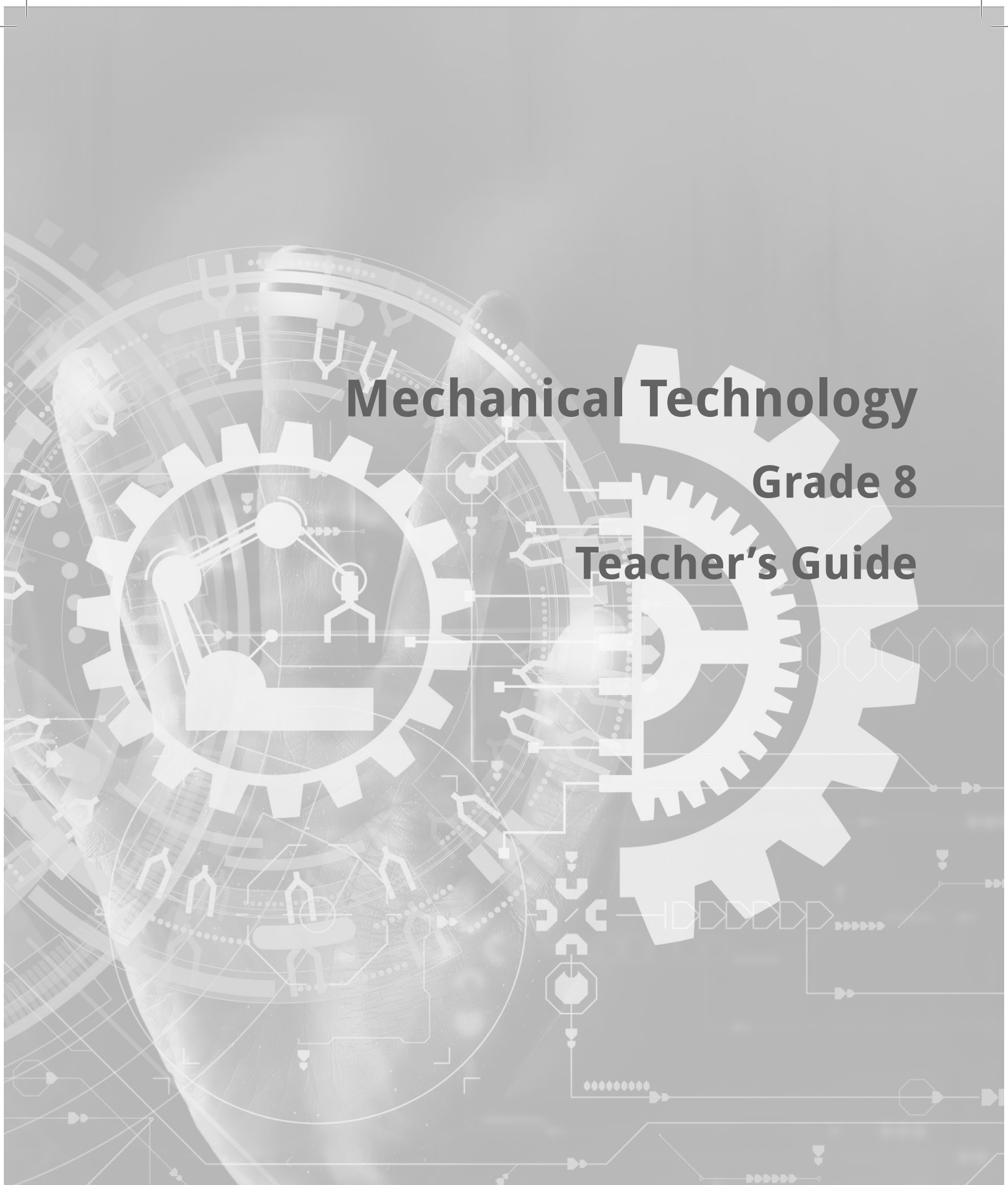

Mechanical Technology

Grade 8

Teacher's Guide

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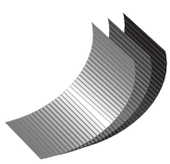

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INTRODUCTION TO

Mechanical Technology

1. What is Mechanical Technology?

Mechanical Technology focuses on concepts and principles in the mechanical (motor, mining, shipping, rail, power-generation, etc.) environment and on technological processes. It embraces practical skills and the application of scientific principles. This subject aims to create and improve the engineering and manufacturing environment to enhance the quality of life of both the individual and society alike and ensure the sustainable use of the natural environment and resources.

It consists of the following subjects:

- Manufacturing (Fitting & Machining)
- Motor Mechanics
- Welding
- Bodyworks.

Embedded in this subject are the following disciplines:

- Motor mechanics: includes encompassing petrol- and diesel-driven vehicles, motorcycles, lawnmowers and tractor mechanics
- Manufacturing: includes turning, milling, cutting, shaping, fitting of keys, couplings, bushes, shafts and bearings
- Welding: includes welding (gas, electric, MIG/MAGS), developments, working with sheet metal and the manufacturing of structures
- Bodyworks: includes panel beating and spray painting of vehicles and motorcycles.

The foundations of Mechanical Technology

During the activities, the learner engages in investigating, diagnosing, adjusting, removing, replacing, designing, manufacturing and applying the necessary skills to provide solutions to problems in mechanical systems, processes and components. Mechanical Technology is however not limited to these processes.

It affords learners with opportunities for life-long learning, self-development, empowerment, awareness of human rights and exposure to socio-economic and environmental injustices, access to the latest international trends and innovations and an awareness of the process of globalisation.

Valuing indigenous knowledge systems, it acknowledges the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution.

Apply solutions – vocational-specific learning

This learning describes a core set of skills that can be developed through projects, simulations and real-life applications that are needs-driven and sensitive to environmental impact. An integrating approach to structuring projects that develop the learner's skills, knowledge, values and attitudes in a holistic way should be adopted.

- Repair/Make/Maintenance:
  This aspect provides the opportunity for the learner to use tools, equipment and materials to solve/monitor identified problems, needs or opportunities. The making should be according to the specific design or the manufacturer's specifications. Repairs include the removal of defective parts and the replacement of fixed or new parts. All work must always be undertaken in a safe and healthy environment. The necessary safety measures and precautions against injuries should be applied with due consideration to HIV/AIDS.

- Evaluate:
  The learner has to evaluate products, actions, decisions and results throughout the process, and where necessary changes or improvements should be recommended and implemented. Evaluation should be done against the applicable criteria that may be given or developed. This stage requires the use of probing questions, fair testing and analysis.

- Communicate:
  The assessment evidence of the process followed in any project is the ability to analyse, investigate, plan, design, draw, report, evaluate and communicate. All reports, designs, assessment forms and assessment records should be kept in a portfolio file.

- Career pathways:
  The curriculum is designed to incorporate the career fields of manufacturing, motor mechanics, welding and bodyworks.

  Elements of entrepreneurship have been included to provide learners with the ability to identify business opportunities in the engineering industry.

1.1 Manufacturing

Also known as *Fitting and Machining* or *Turning*, Manufacturing focuses on the manufacturing and machining of machine parts using processes such as lathe turning, milling, cutting, shaping, fitting of keys, couplings, bushes, shafts and bearings. Turning is a machining process in which a cutting tool, typically a non-rotary tool bit, moves more or less linearly while the workpiece rotates. Turning can be done manually, in a traditional form of lathe, or by using an automated lathe. Today the most common type of such automation is computer numerical control, better known as CNC. (CNC is also commonly used with many other types of machining besides turning.)

When turning, a piece of relatively rigid material is rotated, and a cutting tool is traversed along axes of motion to produce precise diameters and depths. Turning can be either on the outside of the cylinder or on the inside (also known as *boring*) to produce tubular components of various geometries.

The turning processes are typically carried out on a lathe, considered to be the oldest machine tool, and can be of four different types, namely straight-turning,

taper-turning, profiling or external-grooving. These types of turning processes can produce various shapes of materials such as straight, conical, curved or grooved workpieces. In general, turning uses simple, single-point cutting tools. Each group of workpiece materials has an optimum set of tool angles that have been developed through the years.

Milling operates on the principle of rotary motion. A milling cutter is spun about an axis while a workpiece is advanced through it in such a way that the cutters are able to shave chips of material. This non-continuous cutting operation means that no surface cut by a milling machine will ever be completely smooth; at a very close level (microscopic for very fine feed rates), it will always contain regular ridges.

1.2 Motor Mechanics

Motor Mechanics encompasses petrol- and diesel-driven vehicles, motorcycles, lawn mowers, generators and tractor mechanics.

The *automotive industry* is a term that covers a wide range of companies and organisations involved in the design, development, manufacture, repair, marketing, aftermarket products and selling of motor vehicles, motorcycles and mopeds and the recovery and repair of damaged and stolen vehicles. It is one of the world's most important economic sectors by revenue.

Modern automotive engineering, along with aerospace engineering and marine engineering, is a branch of vehicle engineering, incorporating elements of mechanical, electronic, software and safety engineering as applied to the design, manufacture and operation of motorcycles, automobiles, buses and trucks and their respective engineering subsystems. This includes entities such as safety engineering, fuel economy/emissions, vehicle dynamics (ride, handling, steering, braking, comfort and traction), design of the chassis systems of suspension (steering, braking, structure/frame, wheels and tires, and traction control), vehicle electronics (responsible for operational controls such as the throttle, brake and steering controls as well as many comfort and convenience systems such as the HVAC, infotainment and lighting systems; it would not be possible for automobiles to meet modern safety and fuel economy requirements without electronic controls), shift quality (as influenced by the powertrain [engine, transmission], and the vehicle [driveline, suspension, engine and powertrain mounts, etc.], and drivability (cold starts and stalls, RPM dips, idle response, launch hesitations and stumbles, and performance levels).

1.3 Welding

Welding includes welding (gas, electric, MIG/MAGS) developments, working with sheet metal and the manufacturing of structures.

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the workpieces to form a bond between them, without melting the workpieces.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction and ultrasound. While often an industrial process, welding may be performed in many different environments, including in the open air, under water and in outer space. Welding is a potentially hazardous undertaking and precautions are required to avoid burns, electric shock, vision damage, inhalation of poisonous gases and fumes, and exposure to intense ultraviolet radiation.

Modern welding techniques include manual methods such as shielded metal arc welding, now one of the most popular welding methods, as well as semi-automatic and automatic processes such as gas metal arc welding, submerged arc welding, flux-cored arc welding and electro-slag welding. Developments continued with the invention of laser beam welding, electron beam welding, electromagnetic pulse welding and friction stir welding in the latter half of the century. Robot welding is commonplace in industrial settings, and researchers continue to develop new welding methods and gain greater understanding of weld quality.

Metalworking is the process of working with metals to create individual parts, assemblies or large-scale structures. The term covers a wide range of work, from large ships and bridges to precise engine parts and delicate jewellery. It therefore includes a correspondingly wide range of skills, processes and tools. Metalworking is a science, art, hobby, industry and trade. Modern metalworking processes, although diverse and specialised, can be categorised as forming, cutting or joining processes. Today's machine shop includes a number of machine tools capable of creating a precise, useful workpiece.

2. Topics to be studied in Mechanical Technology

1. Safety and first aid – Occupational Health and Safety (OHS)
2. Graphic communication (Engineering Graphics and Design) (rough sketches, simple drawing ISO and orthographic)
3. Tools, instruments and equipment (hand, power and machine)
4. Entrepreneurship
5. Materials – ferrous and non-ferrous materials
6. Joining methods – permanent and semi-permanent
7. Terminology (operations/procedures and equipment)
8. Maintenance (operations/procedures and equipment)
9. Bodyworks (operations/procedures and equipment)

3. Specific aims

The learner is able to do the following:

1. Adhere to and identify safe working practices and demonstrate safe working conditions daily, also adopting proper safety and first-aid procedures
2. Demonstrate knowledge of the mechanical industry and its productivity requirements by applying appropriate work procedures.
3. Understand and interpreting work instructions and drawings for the completion of projects
4. Apply mechanical technology, techniques, processes and skills, as applied in the fabrication and mechanical industry, using appropriate tools and measuring equipment
5. Identify ferrous and non-ferrous metals, alloys and plastics with their differences, applications and uses
6. Demonstrate the joining methods and processes:
7. Use vehicle-lifting equipment
8. Identify and maintain (car) batteries
9. Lubricate machine components
10. Explain fundamental machine technology
11. Remove and fit automotive components
12. Assemble mechanical components
13. Carry out an automotive service.

4. Requirements for Mechanical Technology as a subject

4.1 Time allocation

The total number of hours allocated for the subject in a five-day cycle is 2 hours. Sufficient time must be allocated in the school timetable for the practical work required to be done.

4.2 Resources

Mechanical Technology requires a trained subject specialist (should be a person that has at least five years' industry experience). It is preferred that the educator offering Mechanical Technology is an artisan, technician or technical educator who has worked in the mechanical industry.

Mechanical Technology educators are required to do the following:

- Teach the subject content with confidence and professionalism and in a relaxed but firm manner
- Plan and execute theory and practical lessons/work/demonstrations in a manner that would be suitable for the learners
- Provide a workshop that is properly equipped, clean and safe and first-aid-friendly for learners
- Keep proper records of all learners and results from all SBAs and PATs
- Implement innovative methods to keep learners interested in the subject
- Maintain and service the workshop, tools and instruments
- Produce working PATs for learners, one for every term and scaled at the learners' ability
- Carry out SBAs regularly, at the end of every term, and correctly break down learners' progress.

Each learner should be in possession of the following:

- Workbooks
- Overall
- School leather shoes or safety shoes.

4.3 Infrastructure, equipment and budget

Schools must ensure that teachers have the necessary infrastructure, equipment and financial resources for quality teaching and learning.

Infrastructure:

- Mechanical Technology cannot be implemented in a school without an equipped workshop.
- Electricity supply to the workshop is crucial, preferably a three-phase, four-wire supply, but at least single-phase with a high-current circuit-breaker.

- Lighting and ventilation are of extreme importance and a workshop should ideally have multiple exits with doors that open outward.
- Tools and equipment should have sufficient storage and well-secured storage management systems with an up-to-date inventory.
- Shelves should be clearly marked and storage areas defined.
- Good housekeeping principles require that all workshops be cleaned regularly.
- A suitable waste removal system should be in place to accommodate refuse, off-cut materials as well as chemical waste.
- The requirements of the Occupational Health and Safety (OHS) Act 85 of 1993 need to be complied with at all times.
- Machinery on stands should be permanently affixed to the floor, with isolation switches for the mains supply.
- All machines should have working machine guards.
- Mechanical motors should ideally be painted bright orange.
- Specification plates should be clearly legible.
- The workshop must have a lockable mains distribution board.
- The workshop must be fitted with an emergency cut of switch which is easily accessible at all times.
- The red, mushroom-type emergency switch should preferably be lockable to prevent accidental reconnection with the mains in the case of it being activated.
- Safety rules must be displayed on posters in the workshop.

Finances: Budget and inventory

A budget must be allocated for the subject. The amount will be determined by the number of learners taking the subject across all the years and the nature of the practical work required as stipulated in the curriculum. The budget needs to be revised annually and must consider all resources needed per year. The funding must make provision for the maintenance of equipment and replacement over the years.

Resourcing could be sub-divided into the following categories:

- Safety equipment
- Tools and equipment
- Consumable materials
- Practical assessment
- Task resources (PATs)
- Teaching and learning support material
- Maintenance.

A stock inventory must be quarterly maintained by the teacher and verified annually by a senior management team member.

5. Career opportunities

Career and occupational opportunities for learners with a foundation in Mechanical Technology include, but are not limited to, the following:

- Fitter
- Machinist
- Gunsmith
- Motor mechanic
- Diesel mechanic
- Motorbike mechanic
- Farm mechanic
- Technician
- Instrument specialist
- Vehicle designer
- Auto electrician
- Specialised engine tuner and diagnostic analyst
- Suspension builder
- Blacksmith
- Jeweller
- Rigger
- Welder
- Boilermaker
- Panel beater
- Exhaust fitter
- Brake and clutch fitter and machinist
- Upholsterer
- Draughtsman
- Toolmaker
- Automotive machinist and fitter
- Engine rebuilder
- Transmission machinist
- Roof truss developer
- Technical teacher
- Lecturer
- Technical trainer, etc.

6. Assessment

Assessment is a continuous planned process of identifying, gathering and interpreting information about the performance of learners, using various forms of assessment. It involves four steps: generating and collecting evidence of achievement evaluating this evidence, recording the findings and using this information to understand and thereby assist learners' development in order to improve the process of learning and teaching.

Assessment involves activities that are undertaken throughout the year. In Grades 8 to 9 assessment should be both informal (assessment for learning) and formal (assessment of learning). In both cases, regular feedback should be provided to learners to enhance the learning experience.

Evidence of all assessments, including tests, simulations and tasks, should be placed in learners' scripts. It is imperative that all items are marked clearly. Items that are loose should be pasted into the script to become a permanent part of learners' records.

All items in the learners' scripts must contain the following references:

- Date
- Topic
- Homework assignments, including a textbook page and exercise reference
- Evidence of scrutiny and interaction from the teacher in red pen
- All teacher actions/interventions in the script should be dated
- Learners are required to mark all self-assessments in pencil and all corrections must be shown in pencil.

As the script is a formal assessment document, learners are required to cover and keep the scripts neat and clean. The teacher is required to provide guidance in this respect. Apart from the learners' scripts, no additional files or portfolios are required.

6.1 Informal or daily assessment

Assessment for learning has the purpose of continuously collecting information on learners' achievements that can be used to improve their learning.

Informal assessment is a daily monitoring of learners' progress. This is done through observations, discussions, practical demonstrations, learner–teacher conferences, informal classroom interactions, etc. Informal assessment may be as simple as stopping during the lesson to observe learners or to discuss with learners how learning is progressing. Informal assessment should be used to provide feedback to the learners and to inform planning for teaching, but need not be recorded. It should not be seen as separate from learning activities taking place in the classroom. Learners or teachers can mark these assessment tasks.

Self-assessment and peer assessment actively involve learners in assessment. This is important, as it allows learners to learn from and reflect on their own performance. The results of the informal daily assessment tasks are not formally recorded unless the teacher wishes to do so. In such instances, a simple checklist may be used to record this assessment. However, teachers may use learners' performance in these assessment tasks to provide verbal or written feedback to learners, the SMT and parents. This is particularly important if barriers to learning or poor levels of participation are encountered. The results of daily assessment tasks are not taken into account for promotion and certification purposes.

6.2 Formal assessment

All assessment tasks that make up a formal programme of assessment for the year are regarded as formal assessment. Formal assessment tasks are marked and formally recorded by the teacher for progression and certification purposes. All formal assessment tasks are subject to moderation for the purpose of quality assurance and to ensure that proper standards are maintained.

Formal assessment provides teachers with a systematic way of evaluating how well learners are progressing in a grade and in a particular subject. Examples of formal

assessments include projects, oral presentations, demonstrations, performances, tests, examinations, practical tasks, etc. Formal assessment tasks form part of a year-long formal programme of assessment in each grade and subject.

Formal assessment tasks are school-based and are weighted as follows for the different grades:

Grades	Formal school-based assessments	End-of-year examinations
R–3	100%	–
4–6	75%	25%
7–9 Academic stream	40%	60% (external examination)
8 Occupational/ Vocational stream	60%	40% (internal examination)
9 Occupational/ Vocational stream		40% (external examination)
10–11	25% (including a mid-year examination)	75% (external examination)
12	25% (including mid-year and trial examinations)	75% (external examination)

The cognitive demands in assessment should be appropriate for the age and developmental level of the learners in the grade. Assessment in Mechanical Technology must cater for a range of cognitive levels and abilities of learners. The assessment tasks should be carefully designed to cover the content of the subject as well as the range of skills and the cognitive levels that have been identified in the specific aims. The design of assessments should therefore ensure that a full range of content and skills are assessed within each grade in the phase. The specific aims, topics, content and range of skills in the subject should be used to inform the planning and development of assessments.

Formal assessments must cater for a range of cognitive levels and abilities of learners, as shown below:

Cognitive levels	Low order	Medium order	High order
Percentage of task	50%	30%	20%

6.3 Programme of assessment

<table>
<tr><th rowspan="2">Grade 8</th><th colspan="3">Formal school-based assessments</th><th>Final end-of-year assessments</th></tr>
<tr><th>Term 1</th><th>Term 2</th><th>Term 3</th><th>Term 4</th></tr>
<tr><td rowspan="2">Assignment (theory) 40%
Practical task 60%</td><td rowspan="2">June examination 40%
Practical task 60%</td><td rowspan="2">Test 40%
Practical task 60%</td><td rowspan="3">Examination 100%</td></tr>
<tr><td>Term report</td><td>100%</td><td>100%</td><td>100%</td></tr>
<tr><td>End-of-year</td><td colspan="3">School-based assessment (SBA) 60%</td><td>Examination 40%</td></tr>
<tr><td>Promotion/ progression</td><td colspan="4">SBA + end-of-year (internal) examination = promotion
60% + 40% = 100%</td></tr>
</table>

Compilation of school-based assessment:

Grade 8			
Description	**Timeframe**	**Weighting of final mark**	**Mark allocation**
Assignment	Term 1	4%	50
Practical		8%	50
June examination	Term 2	8%	80
Practical		8%	50
Test	Term 3	4%	50
Practical		8%	50
Internal examination	Term 4	60%	120

Assignment

An assignment is a short task of 1 hour and includes activities such as translation activities, analysis and interpretations of data, research, case study, calculations and drawings and justifying of conclusions. It could further include an activity that the learners do that simulates a Mechanical Technology activity or action. This could include the building of models, computer simulations, planning documents, data gathered from experiments, etc. that are based on a specific technological activity. It should cover all content of Term 1 with a mark allocation of 50 marks. The forms of assessment used should be age- and developmental-level appropriate. The design of these tasks should cover the content and context of the subject and include a variety of tasks designed to achieve the objectives of the subject.

Test

A test for formal assessment should not comprise of a series of small tests. A test should cover Term 3 content and should be set for 60 minutes with a mark allocation of 50 marks (allocate 1 mark per fact). The test must cater for a range of cognitive levels. The design of the task should cover the content and context.

Examination

Each examination must cater for a range of cognitive levels. For Grade 8, the one-hour mid-year (June) examination in Mechanical Technology comprises 80 marks. The mid-year examination should cover Term 1 and Term 2 content. For Grade 8, the 1 hour 30 minutes' final examination in Mechanical Technology comprises 120 marks. The final examination should cover all Term 1 to Term 4 content in Grade 8. The assignment, Term 3 test and mid-year examination and final examination question papers are set by the teacher. The question papers must be moderated by the head of department at the school and approved by the district curriculum advisors/facilitator. This is done to ensure that the prescribed weightings are adhered to by the teacher.

6.4 Test weighting in Mechanical Technology

Term 3 test (50 marks)

Note that a variation of ± 3 marks is allowed.

Topic	Grade 8	
	Percentage	Marks
Maintenance	24%	12
Bodyworks	38%	19
	7,5%	19
Total		**50**

6.5 Examination weighting in Mechanical Technology

June examination (80 marks)

Note that a variation of ± 3 marks is allowed.

Topic	Grade 8	
	Percentage	Marks
Section A (Generic)		
Safety	12,5%	10
Graphic communication	12,5%	10
Entrepreneurship	7,5%	6
Section B (Subject specific)		
Tools, instruments and equipment	15%	12
Materials	7,5%	6
Joining methods	10%	8
Terminology	35%	28
Total	**100%**	**80**

November examination (120 marks)

Note that a variation of ± 3 marks is allowed.

Topic	Grade 8	
	Percentage	Marks
Safety	5,8%	7
Graphic communication	5,8%	7
Entrepreneurship	8,3%	10
Section B (Subject specific)		
Tools, instruments and equipment	3,3%	4
Materials	3,3%	4
Joining methods	8,5%	10
Terminology	30%	36
Maintenance	20%	24
Bodyworks	15%	18
Total	**100%**	**120**

6.6 Clarification on theory assessment periods

- Term 1 theory assessment (an assignment) should cover Term 1 content only.
- Term 2 theory assessment (mid-year examinations) should cover terms 1 and 2 content only.
- Term 3 theory assessment (test) should cover Term 3 content only.
- Term 4 theory assessment should cover terms 1, 2, 3 and 4 (internal examination).

7. Recording and reporting

Recording is a process in which the teacher documents the level of a learner's performance in a specific assessment task. It indicates learner progress towards the achievement of the knowledge as prescribed in the Curriculum and Assessment Policy Statements. Records of learner performance should provide evidence of the learner's conceptual progression within a grade and his/her readiness to progress or promote to the next grade. Records of learner performance should also be used to verify the progress made by teachers and learners in the teaching and learning process.

Reporting is a process of communicating learner performance to learners, parents, schools and other stakeholders. Learner performance can be reported in a number of ways. These include report cards, parent meetings, school visitation days, parent–teacher conferences, phone calls, letters, class or school newsletters, etc. Teachers in all grades report in percentages against the subject. Seven levels of competence have been described for each subject listed for grades R–12. The various achievement levels and their corresponding percentage bands are as shown in the table below.

Codes and percentages for recording and reporting

Rating code	Description of competence	Percentage
7	Outstanding achievement	80–100
6	Meritorious achievement	70–79
5	Substantial achievement	60–69
4	Adequate achievement	50–59
3	Moderate achievement	40–49
2	Elementary achievement	30–39
1	Not achieved	0–29

Note: The seven-point scale should have clear descriptors that give detailed information for each level.

Teachers will record actual marks against the task by using a record sheet, and report percentages against the subject on the learners' report cards.

8. Moderation of assessment

Moderation refers to the process that ensures that the assessment tasks are fair, valid and reliable. Moderation should be implemented at school, district, provincial and national levels. Comprehensive and appropriate moderation practices must be in place for the quality assurance of all subject assessments.

Formal assessment (SBA)

Moderation of written tests and examinations will be conducted by the curriculum advisor/facilitator or a peer teacher.

Grade 8 tasks are internally moderated, except for the PAT, which is externally moderated. The curriculum advisor/facilitator must moderate a sample of these tasks during school visits to verify the standard of the internal moderation.

Moderation of written tests constitutes a re-mark of the learner's work to ensure that the assessment by the teacher is correct. Moderation should be done on three tiers: school, district and province.

School-based moderation requires the head of department to check the following:

Work done by learners complies with the following requirements:

- Classwork and homework must reflect the textbook page and exercise reference.
- Learner scripts should show scrutiny and interaction from the teacher in red pen.
- All teacher actions/interventions in the script must be dated.
- Learners are required to mark all self-assessments in pencil and all corrections to be shown in pencil.

9. Practical Assessment Task (PAT)

The Department of Basic Education issues a Practical Assessment Task for Grade 9 every year. The format of the Grade 9 PAT is duplicated for Grade 8.

In all grades, each learner must do a PAT for the year.

Grade 8: Teachers will set and assess the PAT and it will be moderated externally by the curriculum advisor/facilitator.

The provincial Education departments or schools may not change or use the task of the previous year. Provisioning of the resources for the PAT is the responsibility of the school and schools should ensure that adequate time and funding is allocated for the completion of the PAT. Practical sessions should be scheduled in such a way that learners have enough time to practise skills

needed for the completion of the PAT. Weekly practice sessions are necessary for learners to hone the needed skills.

The ratio of learners per teacher for all practical work is 1 teacher per 15 learners or part thereof. For groups exceeding 15, this means that multiple teachers would be required inside the workshop while practical work is being conducted. Alternatively, groups should be split into numbers below 15 to ensure that a ratio of 1:15 is not exceeded at any time. The motivation for smaller groups lies in the differentiation and mentoring of technical skills that require one-on-one contact between teacher and learner. The safety of learners is paramount and smaller groups would ensure compliance with the OHS Act 87 of 1993.

IMPORTANT: The completed PAT will be made up from different phases and tasks.

Although the final PAT only needs to be completed in the third term, learners should start working on Phase 4 from the first term in order to avoid running out of time to complete the PAT.

10. Work schedule

Lessons	Module	Topics	Activity	Hours
		TERM 1		
±5	**Module 1** Health and safety	1.1 Workshop orientation 1.2 Workshop rules and procedures 1.3 Personal safety equipment 1.4 Safety signs 1.5 Emergency evacuation procedure 1.6 Basic first aid 1.7 Types of injuries	Activity 1.1 Practical activity 1.1 Activity 1.2 Activity 1.3 Activity 1.4 Activity 1.5 Summative assessment	4 hours
±6	**Module 2** Graphic communication	2.1 What is graphic communication? 2.2 The purpose of graphic communication 2.3 General drawing principles 2.4 Drawing instruments 2.5 Linework 2.6 Dimensioning, lettering and borders 2.7 Freehand sketching 2.8 Scale drawing 2.9 Pictorial drawing	Activity 2.1 Practical activity 2.1 Activity 2.2 Activity 2.3 Summative assessment	5 hours
±6	**Module 3** Tools, instruments and equipment	3.1 Hand tools 3.2 Measuring instruments 3.3 Lifting equipment 3.4 Bench grinders	Activity 3.1 Activity 3.2 Activity 3.3 Summative assessment	5 hours

Lessons	Module	Topics	Activity	Hours
±3	**Module 4** Entrepreneurship	4.1 Who is an entrepreneur? 4.2 Different types of entrepreneurship 4.3 How do you know whether you would be a good entrepreneur? 4.4 Marketing and branding products 4.5 Advertising on different media platforms	Practical activity 4.1 Practical activity 4.2 Practical activity 4.3 Practical activity 4.4 Summative assessment	2 hours
REVISION **Term 1 Assignment (covers all work done in Term 1)** Assignment = 50 marks (40%) Practical = 50 marks (60%) Time: 1 hour				
TERM 2				
±5	**Module 5** Materials	5.1 Ferrous metals 5.2 Non-ferrous metals 5.3 Sheet metals	Practical activity 5.1 Summative assessment	4 hours
±5	**Module 6** Joining methods	6.1 Permanent joining methods 6.2 Semi-permanent joining processes	Activity 6.1 Summative assessment	4 hours
±9	**Module 7** Terminology	7.1 Machines used in the fitting and machining workshop 7.2 Engine components 7.3 Engines 7.4 Fundamentals of engine technology	Activity 7.1 Practical activity 7.1 Activity 7.2 Summative assessment	8 hours
REVISION **Examination Term 2 (covers all work done in Terms 1 and 2)** Examination = 80 marks (40%); Time: 1 hour Practical = 50 marks (60%)				

Lessons	Module	Topics	Activity	Hours
		TERM 3		
±7	**Module 8** Maintenance	8.1 Lubrication 8.2 Automotive batteries	Activity 8.1 Activity 8.2 Practical activity 8.1 Summative assessment	6 hours
±9	**Module 9** Bodyworks	9.1 Panel beating 9.2 Spray-painting	Practical activity 9.1 Practical activity 9.2 Practical activity 9.3 Practical activity 9.4 Summative assessment	8 hours
REVISION **Assessment (covers all work done in Term 3)** Test = 50 marks (40%); Time: 1 hour Practical = 50 marks (60%)				
		TERM 4		
±11	Revision and practicals	Module 1: Health and safety Module 2: Graphic communication Module 3: Tools, instruments and equipment Module 4: Entrepreneurship Module 5: Materials Module 6: Joining methods Module 7: Terminology Module 8: Maintenance Module 9: Bodyworks	Revision quiz 1 Revision quiz 2 Revision quiz 3 Practical activity 1 Revision quiz 4 Revision quiz 5 Revision quiz 6 Practical activity 2 Revision quiz 7.1 Revision quiz 7.2 Revision quiz 8 Revision quiz 9	10 hours
REVISION **November examination** Examination = 120 marks (40%); Time: 1 hour 30 minutes Practical = 50 marks (60%)				

MODULE 1

Health and safety

After they have completed this module, learners should be able to:

- follow the rules and procedures that apply in the workshop;
- explain and apply the necessary safety measures;
- define the term *accident* and discuss the causes of accidents in the workshop;
- recognise unsafe acts and conditions in the workshop;
- define *good housekeeping* and practise this in the workshop;
- identify and correctly use personal safety equipment;
- interpret safety signs used in the work environment;
- follow the emergency evacuation procedure applicable to the workshop;
- define *first aid*;
- list items that should be included in a first-aid kit;
- explain what HIV/AIDS is as well as how the disease is transmitted;
- discuss basic first-aid incident management; and
- identify and treat the types of injuries discussed in this module.

Time allocated: 4 hours (±5 lessons)

Introduction

This is a generic module that is used across various vocational subjects.

Lesson 1 – Outline

- Workshop orientation – show learners around the workshop, discuss layout and storage, etc.
- Workshop rules and procedures
  - Note that only general/basic points are covered.
  - Focus on any rules that apply to the subject being taught.
- Workshop safety
  - Definition of accident
  - Unsafe acts and conditions
    - Relate these to the subject being taught.
  - Good housekeeping
    - Add any details that apply to your specific workshop.
- **Homework:** Activity 1.1

Activity 1.1 (LB page 6)

1. **Explain why health and safety rules are necessary.**

   These rules protect workers from injuries and illness; they protect visitors to the workplace and they prevent accidents by making sure that people obey basic safety rules.

2. **Why do you think an overall is necessary when you are doing practical work?**

   Learner's opinion. Accept any relevant answer, e.g.:
   It protects your clothes/body; keeps your clothes clean; covers loose clothing that can be caught in the machinery; provides an extra protective layer between your skin and any hazardous materials you may spill.

3. **List FIVE unsafe acts that may lead to accidents in the workshop.**

   Any FIVE:
   - Working at an unsafe speed
   - Handling equipment without permission or proper supervision and training

Continued →

Activity 1.1 (LB page 6) (continued)

- Placing materials or leaving objects in dangerous places
- Working on or adjusting machines that are in motion
- Behaving recklessly, e.g. running or playing in the workshop
- Being in a dangerous spot, e.g. too close to a moving machine part
- Not wearing personal protective equipment

4. **Why is good housekeeping so important? Provide FOUR reasons.**

   - No time is wasted looking for tools, material and equipment.
   - Space is saved because everything is neatly stacked or stored.
   - The risk of accidents/injuries is reduced.
   - Fire hazards are reduced.

5. **Refer to Figure 1.3.**
   List THREE hazards that may cause accidents.

   - The broom, bucket and roller are tripping hazards.
   - The cloth prevents safe use of the railings.
   - The nails in the plank can injure a foot.
   - The box filled with rubbish is a fire risk.

Lesson 2 – Outline

- Mark homework (Activity 1.1) – suggested answers provided
- PPE
  - Have examples of all the PPE in class for learners to handle and for later use.
  - Add whatever additional gear may be used in your field.
  - Relate the equipment to the vocational subject being taught.
  - Discuss dangers of not wearing PPE when performing tasks related to subject-specific work.
- Safety signs
  - Introduction: Function and importance of signs
  - Categories of signs
- Practical activity 1.1 – as set out on the next page
  Set the date for handing in posters and decide on assessment (peer mark/self-assessment or to be assessed by teacher).
- **Homework:** Activity 1.2

Practical activity 1.1 (LB page 9) Group and individual activity

- Divide the class into five groups according to the categories of safety signs: Prohibition/Danger, Mandatory, Warning/Caution, Emergency/Safety and Fire safety.
- **Each member of the group** must make an A4-size poster of **one** of the safety signs in the category assigned to the group.
- Give the groups 10 minutes to divide the signs among members. There must be no duplication of signs. If more signs than those that appear in the Learner's Book are needed, provide additional examples (Internet or other sources).

Learners complete the assignment individually (homework).

The teacher will divide the class into groups according to the various categories of safety signs.

- Prohibition/Danger
- Mandatory
- Warning/Caution
- Emergency/Safety
- Fire safety.

Instructions

1. Discuss the signs that fall into the category assigned to your group. Divide the signs among the group members – *no duplication is allowed*.
2. Make an A4-size poster of the safety signs assigned to you.

Evaluation and assessment

The following criteria will be used to assess your poster:

Criteria	Mark	Mark obtained
Correctness of sign/symbol:		
• Colour	4	
• Shape	4	
• Category	4	
• Neatness	3	
Total	**15**	

Activity 1.2 (LB page 10)

1. **What is the purpose of safety signage in the workplace?**

   The safety signs help workers to identify hazards and remind them of important safety rules. In short, safety signs:

   - communicate important instructions quickly and effectively;
   - serve as warning;
   - reinforce safety messages; and
   - provide instruction for emergency situations.

2. **For each of the safety signs listed here, write down:**
   (a) whether it is a prohibition, mandatory, warning or emergency sign; and
   (b) the meaning of the sign.

   2.1 
   2.2 
   2.3 
   2.4 

   2.1 (a) Mandatory; (b) Carry out specific action (wear eye and ear protection)
   2.2 (a) Warning; (b) Be careful/take precautions (possible lethal/deadly materials/conditions/area)
   2.3 (a) Emergency sign; (b) Safe route
   2.4 (a) Prohibition; (b) Action forbidden (no cell phone allowed)

3. **Give ONE good reason why each of the following items of personal safety equipment must be used:**

   3.1 Hard hat

   Hard hat protects the head from falling objects; should you bump your head

   3.2 Safety glasses

   To protect the eyes from dust/flying bits when drilling, grinding, etc.; harmful liquids or gas

   3.3 Dust mask

   Protects nose and mouth; prevents inhalation of harmful fumes/dust and mists

   3.4 Gloves

   Protect hands from harmful/corrosive materials, cuts, heat

Lesson 3 – Outline

- Mark homework (Activity 1.2)
- Collect posters (Practical activity 1.1) on due date and assess as planned.
  - Post signs in class and regularly quiz learners.
- Emergency evacuation procedure
  - Discuss the emergency procedure applicable to your school.
  - Practical 3
- Introduction to first aid
  - Define first aid.
  - Discuss infectious diseases and HIV/AIDS and how diseases are transmitted.
- The first-aid kit
  - Have an example of a first-aid kit in class.
  - Show examples of the items listed in the textbook and discuss any other items included in the workshop kit.
- **Homework:** Activity 1.3 – to be marked at the beginning of next lesson

Activity 1.3 (LB page 15)

1. What is the purpose of an emergency evacuation plan?

The purpose of this procedure is to warn all the occupants of a building that a dangerous situation has arisen, and everyone must leave immediately upon hearing the alarm.

2. Define each of the following terms:

2.1 *First aid*

First aid refers to the simple and immediate medical help that is given when an accident occurs or in case of sudden illness, in other words before/until full medical treatment is available.

2.2 *Infectious disease*

An infectious disease is an illness that is caused by microorganisms (such as viruses and bacteria).

3. How would you locate a first-aid kit in the event of an emergency?

By looking for the safety sign – white symbol on green background.

4. Why is it important to ensure that every item in the first-aid kit is sterile?

Sterile equipment prevents infection of the wounds.

Continued →

Activity 1.3 (LB page 15) (continued)

5. **State whether each of the following statements is TRUE or FALSE. Correct the statement if it is FALSE.**

   5.1 **HIV is spread through casual contact with an infected person.**

   False. HIV is not spread through casual contact with an infected person. OR HIV is spread through contact with bodily fluids such as blood and semen.

   5.2 **Covid-19 is spread by casual physical contact with an infected person.**

   True

   5.3 **HIV can be cured by taking antiretroviral therapy medicine.**

   False. The body cannot get rid of HIV. You have it for life.

   5.4 **You can catch an infectious disease by touching surfaces and then touching your mouth.**

   True

   5.5 **Only someone who is HIV positive can contract AIDS.**

   True

6. **List the FOUR ways in which an infectious disease, such as flu, can be spread at school.**

   Direct (physical) contact; indirect contact; droplets and through the air

Lesson 4 – Outline

- Incident management – discuss
- **Homework:** Activity 1.4 (Research) – emergency numbers
- Types of injuries
  - General discussion – relate content to subject-specific injuries
  - Cuts and how to stop bleeding

Activity 1.4 (LB page 17)

Research activity

Currently, there is no single emergency number in South Africa. Having immediate access to the correct contact details in case of an emergency can save lives.

Compile a list of the emergency numbers used in your province or area to post in class. You must include the following:

Police – emergency	
Police – nearest police station	
All emergencies	
Emergency number to dial from a cell phone	
Emergency – ambulance (provincial)	
Emergency – ambulance (Netcare)	
Emergency – ambulance (ER24)	
Fire department	
Hospital nearest to you	
Poison	
Other	

Practical 1: How to stop bleeding

You will need

- Access to the Internet
- Data projector and screen/interactive whiteboard/computers or tablets

Web link

Watch this video in class (length of clip: just over 4 minutes)

This is a good practical demonstration of the application of first aid. Instruct learners to take notes while they are watching the clip:
bit.ly/BleedStop

Follow-up questions

1. What is the most important thing to do to stop a bleed? (apply pressure)
2. Name the TWO other methods used by the medic to stop the bleeding. (using a tourniquet; packing the wound with gauze)

Alternative practical activity

(*should you not have access to the abovementioned equipment*)

Demonstration by learners (pair work)

Appoint learners to demonstrate how to stop a bleed by applying pressure. (The number of demonstrations will depend on the time available.)

You will need

- Clean cloths
- Dirty rags
- Dummy (or lengths of PVC pipe/stockings stuffed with material to represent the injured limb)
- Gloves

Assessment – informal (peers)

Learners watch the demonstration and evaluate their peers using the following rubric:

Action	Yes	No
Gloves prior to treatment		
Clean cloths used to apply pressure		
Downward pressure applied for some time		
Elevated the wound		

Lesson 5 – Outline

- Learners compare the emergency numbers they have collected in Activity 1.3.
- Appoint a learner to compile a list to post in class.
- Types of injuries continued: burns

Practical 2: Demonstrating the application of basic first aid

How to treat burns

You will need

- Access to the Internet
- Data projector and screen/interactive whiteboard/computers or tablets

Web link

Watch this video in class after discussing the treatment of burns (length of clip: just over 10 minutes)

This is a good practical demonstration of the application of first aid. Instruct learners to take notes while they are watching the clip:
bit.ly/FirstAidBurns

Follow-up questions

1. What is the first thing the medic did after examining the wound? (took off watch)
2. What is the main purpose of the special, water-gel dressing that is used in the demonstration? (the gel draws the heat away from the burn)
3. What, according to the medic, are the advantages of using cling film to cover a third-degree burn? (keeps burn safe; it is see-through; does not stick to the wound; can cool the wounded area in water; acts as barrier against infections)

Alternative practical activity

(*should you not have access to the abovementioned equipment*)

Demonstration by learners (pair work)

Appoint learners to demonstrate how to treat a minor burn. (The number of demonstrations will depend on the time available.)

You will need

- Cloth wrapped around ice/ice pack/a water-gel dressing
- Lotion/Cream (any)
- Cling film

Continued →

Practical 2: Demonstrating the application of basic first aid (continued)

Assessment – informal (peers)

Learners watch the demonstration and evaluate their peers using the following rubric:

Action	Yes	No	N/a
Gloves prior to treatment			
Removed any tight items			
Cooled the area			
Applied lotion			
Wrapped wound in cling film			

Lesson 5 continued

- Types of injuries:
  - Fractures
  - Trauma/Shock
- **Homework:** Activity 1.5 and the Summative assessment

Web links

- Visit this link to learn more about the treatment of fractures: *bit.ly/TreatFracture*
- Visit this link to learn more about the treatment of shock: *bit.ly/TreatShock*

Activity 1.5 (LB page 23)

1. **List the SEVEN main points that you should bear in mind when managing an incident.**

   - Check the scene to make sure everybody is safe
   - Examine the victim: consciousness, breathing and bleeding
   - Check for emergency medical information tags
   - If injury is serious, call emergency services
   - Do not move the victim unless necessary
   - Offer reassurance and comfort
   - Treat injuries ONLY if you have the necessary training

Continued →

Activity 1.5 (LB page 23) (continued)

2. **How would you protect yourself from HIV infections when treating a cut?**

   By wearing gloves and avoiding contact with the blood through any open wounds you may have

3. **State whether each of the following statements is TRUE or FALSE. Correct the statement if it is FALSE.**

   3.1 A first-degree burn damages all the layers of the skin.

   False. A third-degree burn damages all the layers of the skin. OR A first-degree burn only damages the outer layer of the skin.

   3.2 The best way to cool a burn is to place ice directly on the damaged skin.

   False. Cool the burned area by holding it under cool running water for 10 minutes or by applying a water-gel dressing.

   3.3 An ice pack can be used to limit the swelling when someone has broken a bone.

   True

   3.4 When treating a fracture, it is important to keep the injured area as still as possible.

   True

   3.5 If someone is suffering from shock, you should give him/her a glass of cold water.

   False. One should never give the person anything to eat or drink.

4. **Clearly explain the difference between *trauma* and *shock*.**

   Trauma can be defined as the emotional response to a terrible event such as an accident, a terrifying incident or a natural disaster. Shock is a critical condition brought on by the sudden drop in blood flow through the body. One may experience shock after an accident, blood loss, severe burns or fractures.

Practical 3: Emergency evacuation drill exercise

This activity should be coordinated and practised with the rest of the school.

Important

The evacuation should not be announced beforehand. Learners must respond to the emergency signal regardless of where they find themselves at the time.

Preparation

- Discuss the emergency evacuation procedure applicable to your school with the learners (see 1.5 Emergency evacuation procedure).
- Arrange meeting point(s) and how the learners should assemble – in their register/homeroom classes or according to the classes they are in when the alarm sounds (whatever is applicable in your school).
- Decide on the alarm signal that will be used.
- Appoint teachers to monitor the evacuation process and ensure that learners behave responsibly. Student Council members can also be used to assist in the process.
- Make sure that every teacher has a class list for roll-call purposes.
- Appoint teachers to check the building after the evacuation to ensure that everyone has exited.
- A teacher should be appointed to keep time (using a stopwatch) – start timing the activity the minute the alarm sounds and end as soon as everyone has gathered at meeting points.

The drill

- Sound the alarm to evacuate the building.
- Start the stopwatch.
- Teachers posted along the routes make sure that learners behave and evacuate the building in an orderly fashion.
- When all the learners are gathered at the meeting points, stop the watch.
- Do roll call to make sure that all the learners are present.

Evacuation drills should be practised at regular intervals. The time it takes to evacuate the building should improve with practice.

Summative assessment (LB page 23)

1. For each of the following questions, choose the correct answer and write down only the letter of your choice, e.g. 1.1 E.

1.1 Which one of the following is NOT an example of unsafe acts?
- **a) Adjusting machines that are in motion**
- **b) Standing too close to a moving machine part**
- **c) Carrying tools with sharp edges pointing downward**
- **d) Not wearing the necessary PPE**

C

1.2 A prohibition sign …
- **a) indicates that one should proceed with caution.**
- **b) indicates that certain actions are not allowed.**
- **c) is triangular with a black symbol on a yellow background.**
- **d) indicates that a specific action must be carried out.**

B

1.3 A mandatory sign …
- **a) indicates that one should proceed with caution.**
- **b) indicates that certain actions are not allowed.**
- **c) is rectangular or square with a white symbol on a green background.**
- **d) indicates that a specific action must be carried out.**

D

1.4 Which one of the following statements does NOT apply to HIV?
- **a) It is spread through casual contact, e.g. shaking hands.**
- **b) It is an infectious disease caused by a virus.**
- **c) It attacks the cells that help the body fight infections.**
- **d) If left untreated, HIV leads to AIDS.**

A

1.5 A third-degree burn is one that …
- **a) causes blisters to develop on the skin around the area of the burn.**
- **b) affects all the layers of the skin as well as the nerves.**
- **c) is not serious, as it affects only the outer layer of the skin.**
- **d) destroys the skin and damages the nerves, tendons and bones.**

(5 × 1) (5)

B

Continued →

Summative assessment (LB page 23) (continued)

2. Choose the description in COLUMN B that matches each of the terms listed in COLUMN A. Write down only the question number and the letter of your choice, e.g. 2.1 H.

COLUMN A	COLUMN B
2.1 Infectious	A immediate medical help offered at the scene of an accident
2.2 First aid	B a critical condition brought on by the sudden drop in blood pressure
2.3 Dust mask	C skills needed to manage the scene of an emergency
2.4 Fracture	D likely to be transmitted from person to person
2.5 Shock	E the emotional response to a terrible event
	F a broken bone
	G protects you and the injured person from infection
	H prevents the inhalation of dangerous fumes

(5 × 1) (5)

2.1 D 2.2 A 2.3 H 2.4 F 2.5 B

3. Your friend has cut his hand badly. You must stop the bleeding. Describe how you would do this. (2)

Apply direct pressure (1) using a clean bandage or cloth (1) until the bleeding stops.

4. List FOUR things that you should NEVER do when you are helping someone who has suffered third-degree burns. (4)

DO NOT:

- immerse a large burn in water;
- remove anything that is sticking to the burned area;
- apply lotions or ointments to the burned area; or
- break blisters or interfere with the burn. (1 mark per point)

Continued →

Summative assessment (LB page 23) (continued)

5. **Your friend tripped in the workshop and broke his forearm. Describe how you would splint the arm. The first-aid kit does not contain a splint.** **(4)**

   Remove any tight-fitting clothing or items. (1) Keep the injured limb as still as possible. (1) Stop any bleeding by applying pressure. (1) Bandage the area without moving the broken bone and apply an ice pack to limit the swelling. (1)

TOTAL: 20

MODULE **2**

Graphic communication

After they have completed this module, learners should be able to:

- explain what graphic communication is;
- explain the purpose of graphic communication;
- list and apply general drawing principles;
- list and apply the safety precautions regarding the use of drawing instruments;
- correctly use and care for drawing instruments;
- make freehand sketches;
- identify and correctly use different types of lines (based on SANS 110 guidelines);
- apply the principles relating to dimensioning, lettering and borders;
- make scale drawings to scales of 1:1 and 1:2; and
- make pictorial drawings.

Time allocated: 5 hours (±6 lessons)

Introduction

This is a generic module that is used across various vocational subjects.

Lesson 1 – Outline

- Ask learners whether they know what graphic communication involves; whether they can think of examples of graphics; whether they know the difference between 2D and 3D; whether any of their family members or someone they know works in the field of graphics/technical drawing/ architecture.
  - What is graphic communication? Its purpose
  - General drawing principles
  - Pictorial and sectional views
- **Homework:** Activity 2.1

Activity 2.1 (LB page 31)

1. Choose the description in COLUMN B that matches the term in COLUMN A. Write down only the question number and the letter of your choice, e.g. 1.1 F.

COLUMN A	COLUMN B
1.1 Three-dimensional	A 3D drawing that helps to define the shape of an object
1.2 Pictorial view	B Invisible internal features of an object
1.3 Oblique drawing	C Having or appearing to have length, width and depth
1.4 View	D Exposing internal details by making a straight cut through an object
1.5 Cross section	E Having or appearing to have length and width, but no depth
1.6 Hidden detail	F Simple drawing to produce 2D images of 3D objects
	G What you see when you look at an object from the top, front or side

1.1 C 1.2 A 1.3 F 1.4 G 1.5 D 1.6 B

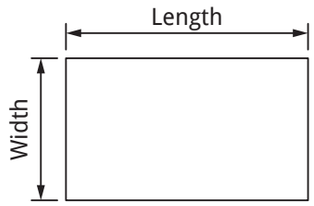
Continued →

Activity 2.1 (LB page 31) (continued)

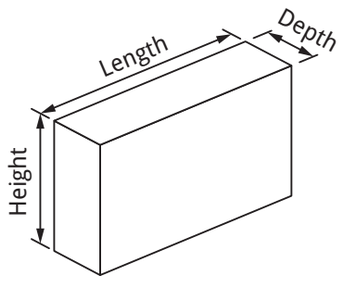
2. **Briefly explain the purpose of graphic communication.**

   The main purpose of graphics is to convey the details that describe the physical shape of a product or construction to the manufacturer or contractor. OR Graphics is used to express and communicate technical or practical ideas completely and accurately.

3. **Make two neat drawings to illustrate the difference between a *two-dimensional* and a *three-dimensional* view of a rectangular object such as your eraser. Label the drawings clearly.**



Two-dimensional view



Three-dimensional view

Lesson 2 – Outline

- Mark homework activity.
- Discuss the drawing instruments.

Lesson 3

Practical activity 2.1 (LB page 39)

Individual activity

You will need

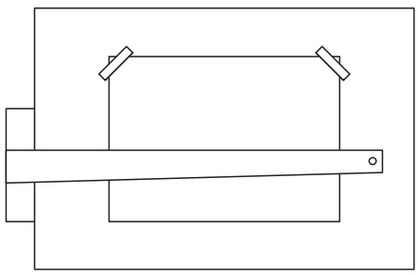
- Drawing board
- A2 drawing sheet
- Ruler
- T-square
- Set squares
- Paper clips or masking tape

Attaching the drawing sheet to the drawing board

The aim of this activity is to teach learners how to attach the drawing sheet to the drawing board.

Instructions

1. Place a clean drawing sheet on the drawing board.
2. Hold the T-square firmly against the edge of the drawing board and align the top edge of the paper with the edge of the T-square (as illustrated in Figure 2.12).
3. Secure the top corners of the paper using two drawing clips or strips of masking tape, as illustrated below.

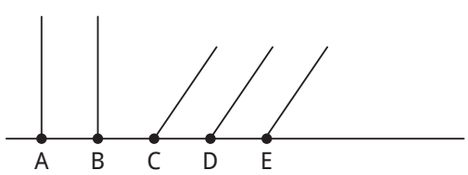


Using set squares and T-square to draw lines

The aim of this activity is to teach learners how to use the set squares and T-square in drawings.

Instructions

1. Use your T-square ruler to draw a 150-mm horizontal line.
2. Mark off the following points on the horizontal line:
   A – 20 mm; B – 40 mm; C – 60 mm; D – 80 mm and E – 100 mm.
3. Use your 30/60° set square to draw a 100-mm vertical line at point A.
4. Use your 45° set square to draw a 50-mm vertical line at point B.
5. Use your 30/60° set square to draw a line at 30° to the horizontal line at point C.
6. Use your 45° set square to draw a line at 45° to the horizontal line at point E.



Lesson 4 – Outline

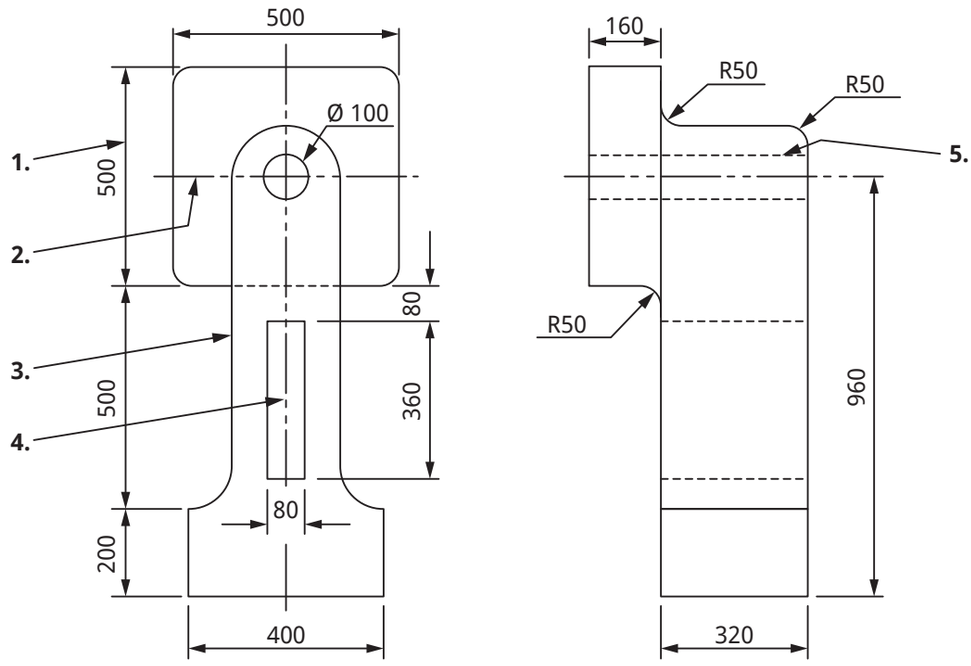
- Discuss drawing principles relating to:
  - Linework
  - Dimensioning
  - Lettering
  - Borders
- **Homework:** Activities 2.2 and 2.3

Important

Try to obtain a copy of the South African Standard Code of Practice, SABS 0111 Part 1 so that you can familiarise yourself with the linework and other drawing specifications. It can also be used as a reference for learners.

Activity 2.2 (LB page 42)

1. **Study the drawings below and identify the various types of lines used by labelling numbers 1 to 5.**

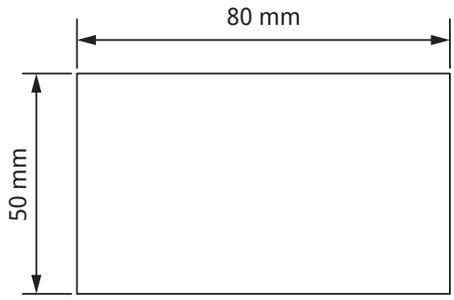


1. Dimension line
2. Centre line
3. Outline
4. Centre line
5. Line showing hidden detail

Activity 2.3 (LB page 47)

Draw an appropriate border for the A4 or A2 sheet(s) you are using.

1. **Draw a rectangle of 80 mm × 50 mm. Insert the dimensioning and label the drawing 'Rectangle'.**

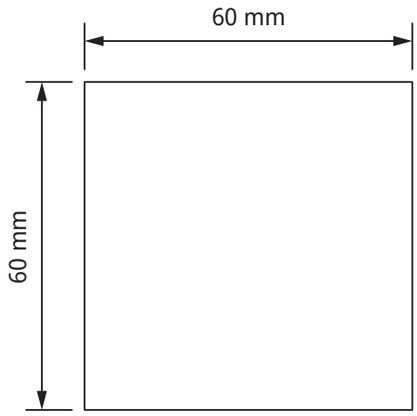


Rectangle

Teacher note

These drawings are NOT drawn to scale.

2. **Draw a square with 60-mm sides. Insert the dimensioning and label the drawing 'Square'.**



Square

Example of a rubric

Indicate using a ✓ or ✗.

Criteria	Question 1	Question 2
Lines are straight		
Correct line type is used for shape		
Dimension lines are positioned correctly		
Dimensions are indicated correctly		
Measurements are accurate		
Angles are correct		

Lesson 5 – Outline

- Freehand drawing
  - Discuss the importance of this skill and what it entails.
  - Illustrate basic movements and point out the technique that can be used to draw circles.
  - Stress the importance of proportions.
  - Discuss the block method.
- Scale drawing
  - Refer to scales with which the learners may be familiar.
  - Point out why scale drawings are necessary and where various scales can be used.
  - Discuss example of scale drawings.

Teacher note

If time allows, practise freehand sketching techniques in class.

Provide learners with paper and pencils.

(a) The six basic movements of freehand sketching

Give them 10 minutes to practise the basic movements set out in Figure 2.28.

You can also practise the block method (2.7.3) in class, if time allows.

Learners will need

- A4 or A2 drawing sheet
- Pencil
- Eraser

Explanation and assistance

- Explain and follow the steps set out in section 2.7.3.
- Illustrate each step by sketching figures 2.31 to 2.33 on the board. You can also ask a learner who is skilled at drawing to take the lead.
- Ask learners to compare sketches and check the proportions.
- Move among learners and assist where necessary.

Summative assessment (LB page 54)

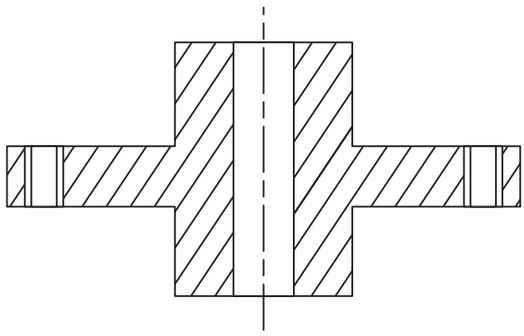
1. What is the main purpose of graphic communication? (2)

The main purpose of graphics is to convey the technical details that describe the physical shape of a product or construction to the manufacturer or contractor accurately and completely.

2. Choose one of the following terms to describe/name drawings 2.1 to 2.4.

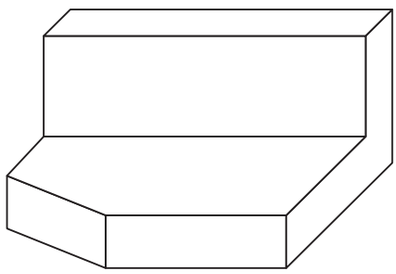
Oblique drawing	Sectional drawing	Scale drawing	Isometric drawing

2.1



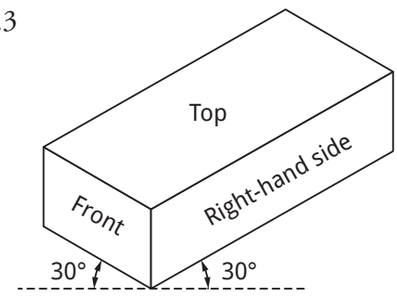
Sectional drawing

2.2



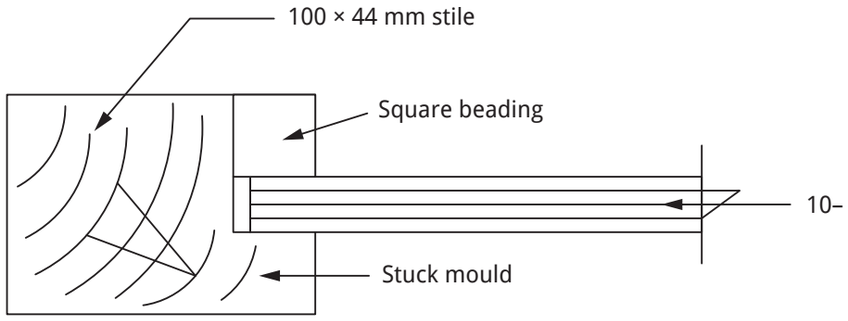
Oblique drawing

2.3



Isometric drawing

2.4



Scale drawing **(4 × 1) (4)**

Continued →

Summative assessment (LB page 54) (continued)

3. Identify each of the following types of lines (type A, B, E or G) and state the application(s) of each type:

3.1 ——————————

B – short centre lines; projection lines; dimension lines; leader lines

3.2 – – – – – – – – – – – – – – – – –

E – shows hidden details

3.3 ——— – ——— – ——— – ——— – ——— – —

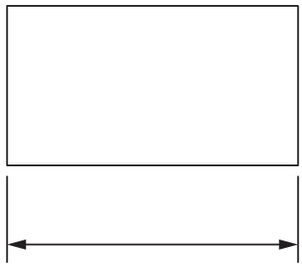
G – centre lines; path of motion; pitch circles; lines of symmetry; cross section

3.4 ——————————

A – visible outlines **(4 × 2) (8)**

4. Study the following dimensions. Identify the examples that DO NOT meet the Code of Practice. Redraw the incorrect example(s) correctly.

4.1

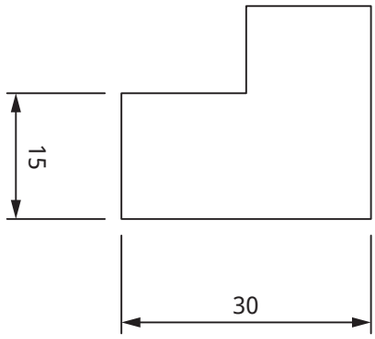


Correct

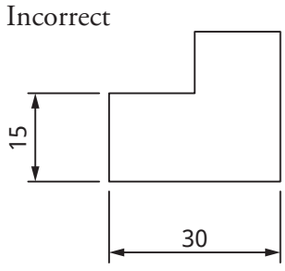
4.2

Incorrect

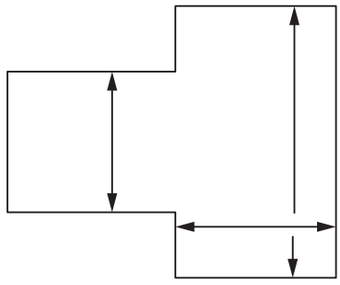
4.3



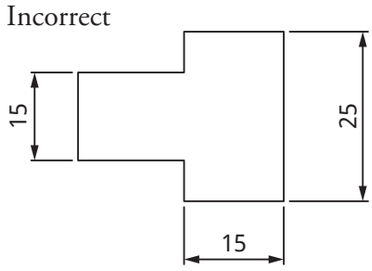
Incorrect



4.4



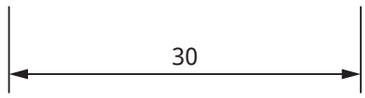
Incorrect



Continued →

Summative assessment (LB page 54) (continued)

4.5



Correct **(5 × 1) (5)**

5. **Choose the correct answer. According to the South African Standard Code of Practice, SABS 0111 Part 1, the recommended height size for printing the titles of drawings is …**

   A 3,5 mm.
   B 5 mm.
   C 7,0 mm.
   D 15 mm. **(1)**

   C 7,0 mm

6. **State THREE functions of lettering in graphic communication.** **(3)**

   - Give information about sizes
   - Give instructions
   - Make notes
   - Indicate dimensions (Any three)

7. **Choose the correct answer. The correct width of the page border when you are using an A4 or A3 drawing sheet is …**

   A 20 mm.
   B 15 mm. **(1)**

   B 15 mm

8. **Name the method that is used in freehand sketching to ensure that objects are in good proportion.** **(1)**

   The block method

9. **Name the THREE types of scales that can be used when drawing an object.** **(3)**

   Full scale; reducing scale; enlarging scale

10. **Briefly explain how you would read and interpret the scale 1:100.** **(2)**

    - The number on the left indicates the measurement in the drawing, i.e. 1 mm.
    - The colon indicates the ratio.
    - The number on the right indicates the actual measurement, i.e. 100 mm.
    - In other words, 1 mm on the drawing represents 100 mm in reality.

TOTAL: 30

MODULE 3

Tools, instruments and equipment

After learners have completed this module, they should be able to:

- identify, care for, safely use and store the following hand tools:
  - spanners
  - pliers
  - screwdrivers
  - hammers
  - cutting tools
  - wire brushes
  - clamping tools
  - marking-off tools
  - rivet guns/rivet set snaps
  - workbenches
  - portable hand drills;
- identify, care for and safely use the following measuring tools:
  - measuring tape
  - steel rule
  - vernier calliper
  - outside calliper
  - outside micrometer;
- identify the different lifting equipment used in the Mechanical Technology workshop:
  - trolley jack
  - bottle jack
  - scissor jack; and
- identify and safely use a bench grinder.

Time allocated: 5 hours (±6 lessons)

Introduction

The amount of information available on tools, instruments and equipment can be overwhelming. There are hundreds of different manufacturers and such a wide variety of tools and equipment that it is impossible to cover them all. The aim of this module is to introduce some of the basic tools and equipment used in most mechanical workshops. The content is kept short with emphasis on identification, safe use and storage in general.

Lesson 1 – Outline

- Introduction
  - Display the tools to be discussed in this module. Ask learners how many they can identify and which tools they have at home/have handled.
- Discuss and briefly demonstrate the use of:
  - Spanners
  - Pliers
  - Screwdrivers
  - Hammers.

  Involve learners in the demonstrations and give them the opportunity to use the tools.
- Demonstrate the use of each of the following tools:
  - Cutting tools – utility knife and hacksaw
  - Wire brushes
  - Clamping tools – bench vice and G-clamp
  - Rivet gun (also covered in Module 6)
  - Workbench.

  Involve learners in the demonstrations and give them the opportunity to use cutting and clamping tools.
- **Homework (optional):** You can ask learners to complete the table on the next page. It can be updated as tools are discussed in the lessons that follow.

Worksheet

Hand tools

Complete the table below by providing the relevant details.

Tool	Illustration	Function	Care
Spanners	Open-ended		
	Ring		
	Combination		
Combination pliers			
Screwdrivers	Flat tip		
	Phillips		
Ball-peen hammer			

Lesson 2 – Outline

- Discuss/Demonstrate the use of any tools not covered in the previous lesson
- Discuss:
  - Portable hand drill
  - Discuss basic units of measurement and symbols
  - Measuring tape – demonstrate use.
- Combine the demonstration of the drill with the following measuring and marking-off tools:
  - Steel rule (learners are familiar with rulers); refer to Graphic Communication and ruler used for drawings
  - Scriber
  - Punch
  - Inside and outside callipers.

  Involve learners in the demonstrations and give them the opportunity to use the equipment.
- **Homework:** Activity 3.1

Activity 3.1 (LB page 72)

1. **Why is it important that the spanners you use should fit securely onto bolts or nuts you want to fasten or loosen?**

   Spanners can slip and cause injury to your hand and damage to the head of the bolt or nut.

2. **Briefly describe the parts of a pair of pliers.**

   Pliers consist of a pair of insulated handles, jaws and a joint that holds them together.

3. **What is the function of side cutters?**

   Side cutters are used to cut wire and the leads of electronic components as well as to strip electrical wires without damaging the conductors underneath the insulation.

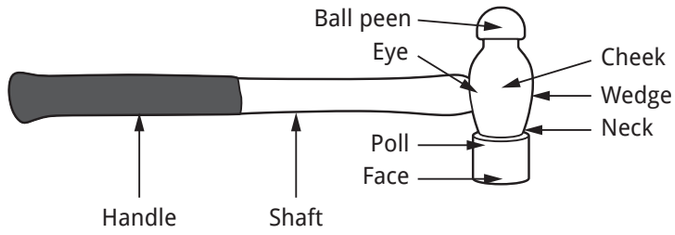
4. **Name TWO types of screwdriver tips that we use in the workshop.**

   Phillips and flat tip/head

Continued →

Activity 3.1 (LB page 72) (continued)

5. **Make a neat, labelled sketch of a ball-peen hammer.**



6. **Name THREE types of material that you would cut using a utility knife.**

   Plastic, veneer, rubber, paper, cardboard, leather or canvas

7. **Why is it important to wear eye protection when working with wire brushes?**

   Bristles of the brush and/or particles from surfaces can hurt your eyes or hands.

8. **Where would you use a scriber?**

   To scribe lines on metal sheets/plates

9. **What is a centre punch used for?**

   To mark indents on workpieces where the hole must be drilled

10. **Name THREE personal safety precautions you would take when using a portable hand drill.**

    Any three of the following:
    - Always wear safety glasses when operating a hand drill.
    - Always disconnect the power supply when you are fitting drill bits.
    - Always use sharp drill bits.
    - Make sure the drill bit is properly secured and do not forget to remove the key from the chuck before use.
    - Set the drill speed correctly for the diameter drill bit you are using.
    - Hold the drill firmly with both hands while drilling and apply constant pressure.
    - Pull the drill bit back from time to time to clear the hole of dust and bits of material. This prevents clogging.
    - Clamp smaller objects to the workbench to prevent them from moving while you are drilling.

Lesson 3 – Outline

- Callipers
  - If time allows, do the Practical activity. Alternatively, you can use it as demonstration.
- Vernier calliper – demonstrate its use
  - Spend time explaining how readings are taken.
- Outside micrometer – demonstrate its use
  - Spend time explaining how readings are taken.
- If time allows, you can do the practical activity provided below.

Practical activity

Group activity

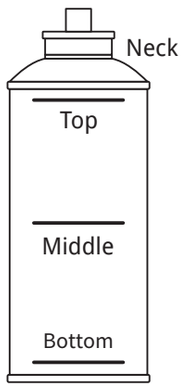
Taking an outside diameter measurement

You will need

- Empty spray canister
- 300-mm steel rule
- Outside calliper
- Black permanent marker

Instructions

1. Make four marks on the canister with the permanent marker as illustrated below: neck, top, middle and bottom.



2. Set the outside calliper on each position and check the sizes on the steel rule.
3. Write down the size you have measured at each position. Everybody in the group can do this individually with the same canister. (Use Figure 3.26 as a guide.)
4. In your group:
   - Compare your measurements.
   - Discuss ways in which you can improve the taking of these types of measurements.

(Your teacher will assist you in the final evaluation of this activity.)

Lessons 4 and 5 – Outline

- Jacks – display, discuss and demonstrate the use of the scissor jack practically, if time allows.
- Discuss the importance of lifting accessories and show examples if available – chock blocks, jacking points on a car, trestles and creepers
- Bench grinder – demonstrate its use and focus on safety.
- **Homework:** Activities 3.2 and 3.3

Activity 3.2 (LB page 82)

1. **Briefly describe a bottle jack.**

   A bottle jack is a sturdy steel jack that consists of a manual oil pump that pushes a lifter inside a steel cylinder upwards to create lift.

2. **Name the main parts of a trolley jack.**

   Pump; body; castor wheels; front wheels; stabilising arm; saddle; lifting arm; handle

3. **What is the most common use of scissor jacks?**

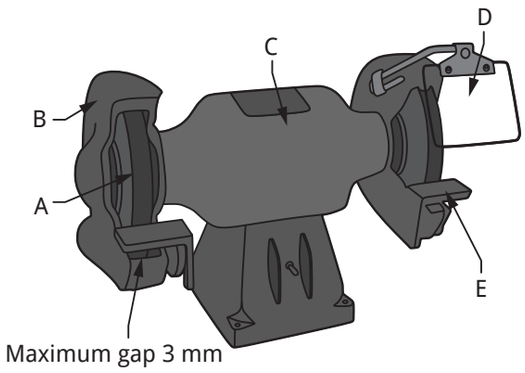
   To lift light vehicles

4. **Briefly explain how you would use the scissor jack to lift a vehicle.**

   - Place the jack on a level, hard surface underneath the vehicle's lifting point.
   - Screw in the screw bolt until the saddle contacts the lifting point.
   - Check that the jack is level and secure. The handle can now be connected to screw the bolt in further.
   - As there are many joints, they need to be checked for security before lifting the vehicle.
   - Turn the handle to raise the jack.

Activity 3.3 (LB page 84)

1. **Identify the components of a bench grinder labelled A–E in the illustration below.**



A Grinding wheel
B Wheel guard
C Electric motor
D Eye shield
E Tool rest

2. **Name FIVE uses of a bench grinder.**

- Grinding the cutting edge of tools
- Removing burrs from cold chisels
- Repairing screwdrivers, drill bits and the points of punches
- Sharpening tools and drill bits
- Polishing metalwork
- Smoothing welded joints or other uneven surfaces
- Grinding off rivets. (Any 5)

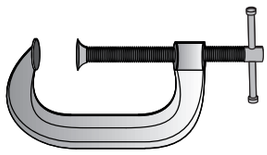
Lesson 6 – Outline

- Finish any theory/demonstrations
- Summative assessment

Summative assessment (LB page 85)

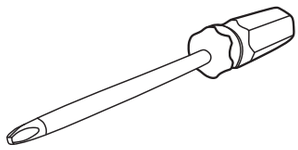
1. Identify each of the following tools and briefly state its function.

1.1



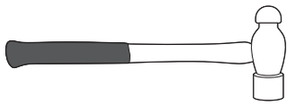
G-clamp – to keep an object or workpiece in the correct position while you are working on it

1.2



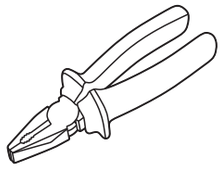
Phillips screwdriver – for tightening or loosening screw heads with the shape of a cross

1.3



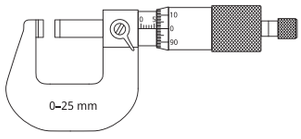
Ball-peen hammer – flat face is used for general hammering; peen is used for shaping metal

1.4



Combination pliers – to grip or cut objects and to twist or bend wire

1.5

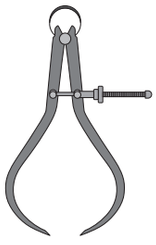


Micrometer – to measure thickness and diameters

1.6

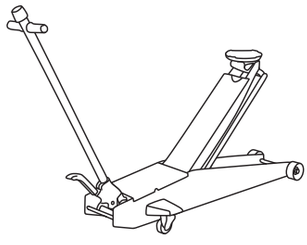
Scriber – to draw lines or mark points on workpieces or various materials

1.7



Outside callipers – to measure the outside of cylindrical objects

1.8



Trolley jack – to reach further underneath a vehicle when lifting it

(8 × 2) (16)

2. 2.1 Name THREE types of spanners. **(3)**

Open-ended; ring; combination spanners

Continued →

2.2 List FIVE precautions that you would take when you are using spanners. (5)

- Always make sure that the spanner is the correct size for the bolt or nut that you are gripping, tightening or loosing.
- Take note of any obstructions that may injure your hand.
- Never push a spanner away from your body when tightening or loosening bolts and nuts. If it slips, the momentum will seriously injure your hand.
- Use a firm, steady pulling action, rather than short jerks. This gives you more control over the operation.
- Never use extension bars on spanners, as this can bend or break the spanner.
- Do not use a hammer to apply extra force to a spanner.
- Keep your hands and tools free of oil/grease so that you have a proper grip. (Any 5)

3. In which direction should the teeth of a hacksaw blade point when you are using the saw? (1)

The teeth should face forward, away from the handle.

4. List FIVE safety measure that must be taken when you use a portable hand drill. (5)

- Always wear safety glasses when operating a hand drill.
- Always disconnect the power supply when you are fitting drill bits.
- Always use sharp drill bits.
- Make sure the drill bit is properly secured and do not forget to remove the key from the chuck before use.
- Set the drill speed correctly for the diameter drill bit you are using.
- Hold the drill firmly with both hands while drilling and apply constant pressure.
- Pull the drill bit back from time to time to clear the hole of dust and bits of material. This prevents clogging.
- Clamp smaller objects to the workbench to prevent them from moving while you are drilling. (Any 5)

5. Why do you think the vernier calliper is described as the most versatile and useful of all the measuring instruments? (4)

It can measure 0 mm to 150 mm (larger verniers are available on request). You can measure outside dimensions, internal dimensions and depth using the same instrument, on the same scale and with the same degree of accuracy. The vernier calliper can measure two-hundredths of a mm or 0,02 mm. (Any 4 details)

Continued →

Summative assessment (LB page 85) (continued)

6. Choose the correct answer from the words between brackets.

When reading an outside micrometer, the number of full millimetres is taken on the thimble **6.1** (above/below) the datum line. The number of half millimetres is read on the thimble **6.2** (above/below) the datum line. (2)

6.1 above

6.2 below

7. 7.1 **Why do you think it is important to wear eye protection when using a wire brush or a bench grinder?** (1)

Flying bits of material can injure the eyes.

7.2 **Why must you move the workpiece back and forth across the face of the grinding wheel?** (1)

To prevent a groove from forming on the face of the wheel

7.3 **What does dressing the wheels of a grinder involve?** (2)

To return the grinding wheel to its original round shape and sharpness/ to remove stuck bits of material and the dull grain to expose the fresh grain

8. How would you use a scissor jack to lift a vehicle? (5)

- Place the jack on a level, hard surface underneath the vehicle's lifting point.
- Screw in the screw bolt until the saddle contacts the lifting point.
- Check that the jack is level and secure. The handle can now be connected to screw the bolt in further.
- As there are many joints, they need to be checked for security before lifting the vehicle.
- Turn the handle to raise the jack.

TOTAL: 45

MODULE **4**

Entrepreneurship

After learners have completed this module, they should be able to:

- explain the term *entrepreneurship* and know who an entrepreneur is;
- identify different types of entrepreneurs;
- understand the marketing and branding of products; and
- identify different kinds of advertising on a variety of media platforms.

Time allocated: 2 hours (±3 lessons)

Introduction

This is a generic module that is used across various vocational subjects.

The module has been written using generic examples. Teachers are encouraged to use additional examples that relate specifically to their vocational subjects in class discussions.

Note

Time is extremely limited. Select one or more practical activities according to the needs of the learners and the resources you have available.

Lesson 1

- Who is an entrepreneur and what is entrepreneurship?
  - Refer to the example of Raymond Ackerman, Mr D Food and the examples mentioned by learners. Discuss the questions posed in the textbook.
- Discuss different types of entrepreneurship
- Characteristics of a good entrepreneur
- Practical activity 4.1 (optional)
  - Set deadline for completion of the activity.
  - Upon completion, the posters can be evaluated and the best ideas may be displayed in class.

Practical activity 4.1 (LB page 89) Individual activity

- Learners are required to make a poster or flyer advertising their businesses.
- Discuss the properties of a good poster/flyer with the class. Refer to the rubric to be used.
- Resources needed: A3 page for each learner, scissors, Pritt, magazines and colour pens or pencils or crayons.
- Discuss the activity in class and go over the rubric and what is expected. Learners must then complete it at home as a homework task.

Rubric (Poster/Flyer)

NAME OF LEARNER	CLASS

Rubric for poster or flyer – your IDEA! (4 = excellent, 3 = good, 2 = average, 1 = poor)

Criteria	1	2	3	4
Ability to identify a problem that can be solved with a good business idea				
Likely to make money or be financially viable				
A creative and original idea				
Care taken in planning and presenting the idea				
Overall impression				
TOTAL (max. marks 4 × 5 = 20)	**/ 20**			
Signature of learner	**Date**			
Signature of teacher	**Date**			

2 COPIES OF RUBRIC PER PAGE. COPY AND CUT IN HALF. ATTACH TO POSTER/FLYER

NAME OF LEARNER	CLASS

Rubric for poster or flyer – your IDEA! (4 = excellent, 3 = good, 2 = average, 1 = poor)

Criteria	1	2	3	4
Ability to identify a problem that can be solved with a good business idea				
Likely to make money or be financially viable				
A creative and original idea				
Care taken in planning and presenting the idea				
Overall impression				
TOTAL (max. marks 4 × 5 = 20)	**/ 20**			
Signature of learner	**Date**			
Signature of teacher	**Date**			

Lessons 2 and 3

- Marketing and branding
  - Explain the difference between marketing and branding.
  - Practical activity 4.2 (optional)
- Advertising on different media platforms
- Summative assessment

Practical activity 4.2 (LB page 92)

Individual activity

Give learners five minutes to complete Practical activity 4.2 and allow feedback for 5 minutes.

How powerful is branding?

Can you identify each of the following companies by only looking at their logos?

	McDonald's		Starbucks
	Facebook		M-Net

Practical activities 4.3 and 4.4 (LB pages 92 and 94)

Individual activities

Assessment: Worksheets provided for learners to complete.

Worksheet template (Practical activity 4.3)

NAME OF LEARNER	CLASS

Complete the activity on this worksheet.

- **Find an example of an entrepreneur in a magazine, newspaper, pamphlet or brochure and paste this in the space provided on the worksheet.**
- **You could also find someone in your family or community. If they do not have a pamphlet, you can interview them and write down their answers on the worksheet.**
- **Identify the kind of entrepreneurship he/she represents.**
- **Explain your answer.**

What advice would you give this entrepreneur?

Paste your example here or write down the questions you asked the business owner.
Kind of entrepreneurship
Choose one of the following: • Small business • Scalable start-up • Large company • Social entrepreneurship
Motivate your answer.
What advice would you give this entrepreneur?

Worksheet template (Practical activity 4.4)

NAME OF LEARNER	CLASS

Complete the activity on this worksheet.

- **Find an example of an advertisement that you can paste onto your worksheet. You can use one from a magazine or a newspaper, a pamphlet or a brochure.**
- **Discuss the advantages and disadvantages of this type of advertising.**

Paste your example here.
What type of advertising is this?
Discuss the advantages of using this type of advertising.
Discuss the disadvantages of using this type of advertising.

Summative assessment (LB page 94)

1. **What is the 'reward' that the entrepreneur will receive for taking business risks?** **(2)**

   Profit

2. **What is the type of business called where a company gives individuals the permission to trade under the company's name?** **(2)**

   Franchise

3. **Are entrepreneurs creative people? Motivate your answer.** **(2)**

   Yes – they need to find solutions to problems to make their business idea viable and successful.

   (Use discretion and award marks for relevant answers.)

4. **Draw a table and explain the difference between THREE different types of entrepreneurs. Provide an example of each type.** **(3 × 4) (12)**

Small business entrepreneurship	Scalable start-up entrepreneurship	Large company entrepreneurship
• Small business to support a family • Not aiming for very high profit • May employ a family member • E.g. hairdresser or plumber	• Company believes that it has a good idea that can be expanded • Persuade people to invest in the company • Focus on technology and fast growth and profits • E.g. Facebook or Uber	• Large team of people run a company that can be expanded • A small business that can grow quickly may be bought by a large company, which then expands • E.g. Disney

5. **What is a *scalable business*?** **(2)**

   A business that is able to change in size or scale

6. **List any FIVE characteristics, skills or values that an entrepreneur must have to succeed.** **(5)**

   Outgoing, willing to take risks, positive belief in themselves and their idea, driven to achieve, able to pay attention to detail, creative and able to adapt ideas, leaders who get people to respect them and can motivate

   (Use discretion and award marks for relevant answers.)

Continued →

Summative assessment (LB page 94) (continued)

7. **What is the difference between *marketing* and *branding*?** **(2)**

   Marketing – the action or business of promoting and selling products or services
   Branding – the promotion of a particular product or company by means of a distinctive design or wording

8. **Explain what medium of advertising you would use for a small repair shop in a community. Include the advantage and disadvantage of using this type of advertising medium.** **(3)**

   Refer to table of options within the module.
   (Use discretion and award marks for relevant answers.)

TOTAL: 30

TERM **2**

MODULE **5**

Materials

After learners have completed this module, they should be able to:

- discuss and classify the following:
  - ferrous metals
  - non-ferrous metals; and
  - sheet metals:
    - cold-rolled sheets
    - galvanising sheets
    - expanded metals.

Time allocated: 4 hours (±5 lessons)

Introduction

Metals have properties that set them apart from other materials. The most important of these properties is strength. Metals are usually good conductors of electricity and heat. They are malleable and ductile, and they have a shiny appearance. More than a thousand different types of metals are used to manufacture products today. This unit focuses on the classification of metals, as well as the uses of some of these metals.

Lesson 1 – Outline

- Introduction
  - Display a variety of metals and non-metal objects.
  - Ask learners to identify the metal objects. How did they identify the metal objects?
- Discuss the properties of metals in general.
- Discuss:
  - Ferrous metals
  - Non-ferrous metals.
- **Homework:** Collect as many examples of metals (in and around the house and the workshop) as you can.

Lesson 2 – Outline

- Practical activity 5.1

Practical activity 5.1 (LB page 101) Individual activity

Identifying and classifying metals

Collect as many examples of metals (in and around the house and the workshop) as you can.

- Instruct learners to collect samples of metals.
- On the day of the practical, make sure there are enough metal samples to divide evenly among the groups.
- Provide magnets.
- Check the classification of items and evaluate each group's work.

You will need Group activity

- Samples of metals
- Magnets

Continued →

Practical activity 5.1 (LB page 101) (continued)

Instructions

1. Identify the type of metal used to make the product.
2. Test your classification by checking whether the items are magnetic.
3. 3.1 Sort the items into two groups:
   - Ferrous metals
   - Non-ferrous metals.

   3.2 Complete the table below by writing down the name of the metal you have identified in the applicable column (as in the example below).

Ferrous	Non-ferrous
E.g. 11. Steel	E.g. 12. Brass

Lesson 3 – Outline

- Sheet metals

Lessons 4 and 5 – Outline

- Finish theory
- Summative assessment

Summative assessment (LB page 105)

1. Complete the following paragraph by filling in the missing words.

Metals are divided into two main groups. **1.1** _____ metals contain iron and therefore have **1.2** _____ properties. **1.3** _____ metals have a low carbon content and are therefore less likely to **1.4** _____. A metal **1.5** _____ is a new, permanent metal made by combining two or more metals (or metals and non-metals). (5)

1.1 ferrous
1.2 magnetic
1.3 non-ferrous
1.4 rust/corrode
1.5 alloy

Continued →

Summative assessment (LB page 105) (continued)

2. You are peer-marking a friend's answers to an activity. Some of the metals have been classified incorrectly. Redraw the table and arrange the metals correctly.

Ferrous	Non-ferrous
Tin	**Brass**
Cast iron	**Zinc**
Copper	**Wrought iron**
Mild steel	**Stainless steel**
Aluminium	**Lead**

($\frac{1}{2}$ × 10) (5)

Ferrous	Non-ferrous
Wrought iron	Tin
Cast iron	Brass
Stainless steel	Zinc
Mild steel	Copper
	Aluminium
	Lead

3. Choose the metal that best suits the description given in 3.1–3.5.

Zinc	Copper	Aluminium	Cast iron
Stainless steel	Wrought iron	Tin	Lead

3.1 Excellent hygienic properties and popular in building designs because of its sleek modern look

Stainless steel

3.2 Lightweight enough to make tin foil and such an excellent conductor of electricity that it used in power transmission lines

Aluminium

3.3 A non-toxic, corrosion-resistant metal that is used to plate cans; also used in solder

Tin

Continued →

Summative assessment (LB page 105) (continued)

3.4 The second-best conductor of electricity and used in electrical cables and wiring; also an excellent material for hot-water pipes and fittings

Copper

3.5 Hard, brittle metal that is used for manhole and stormwater drain covers (5 × 1) (5)

Cast iron

4. How are cold-rolled sheets produced? (3)

Cold-rolled steel is hot-rolled steel that undergoes further processing in cold mills. The material is cooled (at room temperature) and then treated and rolled.

5. List FOUR advantages of galvanising metal sheets. (4)

- Low initial cost compared to other treated steels
- Longer life (increased durability)
- Damaged steel is protected by a zinc coating, which will corrode first
- Rust-resistant

6. In your opinion, what are the most important properties of expanded metals? (3)

Any THREE of the following:

- Less expensive and stronger than wire mesh (chicken wire)
- Made of one piece of material, so it can easily undergo further processing
- Very strong
- Lightweight
- Flexible
- Available in a wide range of colours and designs that look good
- Non-slip surface
- Can be combined with other materials to give products added strength and flexibility

TOTAL: 25

MODULE **6**

Joining methods

After learners have completed this module, they should be able to:

- differentiate between permanent and semi-permanent joining methods; and
- apply procedures of semi-permanent joining processes using the following:
  - bolt and nuts
  - pop-riveting
  - screws
  - keys and keyways.

Time allocated: 4 hours (±5 lessons)

Introduction

Various methods are used to join materials in the metalwork and welding field. *Joining* means to connect, fix, fasten or attach. It includes any kind of device or method used to do this. There are temporary (semi-permanent) and permanent methods of joining parts. In this module, we will look at a few of the common semi-permanent joining methods.

Lesson 1 – Outline

- Introduction
  - Brainstorming session: How are materials joined when products are manufactured?
  - Distinguish between permanent and semi-permanent joining methods – why each type is used (advantages/disadvantages).
  - Show examples of semi-permanent joining methods and how they can be dismantled (why/when is dismantling important).
- Nuts and bolts
  - Display a variety
  - Point out different styles of heads
  - Discuss threads
  - Show how spanners and/wrenches are used to fasten nuts and bolts.
- If time allows, the practical activity below can be used.
- Discuss different methods of screw cutting – focus on taps and dies and how they are used.

Practical activity

Group work

Joining materials using bolts and nuts

Provide each group with the material and equipment needed. Make sure that the material to be joined contains predrilled holes.

Each group will need

- Two pieces of sheet metal or other material
- Bench vice or G-clamp
- Bolts and nuts
- Spanners – open-ended, ring and combination spanner

Instructions

1. Align the holes in the material to be joined. Clamp the workpiece firmly.
2. Join the two pieces of material using the bolts and nuts provided.
3. Use a spanner of the correct size to fasten the bolt and nut.

Lesson 2 – Outline

- Pop-riveting
  - Revise/Refer to information covered in Module 3.
  - Point out the parts of the blind rivet.
  - Demonstrate the use of the rivet gun again.
- **Homework:** Activity 6.1
- If time allows, you can do the practical activity provided on the next page.

Activity 6.1 (LB page 113)

1. **List THREE methods used to permanently joint parts.**

   Riveting; welding (arc and gas); soldering

2. **Why are semi-permanent joining methods used for mechanical parts?**

   Assembled parts sometimes have to be dismantled without breaking them so that inspection, repair and maintenance are possible.

3. **Your friend does not know the difference between *screws* and *bolts*. Briefly explain how these two fasteners differ with regard to the following:**

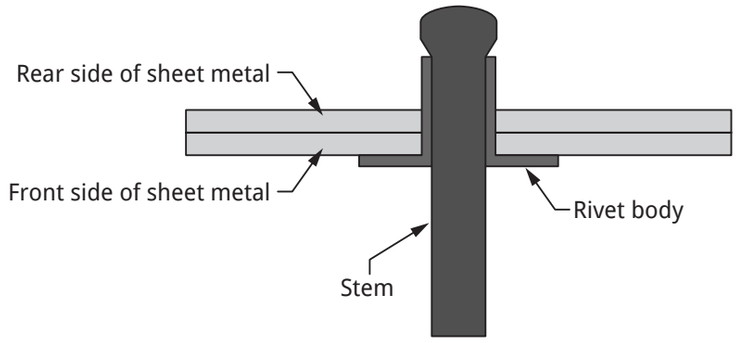
   3.1 Their shape

   Screws are externally threaded fasteners that can be inserted into holes, turned into existing internal threads or can make their own thread. Bolts are externally threaded fasteners designed to be inserted through holes in assembled parts; they are normally tightened or released by turning a nut.

   3.2 How they are fastened

   Screwdrivers are used to tighten or release screws. Spanners or wrenches are needed to tighten or release bolts and nuts.

4. **Make a neat, labelled drawing to illustrate the parts of a pop rivet.**



Practical activity Group activity

Pop-riveting

Divide learners into groups.

Each group will need

- Two plates with predrilled holes for the rivets
- Hand riveter
- Pop rivets

Instructions

1. Place the two plates on top of each other and align the holes. Clamp them securely.
2. Select a nozzle of the correct size for the rivet. Fit the nozzle into the nose of the rivet gun.
3. Select a rivet of the correct size and shank length for the plates to be joined. Fit it into the nozzle.
4. Push the rivet into the hole.
5. Squeeze the handle to pull the mandrel into the body of the rivet.

Evaluate the work and give feedback.

Lesson 3 – Outline

- Screws
  - Display various types and discuss threads, heads and uses.
  - Stress important safety measures.
  - Demonstrate (using both manual and electric screwdriver).
- Keys and keyways
  - Explain this concept.
  - Demonstrate how the key fits into the keyway (if possible, create a model or use existing machine parts).
- Using taps and dies to cut thread

Lessons 4 and 5 – Outline

- Using taps and dies to cut thread
- Finish any theory not covered.
- Summative assessment

Summative assessment (LB page 117)

1. **List FOUR details that you must consider when choosing bolts.** (4)

   Any four of the following:
   - Diameter
   - Type of thread
   - Length
   - Type of head
   - Material

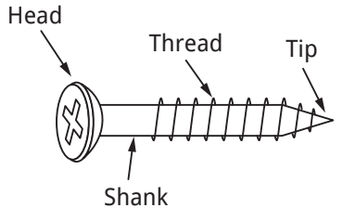
2. **Why is a washer inserted between the nut or bolt and the workpiece?** (1)

   To avoid damaging the surface of the workpiece

3. **Explain how a riveted joint is formed.** (4)

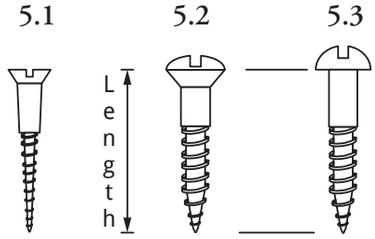
   The rivet gun applies force that deforms the shell. The stem/mandrel is pulled into the rivet body, causing it to expand and grip the parts to be joined. The end of the stem breaks and the joint is formed.

4. **Make a neat, labelled drawing to illustrate the parts of a screw.** (5)



   1 mark for each correct label = 4
   1 mark for accuracy of drawing

5. **Identify each of the following screws based on the shape of the head:**



(3)

   5.1 Countersunk
   5.2 Raised head
   5.3 Round/Domed head

Continued →

Summative assessment (LB page 117) (continued)

6. **Screws and bolts differ in important ways. Point out the main differences between these fasteners.** **(6)**

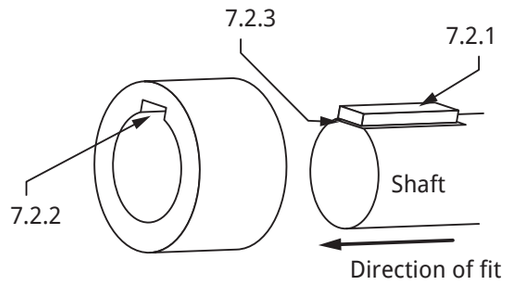
Screws are tapered threaded fasteners. They can be inserted into holes or can cut their own thread (self-tapping). Screws do not need nuts. They become fixed by being tightened into the hole. Screwdrivers are used to tighten or loosen screws.

Bolts are threaded fasteners too, but they are not tapered. A bolt is designed to be pushed through holes in parts and fixed with a suitable nut. Spanners or wrenches are needed to tighten or release bolts and nuts.

7. 7.1 **Briefly explain the terms *key* and *keyway*.** **(4)**

A key is a machined component that is used to join a rotating machine part to a shaft. The key fits tightly into a groove called a keyway that is machined into the rotating machine part (gear or pulley).

7.2 **Provide labels 7.2.1 to 7.2.3.** **(3)**



7.2.1 Key
7.2.2 Keyway
7.2.3 Key seat

TOTAL: 30

MODULE **7**

Terminology

After learners have completed this module, they should be able to:

- discuss the centre lathe and milling machine;
- use the correct terminology to identify and explain the purpose of the following engine components:
  - crankshaft
  - connecting rod
  - cylinder block
  - combustion chamber
  - inlet valve
  - cam
  - camshaft
  - spark plug
  - valve spring
  - exhaust valve
  - cylinder head
  - water jacket
  - piston
  - crankcase;
- understand and discuss the following terms relating to engines and their operation:
  - TDC
  - BDC
  - stroke
  - bore; and
- understand and explain the following fundamental engine technology:
  - four-stroke petrol engine
  - operation (intake; compression; power and exhaust strokes).

Time allocated: 8 hours (±9 lessons)

Introduction

The fields of motor mechanics and mechanical technology are closely linked. While a mechanic focuses on the different parts of an engine and how each part operates, a machinist is the one who makes the parts. A mechanic might overhaul an engine, and the crank or the engine block will be sent to a machine shop for machining.

A variety of cutting and shaping machines is used to manufacture and repair the different steel components used in the mechanical industry. Technology has advanced tremendously over the years. Today, state-of-the-art computerised lathes and milling machines have replaced the older, manually operated ones.

In this module learners will learn more about machining equipment, the purpose of engine components, terminology relating to engines as well as the operation of four-stroke engines.

Lessons 1 and 2 – Outline

- Introduction – general content of module
- Machines
  - Purpose of machining
  - What machining involves
  - Uses of centre lathe and milling machine.
- **Class-/Homework:** Activity 7.1

Activity 7.1 (LB page 126)

1. **How is the size of a lathe and its workpiece capacity determined?**

   It is determined by:
   - the distance between the centres of the lathe; and
   - the swing across the bed of the lathe.

2. **A lathe performs a variety of operations. Provide the correct term for each of the operations described here:**

   2.1 Removing material from the end and/or shoulder of a workpiece

   Facing

Continued →

Activity 7.1 (LB page 126) (continued)

2.2 Shaping a workpiece by cutting away unwanted material to form curves or taper the workpiece

Turning

2.3 The process of enlarging the diameter or depth of a hole that has already been drilled

Boring

2.4 Cutting spiral grooves of equal measurement or shape around a cylinder

Threading

2.5 Cutting ridges around the edge of a workpiece to create a non-slip surface

Knurling

3. Briefly explain the main difference between the operations of a *milling machine* and a *lathe*.

Lathes rotate the workpiece; milling machines hold the workpiece still using a clamping device while the cutting tool rotates.

Lessons 3 to 5 – Outline

- Introduce engine components
  - Display an engine.
  - Point out the various parts (do so again as each part is discussed).
  - Provide examples of the components for learners to observe and handle.
  - Discuss the purpose of each component.
- Practical activity 7.1

Practical activity 7.1 (LB page 136)

Identifying engine components and explaining the purpose of each component

You will need

- Engine (assembled)
- Engine parts
- Worksheet

Oral activity

- Use the assembled engine to point out parts for learners to identify.

Continued →

Practical activity 7.1 (LB page 136) (continued)

Individual activity

- Set out various engine components and label them.
- Learners study the components and complete the worksheet provided (as in Learner's Book).

Worksheet			
Name		**Class**	
Teacher		**Date**	
Time	45 minutes	**TOTAL**	30 marks

Study the engine components and complete the table below.

Name the component	Briefly describe its purpose
1.	•
	•
	•
2.	•
3.	•
4.	•
5.	•
6.	•
	•
	•
7.	•
	•
8.	•
9.	•
	•
	•
10.	•
	•
	•

Continued →

Practical activity 7.1 (LB page 136) (continued)

Memorandum

PLEASE NOTE: This is only a suggested list of components. Feel free to use any parts you have available. You can also label parts on the engine, e.g. the cylinder head and block. Adapt the marks allocated on the worksheet and the answers provided here accordingly.

Name the component	Briefly describe its purpose
1. Piston	• Causes a vacuum in the cylinder during the intake stroke • Forces out the burnt gases during the exhaust stroke • Compresses the petrol mixture in the combustion chamber during the compression stroke
2. Inlet valve	• Opened to allow the air/fuel mixture to flow into the cylinders before compression and ignition take place
3. Cam	• Pushes against the valves to open them as the camshaft rotates
4. Spark plug	• Creates the spark that ignites the air/fuel mixture, creating the explosion that makes the engine produce power
5. Crankshaft	• Converts the reciprocating movement of the pistons into a rotary movement
6. Cylinder block	• Houses the cylinders (and their components) • Contains the crankcase and all its parts, including gaskets, valves and seals • Contains cylindrically bored holes for the pistons and ways to attach other components such as the cylinder head
7. Valve spring	• Keeps the valves closed to build up engine pressure • Keeps specific pressure on all moving parts to follow the camshaft lobe

Continued →

Practical activity 7.1 (LB page 136) (continued)

Name the component	Briefly describe its purpose
8. Connecting rod	• Connects the piston with the crankshaft, thereby transferring the force exerted on the piston to the crankshaft
9. Camshaft	• Converts the rotating movement of the crankshaft into the up-and-down movement of the valves • Opens the valves at predetermined times • Drives the distributor, oil pump and mechanical fuel pump
10. Cylinder head	• Serves as a lid for the cylinders so that the petrol mixture can be compressed without loss of pressure • Allows air and fuel to reach the combustion chamber • Allows exhaust fumes to exit the combustion chamber • Ensures the constant lubrication of the cylinders • Helps to keep the engine cool (passageways allow coolant to circulate through the cylinder head)

Lesson 6 – Outline

- Explain the terms
  - TDC
  - BDC
  - Stroke
  - Bore.
- **Class-/Homework:** Activity 7.2

Activity 7.2 (LB page 138)

Briefly explain each of the following terms:

1. **BDC**

   Bottom dead centre: The piston has reached the lowest point of the downward stroke, in other words, it is at the lowest point it can reach in the cylinder.

2. **Bore**

   The bore of an engine refers to the inside diameter of a cylinder.

3. **Stroke**

   The maximum distance a piston travels between the two extreme points – TDC to BDC

4. **TDC**

   Top dead centre: The piston has reached the end of its upward stroke, in other words, it is at the highest point it can reach in the cylinder. From here it starts moving downwards again.

Lesson 7 – Outline

- Explain the terms
  - Four-stroke petrol engine
  - Engine operation:
    - Intake stroke
    - Compression stroke
    - Power stroke
    - Exhaust stroke.

Lessons 8 and 9 – Outline

- Finish any outstanding theory.
- Summative assessment

Summative assessment (LB page 141)

1. **State whether the following statements are TRUE or FALSE. Correct the statements if they are FALSE.**

   1.1 **In lathes, the workpiece is kept in position by a vice while the cutting tool rotates.**

   False. In milling machines, the workpiece is kept in position by a vice while the cutting tool rotates.

   1.2 **The crankshaft is housed in bearing liners inside the cylinder block.**

   True

   1.3 **The connecting rod links the piston and the crankshaft, transferring the pressure on the piston to the crankshaft.**

   True

   1.4 **The inlet valve is opened during the exhaust stroke.**

   False. The exhaust valve is opened during the exhaust stroke./The inlet valve is opened during the intake stroke.

   1.5 **The piston creates the spark that ignites the air/fuel mixture.**

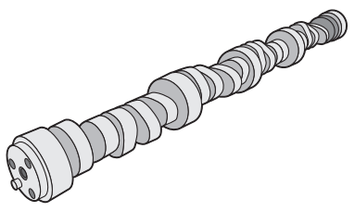
   False. The spark plug creates the spark that ignites the air/fuel mixture.

   1.6 **The engine completes one cycle during two crankshaft revolutions, while the camshaft completes one revolution.** **(6)**

   True

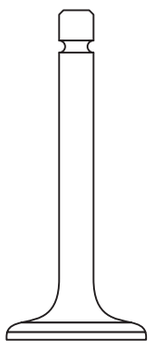
2. **Identify each of the following engine parts. Write down the name of the part next to the question number.**

   2.1

   Camshaft

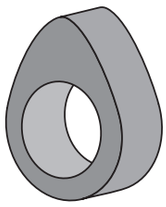
   2.2

   Valve (exhaust/inlet)

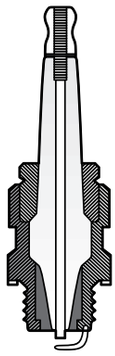
Continued →

2.3



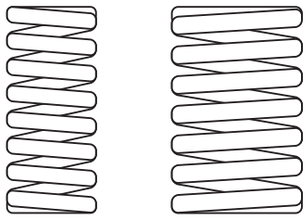
Cam (cam lobe)

2.4



Spark plug

2.5



Valve spring

(5)

3. Choose a term in COLUMN B that best matches a description in COLUMN A. Write down only the question number and the letter of your choice.

COLUMN A	COLUMN B
3.1 The process used to curve or taper a workpiece by cutting away unwanted material	A cycle
3.2 The process of cutting spiral grooves of equal measurement and shape around circular workpieces	B stroke
3.3 The inside diameter of a cylinder into which the piston with its rings fits	C camshaft
3.4 The maximum distance a piston travels between two extreme points when the crankshaft turns 180°	D turning
3.5 Ignition takes place during this stroke	E milling
3.6 Engine part that converts the rotating movement of the crankshaft into the up-and-down movement of the valves	F threading
	G bore
	H compression stroke
	I power stroke
	J crankshaft

(6)

3.1 D 3.2 F 3.3 G 3.4 B 3.5 H 3.6 C

Continued →

Summative assessment (LB page 141) (continued)

4. **Explain each of the following terms associated with the operation of an engine:**

   4.1 **BDC** **(3)**

   BDC refers to bottom dead centre. The piston has reached the lowest point of the downward stroke, in other words, it is at the lowest point it can reach in the cylinder.

   4.2 **TDC** **(3)**

   TDC refers to top dead centre. The piston has reached the end of its upward stroke, in other words, it is at the highest point it can reach in the cylinder. From here it starts moving downwards again.

5. **For an engine to work, FOUR operations need to take place. Together they are referred to as a cycle. Name these operations.** **(4)**

   For an engine to work, four operations need to take place:
   - Intake stroke: Air and fuel need to be drawn into the engine.
   - Compression stroke: The mixture needs to be compressed.
   - Power stroke: The mixture needs to be ignited to produce power.
   - Exhaust stroke: The used air needs to be forced out.

   Each operation is completed in one stroke

6. **Describe the processes that take place during the intake stroke.** **(8)**

   - The piston moves from TDC towards BDC.
   - The intake valve is opened; the exhaust valve is closed.
   - Downward piston movement creates a vacuum that draws the air/fuel mixture into the cylinder via the open intake valve.
   - Just after the piston has reached BDC, the intake valve is closed.

TOTAL: 35

TERM 3

MODULE 8

Maintenance

After learners have completed this module, they should be able to:

- identify lubricants for different components;
- discuss the characteristics of a lubricant;
- discuss the importance of using lubricants;
- describe the lubrication of machines and equipment;
- discuss inspection frequency;
- describe the use and care of appropriate tools and equipment;
- discuss automotive lead-acid storage-type batteries; and
- discuss the use of PPE when handling batteries.

Time allocated: 6 hours (±7 lessons)

Introduction

Lubrication plays an important role in all machines that have moving parts. It ensures that a vehicle runs smoothly. Lubricants also protect parts that are in constant contact from wearing too much or too quickly. There are various types of lubricants for different parts of the vehicle. This module focuses on the types of lubrication needed for the various parts. We will also look at the lead-acid battery and how it should be handled.

Lessons 1 and 2 – Outline

- Introduction
  - Brainstorming session – What is lubrication and why is it necessary?
    - Feedback and discussion
- Discuss:
  - Importance of lubrication
  - Characteristics of lubrication
  - Identify lubricants for different components
  - Lubrication of machines and equipment – show examples of grease guns and oil cans
  - Inspection intervals
  - Tools and equipment used to lubricate machinery/engines.
- **Class-/Homework:** Activity 8.1

Activity 8.1 (LB page 151)

1. **Name FIVE vehicle parts that need lubrication.**
   - Main bearings and big-end bearings – grease
   - Cylinder liners, pistons and rings – a good-quality oil that controls the forming of deposits and prevents wear
   - Crankcase – a mineral-oil lubricant that allows good sludge (dirty oil) and soot (black powdery deposit produced by incomplete burning) control
   - Cylinder head – clean oil delivered by the engine lubrication system
   - Valves – lubricant with good wear protection
   - Main rod and rod bearings – high quality lubricant that prevents corrosion and provides extra protection
   - Gearbox and final drive – oils with additives that can resist pressure loads (extreme pressure oil)
   - Wheel bearings – grease
   - Steering system – grease
   - Ball joints – grease
   - Tie-rod ends – grease that is water-resistant and has a low melting point

   (Any five)

Continued →

Activity 8.1 (LB page 151) (continued)

2. **List the functions of a lubricating oil.**

   - Reduces the amount of power that is lost due to friction
   - Limits wear on moving parts (metal on metal)
   - Seals the piston rings in the cylinder
   - Cleans the inside of the engine
   - Prevents corrosion
   - Cools the engine by carrying heat away from moving parts

3. **List the main properties of the different types of grease.**

   - Grease with sodium base
     - Fibrous (stringy) texture
     - Sticky
     - Limited operating temperatures (no higher than 120 °C)
     - Not as water-resistant as other greases
     - Not affected by vibration
   - Metallic soap grease
     - Outstanding lubricating properties
     - Highly water-resistant
     - Able to form gels
   - Barium complex grease
     - Mechanically stable
     - Can resist high temperatures
     - Able to withstand heavy loads and high speeds
     - Excellent water tolerance
     - Great rust resistance
     - Resistant to various chemicals

4. **Which equipment would you use to lubricate machines and equipment manually?**

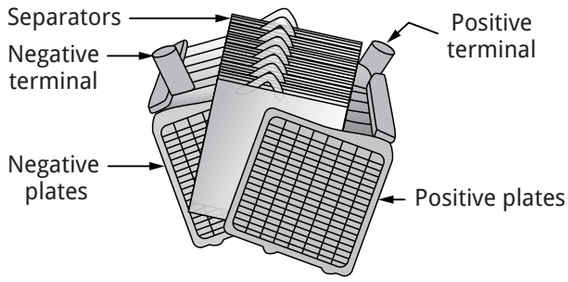
   Grease gun; handheld oil can; brush

Lesson 3 – Outline

- Automotive batteries – lead-acid battery
  - Show an example of a lead-acid battery (and a disassembled one if available).
  - Discuss its construction and how it works.
  - Discuss why PPE is important when handling these batteries.
- **Class-/Homework:** Activity 8.2

Activity 8.2 (LB page 153)

1. **Make a neat drawing of a lead-acid battery to show its different parts.**



2. **Make a list of the PPE that you will need when handling lead-acid batteries.**

   - Always wear acid-resistant safety glasses to protect your eyes.
   - Always wear gloves.
   - Wear overalls or an apron to protect your clothes and skin.

Lessons 4 and 5 – Outline

- Practical activity 8.1 – Demonstration
  - Adherence to the SHE procedure
  - Basic visual inspection
- Before demonstration
  - Explain what the SHE procedure entails

SHE procedure

SHE is an abbreviation that refers to Safety, Health and Environmental procedures. An SHE programme is a lubrication safety plan that focuses on the handling and storage of chemicals, of which oil is one. It covers the following:

- Storage
- Handling
- Equipment monitoring
- Disposal
- General safety practices and training.

1. Storage
   - Oils and greases must be properly stored.
   - Spills and leaks must be prevented.
   - Oils and greases have expiry dates; if the lubricant has expired, it must be disposed of correctly (see point 4).
   - The area must be ventilated well (enough fresh air).
2. Handling
   - Many lubricants are not poisonous (non-toxic), but some contain ingredients that can cause a reaction or injury if not handled correctly.
   - Always read the safety data sheet for the lubricant – copies should be available for everyone who use the area/lubricants.
   - Keep PPE nearby – gloves, goggles, face shield, aprons, etc.
   - Sample any oil under pressure carefully.
   - Never hold a grease gun coupler with your hand during application.
   - Use grease guns with installed pressure-relief valves; rather avoid pneumatic types in high-risk situations.
3. Equipment monitoring
   - After lubrication, recheck the equipment.
   - Look for leaks or spills. Clean the area immediately to avoid slips and trips.
   - Clean any dust or bits of material that may have settled on parts.
4. Disposal
   - Dispose of lubricants safely and in an environmentally friendly way!
   - Waste/Used oil
     - Drain used oil into a clean container with a tight-fitting lid (e.g. an ice-cream tub).
     - Label the containers clearly for the waste management company.
     - Store the containers in a cool, dry place.
     - Keep oil-changing pans free from water and moisture. Rust will contaminate the oil and affect its recyclability.
     - Only give your used oil and lubricants to authorised waste management companies.

NEVER …

- Pour used oil or lubricants down the drain or into a ditch!
- Dispose of motor oil with recycling, compost or household waste.
- Store used oil in containers that previously held chemicals.
- Mix used oil with other fluids/lubricants.

Practical activity 8.1 (LB page 154) Demonstration

Adherence to the SHE procedures and basic visual inspection

You will need

- An engine/workshop machine or piece of equipment
- Lubricants (oil/grease) to illustrate proper storage
- Tools necessary to access parts for inspection
- Vehicle – to check engine
- Clean cloth

Instructions

1. Discuss and demonstrate the steps in the SHE procedure.
2. Visually inspect a lubricated component, including checking the following:
    - Cleanliness
    - Leaks
    - Oil level – is it above or below the indicated level; if below, top up
    - Oil condition – does it appear cloudy or too dark (compare to fresh oil)
    - Filters
3. Checking a vehicle's engine oil level:
    - Open the hood/bonnet and find the dipstick.
    - Pull the dipstick out from the engine and wipe any oil off its end.
    - Insert the dipstick back into its tube and push it all the way back.
    - Remove it again and check the graduations on the dipstick.
    - If the oil level is close to the minimum level, it needs topping up.

Lessons 6 and 7 – Outline

- Finish/Revise theory
- Summative assessment

Summative assessment (LB page 154)

1. **Briefly explain why it is extremely important for engine parts to be lubricated.** **(3)**

   Lubrication plays an important role in the smooth running of the engine. A lubricant forms a thin layer that separates two surfaces so that they do not rub together too much. This helps to reduce the amount of friction between the moving surfaces. If there is not enough lubrication, the components will become jammed, and the engine will break down. (Any 3 clear facts)

2. **How often should the oil level of a car be checked?** **(1)**

   Once a month

3. **The viscosity of an oil is very important. What does the term *viscosity* describe?** **(2)**

   Viscosity refers to the degree to which the oil resists flow, in other words, the degree of thickness of the oil.

4. **List SIX functions of engine oil.** **(6)**

   - Reduces the amount of power that is lost due to friction
   - Limits wear on moving parts (metal on metal)
   - Seals the piston rings in the cylinder
   - Cleans the inside of the engine
   - Prevents corrosion
   - Cools the engine by carrying heat away from moving parts

5. 5.1 **What is *friction*?** **(2)**

   Friction can be described as the resistance that one surface experiences when moving over another.

   5.2 **Why is it important to prevent friction?** **(3)**

   It is important to prevent friction because:
   - it causes wear;
   - it makes moving parts heat up; and
   - it wastes energy (fuel).

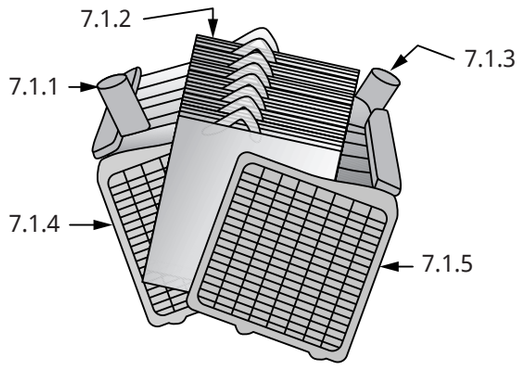
6. **Name TWO pieces of equipment that can be used to lubricate machinery manually.** **(2)**

   Oil can and grease gun

Continued →

Summative assessment (LB page 154) (continued)

7. **Study the drawing of a lead-acid battery below and answer the questions that follow.**



7.1 Label the parts numbered 7.1.1 to 7.1.5. **(5)**

7.1.1 Negative terminal
7.1.2 Separators
7.1.3 Positive terminal
7.1.4 Negative platew
7.1.5 Positive plates

7.2 What is the function of a car battery? **(3)**

The battery supplies electricity to a vehicle, mainly for starting the engine and providing power for lights and other electrical equipment. The battery stores electricity in the form of chemical energy, which can be converted back into electricity when needed.

(Any three clear points)

7.3 Why must you wear PPE when handling lead-acid batteries? **(2)**

Lead-acid batteries are filled with a sulphuric acid and water solution. The acid can burn holes in the skin and clothes and can seriously hurt your eyes.

7.4 List the PPE that you must wear when working with batteries. **(3)**

- Always wear acid-resistant safety glasses to protect your eyes.
- Always wear gloves.
- Wear overalls or an apron to protect your clothes and skin.

TOTAL: 32

MODULE **9**

Bodyworks

After learners have completed this module, they should be able to:

- identify and assess damage to a body panel;
- select appropriate tools to repair a coin-sized dent;
- repair a coin-sized dent on a body panel; and
- prepare a surface for spray-painting.

Time allocated: 8 hours (±9 lessons)

Introduction

The bodywork of a vehicle refers to its outer metal structure. The term *bodywork* also refers to all the steps needed to repair a damaged panel, including preparing it for spray-painting. If the bodywork is dented, the car can be taken to an autobody repair shop. A panel beater will repair the dent and spray-paint the panel. In this module, learners will learn how to repair a small dent as well as prepare a panel for spray-painting.

Lesson 1 – Outline

- Introduction
  - Brainstorming session:
    - What is the bodywork of a vehicle?
    - What does panel beating involve?
  - Feedback and discussion
- Introduce tools to be used in panel-beating practical.
- Discuss safety rules.

Lesson 2 – Outline

- Practical demonstration
  - Set out everything you will need for the demonstration before the lesson.
  - Make sure that learners have a copy of the observation sheet (can be photocopied or redrawn in their workbooks).
  - Follow the steps set out in Practical activity 9.1. Be sure to explain each step and describe how the equipment works/is used.
  - Learners complete the list of observations during the demonstration.

Practical activity 9.1 (LB page 159) Demonstration

How to repair coin-sized dents on ferrous body shell while applying safety rules

You will need

- Selection of hammers
- Selection of dollies

Instructions

1. Inspect the damaged panel and assess the damage.
2. Select the tools to use. (For a small dent, a general-purpose dolly and a cross-peen hammer can be used if you have access to both sides of the panel being repaired.)

Continued →

Practical activity 9.1 (LB page 159) (continued)

3. Mark the dent area with a soft pencil or a marker.
4. Position the dolly right underneath the dent. Push up on the dolly. Most of the force should be from the dolly rather than the hammer.
5. Use short, gentle taps of the hammer to flatten any high spots around the dent while pushing the dolly against the dent from the other side.
6. Keep the hammer head complete flat to prevent damaging the surface. Do not tilt the hammer.
7. Check the surface regularly. Keep feeling for highs and lows with your fingertips.
8. Assess the repaired work.
9. Clean the area and the tools used. Store the tools and equipment in the allocated areas.

Safety rules to point out

- Neatly arrange the tools needed for the job before you start.
- Wear overalls and the necessary PPE.
- Never work underneath the vehicle unless it is properly supported.
- Clean the area and tools after you have finished. Never leave tools lying around.

List observations during demonstration

Steps	Observations
Identifying and assessing damage	
Selecting and setting out tools	
PPE (overalls, etc.) and safety rules	
Marking the area	
Use of dolly – position	
Use of hammer(s) – type of blows	
Checking work	
Final assessment	
Cleaning workspace and equipment	
Storing equipment	

Lesson 3 – Outline

- Practical activity 9.2 – Learners repair small dents on body panels
  - Set out the panels, tools and equipment needed before the lesson starts.
  - Monitor the process and assist where necessary.
  - Assess the repair work using the rubric provided.

Practical activity 9.2 (LB page 159)

Individual or pair activity
(depending on availability of resources)

Repair a coin-sized dent in a body panel

You will need

- Selection of hammers
- Selection of dollies
- Pencil or marker

Instructions

1. Inspect the damaged panel and assess the damage.
2. Select the tools to use based on your observations during the demonstration.
3. Mark the dent area with a soft pencil or a marker.
4. Position the dolly right underneath the dent. Push up on the dolly. Most of the force should be from the dolly rather than the hammer.
5. Use short, gentle taps of the hammer to flatten any high spots around the dent while pushing the dolly up against the dent from the other side.
6. Keep the hammer head complete flat to prevent damaging the surface. Do not tilt the hammer.
7. Check the surface regularly. Keep feeling for highs and lows with your fingertips.
8. Assess the repaired work.
9. Clean the area and the tools used. Store the tools and equipment in the allocated areas.

The rubric below may be used for assessment.

Assessment rubric

(5 = excellent; 4 = good; 3 = average; 2 = basics achieved; 1 = poor/not achieved)

Criteria	Skill/Execution				
	5	4	3	2	1
Adherence to safety measures (overalls, no loose clothing, etc.)					
Ability to assess the damage					
Selection of tools and equipment					
Technique used – hammer					
Technique used – dolly					
Following steps (logical progression) and/or instructions					
Own assessment of work					
Total	**35**				

Lesson 4 – Outline

- Assessment of Practical activity 9.2
  - Feedback and suggestions for improvement

Lesson 5 – Outline

- Introduce the equipment used in surface preparation for spray-painting
  - Terminology
  - Sandpaper grit
  - Using an orbital sander
  - Spot putty.
- Prepare for the demonstration.

Lesson 6 – Outline

- Practical activity 9.3
  - Set out everything you will need before the lesson starts.
  - Make sure that learners have a copy of the observation sheet (can be photocopied or redrawn in their workbooks).
  - Follow the steps. Be sure to explain each step and describe how the equipment works/is used.
  - Learners complete the list of observations during the demonstration.

Practical activity 9.3 (LB page 163) Demonstration

Preparing the surface of a body panel prior to spray-painting

You will need

- Panel that was used in Practical activity 9.1
- Power sander and sanding discs (400–600 grit)
- Sandpaper (120, 320, 400–600 grit)
- Scuff pad
- Cleaning solvent
- Body filler/spot putty (if needed)
- Newspaper
- Masking tape (if needed)
- Dust mask
- Safety glasses
- Latex gloves
- Rags

Continued →

Practical activity 9.3 (LB page 163) (continued)

Instructions

1. Remove any dust and dirt from the surface. Assess the damage to the area.
2. Start with the 120–180-grit sandpaper. (If you are using a portable sander, start off at a low speed.)
3. Dry-sand the entire panel using circular motions. Follow the curves and make sure you sand the inside edges as well. The depth of the sanding will depend on the damage. Sanding it down to the bare metal is recommended.
4. Move to 320-grit sandpaper to remove scratches.
5. Use body filler/spot putty to fill any low spots, if necessary. Sand the area once it has dried.
6. Clean off the dust and inspect the sanded surface. Re-sand spots as necessary.
7. Use a rag and cleaning solvent to wipe down all the surfaces thoroughly. This removes any oil residue. Wear gloves for the rest of the sanding process.
8. Refinish (feather-edge) the area to remove the scratches left by the different grits of sandpaper.
9. For the final sanding use 400–600-grit sandpaper or discs. The area can be wet-sanded too. Pay extra attention to the edges. Sand any hard-to-reach places manually and then use a scuff pad for finishing.
10. The area must be washed well with soapy water before it is primed.

List observations during demonstration

Steps	Observations
Identifying and assessing damage	
Cleaning panels (workshop procedures)	
Selecting sandpaper (wet and/or dry)	
Selecting tools and equipment	
PPE (overalls, etc.) and safety rules	
Using body/spot putty	
Sanding operation – wet/dry	
Sanding operation – manual/sander	
Checking surface for smoothness	
Final assessment	
Cleaning workspace and equipment	
Storing equipment	

Lesson 7 – Outline

- Practical activity 9.4
  - Before the lesson, prepare and set out all the equipment.
  - During the practical, observe learners closely to assess their progress. Help where necessary.
  - After the practical, supervise the cleaning and storing operation.

Practical activity 9.4 (LB page 164)

Preparing the surface of a body panel for spray-painting

You will need

- Panel that was used in Practical activity 9.1
- Power sander and sanding discs (400–600 grit)
- Sandpaper (120, 320, 400–600 grit)
- Scuff pad
- Cleaning solvent
- Body filler/spot putty (as needed)
- Newspaper
- Masking tape (if needed)
- Dust mask
- Safety glasses
- Latex gloves
- Rags

Instructions

1. Remove any dust and dirt from the surface. Assess the damage to the area.
2. Start with the 120–180-grit sandpaper. (If you are using a portable sander, start off at a low speed.)
3. Dry-sand the entire panel using circular motions. Follow the curves and make sure you sand the inside edges as well. The depth of the sanding will depend on the damage. Sanding it down to the bare metal is recommended.
4. Move to 320-grit sandpaper to remove scratches.
5. Use body filler/spot putty to fill any low spots, if necessary. Sand the area once it has dried.
6. Clean off the dust and inspect the sanded surface. Re-sand spots as necessary.
7. Use a rag and cleaning solvent to wipe down all the surfaces thoroughly. This removes any oil residue. Wear gloves for the rest of the sanding process.
8. Refinish (feather-edge) the area to remove the scratches left by the different grits of sandpaper.
9. For the final sanding use 400–600-grit sandpaper or discs. The area can be wet-sanded too. Pay extra attention to the edges. Sand any hard-to-reach places manually and then use a scuff pad for finishing.
10. The area must be washed well with soapy water before it is primed.

Continued →

Practical activity 9.4 (LB page 164) (continued)

Assessment rubric

(5 = excellent; 4 = good; 3 = average; 2 = basics achieved; 1 = poor/not achieved)

Criteria	Skill/Execution				
	5	4	3	2	1
Adherence to safety measures (gloves, dust mask, etc.)					
Cleaning panels (following workshop procedures)					
Ability to assess the damage					
Selecting sandpaper grits for sanding processes					
Sanding technique (manual and/or using sander)					
Technique used to fill dented surface					
Following steps (logical progression) and/or instructions					
Checking surface for smoothness					
Own assessment of work					
Cleaning of workspace and equipment; storing equipment					
Total	**50**				

Lessons 8 and 9 – Outline

- Finish the practical.
- Assess the work and give feedback.

Summative assessment (LB page 166)

1. What does panel beating involve? (3)

The panel-beating process involves removing, repairing and replacing damaged panels as well as spray-painting, chassis alignment and the refitting of body parts.

2. Name TWO hammers that are used to repair a dented surface. (2)

Planishing, cross-peen and finishing, curved pane and finishing, pick finishing (Any two)

Continued →

Summative assessment (LB page 166) (continued)

3. **What is the function of a dolly?** (2)

   Used to support the metal from behind when it is shaped with a hammer

4. **Name TWO types of files used for semi-finishing work on body panels.** (2)

   Beating file; adjustable body file

5. **How would you use an orbital sander when preparing a panel for spray-painting?** (5)

   - Make sure the sander is switched off before connecting the power supply.
   - Fit the sandpaper disc of the correct grit.
   - Start with a lower speed.
   - Keep the sander level on the metal surface.
   - Do not apply too much force.

6. **Explain the difference between *buffing* and *polishing*.** (4)

   Buffing is a finishing process that involves using a loose abrasive on a wheel to create a smooth surface. Polishing is a more aggressive finishing than buffing, using an abrasive fixed to a wheel; it removes more superficial material to produce a brighter finish.

7. **State whether the following statements are TRUE of FALSE. Correct the statements if they are FALSE.**

   7.1 **Primer is used to remove rough scratches from the surface before it is spray-painted.**

   False. Primer pretreats the surface/helps paint to stick to the surface.

   7.2 **The higher the grit number of sandpaper, the coarser it will be.**

   False. The higher the grit number, the finer it will be. OR: The lower the grit number, the coarser it will be.

   7.3 **Wet sanding removes more material and uses a lower-grit sandpaper than dry sanding.**

   False. Dry sanding removes more material and uses a lower-grit sandpaper.

   7.4 **Electric sanders must only be used on level surfaces.**

   True

   7.5 **Spot putty fills tiny pinholes in the body filler to prevent cracks in the painted surface.** (5)

   True

TOTAL: 23

TERM **4**

Revision and practicals

After learners have completed this module, they should be:

- well prepared for the final examination.

Introduction

This module contains summaries and/or revision questions that have been prepared according to the weighting given in the syllabus. You will see that some modules are covered in more detail than others. That is because more marks are awarded to these modules in the final examination. The practical activities included here focus on aspects that were not practised during the previous terms.

Teacher's note

Use the time available to revise the work as you see fit, based on the needs of the learners in your class. The revision exercises can be used for class- and/or homework. The practical activities can be used if you have extra time.

Module 1: Health and safety

Revision quiz 1 (LB page 168)

1. **Give clear reasons why each of the following items of PPE must be worn:**

   1.1 Eye protection

   When working on grinding or drilling machines, or when chipping or welding, you must wear safety glasses. They protect your eyes from flying objects, harmful liquids, gases or rays.

   1.2 Gloves

   Your hands are constantly at risk, especially when you handle dirty, oily, rough, sharp, hot, corrosive or toxic materials. Wear gloves to protect your hands.

   1.3 Dust mask **(3 × 2) (6)**

   When cutting bricks or tiles, sawing wood and cleaning, a dust mask should be worn. A mask can also protect you from inhaling harmful fumes and against splattering liquids or mists.

2. **State the *meaning or purpose* and the *dominant colour* of each of the following safety signs:**

   2.1 Mandatory

   Carry out a specific action – blue

Continued →

Revision quiz 1 (LB page 168) (continued)

2.2 Prohibition

Dangerous behaviour, stop, shut down, emergency, cut-out devices, evacuate – red

2.3 Warning/Caution **(3 × 2) (6)**

Be careful, take precautions, examine – yellow or amber

3. How would you treat someone who is suffering from shock? **(5)**

- Lay the person down and elevate the legs and feet slightly.
- Keep the person still.
- Loosen tight clothing and cover the person with a blanket to prevent chilling.
- If the person is vomiting, turn him/her onto a side to prevent choking.
- DO NOT let the person eat or drink anything.

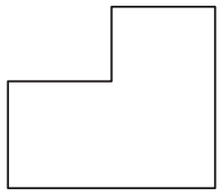
TOTAL: 17

Module 2: Graphic communication

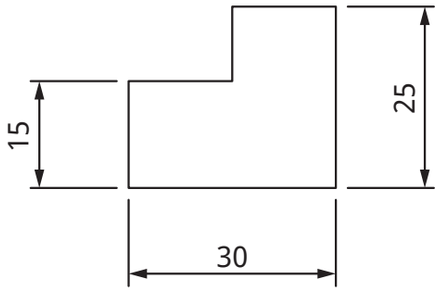
Revision quiz 2 (LB page 169)

1. Redraw the figure below and correctly insert dimension lines and the following measurements:

- **Side 15 mm**
- **Base 30 mm**
- **Side 25 mm**



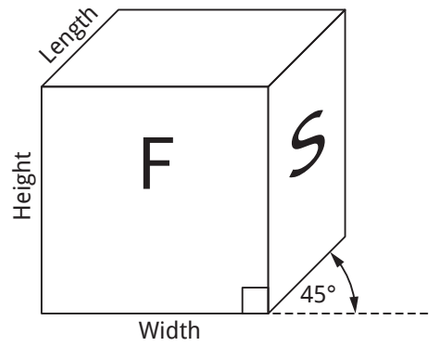
Place the dimensions so that they can be read from the bottom or right-hand side of the drawing. **(5)**

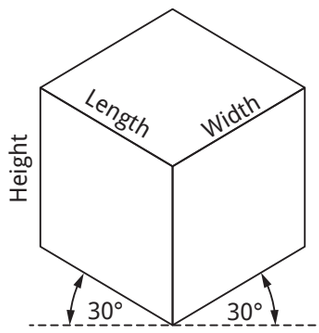


Continued →

Revision quiz 2 (LB page 169) (continued)

2. **Make TWO neat drawings of a cube to show the difference between an *oblique* drawing and an *isometric* drawing. Provide a title for each drawing.** (12)





Award marks as follows for each drawing:

- Correct proportions = 2 (1 x each drawing)
- Correct angle = 2 (1 x each drawing)
- Angle is indicated = 2 (45° and 30°, respectively)
- Correct labels – length, height and width = 6 (3 × each drawing)

TOTAL: 17

Module 3: Tools, instruments and equipment

Revision quiz 3 (LB page 170)

1. **What is the function of each of the following tools?**

1.1 Spanner (2)

To tighten or loosen and grip nuts and/or bolts

1.2 Vernier calliper (3)

Vernier callipers are used to measure the inside and outside diameters of pipes, rods and workpieces. They can also be used to measure the depth of a hole.

1.3 Outside calliper (1)

To measure the outside diameter of workpieces

Continued →

Revision quiz 3 (LB page 170) (continued)

2. **Choose the correct answer from the words between brackets:**

When reading a micrometer, the number of full millimetres is taken on the thimble **2.1** (**above**/below) the datum line. The number of half millimetres is read on the thimble **2.2** (above/**below**) the datum line. (2)

3. **Name THREE types of lifting equipment.** (3)

Trolley jack; bottle jack; scissor jack

TOTAL: 11

Practical activity 1 (LB page 170)

Recognising and reporting damage to tools

Set out a variety of workshop tools and equipment. Learners must inspect each tool carefully and complete the following table:

Name of tool	Condition (*Excellent*, *Damaged* **or** *Not safe to use*)	Describe damage as applicable

Example of tools that can be used:

Name of tool	Condition (*Excellent*, *Damaged* **or** *Not safe to use*	Describe damage as applicable
Spanner	Excellent	
Spanner	Damaged	Worn threading; cannot grip nut/bolt
Hammer	Excellent	
Screwdriver	Damaged	Loose/Cracked handle
Electric drill	Excellent	
	Not safe to use	Damaged power cord
Bench grinder	Not safe to use	Missing eye shield

Module 4: Entrepreneurship

Revision quiz 4 (LB page 171)

1. Provide the term used for each of the following descriptions or actions:

1.1 A person with good business ideas and the courage to start a business, taking financial risks

Entrepreneur

1.2 The right or license granted by a company to individuals allowing them to market and trade under the company's name

Franchise

1.3 Using a distinctive design or catchy phrase that people would associate with a particular product/company

Branding

1.4 A symbol or other small design used by a company to identify its products

Logo

1.5 Using newspapers, social media, radio or television to make people aware of the products or services that you have to offer **(5 × 1) (5)**

Advertising

2. List THREE different types of entrepreneurships and briefly describe each type. **(3)**

- Small businesses – provides enough profit for entrepreneur to support his/her family; small staff
- Scalable start-up – entrepreneurs who believe they have a good idea look for investors/try to fill a gap in the market
- Large company – run by a team/develop new product/expand
- Social entrepreneurship – business is started to solve a social problem, not to make a profit (Any three of the above)

3. Explain the difference between *marketing* and *branding*. **(4)**

- Marketing – the action or business of promoting and selling products and services, including market research and advertising
- Branding – promoting a particular product/company by using a distinctive design (logo) or wording (slogan) associated with the brand

TOTAL: 12

Module 5: Materials

Revision quiz 5 (LB page 172)

1. Metals are divided into two main groups. **1.1** _____ metals contain iron and therefore have **1.2** _____ properties. **1.3** _____ metals have a low carbon content and are therefore less likely to **1.4** _____. A metal **1.5** _____ is a new, permanent metal made by combining two or more metals (or metals and non-metals). (5)

1.1 Ferrous
1.2 magnetic
1.3 Non-ferrous
1.4 be magnetic
1.5 alloy

2. Arrange the metals listed below under the following headings:

Ferrous	Non-ferrous	Sheet metal	Alloy

2.1 Bronze
2.2 Cast iron
2.3 Aluminium
2.4 Mild steel
2.5 Tin
2.6 Stainless steel
2.7 Galvanised plates
2.8 Copper (8)

Ferrous	Non-ferrous	Sheet metal	Alloy
2.2 Cast iron 2.4 Mild steel 2.5 Stainless steel	2.3 Aluminium 2.4 Copper	2.7 Galvanised plates	2.1 Bronze 2.5 Tin

TOTAL: 13

Module 6: Joining

Revision quiz 6 (LB page 173)

1. Why are semi-permanent joining methods used for mechanical parts? **(2)**

The parts must sometimes be dismantled without breaking them so that inspection, repair or maintenance is possible.

2. Clearly explain the difference between *screws* and *bolts*. **(8)**

Screws are tapered threaded fasteners. They can be inserted into holes or can cut their own thread (self-tapping). Screws do not need nuts. They become fixed by being tightened into the hole. Screwdrivers are used to tighten or loosen screws. Bolts are threaded fasteners too, but they are not tapered. A bolt is designed to be pushed through holes in parts and fixed with a suitable nut. Spanners or wrenches are needed to tighten or release bolts and nuts.

3. What is the purpose of the stem of a rivet? **(2)**

It is pulled into the rivet body, causing it to expand and grip the parts to be joined.

4. 4.1 What is the function of a keyed joint? **(2)**

It fixes the hub and shaft and plays a role in safety – when overloading takes place, the key will break before the part or shaft breaks.

4.2 Complete the following paragraph by filling in the missing word(s).

The key fits tightly into a **4.2.1** _____ on the shaft and a **4.2.2** _____ in the rotating machine part. **(2)**

4.2.1 key seat
4.2.2 keyway

4.3 Name THREE types of keys used in the automotive industry. **(3)**

Square, gib-head, feather, woodruff, tapered (Any three)

TOTAL: 19

Practical activity 2 (LB page 173)

Joining two pieces of metal using nuts and bolts

- Prepare the components by drilling holes to fit the bolts. If time allows, you can allow learners to drill the holes.
- Provide a selection of bolts, nuts and washers. Learners must choose the combination to fit the size of the hole in their workpieces.
- They must also choose the correct spanner for the job.

You will need

- Two pieces of metal/wood
- Bolts and nuts (assortment)
- Washers (assortment)
- Spanners (assortment)

Instructions

1. Select a suitable bolt, nut and washer to fasten the metal/wooden components.
2. Select suitable spanners to fasten the bolt and nut.
3. Join the two pieces of metal/wood using the spanners you have chosen.
4. Check that the joint is fastened well, allowing no movement between the two components.

Suggested rubric for peer marking

(5 = excellent; 4 = very good; 3 = average; 2 = poor; 1 = barely mastered/poor)

Criteria	Skill/Execution				
	5	4	3	2	1
Selecting bolt, nut and washer to fit hole					
Handling of tools (spanner matching bolt/nut)					
Following instructions					
Quality of the joint					
Cleaning of workspace and storing equipment, etc.					
Total	**25**				

Module 7: Terminology

Revision quiz 7.1 (LB page 174)

1. **Briefly explain the main difference between the operations of a *milling machine* and a *lathe*.** **(2)**

   Lathes rotate the workpiece; milling machines hold the workpiece still using a clamping device while the cutting tool rotates.

2. **Briefly describe the function(s) of each of the following engine parts:**

   2.1 Piston **(3)**

   - Causes a vacuum in the cylinder during the intake stroke
   - Forces out the burnt gases during the exhaust stroke
   - Compresses the petrol mixture in the combustion chamber during the compression stroke

   2.2 Inlet valve **(2)**

   Opened to allow the air/fuel mixture to flow into the cylinders before compression and ignition take place

   2.3 Spark plug **(2)**

   Create the spark that ignites the air/fuel mixture, creating the explosion which makes the engine produce power

   2.4 Camshaft **(3)**

   - Converts the rotating movement of the crankshaft into the up-and-down movement of the valves
   - Opens the valves at predetermined times
   - Drives the distributor, oil pump and mechanical fuel pump

   2.5 Cylinder block **(3)**

   - Houses the cylinders (and their components)
   - Contains the crankcase and all its parts, including gaskets, valves and seals
   - Contains cylindrically bored holes for the pistons and ways to attach other components such as the cylinder head

3. **Briefly explain each of the following terms:**

   3.1 BDC

   The piston has reached the lowest point of the downward stroke, in other words, it is at the lowest point it can reach in the cylinder.

Continued →

Revision quiz 7.1 (LB page 174) (continued)

3.2 Bore

The bore of an engine refers to the inside diameter of a cylinder.

3.3 Stroke

The maximum distance a piston travels between the two extreme points – TDC to BDC.

3.4 TDC **(4 × 2) (8)**

The piston has reached the end of its upward stroke, in other words, it is at the highest point it can reach in the cylinder. From here it starts moving downwards again.

4. **For an engine to work, four operations need to take place. Together they are referred to as a cycle. Explain each of these operations in ONE sentence.** (4)

For an engine to work, four operations need to take place:

- Air and fuel need to be drawn into the engine.
- The mixture needs to be compressed.
- The mixture needs to be ignited to produce power.
- The used air needs to be forced out.

Each operation is completed in one stroke.

TOTAL: 27

Revision quiz 7.2 (LB page 174)

1. **State whether each of the following statements are TRUE or FALSE. Correct the statements if they are FALSE.**

1.1 The crankshaft is housed in bearing liners inside the cylinder block.

True

1.2 The piston creates the spark that lights the air/fuel mixture.

False. The spark plug creates the spark that lights the air/fuel mixture.

1.3 The inlet valve releases burned gases from the cylinder.

False. The exhaust valve releases the burned gases from the cylinder.

1.4 The fuel and air are compressed and lit in the cylinder head.

False. The fuel and air are compressed and lit in the combustion chamber.

Continued →

Revision quiz 7.2 (LB page 174) (continued)

1.5 The connecting rod changes the reciprocating movement of the piston into a rotary movement. (5 × 1) (5)

True

2. Describe what happens during each of the following strokes:

2.1 Intake stroke (4)

- The piston moves from TDC towards BDC.
- The intake valve is opened; the exhaust valve is closed.
- Downward piston movement creates a vacuum that draws the air/fuel mixture into the cylinder via the open intake valve.
- Just after the piston has reached BDC, the intake valve is closed.

2.2 Compression stroke (4)

- Both the intake valve and the exhaust valve are closed during this stroke.
- The piston moves from BDC to TDC.
- The petrol mixture is compressed in the relatively small combustion chamber.
- Just before the piston reaches TDC, a high-tension spark is introduced into the combustion chamber by the spark plug, and the petrol mixture is ignited.

3. Choose a term in COLUMN B that best matches a description in COLUMN A. Write down only the question number and the letter of your choice.

COLUMN A	COLUMN B
3.1 Both valves are closed, and the burning air/fuel mixture raises the temperature, causing the gases in the cylinder bore to expand	A cycle
3.2 The process of cutting spiral grooves of equal measurement and shape around circular workpieces	B stroke
3.3 Valve that allows air and fuel to enter the cylinders for compression and ignition to take place	C exhaust valve
3.4 The maximum distance a piston travels between two extreme points when the crankshaft turns 180°	D power stroke
3.5 Ignition takes place during this stroke	E milling
	F threading
	G intake valve
	H compression stroke
	I power stroke
	J crankshaft

(5)

3.1 D 3.2 F 3.3 G 3.4 B 3.5 H

TOTAL: 18

Module 8: Maintenance

Revision quiz 8 (LB page 176)

1. Define the following terms:

1.1 Lubrication

Applying/Using oil or grease to make parts run smoothly

1.2 Friction

The resistance that one surface experiences when moving over another

1.3 Additive

Chemical compounds that improve the performance of the base oil

1.4 Viscosity **(4 × 2) (8)**

The degree to which an oil resists flow, i.e. the thickness of the oil

2. 2.1 List THREE methods used to manually lubricate machines. **(3)**

Force feed; dripping; brush application

2.2 What equipment can be used to lubricate machines? **(3)**

Oil can and grease gun

3. 3.1 What is the difference between *oil* and *grease*? **(4)**

Oil is a liquid lubricant; additives can improve the performance or oil. The viscosity of oil varies.

Grease is a semi-solid lubricant; oil is mixed with soap that has an alkaline base; it is thick/viscous.

3.2 Give TWO examples of where grease would be a better lubricant than oil. **(2)**

In hard-to-reach places/where parts cannot be lubricated often; where lubricant needs to stay in place or stick to a part

4. List THREE types of automatic lubrication systems used in machines. **(3)**

Gravity feed; splash-oil feed; pressure lubrication

5. How often should the level of a vehicle's engine oil be checked? **(2)**

At least once a month or every 1 500 km

Continued →

Revision quiz 8 (LB page 176) (continued)

6. **Explain how you would use a grease gun to lubricate engine components.** (6)

- Clean the grease gun fittings before use by pumping a little bit of grease onto a rag.
- Make sure the grease gun is loaded with the correct grease for the parts.
- Check that the nozzle of the grease gun and the grease nipple fit perfectly.
- Make sure the fittings and hose are properly attached to the grease gun. If the grease gun is fitted with a flexible hose, check it for wear and cracks before use.
- Only use as much grease as specified by the manufacturer.
- Clean the grease gun fitting and body with a dry rag after use.
- Keep grease guns covered when not in use.

7. 7.1 **Why is it important to wear PPE when handling lead-acid batteries?** (3)

Lead-acid batteries are filled with a sulphuric acid and water solution. The acid can burn holes in the skin and clothes and can seriously hurt your eyes.

7.2 **Which items of PPE would you wear when working with a lead-acid battery?** (3)

Always wear acid-resistant safety glasses to protect your eyes. Wear gloves. Wear overalls or an apron to protect your clothes and skin.

8. **Summarise the functions/purposes of lubricants in two columns, as indicated below.**

Oil	Grease
Reduces friction	**Reduces friction**
(6)	(6) (12)

Oil	Grease
Reduces amount of power lost due to friction	Reduces friction
Limits wear on moving parts	Slows moving parts
Seals the piston rings in the cylinder	Keeps parts that cannot often be reached lubricated
Cleans the inside of the engine	Used where oil will not stay in position
Prevents corrosion	Protects/Prevents corrosion
Cools the engine by carrying heat away from moving parts	Lubricates horizontal and vertical shafts
	Acts as sealant to keep out water and/or pollutants

TOTAL: 49

Module 9: Bodyworks

Revision quiz 9 (LB page 178)

1. Explain each of the following terms:

1.1 Bodyworks

All the steps needed to repair a damaged panel, including preparing it for spray-painting

1.2 Panel beating

Involves removing, repairing and/replacing damaged panels as well as spray-painting, chassis alignment and refitting of body parts

1.3 Priming

Pretreating a surface to prepare it for painting by applying a primer to help paint stick to the surface

1.4 Buffing

A polishing process that involves using a loose abrasive on a wheel to create a smooth finish

1.5 Grit **(5 × 2) (10)**

The rating of the abrasive materials on the sandpaper using numbers; the higher the grit number, the finer the abrasive will be

2. State the purpose of each of the following panel-beating tools:

2.1 Hammers **(4)**

Flattening, smoothing and/or polishing and finishing metal by hammering; to raise low spots in metal finishing

2.2 Dollies **(2)**

Supporting the metal from behind when it is shaped with a hammer

2.3 Files **(3)**

Removing bumps, dents and flattening wavy surfaces; for semi-finishing/ finishing body panels

3. Name TWO sanding techniques that are use when preparing panels for spray-painting. **(2)**

Wet sanding and dry sanding

4. Name the putties that are used when preparing panels for spray-painting. **(2)**

Body filler and spot putty

TOTAL: 23

GLOSSARY

A

Abrasive – having a rough surface that will remove a thin layer of another surface

Additives – chemical compounds that improve the performance of the base oil

Alkaline – a base that dissolves in water; chemically opposite to an acid

Alloy – a combination (mixture) of two or more metals and/or non-metals

Antiseptic – solution/ointment that prevents the growth of microorganisms that may cause infections

Arc – a bright electric discharge between two electrodes or, simply put, a spark at the expense of the host

B

Ball joint – a mechanical ball-and-socket joint; the round component moves inside the hollow of the socket

Bearings – components that reduce friction between moving parts, e.g. ball bearings or wheel bearings

Bevelled – having a sloping edge rather than a squared one

Bore – the inner diameter of the cylinder

Boring – process of enlarging a hole that has already been drilled

Branding – the promotion of a particular product or company by means of a distinctive design (logo) or wording (slogan) associated with the particular brand

Brittle – hard but likely to break easily

Burrs – uneven edges that stand out on a metal surface after drilling

C

Circumference – the perimeter or outside of the circle

Compression – reducing the volume of the fuel mixture before ignition

Conductive – a substance that allows electricity (or heat) to pass through it

Conductivity – degree to which a material allows electricity (or heat) to pass through it

Conductors – materials through which electrical current or heat flows easily

Corrosion – process during which metals or other materials are damaged or destroyed slowly by chemical action, e.g. rust

Corrosive – materials that contain acid, chloride or other harmful substances that can burn or damage the skin

Countersunk – shaped to fit into a drilled hole with a larger, sloping rim; the head is level with the surface of the workpiece

CPR – cardiopulmonary (heart-lung) resuscitation

Cross section – a surface/shape exposed by making a straight cut through it, especially at right angles along the vertical or horizontal plane

Crude oil – natural liquid petroleum found underground

D

Diameter – the straight-line distance or measurement from side to side through the centre of a circle

Differential – device that allows a vehicle's driven wheels to rotate at different speeds when going around corners

Dimensioning – the process of specifying the measurements of objects using lines, numbers, symbols (arrowheads) and notes

Dress – to return the grinding wheel to its original round shape and sharpness by removing stuck bits of material and dull grain to reveal the fresh grain underneath it

Ductile – able to be drawn out into a thin wire

E

Electrochemically – process in which electricity is produced by a chemical reaction

Electrode – a conductor through which electricity enters or leaves an object

Electrolyte – a solution that conducts electricity

Elevate – to raise or lift the injured limb to a higher position than the heart

Entrepreneur – a person who sets up a business (or businesses), taking on financial risks in the hope of making a profit

Evacuation – the act of removing people from a place of danger to a safer place

F

Facing – removing material from the end and/or shoulder of a workpiece

Fatigue – extreme tiredness because of mental or physical exertion

Final drive – an assembly of gears in the back axle of rear-wheel drive vehicles and in the front axle of front-wheel drive vehicles; the last set of gears in the drivetrain

Forged – made by heating (in a furnace) and hammering

Franchise – the right or license granted by a company to individuals allowing them to market and trade under the company's name, for example as McDonald's or Pick n Pay

Friction – resistance that one surface or object meets when moving over another

Fungi – group of organisms that can cause infections

Furnace – a large, enclosed structure in which material can be heated to extremely high temperatures

G

Galvanise – to coat with a layer of zinc to prevent rust

Gasket – a shaped sheet or ring of rubber or other material used to seal the space between two surfaces/components in an engine

Gearbox – a set of gears with its casing (cover), as illustrated in Figure 8.2

Gudgeon pin – hollow, cylindrical object that fits through holes in the piston and the small-end bearing of a connecting rod

H

Hazardous – risky or dangerous

Helical – having the shape of a spiral or helix

Hexagonal – having six straight sides

Hub – central part of a component

I

I-beam – very strong beam used to support structures

Ignition – the process of making the fuel start to burn (to ignite means to cause to catch fire)

Immunodeficiency – not being able to produce a strong immune response because the body does not have enough antibodies, immune cells or specific white blood cells

Infectious – likely to be transmitted to people or animals through the environment

Internal combustion engine – a heat engine that creates its energy by the burning fuel combined with air inside the combustion chamber

K

Knurling – cutting ridges around the edge of a workpiece

L

Lathe – a machining tool that is used mainly for shaping metal; works by rotating the workpiece around a stationary cutting tool

Logo – a symbol or other small design used by an organisation to identify its products

Lubricant – a substance, such as oil or grease, which is applied between surfaces to reduce friction or wear

Lubricated – oiled or greased to make it run smoothly

M

Magmatic – hot or semi-hot fluid found below or within the Earth's crust

Main shaft – shaft that receives its power directly from the engine

Malleable – able to be hammered or pressed into shape without breaking or cracking

Mandatory – required by law; compulsory

Marketing – the action or business of promoting and selling products or services, including market research and advertising

Micrometer – a precision instrument used to measure thickness and diameter

Mushrooming – when a tool is repeatedly struck with a hammer, it deforms, spreading out into a mushroom shape

O

Oblique drawing – a simple drawing used to produce 2D images of 3D objects

P

Pan head – head of a rivet, bolt or screw shaped like an upside-down, flat-bottomed pan

Pandemic – an infectious disease that has spread across a large region, such as multiple continents or worldwide, affecting a large number of people

Parasite – organism that lives in or on another organism (called the host); takes what it needs

Pinholes – small craters that form in an applied product (e.g. the putty) during the drying process

Prohibition – forbidding specific actions or behaviour

Pulley – wheel or drum fixed on a shaft and turned by a belt

R

Radiation – transfer of energy (such as heat) in the form of waves or as moving particles, e.g. sunlight, microwaves, X-rays and lasers

Radiator – an engine-cooling device that consists of thin tubes in which circulating water is cooled by the surrounding air

Radius – the straight-line distance or measurement from the centre to the circumference of the circle

Reciprocating – a repetitive up-and-down or back-and-forth linear motion of a component in a mechanism such as an engine or a pump

Resin – sticky substance used as basis in plastics, adhesives, varnishes and other products

Rivet – a metal pin that has a head at one end; it is inserted through aligned holes in the workpieces to be joined and then hammered on the plain end

S

Scalable – able to change in size or scale

Sediment – particles that are carried by water, deposited on land or on the seabed and in time combine to form rocks

Serrated – having a jagged edge

Shaft – long, narrow part

Shank – long, narrow part connecting two parts, in this case the two heads of a rivet

Shock – a critical condition brought on by the sudden drop in blood pressure, caused by events such as loss of blood, severe burns, etc.

Siezed – become jammed/unable to move

Slogan – a short, striking, memorable phrase used in advertising

Solder – alloy (usually with a lead, tin, brass or silver base) with a low melting point used to join metals

Splint – any rigid material, such as a folded newspaper or a piece of wood, used to support a broken bone and keep it from moving; can also be used for strains and sprains

Start-up – a newly established business

Sterile – free from bacteria that may cause infection; totally clean and germ-free

Synthetic – made by chemical processes to imitate a natural product

T

Target market – a group of potential consumers to whom a company wants to sell its product, service or ideas

Thread – continuous helical ridge formed on the inside (nut) or outside (bolt and screw)

Threading – process of cutting spiral grooves (screw threads) of equal measurement or shape around a cylinder

Three-dimensional (3D) – having or appearing to have length, width, and depth

Tie-rod end – ball-and-socket parts of the steering linkage

Tourniquet – a device (such as a band of rubber or a cord) that is tightened by twisting; used to stop the flow of blood by compressing the blood vessels

Toxic – poisonous; extremely harmful; can even be deadly

Trauma – the emotional response to a terrible event such as an accident, a terrifying incident or a natural disaster

Triangular bandage – a bandage or large, triangular cloth that can be used as an arm sling

Turning – shaping a workpiece by cutting away unwanted material

Two-dimensional (2D) – having or appearing to have length and width but no depth

V

Valve – a device for controlling the passage of fluid or air through a pipe; allows movement in one direction only

W

Washer – a small, flat metal, rubber or plastic ring fixed between two joining surfaces

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