	In general terms, PUWER requires that equipment provided for use at work is: - suitable for the intended use; - safe for use, maintained in a safe condition and, in certain circumstances, inspected to ensure this remains the case; - used only by people who have received adequate information, instruction and training; and accompanied by suitable safety measures, e.g. protective devices, markings, warnings.
Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)	In general, LOLER requires that any lifting equipment used at work for lifting or lowering loads is: - strong and stable enough for particular use and marked to indicate safe working loads; - positioned and installed to minimise any risks; - used safely, i.e. the work is planned, organised and performed by competent people; and - subject to ongoing thorough examination and, where appropriate, inspection by competent people.
Health and safety audit	Monitoring provides the information to let you or your employer review activities and decide how to improve performance. Audits, by company staff or outsiders, complement monitoring activities by looking to see if your company policy, organisation and systems are actually achieving the right results.

Title	Rules and regulations
Risk management and assessment	A risk assessment is simply a careful examination of what, in your work, could cause harm to people. This is done so that you and your company can decide if you have taken enough precautions or should do more to prevent harm. Workers and others have a right to be protected from harm caused by a failure to take reasonable control measures. It is a legal requirement to assess the risks in the workplace so you or your employer must put plans in place to control risks. How to assess the risks in your workplace: - Identify the hazards - Decide who might be harmed and how - Evaluate the risks and decide on precautions - Record your findings and implement them - Review your assessment and update if necessary.
PPE	Personal protective equipment (PPE) is defined in the Regulations as 'all equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work and which protects them against one or more risks to their health or safety', e.g. safety helmets, gloves, eye protection, high-visibility clothing, safety footwear and safety harnesses. Hearing protection and respiratory protective equipment provided for most work situations are not covered by these Regulations because other regulations apply to them. However, these items need to be compatible with any other PPE provided.



Create an information wall to illustrate the features of a key component or system

2.3.3 Health and Safety law 1

All workers have a right to work in places where risks to their health and safety are properly controlled. Health and safety is about stopping you getting hurt at work or ill through work. Your employer is responsible for health and safety, but you must help. This section is taken from the HSE leaflet for employees.

What employers must do for you:

- 1 Decide what could harm you in your job and the precautions to stop it. This is part of risk assessment.
- 2 In a way you can understand, explain how risks will be controlled and tell you who is responsible for this.
- 3 Consult and work with you and your health and safety representatives in protecting everyone from harm in the workplace.

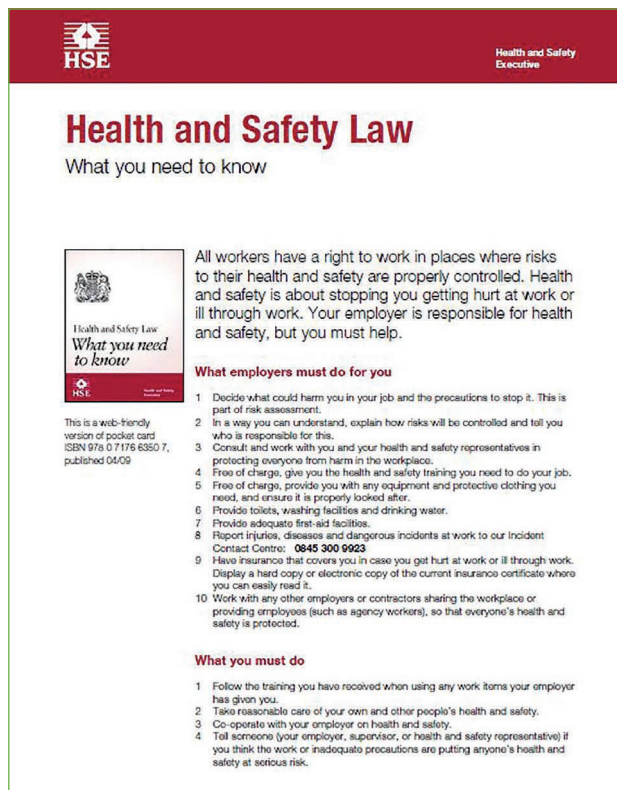


Figure 2.9 Health and Safety Law leaflet (Source: HSE)

- 4 Free of charge, give you the health and safety training you need to do your job.
- 5 Free of charge, provide you with any equipment and protective clothing you need, and ensure it is properly looked after.
- 6 Provide toilets, washing facilities and drinking water.
- 7 Provide adequate first-aid facilities.
- 8 Report injuries, diseases and dangerous incidents at work
- 9 Have insurance that covers you in case you get hurt at work or ill through work. Display a hard copy or electronic copy of the current insurance certificate where you can easily read it.
- 10 Work with any other employers or contractors sharing the workplace or providing employees (such as agency workers) so that everyone's health and safety is protected.

What you must do:

- 1 Follow the training you have received when using any work items your employer has given you.
- 2 Take reasonable care of your own and other people's health and safety.
- 3 Co-operate with your employer on health and safety.
- 4 Tell someone (your employer, supervisor, or health and safety representative) if you think the work or inadequate precautions are putting anyone's health and safety at serious risk.



Figure 2.10 Exhaust extraction is an easy precaution to take



Select a routine from section 1.3 and follow the process to study a component or system

2.4 Hazards and risks

2.4.1 Hazards 1

Working in a motor vehicle workshop is a dangerous occupation – if you do not take care. The most important thing is to be aware of the hazards and then it is easy to avoid the danger. The hazards in a workshop are from two particular sources:

From you, such as caused by:

- ▶ carelessness – particularly whilst moving vehicles
- ▶ drinking or taking drugs – these badly affect your ability to react to dangerous situations
- ▶ tiredness or sickness – these will affect your abilities to think and work safely
- ▶ messing about – most accidents are caused by people fooling about
- ▶ not using safety equipment – you have a duty to yourself and others to use safety equipment
- ▶ inexperience – or lack of supervision. If in doubt – ask!

The surroundings in which you work may have:

- ▶ bad ventilation
- ▶ poor lighting
- ▶ noise
- ▶ dangerous substances stored incorrectly
- ▶ broken or worn tools and equipment

- ▶ faulty machinery
- ▶ slippery floors
- ▶ untidy benches and floors
- ▶ unguarded machinery
- ▶ unguarded pits.

The following table lists some of the hazards you will come across in a vehicle workshop. Also listed are some associated risks, together with ways we can reduce them. This is called risk management.

Hazard	Risk	Action
Power tools	Damage to the vehicle or personal injury	Understand how to use the equipment and wear suitable protective clothing, for example gloves and goggles
Working under a car on the ramp	1. The vehicle could roll or be driven off the end 2. You can bang your head on hard or sharp objects when working under the car	1. Ensure you use wheel chocks 2. Set the ramp at the best working height, wear protection if appropriate
Working under a car on a jack	The vehicle could fall on top of you	The correct axle stands should be used and positioned in a secure place
Compressed air	Damage to sensitive organs such as ears or eyes. Death, if air is forced through the skin into your blood stream	Do not fool around with compressed air. A safety nozzle prevents excessive air forces
Dirty hands and skin	Oil, fuel and other contaminants can cause serious health problems. This can range from dermatitis to skin cancer	Use gloves or a good-quality barrier cream and wash your hands regularly. Do not allow dirt to transfer to other parts of your body. Good overalls should be worn at all times
Exhaust fumes	Poisonous gases such as carbon monoxide can kill. Other gases can cause cancer or, at best, restrict breathing and cause sore throats	Only allow running engines in very well ventilated areas or use an exhaust extraction system
Engine crane	Injury or damage can be caused if the engine swings and falls off	Ensure the crane is strong enough (do not exceed its safe working load – SWL). Secure the engine with good-quality sling straps and keep the engine near to the floor when moving across the workshop

2 Working safely

Hazard	Risk	Action
Cleaning brakes	Brake dust (especially older types made of asbestos) is dangerous to health	Only wash clean with proper brake cleaner
Fuel	Fire or explosion	Keep all fuels away from sources of ignition. Do not smoke when working on a vehicle
Degreaser solvent	Damage to skin or damage to sensitive components	Wear proper gloves and make sure the solvent will not affect the items you are washing
Spillage such as oil	Easy to slip over or fall and be injured	Clean up spills as they happen and use absorbent granules
Battery electrolyte (acid)	Dangerous on your skin and, in particular, your eyes. It will also rot your clothes	Wear protective clothing and take extreme care
Welding a vehicle	The obvious risks are burns, fire and heat damage, but electric welders, such as a MIG welder, can damage sensitive electronic systems	Have fire extinguishers handy, remove combustible materials such as carpets and ensure fuel pipes are nowhere near. The battery earth lead must also be disconnected. Wear gloves and suitable protective clothing such as a leather jacket
Electric hand tools	The same risk as power tools but also the danger of electric shocks, particularly in damp or wet conditions. This can be fatal	Do not use electric tools when damp or wet. Electrical equipment should be inspected regularly by a competent person
Driving over a pit	Driving into the pit	The pit should be covered or have another person help guide you, and drive very slowly
Broken tools	Personal injury or damage to the car. For example, a file without a handle can stab into your wrist. A faulty ratchet could slip	All tools should be kept in good order at all times. This will also make the work easier
Cleaning fluids	Skin damage or eye damage	Wear gloves and eye protection and also be aware of exactly what precautions are needed by referring to the safety data information



Look back over the previous section and write out a list of the key bullet points from this section



SAFETY DATA SHEET ENGINE AND MACHINE CLEANER

Page 1
Issued: 10/07/09
Revision No: 7

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY / UNDERTAKING

Product name: ENGINE AND MACHINE CLEANER
Product code: EMC/1261/040609
Company name: AUTOGLYM
Works Road
Letchworth
Herts
SG6 1LU
UK
Tel: +44 (0) 1462 677766
Fax: +44 (0) 1462 677712
Emergency tel: +44 (0) 1462 489498
Email: sds@autoglym.co.uk

2. HAZARDS IDENTIFICATION

Main hazards: No significant hazard

3. COMPOSITION / INFORMATION ON INGREDIENTS

Hazardous ingredients: DISODIUM METASILICATE 1-10%
EINECS: 229-912-0 CAS: 6834-92-0
[C] R34; [X] R37
• GLYCERINE 1-10%
EINECS: 200-289-5 CAS: 56-81-5
• C9-11 ALCOHOL ETHOXYLATE 1-10%
CAS: 68439-45-2
[Xn] R22; [X] R41
• TETRASODIUM N-N-BIS(CARBOXYLATEMETHYL)-L-GLUTAMATE 1-10%
EINECS: 257-573-7 CAS: 51981-21-6
[X] R36/38

4. FIRST AID MEASURES (SYMPTOMS)

Skin contact: There may be mild irritation at the site of contact.
Eye contact: There may be irritation and redness.
Ingestion: There may be irritation of the throat.
Inhalation: No symptoms.

4. FIRST AID MEASURES (ACTION)

Skin contact: Wash immediately with plenty of soap and water.
Eye contact: Rinse the eye with running water for 15 minutes.

Figure 2.11 Example of a safety data sheet (Source: AutoGlym)

2.4.2 High voltage vehicles 1

Introduction This section covers some risks when working with electricity or electrical systems, together with suggestions for reducing them. This is known as risk assessment. The diagnostic process is no different but avoid working on high voltage vehicles unless you are trained and have specialist equipment – stay safe.

Voltages Electric vehicles (pure or hybrid) use high voltage batteries so that energy can be delivered to a drive motor or returned to a battery pack in a very short time. Voltages of 400V are now common and some are up to 700V so clearly there are electrical safety issues when working with these vehicles. High Voltage means the classification of an electric component or circuit if its working voltage is $>60V$ and $\leq 1500V$ DC or $>30V$ and $\leq 1000V$ AC root mean square (rms). High voltages can also be present on vehicles without high voltage batteries such as headlamps that use ballast resistors for example.

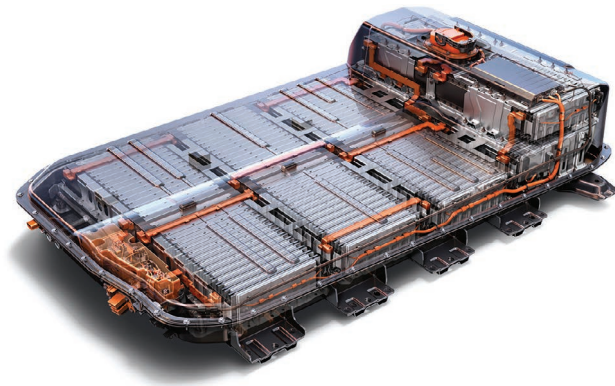


Figure 2.12 High voltage (HV) battery pack (Source: Chevrolet Media)

Components EV batteries and motors have high electrical and magnetic potential that can severely injure or kill if not handled correctly. It is essential that you take note of all the warnings and recommended safety measures outlined by manufacturers. Any person with a heart pacemaker or any other electronic medical devices should not work on an EV motor since the magnetic effects could be dangerous. In addition, other medical devices such as intravenous insulin injectors or meters can be affected.

High energy The electrical energy is conducted to or from the motor via thick orange wires connected to the battery. If these wires have to be disconnected, SWITCH OFF or DE-ENERGISE the high voltage system. This will prevent the risk of electric shock or short circuit of the high voltage system.

Chemicals Electrolytes used in EV batteries can be harmful and it is important to remember that both acid and alkali solutions are used in this technology. Understanding before you start work what type of chemical is present will enable selecting the correct procedure when dealing with a spill.

Stages of work The general advice about working on high voltage vehicles is split into four areas:

Before work: Turn OFF the ignition switch and remove the key

- ▶ Switch OFF the Battery Module switch or de-energise the system
- ▶ Wait for 5 minutes before performing any maintenance procedures on the system. This allows any storage capacitors to be discharged

- ▶ Isolate system and stow key in safe location only accessible to the technician

During work: Always wear correct PPE when there is risk of touching a live component

- ▶ Always use insulated tools when performing service procedures to the high voltage system. This precaution will prevent accidental short-circuits.
- ▶ Always use correct workshop equipment to define the work area, warning others of the dangers present and use a correct insulated rubber mat when appropriate.

Interruptions: When maintenance procedures must be interrupted while some high voltage components are uncovered or disassembled, make sure that:

- ▶ The key is only accessible with the working technician's knowledge
- ▶ The Battery Module switch is switched off
- ▶ No untrained persons have access to that area and prevent any unintended touching of the components.

After work: Before switching on or re-energising the battery module after repairs have been completed, make sure that:

- ▶ All terminals have been tightened to the specified torque
- ▶ No high voltage wires or terminals have been damaged or shorted to the body
- ▶ The insulation resistance between each high voltage terminal of the part you disassembled and the vehicle's body has been checked.



Create a word cloud for one or more of the most important screens or blocks of text in this section

2.4.3 Fire 1

Accidents involving fire are very serious. As well as you or a workmate calling the fire brigade (do not assume it has been done), three simple rules will help you know what to do:

- 1 Get safe yourself, contact the emergency services – and shout 'FIRE!'
- 2 Help others to get safe if it does not put you or others at risk.
- 3 Fight the fire if it does not put you or others at risk.

2 Working safely

Of course, far better than the above situation is to not let a fire start in the first place.

The fire triangle or combustion triangle is a simple model for understanding the ingredients necessary for most fires. The triangle illustrates that a fire requires three elements: heat, fuel, and an oxidizing agent (usually oxygen from the air). The fire is prevented or extinguished by removing any one of them. A fire occurs when the elements are combined in the right mixture.

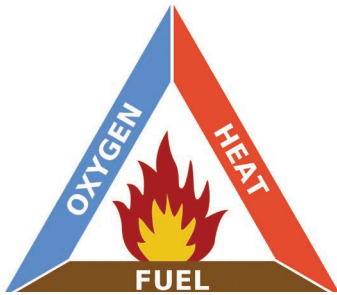


Figure 2.13 Fire triangle (Source: Wikimedia)

Without sufficient heat, a fire cannot start or continue. Heat can be removed by the application of a substance which reduces the amount of heat available to the fire reaction. This is often water, which requires heat to change from water to steam. Introducing sufficient quantities and types of powder or gas into the flame can also reduce the amount of heat available for the fire reaction. Turning off the electricity in an electrical fire removes the ignition source.

Without fuel, a fire will stop. Fuel can be removed naturally, as when the fire has consumed all the burnable fuel, or manually, by mechanically or chemically removing the fuel from the fire. The fire goes out because a lower concentration of fuel vapour in the flame leads to a decrease in energy release and a lower temperature. Removing the fuel therefore decreases the heat.

Without enough oxygen, a fire cannot start or continue. With a decreased oxygen concentration, the combustion process slows. In most cases, there is plenty of air left when a fire goes out so this is not commonly a major factor.

The fire tetrahedron is an addition to the fire triangle. It adds the requirement for the presence of the chemical reaction which is the process of fire. For example, the suppression effect of a Halon extinguisher is due to its interference in the fire by chemical inhibition. Note that Halon extinguishers are now only allowed in certain situations and are illegal for normal use.

Combustion is the chemical reaction that feeds a fire more heat and allows it to continue. When the fire involves burning metals, like magnesium (known as a class-D fire), it becomes even more important to consider

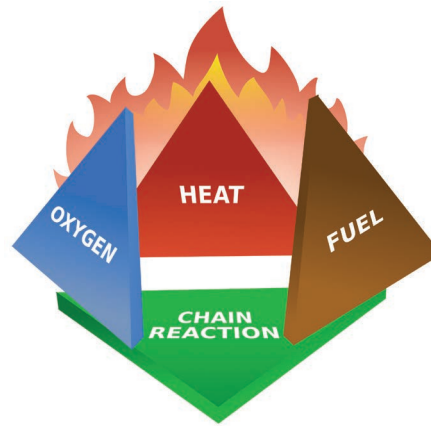


Figure 2.14 Fire tetrahedron (Source: Wikimedia)

the energy release. The metals react faster with water than with oxygen and thereby more energy is released. Putting water on such a fire makes it worse. Carbon dioxide extinguishers are ineffective against certain metals such as titanium. Therefore, inert agents (e.g. dry sand) must be used to break the chain reaction of metallic combustion. In the same way, as soon as we remove one out of the three elements of the triangle, the fire stops.

If a fire does happen, your workplace should have a set procedure. So, for example, you will know:

- ▶ how the alarm is raised
- ▶ what the alarm sounds like
- ▶ what to do when you hear the alarm
- ▶ your escape route from the building
- ▶ where to go to assemble
- ▶ who is responsible for calling the fire brigade.

There are a number of different types of fire as shown in the following table:

European/ Australian/Asian	American	Fuel/Heat source
Class A	Class A	Ordinary combustibles
Class B	Class B	Flammable liquids
Class C		Flammable gases
Class D	Class D	Combustible metals
Class E	Class C	Electrical equipment
Class F	Class K	Cooking oil or fat

If it is safe to do so, you should try to put out a small fire. Extinguishers and a fire blanket should be provided. Remember, if you remove one side of the fire triangle, the fire will go out. If you put enough water on a fire, it will cool down and go out. However spraying water on an electrical circuit could kill you! Spraying water on a petroleum fire could spread it out and make the problem far worse. This means that a number of different fire extinguishers are needed. Internationally there are several accepted classification methods for

handheld fire extinguishers. Each classification is useful in fighting fires with a particular group of fuel.

Fire extinguishers in the UK, and throughout Europe, are red but with a band or circle of a second colour covering between 5–10% of the surface area of the extinguisher to indicate its contents. Prior to 1997, the entire body of the fire extinguisher was colour coded.



Create an information wall to illustrate the features of a key component or system

2.4.4 Signage 1

A key safety aspect is to first identify hazards and then remove them or, if this is not possible, reduce the risk as much as possible and bring the hazard to everyone's attention. This is usually done by using signs or markings. Signs used to mark hazards are often as follows:

Type	Old code	BS EN 3 colour code	Suitable for use on fire classes (brackets denote sometimes applicable)					
Water	Signal red	Signal red	A					
Foam	Cream	Red with a cream panel above the operating instructions	A	B				
Dry powder	French blue	Red with a blue panel above the operating instructions	(A)	B	C		E	
Carbon dioxide CO ₂	Black	Red with a black panel above the operating instructions		B			E	
Wet chemical	Not yet in use	Red with a canary yellow panel above the operating instructions	A	(B)				F
Class D powder	French blue	Red with a blue panel above the operating instructions				D		
Halon 1211/BCF	Emerald green	No longer in general use	A	B			E	

In the UK the use of Halon gas is now prohibited, except under certain situations, such as on aircraft and by the military and police.



Figure 2.15 CO₂ and water extinguishers and information posters

Function	Example	Back colour	Fore-ground colour	Sign
Hazard warning	Danger of electric shock	Yellow	Black	 Figure 2.16 Electricity
Mandatory	Use ear defenders when operating this machine	Blue	White	 Figure 2.17 Wear ear protection
Prohibition	Not drinking water	White	Red/black	 Figure 2.18 Not drinking water
First aid (escape routes are a similar design)	Location of safety equipment such as first aid	Green	White	 Figure 2.19 First aid
Fire	Location of fire extinguishers	Red	White	 Figure 2.20 Extinguisher
Recycling	Recycling point	White	Green	 Figure 2.21 The three Rs of the environment



Construct a crossword or wordsearch puzzle using important words from this section

2.5 Personal responsibilities

2.5.1 Safety procedures 1

When you know the set procedures to be followed, it is easier to look after yourself, your workshop and your workmates. You should know:

- ▶ who does what during an emergency
- ▶ the fire procedure for your workplace
- ▶ about different types of fire extinguisher and their uses
- ▶ the procedure for reporting an accident.



Figure 2.22 Call for an ambulance if the accident is serious

If an accident does occur in your workplace the first bit of advice is: keep calm and don't panic! The HASAW states that for companies above a certain size:

- ▶ first-aid equipment must be available
- ▶ employers should display simple first-aid instructions
- ▶ fully trained first-aiders must be employed.

In your own workplace you should know about the above three points. The following is a guide as to how to react if you come across a serious accident:

Action	Notes
Assess the situation	Stay calm, a few seconds to think is important
Remove the danger	If the person was working with a machine, turn it off. If someone is electrocuted, switch off the power before you hurt yourself. Even if you are unable to help with the injury you can stop it getting worse
Get help	If you are not trained in first aid, get someone who is and/or phone for an ambulance
Stay with the casualty	If you can do nothing else, the casualty can be helped if you stay with them. Also say that help is on its way and be ready to assist. You may need to guide the ambulance
Report the accident	All accidents must be reported; your company should have an accident book by law. This is a record so that steps can be taken to prevent the accident happening again. Also, if the injured person claims compensation, underhanded companies could deny the accident happened
Learn first aid	If you are in a very small company why not get trained now, before the accident?



Select a routine from section 1.3 and follow the process to study a component or system

2.5.2 Environmental protection 1

Environmental protection is all about protecting the environment on individual, organizational or governmental levels. Due to the pressures of population and our technology, the Earth's environment is being degraded, sometimes permanently. Activism by environmental movements has created awareness of the various environmental issues. This has led to governments placing restraints on activities that cause environmental problems and producing regulations.

In a workshop, these regulations relate to many items such as solvents used for cleaning or painting, fuels, oil and many other items. Disposal methods must not breach current regulations and, in many cases, only licensed contractors can dispose of certain materials.

Failure to comply can result in heavy penalties. Make sure you are aware of your local regulations as these can change.

Finally, let's consider the three Rs:

- ▶ **Reduce** the amount of the Earth's resources that we use
- ▶ **Reuse** Don't just bin it. Could someone else make use of it?

- ▶ **Recycle** Can the materials be made into something new?
- ▶ And, as we are automotive technicians, maybe there is a fourth: **Repair?**



Use a library or the web search tools to further examine the subject in this section

Automotive industry



After successful completion of this chapter you will be able to show you have achieved these objectives:

- Understand key organisational structures, functions and roles within the automotive work environment.
- Understand the importance of obtaining, interpreting and using information in order to support your job role within the automotive work environment.
- Understand the importance of different types of communication within the automotive work environment.
- Understand communication requirements when carrying out vehicle repairs in the automotive work environment.
- Understand how to develop good working relationships with colleagues and customers in the automotive workplace.

3.1 The motor trade 1

Introduction This section will outline some of the jobs that are open to you in the motor trade and help you understand more about the different types of business and how they operate. It is easy to think that the operation of a business does not matter to you. However, I would strongly suggest we should all be interested in the whole business in which we are working. This does not mean we should interfere in areas we do not understand. It means we should understand that all parts of the business are important. For example, when you complete a job, enter all the parts used so the person who writes the invoice knows what to charge!



Figure 3.1 A Volkswagen main dealer



Figure 3.2 A Ferrari and Maserati main dealer

Opportunities The motor trade offers lots of opportunities for those who are willing to work hard and move forwards. There are many different types of job and you will find one to suit you with a little patience and study.

Ask your boss to give you a 'tour' of the garage so that you can appreciate the different tasks carried out and systems that are in place – in particular, make sure you get a reasonable idea about the words and phrases in the following table. If you do not yet have a job you may be able to arrange a visit.



Figure 3.3 Modern workshop



Figure 3.4 Porsche showroom



Figure 3.5 Bodyshop

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Key words and phrases Some important words and phrases are presented here:

Customer	The individuals or companies that spend their money at your place of work. This is where your wages come from.
Job card	A printed document for recording amongst other things, work required, work done, parts used and the time taken.
Invoice	A description of the parts and services supplied with a demand for payment from the customer.
Company system	A set way in which things work in one particular company. Most motor vehicle company systems will follow similar rules but will all be a little different.
Contract	An offer which is accepted and payment is agreed. If I offer to change your engine oil for £15 and you decide it is a good offer and accept it, we have a contract. This is then binding on us both.
Image	This is the impression given by the company to existing and potential customers. Not all companies will want to project the same image.
Warranty	An intention that if, within an agreed time, a problem occurs with the supplied goods or service, it will be rectified free of charge by the supplier.
Recording system	An agreed system within a company so that all details of what is requested and/or carried out are recorded. The job card is one of the main parts of this system.
Approved repairer	This can mean two things normally. The first is where a particular garage or bodyshop is used by an insurance company to carry out accident repair work. In some cases, however, general repair shops may be approved to carry out warranty work.
After sales	A term that applies to all aspects of a main dealer that are involved with looking after a customer's car after it has been sold to them by the sales team. The service/repair workshop is the best example.

Types of MV companies Motor vehicle companies can range from very small, one-person businesses to very large main dealers. The systems used by each will be different but the requirements are the same.



Figure 3.6 Accident repair reception



Figure 3.7 Motorist discount store



Figure 3.8 Tyre shop



Figure 3.9 Ford main dealer



Figure 3.10 Good signs are important



Figure 3.11 A fast-fit centre

Systems A system should be in place to ensure the level of service provided by the company meets the needs of the customer. The list presented here shows how diverse our trade is:

Mobile mechanics	Servicing and repairs at the owner's home or business. Usually a one-person company.
Bodywork repairers and painters	Specialists in body repair and paintwork.
Valeters	These companies specialise in valeting – which should be thought of as much more involved than getting the car washed. Specialist equipment and products are used and proper training is essential.
Fuel stations	These may be owned by an oil company or be independent. Some also do vehicle repair work.
Specialised repairers	Auto-electrical, air conditioning, automatic transmission, and ICE systems are just some examples.
General repair workshop or independent repairer	Servicing and repairs of most types of vehicles not linked to a specific manufacturer. Often this will be a small business maybe employing two or three people. However, there are some very large independent repairers.
Parts supply	Many companies now supply a wide range of parts. Many will deliver to your workshop.
Fast-fit	Supplying and fitting of exhausts, tyres, radiators, batteries, clutches, brakes and windscreens.
Fleet operator (with workshop)	Many large operators, such as rental companies, will operate their own workshops. Also a large company that has lots of cars, used by sales reps for example, may also have their own workshop and technicians.
Non-franchised dealer	Main activity is the servicing and repairs of a wide range of vehicles, with some sales.
Main dealers or franchised dealers	Usually franchised to one manufacturer, these companies hold a stock of vehicles and parts. The main dealer will be able to provide the latest information specific

	to their franchise (Ford or Citroën for example). A 'franchise' means that the company has had to pay to become associated with a particular manufacturer but is then guaranteed a certain amount of work and that there will be no other similar dealers within a certain distance.
Multi-franchised dealer	This type of dealer is just like the one above – except they hold more than one franchise – Volvo and GM for example.
Breakdown services	The best-known breakdown services are operated by the AA and the RAC. Others include Green Flag and, of course, many independent garages also offer these roadside repair and recovery services.
Motorists shops	Often described as motorist discount centres or similar, these companies provide parts and materials to amateurs but in some cases also to the smaller independent repairers.

Company Structure A larger motor vehicle company will probably be made up of at least the following departments:

- ▶ Reception
- ▶ Workshop
- ▶ Bodyshop and paint shop
- ▶ Parts department
- ▶ MOT bay
- ▶ Valeting
- ▶ New and second user car sales
- ▶ Office support
- ▶ Management
- ▶ Cleaning and general duties

Each area will employ one or a number of people. If you work in a very small garage, you may have to be all of these people at once! In a large garage it is important that these different areas communicate with each other to ensure that a good service is provided to the customer. The main departments are explained further in the following sections.



Figure 3.12 Honda reception area

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Figure 3.13 Different departments on a main dealer site

The **role of a franchised dealer** is to supply local:

- ▶ new and used franchised vehicles
- ▶ franchised parts and accessories
- ▶ repair and servicing facilities for franchised vehicles.

The dealer is also a source of communication and liaison with the vehicle manufacturer.



Figure 3.14 One of the ATT company cars (we wish!)



Figure 3.15 Sales area



Figure 3.16 Displays in the Maserati dealer are used to present a nice image



Figure 3.17 Cars on sale in a showroom

Reception and booking systems The reception, whether in a large or small company, is often the point of first contact with new customers. It is very important therefore to get this bit right. The reception should be staffed by pleasant and qualified persons. The purpose of a reception and booking system within a company can be best explained by following through a typical enquiry. Your company may have a slightly different system but it will be similar.

- ▶ The customer enters reception area and is greeted in an appropriate way.
- ▶ Attention is given to the customer to find out what is required (let's assume the car is difficult to start, in this case).
- ▶ Further questions can be used to determine the particular problem, bearing in mind the knowledge of vehicles the customer may, or may not, have (is the problem worse when the weather is cold, for example).
- ▶ Details are recorded on a job card about the customer, the vehicle and the nature of the

problem. If the customer is new, a record card can be started; if this is an existing customer then a card is continued.

- ▶ An explanation of expected costs is given as appropriate. An agreement to only spend a set amount, after which the customer will be contacted, is a common and sensible approach.
- ▶ The date and time when the work will be carried out can now be agreed. This depends on workshop time availability and when is convenient for the customer. It is often better to say you cannot do the job until a certain time, rather than make a promise you can't keep.
- ▶ The customer is thanked for visiting. If the vehicle is to be left at that time, the keys should be labelled and stored securely.
- ▶ Details are now entered in the workshop diary or loading chart (usually computer based).

The **parts department** is the area where parts are kept and/or ordered. This will vary quite a lot between different companies. Large main dealers will have a very large stock of parts for their range of vehicles. They will have a parts manager and, in some cases, several other staff. In some very small garages, the parts department will be a few shelves where popular items such as filters and brake pads are kept.



Figure 3.18 Typical parts department in a main dealer

Parts stock Even though the two examples given previously are rather different in scale, the basic principles are the same and can be summed up very briefly as follows:

- ▶ a set level of parts or stock is decided upon
- ▶ parts are stored so they can be easily found
- ▶ a reordering system should be used to maintain the stock.



Figure 3.19 Typical parts department in an independent retailer



Figure 3.20 Tyres in stock

Security is important as most parts cost a lot of money. When parts are collected from the parts department or area, they will be for use in one of three ways:

- ▶ for direct sale to a customer
- ▶ to be used as part of a job
- ▶ for use on company vehicles.

In the first case an invoice or a bill will be produced. In the second case, the parts will be entered on the customer's job card. The third case may also have a job card or, if not, some other record must be kept. In all three cases, keeping a record of parts used will allow them to be reordered if necessary. If parts are ordered and delivered by an external supplier, again they must be recorded on the customer's job card.

The motor trade – Summary To operate a modern automotive business is a complex process. However, the systems have been outlined in this section in order to show that when each part of a complex system is examined, it is much easier to understand and appreciate the bigger picture.

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Figure 3.21 Even the best cars need a wash

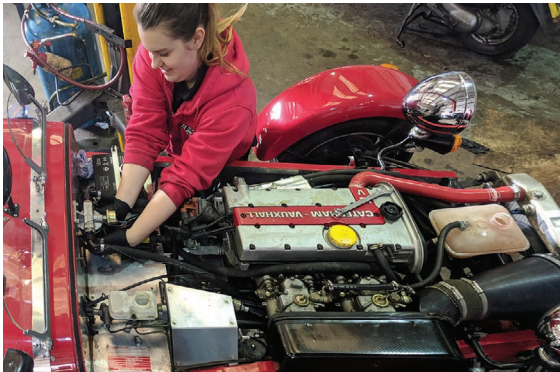


Figure 3.22 Smile, and enjoy your work!

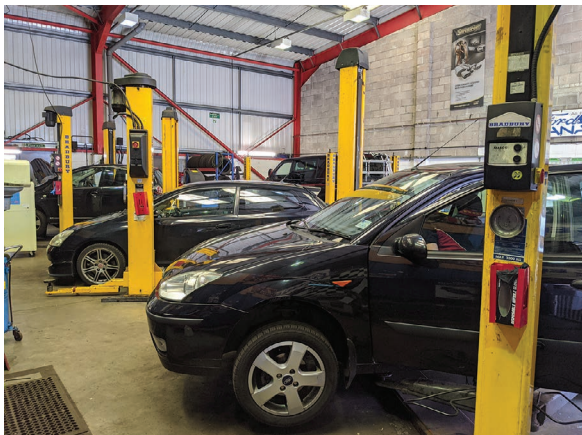


Figure 3.23 Workshop



Figure 3.24 Independent garage



Create an information wall to illustrate the important features of a component or system in this section.

3.2 Information and systems 1

Estimating costs and times When a customer brings his or her car to a garage for work to be carried out, quite understandably he or she will want to know two things:

- 1 How much will it cost?
- 2 When will it be ready?

In some cases, such as for a full service, this is quite easy as the company will have a set charge and by experience will know it takes a set time. For other types of job, this is more difficult.

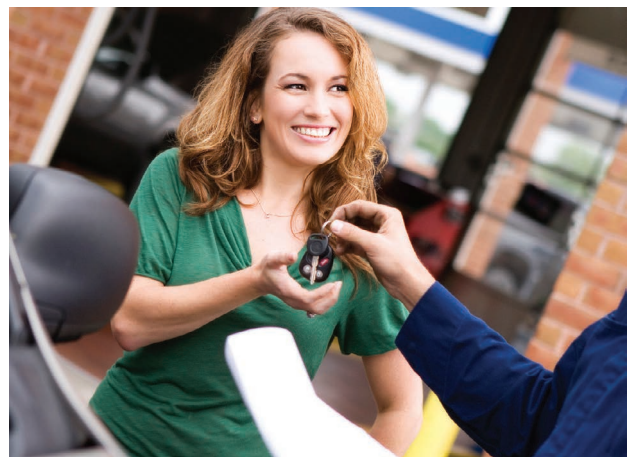


Figure 3.25 Customer interaction

Standard times Most major manufacturers supply information to their dealers about standard times for jobs. These assume a skilled technician with all the necessary tools. For independent garages, a publication known as the ICME manual is available. This gives agreed standard times for all the most common tasks, on all popular makes of vehicle.

To work out the cost of a job, you look up the required time and multiply it by the company's hourly rate. Don't forget that the cost of parts will also need to be included.



Use a library or the web search tools to further examine the subject in this section

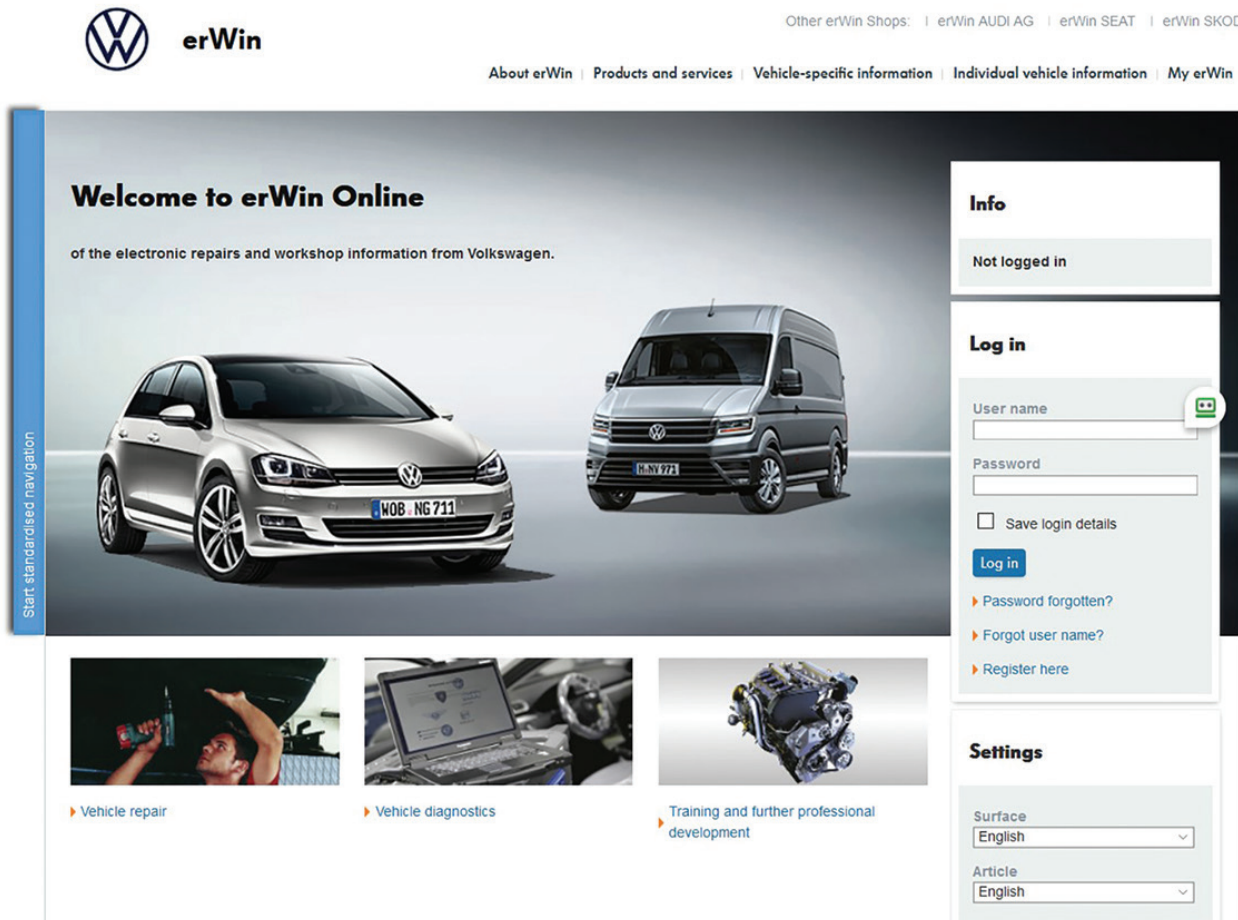


Figure 3.26 Standard times books are now replaced by online systems

3.3 Communication 1

Introduction The way we communicate with other people is important for many reasons. If we communicate well, we are more likely to get what we want. Often disagreements and upsets are caused because communication is poor. It's easy to fall out with someone because you, the other person or both of you are not communicating well – not necessarily because you disagree.

Verbal and nonverbal Communication can be classified as one of two types:

- 1 Verbal communication
- 2 Nonverbal communication

Verbal communication always uses words, spoken and written. Nonverbal communication is any form of communication that does *not* use words. Have a look

at the text below – it gives examples of both types of communication.

Positive or negative Communication can be either positive or negative. It is important for everyone in the workplace to be aware of their communication skills, i.e. try make sure their communication is positive.

The wrong way Let's now look at an example where a trainee, Steve, is asked to service and clean the wheel balancer. Steve could reply like this:

- ▶ 'No, it's not my job!' or even,
- ▶ 'No!' and walk off.

Of course, that's perfectly true, it isn't his job as we discussed earlier but how would you feel if you were Steve's workmate and spoken to in this manner? An obvious example of negative communication. The following text shows a more professional

3 Automotive industry

and friendly way to approach this – positive communication.

A better way Let's now see what happens when Steve explains to Dave why he is unable to do the task. I think the difference in the two approaches is quite clear. In the first instance, apart from responding in an unfriendly manner Steve gives no explanation as to why he doesn't want to clean the wheel balancer. Dave would more than likely be offended and annoyed. In the second response Steve is not only polite but he explains why he can't do the job. He also shows that he's willing to learn.

Eye contact Let's take some of these points individually as they will be beneficial. Firstly, eye contact – this is important because it shows that you are interested in what the person is saying and that you are trying to understand. It is warm and friendly.



Figure 3.27 Eye contact

However, this can be difficult for some people and we will look further at this later. No matter how difficult, though, you should try to do it. It makes the other person feel that what they are saying is important to you. Also, if you can see their facial expressions, it is easier for you to gauge whether or not they understand you.

Body language This is important for the same or very similar reasons. Slouching, leaning, fidgeting, folding your arms in a defensive, stand-offish manner are all examples of negative body language and negative communication. On the other hand the opposite,

standing or sitting upright and relaxed, is positive body language. Fidgeting can be very off-putting, not that you need to remain dead still and be afraid to move. Relaxed gestures are fine and can aid communication.

Nodding in agreement is good because it shows the other person that you understand and/or that you agree with what they are saying. Have you ever been in a situation where you were either explaining something difficult or saying something you thought the other person may disagree with? If the other person nodded, I'm sure it gave you a sense of relief knowing that they understood or agreed with you.

Nervousness Some people are naturally shy and reserved. This can be a positive thing. People generally don't like others to be too loud, constantly talking and overconfident. Quite often this behaviour can be a cover-up for shyness and insecurity.

Be interested and listen If you are nervous or self-conscious, first and foremost try to concentrate fully on what the other person is saying. Be genuinely interested. Show this by nodding and making eye contact. Being interested means you will truly be listening to what the other person is saying and this will help you to relax. It directs your attention from you to them. Really trying to listen and understand another will greatly reduce your feelings of self-consciousness.

Relaxation When you feel nervous, insecure or threatened, your breathing becomes shallow. Try to take deep, slower breaths – it will help you to relax. By feeling relaxed your confidence will grow. You will be in control of your body and voice rather than your body and voice controlling you. Remember to smile! It is so much easier to communicate with a friendly person. When you feel relaxed and confident, communication is a very natural thing. It is unforced, sounds sincere and is more effective.

Take time As with learning all things, developing new skills takes time. Some people learn certain skills more quickly than others. Practice makes perfect! Don't be too hard on yourself – trying too hard can make you feel more self-conscious and tense. Just relax.



Figure 3.28 Take time

Written communication Don't worry – you don't have to be a wonderful speller or excellent at English but it does really help if you have some basic skills. Poor written communication can take the form of illegible handwriting, bad spelling or poor grammar. This can lead to:

- ▶ an unprofessional image
- ▶ misunderstandings.

A **misunderstanding** could lead to someone's safety being at risk. Imagine that you found the cables of a hoist were frayed and your report was so poorly written that it couldn't be understood!

When **reporting problems**, always speak to the relevant person. We covered this in lines of communication. However, reporting a problem is one thing but reporting it *effectively* is another. Always report problems to the appropriate person as soon as possible (media is available online).

Verbal report 1 A technician finds that a piece of equipment is not working correctly and he needs to report this to the supervisor. Imagine that the supervisor is instructing a customer and the report is made something like this.

Verbal report 2 Pete's attention is elsewhere and it is quite likely that he may not have heard or really taken it in. The technician should wait until Pete has finished speaking with the customer and then report the problem. Also, it would be rude to the customer to interrupt like this.

Written report It may be your company's policy to have any such problems written on a report form and given to the appropriate person. It's therefore necessary to write clearly and make sure that another person would understand what you are saying. A good point of practice then is to read what you have written

and ask yourself, 'Will Julie/Jane/Steve/Mick be able to understand this?' This is where some very basic spelling and grammar is required.



Figure 3.29 Written report

Poor handwriting Look at the report on the website filled in by a technician. 'That's a bit over the top,' you may say. 'No one would write like that?' But sometimes reports are really filled in like this. Aside from the obvious poor and illegible handwriting, several boxes have been left blank. The date or time has not been entered and there is no telephone number or contact details for the client. Who is the message for?

Explain yourself clearly There is another report made from a telephone conversation with a supplier, Morris Holdings. All the necessary boxes are filled in but . . . what is it saying? If you can't read it the translation actually says 'Morris Holdings can't do cleaning delivery this Wednesday and can do it next time if we want can call Christine 01732 4691'. Well, you can probably get the gist of the message but it could be explained more clearly. On the next screen we hear this same telephone message and see a much more clearly written report. Clear in this case means handwriting, spelling, grammar and expression – saying what you mean.

Explain yourself clearly 2 'If you would pass this message on please. We're not able to make the delivery this Wednesday; unfortunately, it won't be until Wednesday of next week, the 21st. If that causes any problems you can call Christine on 01732 4671.'

Take time If you know that your handwriting is difficult to read then take greater care. Write more slowly. It may be easier if you write in capital letters.

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Remember, you never became an automotive technician to be good at handwriting and English – all you need is to be understood.

Adapt what you say It's also sometimes important to be able to adapt what you say to colleagues. If you have to speak to the receptionist or one of the office staff, it's probably not a good idea to use highly technical language. 'Well, why don't they ask if they don't understand?' That's true but a big part of good communication means that you take on the responsibility of making yourself understood. Don't leave it to chance and don't rely on the other person asking you. People are much more likely to respond to you if you use their language.

Choosing your words The choice of words and how you say (or write) them is likely to be different when talking to your workmate than if you were talking to, say, a manager of the company. Is it appropriate to use first names for management in your workplace? In many cases it will be but sometimes, especially if you are part of a large organisation and don't often speak to a manager, it may be more appropriate to use Mr, Mrs, Ms or Miss.

Views and opinions Throughout life you will always meet people with different views and opinions to yourself – it will be no different in the workplace. So often, poor working relationships are

caused because people think they are right and the other is wrong. Remember, no one likes a 'know it all'.

Be open and flexible One of the best ways to learn is to be open to new ideas. This doesn't mean that you always have to agree with them but it is polite and professional to listen and consider what your workmate is saying. Don't always assume that you are right. Be flexible in your opinions. Again, by listening and really considering a different point of view shows that you value another person's thoughts and feelings. This in turn leads to a good working relationship.



Figure 3.30 Good communication is important



Figure 3.31 Be open and flexible

Positive or negative approach Sometimes you may be in the right and the other person in the wrong but there are positive and negative ways of dealing with this. In this scenario Ian and Mick, two technicians, are having a discussion over a fault on a customer's car (media is available online).

Honouring commitments If you say you are going to do something, do it! One of the worst things for damaging your career is to have a reputation of making 'empty promises', i.e. saying that you will do something and then not doing it. Quite often it's not a case of being lazy or unwilling but,

- ▶ forgetting
- ▶ being too busy.

Forgetful The best way of remembering to do something is to write it down. Perhaps your workshop may have a noticeboard or whiteboard or you may want to write it on a post-it note. At the very least, decide on a time there and then when you are going to do the task. That way, if you have the time set aside and firmly placed in your mind, you are less likely to forget. Writing something down, though, is always the best option, especially if you can't do the task that same day.

Too busy Be realistic! Consider the following two points if you are asked, or before you volunteer, to do something:

- ▶ Do I have the time?
- ▶ How long will the job take?

Do I have time? Of course you will want to be seen as co-operative and willing, but sometimes you may just not have time. How do you approach this? A response like, 'No, can't, sorry don't have time' isn't likely to do you any favours. You need to explain your situation. Don't assume others will know, even if you think they should. Perhaps you may need to say that you would like to but at the moment you really are too busy with such and such a task. Through discussion you may find that you can do the job with some help, or that the new job takes priority, or that it can be done later. Be aware of your limitations.

Seriously consider If you do make the commitment to do something then do seriously consider how long it is going to take you. Think what other jobs have to be done, and give some time for the unexpected, e.g. other tasks that may arise, unforeseen problems, etc.

Remember! There is more support on the website that includes additional images and interactive features: www.tomdenton.org

Summary In summary, communication can be verbal or nonverbal, spoken or written, and positive or negative. The way we communicate in the workplace can help either to build or destroy working relationships. Feeling reasonably confident and relaxed is important. And finally, Good Luck!



Select a routine from section 1.3 and follow the process to study a component or system

3.4 Documentation 1

Job cards and systems A managed workflow is a vital part of the workshop system in a motor vehicle company. Many companies may dispense with the 'paper' altogether and use digital systems. These can be expensive but allow fast, easy and accurate communication. Whether job cards, digital systems or even a combination are used, the principle is the same and consists of several important stages. This is often described as a four-part job card system:

- 1 Reception – Customers' details and requirements are collected and/or checked; this information could be stored in a paper or digital system or even both.
- 2 Workshop control – Jobs are allocated to the appropriate technician using a loading sheet or again via a digital solution.
- 3 Parts department – Parts used are added to the workshop information.
- 4 Accounts – Invoices are prepared from the information on the job card. Digital systems may automatically produce the invoice when the job is completed.

Invoicing As part of the contract made with a customer, an invoice for the work carried out is issued. The main parts of the invoice are as follows:

- ▶ Diagnostic charges – Applied if investigatory work is required.
- ▶ Labour charges – The cost of doing the work. Usually, the time spent multiplied by the hourly rate.
- ▶ Parts – The retail price of the parts or as agreed.
- ▶ Sundries – Some companies add a small sundry charge to cover consumable items like PPE, nuts and bolts or cable ties etc.
- ▶ Data charge – Some workshops add the cost of accessing manufacturer's data
- ▶ MOT test – If appropriate. This is separated because VAT is not charged on MOTs.

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Garage Hive - A Community Driven GMS | < Service ▾ **Purchasing** ▾ Catalogues ▾ Postt >

Vendors Purchase Orders **Purchase Invoices** Purchase Return Orders Purchase Cr.Memos

Then select +new

Purchase Invoices: All ▾ | Search **+ New** ✕ Delete Invoice ▾

Invoice Posting Request Approval Incoming Document Release Show Attached ...

General Show more

No. PINV107004 ... A Due Date B

Vendor Name * B Vendor Invoice No. * C

Contact Correction ☐

Posting/Tax Point Date ... 19/03/2019

Lines	Manage	More options				
TYPE	NO.	DESCRIPTION/COMMENT	LOCATION CODE	QUANTITY	UNIT OF MEASURE CODE	DIR CC
	:					

Figure 3.32 An example job sheet – most are now software generated (Source: Garage Hive)

- ▶ Waste – Some companies may itemize the cost of handling and disposing of hazardous waste.
- ▶ VAT – Value Added Tax – At the current rate, if the company is registered (all but the very small are).

Hourly rates vary quite a lot between different garages. The hourly rate charged by the company must pay a lot more than your wages – hence it will be much higher than your hourly rate! Just look round in any good workshop, as well as the rent for the premises, some of the equipment can cost tens of thousands of pounds. The money must come from somewhere.

Computerized workshop system There are several digital based workshop management systems available.

Some are specifically designed for main dealers, some for the smaller independent company. In this part, I will outline a system called Garage Hive (www.garagehive.co.uk). This system has three specific benefits:

- ▶ Workshop management
- ▶ Reporting and business intelligence
- ▶ Finance and accountancy

The workshop management built into Garage Hive has all the tools to run your workshop. A live dynamic work schedule, paperless jobcards, integrated Autodata repair times, technician time management, stock control and much more. You can also make informed decisions with the business intelligence & reporting application. View workshop profitability, technician efficiencies, margins and much more on

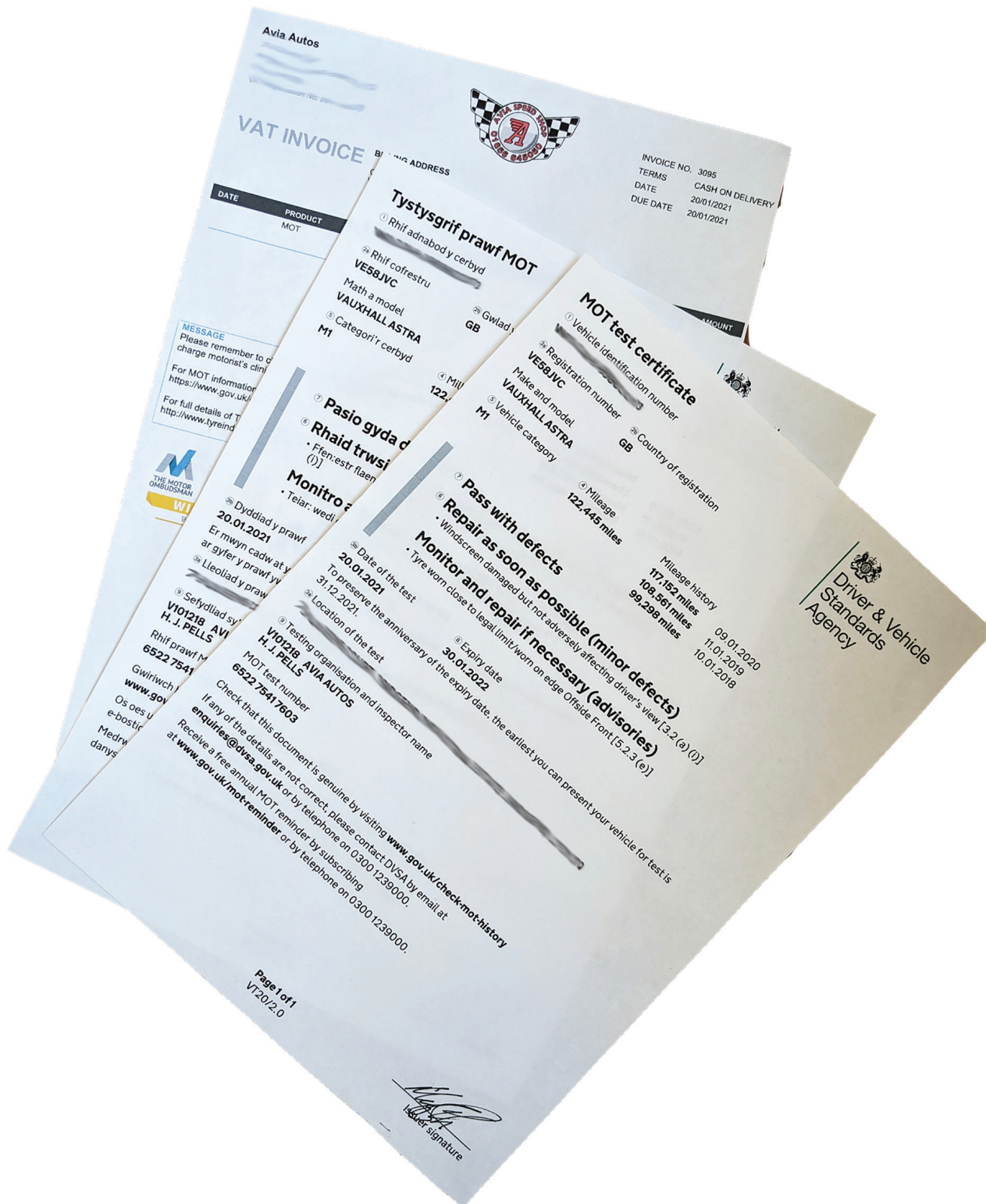


Figure 3.33 Invoice example together with other documents

3 Automotive industry

all of your devices. The system offers a full integrated accountancy system. Alternatively you can take advantage of the integrations with Xero, Sage and Quickbooks.



Figure 3.34 Garage Hive features



Figure 3.35 Special offers such as shown here are in addition to a warranty

Extended warranties It is also possible to have a warranty on a used vehicle or an extended warranty on a new vehicle. These often involve a separate payment to an insurance company. This type of warranty can be quite good but a number of exclusions and requirements may apply. Some examples are listed:

- ▶ regular servicing at an approved dealer
- ▶ only recommended parts must be used
- ▶ wear and tear is not included
- ▶ any work done must be authorised
- ▶ only recognised repairers may be used in some cases.



Figure 3.36 Mitsubishi cars

Authorisation The question of authorisation before work is carried out is very important for the garage to understand. Work carried out without proper authorisation will not be paid for. If a customer returns a car within the warranty period then a set procedure must be followed.

- 1 Confirm that the work is within the terms of the warranty.
- 2 Get authorisation if over an agreed limit (main dealers have agreements with manufacturers).
- 3 Retain all parts replaced for inspection.
- 4 Produce an invoice which relates to standard or agreed times.

In the larger garages, often one person will be responsible for making warranty claims.

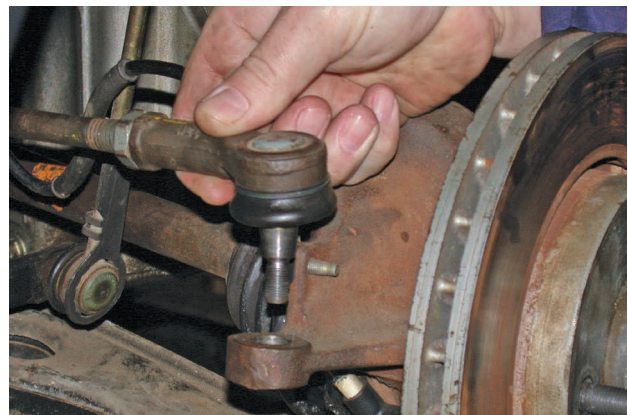


Figure 3.37 If parts are replaced under warranty, they may need to be kept for inspection



Create an information wall to illustrate the features of a key component or system.

3.5 Working relationships

3.5.1 Colleagues 1

Introduction 'He always gets the best jobs.' 'Why should I do that? It's not my responsibility.' 'I'm fed up with having to do her jobs. She's a girl, what do you expect.'

Imagine working in an environment like this or, sadly, perhaps you already do. Of course, from time to time we all have disagreements about certain things but surely the best way is to talk things through and sort out any problems in a friendly and professional manner. By studying this unit you will learn the necessary skills to maintain positive working relationships and gain the knowledge required for your qualification.

It's easy I'm sure that you will find this programme quite easy to learn, as it is mostly common sense. Hopefully it will also be quite fun. I have divided the learning programme into two sections:

- 1 Responsibilities, yours and your colleagues
- 2 Communication skills and working relationships

Your responsibilities To be a successful technician, it is essential that you fully understand your responsibilities in the organisation. That's not only the jobs that you are required to do, but also the jobs that you are not required to do and the duties that, by law, you are not allowed to do.

Job description When you start work at an organisation, you may be given a job description. At



Figure 3.38 It is important to be sure of your duties

the very least it should be made clear to you verbally if it is not written down. Either way, if you are unsure of your work duties, do ask.

Knowing your duties In the following scenario a technician is asked to do something that he is not allowed to because it is against health and safety regulations (media is available online).

Steve should politely decline this request. It is against health and safety law to clean, maintain or use any equipment without adequate training.

Your workmates' responsibilities In the previous scenario Steve's workmate may not have realised that Steve had not been trained to do this job. To avoid confusion, and breaking any laws and regulations, it is important to know and understand your work colleagues' responsibilities. It will also help avoid any bad feeling from asking a mate to do something that just isn't part of his workload, especially if he is very busy.

Giving advice and support Knowing your job role and the limits of your responsibility for giving advice and support is essential. Don't feel pressured into giving advice on something you are not qualified for. It can also be tempting to impress others with your knowledge but if you are unsure of something do make it clear that you are unsure. When the safety of someone is at stake never give advice unless it is your responsibility, and then only if you are absolutely certain of your facts.

Lines of communication How do you communicate in your workshop? Are there any specific lines of communication within your organisation? If it is a large workshop, there is almost certain to be. For instance, if you notice that you may be running low on a product, who should you inform? If someone has an accident, who is responsible for entering it into the accident book?

Job titles For the smooth running of an organisation it is necessary to follow these lines of communication. Start to get familiar with people's titles and jobs and this often will tell you the appropriate person to speak with.



Create a mind map to illustrate the features of a key component or system.

3.5.2 Customers 1

Introduction This section is a general overview of the type of advice and contact that you may need to have with your customers. Remember, customers pay our wages so treat them well!

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Problems It is important to note that, generally, problems do not occur frequently during the life of a motor vehicle. Customers can be reassured that as long as their vehicle is regularly checked and serviced, they are observant of their instrumentation in the vehicle and seek advice when abnormal noises or running conditions occur, they should experience no major problems.

Service records Premature failure of the camshaft drive belt is a common problem that causes severe damage to the engine. This failure can be avoided if the camshaft drive belt is replaced at the correct interval, in addition, regular inspection and adjustment of the belt will generally highlight any problems so that the belt can be replaced before it fails. Customers will appreciate appropriate tracking of the requirement for this work so that they can be contacted and reminded when it is due.

Expensive repairs Always encourage your customers to come back to you whenever they feel that something is wrong, no matter how small. These things can often be put right before they develop into expensive repairs.

Customer records Customer records should be kept for the frequency and type of service carried out so that a check can be made on rubber hoses at appropriate time intervals. This is good practice to avoid the risk of fuel leakage and the potential for vehicle fires.

Quality replacement components It is often tempting to increase the profit on a job by using 'pattern' parts. These are copies of the original

components. Some of these components, produced by well-known companies (Bosch for example) are excellent quality and are used as original equipment by many manufacturers. However, some pattern parts are cheap and you get what you pay for! One of the most irritating things for a customer is to have to return the vehicle for the same job to be repeated – and it wastes your time. Use good quality parts at all times.



Figure 3.39 Bosch wiper components

Summary A customer, who is kept informed and treated with respect, will return and keep you in a job! Explain things to a customer when asked – it will be appreciated.



Look back over the previous section and write out a list of the key bullet points from this section.

Workshop skills



After successful completion of this chapter you will be able to show you have achieved these objectives:

- Understand how to select, use and care for hand tools and measuring devices in the automotive environment.
- Understand how to prepare and use common workshop equipment.
- Understand how to select materials when fabricating, modifying and repairing vehicles and fitting components.
- Understand how to apply automotive engineering, fabrication and fitting principles when modifying and repairing vehicles and components.

4.1 Hand tools and measuring

4.1.1 Hand tools 1

Using hand tools is something you will learn by experience, but an important first step is to understand the purpose of the common types. This section therefore starts by listing some of the more popular tools, with examples of their use, and ends with some general advice and instructions.



Figure 4.1 Ring spanners (wrenches)

Practice until you understand the use and purpose of the following tools when working on vehicles:

Hand tool	Example uses and/or notes
Adjustable spanner (wrench)	An ideal standby tool and useful for holding one end of a nut and bolt.
Open-ended spanner	Use for nuts and bolts where access is limited or a ring spanner can't be used.
Ring spanner	The best tool for holding hexagon bolts or nuts. If fitted correctly it will not slip and damage either you or the bolt head.
Torque wrench	Essential for correct tightening of fixings. The wrench can be set in most cases to 'click' when the required torque has been reached. Many fitters think it is clever not to use a torque wrench. Good technicians realise the benefits.
Socket wrench	Often contains a ratchet to make operation far easier.
Hexagon socket spanner	Sockets are ideal for many jobs where a spanner can't be used. In many cases a socket is quicker and easier than a spanner. Extensions and swivel joints are also available to help reach that awkward bolt.
Air wrench	These are often referred to as wheel guns. Air-driven tools are great for speeding up your work but it is easy to damage components because an air wrench is very powerful. Only special, extra strong, high-quality sockets should be used.

Hand tool	Example uses and/or notes
Blade (engineer's) screwdriver	Simple common screw heads. Use the correct size!
Pozidriv, Phillips and cross-head screwdrivers	Better grip is possible, particularly with the Pozidriv, but learn not to confuse the two very similar types. The wrong type will slip and damage will occur.
Torx®	Similar to a hexagon tool like an Allen key but with further flutes cut in the side. It can transmit good torque.
Special purpose wrenches	Many different types are available. As an example, mole grips are very useful tools as they hold like pliers but can lock in position.
Pliers	These are used for gripping and pulling or bending. They are available in a wide variety of sizes. These range from snipe nose for electrical work, to engineer's pliers for larger jobs such as fitting split pins.
Levers	Used to apply a very large force to a small area. If you remember this you will realise how, if incorrectly applied, it is easy to damage a component.
Hammer	Anybody can hit something with a hammer, but exactly how hard and where is a great skill to learn!

General advice and instructions for the use of hand tools (taken from information provided by Snap-on):

- ▶ only use a tool for its intended purpose
- ▶ always use the correct size tool for the job you are doing
- ▶ pull a spanner or wrench rather than pushing whenever possible
- ▶ do not use a file, or similar, without a handle
- ▶ keep all tools clean and replace them in a suitable box or cabinet
- ▶ do not use a screwdriver as a pry bar
- ▶ look after your tools and they will look after you!

Note The following pages give an overview of some of the tools you will need to become familiar with – there are many more! As you study each main chapter it may be useful to refer back to the tools and equipment presented here.

Hose removal A number of tools have been developed to aid the removal of hoses. These cranked and blunt-bladed probes can be eased into the end of a hose to break the seal against the connector pipe. Blunt screwdrivers can also perform this task. Another method is to use a sharp knife to cut the hose back, but this method can only be used when the hose is to be discarded.



Figure 4.2 Hose remover

Hose clips There are a range of specialized hose clips that require a dedicated pair of pliers for their removal and installation. These tend to be specific to individual manufacturers, and the pliers are included in the workshop-equipment pack for the dealer. Where the special tools are not available, the clip can be replaced with a general-purpose screw-type hose clip.

Strap wrenches These are for removing and replacing fuel and oil canister type filters.



Figure 4.3 Strap wrench

Tools for exhaust removal Some useful tools for exhaust system removal are chain wrenches for twisting seized pipes, and oxyacetylene welding equipment for freeing up rusted joints. An air chisel or cutter may be necessary for cutting off components that will not be reused.



Figure 4.4 Chain cutter



Figure 4.5 Air cutter

Torque wrench A good torque wrench is an essential piece of equipment. Many types are available but all work on a similar principle. Most are set by adjusting a screwed cylinder, which forms part of the handle. An important point to remember is that, as with any measuring tool, regular calibration is essential to ensure it remains accurate.



Figure 4.6 Torque wrench

Bearing puller Removing some bearings is difficult without a proper puller. For internal bearings, the tool has small legs and feet that hook under the bearing. A threaded section is tightened to pull out the bearing. External pullers hook over the outside of the bearing and a screwed thread is tightened against the shaft.



Figure 4.7 External bearing puller

Soft hammers These tools allow a hard blow without causing damage. They are ideal for working on driveshafts, gearboxes and final drive components. Some types are made of special hard plastics whereas some are described as copper/hide mallets. One type has a copper insert on one side and a hide or leather insert on the other. It is still possible to cause damage, however, so you must take care!



Figure 4.8 Some hammers contain metal shot to give a 'dead blow'

Brake adjusting tools On many earlier braking systems, the adjustment (gap between the shoe and drum) had to be adjusted manually during a service. Most modern systems do this automatically. However, many earlier systems are still in use so tools such as these, which are used to rotate a gear inside the drum, will be very useful. Some are made to suit particular manufacturer's systems.



Figure 4.9 These tools are simple levers

Test lamp This is an often underrated piece of test equipment! However, it must be used with care. The advantage of a simple test lamp is that it draws some current through the circuit under test. This allows 'high resistance' faults to be located easily. However, this is also a disadvantage because drawing current

through electronic circuits can damage them. Using a test lamp for checking supplies to electrical items such as lights and motors is fine; for all other tests, a multimeter is the preferred option. If in doubt, consult manufacturers' data.

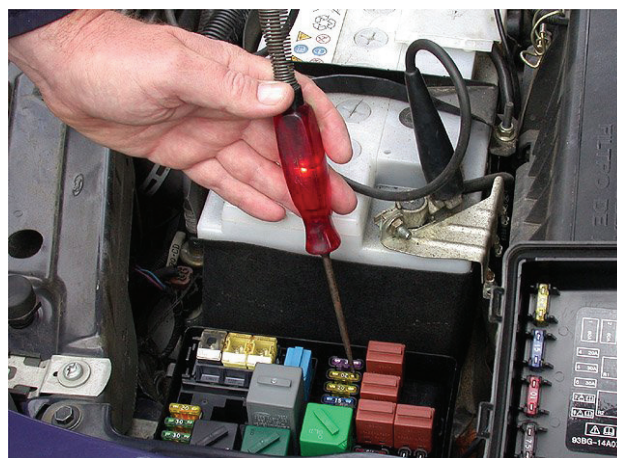


Figure 4.10 Test lamps are simple but useful

A **jumper wire** is useful for bypassing components such as switches. However, do not short supplies to earth using this method. As a safety feature, it is recommended that the jumper wire be fitted with a fuse. A value of 5 to 10A is probably ideal. Crocodile clips or spade terminal ends can be very useful for testing purposes.



Figure 4.11 Fused jump lead

Many **terminal kits** are available. They usually consist of a selection of terminals and special pliers to crimp the terminals on to the wire.

Wire strippers With practice you will be able to strip wire using side cutters. However, special tools are available to make the job easier. A number of different types are shown here.



Figure 4.12 Selection of wire strippers

Most **soldering irons** are electrically heated. However, there are some very good gas-powered types now available. The secret with a soldering iron is to use the right size for a specific job. One suitable for delicate integrated circuits and circuit boards will not work on large alternator diodes. More damaging would be to use a large iron on a small circuit board!

Paper clip Not found in Snap-on or other catalogues, but a very useful tool. It is not only ideal for bridging terminals as shown here, it can also be used for clipping paper together!



Figure 4.13 Paper clip in use



Use the media search tools to look for pictures and videos relating to the subject in this section.

4.1.2 Measurement 1

Introduction Measurement is the act of measuring or the process of being measured. It is the process of comparing a dimension, quantity, or capacity to a known value by using a suitable instrument. Simple examples of measuring instruments would be a tape measure or a steel rule (often referred to as a ruler).



Figure 4.14 Steel rule in millimetres and inches

Accuracy is a key aspect of measurement and generally means how close the measured value of something is in comparison with its actual value. For example, if a length of about 30cm is measured with an old tape measure, then the reading may be 1 or 2mm too high or low. This would be an accuracy of $\pm 2\text{mm}$.

Now consider measuring a length of metal bar with a steel rule. How accurately could you measure it this time? Probably to the nearest 0.5mm if you were careful but this raises a number of issues to consider:

- 1 You could make an error reading the rule.
- 2 Do we actually need to know the length of a piece of bar to the nearest 0.5mm?
- 3 The rule may be damaged and not give the correct reading!

The first and second of these issues can be dispensed with by knowing how to read the test equipment correctly and also knowing the appropriate level of accuracy required. A micrometer for a tyre tread depth would be over the top and, in the same way, a tape measure for valve clearances would be nowhere near good enough. I am sure you get the idea.



Figure 4.15 Tape measure (Source: Jack Sealey)

Remember! There is more support on the website that includes additional images and interactive features: www.tomdenton.org

4 Workshop skills

Equipment To ensure instruments are, and remain accurate, there are just two simple guidelines:

- ▶ look after the equipment; a micrometer thrown on the floor will not be accurate
- ▶ ensure instruments are calibrated regularly – this means being checked against known good equipment.

Here is a summary of the steps to ensure a measurement is accurate:

Step	Example
Decide on the level of accuracy required.	Do we need to know that the battery voltage is 12.6V or 12.635V?
Choose the correct instrument for the job.	A micrometer to measure the thickness of a shim.
Ensure the instrument has been looked after and calibrated when necessary.	Most instruments will go out of adjustment after a time. You should arrange for adjustment at regular intervals. Most tool suppliers will offer the service or in some cases you can compare older equipment to new stock.
Study the instructions for the instrument in use and take the reading with care. Ask yourself if the reading is about what you expected.	Is the piston diameter 70.75mm or 170.75mm?
Make a note if you are taking several readings.	Don't take a chance – write it down!

Straight edge and feelers A 'straight edge' is a piece of equipment with a straight edge! It is used as a reference for measuring flatness. It is placed on top of the test subject. The feeler blades are then used to assess the size of any gaps. The feeler blades are sized in either hundredths of a millimetre or thousandths of an inch.



Figure 4.16 Straight edge

Micrometer The most common uses for a micrometer in the motor trade are for measuring valve shims, brake disc thickness and crankshaft journals.



Figure 4.17 Feeler gauges

The spindle of an ordinary metric micrometer has two threads per millimetre, and therefore one complete revolution moves the spindle through a distance of 0.5mm. The longitudinal line on the frame is graduated with 1mm divisions and 0.5mm subdivisions. The thimble has 50 graduations, each being 0.01mm (one-hundredth of a millimetre). Thus, the reading is given by the number of millimetre divisions visible on the scale of the sleeve plus the particular division on the thimble which coincides with the axial line on the sleeve.



Figure 4.18 Zero to 25mm micrometer

Example Suppose that the thimble were screwed out so that graduation 5, and one additional 0.5 subdivision were visible (as shown in the image), and that graduation 28 on the thimble coincided with the axial line on the sleeve. The reading then would be $5.00 + 0.5 + 0.28 = 5.78\text{mm}$.



Figure 4.19 Metric system – micrometer thimble reading 5.78mm

A **dial gauge** is a device used to test the movement of something very accurately. A good example is the run out of brake discs. A plunger on the dial gauge is made to run up against the disc as it is turned. The body of the gauge is clamped in position and via accurate gears the movement of the plunger makes a hand turn on a clock dial. The face of the clock is marked off in 0.01mm increments and will usually rotate enough times to measure up to 10mm. Diesel pump timing is often set or checked with a dial gauge. The pumping plunger is made to act on the dial gauge so that, as the engine is turned, it is possible to tell the position of the injection plunger very accurately.



Figure 4.20 Dial gauge

Vernier caliper There are now three types of caliper used for accurate measuring: vernier, dial, and digital. These calipers have a calibrated scale with a fixed jaw, and another jaw, with a pointer, that slides along the scale. The distance between the jaws is then read in different ways for the three types. Vernier, dial, and digital calipers can measure internal dimensions, external dimensions using the lower jaws and, in many cases, depth by the use of a probe that is attached to the movable head and slides along the centre of the body. This probe is slender and can get into deep grooves that may prove difficult for other measuring tools. The vernier scales may include metric measurements on the lower part of the scale and inch measurements on the upper, or vice versa in countries that use inches. Vernier calipers commonly used in industry provide a precision to 0.01mm, or 0.001 inch. They are available in various sizes.



Figure 4.21 Digital caliper

Reading To take a reading on the digital type is simple as it is displayed as a figure. The dial type displays the major distance on the sliding scale and then greater accuracy is achieved by adding the reading on the dial. The vernier type (Figure 4.22) is read as follows: First read the position of the pointer directly on the millimetre scale (24mm in this case). When the pointer is between two markings (as it is here), you can mentally interpolate to improve the precision of the reading (my guess would be about 24.8). However, the addition of the vernier scale allows a more accurate interpolation. All you need to do is check which mark on the vernier scale lines up exactly with one of the main scale. In this example I would say it is the one halfway between the 7 and the 8. This means the actual measurement is 24.75mm.

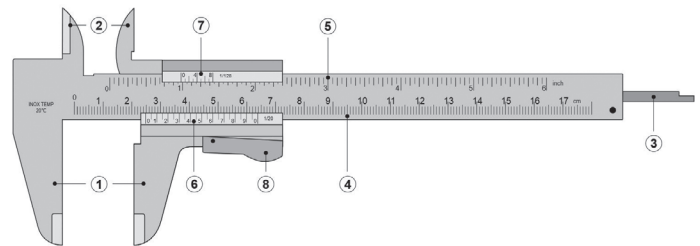


Figure 4.22 Vernier caliper – the main parts are: 1 Outside jaws: used to measure external diameter or width of an object, 2 Inside jaws: used to measure internal diameter of an object, 3 Depth probe: used to measure depths of an object or a hole, 4 Main scale: scale marked every mm, 5 Main scale: scale marked in inches and fractions, 6 Vernier scale gives interpolated measurements to 0.01mm or better, 7 Vernier scale gives interpolated measurements in fractions of an inch, 8 Retainer: used to block movable part to allow the easy transferring of a measurement

Angle locator This magnetic device is used to check that the angles of a propshaft are equal. This is important because it ensures that the changing velocity effects of the universal joints (UJs) are cancelled out.

4 Workshop skills

The angle locator attaches magnetically to the shaft. A dial is set to zero and then, when it is moved to a new location, the difference in angle is indicated.



Figure 4.23 This device checks propshaft angles

Multimeter An essential tool for working on vehicle electrical and electronic systems is a good digital multimeter (often referred to as a DMM). Digital meters are most suitable for accuracy of reading as well as other facilities.



Figure 4.24 Multimeter and current clamp

The following list of functions broadly in order, starting from essential to desirable, should be considered:

Function	Range	Accuracy
DC voltage	500V	0.3%
DC current	10A	1.0%
Resistance	0 to 10M Ω	0.5%
AC voltage	500V	2.5%
AC current	10A	2.5%
Dwell	3,4,5,6,8 cylinders	2.0%
rpm	10 000 rpm	0.2%

Function	Range	Accuracy
Duty cycle	% on/off	0.2%/kHz
Frequency	over 100kHz	0.01%
Temperature	> 9000°C	0.3% + 30°C
High current clamp	1000A (DC)	Depends on conditions
Pressure	3 bar	10.0% of standard scale

An **oscilloscope** is a very useful measuring instrument. There were traditionally two types of oscilloscope – analog or digital. However, the digital scope is now universal. An oscilloscope draws a graph of voltage (the vertical scale or Y axis) against time (the horizontal scale or X axis). The trace is made to move across the screen from left to right and then to ‘fly back’ and start again. The frequency at which the trace moves across the screen is known as the time base, which can be adjusted either automatically or manually. The signal from the item under test can either be amplified or attenuated (reduced), much like changing the scale on a voltmeter.

The trigger, which is what starts the trace moving across the screen, can be caused internally or externally. When looking at signals such as ignition voltages, triggering is often external – each time an individual spark fires or each time number one spark plug fires, for example.



Figure 4.25 Automotive Oscilloscope EV kit (Source: Pico Technology Ltd)

PicoScope The Pico automotive kit turns a laptop or desktop PC into a powerful automotive diagnostic tool for fault-finding sensors, actuators and electronic circuits. The oscilloscope connects to a USB port on a PC and can take up to 32 million samples per trace, making it possible to capture complex automotive waveforms. The scope can be used to measure and test virtually all of the electrical and electronic components and circuits in any modern vehicle including:

- ▶ ignition (primary and secondary)
- ▶ injectors and fuel pumps
- ▶ starter and charging circuits
- ▶ batteries, alternators and starter motors
- ▶ lambda, airflow, knock and MAP sensors
- ▶ glow plugs/timer relays
- ▶ CAN bus, LIN bus and FlexRay.

Waveform When you look at a waveform on a screen it is important to remember that the height of the scale represents voltage and the width represents time. Both of these axes can have their scales changed. They are called axes because the 'scope' is drawing a graph of the voltage at the test points over a period of time. The time scale can vary from a few μs to several seconds. The voltage scale can vary from a few mV to several kV. For most test measurements only two connections are needed, just like a voltmeter.

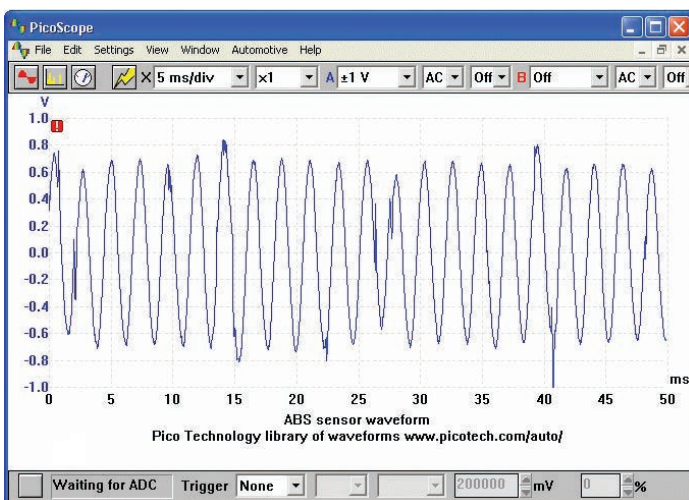


Figure 4.26 ABS waveform captured on a PicoScope



Create an information wall to illustrate the features of a key component or system.

4.2 Equipment

4.2.1 Workshop equipment 1

In addition to hand tools and test equipment, most workshops will also have a range of equipment for lifting and supporting, as well as electrical or air-operated tools. This table lists some examples of common workshop equipment together with typical uses:

Equipment	Common use
Ramp or hoist	Used for raising a vehicle off the floor. Figure 4.27 shows a two-post wheel-free type. Other designs include four-post and scissor types where the mechanism is built in to the workshop floor.
Jack and axle stands	A trolley jack (such as Figure 4.28) is used for raising part of a vehicle such as the front or one corner or side. It should always be positioned under suitable jacking points, axle or suspension mountings. When raised, stands must always be used in case the seals in the jack fail, causing the vehicle to drop.
Air gun	A high-pressure air supply is common in most workshops. Figure 4.30 is a typical wheel gun used for removing wheel nuts or bolts. Note that when replacing wheel fixings it is essential to use a torque wrench.
Electric drill	The electric drill is just one example of electric power tools used for automotive repair. Note that it should never be used in wet or damp conditions.
Parts washer	There are a number of companies that supply a parts washer and change the fluid it contains at regular intervals.
Steam cleaner	Steam cleaners can be used to remove protective wax from new vehicles as well as to clean grease, oil and road deposits from cars in use. They are supplied with electricity, water and a fuel to run a heater – so caution is necessary.
Electric welder	There are a number of forms of welding used in repair shops. The two most common are metal inert gas (MIG) and manual metal arc (MMA). Figure 4.29 shows the MMA process.
Gas welder	Gas welders are popular in workshops as they can also be used as a general source of heat, for example, when heating a flywheel ring gear.
Engine crane	A crane of some type is essential for removing the engine on most vehicles. It usually consists of two legs with wheels that go under the front of the car and a jib that is operated by a hydraulic ram. Chains or straps are used to connect to or wrap around the engine.
Transmission jack	On many vehicles the transmission is removed from underneath. The car is supported on a lift (perhaps similar to Figure 4.27) and then the transmission jack is rolled underneath. An example is shown as Figure 4.31.



Figure 4.27 Car lift (Source: asedeals.com)



Figure 4.28 Trolley jack and axle stands (Source: Snap-on Tools)



Figure 4.29 Welding process (Source: Wikimedia)



Figure 4.30 Wheel gun (Source: Snap-on Tools)



Figure 4.31 Transmission jack (Source: Snap-on Tools)

Note The following pages give an overview of some of the equipment you will need to become familiar with – there is a lot more! As you study each main chapter it may be useful to refer back to the tools and equipment presented here.

AC servicing unit Most modern servicing units can be used to drain, recycle, evacuate and refill air conditioning systems. Some older types would only carry out individual procedures. Note that different servicing units are required for R12 and R134a refrigerants and their oils must not be mixed with one another. If work is to be carried out on an air conditioning system, a servicing unit is essential. Refrigerant must never be released into the atmosphere.

Coil spring compressors Springs must be compressed before they are removed from suspension struts. A number of different tools are available. However, the type shown here is very

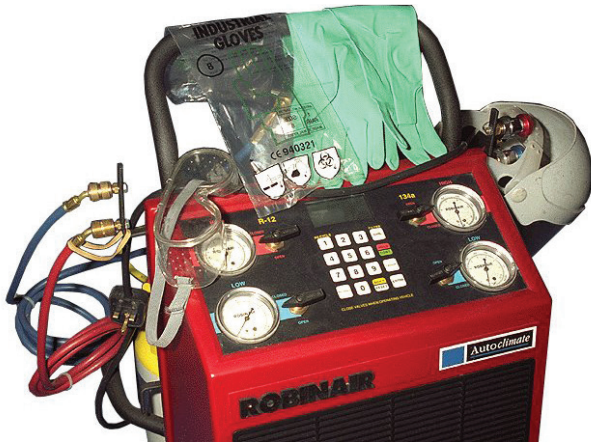


Figure 4.32 AC servicing equipment

popular. The two clamps are positioned either side of the spring using the hooked ends. The bolts are then tightened evenly until the tension of the spring is taken by the clamps.



Figure 4.33 MacPherson springs must be compressed for removal

Ball joint presses To remove a taper fitting ball joint, a splitter or press is usually needed. If the joint is to be reused, a lever- or clamp-type splitter is preferred. The tool clamps onto the arm and threaded section of the joint. A bolt is tightened, which applies a force to push the joint free.



Figure 4.34 This clamp removes tapered ball joints

Ball joint splitter Two types of ball joint splitter are in common use. One type is a simple forked wedge that is hammered in between the joint and the arm. This works well but can damage the joint. If the joint is to be reused, the lever-type splitter is preferred. This tool clamps onto the arm and threaded section of the joint. A bolt is tightened, which applies a force to push the joint free.



Figure 4.35 Lever-type splitter

A **pipe clamp** is used to block a pipe for tests or repairs to be carried out. For example, on a braking system, it can be used to prevent leakage of fluid when cylinders are replaced. Alternatively, the source of spongy brakes can be narrowed down. This is done by clamping each flexible pipe in turn and pressing the pedal. However, some manufacturers do not recommend these tools because the pipe can be damaged.



Figure 4.36 Only use recommended types

Pressure bleeder This equipment forces fluid through the reservoir under pressure. The tank is in two parts, separated by a diaphragm. The top of the tank is filled with new brake fluid and the lower part pressurised